Economic Analysis of Agro-Food Value Chains and Effect on Household Food Security and Poverty Alleviation: The Case of Wheat, Dairy and Beef in North West Mt. Kenya

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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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"...s*mall steps that you take every day so when you look back down the road it all adds up and you know you have covered some distance."* – Katie Kacvinsky

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ABSTRACT

Agricultural activities have become increasingly organized along value chains that constitute actors and activities that cause the flow of food from production to consumption. This change has been necessitated by among other things, globalization, the need to efficiently meet rising and changing consumer demand and preferences, emergence of niche markets and the need to meet quality standards. However, major concerns still persist as to the performance of agro-food value chains, particularly in developing economies. Evidence has shown that a significant share of the population involved in agro-food value chains remain food insecure and poor. Profound changes of our current agro-food value chains are needed if they are to meet current and future demands.

This study sought to assess the contribution of three agro-food value chains to participating actors by establishing the value added and its distribution among the actors. The study analysed the structure of the agro-food value chains in terms of economic activities, actors, product flows and governance. Furthermore, constraints to efficiency and growth were assessed at every level of the agro-food value chains. Moreover, the study sought to examine the status and determinants of household food security and poverty of smallholder producers in the agro-food value chains. Therefore, the main objective of the study was not only to analyze the structure and nature of the agro-food value chains and the economic returns derived by participants of the value chains but also their contribution to household welfare in terms of food security and poverty alleviation.

To achieve the objectives, three agro-food value chains of wheat, dairy and beef in North West Mt. Kenya were selected for study. Five value chain activities of production, trade, processing, distribution and retailing for each of the agro-food value chain were considered. Using multi-stage stratified random sampling, a sample of 312 respondents including producers, traders, processors, distributors, retailers and key informants were selected for the study. The study used value chain analysis to examine the structure, value addition, governance and constraints in the agro-food value chains. The Household Food Insecurity Access Scale (HFIAS) and Foster-Greer-Thorbecke Poverty (FGT) Indices were used to examine the food security and poverty status of smallholder producer households. Multinomial logit, poisson and logit regression models were utilized to assess the determinants of food security and poverty among smallholder producer households.

Results showed that the agro-food value chains constitute five main economic activities of input supply and production, trade and transportation, processing, wholesale and retail that are interlinked; and through which wheat, milk and beef products flow and are transformed for final consumption. The actors involved in these activities are input suppliers, farmers, traders and brokers, processors, distributors, wholesalers and retailers. Results also revealed that some actors add more value than others. Actors such as large-scale farmers and ranchers, processors and traders obtain higher gross margins compared to other actors. The governance structure of the agro-food value chains is heavily influenced by the marketing structure of the value chains. Results revealed weak vertical linkages in the wheat and beef value chains compared to the dairy value chain and strong horizontal linkages at the production level of the agro-food value chains. Moreover, there exists multiple power centers within the value chains with large-scale farmers and ranchers, traders and processors being dominant in the agro-food value chains.

Constraints to value chain efficiency and growth exist at every stage of the agro-food value chains. However, smallholder producers and pastoralists seemed to face multiple constraints compared to other actors in the value chains. Furthermore, results revealed that 61% of the smallholder producer households were either severely, mildly or moderately food insecure. Higher incidences of food insecurity and poverty rates were found in households in the beef value chain. Income and income-related variables, household size, membership in farmers' groups, transport assets, household energy, number of cattle and access to extension services were significant in determining household food security and poverty.

Strategies focused on value chain upgrading should consider constraints facing each actor along the value chain to achieve improved coordination and holistic growth of the value chains. However, innovations and interventions should target actors where the greatest impact on food security and poverty reduction can be achieved. Policies that are geared toward enhancing smallholder farmers' incomes, increasing productivity, building strong farmer groups have the possibility of getting smallholders out of persistent poverty and recurrent food insecurity. Moreover, such intervention strategies should be differentiated according to the food security and poverty status of different producers and an understanding of the aspects that contribute most to their vulnerability to food insecurity and poverty.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

CHAPTER 1. INTRODUCTION

1.1 Background to the Study Problem

Agriculture remains one of the most important sectors in many global economies and particularly those of developing countries. It is a major contributor to food security, employment (directly or indirectly) and provides the means of livelihood for the majority of the rural population in developing countries. Agriculture employs one out of three workers, globally, and significantly provides to the livelihoods of about 3 billion people who live in the rural areas of low and middle income developing countries (FAO, 2020b). In Africa, the sector, contributes around 16% to Gross Domestic Product (GDP) higher than the global average of 4% (FAO, 2020b). In Kenya, agriculture is very key to the economy, contributing about 34% to the GDP and employing over 40% of the total population and majority (70%) of the rural population (GOK, 2019; KNBS, 2020).

Agricultural activities have become increasingly organized along value chains. A value chain constitutes actors and activities that cause the flow of food from production to consumption. It comprises all the activities that together get a product from the initial stage of conception, through different levels of production (and physical transformation), delivery to end consumers for utilization, and final disposal (Kaplinsky & Morris, 2001). Increased organization along agro-food value chains, has been necessitated by scarcity of agricultural raw materials, globalization, the need to efficiently meet rising consumer demand as well as emergence and expansion of niche markets (Donovan et al., 2015). Consequently, agro-food value chains have succeeded in opening up markets, increasing production, raising quality standards, providing employment and improving food security (Dolan & Humphrey, 2000; Kumar et al., 2011).

However, major concerns still persist as to the performance of agro-food value chains, particularly in developing economies. A large percentage of the population in these developing countries, most of whom live in the rural areas and are engaged in agro-food value chains either as producers or wage workers, remain food insecure and poor (FAO, 2000; WFP, 2016). In 2019, 22% of the population in sub-Saharan Africa (SSA) was considered undernourished with East Africa having a higher prevalence of 27% (FAO et al., 2020). In the same period, Kenya's prevalence of undernourishment stood at 23% of the total population (FAO et al., 2020). In 2017, Food and Agriculture Organization of the United Nations, adopted a new indicator of monitoring

hunger, the prevalence of severe food insecurity. Approximately 19% of Kenya's total population is considered severely food insecure (FAO et al., 2019). While the rate of food insecurity remains at high levels so is the rate of poverty. The 2015/16 Kenya integrated Household Budget survey (KiHBs) estimated that at least 36% of the population lives in poverty with the rural areas having a higher poverty incidence (40%) compared to urban areas (28%) (KNBS, 2018a).

However, although food insecurity and poverty persist, some marginal gains have also been achieved and more still needs to be done so as to sustain the progress. In any case, there are increasing concerns that gains achieved in reducing food insecurity and poverty over the past years could be eroded by the changing context under which agro-food value chains are operating (FAO et al., 2018). Climate change, population growth and urbanization are major concerns that are exerting insurmountable pressure on agro-food value chains (FAO et al., 2017; Schaffnit-Chattenjee, 2014). The effect of climate change on agro-food value chains is particularly worrying for Africa where agricultural systems are more vulnerable to climate variations and heavily dependent on rainfall. By 2030, the global population is projected to reach 8.5 billion and increase further to 10 billion by 2050 with more than half of this increase projected to take place in Africa (UN, 2017). This implies that agricultural output would need to be twice as much by 2050 to meet increased food demand (FAO et al., 2017).

Furthermore, it is expected that urban areas in the developing countries will have the highest share of the population growth, with almost 70% of the population living in metropolises by 2050 (UNDP, 2017). With Africa being the second fastest urbanizing continent, the possible implications of a growing urban population demand attention and foresight planning. Urbanization has been accompanied by a transition in dietary patterns from basic staples to more processed food, and animal-based products like meat and milk. At the same time, urbanization is causing a shift of labour from the rural to urban regions, leaving an ageing farming population (FAO et al., 2017). In this context of changing climate, a growing population, urbanization and changing dietary preferences, profound changes of our current agro-food value chains are not only necessary but a must if we are to attain the important goals of ending hunger and poverty as stipulated in the sustainable development goals SDG 2 and SDG 1 respectively.

It is largely acknowledged that agro-food value chains have great potential to provide the best option for developing countries in reducing hunger and poverty, especially on a larger scale, through employment creation, use of local resources and provision of food to the households involved (FAO, 2006). It has been argued that some of the challenges confronting agro-food value chains in Africa are regional in nature and thus scientific efforts to address them should be regional in design (De Pinto, & Ulimwengu, 2017). This study responds to this complex and huge challenge by attempting to bring out the role of agro-food value chains on food security and poverty using three national agro-food value chains of wheat, beef and dairy. Wheat, beef and dairy value chains are important for Kenya's economy. For example, wheat is the second most important staple after maize while the beef and dairy value chains constitute the major part of the livestock sector (Kiriti Nganga & Mugo, 2018).

These agro-food value chains have a significant role in the livelihoods of many smallholder farmers in North West Mt. Kenya. Beef and dairy value chains are the leading livestock economic activities in the region with beef being the top most single contributor to the economy of North West Mt. Kenya (GOK, 2018a). They therefore, have the potential to contribute to improved food security and reduction of poverty. Against this background, the objective of this study was to interrogate the role, if any, of agro-food value chains on food security and poverty using three national agro-food value chains, and by so doing gain an in-depth comprehension of the structure and dynamics of the three agro-food value chains. At the same time, the study endeavored to understand the correlation between the agro-food value chains, food security and poverty.

1.2 Statement to the Research Problem

Agro-food value chains continue to be under increasing pressure to produce more food for an increasing population in the backdrop of a rapidly changing climate, increasing urbanization, a growing middle class and dramatically changing consumption patterns (FAO, 2012; Kumar et al., 2011; Schaffnit-Chattenjee, 2014; UN, 2014). Urbanization and a growing middle class with increased incomes are not only driving demand for food up but also contributing to change in consumer preferences from basic staples to more processed foods, meat and dairy products (Godfray et al., 2010; Kumar et al., 2011). Invariably, the ability of agro-food value chains to supply these food products is constrained by several factors related to production, processing and

distribution. As such, making them incapable of meeting the ever-rising demand for these food products.

In developing countries, the contribution of agro-food value chains to food security and reduction of poverty is minimal due to the current arrangement of value chains. Most agro-food value chains are disaggregated, with minimal vertical linkages and several inefficiencies at every stage (Chemonics International, 2010; Gitau et al., 2010; Monroy et al., 2013). Adapting value chains to respond to the current demands and to effectively contribute to food security and poverty reduction requires transformations at all levels of the value chain. These transformations can only be based on adequate knowledge and information from scientific research. This study endeavors to contribute to the developing body of literature that attempts to address this complex challenge of achieving food security and reducing poverty through sustainable agro-food value chains.

Although research on agro-food value chains has gained ground in Kenya, there is a general tendency to focus on the general output or productivity of value chains. This has the tendency to hide the welfare status of value chain participants. Whereas the overarching goal of agro-food value chains is to provide food, there has been little attempt to understand and document the contribution of value chain activities on food security and poverty alleviation. Value chain research has largely focused on the structural components of value chain analysis with the traditional value chain focus on identifying constraints, inefficiencies and opportunities for improvement (Alarcon et al., 2017; Behnke & Muthami, 2011; Chemonics International, 2010; Hassan et al., 1993); and establishing value chain competitiveness (Gamba, 2006; Gitau et al., 2010; Makokha & Witwer, 2013).

Other studies have attempted to link value chains and gender (Farnworth et al., 2015; Katothya, 2017; MacOpiyo, 2014); environmental concerns (Abong'o et al., 2014; Macharia et al., 2009; Ibrahim Macharia, 2015; Wainwright et al., 2014); and climate change and resilience (Agesa et al., 2019; Carabine & Simonet, 2018). However, less is known about the contribution of value chains on food security and poverty, particularly for the participating households. In fact, Bolwig et al. (2008) notes that, a few value chain studies have succeeded in clearly detailing the effect of value chain activities on poverty. Moreover, studies on poverty and food security are often

dominated by surveys that collect information in a decontextualized manner, and at a level of high generality (Bolwig et. al., 2008). This does not allow for links to be made between a person's level of poverty, food insecurity and their economic activity creating a research gap as to how value chains contribute to household welfare.

This study fills this gap by integrating value chain analysis with household food security and poverty, with specific reference to the wheat, dairy and beef value chains in North West Mt. Kenya. An understanding of the magnitude, nature and determining factors of food security and poverty in relation to household economic activities is important to effectively help to reduce food insecurity and poverty levels. The main objective of the study was, therefore, to analyze not only the structure and nature of the agro-food value chains and the economic returns derived by participants of the value chains but also their contribution to household welfare in relation to food security and reduction of poverty. The ultimate desired outcome was to identify where innovations and interventions can have the greatest impact on food security and poverty reduction.

1.3 Research Questions

Based on the research problem, the study set to answer the following questions:

1. What are the activities, actors and product flow in the wheat, dairy and beef value chains in North West Mt. Kenya?

2. How much value is added by each actor and how is it distributed among the actors in the wheat, dairy and beef value chains in North West Mt. Kenya?

3. What is the governance structure and constraints in the wheat, dairy and beef value chains in North West Mt. Kenya?

4. What is the status and determinants of household food security and poverty in the wheat, dairy and beef value chains in North West Mt. Kenya?

1.4 Research Objectives

The following objectives were the focus of this study:

1. To examine the activities, actors and product flow in the wheat, dairy and beef value chains in North West Mt. Kenya.

2. To determine value added and its distribution among actors in the wheat, dairy and beef value chains in North West Mt. Kenya.

3. To analyze the governance structure and constraints in the wheat, dairy and beef value chains in North West Mt. Kenya.

4. To examine the status and determinants of household food security and poverty in the wheat, dairy and beef value chains in North West Mt. Kenya.

1.5 Research Hypothesis

This study set out to integrate value chain analysis with household food security and poverty by not only analyzing the value chain's structure, value added and constraints (objectives 1, 2 and 3) but also their contribution to household food security and poverty (objective 4). For this reason, the study focused on a null hypothesis for objective four to gain an in-depth understanding of household food security and poverty. Moreover, through this extended analysis, the study anticipated to make a novice contribution in establishing the link between value chains, household food security and poverty.

Thus, based on the fourth objective, the study tested the following two main null hypothesis:

1. There is no significant relationship between household demographic, social and economic variables and household food security status in the wheat, dairy and beef value chains.
2. There is no significant relationship between household demographic, social and economic variables and household poverty status in the wheat, dairy and beef value chains.

The null hypotheses can be represented as: $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \ldots \beta_k = 0$

Where $\beta_1 \ldots \beta_k$ are the coefficient estimators.

Thus, the alternative hypotheses is: $H_0 = H_1$ is not true.

1.6 Justification of the Study

Agro-food value chains in Kenya have a very strategic role in attaining food security and poverty reduction through provision of food, employment and as a means of livelihood, particularly for the rural population. Food security and poverty are important development issues embodied in Kenya Vision 2030, the government's Big Four Agenda, as well as the Agricultural Sector Transformation and Growth Strategy (ASTGS) blueprints. These agendas are also aligned to the global Sustainable Developments Goals (SDGs). This study is set against the background of Kenya's Vision 2030 agenda of eliminating poverty; ASTGS pillars of raising smallholder and pastoralist's incomes, increasing agricultural output and value addition; and SDGs 1 and 2 of eradicating poverty and hunger.

Realizing food security and poverty reduction requires, among others, a clearer understanding of agro-food value chains. A value chain analysis approach provides the capacity to breakdown economic activities in the value chain to their monetary value, thereby enabling links to be made between each value chain activity and earnings achieved. Subsequently, an examination of the contribution of earnings on the socio-economic status of households can be deduced and links to food security and poverty reduction established. This type of analysis enabled the desired breakdown and links between value chain activities and benefits in the wheat, dairy and beef value chains in North West Mt. Kenya.

The three agro-food value chains were chosen due to their spatial, social and economic significance, as well as their ability to produce food for the national and regional markets. Furthermore, their co-existence within the same geographical space allowed for investigations into their interactions. Wheat, dairy and beef farming are important economic activities and means of livelihood for many households in North West Mt. Kenya. Additionally, growing urbanization is currently escalating demand for wheat, beef and dairy products which have become important household expenditure items for the urban population in Kenya. Dairy is the leading urban household food expenditure item, followed by wheat and beef (Muyanga et al., 2005).

Given their economic importance and strong urban demand, the three agro-food value chains present a possible growth potential for farmers through connections to a larger urban market and

better prices. Moreover, innovating ways of improving them would have a direct impact on food security and poverty reduction due to the multiplier effect emanating from upgraded economic activities. Such innovations are best guided by scientific research that yields evidence-based knowledge that can be used for formulation of policy options geared towards improving value chains' efficiency with specific focus on food security and poverty reduction.

1.7 Scope of the Study

This study was part of a larger Research for Development (R4D) Food Systems Project that was implemented in Kenya and Bolivia. The project had four broad objectives: 1) to determine which laws and treaties regulate food systems, including policy and legal options contributing to a supporting environment for food sustainability; 2) to determine how formal and informal institutions transform and shape food-system-specific institutions; 3) to assess how food system activities influence the main outcomes of different food systems in relation to food security, reduction of poverty and inequality; and 4) to determine the state of food systems environmental integrity. This study is framed within the third project objective and focuses on wheat, beef and dairy value chain activities in North West Mt. Kenya region as case studies. Therefore, the scope of this study and the choice of the study area were largely informed by the dictates of the larger project.

As stated earlier, the three agro-food value chains were selected because of their importance both spatially and economically; their co-existence within the same geographical space; and their ability to supply food nationally and regionally. This study considered the following economic activities in the value chain: 1) production; 2) processing and packaging; 3) distribution; 4) retailing; and 5) consumption (for smallholder farmers and pastoralists), including all the actors involved in these activities. By doing so, the study achieved a complete analysis of the value chain without excluding any actor or creating a disconnect in the systematic flow of the chain. However, collection of data and analysis of consumption was limited to smallholder farmers and pastoralists' households at the production level.

Value chain actors can participate in multiple value chain activities, say production and distribution. In such cases, the study considered the primary occupation of the actor. The study placed same level actors in different categories. However, some categories of actors (medium

wheat farmers) in the value chains were not considered for the study because they were too few and difficult to trace during data collection. Smallholder mixed farmers (highland farmers) were not considered for a detailed analysis on costs, revenues and profits, as part of beef producers, because their contribution to the value chain is localized and thus did not meet the threshold of contributing to the national and regional value chains.

As for commodity flows, the study considered the primary product in the value chains. As such, sub-value chains and by-product value chains were not included. The wheat value chain was considered from grain to flour (wheat-flour value chain), dairy value chain as liquid milk only, while beef value chain considered cow's meat. The geographical scope of the study (North West Mt. Kenya) was the focal point. However, the study followed the flow of products beyond the boundaries of the study area. This was in the case of processing which occurred beyond the study area boundaries. Calculation of value added was restricted to gross margin analysis and excluded other metrics such as profit, net margin, Return on Assets (ROA) or Return on Sales (ROS), which would have otherwise necessitated collection of more data and extended analysis. Gross margins were deemed sufficient to provide a relatively good picture of the benefits each actor obtained from participating in the value chain.

1.8 Limitations of the Study

The study made use of recall data, particularly for the smallholder farmers and traders, most of who are informal and do not keep records of their economic activities. Use of recall data may create recall bias as respondents may fail to accurately remember details. To minimize recall bias the study reduced recall periods for specific data such as food security assessment from one year to three months. The study also broke down study components to specific items that would systematically aid in data collection. Consequently, field interviews took more time than expected. To the extent possible, data was triangulated by key informants comprising government officials (Agricultural and Extension Officers, Veterinary Officers and Chiefs), community leaders and elders. Data on constituent costs and revenue was difficult to obtain for some actors, particularly at the processing, wholesale and retail levels of the value chains. In such cases, data was collected in terms of mark ups and used to estimate the costs and gross margins of the particular actors.

Analysis of food security and poverty status is best undertaken at household or individual level. Given the wide scope of value chain actors, it became difficult to undertake such an analysis for each and every actor. It was equally challenging to identify households for such an analysis at some levels of the value chain, for example, retail and processing. Consequently, the study made this analysis at the production level only. After all, the intention of the study was to conduct this type of in-depth analysis on value chain actors that least benefitted from the value chain - smallholder farmers and pastoralists - as revealed by value chain analysis.

It proved difficult to obtain a considerable sample on the medium-scale wheat and dairy farmers because they were few in the study area. However, those that were located were grouped in either small or large-scale categories of farmers based on homogeneity of production, hence avoiding loss of information on this group of actors. Non-availability of an official inventory for the target sub-population in the study area (for example number of producers, distributors and retailers) was a challenge for the study. However, the study made an attempt to establish the sampling frames through key informant interviews, study area maps and a reconnaissance visit. Despite these data limitations, the study analysis allowed for an unbiased evaluation of the value chains and provided scientific evidence that can inform design of strategies and policy for improving the agro-food value chains.

1.9 Operational Definitions and Concepts

Agro-food value chains: Supply chains that involve movement of farming goods from production level through the various processes of transformation to consumption and final disposal.

Agrovet: Refers to a supply store where famers can purchase agricultural and veterinary products.

Constraint: Something that imposes a limitation. For example, drought and insufficient rainfall limit farmer's productivity.

Governance: The processes of business interaction (linkages and relationships) and decision-making, and power relations among the different actors that shape a value chain.

Gross margin: The difference between revenue and cost of intermediate inputs without fixed capital consumed.

Horizontal integration: A business strategy where same level value chain actors exhibit high levels of coordination.

Linkages: Business relationships that are existent among actors in the value chain.

Revenue: Income received from sale of a product, in this case, wheat, milk and beef products.

Value added: Benefit that is created and captured by value chain actors when a product passes through the value chain activities. It is basically the difference between total revenue of a product and the costs used for production. In this study, it is equivalent to gross margin.

Value chain: All activities that are essential in bringing a product or service from the initial stage of conception, through the different stages of production, processing, distribution, delivery to consumers, and eventual disposal after use.

Value chain activities: The economic activities which take place in specific links in the chain and include supply of inputs, production, processing and packaging, distribution, retail and consumption.

Value chain actors: Persons and institutions involved in value chain activities.

Vertical integration: A strategy where actors along the value chain exhibit high levels of coordination.

1.10 Summary of Chapters

This study is organized around nine chapters. Chapter two presents the review of relevant literature, theories underpinning the study and the conceptual framework. Chapter three describes the geographical, physical and demographic characteristics of the study area. Chapter four lays out the research methodology by discussing the sources and methods of data collection, the sampling strategy and data analysis. This is followed by four separate but related result chapters, each discussing the study objectives. Chapter five presents the activities, actors and product flows in the agro-food value chains. Chapter six analyses value addition and its distribution in the agro-food value chains. Chapter seven is on governance structure and constraints in the value chains. Chapter eight analyses household food security and poverty status in the three agro-food value chains. The last chapter gives a summary of the research findings, conclusion and recommendations for policy and future research.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

This chapter begins by contextualizing agro-food value chains within agriculture. Agro-food value chains are defined and described to give a clear picture of their meaning. This is followed by an overview of the wheat, dairy and beef agro-food value chains, globally and in Kenya. A review of the value chain actors, activities and flow of products in the three agro-food value chains is then undertaken, while highlighting previous research studies that have been carried out on the same. Additionally, the concept of value addition in value chains is explained and empirical studies on the same reviewed. This leads to a review of the issues of value chain governance and identification of constraints and opportunities. Empirical studies on value chain governance and constraints are reviewed for identification of existing gaps. The link and relationship between agro-food value chains, food security and poverty is equally reviewed. The chapter also looks at the existing measures and determinants of food security and poverty. After that, gaps in past empirical studies on the three agro-food value chains are highlighted. Finally, the theoretical frameworks underpinning the study are explained and a conceptual framework elaborated.

2.2 Agriculture and Agro-food Value Chains

The importance and contribution of agriculture value chains to economic growth, particularly for developing countries, cannot be over emphasized. Research continues to reiterate the positive relationship between economic growth and agriculture in these countries. This is more so because agriculture is the predominant sector as regards to contribution to GDP, rural employment, incomes and livelihoods; contributing about 20% of GDP in Africa and involving close to 70% of the population (AGRA, 2017; FAO, 2020b).

Just like in other African countries, agriculture is an important sector to the economy of Kenya. The sector contributes 33% to the GDP, provides employment to 40% of the total population and is the leading source of employment for the rural population (GOK, 2019). It has been argued that economic development in Kenya is synonymous with progress in the agricultural sector, due to its importance. It is, therefore, critical to sustain agricultural growth to improve the livelihoods of the people. Kenya's Vision 2030 recognizes agriculture as one of the key sectors to contribute to 10% national economic growth. However, the sector has generally recorded unstable and

mixed performance in the past years due to various challenges, key among them effects of extreme weather conditions as a result of over reliance on rain fed agriculture. For example, in the year 2017, the agriculture sector recorded a modest 1.6% growth compared to 5% in 2016 due to the impacts of drought; in 2019, growth declined to 3.6% from 6.0% recorded in 2018 (KNBS, 2018b, 2020).

The process of getting food from the producers to consumers is increasingly transforming in many ways. Food is now moved many miles far away from producing areas (Bokelmann & Adamseged, 2016). Consequently, more actors are being involved in more activities that are now taking place between production and consumption in different geographical locations (Esnouf et al., 2013). This is more evident with current global and regional value chains where, for example, in the vegetable value chain of Kenya, production takes place in Kenya while consumers are largely located in Europe. Food products are increasingly transforming and are no longer reaching consumers in raw form; from simple transformations of cleaning, grading, chilling and packaging to complete processing. Such changes are not only happening at a global level but at the local level as well. Agro-food value chains, therefore, can be defined as all the activities necessary in bringing food products from inception, through various stages of production, processing, delivery to consumers, and ultimate discarding after use (Kaplinsky & Morris, 2001).

Agro-food value chains exist in a dynamic and complex environment that inevitably cause changes in their structure, relationships, market positioning and productivity (Webber & Labaste, 2009). A number of factors drive these changes resulting in the agro-food value chains we have today. Key among the drivers of change in agro-food value chains have been globalization, climate change, rise in population, urbanization, an expanding middle class with higher incomes and change in consumer dietary preferences (Donovan et al., 2015; FAO, 2017; Zurek et al., 2020).

Globalization has facilitated an increase in international trade of agricultural products and globalization of markets (Donovan et al., 2015; Esnouf et al., 2013; World Bank, 2020b). As a result, agro-food value chains are now longer with increased food miles where different value chain participants are located in different parts of the world. Such is the case for the vegetable

value chain in Kenya. Globalization of value chains has been argued to provide better markets and improved incomes, knowledge and technology transfer and better welfare, particularly for the smallholder producers located in developing countries (Minten et al., 2009; NBT, 2013). On the other hand, it is said to expose farmers and consumers alike to price volatility (Gitau et al., 2010; Hobson, 2006).

Climate change has been a major concern affecting productivity of agro-food value chains. The International Panel on Climate Change (IPCC) has in the past years warned of the consequences of unchecked rise in global temperatures. It has been hypothesized that the rise in global temperatures is likely to cause extremities in weather conditions, for example, droughts and erratic weather patterns (Esnouf et al., 2013; Foresight, 2011; IPCC, 2018). This will have negative consequences on production of crops and livestock keeping with the likelihood of reduced productivity and loss of livestock. The effects of change in climate are anticipated to be more severe in developing countries which are heavily dependent on agriculture (FAO, 2017). Unfavorable weather conditions that resulted to widespread drought in late 2016 and suppressed rains in 2017, for example, contributed to depressed growth of the agricultural sector in Kenya, causing scarcity of key crops (maize, vegetables) and affecting livestock production (KNBS, 2018b).

It is projected that by 2050, at least 2.4 billion people will have been added globally, more than half (54%) of whom will be added in Africa (FAO, 2017; UN, 2019). In the past few years, Kenya has maintained an average growth rate of 2.7% in population (KNBS, 2018b). This steady rise in population is exerting continuous pressure on agro-food value chains to produce more food. Trends in population growth indicate that the population is increasingly becoming urbanized with most of the growth occurring in Asia and Africa (UN, 2018). In addition to increased demand for food, urbanization has been associated with higher incomes and change in diets which have had profound changes in agro-food value chains. The urban population is driving a change of diets away from basic staples (grains) to more processed foods, meat and dairy products while at the same time requiring foods that meet higher quality and safety standards (FAO, 2017; Schaffnit-Chattenjee, 2014; Zurek et al., 2020). However, information on the extent to which this change has happened in African countries is limited. As Foresight (2011) states, there are still major uncertainties as to the degree to which diets in African countries will

conform to those of developed countries. However, it is certain, from the findings of previous studies (Rakotoarisoa et al., 2008; Wanyoike et al., 2018) that urban consumers are driving change in diets and consequently on agro-food value chains.

2.2.1 Global wheat production, supply and utilization

Wheat is a significant crop worldwide; it provides about 19% of food calories, covers the largest share of global crop area and has the largest share (31%) of the total cereals traded (Nyangito et al., 2002; OECD & FAO, 2020). Global wheat production and demand has been increasing over time. Annual global wheat production was estimated at 762 million tonnes as at 2019 (FAO, 2020a). The major producers of wheat, globally, as at 2019, are the European Union, China, India, Russia federation, USA and Canada, in that order (FAO, 2021a). However, FAO (2021) projected that China would be the leading producer in the year 2020. The major ten wheat producing countries account for 70% of global wheat production (Gitau et al., 2010), while the global wheat yields average 3.5 tonnes per hectare (Grote et al., 2021). However, there are significant regional disparities in yields. In East Asia and the European Union wheat yields average between 4.3 tonnes per hectare and 5.3 tonnes per hectare; in South Asia 3 tonnes per hectare and in Africa 2.6 tonnes per hectare (Grote et al., 2021). Wheat production is projected to increase the most in the European Union due to high yields and competitive prices (OECD & FAO, 2020).

Wheat is becoming an important staple crop in sub-Saharan Africa (SSA). Its increased importance has been attributed to a rising population with increased urbanization and change in food preferences (Macauley, 2015). Africa produced about 79 million tonnes of wheat in 2019 (FAO, 2021a). SSA produces about 8 million tonnes of wheat, with Ethiopia, South Africa, Sudan, Kenya, Tanzania, Nigeria, Zimbabwe and Zambia being the most notable wheat producing countries in the region (FAO, 2021a; Tadesse et al., 2019). In SSA, Ethiopia has the largest wheat production area (1.7 million ha) and the highest average annual production of 3.6 million metric tonnes (Anteneh & Asrat, 2020; Tadesse et al., 2019). South Africa is second at 1.8 metric tonnes per year (FAO, 2021a). There are two wheat production systems in SSA: rain-fed and irrigated. The rain-fed production system is dominant in Eastern Africa and South Africa while the irrigated systems are common in Southern Africa, Western Africa and Sudan (Tadesse et al., 2019). Wheat yield in SSA have remained low (about 2 tonnes per hectare). This has been

attributed to factors such as abiotic and biotic stresses, high production costs, weak extension systems and policies, growing rural-urban migration and slow adoption of new technologies (Grote et al., 2021; Tadesse et al., 2019).

United States of America is the leading exporter of wheat (Nyangito et al., 2002). In Africa, Egypt and Mauritius are main exporters of milled wheat to the COMESA region (Gitau et al., 2010). Major global wheat importers are developing countries and include Egypt, Indonesia, Algeria, Brazil, and the Philippines (OECD & FAO, 2020). Combined, they import about a third of the world global imports. Brazil is the world's leading importer of wheat (Nyangito et al., 2002). In Africa, North African countries are the largest importers wheat, with Egypt being the leading importer (Macauley, 2015). In SSA, Nigeria, Ethiopia and Sudan are the largest wheat importers (Tadesse et al., 2019). The largest share (70%) of demanded wheat is utilized for food, 18% for feed and the balance (12%) for other uses (FAO, 2020a; Nyangito et al., 2002). Global consumption of wheat stands at about 67 kilograms per capita. North African countries have the highest (200 kilograms) per capita consumption of wheat (Tadesse et al., 2019). In fact, Egypt has the highest consumption of wheat in the world at 180 kilograms per capita (Gitau et al., 2010). However, SSA has a very low average per capita consumption of wheat at 30 kilograms (Tadesse et al., 2019).

2.2.2 Wheat value chain in Kenya

The second most essential staple grain in Kenya is wheat, making it significant for food security (FAO, 2015; Monroy et al., 2013). The wheat industry generates more than KShs 20 billion and supports livelihoods of nearly 11% of the national population (Gitau et al., 2010). Kenya annual wheat production averages 300,000 metric tons produced on about 140,000 hectares mainly in the Rift-Valley, some parts of Nyandarua, Laikipia and Meru Counties with an average yield of 2.3 tonnes per hectare (KNBS, 2020; Negassa, et al., 2013). Rift valley is the leading producer (82% of production) of wheat in the country followed by Meru County (14%).

Medium and large-scale farmers account for 75% of the area planted with wheat, and 83% of production (Monroy et al., 2013; Nyangito et al., 2002). In the last four decades, the acreage under wheat production has stayed fairly constant while production has gently increased (Gitau et al., 2010). Production trends have also exhibited an erratic trend primarily due to rainfall

fluctuations (Table 2.1). In fact, growth in production and yield has been minimal in the past five decades (1961 to 2011) at only 3.6 and 5.2 %, respectively (Negassa, et al., 2013). This low performance has been linked to a combination of several constraints that hamper increased wheat production. They include drought, high cost of inputs, weak extension services and low uptake of high-yielding wheat varieties, subdivision of land, competition from other food crops and dairying (Chemonics International, 2010; Hassan et al., 1993; Mahagayu et al., 2007). Smallholders have especially been most impacted by these challenges.

Table 2.1. Wheat production and imports, 2013-2019 (000' tonnes)

Year	Production	Imports	Total
2013	194.5	1,033.1	1,227.6
2014	228.9	1,225.7	1,454.6
2015	238.6	1,421.8	1,660.4
2016	214.7	1,362.3	1,577.0
2017	165.2	1,855.0	2,020.2
2018	336.6	1,736.7	2,073.3
2019	366.2	1,998.9	2,365.1

Source: KNBS (2018b, 2020)

While wheat production has shown minimal growth, demand for wheat on the other hand has grown significantly. Production meets only about 15% of local demand and the shortfall is met through imports of wheat which have steadily increased (Table 2.1). Currently, Kenya imports almost two million metric tonnes of wheat, approximately six times the amount produced (KNBS, 2020). United States Department of Agriculture, Foreign Agricultural Service estimates the country's wheat demand at over 900,000 metric tonnes. The average per capita consumption of wheat is 41 kilograms annually (KNBS, 2019). However, the average annual per capita consumption of wheat is slightly higher (43 kgs) in Nairobi where wheat constitutes the greatest proportion (32%) of households' staple budget (Kamau et al., 2011). This is because wheat is more expensive per kilogram than other staples (Muyanga et al., 2005).

The demand for wheat in Kenya has continued to grow driven mainly by urbanization and change in dietary patterns with a growing preference for wheat products as convenience foods (Gitau et al., 2010; Townsend & Gitonga, 2018). This rapid increase in demand and consumption of wheat indicates its growing importance in the food budget and as a food security staple. This explains the concerns of past studies (Chemonics International, 2010; Gitau et al., 2010; Muyanga et al., 2005; Nyangito et al., 2002) that unless, major interventions are done in wheat

production, the situation may remain the same or worsen in the future. Therefore, policies that enhance wheat production would be key in improving household food security and reducing poverty (Muyanga et al., 2005).

2.2.3 Global dairy production, supply and utilization

Global production of milk reached 906 million tonnes in 2020 and is projected to grow to 997 million tonnes by 2029 (FAO, 2021b; OECD & FAO, 2020). Asia, Europe and North America are the most important dairy regions in the world, producing about 80% of the global milk production (FAO, 2021b). In Asia, and globally, India is the highest milk producer, producing about 190 million tonnes of milk annually (OECD & FAO, 2020). China too is an important milk producer in Asia (World Bank, 2015). Germany and France are the prominent milk producers in Europe whereas USA is a significant producer in North America (FAO, 2010). India and Pakistan are projected to produce a third of global milk production by 2029.

In comparison to other regions in the world, Africa's dairy market is less developed and contributes only 5% to the global milk production (PMFood, 2014). Egypt, Kenya, Sudan, Algeria, Ethiopia and South Africa are the prominent milk producers in Africa, accounting for half (25 million tonnes) of the milk produced (Mamopanel, 2020). High milk production in South Africa is associated with high milk production per cow, while in Ethiopia it is attributable to the high number of cows (Bingi & Tondel, 2015). The East Africa region accounts for the larger share of milk output in Africa (Opoola et al., 2019). Growth in production of milk has been slow in Africa compared to other continents (FAO, 2021b). In Africa, the dairy industry has two different types of models, namely, modern and smallholder. The smallholder model is associated with farmers who own less than 5 cows while in the modern system, farmers own in excess of 500 cows (Bingi & Tondel, 2015).

International dairy trade was estimated at 79 million tonnes, in milk equivalent by 2020 (FAO, 2021b). The larger share of milk trade takes place in the developed countries. The European Union, New Zealand and the United States are the major exporters of dairy products (OECD & FAO, 2020). Despite India being the leading world milk producer, it trades only marginal quantities of its production (OECD & FAO, 2020). East Africa, the leading milk producer in Africa exports less than 1% of its dairy products (Bingi & Tondel, 2015). In Africa, only 40% of

the produced milk is traded in formal markets (Opoola et al., 2019). In East Africa, lower quantities of between 10 and 20% are marketed through formal channels (Bingi & Tondel, 2015).

China is the world's leading importer of milk products, particularly whole milk powder and is projected to continue so in the near future (OECD & FAO, 2020). In 2019, China purchased 17 million tonnes of milk products (FAO, 2021b). Other important net importers of milk products include Mexico, the United Arab Emirates, the Russian Federation, the Philippines, Bangladesh, Japan and North Africa (FAO, 2021b; OECD & FAO, 2020). Due to the perishability of milk, most of the dairy production is consumed on the farm or informally distributed, with a smaller proportion (15%) processed into fresh products (Mamopanel, 2020). In fact, in sub-Saharan Africa, 80% of milk produced is consumed as liquid (Opoola et al., 2019).

The global consumption of milk stands at an average per capita of about 100 kilograms of milk equivalent (FAO, 2010). However, there are significant variations in per capita milk consumption between countries. Parts of Europe have per capita milk consumption in excess of 300 kilograms compared to less than 30 kilograms in some African and Asian countries (FAO, 2010). However, some African countries such as Kenya, Sudan and Algeria have a high per capita consumption of milk of more than 95 kilograms (Mamopanel, 2020). Population growth, urbanization and changing lifestyles have been associated with the growing milk demand in these sub-Saharan countries (Bingi & Tondel, 2015).

2.2.4 Dairy value chain in Kenya

Kenya's dairy sub-sector is considered as one of the largest and fastest growing sectors in Africa; growing at an estimated rate of between 3 and 4% annually (Auma et al., 2017; Bingi & Tondel, 2015; MoALF, 2013). This key livestock sub-sector contributes almost 70% of the entire gross value of livestock's contribution to the agricultural sector and between 6 and 8% of GDP (Behnke & Muthami, 2011; Gade & Thomas, 2014). The dairy sub-sector has been valued from as low as Kshs 100 billion to as high as Kshs 257 billion in different reports and studies (Behnke & Muthami, 2011; MoLD, 2010; TechnoServe, 2008). The inconsistency in the estimates of the value of the sub-sector has been due to unavailability of reliable data owing largely to its informal nature. In fact, TechnoServe (2008) observed that most of the dairy statistics are at best

estimates of data collected by Ministry of Livestock and Fisheries Development extension officers.

Nevertheless, the significance of the dairy sub-sector cannot be underestimated, particularly as an income source for the rural population. About 2 million rural households (mostly women and youth) are estimated to derive their income from the sub-sector, producing approximately 80-90% of the milk consumed nationally (Gade & Thomas, 2014; MoLD, 2010; TIAPD, 2016). Kenya is said to be self-sufficient in milk with even instances of milk glut in some months of the year. Milk imports of processed milk and milk products (from New Zealand and the European Union) are minimal at only 2% to cater for specific user tastes and preferences (MoALF, 2013; MoLD, 2010).

Recorded national milk production shows steady growth with the exception of a significant drop in 2017 due to prolonged drought during that period (Table 2.2). The steady increase in milk uptake by processors can be linked with the increase in milk production and number of dairy societies which are their primary milk suppliers (Table 2.2). Out of the milk produced, only about 20 to 55% enters the market, with farmers retaining about 45% either for home consumption or for calves (Bergevoet & van Engelen, 2014; FAO, 2011).

Table 2.2. Milk production and processing, 2013-2019

	Unit	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Milk production	Million litres	523	540	616	648	536	634	668
Milk processed	Million litres	407	420	438	449	411	468	492
Butter and ghee	Tonnes	1,231	1,445	1,646	1,445	1,127	1,249	1,013
Cheese	Tonnes	267	266	303	311	338	384	305
Number of dairy societies		376	412	427	465	518	623	639

Source: KNBS (2018b, 2020)

Consumption of milk and milk products has been growing more fast than production due to population increase, rising urbanization and incomes accompanied by changing lifestyles (Auma et al., 2017; Bingi & Tondel, 2015; Kurwijila & Bennett, 2011). As per the food balance sheet, per capita consumption of milk in Kenya stood at 99 litres per annum in 2019 (KNBS, 2020). Earlier estimates by Behnke et al. (2011), however, indicated that about 198 litres of liquid milk

are accessible on average for each person, whether for consumption or processing, a figure that is much higher than official estimates.

Kenya's milk consumption levels are said to be among the highest in the developing world and are projected to grow by about 3% annually to reach 220 litres per person annually by 2030 (Gade & Thomas, 2014; MoALF, 2013; MoLD, 2010). If the existing state of affairs holds, milk consumption would likely outstrip supply in the future unless timely interventions are taken to boost production. Urban demand is particularly pushing up consumption with urban consumption estimated to be 45-49% higher at 125 litres than rural consumption (MoALF, 2013). In addition, urban milk demand has been projected to increase at an yearly level near double that of rural demand (Gade & Thomas, 2014). This is generally expected as incomes in urban areas are higher than rural areas and milk consumption tends to be income elastic.

2.2.5 Global beef production, supply and utilization

Global bovine production was estimated at 71.4 million tonnes in 2020 (FAO, 2021c). Regionally, Asia is the largest producer of beef, producing about 18.7 million tonnes, followed by South America, North American and Europe (FAO, 2021c; Ritchie & Roser, 2017). By country, USA is global leader in beef production. In 2019, beef production in the USA was about 12.3 million tonnes accounting for 20% share of global production (OECD & FAO, 2020; USDA, 2021). USA utilizes extensive grain feeding systems in beef production that enable quick weight gain and heavy cattle (MLA, 2021). It has more than 80 breeds of cattle, among which the British breeds and their crosses are predominant (Smith et al., 2018). Other major beef producers include Brazil (10.1 million), European Union (7.8 million), China (6.7 million), India (3.7 million) and Argentina (3.2 million) (USDA, 2021). In the European Union, France is the largest beef producer, accounting for 17% of the regions production, followed by Germany (13%) and the UK (11%) (MLA, 2021). The European Union derives most of its production from a dairy based herd and is said to be a high-cost beef producer. Among the top beef producing countries in the world, Brazil has the highest number of cattle (244 million) followed by USA (94 million, China (91 million), European Union (77 million) and Argentina (54 million) (MLA, 2021). Beef production in the developed countries is projected to be at least 4% higher by 2029 supported by growth in Canada and USA due to higher carcass weights and rising number of slaughtered cattle (OECD & FAO, 2020).

In developing countries, growth in meat production is projected at 2.4% by 2030 (FAO, 2003b). In fact, developing countries are projected to account for the bulk (81%) of the total global growth in beef production with countries such as Argentina, Brazil, China, Pakistan and SSA contributing greatly to this growth (OECD & FAO, 2020). This growth may emanate from efficiency gains from improved herd production in countries such as Brazil that has less productive herds (MLA, 2021). Beef production in Africa is estimated at about 7 million tonnes (FAO, 2021c). South Africa is the leading beef producer in the continent, producing 1 million tonnes per year, followed by Egypt (747,000) and Algeria (147,000) (FAO, 2021c). Sub-Saharan Africa is estimated to have about 285 million heads of cattle (FAO, 2003b). Annual growth in SSA livestock production is projected at 3.5% (FAO, 2003b).

Global beef exports amount to about 11.1 million tonnes (USDA, 2021). Brazil is the leading exporter of meat, followed by Australia, USA, India, Argentina, New Zealand, Canada in that order (USDA, 2021). However, USDA (2021) projects that USA will be the second largest exporter in 2021, trailing Brazil and marginally ahead of Australia and India. Brazil exports in excess of two million tonnes of beef annually, primarily to China, Hong Kong and Egypt (FAO, 2021c; MLA, 2021). Brazil's share of exports has grown to 25% of the total global exports (USDA, 2021). India, USA, Australia export at least 1.4 million tonnes each annually, making them significant global exporters too (FAO, 2021c). The major export markets for USA include, Japan, Mexico, Hong Kong, South Korea, Canada, and the Middle East (Smith et al., 2018). India mainly exports to price sensitive markets in developing countries in South-East Asia and the Middle East (MLA, 2021). Brazil, the European Union and USA, combined, are projected to account for nearly 60% of exports by 2029 (OECD & FAO, 2020). Africa is among the least beef exporting regions. In 2019, Africa exported about 96 thousand tonnes, with South Africa accounting for the larger share (50%) of the continent's exports (FAO, 2021c). In terms of live cattle exports, Australia is the leading exporter globally, supplying the middle East and Asia about 1 million head of cattle annually (MLA, 2021). Other exporters of live cattle include Canada and the European Union.

Approximately 10.6 million tonnes of beef are imported by different countries worldwide (FAO, 2021c) Asia imports more beef than any other region globally on account of high imports by China. In 2020, China imported more than three million tonnes (FAO, 2021c). USA is the

second largest importer, importing about 1.5 million tonnes of beef (USDA, 2021). Japan, South Korea, Hong Kong, Russia, European Union trail the two major importers but are notable importers too. Africa imports low quantities of beef with Egypt being the major continents importer (300,000 tonnes) followed by Algeria (96,000 tonnes) (FAO, 2021c).

Beef consumption varies across different regions and countries in the world. This variation is caused by factors such as population growth, economic growth, consumer purchasing power, urbanization and dietary preferences (MLA, 2021). Global beef consumption is estimated at 60 million tonnes and is expected to increase to 76 million tonnes by 2030 on account of rising population growth and per person consumption (USDA, 2021). The large proportion of the growth in beef consumption has been in developing countries, especially in Asia, and this trend is expected to continue at least in the next decade (MLA, 2021). USA has the highest domestic beef consumption (12.5 million tonnes) followed by China (9.4 million), Brazil (7.6 million tonnes) and the EU (7.7 million tonnes) (USDA, 2021). However, per capita domestic consumption is highest in Uruguay (56.3 kg/person) and Argentina (53.5 kg/person); lower in countries such as Mexico (13 kg/person) and the EU (15 kg/person) and much lower in China (6 kg/person) and India (0.8 kg/person) (MLA, 2021). Per capita beef consumption in SSA is expected to remain low at one third, in terms of volume, compared to developed countries (OECD & FAO, 2020). In sub-Saharan Africa, per capita beef consumption has been unchanging at about 10 kilograms in the last three decades and little growth is projected (3.7%) by 2030 (FAO, 2003b).

2.2.6 Beef value chain in Kenya

The red meat sub-sector is the largest of the livestock sub-sectors with cattle being a significant source of red meat, comprising 77% of Kenya's ruminant off-take meant for slaughter (Farmer & Mbwika, 2012). Although ASDSP (2010) estimates the number of beef cattle in Kenya to be 9 million, the livestock census done in 2009, as part of the wider national human population census, estimated the cattle population at 17.5 million with the large population (70%) of cattle stock found in the Arid and Semi-Arid Lands (Behnke & Muthami, 2011). About 80% of the red meat consumed in Kenya originates from pastoralists livestock that are reared in the arid and semi-arid counties of Kenya, whereas another 2% originates from the commercial ranches, and the remainder from highland farmers (Farmer & Mbwika, 2012). Kenya is 70-75% sufficient in

meat production, with the deficit being met through illegitimate movement of cattle from neighboring countries (Aklilu et al., 2013). It is not known exactly how many heads of cattle pass through Kenyan boundaries as imports, but studies have estimated the number at 20-30% of cattle slaughtered (Behnke & Muthami, 2011; Farmer & Mbwika, 2012; Muthee, 2006).

There has been a consistent rise in the number of cattle slaughtered with a remarkable increase as from 2016 (Table 2.3). The increase in number of cattle slaughtered in 2016 and 2017 was attributed to increased livestock off-take to cushion farmers from losses due to drought (KNBS, 2018b). The consistent rise in the number of slaughtered cattle can also be attributed to a concurrent rise in the demand for beef, particularly in the urban areas. Bosire et al. (2017) estimated a rise of 85% in the meat consumption from the 1980s to 2000s, with a remarkable increase of 282 % in the urban areas.

Table 2.3. Beef production, 2013-2019

	Unit	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Livestock slaughtered (Cattle and calves)	000' heads	2,147	2,077	2,275	2,460	2,590	2,782	3,081
	KShs (millions)	58,237	59,273	66,217	84,701	93,630	100,249	107,353

Source: KNBS (2018b, 2020)

Similarly, Bergevoet and Engelen (2014) notes that beef consumption has increased twice as much in the past twenty years and projects the trend to continue into the future. Kenya's food balance sheet sets the per capita consumption of beef at 9.8 kilograms given a total consumption of 465,000 metric tons (KNBS, 2020). However, studies have estimated a higher national average per capita meat consumption of between 15 and 17 kilograms, with Nairobi having the highest meat consumption of between 15 and 25 kilogram per person per year (Bosire et al., 2017; Farmer & Mbwika, 2012; Muthee, 2006; Wanyoike et al., 2018). Of the 465,000 tons of beef produced annually, less than 1% is exported to countries in the middle east such as Oman, Kuwait and Qatar, Tanzania and Egypt with most of the beef consumed in the country (ASDSP, 2010; Farmer & Mbwika, 2012; KNBS, 2018b). However, there is great potential for growth in capacity of meat exports to the region in the future (Aklilu et al., 2013).

2.3 Agro-food Value Chain Activities, Actors and Product Flows

As defined earlier, a value chain constitutes all activities that bring food products from the initial stage of conception, through the various stages of production to the ultimate delivery to consumers. The activities are depicted as an input-output structure where a particular activity receives input from a previous activity and provides output for the next activity. In agro-food value chains, it is common to begin by identifying the primary activity of agricultural production then proceed to identify a maximum of six or seven activities that constitute the transformational steps that the raw material goes through until the final activity of consumption (Bockel & Tallec, 2005a; Sanogo, 2010).

For each of the activities in the value chain, it is essential to identify the actors. Actors are considered as economic agents who carry out a set of integrated economic activities to produce a given output (FAO, 2013). They are the participants in the activities of production, distribution, processing, retail and consumption of a particular product(s). Actors link to one another through vertical and horizontal relationships. Vertically, each actor is a customer of an upstream actor and a supplier of a downstream actor in the value chain (Europeaid, 2011; FAO, 2013). While horizontally, the actors are involved at the same level of the chain, say production. Actor relationships can be as simple as spot relations or merely transferring information to long term contractual relationships with high degrees of coordination. An actor can take on more than one role in the value chain by being involved in different value chain activities. It is, therefore, key to ascertain the primary role of such actors. Actors can be classified into homogenous groups, say by size or scale, location, ownership, poverty or food insecurity status, among others (M4P, 2008; Sanogo, 2010). As such, their characteristics can be assessed based on particular similarities.

Mapping of product flows and services in value chains follows a similar pattern to activities and actors. That is, vertically from the primary producer to the end consumer. Hence also referred to as the supply chain. Mapping of product flows involves identifying the products at each activity level, and may also include establishing the volumes, sales, and geographical flow of the product (M4P, 2008). This creates a clear picture of the nature of the product, how it is transformed, distributed and the form in which it is finally consumed. While mapping product flows, it would

be appropriate to differentiate between the main product, which would then form the main value chain, and other sub value chains, say of by-products.

The interaction between value chain activities, actors and flow of products and services can be presented using a functional analysis table. Alternatively, the same information can be presented in a product flow diagram, which is more visual and makes it easier to understand the complex interactions and flows between actors (Bockel & Tallec, 2005a). The product flow chart is usually presented as boxes linked by arrows that indicate the flows of products and services (Gereffi & Fernandez-Stark, 2016). The product flow chart may represent a simple value chain with few boxes and arrows to more complex value chains shown with several boxes and arrows of varied intensity, running in various directions depicting differentiated flows of products and services. In essence, the result is a network structure where the vertical dimension shows the flow of products and services while the horizontal dimensions displays the relationships among actors in the same level of the value chain (Trienekens, 2011).

2.3.1 Wheat value chain activities, actors and product flows in Kenya

Earlier studies and research (Chemonics International, 2010; Gitau et al., 2010; Mahagayu et al., 2007; Monroy et al., 2013; Nyangito et al., 2002) identified the actors and activities that link to form the wheat value chain in Kenya. Among the actors identified are input suppliers, farmers, transporters, traders, millers and consumers.

The main inputs for wheat production are seed, fertilizer and agro-chemicals (insecticides, herbicides, fungicides, foliar feed). Farmers obtain these inputs from agro-dealers who are spread out in most towns and shopping centres in the rural areas (Gitau et al., 2010). The role of breeding new wheat varieties rests with Kenya Agricultural and Livestock Research Organization (KALRO) in collaboration with other partners such as The International Maize and Wheat Improvement Center (Gitau et al., 2010). Large-scale wheat farmers are known to use new varieties, mainly motivated by the need to obtain the genetic material in the improved seeds (Mahagayu et al., 2007). On the contrary, majority of smallholder wheat farmers utilize seeds from the previous seasons.

Three categories of farmers have been identified as wheat producers: smallholder (<20 acres), medium (20 to 100 acres) and large-scale farmers (> 100 acres) (Chemonics International, 2010;

Gitau et al., 2010; Monroy et al., 2013). They are organized under the Cereal Growers Association. The medium and large-scale farmer's account for 80% of the total wheat production while smallholder farmers account for 20% (Chemonics International, 2010; Nyangito et al., 2002). Smallholder wheat farmers sell their wheat to the National Cereal and Produce Board (NCPB), whereas medium and large-scale farmers sell either to the NCPB or to millers (Monroy et al., 2013). NCPB in turn sells to millers, who collect the grain or engage traders. Gitau et al., (2010) categorized the traders, according to their load capacity, into small-scale traders who use pickups for transport and large-scale traders who use 10 metric ton lorries to transport wheat.

Millers mill the wheat grain into different types of flour. The packed flour is sold mainly to the bakery industry or to wholesalers for onward distribution and sale to various retailers and onwards to consumers (Monroy et al., 2013). Small quantities of milled flour are exported to the COMESA region. Additionally, millers obtain by-products of bran and pollard from the milling, which constitute inputs for the animal feed industry (Chemonics International, 2010). Millers are categorized according to their milling capacity into small, medium and large-scale millers. According to Gitau et al., (2010), small scale millers use simple machinery and are located in trading centers. Further, Kenya has about 23 medium and large-scale millers, each with an estimated installed milling capacity of 100-200 metric tons per day for medium-scale millers and 3,600 metric tons per day for large-scale millers. These millers are registered and organized under the umbrella group, Cereal Millers Association.

As an actor in the wheat value chain, the government supports farmers through research and extension services; regulates wheat trade; and monitors and stabilizes market prices through NCPB (Monroy et al., 2013).

2.3.2 Dairy value chain activities, actors and product flows in Kenya

Studies by Auma et al. (2017); Bingi and Tondel (2015); FAO (2011); Gade and Thomas (2014); Kurwijila and Bennett (2011); and TechnoServe (2008) reveal the structure of the milk value chain in Kenya. The studies identified the actors and relationships that link them together from producers up to consumers; and depict a dairy value chain that is dualistic in nature, defined by the marketing channels through which milk flows from production to consumption. The marketing channels are commonly classified into two, formal and informal, otherwise also

referred to as cold and warm milk value chains, respectively (Bingi & Tondel, 2015; Kurwijila & Bennett, 2011). Although these two value chains vary in size, physical distribution and perception of quality, they are interconnected through transactions and commercial relations (Bingi & Tondel, 2015; Gade & Thomas, 2014).

The informal milk value chain handles about 80% of the marketed milk with the remaining 20% going through the formal chain (MoALF, 2013). This makes the informal milk value chain more dominant in the market. This dominance has been partially blamed for constraining development of the sector by creating unfair competition and failing to maintain safety and hygiene standards (Kurwijila & Bennett, 2011). Milk in the informal chain is sold raw while the formal chain processes milk into pasteurized milk and other milk products. The formal milk chain is longer compared to the informal milk chain because, it has additional activities of transporting milk to cooling and bulking hubs, then onwards to processing facilities (TechnoServe, 2008). Additionally, once milk is processed, several agents and/or distributors are involved in delivery to points of sale.

The actors involved in the dairy value chain include input suppliers (agro-vets, artificial insemination service providers); producers/farmers; milk bulking enterprises (dairy cooperatives, traders, producer groups); transporters (private, milk traders); and processors and retailers (milk bars, restaurants, supermarkets, shops and kiosks) (FAO, 2011; Gade & Thomas, 2014). Other actors like researchers, policy makers, regulators, financial services also support the chain (FAO, 2011; TechnoServe, 2008).

Agro-vet shops are key input suppliers in the dairy value chain, providing feed (concentrates) and animal drugs as well as advising farmers over the counter (Auma et al., 2017). Other input suppliers include service providers of animal health and Artificial Insemination (AI), livestock feed, farm and dairy equipment suppliers (Gade & Thomas, 2014). In an effort to improve and sustain farmers production levels, dairy cooperatives have begun supplying their farmers with inputs, A.I and veterinary services as well as extension services (Bingi & Tondel, 2015). Extension services, being a devolved function, is the sole responsibility of the county governments and differ across counties in terms of level of provision (Auma et al., 2017). However, majority of the farmers access extension services and other services like A.I and

veterinary services from private service providers and meet the entire cost of service. Besides the use of A.I, farmers rear their own replacement stock, with some farmers purchasing replacement heifers from fellow farmers, particularly the large-scale farmers (MoLD, 2010).

Milk production is done by farmers categorized into pastoralists, smallholder and large-scale farmers. Smallholder farmers own one to five cows and collectively produce the bulk of the milk (over 80 %) while large-scale farmers own more than 10 cows (MoLD, 2010). It is estimated that Kenya has about 2 million smallholder farmers who practice dairy farming under zero, semi-zero and extensive grazing methods (Gade & Thomas, 2014; Kurwijila & Bennett, 2011; TechnoServe, 2008). They produce milk mainly for home consumption and sell excess milk to the market. Smallholder farmers sell on average 3 to 5 liters of milk per day (TechnoServe, 2008). They sell either directly to the consumers in the rural areas (mostly neighbors), through milk traders or dairy cooperatives and producer groups (Gade & Thomas, 2014).

Several actors are involved in collecting, bulking and transportation of milk. They include collectors, transporters, and traders in the informal market; and collection agents, transporters, dairy cooperatives, producer groups or employees of processing companies in the formal milk chain (Bingi & Tondel, 2015). Milk traders have been identified as the single most important marketing actor, particularly in the informal milk chain. It is estimated that they control over 70% of the marketed milk (Gade & Thomas, 2014). The traders purchase milk from the farmers and transport it by bicycle, motorcycles or pickups using aluminum milk cans and plastic jerry cans (Auma et al., 2017; Gade & Thomas, 2014). However, use of plastic jerry cans is prohibited by the regulatory body, Kenya Dairy Board, for safety and hygiene purposes.

Dairy cooperatives are equally an important actor in milk collection and bulking. They are the major suppliers of milk to the processors. The number of dairy cooperatives has grown steadily over the years, achieving a major leap from 376 in 2013 to 518 in 2017, a 38% growth rate (KNBS, 2018b). This rapid growth rate indicates their increased importance in dairy production and marketing in Kenya. Bingi and Tondel (2015), state that, Kenya has the most progressive and structured dairy cooperatives in sub-Saharan Africa, with some processing milk.

Of the milk going through the formal markets, 80% is processed by the licensed processors while 20% is handled by farmer's organizations such as dairy cooperatives and farmers' groups (FAO,

2011). The processors preferably buy milk through organized groups and formal traders and collect the milk from designated centres, bulk the milk into stainless steel cans and transport to the main processing plants (Gade & Thomas, 2014; MoLD, 2010). There are about 34 operational registered milk processors though a few like New Kenya Cooperative Creamaries (KCC), Brookside Dairy, Cooperative Dairy, Githunguri Dairy Cooperative Society, Sameer Dairies and Meru Central Dairy Cooperative Union dominate the market (MoALF, 2013; MoLD, 2010). Besides dairy processors, there are also small dairies and cottage industries. Dairy processors produce a variety of products: fresh milk, yoghurt, ghee, butter, cheese, and milk powder. Fresh milk is the dominant product, and is sold either as pasteurized milk or UHT milk. It constitutes 85% of the processed milk while yoghurt, fermented milk and milk powder, cheese and butter constitute the remaining 15% (TechnoServe, 2008).

Milk retail is determined by the nature of milk (processed or raw) and the geographical location (urban or rural). In rural and sub-urban areas, consumers purchase raw milk from the farmers, traders, kiosks, shops and hotels (FAO, 2011). It is worth noting that there is a high consumer inclination for raw milk, which is more pronounced in the rural areas. Consumers find raw milk reasonably cheaper, tastier, higher in butter content, available in diverse quantities and widely accessible (MoLD, 2010). The preference for unprocessed milk has a heavy influence on the configuration of the milk value chain and has contributed to the dominance of the informal market in the industry. Processed milk and dairy products are sold by similar retail outlets as the informal value chain. However, supermarkets retail processed milk only unlike other retail outlets that may sell both raw and processed milk.

Other actors in the dairy value chain include supporting institutions such as the Kenya Dairy Board, the public health division of the Ministry of Health and Kenya Bureau of Standards. The Kenya Dairy Board is the key player in promotion, coordination, design of dairy policy, monitoring and supervision of the dairy sector (MoALF, 2013). The Kenya Bureau of Standards is involved in setting milk standards. These institutions implement and enforce laws that ensure food safety and hygiene (Kurwijila & Bennett, 2011). The Kenya Veterinary Board also provides support to the dairy chain by assisting in controlling and managing animal related diseases and vectors as well as regulating the professional conduct of veterinary practitioners (MoALF, 2013).

2.3.3 Beef value chain activities, actors and product flows in Kenya

The beef value chain in Kenya involves several actors that participate in production, transportation, slaughter and processing, retail and marketing, among other activities and services that combined result in the final products (meat and meat products) for consumption. They include pastoralists and commercial ranch producers, livestock traders and brokers, butchers and meat sellers. They have been mapped by earlier studies by Aklilu et al. (2013), Alarcon et al. (2017), ASDSP (2010), Behnke and Muthami (2011), Bergevoet and Engelen (2014), Farmer and Mbwika (2012), Muthee (2006) and Wanyoike et al. (2018).

The responsibility of producing and supplying breeding stocks lie with the farmers though the government has been complementing this through its reproduction farms and A.I services (ASDSP, 2010). However, the past years have seen a significant decline in government extension services to the farmers. As a result, government has been unable to meet the demand for quality breeding stock due to low investment in infrastructure necessary to support this service (ASDSP, 2010). Commercial ranches have taken up this role with some focusing on breeding of high quality beef stock for breeds like the Boran which fetch high prices in the local high-end market (ASDSP, 2010; Bergevoet & van Engelen, 2014; Farmer & Mbwika, 2012).

Beef producers can be categorized into three: pastoralists, commercial ranchers and small-scale highland producers. As noted earlier, pastoralists living in the ASALs produce most (80%) of the red meat consumed locally (Behnke & Muthami, 2011; Farmer & Mbwika, 2012). Although, they account for the bulk of the red meat consumed in nationally, pastoralists keep livestock primarily as a means of livelihood than for commercial purposes. Consequently, they tend to sell male or unproductive female animals in times of critical need to meet their immediate needs or during drought (Farmer & Mbwika, 2012). Subsequently, the quality of meat from their cattle is considered of low quality and thus is targeted at the middle and lower end of the market (Alarcon et al., 2017; Wanyoike et al., 2018).

Commercial ranches on the other hand account for only about 2% of red meat consumed in Kenya while small-scale highland producers produce about 10% (Farmer & Mbwika, 2012). Production by commercial ranches is commercially oriented and serves the high end markets as

they are quality producers of well-finished animals (Muthee, 2006). In addition to production and breeding, commercial ranches also play the role of livestock fattening.

Traders in the livestock business are the link between the producers and the market. Farmer and Mbwika (2012) identified two types of traders in the beef value chain: primary and secondary traders. Primary traders operate on a small-scale. They purchase livestock from pastoralists in small numbers which they sell to secondary traders who buy in bulk and sell the animals in terminal markets. Secondary traders also purchase livestock from commercial ranches. In addition to traders, terminal markets also host brokers who connect buyers to sellers and assist in negotiating prices (Muthee, 2006). Traders, either individually or as a group, contract transporters to move the livestock from the markets to slaughterhouses (Farmer & Mbwika, 2012).

Cattle in Kenya are slaughtered in abattoirs and slaughterhouses which are licensed to slaughter either for the domestic market or export markets or both. In addition to slaughtering livestock, abattoirs often process meat (Farmer & Mbwika, 2012). Most slaughterhouses slaughter for the domestic market. Kenya Meat Commission is the largest beef processing and export abattoir but it has consistently operated below capacity due to financial and management problems (Aklilu et al., 2013; Bergevoet & van Engelen, 2014). Private commercial abattoirs and slaughterhouses have now taken over the role of processing and export (Aklilu et al., 2013). These abattoirs grade meat according to specific cuts with common categories being Prime, Choice, Fair Average Quality (FAQ), standard and commercial grades (Farmer & Mbwika, 2012). In addition, some of them manufacture meat products like canned and corned beef and bone meal.

From the slaughterhouses and abattoirs, meat is exported or distributed to the domestic market by meat traders or their agents, large butchers and operators of butcheries (Muthee, 2006). Export volumes remain small (at about 1%) out of total meat produced (Farmer & Mbwika, 2012). The largest share of produced meat is consumed locally and is retailed through butcheries, supermarkets, hotels and restaurants. The majority of meat is transported by hired transporters who operate independently, and in most cases use motorcycles and small trucks/cars (Alarcon et al., 2017). Locally, the end market for meat is largely urban and is organized according to income into high, middle and low class (Farmer & Mbwika, 2012). The middle class constitutes

the largest class of meat consumers in the urban areas. The high income class of urban consumers source their meat from high class butchers and large retailers such as supermarkets while small hotels, and butcheries cater for low income consumers (Muthee, 2006). The local butchery is the primary source of beef for the rural consumers. In high end retail supermarkets and butcheries, meat is stored and displayed in refrigerated conditions while in low class butcheries meat is displayed openly and in some instances stored overnight under refrigerated conditions in case it is not sold out during the day (Farmer & Mbwika, 2012). Overall, butcheries are the leading group of retailer of red meat locally with regards to volume, selling about 60% of total production followed by supermarkets, hotels and restaurants (Alarcon et al., 2017).

Other actors in the beef value chain include the county governments who own the livestock markets in which various livestock transactions take place. They also provide veterinarians who inspect and license movement of livestock to prevent the spread of diseases. In addition, they also examine and put an imprint on meat at slaughterhouses as well as issue certification for meat transportation.

2.4 Value Addition in Agro-food Value Chains

Value chains form a framework for comprehending exactly how inputs are put together to produce food that is transformed through processing and physically moved up to the final consumer (Webber & Labaste, 2009). This has been applied to agro-food value chains to understand how value is added along the chain and proportion of value captured by value chain participants. Value added is often defined and calculated quantitatively. Hence, the common definition as the difference between the total product revenue and the costs of inputs (for example, materials and labour) utilized to produce the product (Bockel & Tallec, 2005b; Hawkes & Ruel, 2011). Basically, it is the difference between the value of the output and the value of intermediate inputs. This is referred to as the gross value added. However, when fixed capital is taken into consideration, such that both intermediate and fixed capital utilized are subtracted from the value of output, then the net value added is obtained (M4P, 2008).

The value of output includes revenue from sales, value of consumed output and changes in stock/inventories (FAO, 2013). In calculating the value of intermediate and fixed capital (cost of production) some of the components to consider include cost of inputs, interest payment and

taxes, and depreciation on capital equipment (M4P, 2008). Quantifying value added in a value chain requires collection of data related to output, prices paid and received by actors and costs since the purpose is to appraise revenues, costs and margins (FAO, 2013). This makes the process of data collection as well as analysis an intensive and sometimes tedious exercise. For this reason, it may be done for a selected activity or actor, parts or the whole value chain (FAO, 2013) depending on purpose, availability of time and resources.

Analysis of value added makes it possible to establish the distribution of value among actors in a value chain. This provides an understanding as to why certain activities in the value chain are well compensated and others are not (Kaplinsky & Morris, 2001). It also makes it possible to determine which actors may possibly benefit from more support or organization (M4P, 2008). Sanogo (2010) points out that from a food security and reduction of poverty perspective, the main goal of analyzing value added is to increase the margins per product unit for a value chain actor. This may in turn lead to an increase in incomes. Additionally, determination of value added can inform the extent to which a value chain is accessible to the poor. It is also possible to compare the performance of a selected value chain to another, industry standards or best practices, also referred to as bench marking, in order to improve efficiency and effectiveness of the value chain (M4P, 2008).

The scope of value chain analysis is usually wide. As stated earlier, an analyst may therefore decide to look at the complete value chain or parts of it. Different studies (Maina et al., 2015; Nyokabi et al., 2018; Staal et al., 2003; Wambugu et al., 2011; Warsanga & Evans, 2018) have analyzed value addition at different levels. However, the underlying concept is to establish benefits accruing to an actor(s) or activity (ies). Value addition can be analyzed for the complete value chain with the objective of identifying the value chain actor who gets the highest margin. For example, Odongo and Etany (2018) in their analysis of the cassava value chain in Northern Uganda showed that retailers had higher margins than producers and wholesalers. Using gross margins, Warsanga (2014) showed that wholesalers and processors in the banana value chain of Tanzania obtained higher prices and margins compared to other actors in the value chain.

Wambugu et al. (2011) analyzed value addition for different dairy production systems to compare their profitability. The study established that dairy farming was a profitable and viable

enterprise for farmers in non-zero method of production having higher margins than zero grazing. Value addition can also be used to compare profits between different actors at the same stage of the value chain. Using gross margin analysis, Mburu et al. (2014), found out that wheat production in Kenya was potentially profitable for all categories of farmers, though large-scale wheat farmers had higher margins compared to small-scale farmers. Studies by Staal et al. (2003) and Wambugu et al. (2011) also used gross margin calculation as a measure of economic performance of the activity.

Value addition has further been used to compare profitability between products as opposed to between actors in order to make a case for a more beneficial product. For example, Kariuki et al. (2015) showed that the average profit per litre of value-added milk products was much more than that of the fresh milk. Similarly, Odongo and Etany (2018) showed that it was more profitable for a cassava value chain actor in Uganda to trade in processed products like chips rather than fresh tubers. Thus, proving that actors can obtain improved margins by adding value to their products, particularly, raw agricultural products. Other studies (Mburu et al., 2007; Warsanga & Evans, 2018) have used value addition to show the best marketing channels for producers through analysis of prices.

Due to data requirements and intensity of calculations involved, most of these studies establish value addition by calculating gross margins. This involves establishing the costs of production and revenues for the actors or activities. While some studies (Mburu et al., 2014) compare costs between various production methods, others (Maina et al., 2015, Staal et al., 2003; Wambugu et al., 2011) just establish the main costs with the objective of identifying the highest costs whose variance, either by reducing or increasing has the greatest impact on margins. By establishing revenues accruing to an actor, the study by Mburu et al. (2007) showed that the dairy value chain in the Kenya highlands was the main income generating enterprise in majority of the households.

Whereas most studies relate value addition to calculation of margins and profits, some simply identify any attempts at transforming or improving a product. Value addition could also be considered in terms of adoption of technology at either stage of the value chains. For example, Maina et al. (2015) noted that value addition along the fish value chain in Kenya was limited with use of only simple technologies and minimal improvement of fish in terms of changing it

from its very raw form. Nyokabi et al. (2018) showed that very few dairy farmers in Kenya made any attempt of adding value to milk by processing it into any other form except its raw status.

2.5 Governance in Agro-food Value Chains

In the framework of value chains, Governance denotes the relationships and linkages that exist among actors in a value chain (Europeaid, 2011). These relationships make the interactions in a value chain more coordinated and organized rather than being random (Kaplinsky & Morris, 2001). Coordination in a value chain can take different forms like actor associations, contractual relationships and strategic alliances (Donovan et al., 2015). These determine allocation and flow of resources, price, quality and quantity of products and services in the value chain. Relationships and linkages in a value chain exist horizontally among actors in the same node of the value chain or vertically in buyer-seller kind of relationships.

In advancing the concept of governance, Gereffi et al. (2005) argued that relationships in a value chain are determined by three aspects: the extent of a transactions' complexity, ability and capability of suppliers to codify information and supply the product. That is, the relationships that exist among the value chain actors are determined by how simple or complicated a transaction is in terms of information and knowledge, the degree to which this information can be deciphered by the actors and the ability of the actors to execute the transaction. Based on the three aspects, Gereffi et al. (2005) identified five typologies of value chain governance: markets, modular, relational, captive and hierarchy value chains.

Based on the level of integration and coordination, relationships and linkages between similar actors in a value chain can be put into three general categories: horizontal integration, spot and persistent relations (M4P, 2008). In spot market associations, relationships are created at the moment. They are also referred to as arm's length relationships because aspects of a transaction conducted under this kind of relationship including price, quality and quantity are concluded on the spot. On the other hand, persistent network relations occur where actors have a preference of transacting with each repeatedly. In such transactions, actors develop some high level of trust and dependency allowing for repeated transactions (M4P, 2008). Finally, in horizontal integration, actors are more integrated into business, for example, through ownership or shareholding. As M4P (2008) puts it, relations exist where actors have ownership over the

business and trust is an important aspect in this relationships as it enables strong and more efficient linkages.

Power relations among actors constitute an important aspect of governance in value chains. In value chains, some actors work within terms and conditions set by other actors who wield more power in the value chain. Such actors are often referred to as lead actors (Kaplinsky & Morris, 2001). Lead actors could force or influence other actors in the value chain to abide by their conditions or may choose to be ignorant to the demands of other actors. The extent of such power could be related to their size, share of sales, value added, buying power or access and control over both tangible and intangible key resources like capital, land, credit, information and knowledge (Kaplinsky & Morris, 2001; M4P, 2008; UNCTAD, 2016).

Analysis of governance thus involves 1) mapping and analysis of value chain linkages, establishing the purpose or reasons for which the linkages exist and assessing their benefits or otherwise to the actors involved; and 2) highlighting power relations in the value chain by identifying which actors are more powerful, why and how they influence other actors/persons in the chain. In so doing, we are able to identify which actor's behavior need to change if the chain is to achieve different outcomes (Kaplinsky & Morris, 2001). In addition, discerning in what way a value chain is controlled gives insights into any existing barriers to entry (constraints) and which linkages need to be strengthened to improve value chain efficiency and effectiveness.

The aspect of governance in value chains has developed in the recent past, and therefore only few studies have solely focused on it. Governance has in most cases been treated second to other aspects of value chain analysis. Studies have analyzed governance, classically, as simply unpacking the relationships and linkages between actors in a value chain. This focus has continued in recent studies. For example, a study on the camel milk system in Nairobi by Muloi et al. (2018) revealed regular informal interaction between actors in the chain. Similarly, Nyokabi et al. (2018) showed the multi-layered web of actors, in the formal and informal dairy marketing value chains, using different colored lines to indicate their relationships and linkages in terms of exchange of information and goods. Also Kiambi et al. (2018) made a detailed assessment of the connections between the formal and informal dairy marketing chains in Nairobi. Analysis of relationships and linkages has also encompassed establishing existence of

associations between actors and their purpose (Nyokabi et al., 2018). Such association can be in the form of farmer groups or cooperatives which enhance either vertical or horizontal integration in the value chain.

At the core of understanding relationships as part of governance is the aspect of power relations in a value chain. This includes establishing actual or perceived actor dominance in a value chain which can be expressed through ability to determine pricing, control of information flow, holding key knowledge or technical expertise and/or control of large volumes of trade. Carron et al. (2017), Muloi et al. (2018) and Nyokabi et al. (2018) in their studies used these power factors to identify actors who seemed dominant in value chains. Carron et al. (2017) found out that, in the broiler meat value chain in Nairobi, broiler companies, brokers and agrovets dominated the chain through supply, market information and technical knowledge. Similarly, Muloi et al. (2018) identified milk traders in the Nairobi camel milk chain as having a dominant role owing to the large volumes of milk they traded.

While analyzing governance, studies also highlight the rules and regulations governing value chains. This has more often than not resulted in classification of value chains as either formal or informal. Formal rules have been found to govern operations of large companies or associations since they have a legislative backing. Studies such as that of Carron et al. (2017) and Muloi et al. (2018) established existence of formal rules, regulations and standards, particularly with processing companies in value chains. Such clear set of rules and regulations result in better coordination and sometimes vertical integration of actors. While on the other hand, studies (Muloi et al., 2018) have found informal value chains to operate under the basis of mutual trust.

A few recent studies have expanded the classical ways of analyzing governance. Studies such as those by Gachukia and Muturi (2017) and Warsanga and Evans (2018) have digressed to look at the determinants of governance, vertical and horizontal coordination. Such factors include the nature of transactions and contract, chain integration, standards and relational characteristics (Gachukia & Muturi, 2017).

2.6 Constraints in Agro-food Value Chains

Identification of constraints in a value chain is one of the major components of value chain analysis. It is almost obvious that any value chain study will point out constraints in a value

chain. This is partly because constraints, otherwise also referred to as challenges, exist in almost all levels of a value chain (M4P, 2008). Constraints hinder growth and development of a value chain making value chains inefficient, ineffective and unable to meet their potential to benefit the actors (Europeaid, 2011). In other words, they are constraints to greater efficiency and effectiveness, upgrading, integration or more involvement of the some actors (M4P, 2008). Hence, any changes that would need to be made in a value chain will be based on tackling the existing constraints first. Studies on value chain constraints are popular because identification of constraints is a principal pillar of value chain analysis. In most studies, the most common way of identifying constraints is through enquiring from respondents.

Constraints in agro-food value chains in developing nations are similar and related and can be categorized into groups. Constraints have been found to be related to market access and orientation, availability of resources (e.g. physical, social, financial), physical infrastructure and institutions (Trienekens, 2011). A study by Muloi et al. (2018) identified nine broad areas under which these constraints fall: policy, marketing, financial, infrastructural, relational, environmental, security, technological and organizational. Most common are constraints related to marketing which include poor or insufficient market access, lack of market information, low product quality, price fluctuations and low prices (Carron et al., 2017; Maina et al., 2015; Odongo and Etany, 2018; Wanyoike et al., 2018). Infrastructural and storage constraints encompass poor roads, high transport costs, poor linkages to transport systems and lack of storage facilities (cold or otherwise) (Bolo et al., 2011; Korir, 2016; Muia et al., 2011; Muloi et al., 2018; Odongo and Etany, 2018; Wanyoike et al., 2018).

It is common for studies to group constraints according to every level of the value chain or just analyze a particular level of the value chains. Studies on constraints at production level are particularly popular. For example, Alarcon et al. (2017), Bolo et al. (2011), Carron et al. (2017), Korir (2016), Muia et al. (2011), Odongo and Etany (2018) and Wanyoike et al. (2018) focused on constraints at the production level of the individual value chains. Key constraints to production identified by these studies include high production costs, lack of knowledge and training in production, droughts, pests and diseases and lack of organization among farmers. In a different approach, studies such as that of Korir (2016) analyzed constraints in terms of threats and weakness as part of SWOT analysis.

In recognition of the multiple constraints facing agro-food value chains in developing countries, Trienekens (2011) suggests that value chain analysis should prioritize identification of constraints in a value chain so as to design opportunities and define upgrading options based on the constraints identified. This way, upgrading has the possibility of having a larger impact on those who may not be gaining as much as they could from the value added along the chain (FAO, 2014; Sanogo, 2010). Kaplinsky and Morris (2001) identify four ways in which upgrading can occur in value chains. They include introducing new products or improving old products (product upgrading); improving internal processes (process upgrading); changing the mix or focus of activities (functional upgrading); or moving to a new value chain altogether (chain upgrading).

2.7 Agro-Food Value Chains, Food Security and Poverty

2.7.1 Agro-food value chains and food security

The primary outcome of agro-food value chains is food security. It follows therefore, that food insecurity has often been linked with insufficient food production (Esnouf et al., 2013). It has been argued that, globally, agro-food value chains produce enough to feed the global population, yet, 800 million people are undernourished (FAO et al., 2017, 2019). Prevalence of undernourishment is highest in Sub-Saharan Africa; the East Africa region has the second highest prevalence (27%), second to middle Africa region, where a third of the population is affected (FAO et al., 2020). Currently, 24% of the total population in Kenya is undernourished with 36% considered severely food insecure (FAO et al., 2018).

Although agro-food value chains are not the panacea to food security, they are a central component in achieving food security (AGRA, 2017; One planet, 2020). Food security exists "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Agro-food value chain activities (production, processing, distribution, retailing and consumption) are directly related to food security. They affect the four facets of food security, that is, availability, accessibility, utilization and stability, which must be achieved simultaneously (FAO, 2008). In addition, other dimensions like resilience, cultural acceptability have emerged, making the concept more complex and wider.

Food availability is determined by supply of food through production, the mechanisms of exchange that are in place, and how food is distributed (WWF-UK, 2016). The agro-food value chain activities that influence food availability are production, distribution and retailing. The factors that determine food availability through production are land holding sizes and human capital (hence, poor production methods); fluctuating weather patterns; unsuitable state economic policies; lacking agricultural inputs; poor transport and market infrastructure; and poor storage facilities (Ericksen, 2008; FAO, 2006, 2016). On the other hand, distribution affects food availability largely through availability of infrastructure and means of transport used (FAO, 2016).

Food access refers to the affordability, allocation and household preference of food. Food access is therefore determined by an individual or household affordability of food, as well as food allocation and preference that are mainly influenced by food production and retailing (FAO, 2016). The determinants of food affordability include prices, income and wealth levels, while allocation is determined by market and household allocation decisions (Ericksen, 2008). Besides income and employment, which improve purchasing power, access to food can also be achieved through household own production (FAO, 2016). Household access to food can be limited by low income, limited work opportunities, limited access to off-farm employment, low returns to farmers for their production, a high and increasing level of poverty and skewed income distribution (Boussard et al., 2006).

Food utilization denotes the proper use of food or ability to utilize accessed food based on sufficient water, sanitation and an understanding of nutrition (FAO, 2003a, 2016). Food utilization is determined by the diversity of foods consumed, facilities for cooking, criteria and guidelines for processing and packaging (Ericksen, 2008). Food utilization can be achieved through adequate intake of nutrients through good food preparation and intake practices, dietary diversity and distribution of food within household members (FAO, 2008). Lastly, food stability is determined by the consistency of availability, access and utilization of food, over time. If periodically one lacks food, s/he will be considered food insecure even if s/he has adequate food at a certain point in time. Food stability may also be affected by extreme weather conditions, political conflicts or instability and economic issues like high food prices and unemployment (FAO, 2008).

The multidimensionality of food insecurity makes it complex and challenging to measure in totality. Though the increase of food security indicators has provided a greater variety of measures, there has been little consensus among different institutions (Headey & Ecker, 2012). This has resulted in multiplication of survey instruments and measures of food security (Carletto et al., 2013; Jones et al., 2013; Pérez-Escamilla & Segall-Corrêa, 2008; Webb et al., 2006). Even then, these measures complement each other, and as a result, studies have often combined two or more of them (Jones et al., 2013).

Among the most common categories of food insecurity measures include 1) dietary and food consumption metrics like the household dietary diversity score and food consumption score; 2) anthropometric measures; 3) experience based measures (household hunger scale, coping strategies, food insecurity experience scale); and 4) household income and expenditure surveys (Herforth & Ballard, 2016; Pérez-Escamilla & Segall-Corrêa, 2008). These metrics may measure food insecurity at the global, regional, household or individual levels depending on which level they draw their data (Abafita & Kim, 2018). Jones et al. (2013) points out that they vary in simplicity or complexity of data collection and analysis to give the desired results.

Dietary and food consumption measures collect household information on food consumed or purchased in a specified recall period, typically up to 14 days (Carletto et al., 2013; Headey & Ecker, 2012). Anthropometric measures assess individual food insecurity through indicators such as stunting, wasting and underweight and are most common in assessing nutritional status, especially among young children (Jones et al., 2013; Pérez-Escamilla & Segall-Corrêa, 2008). Household income and expenditure surveys are mostly implemented at a national level (Pérez-Escamilla & Segall-Corrêa, 2008) to calculate indices such as the consumer price index. It can also yield results on patterns of food consumption among households as well as the monetary value of foods (Jones et al., 2013).

Behavior and experience based measures are more focused in assessing the access dimension of food security (Ballard et al., 2013). These categories of indicators are considered a more direct measure of food security in comparison to the other derivative or indirect measures. The Household Food Insecurity Access Scale (HFIAS) and Food Insecurity Experience Scale (FIES)

are examples of commonly used experience based food insecurity measures (Abafita & Kim, 2018; Coates et al., 2007; Headey & Ecker, 2012).

It is common for studies to validate food security metrics by studying their associations with variables that are deemed to be theoretical constituents of food security (Ballard et al., 2013). Webb et al. (2006) notes that food security measurements in developing countries rely on proxy measures that are basically the determinants or consequences of household food insecurity. There is a wide array of variables that are considered as determining factors of the main aspects of food security. They range from household income and assets, production and marketing factors to socioeconomic and demographic characteristics of households (Silvestri et al., 2015).

For example, age, education level, amount of rainfall, farm and off-farm income, livestock, soil conservation practices, per capita consumption expenditure, land size, use of improved seed and soil fertility status have been shown to positively influence household food security. On the other hand, access to credit and irrigation, level of income, distance to selling points, gender of household head and number of family members have been shown to negatively influence household food security (Abafita & Kim, 2018; Abdulla, 2015; Mbolanyi et al., 2017; Muche et al., 2014; Otunaiya & Ibidunni, 2014; Sani & Kemaw, 2019).

2.7.2 Agro-food value chains and poverty

Poverty continues to be a major developmental challenge for Africa. Global poverty rate has been on a decline since 1990, however, extreme poverty is still concentrated in sub-Saharan Africa where 40% of the population live on less than USD 1.90 a day (World Bank, 2020a). Although the proportion of poor individuals in Kenya reduced by 10% in the decade 2005/06 to 2015/16, the number of poor persons remains unacceptably high at 16 million (36%) of the total population (KNBS, 2018a). A review by the World Bank shows that Kenya is not on the trajectory to eliminate poverty by 2030 and the incidence of poverty is relatively high in contrast to similar middle income countries (World Bank Group, 2018). Evidence by the World Bank shows that the poor predominantly rural; four out of five poor persons live in the rural areas (World Bank, 2020a). In Kenya, poverty rate is higher in the rural areas (40%) compared to the urban areas (30%). The majority (70%) of the rural population are involved in agro-food value

activities mainly as smallholder farmers or laborers (ASDSP, 2010; Geda et al., 2001; KNBS, 2018a).

Production, marketing and climatic challenges, among others, converge to deny farmers the opportunity to reap substantial benefits from farming, while making them vulnerable. As Boussard et al. (2006) notes, rural households generate income by either selling goods they produce or labour. When these fail to generate sufficient income to meet basic needs, households fall into poverty. Unless the volume of agricultural goods produced by rural households is matched by prices that result in productivity gains, the households remain poor. As such, tackling poverty means dealing with the problems that smallholder farmers face (Dixon et al., 2001).

Agriculture, and more specifically, agro-food value chains have great potential to reduce poverty in sub Saharan Africa (AGRA, 2017; Schaffnit-Chattenjee, 2014; Webber & Labaste, 2009). This is largely because they employ (directly or indirectly) majority of the poor, utilize factors of production (labour) that the poor have and generate outputs which they consume (Boussard et al., 2006). In other words, agro-food value chain activities have the potential to raise producers' incomes, raise real wages of workers, reduce prices of food products, create demand for services and accelerate economic growth (Dixon et al., 2001; Kamau et al., 2011).

An increase in production has the impact of increasing incomes for the rural households while at the same time increasing the quantity of food available for consumption (Schaffnit-Chattenjee, 2014). Given the importance of agro-food value chains in the rural areas of Kenya, their role in poverty alleviation cannot be understated. Strategies for strengthening and improving their performance while ensuring inclusion of the poor are therefore necessary for achieving poverty reduction (Dixon et al., 2001). Such strategies should be geared not only towards increasing the amount of food produced but also increasing the income received from both on farm and off-farm activities (AGRA, 2017).

Just like food security, poverty is a complex and multidimensional concept which involves interaction of economic, social, political and demographic factors in a dynamic, institutionally embedded, gender and location specific environment (Chaudhry et al., 2009). Even then, poverty measures makes it possible to target, monitor and evaluate interventions that are focused on

alleviating poverty, while ensuring the poor are kept on the agenda (World Bank Institute, 2005). Poverty has been associated with deprivation of well-being which constitutes material, social and emotional deprivation (Chaudhry et al., 2009). Poverty lines are commonly used to define the minimum consumption level below which persons are deemed poor (Jan et al., 2008). Globally, persons living on below USD 1.90 per day are considered extremely poor. However, this is adjusted for different countries depending on income categorization. It is also common for countries to set country specific poverty lines. Kenya's poverty line is set at KShs 3,252 (USD 32) and KShs 5,995 (USD 58) for rural and urban areas, respectively (KNBS, 2018a). The most common poverty indicators are income and consumption (World Bank Institute, 2005). However, consumption is preferred over income, particularly in developing economies, for the reasons that: a) majority of the population in these countries are involved in agriculture where prices, output and hence income fluctuate a lot; and b) households tend to feel more comfortable giving accurate information on consumption rather than income (Jan et al., 2008; Suri et al., 2009; World Bank Institute, 2005).

Poverty analyses usually focuses on indices. Poverty indices are determined as a function of the level of household consumption (Jan et al., 2008). Among the most desirable characteristics of a poverty index is the ability to decompose the poverty measures into population sub groups (Chaudhry et al., 2009). In addition, this characteristic allows for comparison of where or when poverty is greatest (Celidoni, 2011; Ravallion & Bidani, 1994). Foster, Greer and Thorbecke (FGT) indices are particularly popular in the category of decomposable poverty indices. FGT indices include the head count, poverty gap and severity of poverty indices (World Bank Institute, 2005). Other indices of poverty include the Sen-Shorrocks-Thon Index, Sen Index, Watts (1968) Index, individual daily calorie consumption and food consumption as a share of total expenditure (Chaudhry et al., 2009; World Bank Institute, 2005). The choice of an index depends on the objective of undertaking the poverty measurements, as well as the strengths, weakness and assumptions of the measure chosen.

Although poverty indices help in constructing poverty profiles, they do not explain the causes of poverty. An understanding of the factors that drive households into poverty is important for policy makers in designing strategies for poverty alleviation (Suri et al., 2009). Analysts and researchers often use correlates (determinants) of poverty to explain why a household is poor.

The determinants of poverty are modelled using regression analysis (e.g logit or probit) where the endogenous or dependent variable is a dummy or binary variable with (1) representing a poor household and (0) a household that is not poor (Chaudhry et al., 2009). Alternatively, per capita expenditures used as a proxy for income or incomes of households can be used in place of the binary variable. It has been argued that use of the binary variable as opposed to expenditure results in loss of information on poverty distribution. However, it remains a popular way of poverty profiling.

The exogenous or explanatory variables can take the form of categorical variables, dummy variables or continuous variables. Several explanatory variables have been modelled as determinants of poverty and can be categorized into regional; community (infrastructure, health and education services and markets); and household and individual characteristics (World Bank Institute, 2005). Household and individual characteristics are most important and popular. They include economic (income, consumption spending, employment, household property and assets); social (education, shelter, health and nutritional status, availability of health and medical services); and demographic (household size and structure, female-male ratio, dependency ratio age and gender) characteristics of households (Chaudhry et al., 2009; Jan et al., 2008; World Bank Institute, 2005).

Studies have shown that education, household size, age of household head are important determining factors of poverty (Chaudhry et al., 2009; Geda et al., 2001; KNBS, 2018; Suri et al., 2009). Households headed by a male are less likely to be poor than those headed by a female (Geda et al., 2001). According to Biyase and Zwane (2018), the level of education of household head significantly reduces the possibility of a household being poor. In addition, poverty increases with large household sizes and increase in age of household head (KNBS, 2018a). Dependency ratio and living in a rural area also increases the likelihood of being poor (Biyase & Zwane, 2018). A study by Ravallion and Bidani (1994) showed that land use variables were strong determinants of poverty in the rural areas. However, Geda et al. (2001) found that size of the land holding is not a determinant of poverty. Finally, Suri et al. (2009) found that cultivating more land, use of fertilizer and being a participant of a producer group are important in protecting households against poverty.

2.8 Gaps in Literature Review

a) Limited in-depth studies on wheat value chain in Kenya

Studies on the wheat value chain in Kenya seem sparse and limited. This is despite the documented concerns on stagnated wheat production against growing wheat consumption. Studies such as those of Chemonics International (2010); Monroy et al. (2013); and Nyangito et al. (2002) have provided a background on the wheat value chain by analyzing production, consumption and policies related to the commodity in a view of establishing trends and competitiveness of the product. In these studies, wheat forms one of the commodities under study and as such lack in-depth analysis of the value chain. Furthermore, existing studies on wheat value chain tend to concentrate on a specific level of the value chain, say production, consumption or trade. For example, Muyanga et al. (2005) and Kamau et al. (2011) analyzed consumption and expenditure on wheat and wheat products by urban households but in the context of other selected commodities consumed by urban households. Nyoro et al. (2007) focused on compatibility of trade and domestic policy intervention on wheat, while Macharia and Ngina (2017) focused on wheat breeding. Although Hassan et al. (1993), Njeru (2010) and Mahagayu et al. (2007) analyzed wheat productivity among farmers, focusing on the sources and factors influencing farmers inefficiency, their results may not adequately reflect the current situation. The study by Mahagayu et al. (2007) is in the same study area as the present study; and although it gives the opportunity to compare results in the same area, Mahagayu's study was undertaken more than a decade ago. No other similar study (wheat value chain) has ever been done in the region since.

b) Understanding the economic benefits of actors in the dairy value chain

The economic and social importance of the Kenya dairy value chain has attracted consideration as a subject of study. For example, studies conducted by FAO (2011); Gade and Thomas (2014); Kurwijila and Bennett (2011); Makoni et al. (2013); Muriuki (2003); Staal et al. (2003); and Wambugu et al. (2011) focused largely on identifying issues affecting the performance and effectiveness of the dairy value chain with the objective of identifying opportunities for improving production and expanding the sector. Given the dominance of smallholder farmers in the dairy sector, Mburu et al. (2007) and Muriuki (2003) leaned more towards analyzing issues around the smallholder farmer in an effort to improve the production level of the value chain. However, fewer studies have focused on other value chain actors leaving room for more studies

to be undertaken. Setpro (2013) identified milk processors in Kenya, their supply chain, products and markets, while Argwings-Kodhek et al. (2005) and Bosire et al. (2017) focused on consumers by looking at the consumption trends of dairy consumers, particularly in the urban areas.

c) An understanding of the value added by actors in the beef value chain

The beef value chain in Kenya is more-often-than-not classified as a sub chain of the livestock value chain. Much focus has been given to the pastoralists beef value chain which accounts for approximately 80% of the red meat consumed in Kenya (Wanyoike et al., 2018), as well as to livestock and fodder value chain in the pastoral regions (Aklilu et al., 2013; Farmer and Mbwika, 2012; Wanyoike et al., 2018). Using a production approach, Behnke and Muthami (2011) made an attempt at measuring the direct use value as well as non-agricultural contributions of livestock in Kenya, confirming that cattle was the most important source of red meat. Given the need to quantify the value of the sector and for an enhanced comprehension of the value chain, Alarcon et al. (2017), Makokha and Witwer (2013) and Wanyoike et al. (2018) analyzed the value chain actors, their roles and relationships and the supporting environment (markets, business, legal and regulatory framework). This approach results in identification of the challenges and constraints in the value chain. On the same line of thought, Bergevoet and Engelen (2014) identified the challenges, threats and opportunities for investment in the Kenya meat value chain. However, these studies did not provide a value-added analysis of the value chain.

d) Value chain analysis for all actors in the value chain

Arguably, there are few studies that engage in value added analysis for all actors in the chain due to the intensity of work especially considering the amount of data and analysis involved. Few have made considerable effort in analyzing value added by all actors in the chain (Gitau et al. 2010). Consequently, there remains a gap for more studies to undertake complete value chain analysis on the various agricultural value chains at national and local levels. Moreover, focus on a certain level of the value chain misses on the opportunity of looking at the complete value chain in totality.

e) Broader understanding of governance and constraints in the agro-food value chains

Studies on governance of agro-food value chains are limited. Partly because the concept of governance in value chains has developed recently. Recent studies such as those of Kiambi et al. (2018); Muloi et al. (2018); and Nyokabi et al. (2018) have investigated the relationships and linkages of actors in both formal and informal marketing channels of the milk and poultry value chains. Further, as part of analysis of governance, Carron et al. (2017), Muloi et al. (2018) and Nyokabi et al. (2018) examined the aspect of power and dominance in value chains. However, there is still room to explore governance of various agro-food value chains in Kenya. Past studies have analyzed constraints and opportunities in different value chains. For example, MacOpiyo (2014) brought out the potential for women to fully take part in the livestock value chain by highlighting the constraints and opportunities for women within the livestock value chain. Carabine and Simonet (2018) assessed the climate threats at every stage of the value chain, pointing out the adaptation and investment prospects of transforming value chains to be more climate resilient. On the other hand, Korir (2016) analyzed the threat posed by high cattle population to sustainability and reforestation efforts in South West Mau forest. Constraints in agro-food value chains change in nature and magnitude due to the dynamic environment under which they operate. This creates the need to constantly evaluate these constraints in order to design opportunities based on these changes.

f) Linking value chains to food security and poverty

Linking food insecurity and poverty to the economic activities of farmers, especially at the household level, remains an open area for research, and which remains quite limited to date, as the relevant literature reveals. While studies on determinants of food security and poverty are available, studies linking specific value chain activities to food security and poverty are limited. With the growing popularity of the value chain concept in analysis of agricultural value chains, studies have delved deeper into analyzing costs and benefits of the actors in the value chain. This helps to clearly bring out the performance of the value chain in terms of benefits accrued to each participant. Gade and Thomas (2014), Mburu et al. (2007), Staal et al. (2003), TechnoServe (2008) and Wambugu et al. (2011) have made attempts to establish the distribution of margins for the dairy value chain actors. Whereas the focus of most studies have been on the performance, output, consumption and value added by actors in the value chain, some studies have attempted to include gender (Auma et al., 2017; Katothya, 2017) and financial perspectives

(Coates et al., 2011) in their analysis. However, there is still room to investigate these factors for local value chains and assess their contribution to developmental goals such as reduction of poverty and food security.

In summary, this study intends to fill the following major gaps in the existing literature of agro-food value chains:

1. Perform a value chain analysis (identification and mapping, establishing value added, identification of constraints and opportunities) of all the actors in the wheat, beef and dairy value chains.
2. Link the contribution of value chain participation to household welfare outcomes of food security and reduction of poverty.
3. Contribute to the existing body of knowledge on wheat, beef and dairy value chains in Kenya and a better understanding of the three agro-food value chains at the local level.
4. Through evidence-based results, contribute to the identification of innovations and policy alternatives for improving not only the economic returns derived from participating in these value chains but also household welfare.

2.9 Theoretical Framework

This study draws its theoretical foundation from two theories: Value Chain Theory and Transaction Cost Theory. These theories are applicable to this study because they help in understanding the study concepts and variables as well as in data analysis. In addition, the two theories complement each other and provide important explanations to various aspects of the study.

2.9.1 Value chain theory

The concept of value chain has evolved over time from its initial conceptualization in the early 1960s through the French filière framework and later in the early 1980s commodity chain by Hopkins and Wallerstein. The concept continued to develop through the notable works of Michael Porter (paper on competitive advantage), Gary Gereffi and others on global commodity chain in the 2000s. Hopkins and Wallerstein described commodity chains as a web of both labour and production practices that end in a complete commodity (Hopkins & Wallerstein, 1986). In building the chain, they began from the final production moving backwards to reach

the primary raw materials used. Preceding the works of Hopkins and Wallerstein, was the filière approach which was developed in France by researchers in the 1960s (Bair, 2008). It was used to analyze agricultural systems in the developing countries. The filière approach focused on the physical and quantitative relationships which were summarized in flow-charts of commodities and mapping of relationships (M4P, 2008).

An important contribution to Value Chain Theory was through the works of Porter. He introduced 'value chains' as a new term (FAO, 2014). Porter distinguished between activities that directly add value to the production process of a product (primary activities) and those that indirectly influence the final value of the product (support activities) (M4P, 2008). He argued that a firm consists of a chain of activities. This set of activities form linkages through which different enterprises are connected and which may extend from an individual firm to its suppliers or distribution channels (Bair, 2008). He further argued that a firm should identify which of these activities it has competitive advantage.

A commonly mentioned contribution to the literature on commodity chains was the work by Gary Gereffi which changed the terminology commodity chains to Global Commodity Chains (GCCs). Gereffi laid out a framework with four key structures that shape GCCs: 1) an input-output structure, which describes the process of converting raw materials into finished products; 2) a geographical dispersion of production and marketing networks; 3) an institutional framework within which a value chain is entrenched; and 4) a governance structure, which describes the manner in which certain chain actors wield control over others and how lead firms allocate the value that is generated along the chain (Gereffi, 1995; Gereffi & Fernandez-Stark, 2016). In addition, a fifth dimension to value chain – upgrading- developed. Upgrading, examines how actors move between different levels of the chain (Gereffi & Fernandez-Stark, 2016).

The governance aspect of the GCC framework received a lot of attention from the author (Gereffi) as well as others who have used the framework. In later work (2005), he proposed "a more complete typology of value chain governance" by differentiating between the markets, relational, modular, hierarchy and captive type of value chains (Gereffi et al., 2005). According to Gereffi et al. (2005), the type of value chain governance structure is determined by three key

factors: the complexity of the transaction, capability to codify information and capability of production by suppliers in relation to the requirements of the transaction.

Variations on the value chain concept have since emerged from the 2000s in response to perceived limitations of the original value chain concept (FAO, 2014). The most recent is the Sustainable Food Value Chain (SFVC) by FAO. This was an attempt to integrate the concept of sustainable development in food value chains. However, the value chain has come to generally be described as all the activities which together bring a product or service from the initial stage of conception, through the various stages of production that involve physical transformation of inputs and use of producer services to delivery to finished product to consumers, and eventual discarding after use (Kaplinsky & Morris, 2007). To understand a value chain, three key steps are necessary (FAO, 2014; Hawkes & Ruel, 2011; Kaplinsky & Morris, 2001). The first step is to identify and map the actors and activities that link together to cause the movement of goods and services from initial production to consumption. The second step is to understand in what way value is generated and added at each stage of the value chain, while the third step is to identify opportunities for change in the value chain. In addition, evaluating governance and upgrading options is equally important.

Value chain concept has been applied widely in agro-food value chains. The rise in globalization in the 2000s witnessed increasing interest in global value chains. The global economy was increasingly being organized into global value chains (Gereffi & Fernandez-Stark, 2016). Literature on value chains also emerged to help increase the understanding of how actors in developing economies are incorporated into international markets (Bolwig et al., 2008). This has been viewed as an opportunity to assist developing countries integrate more into the global value chains in order to capture more gains and open new markets (Hawkes & Ruel, 2011). Locally, the concept of value chain has been used extensively in examining the competitiveness, productivity and effectiveness of agricultural value chains (for example, Coates et al., 2011; Farmer and Mbwika, 2012; Gade and Thomas, 2014; Korir, 2016; Monroy et al., 2013; Muthee, 2006; TechnoServe, 2008). It has also been used to determine agricultural value chains that can be prioritized for investment and development. The flexibility of use of value chain concept has also been adopted to exploring associations between agricultural value chains and food security, environment and gender (Europeaid, 2011).

2.9.2 Transaction cost theory

Transaction Cost theory finds its early roots in the 1930's with the work of Ronald Coase 'The nature of the firm'. However, it is Oliver Williamson who attracted more attention to this theory in the 1970's. One of his notable contributions to the theory was showing that firms avoid negative transaction costs by seeking alternative governance forms within which business transactions can be structured.

Transaction Cost theory takes the transaction as the basic unit of analysis. A transaction is deemed to occur when a good or service moves across a technologically distinguishable boundary, that is, one phase of activity ends and another begins (Williamson, 1981). In other words, the production of goods and services involves a succession of stages. Transaction Cost theory seeks to understand how the parties involved in a transaction relate. The theory postulates that the existence of a transaction is contingent upon: 1) asset specificity; 2) bounded rationality; and 3) opportunism.

Asset specificity is the degree to which assets, physical and human, are confined in a particular transaction or business relationship and thus the degree to which the assets are worth in other activities (Dietrich, 1994). Bounded rationality and opportunism are important human behavioral assumptions that help understand the nature of transactions. Bounded rationality assumes that the "organized man" is not capable of solving complex problems due to limited competence, while opportunism assumes that some "economic agents" in a contracting transaction will tend to be dishonest in order to pursue self-interests (Williamson, 1981). In value chains, each actor aims at minimizing transaction costs and capturing more value, under circumstances of limited wisdom and opportunistic actions. This explains the incentives or disincentives of an actor's involvement in value chains.

Transaction Cost theory has been used widely in social sciences to explain the behavior of firms, markets and organizations. The concept of value chain borrows heavily from this theory. Value chain involves a set of interlinked activities that cause the transformation of a product from initial production to consumption. These activities are viewed as transaction blocks which are interdependent, one activity has to complete in order for the other to begin. Transaction Cost theory provides a framework for examining how value is created at each stage of the chain

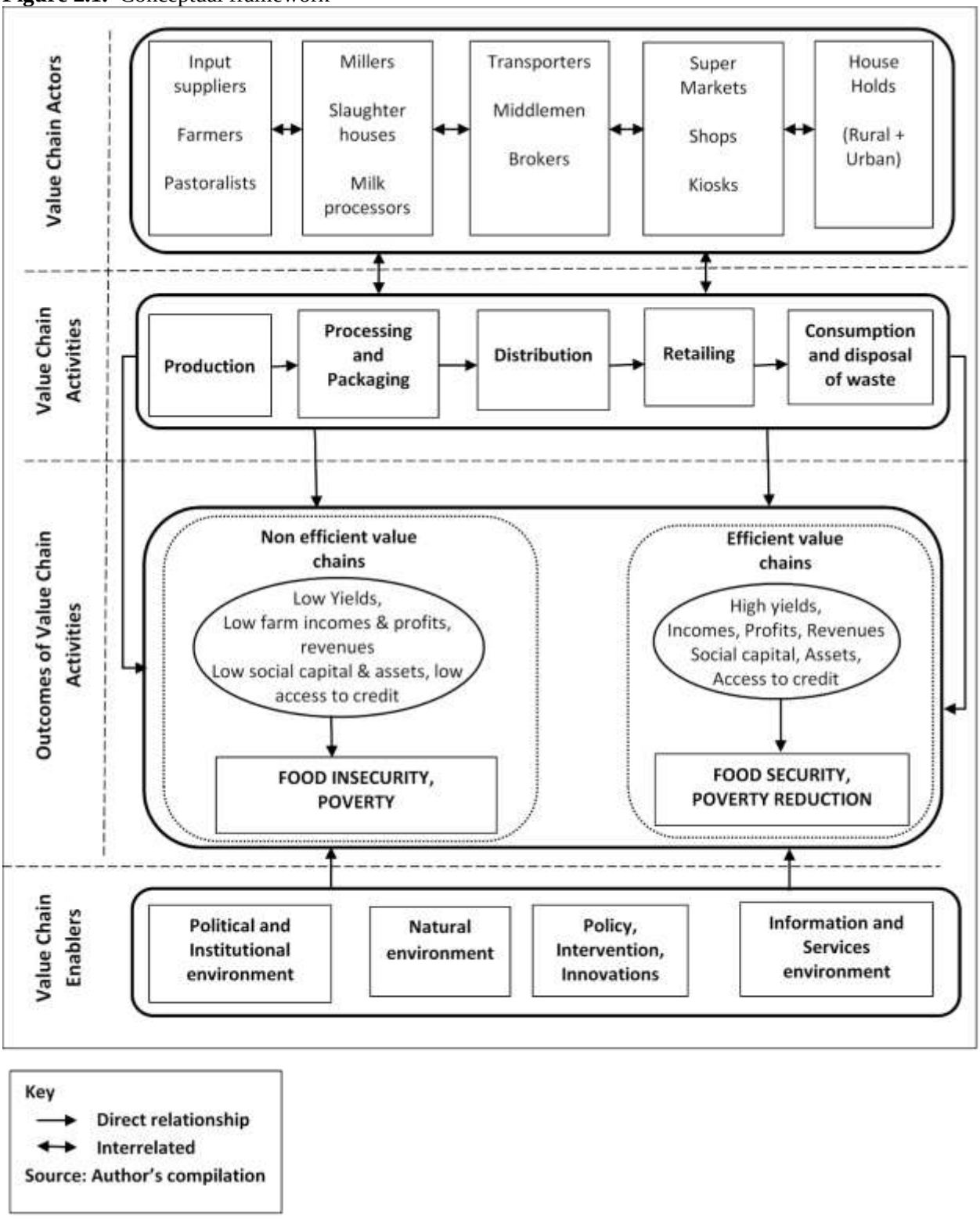
through the 'transaction'. Establishing the value of each activity (transaction block) involves identifying the revenue and costs which constitute the transaction – the unit of analysis for value addition. Transaction cost theory looks at a transaction as the very unit of analysis. Therefore, understanding transaction cost is vital to the study of firms and farms by evaluating how their governance assists in economizing costs (Williamson, 1981). Trienekens (2011) argues that under the conditions of opportunistic behavior and limited wisdom or rationality of actors, companies choose a governance form that minimizes their transaction costs.

In Transaction Cost theory, an actor is viewed as being more than a production function who possess coordination potential that sometimes transcends that of the market (Dietrich, 1994). Further, it recognizes that where transaction costs are positive, exchange arrangements must be ruled, and depending on the nature of the transaction, some governance forms are superior to others (Richman & Macher, 2006). This could explain why some farms and firms vertically integrate in the value chain by choosing to perform certain transactions internally. This is applicable to value chains, as actors often make decisions (depending on actual or perceived benefits) whether to vertically integrate upwards or downwards in the value chain by performing additional roles. Additionally, Transaction Cost theory can explain governance structures in value chains by showing why particular actors in the chain (lead actors) wield control over other actors and how the lead actors capture more value in the chain.

2.10 Conceptual Framework

The conceptual framework (Figure 2.1) seeks to show and explain the actors and activities in a value chain and their relationships as well as the output of a value chain in terms of production and welfare outcomes of food security and poverty alleviation. In an agro-food value chain (for this study wheat, beef and dairy), the main value chain activities include production, processing, distribution, retail and consumption. These activities are interdependent, interrelated and collectively form the value chain. For each of the value chain activities there are different actors involved. For production, there are farmers (smallholder and large-scale) and pastoralists who are involved in wheat, dairy and beef production. They receive their inputs and services for production from input suppliers dealing with agrochemicals (popularly known as agrovets), breeding, veterinary and agriculture extension service providers.

Figure 2.1. Conceptual framework



At the processing stage, there are milk processors in the dairy value chain, slaughterhouses and abattoirs in the beef value chain and millers for the wheat value chain. From the processing stage, products are distributed to the retailers by transporters. For this study, distributors also include other persons who are involved in moving goods in whatever form along the value chain at any stage. They include collectors, middlemen and brokers. The retailers receive both processed and unprocessed products from distributors for sale. Retailers include shops, kiosks, supermarkets, milk bars and butcheries who sell the products to consumers, that is, households (both rural and urban).

The activities of the actors in the value chains result in transition of food from the farm (production) to the plate (consumption). For the actors, these activities are a source of employment and livelihood through which they earn income, revenue, food for consumption and assets. Households that participate in efficient value chains are capable of remaining food secure and out of poverty, for the value chains are able to sufficiently guarantee these outcomes. On the other hand, value chains can be constrained by various challenges, making them inefficient and unable to generate sufficient yields, incomes and revenues. Consequently, households participating in such value chains are likely to fall into poverty and become food insecure.

Value chain activities and actors exist within supporting environments. The political and institutional environments provide policy and regulatory framework and support the actors through among others research and development. The information and services environment provides information, knowledge and training to the value chain actors. Whereas the natural environment forms the context within which value chains draw their resources. In addition, policies, innovations and interventions form part of the enabling environment that has the potential to improve value chain efficiency and hence contribute to improved food security and reduction of poverty.

CHAPTER 3. THE STUDY AREA

3.1 Introduction

This chapter presents the geographical, physical and human characteristics of the study area – North West Mt. Kenya region. It begins by giving the location and size of the study area before describing the physiography, climate, vegetation and soils which support the different land use and economic activities of the area. Finally, the chapter presents the population dynamics, land use and farming systems – as they relate to wheat, dairy and beef farming in the area.

3.2 Geographical Characteristics

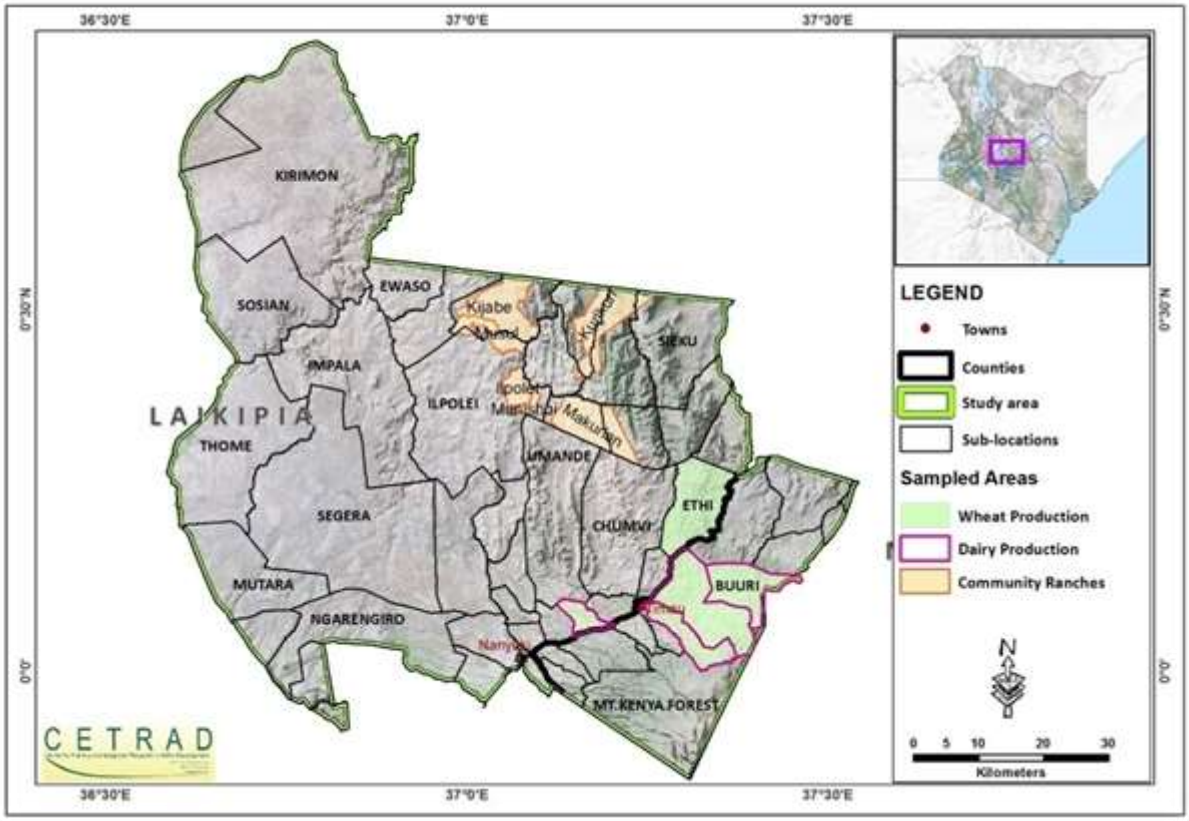
The study area – North West Mt. Kenya region – is located between latitude $0^0$18'S and $0^0$30'N and longitudes $36^0$70'E and $37^0$30'E, and covers approximately 5,000km^2 (Figure 3.1). The area, North West Mt. Kenya, is a geographically defined region for the purposes of this study and is not demarcated by administrative boundaries as is common in most studies. It occupies a part of the Upper Ewaso Ngiro North Basin sandwiched within the north western slopes of Mt. Kenya and the eastern end of the Nyandarua Ranges. The area extends northwards of Mt. Kenya into the Laikipia Plateau, which is predominantly under arid and semi-arid condition. Administratively, the study area lies within three sub-counties in two counties: Laikipia East and Laikipia North sub-counties of Laikipia County; and Buuri sub-county of Meru County. The Laikipia East sub-county headquarters Nanyuki and that of Laikipia North sub-county mark the western and northern limits of the study area; Nanyuki is the biggest town in the area.

3.3 Physical Characteristics

3.3.1 Physiography

The main physical feature in the study area is Mount Kenya standing at an imposing height of 5,199 m asl; and one of the two forest ecosystems in the area. It is the primary source of water in the area; the tributaries that drain through the study area flow northwards to drain into the Ewaso Ngiro North River. Other protected forest areas in the northern fridges of the study area include Mukogodo and Ngare Ndare forests. The altitude drops northwards to reach an average of 1500 m asl at the Laikipia Plateau interspersed with numerous peaks notably the Mukogodo hills and the Ol Daiga ranges (2,200 m asl). This steep altitudinal drop results in the diverse topography and climatic zones present in the area.

Figure 3.1. Location of the study area



Source: Centre for Training and Integrated Research in ASAL Development

3.3.2 Climate

The annual average rainfall in the area varies between 400mm and 1200m. The rainfall pattern in the areas differs with the altitude. The foothills of Mt. Kenya receive between 750mm to 1200mm of rainfall, reducing to 500mm in the plateau while the drier parts in the north receive 400mm annually (GOK, 2018a). The area around Mukogodo Forest gets an average rainfall of around 700mm annually. There are two main rainfall seasons; the long rains, between March and June, and the short rains, between October and December (Kiteme et al., 1998). However, the areas around Mt. Kenya gets conventional rainfall between June and August as a result of the effect of the trade winds (GOK, 2013). The mean annual temperature of the area ranges between 16ºC and 26ºC, though it can go to as low as 8ºC to a high of 32ºC during the cold and hot seasons, respectively, and in specific areas within the region (GOK, 2014, 2018b). The area

around Mt. Kenya is cool and it gets hotter as you move to the lowlands in the north. The average duration of sunshine is between ten and twelve hours daily.

3.3.3 Vegetation and soils

The study area has different types of soils, primarily, loam, sand and clay. Red friable to dark red brown soils are found on the hillsides while the plateau is characterized by black cotton soils (GOK, 2013)**.** These soils support different types of vegetation. The area around Mt. Kenya is forest with dense vegetation. Next to the forest area is crop land (Photo 3.1). This transits to a mix of savannah, open grassland (Photo 3.2) and woodland on the black cotton and red soils in most of the Laikipia Plateau (Graham, 2012). The dry northern parts of Laikipia are dominated by acacia woodland with very sparse grass cover (Photo 3.3) which has been attributed to heavy grazing and soil degradation by erosion (Kiteme et al., 1998).

Photo 3.1 Crop land

(Photo credit: Author, 2016)

Photo 3.2. Grassland

(Photo credit: Author, 2017)

Photo 3.3. Wood grassland

(Photo credit: Author, 2017)

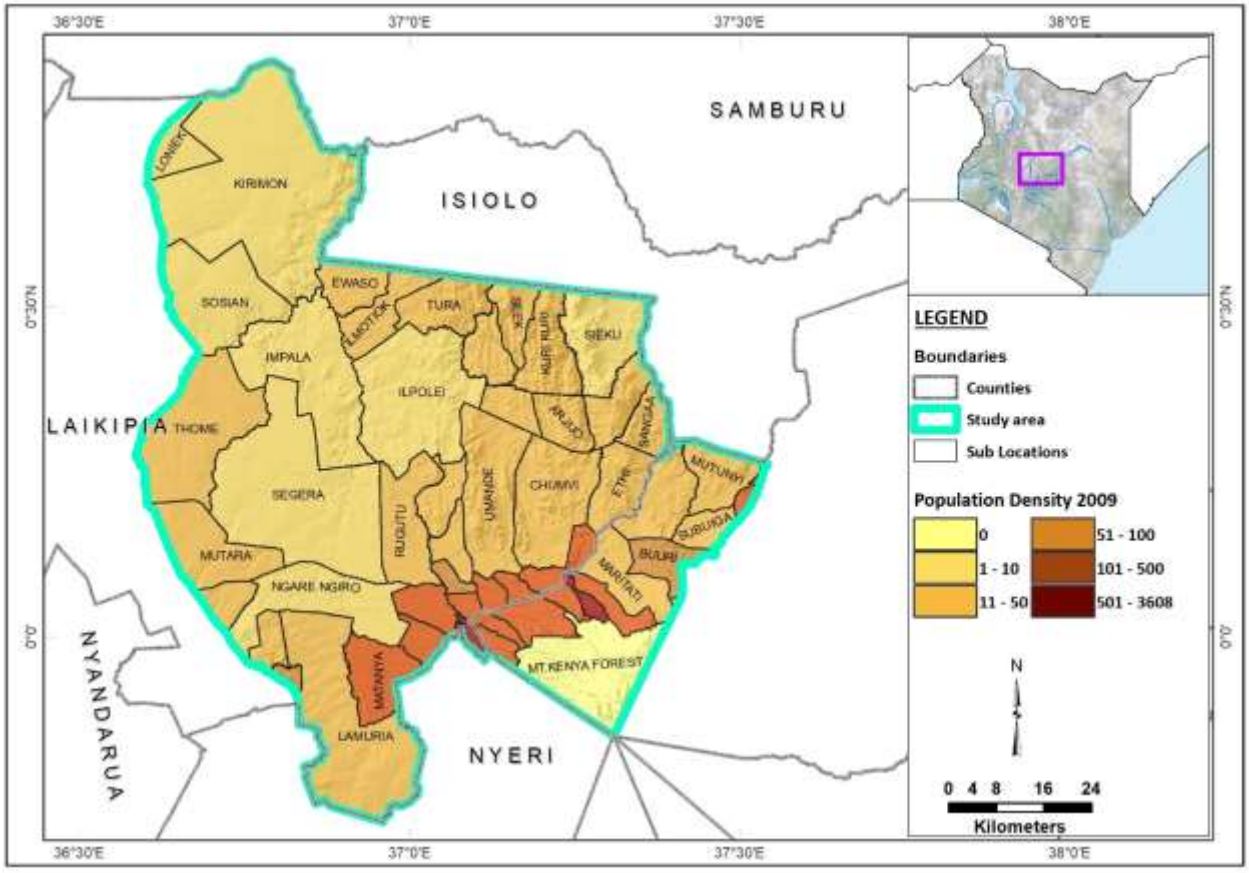
3.4 Demographic Characteristics

3.4.1 Population density and settlement

The settlement pattern in the study area is influenced by the history of settlement and differences in land potential, climate, infrastructure development and availability of social amenities among the different settlement blocks. Higher population densities are found in the high agricultural

potential areas and infrastructure developed areas (Figure 3.2). The population density of the study area is defined under three sub-counties: Laikipia East with a population density of 94 persons per km^2, Laikipia North with 17 persons per square kilometer (km^2) (GOK, 2013) and Buuri with a population density of 152 persons per km^2 (GOK, 2018a). In the study area, the population density is higher at Buuri sub-county because of its high agricultural potential and lower in Laikipia North where land is drier and less cultivable. Population density is equally high in Laikipia East sub-county because of Nanyuki town.

Figure 3.2. Population density



Source: Centre for Training and Integrated Research in ASAL Development

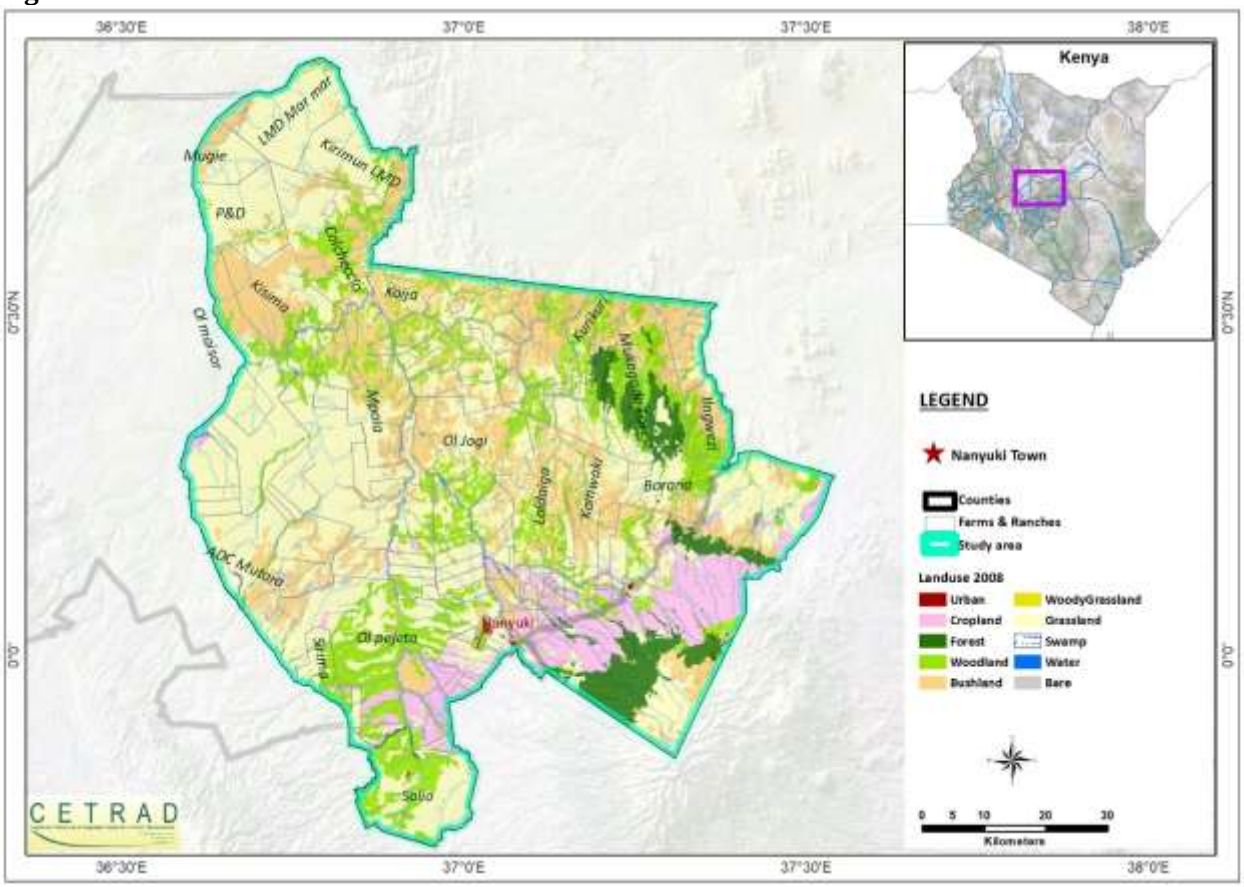
3.4.2 Land use and farming systems

Similar to population distribution, land use patterns in the area are greatly influenced by the climatic conditions and ecological zones (Figure 3.3). The main types of land use include pastoralism, agro-pastoralism, mixed farming, large-scale farming and ranching (GOK, 2018a, 2018b). The area next to Mt. Kenya Forest is crop land where both small-scale and commercial agriculture is practiced. Photo 3.1 shows crop land in Buuri Sub County where large-scale

commercial farming is practiced. Towards the north, where land changes to a mix of bush land, woodland and grass land, livestock keeping is practiced by large-scale ranchers and pastoralists.

Smallholder farmers practice mixed farming (crop farming and livestock keeping) on average two acres of land. On the other hand, the large-scale farmers are involved in commercial farming on extensive pieces of land of over 18 hectares (GOK, 2018b). The crops cultivated in the area consist of wheat, barley, maize, beans, Irish potatoes and vegetables. Crop production is predominantly rain fed for the two production types of large-scale and smallholder farming with minimal irrigation restricted to the few farmers engaged in horticultural production. Extensive cultivation of commercial wheat, barley, irrigated flower and vegetable is practiced in the Timau region in Buuri Sub County (Graham, 2012).

Figure 3.3. Land use



Source: Centre for Training and Integrated Research in ASAL Development

Wheat is grown in the Timau area, and some parts of Laikipia East, and is a significant food crop in the region, occupying most of the cultivated land followed by Irish potatoes, beans and maize. On average, about 13,000 hectares of land in Timau is under wheat cultivation in a season, with two seasons in a year. Just like the national trend, county data shows that wheat production in the study area (Timau region) has generally maintained the same stagnant and erratic trend.

Dairy farming is practiced by smallholder farmers as part of mixed farming. Milk production is either for self-consumption or sale. Smallholder farmers keep on average five dairy cattle (primarily local breeds), milking about four litres of milk per day in the dry season and five litres in the wet season (GOK, 2014). They account for the largest share of milk production. Milk production is also found with the large-scale farms around Timau which produce milk for commercial purposes.

Livestock production is a significant means of livelihood in the study area. In the region, most of the beef production occurs in Laikipia County which has vast rangeland than in the Meru County side. For the study area that lies in Laikipia County, livestock rearing is the most important land use activity with beef production being the single largest contributor to total livestock income (GOK, 2014). Reports indicate that beef production under pastoralism produces food worth between Kshs 1 and 2 billion, while production under large-scale commercial ranches generates more than Kshs 2 billion per annum with mixed commercial ranches being more profitable than pure livestock ranches (LWF, 2013). LWF (2013) describes pure ranches as exclusively keeping livestock and mixed ranches (usually larger in scale) having varied activities, including wildlife conservation, tourism, livestock and British Army training leases. In addition, the large-scale ranches spend about KShs 800 million in wages by employing between 8,000 and 11,000 people.

Beef production in North West Mt. Kenya region is done by the pastoralists, large-scale commercial ranches and small-scale farmers as part of mixed farming. The study area has about 25 privately owned large-scale ranches and 13 group ranches owned by the community (Letai, 2011). The community group ranches are predominantly in the northern part of the study area occupying approximately 67,720 hectares with an average land holding size of 10 hectares per household (GOK, 2018a). Conversely, large-scale ranches take up large swathes of land averaging about 10,000 acres (GOK, 2013).

Large-scale ranches in the study area have now evolved to a new system of livestock keeping (Bergevoet & van Engelen, 2014). They have developed conservancies where they maintain livestock together with game animals, engineering a new business model of game viewing/tourism and livestock. Due to their commercial orientation, large-scale ranches exhibit high levels of animal husbandry. They are also important for breeding quality steers as well as fattening animals which are targeted at the high end market (Farmer & Mbwika, 2012). However, Bergevoet and Engelen (2014) noted with concern the lack of an established market outlet for the high-quality beef products produced by these large-scale ranches. Other economic activities that the residents of the study area are involved in include formal employment, trade and business in the urban centres of Nanyuki, Timau and Doldol.

CHAPTER 4. RESEARCH METHODOLOGY

4.1 Introduction

This chapter describes the methodological procedures and techniques used in this study in order to answer the research questions and achieve the research objectives. The chapter begins by explaining the sources of data and the methods used to collect the data. It then gives a step-by-step description of the sampling strategy in terms of identification of the study sites, determination of the study target populations and sub-populations, and determination of the sample sizes. The last section of this chapter describes the main statistical techniques and analysis used in the study. These are Value Chain Analysis, Household Food Insecurity Assessment Scale, Foster-Greer-Thorbecke Indices and Regression Analysis.

4.2 Sources, Types and Methods of Data Collection

The study used both primary and secondary data to realize its objectives. The collection of primary data involved use of questionnaires, structured and controlled in-depth interviews and field observations.

4.2.1 Questionnaires

The study used questionnaire-based surveys with pre-coded and semi-structured questions as the main data collection tool for both quantitative and semi-qualitative data. The questionnaires were developed based on knowledge from literature review, field reconnaissance, key informant interviews and pre-testing. The questionnaires were administered thorough face-to-face interviews to increase the response rate, enable clarifications, as well as allow for field observations. The study engaged the help of a research assistant and resource person who were trained in administering the questionnaires.

Different questionnaires were prepared and administered to the different actors along the three agro-food value chains. These actors were input suppliers, producers, distributors and traders, processors and retailers. The input suppliers were agrovets and fellow farmers. The producers were pastoralists and large-scale ranches for the beef value chain and small, medium and large-scale farmers for the wheat and milk value chains. The processors were small and medium-sized millers for wheat and abattoirs and slaughterhouses for beef. The distributors were middlemen, traders, brokers, transporters and dairy cooperatives in the three agro-food value chains. Lastly,

the retailers were supermarkets, wholesale shops, retail shops, kiosks, butcheries, hotels and restaurants, milk bars and market stalls.

At retail level, the study collected data on the type of product; source and consistency of supply; brand names and package quantity; product shelf life; buying price, selling price and price changes; employee information; access to credit; membership to organizations; and challenges. The questionnaire was administered to the proprietor of the retail outlet or a manager with knowledge of the business.

At distribution and trade level, the study collected data on years in trade; source of product; volumes and consistency of volumes collected; buying price, selling price and changes in prices; existing supply agreements or arrangements; destination of product; product value addition; losses and waste; means and cost of transport; fees, levies and charges incurred; institutional support; income and revenue; and challenges. The questionnaire was administered to the different categories of traders and transporters.

At the processing stage, the study collected data on processing capacity; source of raw materials and buying price; amount of product processed; type, quantity, shelf life and price of processed products; product safety; marketing and distributing channels; losses and waste; processing costs; employee details; institutional support; access to credit; and challenges. The questionnaire was administered to the most senior person in the firm with knowledge on processing operations.

Input suppliers were interviewed on type, source, cost and price of agricultural inputs sold; application rates of inputs, input subsidies and other credit arrangements; services offered to farmers; and challenges. The questionnaire was answered by the proprietors of the input shops.

At production level, the questionnaire was divided into two parts. The first part collected data related to production. These were land size, ownership, tenure and utilization; yields or output, sales and output consumed; marketing channels, distance to markets and selling price; type and amount of inputs used; costs of production; employee details; institutional support and training; membership to farmers groups; access to credit; storage facilities; machinery, equipment and tools; varieties of wheat; breeds of cattle and number of livestock; value addition; access to extension services and credit; revenue; and challenges. The second part collected household

information on household size; household expenditure; income and assets; type of housing; access to water and electricity; and household food security. The questionnaire was administered either to the household head or spouse who was most knowledgeable on production activities, family's expenditure and/or food preparation.

4.2.2 Structured and controlled in-depth interviews

Structured and in-depth interviews were undertaken with a number of selected key informants. These were agricultural and livestock officers, administrative officers (chiefs, assistant and/or sub-county commissioners), officials of farmers groups, milk and livestock marketing cooperatives, officials of group ranches and rangeland officers. In addition, some traders and input suppliers acted as key informants owing to their years of experience in their respective trades and their vantage position in the value chains. These interviews sought views and opinions on the structure (actors, activities, flow of products), performance, marketing, power relations and challenges of the value chains. Through these interviews the study also sought to understand the study area better. Information collected was also used in mapping the sampling areas, verification of data obtained from other actors and complimenting the data collected, particularly from the producers.

4.2.3 Field observations

The study made use of observation at all stages of the value chains. Observations were made on machinery and tools used for production (land preparation and harvesting) and processing; products and prices at retail outlets; transactions at the livestock auction markets; types of input supplies at the input shops; and means of transportation. These observations were documented in a field observation note book and through photographs. The observed data was used to complement data collected using questionnaires and interviews.

4.3 Sampling Strategy

The study involved 1) three agro-food value chains: wheat, dairy and beef; 2) five value chain activities for each value chain: input supply, production, trade and distribution, processing and retailing; and 3) actors for each value chain: input suppliers, producers, traders and distributors, processors and retailers. Due to this complexity, the study used a multi-stage stratified random sampling strategy to determine the various study sub-samples. As mentioned earlier, the three

value chains were selected based on three key aspects of consideration that include: 1) their spatial, social and economic importance; 2) their co-existence within the same geographical space thus allowing for investigations into their interactions; and 3) their ability to produce food both for the national and regional markets.

4.3.1 Identification of study sites

The first step in the sampling strategy was to identify the specific sites from where the study sub-samples would be drawn. Nine administrative locations within the study area where wheat, milk and beef are predominantly produced were singled out through key informants. These were Ngusishi, Kisima, Umande, Ethi, Impala, Ilpolei, Ildigiri, Makurian and Mukogodo. The nine locations have a total of 16 administrative sub-locations. These are Mutarakwa and Maritati in Ngusishi location; Buuri and Ngare Ndare in Kisima location; Kalalu, Umande and Nyariginu in Umande location; Ethi, Chumvi and Ngenia in Ethi location; Rugutu in Impala location; Ilpolei in Ilpolei location; Tura in Ildigiri location; Makurian and Arjijo in Makurian location; and Kurikuri in Mukogodo location. Out of the 16 administrative sub-locations 11 of them were selected for the study. These are Mutarakwa, Maritati, Buuri, Kalalu, Umande, Ethi, Rugutu, Ilpolei, Tura, Makurian and Kurikuri. The final distribution of the sampled sub-locations for each actor in the three value chains was based on the distribution of large-scale farmers, climatic conditions and production for the national market.

4.3.2 Determination of target populations

The second step in the sampling strategy was to determine the target populations and sub-populations (actors) for each agro-food value chain. In all the three value chains, the target populations of actors selected for the study were 1) input suppliers, 2) producers, 3) traders and distributors, 4) processors and 5) retailers involved in all the value chain activities (Table 4.1, column 1). For clarity and comparative analysis, the target populations were further categorized into different and/or specific sub-populations of actors (Table 4.1, Column 2).

The *input suppliers* were mainly the agrovets in the wheat and dairy value chains. The *producers* were categorized on the basis of their scale of production into smallholder famers and large-scale farmers for wheat and dairy and large-scale ranches and pastoralists for beef. The category of medium-scale wheat farmers (10-40 ha) was excluded in the study since they were few in the

study area. However, the medium-scale dairy farmers (5-20 cows), who were also few in number, were combined with the large-scale farmers because of similarities in their modes of production.

The *processors* were categorized based on the emerging categories of millers (for wheat); abattoirs and slaughter houses (for beef); and milk processors (for dairy) the farmers and traders use as was reported in the producers' and traders' questionnaires. Similarly, the *distributors* and *retailers* were also categorized according to the emerging categories of the distributors and retailers the farmers and processors use, respectively. However, large wheat millers (>150MT) declined to be interviewed.

Table 4.1. Summary of target populations and sub-populations

Target population	**Target sub-population**	**Sample size**
WHEAT VALUE CHAIN		
Input suppliers	Agrovets	8
Producers	Smallholder farmers (<10 ha)	58
	Large-scale farmers (> 40 ha)	7
Processors	Small millers (<50MT)	4
	Medium millers (50-150MT)	3
Distributors	Middlemen/traders/brokers and transporters	4
Retailers	Supermarkets, wholesalers and retail shops	11
Along the value chain	Key informants	11
BEEF VALUE CHAIN		
Producers	Pastoralists	67
	Large-scale ranches	7
Processors	Abattoirs and slaughterhouses	4
Distributors	Middlemen/traders/brokers	10
Retailers	Butcheries	5
Along the value chain	Key informants	13
DAIRY VALUE CHAIN		
Input suppliers	Agrovets	4
Producers	Smallholder farmers (1-5 cows)	50
	Large-scale farmers (> 20 cows)	3
Processors	Milk processors	2
Distributors	Brokers/traders and milk cooperatives	16
Retailers	Wholesalers, supermarkets, retail shops and kiosks, hotels and milk bars and market stalls	17
Along the value chain	Key informants	8

4.3.3 Determination of sample sizes

The third and final step in the sampling strategy was to determine sample sizes of the targeted sub-populations (Table 4.1, Column 3). A major challenge for this study was non-availability of sampling frames for the target sub-populations. For example, there was no official inventory for the number of producers, distributors and retailers in the region. The study established the sampling frames through key informant interviews, study area maps and a reconnaissance visit.

The producers formed the basis of the sampling frame for other actors. For example, processors were selected based on the ones used by farmers and traders, while input suppliers were selected based on the named sources from where the farmers obtained their inputs. The study had four categories of producers: smallholder farmers, large-scale farmers (in wheat and dairy value chains), large-scale ranches and pastoralists (in beef value chain). A summary of the determination of sample sizes is presented in Table 4.2.

First, 7 large-scale wheat farmers and 4 large-scale dairy farmers were selected. The 7 large-scale wheat farmers were randomly picked from a generated list of 15 large-scale farmers as identified by the key informants and fellow large-scale farmers. The 4 large-scale dairy farmers were identified by the key informants, one declined to be interviewed.

Second, 58 smallholder wheat farmers and 50 smallholder dairy farmers were picked. To enable comparisons between the two different production systems, the 58 smallholder wheat farmers were selected within 20 kilometer radius of the sampled large-scale wheat farms using a combination of random and snow ball sampling procedures. The 50 smallholders in the dairy value chain were randomly sampled from a listing of 100 active dairy farmers generated from 5 selected dairy cooperatives. That is, 10 smallholder dairy farmers from 20 active dairy farmers in each dairy cooperative.

Third, 25 privately owned large-scale ranches and 13 group ranches owned by the pastoral communities formed the sampling frames for the sampled large-scale ranches and pastoralists, respectively. The ranches were situated in the drier parts of the Laikipia plateau, northwest of the study area. The sampling frames were generated from study area maps, key informants and leaders of the group ranches. From the 25 large-scale ranches, 7 of them that bordered the

community group ranches were selected for the study. This was done to allow for comparisons and to reduce spatial variations between the two groups.

Table 4.2. Summary of determination of sample sizes

Sampled actors	Derivation of sampling frames	Generation of sub-samples	Sub-sample size
Large-scale wheat farmers	Large-scale wheat farmers identified through key informants	Random sample of 7 out of 15 large-scale wheat farmers	7 large-scale wheat farmers
Large-scale dairy farmers	4 Large-scale dairy farmers identified by key informants	The 4 large-scale dairy farmers identified by key informants	3 large-scale dairy farmers
Smallholder wheat farmers	The sampled large-scale wheat farms	Random and snowball sample of smallholder wheat farmers within 20 km radius of the sampled large-scale farms	58 smallholder wheat-farmers
Smallholder dairy farmers	5 dairy cooperatives identified through key informants	Random sample of smallholder dairy farmers using a list of 100 active dairy farmers generated from the sampled cooperatives	50 smallholder dairy farmers
Large-scale ranches	Large-scale ranches identified through study area maps and key informants	Random sample of 7 out of 25 private ranches	7 private ranches
Pastoralists	6 out of 13 community group ranches identified through key informants and group ranch leaders	Random sample of pastoralists using a list of 150 pastoralists generated from the sampled group ranches	67 pastoralists
Agrovets	Outlets where farmers obtained their inputs	Random sample of 8 out of 10 agrovets for wheat farmers; and 4 out of 5 agrovets for dairy farmers	12 agrovets
Distributors	Distribution channels used by the farmers	Selection based on availability and willingness to be interviewed	30 distributors
Processors	Processors identified by the traders and farmers	Selection based on availability and willingness to be interviewed	13 processors
Retailers	Retailers identified by processors and traders	Selection based on availability and willingness to be interviewed	33 retailers

On the other hand, from the 13 community group ranches, 6 were randomly selected (see Appendix A1), out of which 67 pastoralists were randomly sampled from a list of 150 pastoralists. A sampling frame of 180 pastoralists was created by listing 30 pastoralists from

each of the 6 community group ranches. Then, 40 pastoralists were sampled from 4 group ranches with less than 300 pastoralists (10 each), while 30 pastoralists were sampled from 2 group ranches with more than 300 pastoralists (15 each). During analysis, three questionnaires were discarded due to missing information, and therefore a final sample of 67 pastoralists.

Fourth, the study selected a total of 12 agrovets (8 for wheat and 4 for dairy farmers) from a generated list of 15 agrovets from which the farmers obtained their inputs (10 for wheat and 5 for dairy farmers). In the beef value chain, most pastoralists obtained their inputs (in most cases one type) from the livestock markets. As such, these markets were visited to observe the inputs available and their prices.

Fifth, the study sampled a total of 30 distributors who were identified from interviews with farmers and key informants. These were 3 traders/brokers, 1 transporter (for wheat farmers); 10 traders/brokers (for beef farmers); and 11 traders/brokers and 5 dairy cooperatives (for dairy farmers). The final number of the interviewed distributors was affected by the following factors: 1) traders/brokers and transporters were difficult to locate and hesitant to be interviewed; 2) traders and transporters in the wheat value chain were few; 3) in most cases traders also doubled as transporters; 4) wheat traders seemed to operate within a given territory; 5) milk from producers to processors was mainly distributed through dairy cooperatives and traders; 6) beef traders/brokers were identified at the livestock markets with the assistance of the veterinary and livestock officers, as well as large-scale ranchers; there were few traders dealing with beef from the large-scale ranches; and that most large-scale ranches sold directly to retailers or processors.

Sixth, the study sampled a total of 13 processors identified by the traders, farmers or dairy cooperatives. These were 4 small millers, 3 medium millers (for wheat farmers); 4 abattoirs and slaughterhouses (for beef farmers); and 2 milk processors (for dairy farmers). The final number of the interviewed processors was affected by the fact that the large-scale wheat millers and 3 milk processors declined to be interviewed.

Seventh, the study sampled a total of 33 retailers who were identified by the processors and traders. These were 3 supermarkets, 3 wholesalers, 5 retail shops (for wheat farmers); 5 butcheries (for beef farmers); and 2 wholesalers, 3 supermarkets, 5 retail shops and kiosks, 6 hotels and milk bars and 1 market stall (for dairy farmers).

Lastly but not least, key informant interviews were undertaken all value chains throughout the study period. A total of 32 key informant interviews were carried out in the wheat (11), dairy (8) and beef (13) value chains. These interviews were conducted with government administrative officials (Chiefs, Assistant Chiefs, Assistant County and Deputy County Commissioners), agriculture officers (crop and livestock officers, veterinary officers), traders, officials of group ranches, farmer groups and cooperatives, officials of government and private agriculture organizations and officers in research institutions. Table 4.3 presents the distribution of sampled production actors in the sampled locations and sub locations.

Table 4.3. Distribution of sampled production actors by administrative locations

Sampled locations	Sampled sub-locations	Large-scale wheat farmers	Large-scale dairy farmers	Smallholder wheat farmers	Smallholder dairy farmers	Large-scale ranches	Pastoralists
Ngusishi	Mutarakwa, Maritati	3	1	21	25		
Kisima	Buuri	1		12	12		
Umande	Kalalu, Umande	2	2	15	13	1	
Ethi	Ethi	1		10	0	3	
Impala	Rugutu					2	
Ilpolei	Ilpolei					1	19
Ildigiri	Tura						25
Makurian	Makurian						14
Mukogodo	Kurikuri						9
Total		7	3	58	50	7	67

Note: Other actors were sampled based on their identification from the previous value chain level

4.4 Data Analysis

The study used various data analysis techniques and tools that complemented each other. These are descriptive statistics, Value Chain Analysis, Household Food Insecurity Assessment Scale (HFIAS), the Foster-Greer-Thorbecke (FGT) Poverty Indices and Regression Analysis. Value Chain Analysis was the main tool of analysis used in this study. Based on Kaplinsky and Morris (2001); M4P (2008); Sanogo (2010) and Trienekens (2011), the study characterized a value chain by its network structure, the way value is added and distributed, its relationships and governance form; and identification of constraints upon which upgrading options are based. With this in mind, the study adopted a three-step framework for value chain analysis in analyzing objectives one, two and three. These steps comprised i) identification and mapping of actors, activities and product flows; ii) establishing value added and distribution of benefits; and iii)

analysis of governance and constraints in the value chains. They are discussed under each of the three objectives.

4.4.1 Value chain activities, actors and product flows

The first aspect of a value chain analysis involves identification and mapping of actors, activities and product flows; and this was used to analyze the first objective of this study. All the actors and activities that link to cause the flow of wheat, milk and beef from production to consumption were identified and mapped. The identified actors were classified into homogeneous groups undertaking a similar activity. In mapping the value chain activities, the study restricted itself to the core activities. In the same vein, value chain actors were mapped based on their primary occupation. At value chain stage, the nature, source and destination of the products was established. Only the primary products were considered in the value chains. By-products and other products produced in sub-value chains that feed in or out of the main value chain were excluded. The study used flowcharts to analyze the interaction between actors and the activities as they cause the flow of products; the vertical and horizontal relationships that exist among the value chain actors; the economic and social relationships between the actors; and product flows from one actor/activity to the next as well as geographical mapping of the products (places where activities take place). Finally, the study established institutions providing support to the value chains.

4.4.2 Value addition and its distribution in the value chains

The second aspect of value chain analysis, establishing value added and distribution of benefits, was utilized in analyzing the second objective. Value added by value chain actors was estimated through calculation of gross margins. The gross margin was taken as the value added by a particular actor in the value chain. Hence, the difference between the value of output and the intermediate inputs. Therefore, to calculate gross margins, the study established revenues, costs and sales for the value chain actors at each stage.

Calculation of gross margins at the production level

The study utilized gross margins to determine the economic gains from participating in production. The revenues and costs for the different production systems under each value chain

were estimated. The producers' gross margin was given by the difference between revenue and costs. Mathematically, it can be denoted by the following equation:

$$\boldsymbol{GM_{i=}TR_i - TC_i}$$

Where $\boldsymbol{GM_i}$ is the gross margin of the producer $\boldsymbol{i}$; $\boldsymbol{TR_i}$is total revenue of producer $\boldsymbol{i}$; and $\boldsymbol{TC_i}$ is total cost of producer $\boldsymbol{i}$. Certain assumptions and proxy values were used in calculating revenues and producer costs. This was made necessary by absence of production records, lack of recognition of some costs and dependence on recall data. These assumptions were more applicable to the smallholder farmers and pastoralists. In calculating large-scale producer's costs, minimal assumptions were made because they maintained good records of their input costs.

In the wheat value chain, revenue was obtained by multiplying a farmers total wheat output by the price. The output was quantified in number of bags harvested. The weight of the bag was taken as 90 kilograms. Price considered was the farm gate price. This is the price at which the farmer sold a bag of wheat at the farm. The costs of production for the wheat farmers were grouped into six categories: land preparation, seed, fertilizer, chemical, harvesting and labour costs (see Appendix A2). These costs were considered under variable costs, calculated per acre of land. Fixed costs were not considered in the study. Data on cost of production, particularly for the smallholder wheat farmers, was easier collected per acre unlike output data which was easier collected in bags per acre. The study considered family labour while collecting data on costs. This was calculated at the prevailing rate of payment for casual employees. In summary, the value added by wheat farmers was the difference between the revenue received from sale of wheat and these costs of production.

The costs and revenue calculation for dairy farmers relate to the dry season, during which data for this study was collected. During the dry season, costs of production are considered higher compared to the wet season due to limited availability of fodder. Similarly, revenues are suppressed due to lower sales volumes for majority of the smallholder dairy farmers. However, this allows establishing whether dairy farmers are still capable of attaining value in low season. Milk revenue was calculated as the total daily milk output for all dairy cows owned by a farmer multiplied by the selling price. The total daily milk output included milk sold as well as retained for consumption by the household and calves. Other possible sources of revenue like sale of

cows and manure were not considered. The study randomly selected 10 farmers from the sample of 50 smallholder dairy farmers as case studies to calculate cost of production. Cost analysis for the smallholder dairy farmer included the cost of purchased fodder, concentrates, salts and supplements, labour, spraying and deworming, which are the most common variable costs. Fodder included feed such as hay, wheat straws, maize stalks and Napier grass. Concentrates included feeds such as dairy meal.

Both hired and family labour were accounted for in the analysis. Family labour was calculated using the average labour cost incurred by the smallholder dairy farmers that hired labour. The study did not consider fixed costs. As Mburu et al. (2007) had shown, fixed costs are unrelated to higher milk production and have no effect on the optimum combination of variable inputs. In addition, the study did not consider costs of own produced fodder, veterinary and artificial insemination costs. Quantifying own produced fodder was very challenging while veterinary and artificial insemination costs are random costs. The cost components for the smallholder dairy farmer depict case study calculation of costs for smallholder dairy farmers, as mentioned earlier (see Appendix A3 and A4). Value added by the smallholder dairy farmer was taken as revenue minus cost of variable inputs.

In the beef value chain, labour, feeds and supplements, veterinary services, routine dipping or spraying constituted the variable costs. Fixed costs, for instance, land and stables were not considered in calculating total costs for both large-scale ranches and pastoralists. This is because pastoralists lacked permanent livestock holding structures while ownership of land was communal. The assumption was applied to large-scale ranches to enable a comparison between the two production systems. Moreover, in calculating pastoralist's cost of production, veterinary costs were not included. This was mainly because majority of the pastoralists reported administering livestock drugs on their own and having minimal access to veterinary services. Extensive provision of veterinary and vaccination services is hampered by the migratory nature of pastoralists and the challenging climatic and infrastructural conditions (FAO, 2018b)**.**

Seasonality of pasture was taken into account in establishing pastoralists cost of grazing. Thus, pastoralists cost were calculated under two circumstances. First, where cost of pasture was nil due to the assumption that it is freely available throughout. Second, where an expense on pasture

was incurred during the dry months. The study area experiences 7-9 wet months and 3-5 dry months in a year. Four months were, on average, considered as the dry period during which pastoralists incurred an expense as they sought alternative pasture. This cost was taken as the grazing fee paid to access pasture in large-scale ranches, in addition to other services like salt licks and dipping. However, large-scale ranches take it as a reciprocal fee partly due to the absence of measures or inability to enforce its payment. Previous studies (Korir, 2016; Wanyoike et al., 2018) have also used grazing fees to determine cost of livestock feed.

The cost of salt licks basically constituted the cost of supplements, which was obtained from the pastoralists. Labour cost for the pastoralists was calculated based on the local labour cost (that is, cost of hiring a herder). The study calculated the average monthly pay for herders hired by 40% of pastoralist households. This was to avoid treating family labour as a free resource which would otherwise lower the cost of production and hence distort a near true estimate of cost and margins. However, the cost paid to a herder (labour cost) was not equal to the size of the herd. Therefore, the total cost of production for a beef farmer was taken as the monthly cost of rearing a cow multiplied by the age of the cow at the time of sale. The average age at sale for steers sold by large-scale ranches was established as three years while that of a pastoralist's cow was taken as approximately five years.

The selling price of live cattle was basically the producer's revenue. Only the value of meat was considered. Other products such as milk were not taken into account in calculating revenue, for two main reasons. First, during the survey, most of the cattle had migrated due to drought and the little milk produced from the remaining herd was primarily used for domestic consumption. Hence, making it difficult to collect information on milk production and sale. Secondly, earlier studies (Hauck & Rubenstein, 2017; Rakotoarisoa et al., 2008) have indicated very low milk production among the pastoralists utilized primarily by the households. In addition, milk capacity is only present during specific short periods in the year.

Calculation of gross margins at trade level

Similarly, at trade and distribution level, gross margins for traders were calculated by deducting their operational costs from revenues attained. In the wheat value chain, trader's gross margins were calculated per bag of wheat grain. The study established the price at which traders sold a

bag of wheat grain to the millers and the costs they incurred. The costs for the wheat trader included the cost of buying the grain, transport, labour and loading, government charges and taxes incurred like cess. These costs were calculated per 90kg bag of wheat grain. In the dairy value chain, the trader's revenue was taken as the amount of cash received from selling milk. Costs considered for the milk trader included the cost of purchasing milk, transport, labour and the cost of obtaining a movement permit, medical certificate and insurance for motorcycles.

Revenue calculation for the beef trader, considered income obtained from selling all edible (carcass, offals, liver, head and legs) and non-edible saleable (hide) parts of a cow. The beef trader's revenue was calculated based on the carcass weight of a well finished pastoralist cow. Key informants estimated the best average live weight of a pastoralist's cattle at 300kg which converts to about 135-150kg of carcass weight (with a kill out rate of 45-50%) while the weight of a cow's hide was estimated at between 12 and 30 kgs; and offals at between 15 and 20kgs. Reviewed literature estimates the weight of a cows hide at 7% of its live weight. With an estimated average live weight of a pastoralist's cattle at 300kg, the study calculated the weight of a hide at 21kg which corresponds to the average weight given by key informants.

The average weight of offals was taken as 17.5kg and 3kg for the liver. The prices used to calculate traders' revenues were KShs 20 per kg for a single hide, KShs 200 per kg for offals, KShs 270 per kg for liver and KShs 1,000 for the heads and legs. The beef trader's costs included purchase of cattle, cess and labour charges at the livestock market. Cess is a payment made for use of livestock markets by the seller and buyer; and is shared between the county council that owns the market grounds and the livestock marketing association that facilitates transactions at the livestock market. The labour costs may include costs for watching purchased cattle, painting and loading. In addition, beef traders incur transport, slaughter and other related charges (county government fees, veterinary inspection fees, carcass cleaning and washing, loading fees, holding area charges and transport permit). Beef traders also reported paying unofficial fees and levies such as security fees.

Calculation of gross margins at the processing level

At the processing level, the gross margins for the processors were taken as the difference between the product price (factory price) and the cost of processing. In calculating revenue

accrued by wheat millers, income obtained from selling by-products of milling wheat (bran and pollard) were considered in addition to income from selling white wheat flour. Using data obtained from wheat millers, the rate of conversion for a 90-kilogram bag of grain into flour and its by-products, bran and pollard, was taken as 72% for flour, 26% for the by-products and 2% for waste. Therefore, from a 90 kg bag of wheat grain, a miller obtained 65 kg of white flour, 14kg of bran, 9 kg of pollard while 2 kg was waste. The costs of processing wheat included the cost of purchasing the wheat grain, electricity, water, depreciation, labour and packaging.

Revenue per unit for milk processors was taken as the price of selling a litre of liquid milk. The study did not consider other products obtained from processing milk. The costs associated with milk processing include purchase of milk, transport, labour, electricity, water, licenses and taxes. However, the study was not able to get a breakdown of these costs per litre of milk obtained. Nevertheless, the study established that milk processors obtained a 30% margin on the retail price of a litre of milk.

In the beef value chain, gross margin analysis at processing stage was calculated for private beef processors. Calculation of revenue for the private beef processor considered sale of lean beef from a high-quality beef carcass weighing 175kgs. In addition, sale of other products obtained from slaughter such as offals, skin, bones, liver and low-grade beef were considered in calculating revenue. The variation in price due to the different categories of beef cuts was not considered. The costs for beef processors were purchase of cattle, transport of finished products and operational costs like water, electricity and labour.

Calculation of gross margins at the wholesale and retail level

The study did not calculate the costs for wholesalers and retailers for the wheat and milk value chains due to difficulty in assigning specific costs to flour and milk as single products among many others sold. Instead, data on gross margins was collected directly from the field. The study established the mark up put by the wholesaler and retailers on a 2kg packet of wheat flour and a litre of milk for the wheat and milk value chain respectively. That is, buying price minus selling price. However, wholesalers and retailers identified transport, labour, electricity and storage among costs incurred.

In the beef value chain, however, gross margin was calculated for the main retailers of beef meat; butcheries. This was possible because beef retailers stock beef and beef products only. In calculating revenue for the beef retailer, the study considered income received from selling meat on bone for a carcass weighing 175kg. However, to cater for waste on a carcass from shrinkage, fat and non-saleable bones, a reduction of 2-3% of the carcass weight was taken into account. Thus, the saleable carcass was taken as 170kg. Income generated from sale of bones and offals was not considered. Revenue was thus calculated as the saleable or recovered carcass multiplied by the average selling price. The study identified the costs for the retailer to include cost of purchasing the carcass, rent, transport, labour, electricity, water, business permit and packaging. The study collected information on costs under the categories of rent, labour and other costs (transport, electricity, water, business permit and packaging) with each being apportioned a percentage of the total cost.

4.4.3 Governance and constraints in the value chains

The final aspect of value chain analysis which involves analysis of value chain governance and constraints was used in achieving the third objective. Analysis of governance entails mapping the linkages and relationships in the value chain. This was done as part of mapping actors and activities. The study established the relationships that exist among actors at the same level and across the five levels of the value chain. These relationships were described based on their level of integration or coordination as being spot market, persistent or horizontally integrated relations. They were also described based on the type of market relations such as monopoly, oligopsony, monopolistic and monopsony. Linkages between actors were described as being either formal (with contractual agreements) or informal (without contractual agreements), between actors along the value chains (vertical) or between actors at the same level of the value chain (horizontal).

The study endeavored to understand the purpose for which the relationships and linkages exist and the benefits (if any) actors get from such associations. This was done by collecting data on membership to groups and associations; and establishing the purpose for which such groups were formed and continue to exist. Borrowing from the works of Gereffi et al. (2005) on governance of value chains, information has a vital role in shaping relationships in a value chain. As such the study made an assessment of source and flow of information in the value chains, actor's

knowledge of market information and whether such information influence an actor's activities. As part of governance analysis, the study also assessed power relations between actors. The study established power centres within the value chains which were determined by the ability of actors to influence or dominate other actors in the value chain. Through key informants and gross margin analysis, the study established actors who were dominant in the value chains and how they influenced others.

The study collected data on constraints facing the actors in the value chains. Value chain actors were asked to identify the challenges they face by participating in the value chains. In addition, key informants were helpful in collaborating some of the information given by respondents as well as in identification of value chain constraints. The study also used observation to identify some of the challenges facing different value chain actors. The study has descriptively analyzed these challenges/constraints for all actors in the three agro-food value chains. This analysis provides important insights into areas that could be prioritized for value chain upgrading.

4.4.4 Household food security and poverty status in the value chains

Analysis of the fourth objective involved i) Household food insecurity access scale indicators to analyze household food security status; ii) Foster-Greer-Thorbecke poverty indices to analyze household poverty status; iii) Poisson and multinomial logit regression to analyze the determining factors of household food security; and iv) logistic regression to analyze the determining factors of household poverty. Each of this analysis techniques are explained in detail here.

The Household Food Insecurity Access Scale Indicators

The study used the Food Insecurity Experience Scale (FIES) to measure household food insecurity in the three agro-food value chains. FIES is an experience-based food insecurity scale developed by FAO. It is based on how people experience and behave faced with food insecurity (INDDEX Project, 2018). FIES has eight occurrence questions. Respondents were asked whether during a specific time period they worried about their ability to get enough food; if they actually ran out of food or were forced to compromise on the diversity; and the food quality and quantity due to inadequate resources. A frequency-of-occurrence question followed each occurrence question. It established the rate of the "occurrence question" in a month. FIES was chosen as a

tool for food insecurity analysis in this study because 1) it is the latest tool directly evaluating food insecurity having been developed based on previous food insecurity experience indicators; 2) it is possible to disaggregate results among sub-groups and thus make comparisons; and 3) its flexibility of application. Owing to the flexibility of adoption, a 3 month recall period and 2 options for frequency-of-occurrence were used (see Appendix A5).

The FIES was administered to the smallholder farmers in their capacity as a household. It formed part of the producer's questionnaire on household related questions and was administered to the household member that was most involved with preparation of meals (in most cases it was the female spouse). Data collection for this study took place during the dry season which was more appropriate for application of a food insecurity survey because responses are not influenced by the bountifulness of harvest seasons.

To analyze the FIES responses, the study used the guidelines of the HFIAS tool. The similarities between the FIES and HFIAS allowed for this kind of analysis. HFIAS produces four indicators of household food insecurity access among which this study used the household food insecurity access scale score (HFIAS score) and household food insecurity access prevalence (HFIAP).

To calculate the HFIAS score occurrence questions were labelled 1–8 and frequency-of-occurrence questions 1a–8a. To obtain the HFIAS score, the frequency-of-occurrence codes were summed up. Households obtained scores of between 0 and 16. The HFIAS score is a continuous variable which was appropriate for further use in regressing the determining factors of food insecurity. The first step in calculating the second food insecurity indicator, HFIAP, was to assign a code for the food insecurity category for each household. The result was a food insecurity categorical indicator where each household was placed in either of four mutually exclusive categories as shown in Table 4.4.

Table 4.4. Calculation of Household Food Insecurity Access (HFIA) categories

Household food insecurity categories	Description of household experience	Calculation
Food secure	Household experiences none of the food insecurity conditions, or just experiences worry rarely (once per month).	IF (Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0
Mildly food insecure	Household worries about not having enough food sometimes or often, and/or eat a low diversity of foods, and/or eats unhealthy but only rarely. But it does not cut back on quantity nor experience any of three most severe conditions (lacking food, feeling hungry but did not eat due to lack of food, or going a whole day without eating)	IF (Q1a=2 or Q3a=1 or Q4a=1) and Q2=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0
Moderately food insecure	Household sacrifices quality more frequently, by eating a low diversity and unhealthy foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or skipping meals, rarely or sometimes. But it does not experience any of the three most severe conditions.	IF (Q3a=2 or Q4a=2 or Q5a=1 or Q6a=1) and Q2=0 and Q7=0 and Q8=0
Severely food insecure	Household cuts back on size of meals or skipping meals often, and/or experiences any of the three most severe conditions, even as infrequently as rarely.	IF Q5a=2 or Q6a=2 or Q2a=1 or Q2a=2 or Q7a=1 or Q7a=2 or Q8a=1 or Q8a=2

Source: Adapted from Coates et al. (2007)

Foster-Greer-Thorbecke poverty indices

As a first step towards measuring poverty, the study adopted consumption as the indicator of welfare. This is because consumption has been shown (Jan et al., 2008, World Bank Institute, 2005) to work relatively well in the context of developing countries where 1) the bulk of the rural population are involved and derive their income from agriculture primarily by selling farm produce which tends to fluctuate with seasons, while on the other hand households tend to stabilize their consumption expenditure from credit and savings; 2) majority of the farmers do not keep records hence a likelihood of misreporting on production income; and 3) households feel more comfortable reporting on their expenditure compared to income hence reducing the possibility of measurement errors. Households tend to underestimate or omit some sources of income either willingly or often not considering them as sources of income, for example, food produced and consumed by the household.

The second step was to establish the amount used in acquiring a minimum bundle of consumption goods and services for them to be considered not poor. The study adopted Kenya's rural poverty line of KShs 3,252 per person per month as calculated by the Kenya National Bureau of Statistics (KNBS, 2018a). The rural poverty line was preferred as opposed to the overall poverty line because the respondents were based in a rural area of Kenya. The poverty line is based on household consumption expenditure per month and any household in this study whose overall consumption expenditure fell below KShs 3,252 per person per month was considered poor. In calculating per capita expenditure per month, the study assumed that all household members enjoyed the same level of well-being. However, the number of household members was adjusted into adult equivalent by applying the equivalence scale used by KNBS (2018). Thus, household members were grouped into three age groups with different weights: 0-4 years were weighted as 0.24 of an adult, 5-14 years as 0.65 and those aged 15 years and above as 1. Data collection on household expenditure included both food and non-food items (rent, clothes, entertainment, health, education, electricity, water, domestic labour and cash transfers).

The third step was to sum up the consumption expenditure in respect to the poverty line through a summary statistic. To achieve this, the study used the Foster-Greer-Thorbecke *(*FGT) poverty indices which include the head count index, poverty index gap and the squared poverty gap index. The headcount index measured the proportion of the population that was poor. The poverty gap index showed the degree to which persons fall below the poverty line as part of the poverty line, while the squared poverty gap was in essence the weighted sum of the poverty gaps. The squared poverty gap puts more weight on the individuals or observations that have huge income deficits from the poverty line. The FGT class of indices were chosen because 1) they are decomposable across population sub-groups and; 2) simplicity of computation and understanding. Povdeco, a module available within Stata, was used to estimate the FGT poverty indices (FGTα) where F_0 is the head count index, F_1 is the average normalized poverty gap and F_2 is the average squared normalized poverty gap. The larger α is, the more the degree of poverty aversion, that is, the greater the weight attached to very poor observations or individuals. In addition, povdeco gave other statistics like the mean income amongst the poor and the decompositions of indices by population subgroups. Thus, the FGT poverty indices are given by:

$$FGT[\propto] = \sum_{i=1}^{n} F_{1[(z-y_i)/z]} \propto_{I_i}$$

Where I_i = 1 if $y_i < z$ and $I_i = 0$ otherwise.

Each $FGTa$ index can be additively decomposed as:

$$FGT(\propto) = \sum_{k=1}^{K} v_k FGT_k\,(\propto)$$

Where $v_k = N_k/N$ is the number of persons in sub group k divided by the total number of persons and $FGT_k(\propto)$, poverty for subgroup k, is calculated as if each sub group were a separate population.

For sub group decompositions, povdeco displays for each k, the following additional sub group summary statistics:

Subgroup poverty share, $S_k = v_k FGT_k\,(\propto)/FGT(\propto)$, and a sub group poverty risk, $R_k = FGT_k\,(\propto)/FGT(\propto) = S_k/v_k$

The money incomes for each income receiving unit i, x_i, are equivalised using an equivalence scale factor, m_i, so that $y_i = x_i/m_i$, and the poverty line is a single (common) value (Jenkins, 1999).

Regression analysis

HFIAS and FGT analysis provide food insecurity and poverty profiles that describe the patterns of food insecurity and poverty among the smallholder farmers. However, they do not explain why the households are either food insecure or poor. Therefore, to understand the correlates of food insecurity and poverty among smallholder farmers and pastoralists, the study applied regression analysis. The study applied, certain demographic, social and economic household characteristics (variables) that have been theoretically linked to the occurrence of poverty and food insecurity. These variables are defined in Appendix A6. Different predictor variables were used for the three regression models according to their fit in the individual models. In other

words, variables that did not fit in specific models were dropped. For each model, the dependent and independent variables are specified in the model equation. The study attempted to explain whether a household was food insecure or not through poisson and multinomial logit regression models and; and whether a household is poor or not using a logit regression model. The multinomial logit model was used to show the correlates of household food security among household groups that experienced the same level of food (in)security status. Poisson regression analyzed the correlates of household food security for each individual household. The count variable used in poisson regression was considered sensitive to small changes to the household food security situation unlike the multinomial categorical indicator. Hence, the reason the study used two models for the determinants of household food security. These regression analyses are explained here in more details.

Multinomial Logit Regression

In the multinomial logit regression, the dependent variable is the Household Food Insecurity Access Prevalence (HFIAP) status indicator, a categorical variable, taking the form of four categories: food secure, mild, moderately and severely food insecure. Given that this categorical dependent variable has more than two categories with no natural ordering per se, multinomial regression was suitable. Still, the study desired to understand the factors that influence the probability of a household being food insecure based on defined food security categories. This was possible through a multinomial logit regression. The independent variables consist of a set of continuous and categorical demographic, social and economic household variables. They include value chain type; number of household members; daily income; access to credit; borrow to meet family needs; enough income to save, number of cattle; ownership of television; membership to farmer group; contact with NGOs; distance to selling point; contact with government. These variables are defined in Appendix A6 as part of other variables used in this study's regression models. The variable daily income was transformed into its logarithm to improve the fit of the model; McFadden R-square was higher with use of log income.

Borrowing from Long and Freese (2001), the multinomial logit regression formula can be written as follows:

$$\ln\Omega_{m/b}(x) = \ln\frac{\Pr(y=m|x)}{\Pr(y=b|x)} = x\beta_{m/b} \qquad \text{for } m = 1 \; to \; J$$

where b is the base category or the comparison group (food secure category). Since $\ln\Omega_{b/b}(x) = \ln 1 = 0$, it must hold that $\beta_{b/b=}0$. The J equations compute the following predicted probabilities:

$$\Pr(y = m|x) = \frac{\exp(x\beta_{m|b})}{\sum_{j=1}^{J}\exp(x\beta_{j|b})}$$

The food security equation for the multinomial model was defined as follows:

$$\begin{aligned} HFIAP = \beta_0 &+ \beta_1 Vt + \beta_2 HH + \beta_3 LDI + \beta_4 AC + \beta_5 BF + \beta_6 EI + \beta_7 C + \beta_8 B + \beta_9 P \\ &+ \beta_{10} T + \beta_{11} M + \beta_{12} FG + \beta_{13} ES + \beta_{14} N + \beta_{15} E + \beta_{16} SP + \beta_{17} E \\ &+ \beta_{18} G + \beta_{19} S + \beta_{20} K \end{aligned}$$

Where HFIAP is a measure of food security; *Vt* is value chain type; *HH* is number of household members; *LDI* is log of daily income; *AC* is access to credit; *BF* is borrow to meet family needs; *EI* is enough income to save, *C* is number of cattle; *T* is own television; *FG* is membership to farmer group; *N* is contact with NGOs; *SP* is distance to selling point; *G* is contact with government; β_0 is the constant; β_1 ……β_{17} are the coefficients.

Using multinomial logistic regression, null hypothesis that all the regression coefficients for the explanatory variables are zero was tested, the study determined which predictors were statistically significant; and calculated a coefficient and standard error for each predictor variable. Moreover, the likelihood ratio chi-square and R test-statistics were calculated to indicate the overall model fit; and diagnostic tests were done to examine the validity of the model assumptions. The null hypothesis that there is no association between the predictor variables and food insecurity was rejected ($p=0.00 <0.05$). Therefore, concluding that one or more of the social, economic and demographic variables can be used to predict household food insecurity. The predictors which were statistically significant are discussed in chapter 8. The multinomial logit model generated shows how these predictors affect the probability that a household fits into any of the categories of food insecurity in reference to the food secure households. The coefficient and standard errors of each predictor are indicated in the model (chapter 8 Table 8.8). A one-unit change in the predictor variable is associated with a change in the relative log odds of being in a food insecurity category vis-à-vis the base category, food

secure. Coefficients having p values less than alpha (0.01, 0.05, 0.1) were statistically significant.

The likelihood ratio chi-square of 198.12 with a p-value = 0.000, < 0.05 showed that the model generally fits significantly better than a model with no predictors. McFadden R-square indicated a relationship of 50.8% between the predictors and the dependent variable. The Cox and Snell's R-Square (0.68) and the Nagelkerke modification (0.76) indicated a higher relationship. The assumptions of the multinomial regression were checked as follows:

1) In multinomial regression, the dependent variable should be measured at nominal level. This assumption is met because the dependent variable has four categories; food secure, mild, moderate and severe food insecurity.
2) One or more independent variables should be continuous, ordinal or categorical. However, ordinal variables must be dealt with as either continuous or nominal variables. This requirement is met in this study with the independent variables either being continuous or nominal.
3) The dependent variable should have mutually exhaustive and exclusive categories. This requirement was met with the categories of the dependent variable being mutually exclusive as stated in the analysis of the HFIAP indicator.
4) Independence of Irrelevant Alternatives (IIA) must be observed. That is, the odds for any pair of outcomes are determined without reference to other outcomes that might be available. IIA was checked with the hausman test of IIA assumption. The results showed that the test was not significant (p-values= 0.897, 1>0.05) for categories one and three of the nominal dependent variables, hence the assumption was not violated. Categories two and four had a negative chi-square which has also been shown to be evidence that the IIA has not been violated (Freese & Long, 2000).
5) There should be absence of multicollinearity among the independent variables. That is, the independent variables must not be highly correlated. To test this, Variance Inflation factor (VIF) was used. VIF indicates how much of the inflation of the standard error could be caused by collinearity. In the presence of multicollinearity, the variance inflation is very large. Therefore, a VIF equal or greater than 10 indicates multicollinearity. Usually, Stata software drops a variable that has a perfect combination of the others. However, it is

advisable not to assume that the variable Stata drops is the correct one to omit from the model, thus the need to carry out the multicollinearity test. The results of the test showed that none of the predictor variables had a VIF greater than 10 (Table 4.5), hence the assumption was not violated.

Table 4.5. Collinearity diagnostics for multinomial predictor variables

Variable	VIF
Value chain type	2.76
Number of household members	1.33
Log daily income	2.09
Access to credit	1.27
Borrow to meet family needs	1.40
Enough income to save,	1.33
Number of cattle	1.33
Own television	2.24
Membership to farmer group	1.74
Contact with NGOs	1.48
Distance to selling point	1.77
Contact with government	1.29
Mean VIF	1.67

Poisson Regression

Poisson regression was used to determine the factors that affect household food insecurity among the smallholder farmers using a count variable, HFIAS, as the dependent variable. The HFIAS is a continuous variable, with positive integers ranging from 0 to 16, and having a poisson distribution; as such, poisson regression was most appropriate method of analysis. Selection of independent variables (determinants of household food insecurity) was guided by review of literature and past research studies. The independent variables used in the poisson model include value chain type; number of household members; income diversity; daily income; access to credit; borrow to meet family needs; enough income to save, number of cattle; ownership of bicycle; ownership of mobile phone; ownership of television; ownership of motorcycle; belonging to a farmer group; extension services; contact with NGOs; sharing of equipment and tools; distance to selling point; access to electricity; contact with government; ownership of solar panel; and sharing knowledge. These variables are defined in Appendix A6 as part of other variables used in this study's regression models. The independent variable income was

endogenous in the model whereas all others were not, hence it was log transformed to improve the fit of the model.

The Poisson distribution models the probability of y events with the formula:

$$\text{Prob}(Y_i = y_i|\mathbf{x}_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} y_i = 0,1,2, \ldots$$

Each $y_i$is taken from a Poisson distribution with parameter λ_i, which is associated with the regressors x_i(Greene, 2003).

Using the study's variables, the food security equation was specified as:

$$\begin{aligned} HFIAS = \beta_0 &+ \beta_1 Vt + \beta_2 HH + \beta_3 ID + \beta_4 LDI + \beta_5 AC + \beta_6 BF + \beta_7 EI + \beta_8 C + \beta_9 B \\ &+ \beta_{10} P + \beta_{11} T + \beta_{12} M + \beta_{13} FG + \beta_{14} ES + \beta_{15} N + \beta_{16} E + \beta_{17} SP \\ &+ \beta_{18} E + \beta_{19} G + \beta_{20} S + \beta_{21} K \end{aligned}$$

Where HFIAS is a food security measure; *Vt* is value chain type; *HH* is number of household members; *ID* is income diversity; *LDI* is log daily income; *AC* is access to credit; *BF* is borrow to meet family needs; *EI* is enough income to save, *C* is number of cattle; *B* is own bicycle; *P* is own mobile phone; *T* is own television; *M* is own motorcycle; *FG* is affiliation to a farmer group; *ES* is extension services; *N* is contact with NGOs; *E* is share equipment and tools; *SP* is distance to selling point; *E* is access to electricity; *G* is contact with government; *S* is own solar panel; *K* is sharing knowledge; β_0 is the constant; $\beta_1 \ldots\ldots \beta_{17}$ are the coefficients.

The null hypothesis (coefficients equal zero) was tested. The model p-value with an alpha (0.000) less than 0.05, led to the conclusion that it is unlikely that all coefficients equal zero. Therefore, the correlation between the social, economic and demographic variables and the dependent variable, (food security) was statistically significant. The Poisson regression modelled the differences in the logs of the expected count as an expression of the predictor variables. The predictors that were statistically significant were determined; each predictor's coefficient and standard error was calculated; goodness-of-fit tests (chi-squared and Pearson) were calculated to indicate the model form; and diagnostic tests were undertaken to test validity of assumptions.

The predictors which were statistically significant are discussed in chapter 8. The p-value for each predictor tested the null hypothesis that the variable has no relationship with food security. Thus, coefficients having p-values less than the alpha (0.01, 0.05, 0.1) were statistically significant. The coefficient and standard errors of each predictor are shown in the model (chapter 8 Table 8.7). The goodness-of-fit chi-squared and Pearson goodness-of-fit were both significant ($p=0.000 < 0.05$) indicating poor fit of data in the model, most likely, due to over dispersion associated with count variables. This was confirmed through an analysis of the assumptions of poisson regression. The assumptions were checked as follows:

1. Poisson regression requires that the poisson response (dependent variable) is a count variable and the counts must be positive integers. This assumption was met because the dependent variable is a count variable extending between 0 and 16.
2. Explanatory variables must be continuous, dichotomous or ordinal. This requirement was met in this study with the independent variables either being continuous or nominal.
3. There should be independence of observations in poisson regression. In other words, there is no relationship between the observations as they should not come from repeated or paired data. This requirement was met with data for the study sourced from individual households with no possibility of repeated measures.
4. Poisson regression requires that the mean of a poisson random variable must be equal to its variance (mean=variance). Analysis on the HFIAS indicated that its variance (41.88) was nearly seven times larger than the mean (6.32). Meaning that the distribution of the HFIAS displayed signs of over dispersion. Due to the violation of this assumption, the study used negative binomial regression.
5. Multicollinearity among the predictor variables was tested using Variance Inflation Factors (VIF). A VIF equal or greater than 10 indicated multicollinearity. The results showed that the predictor variables had a VIF of less than 10 (Table 4.6), hence the independent variables are not correlated with each other.

Table 4.6. Collinearity diagnostics for poisson predictor variables

Variable	VIF
Number of household members	1.38
Income diversity	2.35
Log of daily income	2.52
Access to credit	1.33
Borrow to meet family needs	1.49
Enough income to save,	1.34
Number of cattle	1.54
Own bicycle	1.61
Own mobile phone	1.26
Own television	2.88
Own motorcycle	1.28
Membership to farmer group	1.88
Access to extension services	2.37
Contact with NGOs	1.54
Share equipment and tools	2.78
Distance to selling point	1.76
Access to electricity	1.87
Contact with government	2.52
Own solar panel	1.78
Sharing knowledge	1.11
Mean VIF	1.83

Logit Regression on Poverty Index

To examine the determinants of poverty for the smallholder farmers, the study applied a logistic regression analysis. In selecting the binary regression model (logit or probit), the study chose the method easiest to use with stata. Literature has shown that both logit and probit models yield similar output and the choice of either model is largely subjective. However, logit has been shown to have better prediction than the probit model (Adekanmbi, 2017). The dependent variable was a binary variable with 1 representing a household that is poor and 0, if a household is not poor. This classification was derived from calculation of the FGT indices, specifically the head count index. The independent variables are the social economic and demographic characteristics of households which were selected based on literature review and past empirical studies. The variables included value chain type; number of household members; income diversity; daily income; access to credit; borrow to meet family needs; enough income to save, number of cattle; ownership of bicycle; ownership of mobile phone; ownership of television; ownership of motorcycle; affiliation to farmer group; extension services; contact with NGOs;

share equipment and tools; distance to selling point; and access to electricity. These variables are defined in Appendix A6 as part of other variables used in this study's regression models. The independent variable income was a great predictor variable and was log transformed to improve the fit of the model.

The null hypothesis that there is no correlation between these independent variables and poverty was tested. If the model p-value is less than alpha (0.05), we fail to accept the null hypotheses and come to the conclusion that one or more of the social, economic and demographic variables can be used to predict household poverty. In addition, the p-value for each predictor tests the null hypothesis that the given variable has no relationship with household poverty. Thus, coefficients having p values less than alpha (0.01, 0.05, 0.1) are statistically significant.

The explanatory variables were both continuous and categorical. The number of household members, income diversity, daily income, number of cattle, distance to selling point were continuous explanatory variables, while access to financial credit, borrowing to meet the households needs, having enough income to save, ownership of bicycle, television and motorcycle, membership to a farmers group, access to extension services, contact with NGOs and sharing of equipment and tools were explanatory binary variables with 1 representing yes and 0 otherwise (see appendix A6). In selecting these explanatory variables, the study ensured they were exogenous to household consumption expenditure, that is, they were not part of the dependent variable construct. The logit regression formula is expressed as follows:

$$Pr(Y_i = 1|X_i = xi) = \frac{\exp(\beta_0 + \beta_{1\,x_i})}{1 + \exp(\beta_0 + \beta_{1\,x_i})}$$

Where:

Y is the binary response (dependent variable)

$Y_i = 1$ if the household is poor

$Y_i = 0$ if the household is not poor

β are the parameter estimates

$X = X_1 X_2 \ldots\ldots X_{k,}$ are the explanatory variables. x_i is the observed value of the explanatory variables for observation i (Tranmer & Elliot, 2008).

Using the study's variables, the poverty equation was specified as:

$$FGT = \beta_0 + \beta_1 Vt + \beta_2 HH + \beta_3 ID + \beta_4 LDI + \beta_5 AC + \beta_6 BF + \beta_7 EI + \beta_8 C + \beta_9 B + \beta_{10} P + \beta_{11} T + \beta_{12} M + \beta_{13} FG + \beta_{14} ES + \beta_{15} N + \beta_{16} E + \beta_{17} SP + \beta_{18} E$$

Where *FGT* is the poverty index; *Vt* is value chain type; *HH* is number of household members; *ID* is income diversity; *DI* is log daily income; *AC* is access to credit; *BF* is borrow to meet family needs; *EI* is enough income to save, *C* is number of cattle; *B* is own bicycle; *P* is own mobile phone; *T* is own television; *M* is own motorcycle; *FG* is affiliation to farmer group; *ES* is access to extension services; *N* is contact with NGOs; *E* is share equipment and tools; *SP* is distance to selling point; *E* is access to electricity; β_0 is the constant; $\beta_1 \ldots\ldots \beta_{17}$ are the coefficients.

Using logistic regression, the study determined which predictors were statistically significant; calculated a coefficient and standard error for every predictor; test-statistic Pseudo R-squared and the Hosmer-Lemeshow test were calculated to indicate the overall model fit; and finally diagnostic tests to test validity of assumptions were done. The predictors which were statistically significant are discussed in chapter 8. The coefficient and standard errors of each predictor are indicated in the model (chapter 8 Table 8.9). The coefficients show the degree of change anticipated in the log odds while there is a unit change in the independent variables, holding all others constant. The pseudo r-squared generated after fitting the model gave a general idea of the amount of variance that was accounted for. The Pseudo R-squared of the logit regression was statistically significant meaning that the model with the chosen predictor variables fit the data statistically better than the model without the predictor variables.

The general significance of the logit model was also checked with the Hosmer-Lemeshow test. The test divides the sample into groups (10 for this case) whereby for each group, the observed values are compared with the predicted or expected values. A large chi-squared value points to a poor fit. The test results showed a small chi-squared value (4.62) with a large p-value nearer to 1 (0.79), indicating that the model fits well. The assumptions were checked as follows:

1. The dependent variable should be a binary variable, and the two categories need to be mutually exhaustive and exclusive. This assumption is met because the dependent variable is dichotomous (poor/not poor)
2. Independent variables should be two or more, and measured at the continuous or nominal level. Ordinal predictors must be taken as either continuous or nominal variables. This requirement is met in this study with the independent variables either being continuous or nominal.
3. The model assumes a linear relationship between any continuous predictor variables and their log odds. The Box-Tidwell test was used to test this assumption. The Box-Tidwell tests adds the non-linear transform of the original predictor variable as an interaction term to test if the addition makes a better prediction. The results showed that the interaction terms of the continuous variables (number of household members, income diversity, daily income, number of cattle and distance to selling point) were not significant (p-value = 0.544, 0.056, 0.274, 0.107, 0.314 > 0.05, respectively). Meaning that the assumption of linearity was satisfied.
4. There should be independence of observations in logistic regression. In other words, there is no relationship between the observations as they should not come from repeated or paired data. This requirement was met with data for the study sourced from individual households with no possibility of repeated measures.
5. Logistic regression requires a large sample size. Because it uses maximum likelihood, its behavior with small sizes is not well understood. Generally, 100 is considered as the minimum sample size with at least 10 observations or cases for every predictor. This requirement is met with the sample size for the study being 175 and all the independent variables have 175 observations.
6. Logistic regression assumes little or nil multicollinearity among the predictors. To test this, Variance Inflation factor (VIF) was used. A VIF equal or greater than ten indicates multicollinearity. The results of the test showed that none of the independent variables had a VIF greater than 10 (Table 4.7), hence the assumption was not violated.

Table 4.7. Collinearity Diagnostics for logit predictor variables

Variable	VIF
Number of household members	1.38
Income diversity	2.44
Daily Income	1.42
Access to credit	1.22
Borrow to meet family needs	1.38
Enough Income to save	1.34
Number of cattle	1.5
Own bicycle	1.54
Own mobile phone	1.19
Own television	2.72
Own motorcycle	1.26
Membership to farmer group	1.88
Access to extension services	1.24
Contact with NGOs	1.47
Share equipment and tools	3.05
Distance to selling point	1.85
Access to electricity	1.58

CHAPTER 5. ACTIVITIES, ACTORS AND PRODUCT FLOWS IN WHEAT, DAIRY AND BEEF VALUE CHAINS

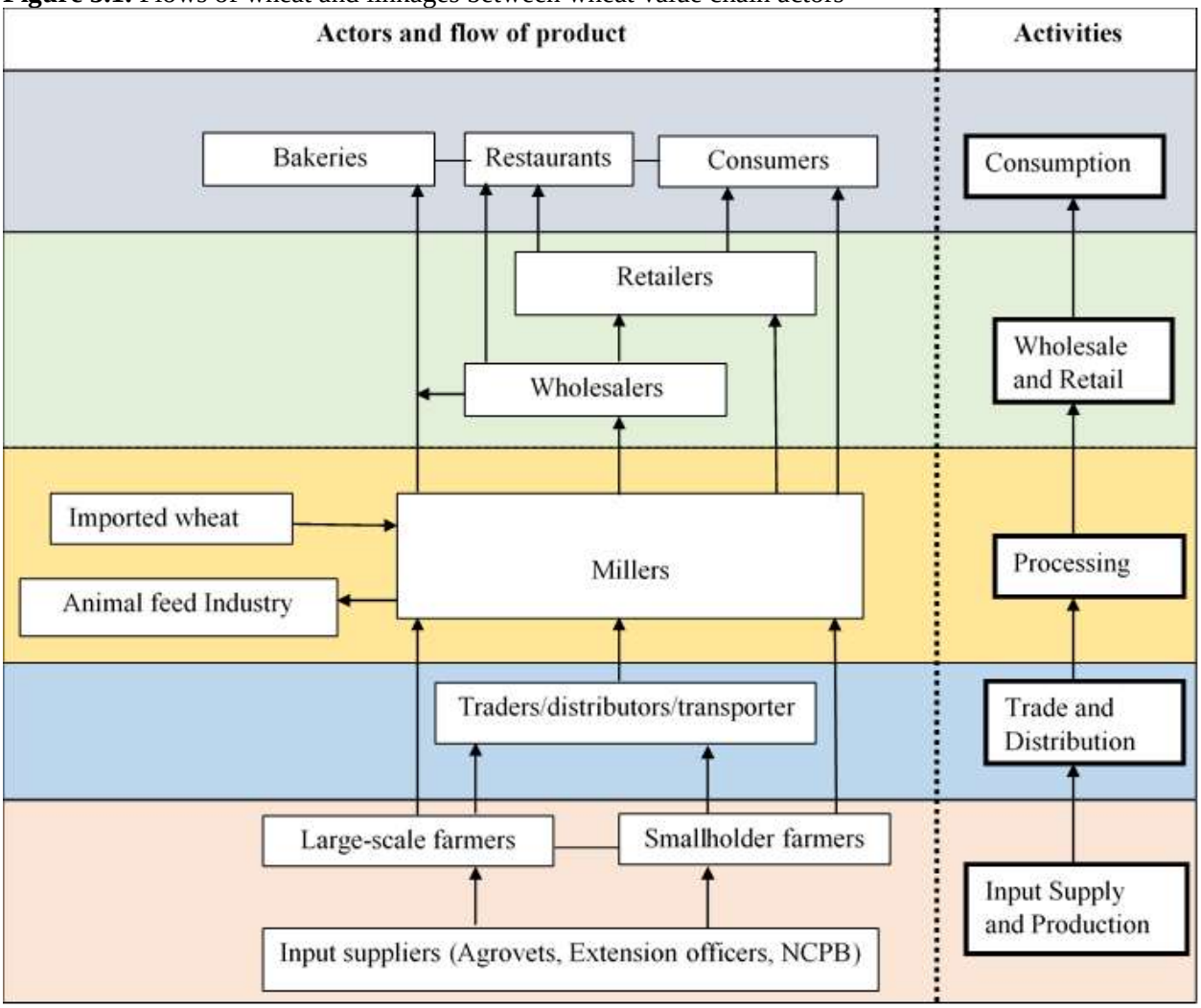
5.1 Introduction

This chapter gives an analysis of the actors, activities and flows of products in wheat, milk and beef value chains. The characteristics and roles of the actors in the value chain activities of input supply and production, trade and distribution, processing, wholesale and retail are discussed in detail. The results presented in this chapter seeks to achieve the first objective of the study on the activities, actors and product flow in the wheat, dairy and beef value chains in North West Mt. Kenya.

5.2 Activities, Actors and Product Flows in the Wheat Value Chain

The wheat value chain is a fairly direct value chain from production to consumption. The main actors in the wheat value chain are input suppliers, farmers, traders, millers, wholesalers, retailers and consumers (Figure 5.1). These actors cause the flow of wheat and wheat products along production, distribution, processing, wholesale, retail and consumption stages of the value chain. The study considers the wheat to flour value chain. The by-product value chains are not considered in the study. Each stage of the value chain is discussed, detailing how each activity occurs, the actors involved and their role in each value chain activity. The flow and form in which wheat moves from one stage to the other is also highlighted.

Figure 5.1. Flows of wheat and linkages between wheat value chain actors



Source: Researcher, 2021

5.2.1 Wheat input supply and production

Wheat input supply

Wheat farmers obtain their inputs from agrochemical shops (known as agrovets), government institutions like the NCPB, agrochemical companies and fellow farmers (Figure 5.1). Agrovets are the most popular source of agricultural chemicals, particularly for smallholder wheat farmers due to their proximity. All agrovets interviewed were privately owned and located in towns and shopping centres. The agrovets were serving farmers within an average of 15 km radius. Most (5 out of 8) of the agrovets did not sell wheat seed due to low demand from farmers who preferred to use seed from the previous season. However, of the three agrovets selling seeds, two sold

untreated wheat seed. Agrovets stocked a variety of pesticides and foliar used by the wheat farmers. The study identified at least 12 different brands of herbicides, 4 different brands of fungicides, 15 different brands of insecticides and 10 different brands of foliar feed on sale. These agrochemicals were sourced from nine different chemical companies. In addition, the agrovets stocked about four different types of fertilizers.

A pesticide became popular among the wheat farmers if it proved to be effective and was reasonably priced. However, in some cases, the popularity of a pesticide was due to active marketing by the source company. None of the inputs sold by the agrovets had a price subsidy. Majority (6 of 8) of the proprietors of agrovets were not involved in any other activity in the value chain with the exception of two who were in production and trade of wheat. Agrovets have a key role in providing advice to farmers, filling in the gap of few available extension officers. Smallholder wheat farmers sought advice from the agrovets on issues ranging from diseases, pests, timing of input application, application rate, seed varieties, chemicals and safe use of chemicals. Among the smallholder wheat farmers, it is not unusual to collectively purchase a chemical for sharing, which is necessitated by unavailability of specific chemicals in low quantities.

The government through National Cereals and Produce Board (NCPB) acts as an input supplier by providing subsidized fertilizer and also providing extension services to the wheat farmers through ward extension officers. Large agrochemical companies or their primary local selling agents provided inputs to the agrovets as well as the large-scale wheat farmers. Because of the large volume of inputs required by the large-scale wheat farmers, they were able to negotiate better prices and delivery at farm gate. In fact, some large-scale wheat farmers are organized in associations that assist them in negotiating the buying price of inputs. Agrochemical companies are also involved in training large-scale farmers and agrovets on proper use of agrochemicals. They also organize and participate in farmer's field days where they educate farmers on use of agrochemicals. Lastly, the wheat farmers act as input suppliers among themselves. This is more so for seed inputs.

Wheat production

Wheat production is done by famers who are the majority actors in the wheat value chain (Figure 5.1). Informed by review of literature, this study classified farmers into small (<20 acres), medium (21-100 acres) and large-scale farmers (>100 acres). However, the study identified very few farmers in the category of medium-scale wheat farmers. As such only two classifications of small and large- scale wheat farmers were maintained for analysis.

Large-scale wheat farmers were producing large volumes of wheat, up to 3000 tons per farm. They on average owned 4,080 acres of land, with the highest land holding size being 11,200 acres. Large-scale wheat farmers committed only 17% of their cultivable land to wheat production (Table 5.1). The remaining part was apportioned tree cover, horticulture, cultivation of barley, hay and canola. The farming operations of large-scale wheat farmers were mechanized with the majority owning the different machinery required for wheat production. The large-scale wheat farmers were well informed of the market needs and produced accordingly to satisfy these needs. Their financial ability and possession of high production skills enables them to consistently produce high quality wheat. The large-scale farmers have invested in wheat storage facilities that enable them store wheat for months (up to 4 months), as they sell in consignments depending on market conditions of demand and price. Owing to the large volumes of wheat, most (71%) of the large-scale farmers transacted directly with the millers in arrangements where millers collected wheat from the farms or contracted transporters to do so. In few instances, the large-scale farmers may deliver the wheat to millers. Wheat traders may also purchase wheat from the large-scale farmers to sell onwards to the millers.

Smallholder wheat farmers were fragmented and generally more in number compared to large-scale farmers. They are mainly involved in the value chain as producers with a few (9%) also engaged in input supply, brokering and retail of wheat products. Only 36% of the smallholder farmers had completed secondary education. On average, smallholder farmers had 10 acres of land. Ownership of land was through purchase (60%), inheritance (53%) and gifting (2%). While all the smallholder wheat farmers owned land, 22% leased additional land for cultivation at an average rate of KShs 7,928 per annum. The lowest land holding size was an acre. Majority (84%) of the smallholder farmers practiced mixed farming; keeping livestock while at the same time engaging in cultivation. Despite smallholder farmers having been engaged in wheat

cultivation on average 12 years, most (72%) had committed less than half of their land to wheat cultivation. The average land under wheat cultivation was 3.5 acres of land.

Table 5.1. Selected characteristics of smallholder and large-scale wheat farmers

Parameter	**Smallholder farms**	**Large-scale farms**
Land size and tenure	(n=58)	(n=7)
Average land size (acres)	10	4075
Proportion of farmers owning land (%)	100	86
Average land size under wheat cultivation (acres)	3.5	690
Proportion of land allocated to wheat (%)	35	17
Wheat production	(n=48)	(n=7)
Average number of years in wheat production	12	35
No. of bags (90kgs) per acre	10	19
Price per bag (KShs)	2420	2776
Channel through which wheat sold	(n=47)	(n=7)
Traders/Brokers (%)	68	29
Millers (%)	30	71
Neighbors/Farmer (%)	2	0

Source: Researcher, 2021

Majority of the smallholder wheat farmers (85%) used two wheat varieties: Duma and Kenya robin. Duma and Kenya robin are average yielding varieties. However, they are popular with millers because they are hard wheat varieties with Duma having a high flour content. As a result, they sometimes fetch higher prices due to millers' demand. Although 62% of the smallholder farmers are aware of the miller's wheat preferences, they stated that it does not influence the wheat variety they grow. Instead, decision on which variety to grow is made in consideration of factors such as tolerance to climatic conditions, bushel weight and yield potential. Nevertheless, in doing so, smallholder farmers are "unknowingly" producing what the market demands. Smallholder wheat farmers obtain information on new wheat varieties from fellow farmers, brokers, local millers and their agents, perhaps explaining why smallholder farmers were utilizing limited varieties. Smallholder wheat farmers sourced wheat seed, treated or otherwise, from various sources. They included fellow smallholder farmers (24%), large-scale farms (21%), millers (10%), agrovets (10%), retained from the previous harvest (24%) and collectively (11%) from NCPB, farmers groups or farmer's field day exhibitions. Only 30% of the smallholder farmers used treated seed.

Most (76%) of the smallholder farmers used fertilizers that were purchased from agrovets. However, a smaller number (23%) of those who used fertilizer had access to subsidized fertilizer from NCPB stores, perhaps confirming its inaccessibility. Eight out of ten (80%) smallholder wheat farmers used pesticides (herbicides, fungicides, insecticides) and foliar in wheat production which they bought from agrovets located at an average distance of 8km. Choice of inputs was influenced by advice from agrovets and agricultural extension workers. Smallholder farming operations are less mechanized due to several factors, among them, lack of machinery at the appropriate time, inability to meet machine hiring costs, small size of land parcels and the need to reduce production costs.

More than half of the smallholder wheat farmers (68%) sold their wheat through traders (Table 5.1). Others sold directly to local small-scale millers. In both cases, wheat is collected at the farm gate. Often, traders negotiate a buying price at the farm before harvesting takes place, whereby, they offer to assist in harvesting and pay the smallholder farmer net of harvesting costs. Alternatively, smallholder farmers harvest the wheat and sell to traders on the farm.

5.2.2 Wheat trade and distribution

Wheat traders are an important link between the farmers and the millers. They purchase and transport wheat from the farmers (especially for the smallholder farmers) to the millers (Figure 5.1). The bulk (about 80%) of the wheat they trade in comes from smallholder farmers. Traders visit smallholder farms during the wheat harvesting period which lasts approximately two months. They make a visual assessment of the wheat and make an offer to buy. The traders may negotiate the buying price with the smallholder farmers before or after the grain has been harvested. There are no contractual arrangements between the traders and the smallholder wheat farmers.

There are very few wheat traders buying from many farmers and creating an oligopsony market structure. In which case, they have an upper hand in determining farm gate prices for smallholders who have limited choices on whom to sell to. During the harvest period, large-scale traders can buy and sell up to 22,000 bags (90kg) of wheat. Such traders have established relationships with millers and can deliver up to 1000 bags of wheat in a single trip. When the wheat market prices or demand is low, traders may choose to store the grain and sell later. Small

traders transact about 100 bags of wheat in a day. Large traders may use a 10 ton lorry to transport wheat while small traders use 4 ton lorries. Usually, traders will provide the miller with a sample of available wheat. If the wheat meets the miller's quality standards, an order for delivery is given. A trader may undertake to deliver the wheat using his own means of transport, in which case the miller gives a rebate on transport. Alternatively, the miller may make his own transport arrangements to collect the grain and deduct a certain agreed amount from the buying price to cater for transport.

Wheat traders seem more integrated in the value chain with all interviewed traders being involved either in production, supply of inputs or small-scale milling. Some traders provided financial credit to smallholder wheat farmers during the wheat growing season, who repaid upon harvest. Traders are also a significant source of information for the smallholder farmers as they link the farmers to the market and are well aware of the market needs. However, this information does not reach the farmers in a way that could benefit them or improve their production, but is used by the traders for their own benefit. Lastly, in dealing with large-scale farmers, traders are more of transporters than buyers of the grain. As such, majority of the large-scale farmers negotiate the prices directly with millers and traders are contracted, by either the farmers or miller, to transport the wheat.

5.2.3 Wheat processing

Wheat processing is concentrated within a few large and medium-scale millers (Figure 5.1). Millers are categorized according to their milling capacity into small millers, with a milling capacity of not more than 50 tonnes in a day (24 hours), medium millers 50 to 150 tonnes and large-scale millers above 150 tonnes per day. However, the study further categorized medium-scale millers into lower medium-scale (50-100 tonnes) and upper medium-scale (100-150 tonnes) due to the differences in their operations and marketing. Medium-scale wheat millers obtain wheat locally, from the farmers and brokers, and also import. Upper medium-scale wheat millers reported importing at least 70% of their wheat requirements, while the remaining 30% was sourced locally from farmers. The largest proportion (90%) of this local wheat was delivered to the millers by traders. Lower medium-scale millers, however, sourced a larger proportion (more than 50%) of their grain locally. This category of millers were also integrated in other value chain activities such as supply of inputs and retail. Due to their close contact with

smallholder farmers, they offer credit against the crop in the field which is settled by delivering harvested wheat to the miller. Medium-scale millers are organized into millers' associations that help them in addressing market issues and in advocacy.

Millers convert wheat to various flours for different purposes. The milling process also generates by-products, bran and pollard, which are sold to the animal feeds industry. The main types of flour identified were white, brown and bakers flour. White flour constituted 80% of sales. Wheat products from medium-scale wheat millers were fortified with minerals such as iron, vitamin A and B. Wheat flour was priced based on cost of the grain, production and competitors prices. Medium-scale wheat millers distribute wheat products in two main ways: 1) they deliver the products to wholesalers and large retailers like supermarkets using their own transport; and 2) wholesalers collect the wheat products from millers for onward selling to retailers. However, lower medium-scale millers also sell wheat flour directly to retail customers, but this constituted only 30% of their sales.

Small-scale millers are located in shopping centres and towns. They mainly provide milling services, usually to consumers, which are charged per kilogram of milled wheat. They open for a few hours in a day, usually in the afternoon, during which period they milled about 2 tons of wheat. Their main product was brown flour, otherwise referred to as Grade 2 flour, but some also had the capacity to mill white (Grade 1) flour. They have a storage capacity of about 50 bags of wheat which they mill and sell at their premises. However, they do not market their flour beyond their premises.

5.2.4 Wheat wholesale and retail

Distribution of wheat flour is done by distributors and wholesalers (Figure 5.1). The difference between these two actors lies in their capacity for distribution, determined by their capital ability. Distributors have a higher financial capacity to purchase and transport high volumes of wheat products compared to wholesalers. Unlike wholesalers, distributors are charged with distribution of products in a specified region as agreed with millers. Distributors are, however, only found in the marketing channel of large-scale and upper medium-scale millers. Wholesalers constitute the main channel through which large and medium-scale millers distribute flour to the market.

Millers or their distributors deliver wheat flour to the wholesalers. Wholesalers may also opt to collect the flour from the mill.

Although millers prefer to distribute wheat flour through distributors and wholesalers, retailers are not entirely restricted from purchasing the flour directly from the mill. However, they must purchase the minimum volume of wheat flour required of anyone desiring to purchase directly from the millers (large-scale and upper medium-scale). Retailers and consumers can nonetheless purchase wheat flour from lower medium and small-scale millers without having to meet any predetermined threshold in quantities. For this reason, wholesalers refrain from purchasing and stocking wheat flour from these two categories of millers due to lack of price differentiation. In other words, lower medium and small-scale millers sell wheat flour at the same price to wholesalers, retailers and consumers, denying wholesalers and retailers the opportunity to make a sale margin.

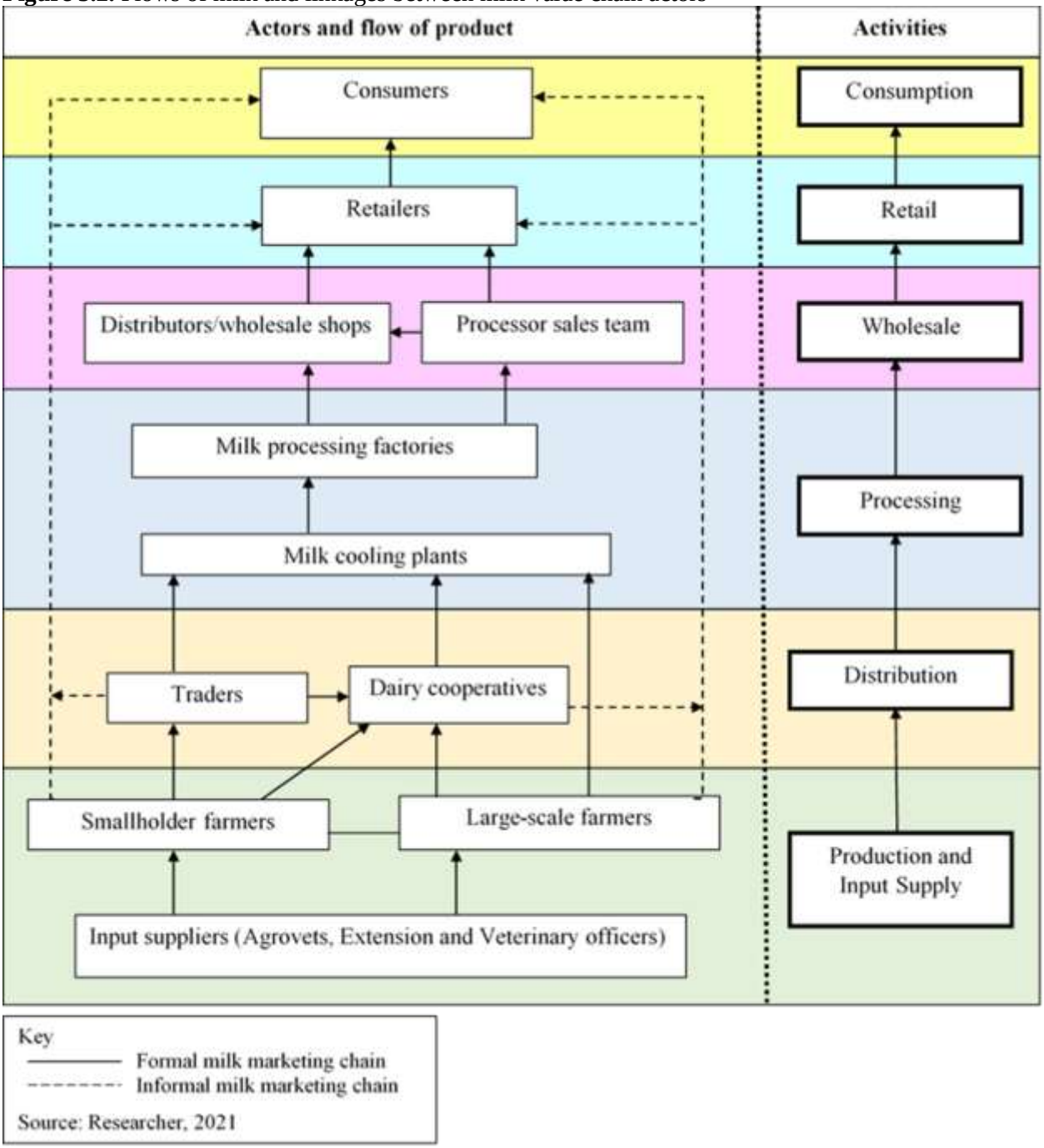
Wholesalers are the main marketing channel through which retailers obtain wheat flour. Usually, retailers place an order and the wholesaler may either deliver the flour to the retailer or alternatively, the retailer may choose to collect the flour from the wholesaler. Supermarkets, who are large retailers, are an exception to this type of arrangement. They procure wheat flour directly from the millers or distributors as opposed to through wholesalers due to the large quantities of flour they retail. In addition, baking flours, which constitute about 10% of processed flour, are in most cases delivered directly to bakers by millers. Distributors, wholesalers and supermarkets are allowed a credit period of 14 to 30 days. Retailers usually settle invoices on the same day of delivery but may also be allowed (by wholesalers) a shorter credit period of up to 4 days depending on the business relationship.

5.3 Activities, Actors and Product Flows in the Milk Value Chain

The milk value chain shows two distinct but interlinked flows of milk from production to consumption, defined by the marketing or distribution channels (Figure 5.2). The two channels are referred to as the formal and informal milk marketing channels. The main difference between these two distribution channels is that the formal milk channel involves processing of milk into various products while the informal channel simply involves distribution and sale of raw milk. Comparatively, the formal milk chain has more actors and stages to consumption than the

informal milk chain. The actors involved include the farmers, traders/hawkers, cooperatives, processors, wholesalers and distributors, and retailers who participate in the production, distribution, processing and retailing of milk while the informal milk chain lacks the processors and wholesalers.

Figure 5.2. Flows of milk and linkages between milk value chain actors



5.3.1 Milk input supply and production

Milk input supply

The main providers of inputs in the milk value chain are agrovets, livestock and veterinary officers (Figure 5.2). All (4) agrovets interviewed were privately owned. Some (25%) of the proprietors were also involved in dairy production as farmers. They sold a variety of feeds and supplements to the dairy farmers. Agrovets did not provide any subsidies on inputs and all were sold at market prices. However, some agrovets entered into special arrangements with dairy cooperatives to provide inputs on credit. In addition to selling inputs, agrovets had a significant role in providing advice to dairy farmers on a various issues including use of feed and supplements, improving animal breeds and productivity, and treatment of livestock diseases. Some (50%) agrovets had the capacity to offer veterinary services. Private veterinary officers were the major providers of veterinary services to the smallholder (42%) and large-scale (100%) farmers. The same services were also accessed by smallholder farmers through veterinary officers contracted under dairy cooperatives (22%) and from government livestock officers (8%).

Milk production

The study differentiates between three types of farmers: large (more than 20 cows), medium (6-20 cows) and smallholder farmers (5 or less cows). The medium-scale farmers were few (2) and hence regrouped into in the large-scale farmer's category due to their homogeneity of production practices (Figure 5.2). Less than half (40%) of the smallholder dairy farmers had finalized primary education; 26% had a secondary education; and 16% had pursued education beyond secondary level. Majority (94%) were involved in the value chain as producers with only 2% involved at retail level and 4% having an additional role of training fellow farmers. Smallholder dairy farmers owned, on average, 4 cows, and kept three main breeds namely; Fresian (66%), Aryshire (48%) and crossbreeds (16%). Not all the cows were milked in a given period of time. Only 50% of the cows were milked, with the other half either being in-calf (37%), calves and heifers (55%) or were either sick or dry (8%). Daily yields averaged 9 litres per cow in two milking's, from which 80% was sold and 20% retained for calves and household consumption. Majority (98%) of the smallholder dairy farmers sold their milk raw and did not undertake any form of value addition. They sold their milk through multiple channels, predominantly to the

dairy cooperatives (70%), traders/hawkers (12%), neighbors (10%) and institutions and other small outlets (7%). Very little (1%) is sold directly to the processors (Table 5.2).

Table 5.2. Selected characteristics of smallholder dairy farmers

Parameter	**Mean values (n=50)**
Household size	3
No. of dairy cattle	4
% dairy cattle being milked	51
Breed of cattle (%)	
Friesian	66
Ayrshire	48
Jersey	6
Guernsey	4
Crossbreeds	16
Labour to the dairy activity	
% hiring monthly labour	44
Average daily hours spent on activity	4
Milk production	
No. of milking per day	2
Yield (L)	9
% Milk utilization (L)	
Sold	80
Home consumption	18
Calves	2
Channel through which milk is sold (%)	
Dairy Cooperative	70
Processor	1
Trader/Hawkers	12
Neighbors	10
Institutions e.g schools, offices	4
Local restaurants	1
Own shop	2

Source: Researcher, 2021

Almost all (90%) the smallholder dairy farmers transported their milk to a collection or selling point while for a few (10%) milk was collected from the farm. They walked an average distance of one kilometer to the collection or selling points, with some (11%) using motorcycles, paying about KShs 50 daily for milk transportation. Smallholder dairy farmers obtained fodder from their farms which they complemented with more nutritious feed and supplements purchased from

agrovets. At least half (56%) of the smallholder farmers spent on average 4 hours daily engaged in dairy keeping activities while less than half (44%) hired male workers on a monthly pay.

Large-scale dairy farmers kept as many as 450 dairy cows. The most common breed among large-scale dairy farmers was Holstein Friesian. Just like smallholder farmers, they milked half their herds with the other half being in-calf, calves, weaners or heifers. Large-scale dairy farmers either purchased feed components and supplements in bulk from manufacturers or their main suppliers, or constituted their own feed. They kept high milk producing cows, some producing as high as 55 litres of milk per day, and therefore milked 3-4 times in a day. Due to the large volumes of production, they sold between 50-100% of their total production directly to processors (government and private owned) and in raw form. They did not engage in value addition. Those supplying to the government processor delivered their milk while the private processors collected from the large-scale farms. They also sold milk to hotels and institutions. However, they retained 5-20% of the milk produced for consumption by farm workers and calves. Just like smallholder farmers they employed male workers but on a higher monthly pay (twice as much).

5.3.2 Milk trade and distribution

Traders and dairy cooperatives are the two main actors involved in collecting, distributing and delivering the bulk of raw milk, particularly from smallholder dairy farmers in the formal and informal marketing value chains (Figure 5.2). Large-scale dairy farmers sell the larger proportion of their milk directly to processors.

Milk traders

Milk traders are the primary distribution agents in the informal milk value chain. Majority had been in milk trade for a significant number of years, averaging 10 and tended to do multiple activities in the value chain. For example, most (91%) of them were also involved as producers while 9% were retailers of milk. As primary distribution agents, they collect milk from the smallholder dairy farmers for delivery to retailers (milk bars and shops), individual consumers and processors. Traders intimated preference for selling milk to retailers and consumers as opposed to processors (Table 5.3) because they (traders) were able to get higher prices and receive regular and timely payments. Yet, they (traders) still maintained an active relationship

with the processors through minimal deliveries for strategic reasons. Such delivery of small amounts of milk during off peak (dry) season, ensured a good business relationship in order to sell excess milk to the processors during the peak (wet) season.

Table 5.3. Selected characteristics of milk traders

Parameter	**Mean values (n=11)**
Years in trade	10
Amount of milk collected and sold per day (L)	195
Distance from farmer to selling point (km)	15
Number of (smallholder farmers) collection points	46
Channel through which milk is sold (%)	
Hotels	30
Shops	21
Processors	18
Milk bar	16
Individuals	11
Offices and schools	4
Means of transport used (%)	
Motorcycle	91
Car	9

Source: Researcher, 2021

Daily collection points varied greatly, ranging from 46 smallholder dairy farmers to as many as 100 smallholder farmers in a day. The aim was to accumulate large volumes of milk from smallholder farmers whose average milk sale was 5 litres per day. Milk traders collected varying amounts of milk per day ranging from 100 to more than 1,000 litres of milk depending on the season. They reported a decline of up to 50% in the volume of milk collected during the dry months. Consequently, they had to cover large areas in order to collect substantial volumes of milk from dispersed farmers. Traders travelled approximately 15 kilometers to the point of milk delivery. Motorcycles were the main mode of transporting milk for majority (91%) of the traders, while others (9%) used pick-up trucks. It is mandatory for milk traders to obtain a trading license from the regulatory authorities allowing them to transport and trade in milk.

The smallholder dairy farmers and milk traders have established a mutual supply arrangement on milk collection/delivery times and payment. The traders collect milk in the morning. Milk from the previous evening was bulked differently from that which was milked in the morning. Payment to smallholder dairy farmers was done weekly, fortnight or monthly depending on the

agreement. Milk traders also extended credit to smallholder farmers on trust but in consideration of a farmer's consistency and amount of milk delivered. Money lent was repaid through deductions at the time of payment for milk supplied.

Dairy cooperatives

Dairy cooperatives are significant suppliers of milk in the formal milk marketing chain (Figure 5.2). They bring together as little as 50 and as many as more than 1000 smallholder dairy farmers. While some dairy cooperatives were able to maintain more than 75% active member participation, others had as low as 13% members actively delivering milk. Dairy cooperatives maintain a two-tier management structure whereby a management committee consisting of a Chairperson, Vice Chairperson, Treasurer and Secretary oversee the daily operations under the watch of a supervisory or executive committee. Some dairy cooperatives have shareholding with processors that enable them to be represented at the processors governing body and indeed participate in decisions such as pricing. The main role of dairy cooperatives is to collect, bulk and market smallholder farmer's milk. They sell most (over 80%) of their milk to processors with the balance sold to hotels and households.

All the dairy cooperatives sold raw milk, and therefore did not engage in any value addition activity. Dairy cooperatives with high numbers of active members delivered more than 2,000 litres of milk in a day during the wet season. To maintain milk supply levels and boost smallholder milk production, dairy cooperatives offer training on fodder production and silage making; provide inputs (e.g feed) and food on credit directly to farmers or by contracting agrovets; provide subsidized animal feeds; and contract veterinary officers to offer artificial insemination and veterinary services on credit.

Dairy cooperatives are governed by a set of rules and regulations that are clearly stipulated in their constitution. They guide farmers on, among other things, time of milk delivery, containers to use in carrying milk and time and method of payment. For the purposes of milk collection and traceability, dairy cooperatives divide smallholder dairy farmers into smaller milk delivery groups. Each of these groups delivers milk at a designated collection point, usually by the roadside or shopping centres. Dairy cooperatives used motorcycles (collects milk from interior areas), tuk-tuks and lorries to collect and transport milk. Due to the high perishability of milk,

dairy cooperatives ensure that milk is collected under clean and hygienic conditions and delivered to milk cooling plants within the shortest time possible but within an agreed time limit. Dairy cooperatives enter into agreements with processors on minimum amounts of milk to deliver in order to cushion processors from sudden high fluctuations.

Dairy cooperatives received a rebate to cover for cost of transport incurred in delivering milk to the processor. Processors made payments to dairy cooperatives for milk delivered once or twice a month. Dairy cooperatives in turn paid their members through accounts held in Savings and Credit Cooperative Organizations (SACCO) less any credit that a farmer had taken and dairy cooperative operating expenses. Dairy cooperatives deducted between KShs 1 and 3 per litre of milk delivered by the farmers to cater for expenses related to running their offices and operating licenses from the regulatory board and county government cess collectors.

5.3.3 Milk processing

Milk processing begins at the cooling plants where milk is chilled at less than 5 degrees Celsius. The cooling plants were owned and operated by processors (private and government). They are located closer to the farmers to maintain milk quality because this reduces the distance and time taken to deliver milk to the coolers, and thus the risk of contamination. Most (80%) of the milk received at the cooling plants was delivered through dairy cooperatives and self-help groups, with the remaining 20% coming from the traders and individual farmers (mostly large-scale farmers). Milk cooling plants operated below capacity: while they could bulk and hold up to 28,000 litres of milk in a day, they only received between 15,000 and 20,000 litres of milk in a day, depending on the season. Once milk was chilled it was transferred to the processing factories using tankers made of stainless steel. Transportation of milk was undertaken either by the processor or contracted to an external agent.

The study identified two types of milk processors: private and government owned processing plants. These processors co-exist in the same business environment creating market options for farmers, competition for processed milk and milk products and generally shaping the structure of the milk value chain. Milk processors are few, in comparison to other value chain actors, and although they source their milk from the same catchment areas, they have established territorial boundaries with each having dominance in particular areas. Milk processors processed raw milk

into various products: pasteurized milk, long life milk, powder milk, yoghurt, fermented milk, butter, cheese and ghee which are packaged into different quantities to serve different target markets.

Processed milk varied between 25,000 and 100,000 litres of milk per day for a single processor depending on the season. Dry seasons have low milk intakes and capacity utilization while wet seasons result in excess milk which is processed to powder milk by some processors to cushion farmers. The study revealed that milk processors prioritize liquid products, which have more market demand than other products. To help maintain consistent milk supplies, processors support smallholder dairy farmers by providing extension services and training on different aspects of dairy farming.

5.3.4 Milk wholesale and retail

Milk wholesalers

Wholesale activity in the milk value chain is found in the formal milk marketing chain. Wholesalers operate shops in towns and large shopping centres. They receive milk directly from processors through their sales/marketing department or their appointed distributors. Processors may use own company or hire vehicles to distribute milk and milk products. Also, appointed distributors collect milk and milk products from the processor's depots for delivery to a defined area. Distributor's get a rebate on transport based on distance to delivery points. The distributors and processors deliver milk to wholesalers, institutions, large hotels and retailers.

Milk retailers

The milk value chain has several types of retailers that include supermarkets, shops, kiosks, milk bars, restaurants, market stalls and farmers. The two distinct milk chains, informal and formal, determine the retail channels. In the informal channel, raw milk is sold in milk bars, shops, kiosks, market stalls and restaurants. Half of the retailers in the informal marketing chain were also involved as producers or traders in the value chain. Farmers also sell raw milk directly to consumers. Consumers purchase raw milk in desired quantities usually carried using their (consumers) own containers. The study revealed that retailers such as milk bars and restaurants stored milk in coolers, boiled raw milk and some added value by making yoghurt and fermented milk. Retailers intimated that the form in which milk is retailed is determined by consumer

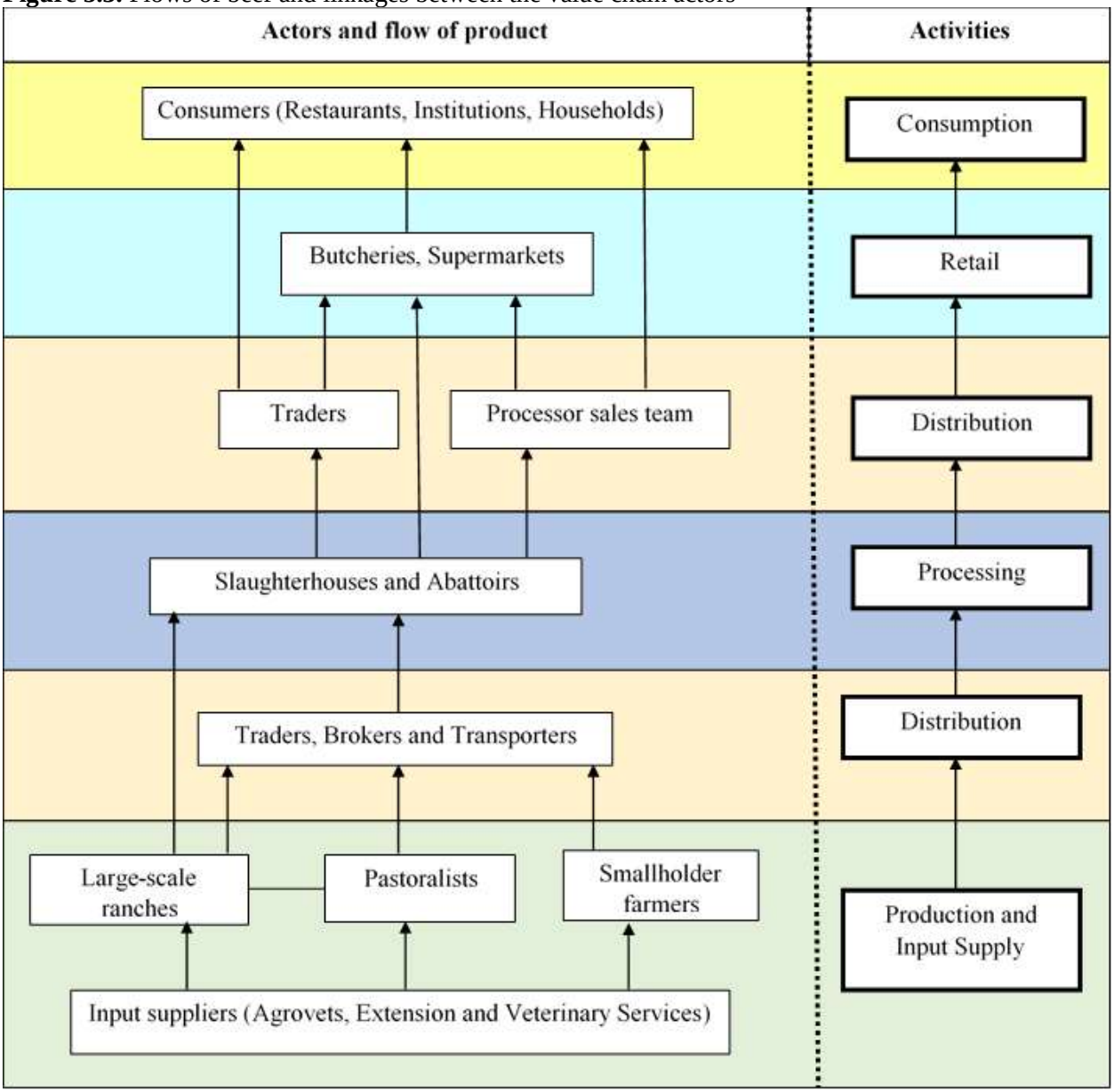
preferences and returns on sale. Supply arrangements between the retailers and their suppliers (traders and farmers) in the informal marketing chain are based on mutual agreement regarding the quantity, time of milk delivery and payment. Credit on delivery of milk is minimal in the informal milk marketing chain and if available the repayment periods were short; up to fourteen days.

In the formal milk marketing chain, supermarkets, shops and kiosks constitute the retail outlets. These retailers receive branded processed milk packaged in different quantities and package material like the pouch and tetra packs of different sizes from 0.25 litre, 0.5 litre to 1 litre. Larger quantities of milk above 5 litres were packaged in plastic containers. Retailers of processed milk received milk supplies from wholesalers on order. While some retailers obtained credit on milk supply, which varied from one day to fourteen days, others settled payment upon delivery of supplies at their premises. Supermarkets are an exception and may receive milk supplies directly from the processors owing to their high stocking levels. They are able to negotiate for slightly more margins per litre of milk and longer credit periods of up to 30 days.

5.4 Activities, Actors and Product Flows in the Beef Value Chain

The activities and actors in the beef value chain are graphically presented in Figure 5.3. The value chain is defined by two different end markets, a high-end market and a low to middle income market which influence the mode of production. The flow of beef destined for the high-end market is shorter. The main value chain activities in the beef value chains are input supply and production, trade and distribution, processing, retail and consumption. The main actors involved in these activities include beef producers (pastoralists, large-scale ranches, smallholder farmers), livestock traders and brokers, processors (slaughterhouses and abattoirs) wholesalers and distributors, retailers (butcheries and supermarkets) and consumers (households, hotels and restaurants, institutions).

Figure 5.3. Flows of beef and linkages between the value chain actors



Source: Researcher, 2021

5.4.1 Beef input supply and production

Beef input supply

Input supplies for beef production include breeding stock, extension and veterinary services, feeds and supplements and livestock drugs (Figure 5.3). Input suppliers include agrovets, livestock markets, veterinary and extension officers. The government produces and supplies breeding stocks, a role which has gradually been taken up by the large-scale ranches due to poor services (ASDSP, 2010; Farmer & Mbwika, 2012). Large-scale ranchers and pastoralists breed

from their own herds instead of depending entirely on artificial insemination mainly because of the large size of herds. Pastoralists build their herds either through use of own bulls (88%), community bulls (16%) or purchase young calves (18%). Large-scale ranches indicated importing semen to upgrade their herds while the pastoralists used bulls acquired from the large-scale ranches for herd upgrading.

Government officers provide livestock extension and veterinary services, particularly to pastoralists. However, 46% of the pastoralist had no access to veterinary services, primarily due to lack of livestock officers. The few available livestock officers were constrained by lack of adequate resources against the very large areas under their jurisdiction. Large-scale ranches engaged private veterinary service officers. Livestock markets were the main source of animal supplements and drugs for majority (84%) of the pastoralists. Other sources included agrovets located in their local shopping centres and nearby towns. Large-scale ranches purchased supplements and livestock drugs from agrovets or main suppliers.

Beef production

Production in the beef value chain is done by large-scale ranches, pastoralists and smallholder farmers (Figure 5.3). These production systems differ in method and scale of operations. Majority (93%) of the pastoralist were solely involved in the value chain as producers with only 6% engaging in trade (brokers) and retail (butchers). The average Tropical Livestock Unit (TLU) for a pastoralist was 15 (Table 5.4). This study adapts the definition of a tropical livestock unit as an animal having a live weight of 250kg (FAO, 2018a). The study used conversion factors for a tropical livestock unit as suggested by FAO (2018a) and Nyariki & Amwata, (2019) as follows: camel, 1; steer, 0.8; cow or heifer, 0.7; sheep or goat, 0.1. Majority (73%) of the pastoralists reared the zebu breed of cattle. It was most preferred due to its adaptability to dry conditions. The pastoralists herd of cattle consisted mainly (65%) of female cows. Pastoralists are organized into community ranches where they graze their cattle. However, during drought they move their cattle in search of pasture in open spaces which they also supplemented with pasture from the large-scale ranches availed under special grazing arrangements between the two. Three quarter (76%) of the pastoralists had benefitted from these grazing arrangements.

Table 5.4. Selected characteristics of pastoralists

Parameter	**n=67**
Average household size	6
Average TLU per household	15
Average number of cattle per household	14
Average number of sheep and goats per household	55
Breeds of cattle	(as a % of households)
Zebu	73
Sahiwal	4
Crossbreeds	8
Do not know	15
Livestock selling channels	(as a % of households)
Trader/Broker	87
Neighbors	2
Large-scale ranches	11
Average distance to livestock market (km)	6

Source: Researcher, 2021

Majority (87%) of the pastoralists sold their cattle and other livestock to traders in the livestock markets (Photo 5.1), through large-scale ranches (11%) and to neighbors (2%). Pastoralists trekked their cattle on average 6 kilometers to the livestock markets which took place every two weeks. The primary buyers of cattle at the livestock markets are traders although brokers are sometimes also involved in negotiating prices between buyers and sellers. There were several reasons why pastoralists sold their livestock, with the majority (85%) citing the need to raise school fees and related expenses, and purchase of food (57%). Others sold livestock in order to raise money to cover medical bills (10%); expenses during family ceremonies (9%); large unexpected bills (7%) and during drought (6%). It is not common for pastoralists to slaughter cattle at home. Nevertheless, 27% of the pastoralists had slaughtered a cow in the past one year during family ceremonies. The average age of cattle slaughtered during such ceremonies was 4 years.

Photo 5.1. Pastoralists' livestock market

(Photo credit: Researcher, 2021)

Large-scale ranches had an average TLU of 2,015 (Table 5.5). The large herds of livestock correspond to ownership and access to extensive pieces of land. The average land holding size for the large-scale ranches is 34,285 acres with the largest land holding size being 60,000 acres. In addition to livestock keeping, large-scale ranches (6 of 7 sampled) have wildlife conservancies that support ecotourism ventures. The most popular (71%) breed of cattle reared by the large-scale ranches was the Boran.

Table 5.5. Selected characteristics of large-scale ranches

Parameter	**n=7**
Average ranch size (acres)	34,285
Average TLU	2015
Breeds of cattle	(number of ranches)
Boran	5
Redpoll	2
Crossbreeds	2
Sahiwals	1
Shirley	1
Aberdare Angus	1
Livestock selling channels	(number of ranches)
Trader/broker	3
Private businesses	4

Source: Researcher, 2021

Just like pastoralism, large-scale ranching is also pasture based. In addition, cattle are well supplemented with minerals to ensure good finishing for the high end market. Large-scale ranches sold the largest share of their cattle (60%) directly to private slaughterhouses, abattoirs, institutions and retailers (Figure 5.3). This category of buyers had a preference for beef steers (castrated male cattle) (Photo 5.2). The other 40% of the cattle in large-scale ranches were sold to beef traders, who purchased both steers and cull cows (female cattle being removed from the herd). The sampled large-scale ranches did not engage in processing or distribution in the value chain. Buyers collected purchased cattle from the farm.

Photo 5.2. A steer in a large-scale ranch

(Photo credit: Researcher, 2021)

5.4.2 Beef trade and distribution

The transactions involving buying and selling of pastoralist's cattle take place primarily at the livestock markets. Different actors including traders, brokers, transporters, livestock marketing cooperative society officials, county officials and veterinary and livestock officers are involved in the livestock markets. Traders drive the demand in livestock markets and are the primary link between producers and processors (Figure 5.3), and comprise of people with long period of involvement (average of 16 years) in the livestock trade. There were up to 10 traders in a livestock market day. Most (88%) traders had vertically integrated in the value chain: 88% in retail as butchers and 25% in production as beef farmers. Different livestock markets take place on different days hence the same traders are able to participate in all.

Traders purchased on average 10 heads of cattle in a livestock market day. However, the numbers can vary greatly depending on demand and supply. Body size, fat content and weight which were assessed visually determined the price and purchase of cattle. Most livestock transactions take place in the morning to allow time for traders to transport cattle. As traders purchase cattle, they are marked with different colored paint or codes for each trader. Once transactions are complete, the cattle are loaded into lorries. Loading of livestock would take unnecessarily longer due to lack of proper loading zones. Cattle were transported mainly using small trucks that hold up to 20 heads of cattle. A trader may use their own lorry or hire, solely or jointly, in which case they share transport costs.

Negotiations between the traders (and other buyers) and the seller may involve a broker. This was sometimes necessitated by language barriers or lack of trust on the part of the seller. The seller may also not want to deal directly with potential buyers. Key informants estimated the number of brokers at about 10, in a single livestock market. Brokers earn their margin by negotiating a high price for the buyer and lower for the seller, and take the difference in price. This was possible because the broker negotiated the prices separately without the knowledge of both parties. Alternatively, brokers would charge a commission for negotiating a transaction. This brokerage fee would be agreed upon before the transaction and was payable by the party that tasked the broker to either sell or assist in purchasing specific cattle at a certain price. An example of such a transaction was sale or purchase of a young bull. Brokers were also known to purchase cattle at the opening of the livestock markets and sell later within the day or at a different market on a later day, at a higher price.

The livestock markets (infrastructure) are owned and operated by the relevant County government within which it is located. A fee is levied for use of the market and is collected by the Livestock Marketing Cooperative Society (LMCS). Part of this fee is retained by the LMCS for their operating expenses while the other proportion is remitted to the county government. LMCS issues the transacting parties with a receipt showing the date of transaction, buyer and seller national identification numbers, place of transaction, description of livestock and price. This serves as proof of ownership and purchase; and to minimize sale of stolen cattle. LMCS plays various roles, key among them, assisting pastoralists with livestock marketing. They also collect data on livestock, engage in capacity building, value addition (e.g leather processing),

rangeland and water management. Its membership constitutes the community ranches. Veterinary officers assess the health conditions of the cattle to ensure they are free of diseases and fit for transportation. Buyers are issued with a movement permit to facilitate movement and transportation of cattle.

Trader's decision on whether to buy cattle from pastoralists, large-scale ranches or smallholder farmers was largely dependent on the destination market/consumer. Traders intimated they buy from large-scale ranches to service specific orders of high-quality beef from private processors, institutions and retailers. Traders enquire availability of cattle from the large-scale ranches in advance of purchase and transport for slaughter. Cattle purchased by traders are not necessarily slaughtered on the same day. They may be held in a holding ground, usually, next to the slaughter houses. Cattle can remain in the holding ground for up to two weeks depending on demand. Traders hire herders to look after the cattle and graze them in nearby open spaces or feed them on hay until slaughter. However, it was not common to find a trader holding cattle purchased from large-scale ranches as this were purchased for immediate slaughter.

5.4.3 Beef processing

Processing in the beef value chain is done by the slaughterhouses and abattoirs, which can either be private or government owned (Figure 5.3). Basically, slaughterhouses offer slaughtering services at a fee. Traders are the key actors who organize slaughtering and selling of cattle. Traders hold livestock for short periods at designated holding areas next to the slaughterhouse awaiting purchase from butchers or orders for delivery of beef carcass. Butchers may visit the holding grounds, purchase cattle, supervise slaughter and organize for transport to their retail points. But most often than not, traders slaughter cattle and deliver meat already pre-ordered by clients (institutions and butcheries). Traders may also slaughter and hang the carcass at the slaughterhouse waiting for clients to purchase.

At the slaughterhouse, the inspecting officer receives the movement permit and undertakes an ante-mortem inspection of the cattle to ensure they are fit for slaughter. The slaughtering process takes about 45-60 minutes for a single cow. A post-mortem inspection of meat is undertaken by the veterinary-in-charge of the slaughterhouse to ensure the meat is fit for human consumption. A stamp is put on the carcass as evidence of post-mortem inspection. Although there were

traders using privately owned slaughter houses, majority prefer government owned slaughterhouses which charge a lower service fee. Nevertheless, the sampled government owned slaughterhouses at the county level, were operating below their full capacity. They slaughtered an average of 10 cows which may vary between 5 and 15 cows in a day. There is hardly any meat grading that takes place in the slaughterhouses. Meat and other edible parts such as offals are transported from the slaughter houses in metal boxes using either hired motorcycles or pickup trucks depending on the volume. Traders sell the inedible by-products like skin and hooves to interested buyers present at the slaughterhouses.

This study interviewed a government owned and private meat abattoir in Nairobi. As stated before, abattoirs process meat into different products in addition to slaughtering. These processors were operating below (50%) their capacity, slaughtering 100-150 head of cattle in a day. Cattle slaughtered at the abattoirs were mainly sourced through traders (90%), who purchased them from the large-scale ranches. The private abattoir had a preference for Boran and Sahiwal breed of steers perceived to have a good finish and produce desired beef cuts. Upon arrival at the abattoirs, cattle are inspected by a veterinary officer and allowed 12-24 hour rest period before slaughter. Once slaughtered a post-mortem inspection and grading is done. Abattoirs grade the carcass into 6 different grades based on weight, muscle conformation and other quality parameters such as bruising and blemishes. The grades are premium or prime, high grade 1 and 2, Fair Average Quality (FAQ), standard and commercial grade. Suppliers are paid based on this grading.

Premium grade is the highest grade, fetches the highest price and targeted for the high end market (high class butcheries and hotels, large supermarkets). Cattle were considered premium grade if they were below 4 years of age, have well distributed white fat cover and good muscle conformation. Commercial grade is the lowest quality and thus fetches the lowest price. This category of meat is used in manufacturing products like sausages. Abattoirs operated a cold chain from processing to delivery of meat. After slaughter and processing, meat was sold in different forms such as beef carcasses, beef steak cuts, meat on bone and minced meat, which were graded differently. Other value-added products included canned and corned beef, sausages and burgers which were sold in branded packages. Most of these meat and meat products are destined for the local market. The processor distributes these products through their sales

departments to different classes of consumers and retailers: government and non-governmental institutions, supermarkets, hotels and mini-shops (Figure 5.3). Private abattoirs export about 5% of their meat.

5.4.4 Beef wholesale and retail

The wholesale level of the meat value chain is more of a distribution role. The role of selling meat from slaughterhouses to retailers is mainly done by traders. In the marketing chain of meat sourced from abattoirs, the processors through their sales departments and agents distribute meat and meat products to retailers (Figure 5.3). Locally, beef is retailed by butcheries, supermarkets, hotels and restaurants. Butcheries form the main retail points and are conveniently located in towns and shopping centres. They sell beef to individual customers as take away to cook at home as well as to institutions like schools and hospitals. Most butcheries do not grade their beef; consumers walk in and purchase meat on bone or minced meat. However, some butcheries selling to high- and middle-income households offer special cuts of meat that retail at higher prices. These butcheries retail beef, said to be of higher quality, sourced from large-scale ranches either directly or through traders. The study identified some butcheries that had vertically integrated in the value chain from sourcing cattle, transporting and organizing for slaughter, and delivery to their premises. Restaurants and hotels sell cooked beef, prepared in various ways. In some cases, a butchery could have a restaurant or hotel thus retail both uncooked and cooked beef. Supermarkets grade their beef into different meat cuts. They also retail meat products from the processors.

5.5 Summary of Chapter

An analysis of value chain actors, activities and flow of goods has not only brought out the overall picture of the structure of the value chains but has provided a detailed appreciation of what constitutes the value chains. The three value chains constitute five main activities of input supply and production, trade and transportation, processing, wholesale and retail through which food products flow and are transformed for final consumption. Distribution and marketing chains for the food products in all value chains have both informal and formal chains. This is more distinct for the milk value chain. However, both informal and formal marketing chains are interlinked through transactions exchange of goods and services, sharing of knowledge and information, and relationships between actors. Analysis shows that products flow in raw form in

the informal marketing chain with minimal value addition. This marketing chain mainly serves the local market. It is a shorter chain with fewer actors compared to the formal marketing chain which involves value addition of food products through processing into different products targeted for the urban market.

Agrovets are key inputs and service providers to producers in all the value chains. In all agro-food value chains, producers are the majority actors and are important in sustaining consistent supplies of food products in the value chains. Two main modes of production emerged in all three value chains based on the scale of operation; small and large-scale production. Large-scale producers are commercial oriented in production compared to small-scale producers. Although both smallholder and large-scale farmers participated in both formal and informal marketing chains, large-scale farmers were more dominant in the formal marketing chain while smallholder farmers were the majority producers in the informal value chain.

In the three agro-food value chains, traders are an important link between the producers and the processors or the market. They move farm produce from the farm and livestock markets to processors in the formal marketing chains and to retailers and consumers in the informal value chains. They also provide financial credit to smallholders in the dairy and wheat value chains. Moreover, they are key originators of information for the smallholders. However, their role is more prominent in the informal marketing chains of the three agro-food value chains. The wheat value chain exhibited fewer numbers of traders compared to the milk and beef value chains.

Processing stage of the value chains seem to be dominated by far fewer actors compared to other levels of the value chains. Processors were classified according to their scale of operation and the target market for their end products. Extensive processing of wheat, milk and beef takes place in the formal marketing chain with private processors being the key actors. The informal milk and beef marketing chains have minimal, if any, processing taking place. Processing is carried out by millers in the wheat value chain, milk processors in the dairy value chain and slaughterhouses and abattoirs in the beef value chain. Wheat millers obtain about a third of their wheat requirements locally, with the bulk being imported. However, milk processors, slaughterhouses and abattoirs obtain all their raw products locally.

Distributors were more present in the formal marketing chains as the link between processors and wholesalers. They were important in moving large volumes of processed products to wholesalers and large retailers like supermarkets. Similarly, wholesalers were more present in the formal marketing chains compared to the informal marketing chains. The difference between distributors and wholesalers lies in their capacity for distribution, determined by their capital ability. Distributors have a higher financial capacity to purchase and transport the food products compared to wholesalers. Distribution and supply of finished products to retailers is also undertaken by the processors through their sales or marketing departments.

The end products of either the informal or formal marketing chains in all value chains seemed to define the retail outlet. The end products of the informal marketing chain are sold raw or having undergone minimal processing. On the other hand, the end products of the formal marketing chain are processed. In the milk value chain, supermarkets, shops and kiosks constitute the main retail outlets for processed milk and milk products. While milk bars, shops, kiosks, market stalls and restaurants retail raw milk. In the beef value chain, butcheries form the main retail points for non-graded and unprocessed beef. However, supermarkets and high-end butcheries stock various beef products including graded beef cuts. In the wheat value chain, supermarkets and shops stock different types of fine milled wheat flour. Generally, majority of actors are primarily involved in one stage of the value chain. However, some integrate vertically in the preceding or next level of the value chain.

CHAPTER 6. VALUE ADDITION AND DISTRIBUTION IN WHEAT, DAIRY AND BEEF VALUE CHAINS

6.1 Introduction

The results presented in this chapter seek to achieve the second objective of the study on value added and its distribution among actors in the wheat, dairy and beef value chains in North West Mt. Kenya. This is done by establishing the gross margins each actor obtains from their involvement in the value chain. Cumulatively, the gross margins for all actors give an indication of the value added in the value chain and consequently the economic benefits received by the actors. For each of the value chains, analysis begins at the production level proceeding to trade and transportation, processing, wholesale and finally retail. At the production level, the chapter analyses yields, revenue, costs, prices and gross margins of producers. The differences between small-scale and large-scale production are brought out. At the trade stage of the value chains, the chapter analyses revenues accruing to traders, their costs of operations and gross margins. Similarly, at the processing level, the chapter provides revenues for the processors, costs of processing and gross margins from sale of processed products. In addition, the costs and gross margins of wholesalers and retailers are discussed. Each value chain concludes with a review of gross margins for all levels to enable comparisons across all actors. In addition, price transfer along each value chain is discussed. Finally, the chapter concludes by highlighting the key findings.

6.2 Value Addition and Distribution in the Wheat Value Chain

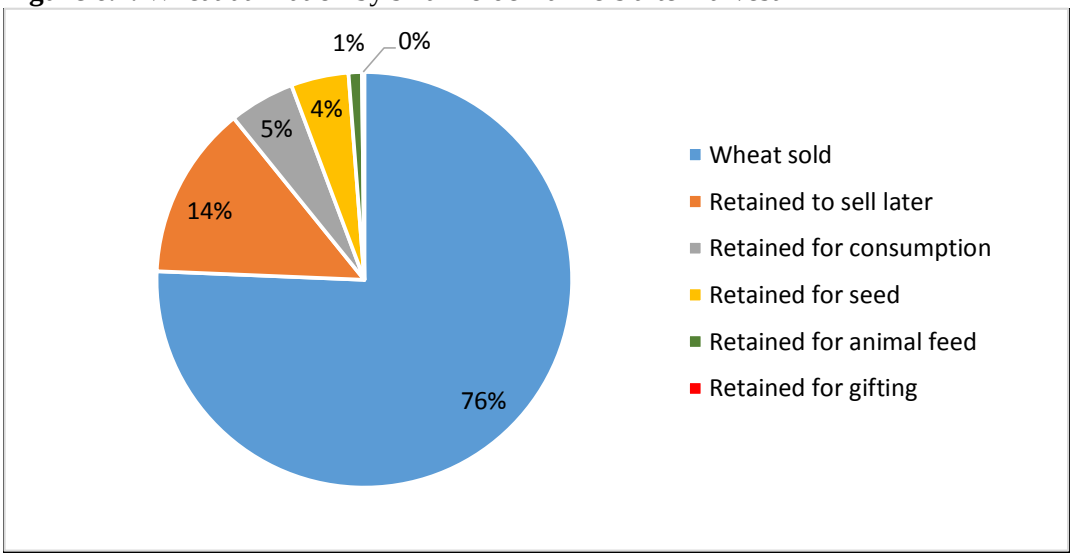
6.2.1 Yields, costs and gross margins of wheat producers

Yields

The yield per acre for large-scale wheat farmers was 19 bags. The highest yield per acre attained by a large-scale wheat farmer was 26 bags whereas the lowest was 14 bags. Large- scale wheat farmers sold most (96%) of their harvested wheat, in consignments, retaining only 4% as seed for the next planting. The average yield for the smallholder wheat farmers was 9 bags per acre. The highest yield attained by a smallholder wheat farmer was 30 bags per acre, the highest attained among both small and large-scale farmers. This could possibly be explained by the reason that this particular farmer used irrigation.

Some (17%) of the smallholder wheat farmers were able to achieve a yield equivalent to the average yield of large-scale farmers, while some (5%) had no harvest at all for the season. They lost their crop during the season from diseases and pests. Smallholder wheat farmers were producing at half the large-scale farmer's yield. Wheat produced was either sold in the market, stocked for future sale or usage, retained as seed or used for own consumption. Smallholder wheat farmers sold the largest proportion of their output immediately upon harvest (76%) and retained a smaller proportion in the form of wheat grain for different uses (Figure 6.1). Immediate sale of wheat is necessitated not only by the need for money to meet pressing family needs but also by the lack of wheat driers and proper storage facilities

Figure 6.1. Wheat utilization by smallholder farmers after harvest



Source: Researcher, 2021

Costs of production

Costs of production for the wheat farmers were grouped into 6 main categories: land preparation, seed, fertilizer, chemical, harvesting and labour costs. The average production cost for the smallholder wheat farmer was KShs 15,950 per acre. Table 6.1 gives a breakdown of individual costs for the two wheat production systems. Land preparation constituted the highest proportion (32%) of total production costs for the smallholder wheat farmer (Table 6.1). This was because of the high cost and frequency of hiring machinery.

Table 6.1. Smallholder and large-scale wheat farmer's costs of production (per acre)

Type of cost	Smallholder farmers (n=58)		Large-scale farmers (n=7)	
	Amount (KShs)	Percentage of total cost	Amount (KShs)	Percentage of total cost
Labour costs (largely for spraying)	1,065	7	2,710	10
Land preparation costs (1st plough, 1st harrow, 2nd harrow and seed row hire)	5,073	32	6,942	26
Seed cost (including transport)	2,344	15	2,020	8
Fertilizer (including foliar) cost	2,507	16	5,739	22
Pesticides (herbicide, fungicide and insecticide	2,000	13	6,759	25
Harvesting cost (hire of combined harvester, handling to store)	2,958	19	2,501	9
Total cost	15,947		26,671	

Source: Researcher, 2021

The cost of machinery hire constituted the larger share (94%) of the land preparation cost. During land preparation smallholder farmers hired machinery to plough, harrow and plant. Cost of harvesting wheat was the second most important cost for the smallholder farmers. Its significance can be associated with high cost of machinery hire. About three quarters (78%) of the cost of harvesting was attributable to hiring of harvesting machinery. Cost of labour was the least significant of the smallholders cost of production. Mechanization of most wheat production activities meant that less labour was required. In addition, smallholder farmers engaged casual workers for a few days during the wheat season while large-scale farmers engaged their workers in temporary jobs with monthly wages which were relatively higher. Fertilizer and pesticide costs were lower for smallholders in comparison to large-scale farmers. Nonetheless, the study found that smallholders had a tendency applying rather low amounts of fertilizers and pesticides while at the same time procuring the lowest priced pesticides which were sometimes not effective.

The cost of production for the large-scale wheat farmer averaged KShs 26,670 per acre. The bulk of costs for large-scale farmers constituted fertilizers and pesticides (Table 6.1). Large-scale farmers relied more on chemicals for land preparation, control of weeds and diseases. Half of these farmers had adopted conservation agriculture and this could explain the high chemical cost, particularly when compared to smallholder farmers. Cost of seed was the least for the large-scale farmers; they retained seed and hence did not incur cost of purchase and transport of seed. All the large-scale farmers interviewed owned machinery necessary for wheat production and did not

incur cost of hire. This could explain the difference in harvesting cost between the smallholder and large-scale farmers.

Gross margins

For every kilogram of wheat produced large-scale wheat farmers obtained a gross margin of KShs 15 while smallholder farmer obtained KShs 9 (Table 6.2). There were wide disparities in gross margins among smallholder farmers. While some smallholder farmers had as high as KShs 22 gross margin for every kilogram of wheat produced others made losses of upto KShs 300 per kilogram. In fact, 41% of smallholders made a loss from wheat production for the season. High yields and prices can be associated with large-scale farmers' high revenues. Large-scale farmers made twice as much yields and revenue in comparison to smallholders, but their cost per hectare, was 67% more. Even so, their cost per bag of wheat grain was lower compared to smallholders primarily because of higher yields.

Table 6.2. Gross margins for wheat farmers

	Smallholder farmers (n=58)	**Large-scale farmers (n=7)**
Yield per acre (90 kg bags)	9.7	19
Price per 90 kg bag (KShs)	2,420	2,765
Revenue per acre (KShs)	23,474	52,535
Total production cost per acre (KShs)	15,947	26,671
Gross margin per acre (KShs)	7,527	25,864
Cost per bag	1,644	1,404
Gross margin per bag	776	1,361
Gross margin per kg	8.6	15.2

Source: Researcher, 2021

6.2.2 Revenue, costs and gross margins of wheat traders and distributors

Purchase of wheat constitutes the largest cost component for the wheat traders. Other costs include transportation, labour and loading costs, and payment of cess. The costs and gross margins for the traders (N=3) are summarized in Table 6.3. Traders make a gross margin of KShs 340 per bag of wheat transported to the millers.

Table 6.3. Wheat traders' costs, revenue and gross margins

Parameter	KShs per 90kg bag of wheat
Revenue[1]	2,900
Costs	
Purchase of wheat grain	2,400
Transport	100
Cess	40
Loading	20
Total costs	2,560
Gross margin	340
Gross margin per kg	3.8

[1]Revenue= 1bag of wheat grain multiplied by the selling price
Source: Researcher, 2021

6.2.3 Revenue, costs and gross margins of wheat processors

Millers estimated that a 90kg bag of wheat grain produces on average 65kg of white wheat flour, 14kg of bran and 9 kg of pollard (by products of wheat milling). About 2% (2kg) is waste. These quantities vary, though marginally, depending on the quality of wheat grain. The average selling price for a kilogram of white flour by the millers was KShs 54.5, KShs 18 for a kg of bran and KShs 26.5 for a kg of pollard. Table 6.4 shows the revenue and costs for a miller per 90 kg bag of wheat grain. The sale of wheat flour, bran and pollard earned millers a gross margin of KShs 862 per bag of wheat grain which translated to approximately KShs 9.6 per kg.

Table 6.4. Wheat miller's costs, revenue and gross margins

Parameter	KShs per 90kg bag of wheat
Revenue	
White flour	3,543*
Bran	259**
Pollard	260***
Total revenue	4,062
Costs	
Wheat grain	2,900
Electricity, water, depreciation, labour, packaging	300
Total costs	3,200
Gross margin	862
Gross margin per kg	9.6

*65kg of white flour multiplied by KShs 54.5 per kg. **14kg of bran multiplied by KShs 18.5 per kg.
*** 10kg of pollard multiplied by KShs 26 per kg.
Source: Researcher, 2021

6.2.4 Costs and gross margins of wheat wholesalers and retailers

The difference between the wholesalers and retailers is in the quantity of wheat flour they buy and sell. Wholesalers buy large volumes of wheat flour that require a large capital outlay compared to retailers. However, some wholesalers have increasingly taken up retail role and vice versa. For example, supermarkets are essentially retailers but purchase large volumes of wheat flour at wholesale prices either directly from the millers or from the distributors. Additionally, supermarkets will offer both wholesale and retail prices to their customers depending on the type of customer. Interviews with wholesalers established that they made a gross margin averaging KShs 5 per kilogram of wheat flour sold to retailers. Retailers (shops and kiosks) in turn sold at a higher price and took an average gross margin of about KShs 6 per kilogram of wheat flour while supermarkets took a gross margin of KShs 5.

6.2.5 Gross margins along the wheat value chain

The gross margin that each actor is able to capture out of a kilogram of wheat grain or wheat flour in the value chain is presented in Table 6.5. Column 5 shows the gross margins for each actor, which is achieved by subtracting costs (column 2) from revenues (column 3). An exception to this was at the wholesale and retail level, where costs were not calculated. Gross margins were established as the difference between the selling and the buying price (column 2 and 3). The gross margin percentage for each actor is shown in column 6 and 7 based on the two production systems (small and large-scale) respectively. The results show that large-scale farmers capture the highest percentage of gross margins (38%) in the value chain compared to other actors. Subsequently, other actors capture less value compared to the marketing chain originating from the smallholder farmers. Processors capture the highest margin (29%) for wheat originating from smallholder farmers. Interesting, retailers and wholesalers obtain higher margins than traders. In summary, large-scale farmers have the highest gross margins, followed by wheat millers, smallholder farmers then retailers, wholesalers and finally wheat traders. Although wheat traders obtain the smallest gross margin compared to other actors, they attain higher incomes than actors such as smallholder farmers, owing to the large volumes of wheat they transact in a season as shown in Table 6.6.

Table 6.5. Calculation of gross margins along the wheat value chain

(1)	(2)	(3)	(4)	(5)	(6)	(7)
			(KShs per kilogram of wheat)			
Value chain actor	**Cost**	**Selling Price/ Revenue**	**Buying price**	**Gross margin**	**Smallholders Gross margins (%)**	**Large-scale farmers Gross margins (%)**
Large-scale farmer	15.6	30.8		15.2		38
Smallholders	18.3	26.9		8.6	26	
Traders	28.4	32.2		3.8	11	10
Processors	35.6	45.1		9.5	29	24
Wholesalers	*	61	56	5	15	13
Retailers	*	65	58	6	18	15
Supermarkets	*	60	55	5		

*Not calculated
Source: Researcher, 2021

Table 6.6. Estimated volumes per actor for a wheat season

Actor	**Average volume transacted in a season (MT)**
Smallholder farmer	2.9
Large-scale farmer	1,200
Trader	2,000
Processor	122,000
Wholesalers	48

Source: Researcher, 2021

6.2.6 Price transfer along the wheat value chain

As wheat moves from one value chain level to the other, price changes as value addition takes place. Figure 6.2 shows the average price of a kilogram of wheat at every value chain stage. At the production stage, the prices obtained by the large-scale and smallholder farmer are shown separately to highlight the difference in price per kilogram for each. The farmer's price represents the farm gate price. This price (farm gate) was determined largely by the quality of the wheat grain. However, factors such as accessibility of harvesting machinery, ability to store wheat grain and the need for cash determined the bargaining power of farmers (especially smallholder farmers) and subsequently the farm gate price. Traders seemed to exert power in determining the smallholder's farm gate price due to their significant role in transporting wheat, ability to assist farmers in harvesting and paying cash immediately upon harvest.

Figure 6.2. Price transfer along the wheat value chain

Source: Researcher, 2021

Traders were paid by the wheat millers a price based on the quality of wheat and cost of transportation. The miller's price of KShs 45 is estimated based on approximately 0.72kg of flour, 0.16kg of bran and 0.1kg of pollard obtained from one kilogram of wheat grain, and sold at KShs 39, KShs 3 and KShs 3 for white flour, bran and pollard, respectively. Wholesalers and retailers sold a kilogram of wheat flour at an average price of KShs 61 and KShs 65, respectively. Although millers may recommend a retail price for wheat flour, wholesalers and retailers reported putting their own mark up on the wheat flour, guided by procurement costs and market competition.

6.3 Value Addition and Distribution in the Milk Value Chain

6.3.1 Yields, costs and gross margins of milk producers

Yields

The average daily milk yield for a cow among smallholder dairy farmers was 9 litres. The highest yield was 22 litres while the lowest yield was 2.5 litres. In terms of total quantity of milk, smallholder farmers produced on average 21 litres of milk daily from their milking herd. The highest daily quantity of milk produced by a smallholder farmer was 60 litres and the lowest 3 litres. Smallholder farmers had an average of 4 dairy cattle out of which they milked 50%. Majority (96%) of the farmers milked twice daily. Smallholder farmers sold the largest proportion (80%) of their milk while retaining the balance for home consumption and for calves.

The average daily milk yields for a cow among the large-scale dairy farmers varied from 6 litres to 28 litres. However, total quantity of milk produced daily from the milking herds ranged from 200 to 1200 litres. The bulk (85%) of this milk was sold while the balance was retained for farm consumption. Also, a large share (70%) of the milk was sold directly to milk processors. Large-scale dairy farmers milked on average three times daily.

Costs of production

The study estimates the cost of production for the smallholder dairy farmer at KShs 15 per litre of milk (Table 6.7). The study considered fodder, concentrates, salts and supplements, labour, spraying and deworming among the costs dairy farmers incur in milk production. The cost of production varied widely among the smallholder dairy farmers. Among the reasons for this were the different costs of inputs, notable for fodder and concentrates, as a result of price differences (see Appendix A3 and A4). In addition, differences in feeding, in terms of quantity and type of feed also contributed to the cost differences. For example, some smallholder farmers did not feed their dairy cows with concentrates while others used few supplements or none at all, hence reduced costs.

Fodder and concentrates comprise the largest share (65%) of the smallholder cost of production (Table 6.7). The cost of concentrates is the most expensive component of feed and this can be explained by high prices of concentrates. Second to fodder and concentrates, labour formed a substantial proportion (23%) of total cost. Perhaps, this could explain why majority (62%) of the smallholder farmers did not hire labour. Instead, they engaged family labour, which is often not considered as a cost. Spraying and deworming constituted a small proportion (3%) of the smallholder dairy farmers total cost of production.

The study estimates that large-scale dairy farmers incur an average cost of KShs 12 to produce a litre of milk. Appendix A7 shows detailed calculation of costs for a large-scale dairy farmer. The bulk of costs for the large-scale farmers were purchase of concentrates which constituted 64% of total cost (Table 6.7). Unlike the smallholder farmers, cost of fodder was lower for the large-scale farmers perhaps because they were able to prepare fodder such as silage in bulk hence reducing costs. In addition, the study noted that large-scale farmers planned for feeding sufficiently ahead of the dry season hence avoiding the increased cost of fodder that comes with

the dry season. Similar to smallholder farmers, spraying and deworming constituted the lowest cost. Interestingly, the cost of labour for the large-scale dairy farmers was lower (11%) in comparison to that of smallholders. Perhaps this can be explained as an advantage of economies of scale.

Table 6.7. Smallholder and large-scale dairy farmer's costs of production, revenues and gross margins

Type of cost	Smallholder farmers (n=10)		Large-scale farmers (n=2)	
	Amount (KShs)	Percentage of total cost	Amount (Kshs)	Percentage of total cost
Fodder	56.6	31	33.6	11.8
Concentrates	63.2	34	180.3	63.3
Salt and supplements	16.8	9	31.2	11.0
Spraying	3.4	2	3.6	1.3
Deworming	2.4	1	4.0	1.4
Labour	41.9	23	32.1	11.3
Total cost per day per cow	184.3		284.9	
Average output per litre per day	12.3		23.3	
Cost per litre	15		12.2	
Revenue per litre*	34		41	
Gross Margin (Kshs per litre)	19		29	

* calculated using 48 smallholder farmers and 3 large-scale farmers respectively.
Source: Researcher, 2021

Gross margins

As stated earlier, only sale of milk was considered as revenue accrued to the farmer from the dairy cows. The average revenue per unit (litre) for the smallholder dairy farmer was KShs 34. This is equivalent to the average selling price of a litre of milk in all the marketing channels that smallholder farmers used. With a cost of production per litre of KShs 15, smallholder dairy farmers had a gross margin of KShs 19 per litre of milk. Large-scale dairy farmers had a higher gross margin of KShs 29 per litre of milk. This is the difference between their average revenue per litre of milk (KShs 41) and cost of production (KShs 12). Results clearly show that the cost of production for large-scale dairy farmers was lower in comparison to the smallholders, whereas their revenue per litre of milk was higher too.

6.3.2 Revenue, costs and gross margins of milk traders and distributors

The study estimated the average cost per litre of milk for the traders at KShs 36 (Table 6.8). The main costs for the milk trader were purchase of milk (94%) and transport (6%). Other costs such as movement permit required for trade in milk, insurance for motorcycles, medical certificate

and employment of casual labour constituted a negligible proportion of the total costs. Milk traders were able to generate sufficient revenue to cover for their costs. The study estimates revenue for the milk trader at KShs 47 per litre. Consequently, trader's gross margin is estimated at KShs 10.5. However, there were notable differences of up to KShs 14 between the highest and lowest gross margins generated by milk traders. These differences were brought about by variations in the buying and selling prices of milk, volume of milk collected/sold and the channel through which milk was sold. Appendix A8 shows calculations of milk trader costs and gross margins using three case examples that highlight the differences. Traders who sold milk purely in the informal milk value chain made more revenue than those who sold to the processors.

Table 6.8. Milk traders' costs, revenue and gross margin (per litre)

Parameter	Amount (KShs)	Percentage of total amount (n=11)
Costs		
Purchase of milk	33.86	93.9
Transport	2.10	5.8
Casual labour	0.08	0.2
Other costs*	0.04	0.1
Total cost	36.07	
Revenue	46.63	
Gross margin	10.56	

*other costs include movement permit, medical certificate and insurance for motorcycle
Source: Researcher, 2021

6.3.3 Revenue, costs and gross margins of milk processors

Interviews with milk processors established their cost of production constitute 65% of the market price for a litre of fresh milk. Of the total costs, milk procurement constitutes the largest proportion (62%) while processing accounts for 38%. The average price of a litre of milk at the time of this study was KShs 100. It follows, therefore, that the production cost for the processor was KShs 65 per litre. Subsequently, the gross margin per litre was KShs 35. However, the gross margin of KShs 35 is shared between the processor (73%), distributor (10%) and retailer (17%). The processor recommends a milk retail price thus determining the margins accruing to the distributor and wholesaler. Thus, with a share of about 73% of the gross margin, the processors gross margin is KShs 25.5 per litre of milk.

6.3.4 Costs and gross margins of milk wholesalers and retailers

The study did not calculate costs related to stocking and selling of milk at wholesale and retail level in the formal milk marketing chain due to difficulties associated with establishing the specific cost of milk as an item among many that these actors trade in. However, the study made attempts to establish the gross margins from interviews as well as through the differences in buying and selling prices. As mentioned earlier, wholesalers and distributors received a margin of 10% of the processors gross margin. The study estimated this share of gross margin at KShs 3.5 per litre of milk. Distributors get a rebate for transport cost (which is their major cost component) based on the distance covered to deliver milk to retail points. This is factored in the distributors purchase price and margin; and may therefore cause gross margin variations among different distributors.

With a 17% gross margin allowed by the processor on retail of milk, retailers attained approximately KShs 6 from a litre of milk sold. Although processors recommend the milk retail price, therefore determining the margins accruing to the wholesalers, distributors and retailers, they do not bind these actors to compliance. Interviews revealed that retailers such as shops and kiosks with lower sales turnover tend to sell milk at a high price than that recommended by processors. Subsequently, some of these shops attained as high as 27% gross margin difference between their buying and selling price.

The informal milk value chain does not have wholesalers. Milk traders distribute the milk from the farmers to the retailers (milk bars, shops, market stalls and open market) or consumers. At the retail level of the informal milk marketing chain, the study estimated the cost of retailing milk by milk bars at KShs 53 per litre (Table 6.9). Costs considered include purchase of milk, rent, labour and utilities such as water and electricity. Purchase of milk constituted the largest proportion of total cost (88%). The average revenue per litre of milk for the milk bars was KShs 66. Thus, milk bars obtained a gross margin of approximately KShs 13 per litre.

Table 6.9. Informal milk retailer costs, revenue and gross margins (per litre)

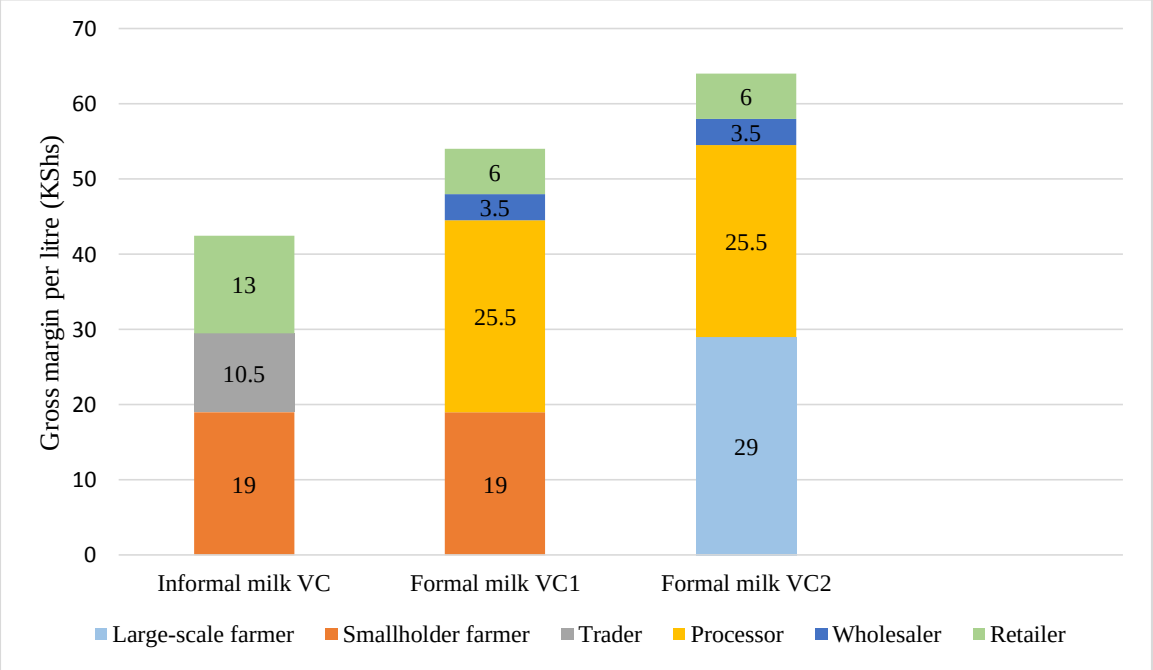
Parameter	Amount (KShs)	Percentage of total amount (n=4)
Costs		
Purchase of milk	46.83	88.54
Business permit	0.05	0.10
Electricity	0.27	0.50
Water	0.21	0.40
Rent	1.25	2.36
Labour	3.88	7.33
Transport	0.41	0.77
Total cost	52.89	
Revenue per litre	66.25	
Gross margin per litre	13.36	

Source: Researcher, 2021

6.3.5 Gross margins along the dairy value chain

The study presents gross margins for actors along the milk value chain under three channels through which milk is marketed (Figure 6.3). The first, referred to as the informal milk VC (Value Chain), shows gross margins per actor along the informal milk chain. Total value added along this chain is 42.5. In this marketing chain, the smallholder farmer captures the largest value (45%) compared to the retailers (30%) and traders (25%).

Figure 6.3. Gross margins along the milk value chain.



Source: Researcher, 2021

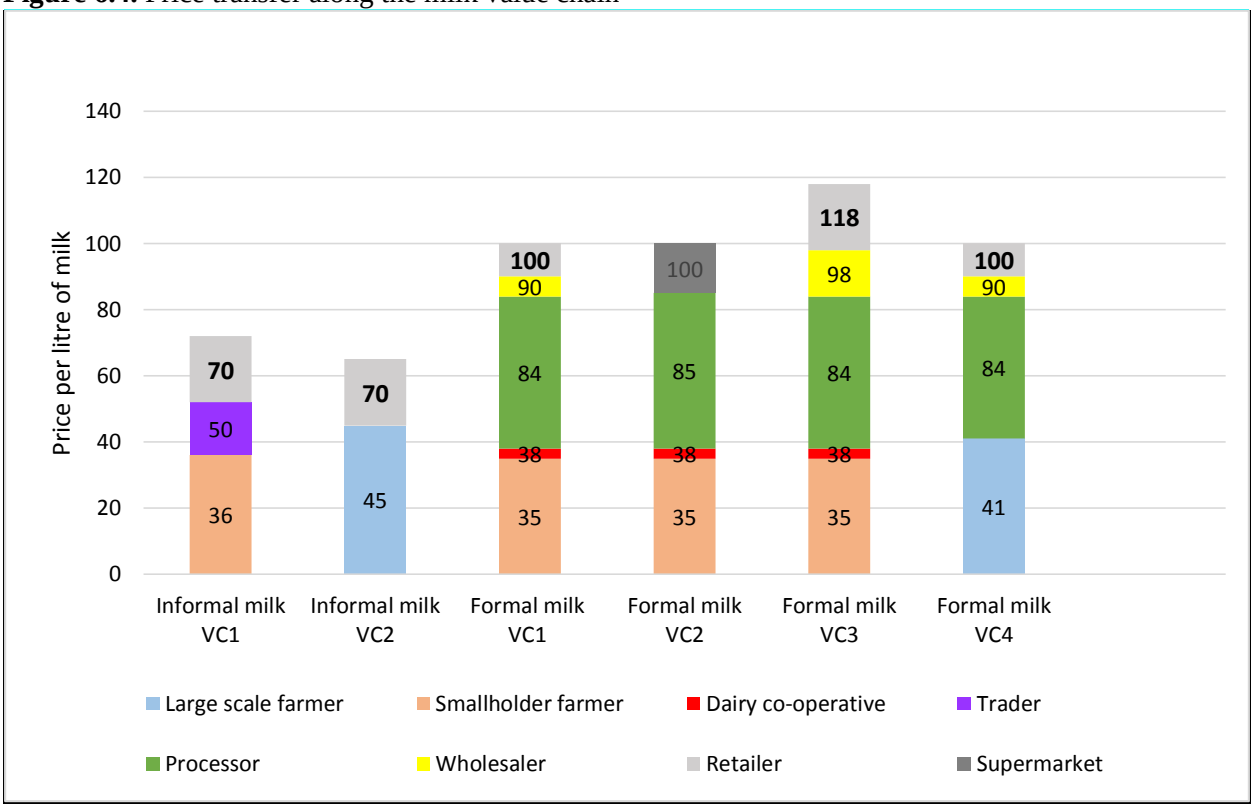
The second marketing channel referred to as formal milk VC1 represents milk that originates from smallholder farmers, sold to processor for processing, and distributed by wholesaler for sale by retailers. This chain has more value added compared to the informal milk VC due to milk processing. In this milk marketing chain, processors capture more value (47%) compared to the smallholder farmers (35%), wholesalers (7%) and retailers (11%). Finally, the third marketing chain, formal milk VC2 shows milk originating from large-scale farmers, to the processor and sold as processed milk by retailers. In this chain, the large-scale farmers capture the largest proportion of value (45%) compared to processors (40%), wholesalers (6%) and retailers (9%).

6.3.6 Price transfer along the milk value chain

Price transfer along both the formal and informal milk value chain happens in various ways based on the actors involved in the value chain, ability to transform the raw product and transacting terms. Figure 6.4 shows transfer of milk prices under two informal marketing channels and four formal channels. In the informal milk value chain, transfer of price happens from the smallholder and large-scale farmers to traders and finally retailers. Smallholder farmers sell milk to traders at KShs 36, traders then sell to retailers (milk bars) at KShs 50 and retailers sell to consumers at KShs 70 (informal milk VC 1).

To a large extent, traders determine the prices along informal milk VC1 because they are key in bulking, transporting and selling milk from smallholder farmers. However, the study noted that traders consider the price offered by market competitors, like processors, in setting their buying price. Informal milk VC1 depicts the prices in the informal milk channel through which a large share of raw milk flowed. However, smallholder farmers and traders sell milk through various other channels at different prices (Table 6.10). Smallholder farmers earn higher prices by selling their milk directly to institutions such as schools and offices; and lower when selling to restaurants and milk processors through dairy cooperatives. Traders fetched higher prices by selling milk to offices and households and lower when selling to processors. This could imply that processors and dairy cooperatives are not competitive in pricing, leaving room for the informal value chain, selling raw milk, to thrive.

Figure 6.4. Price transfer along the milk value chain



Source: Researcher, 2021

Table 6.10. Average milk prices in the informal milk value chain

Smallholder prices to different buyers (KShs)		**Traders' prices to different buyers (KShs)**	
Trader	36	Milk bar	50
Institutions	45	Offices	60
Own shop	45	Individuals	52
Neighbors	40	Hotels	49
Local restaurant	35	Shops	48
Dairy cooperatives	35	Schools	48
		Processor	37

Source: Researcher, 2021

Large-scale farmers sell their milk informally directly to retailers at a higher price (KShs 45) than the smallholder farmers (Figure 6.4; informal milk VC2). The study did not identify, sale of milk to traders by large-scale farmers interviewed hence their exclusion from this marketing chain. Although large-scale farmers are open to selling milk to traders, the absence of traders in this marketing chain could be explained by the high price compared to the smallholder selling

price. Since lower prices would translate to lower margins for traders, hence their absence from this particular marketing channel.

The study identified five variations of the formal milk value chain through which prices are transferred differently. Formal milk VC1 shows the movement of price from the smallholder farmers through the dairy cooperatives to the processor and onward to the wholesalers and retailers. The price change at the dairy cooperative level is not a real price but an accounting for the amount deducted from smallholder farmers payment to meet the daily operational costs of the dairy cooperatives. Formal milk VC2 is different from formal milk VC1 in that there is absence of wholesalers. In this marketing chain, the processor delivers processed milk directly to the supermarkets (retailer).

Formal milk VC3 shows the transfer of price from smallholder farmers through the dairy cooperatives to the processor and onwards to wholesaler for final sale by retailers (shops and kiosks). The notable difference between this marketing chain and formal VC1 is at retail level where the category of retailers (shops and kiosks) takes a higher price. Finally, formal milk VC4 depicts transfer of prices from the large-scale farmer to the processors and onward to the wholesalers and retailers. In this chain, unlike formal milk VC2, 3 and 4 where milk from smallholder farmers pass through dairy cooperatives to the processors, milk from large-scale dairy farmers is delivered straight to the processors. The study noted that processors pay large-scale dairy farmers a higher price than smallholders. This could be explained by the ability of large-scale farmers to negotiate better prices based on their large volumes and supply consistency. Prices in the formal milk value chains are influenced to a large extent by the processor because the retail price is recommend by the processor.

6.4 Value Addition and Distribution in the Beef Value Chain

6.4.1 Revenue, costs and gross margins of beef producers

Costs of production and revenues

Key informants such as traders, officers at the slaughterhouses and veterinary officers estimated the weight of cattle reared by pastoralists as 300 kilograms at sale and/or slaughter . With the exception of cattle sold through large-scale ranches, pastoralists cattle were not weighed at the time of sale. Steers sold by large-scale ranches weighed on average 400 kilograms and were

considered well finished (Table 6.11). These steers had high carcass weight of between 200 and 240 kilograms and were most favored by private processors.

Table 6.11. Cost of production, revenues and gross margins for pastoralists and large-scale ranches

Parameter	Pastoralists (n=67)		Large-scale ranches (n=7)
Average live weight at time of sale (kg)	300		400
Average age at time of sale (years)	5		3
Average price per kg - live weight (KShs)	87		167
Carcass weight (kg)	135-150		200-240
Average number of cattle sold (per year)	3		410
Average distance to the livestock market (km)	6		0
Cost component (KShs)	without purchase of pasture	with purchase of pasture	
Labour (per head, per month)	212*	212*	396
Pasture (per head, per month)	0	50**	0
Supplements, dipping/spraying and veterinary (per head, per month)	68	68	264
Total Cost (per head, per month)	280	330	660
Cost per head per year	3,360	3,960	7,920
Cost per head at sale (KShs)***	16,800	19,800	23,760
Revenue per head at sale (KShs)	26,281	26,281	66,800
Gross margin per head	9,481	6,481	43,040

*Average rate of labour is 3,185 per month.
**Total cost of pasture in 4 dry months spread out in 12 months
***Total cost per head per year multiplied by age at sale.
Source: Researcher, 2021

The study estimates production cost of the pastoralists' at KShs 280 per head of cattle per month for the pastoralists who do not purchase pasture and KShs 330 for those who purchase pasture during the dry months (Table 6.11). Large-scale ranches gave pastoralists access to their pasture during dry months (3-5 months annually) for which they charged approximately KShs 150 per cattle. Therefore, the cost of pasture has been calculated at a monthly fee of KShs 150 for 4 dry months and the cost apportioned to the 12 months of the year. Pastoralists whose cost on pasture is nil migrate their herds, during the dry season, to graze in open spaces. A low proportion of pastoralists (28%) reported receiving relief livestock feed, either hay or dairy feed, from the government during the dry period. Relief feed was not considered in calculating the cost of feed since it was free of charge.

Monthly labour cost for the pastoralist was KShs 212 per cattle. The study considered the opportunity cost of family labour. It was obtained by taking the average wage paid by

households that hired labour (a herder). At least 40% of the households hired labour (herders) for grazing at an average of KShs 3,185 per month. Labour made up the larger share of cost for the pastoralist. For the large-scale ranches, production cost was estimated at an average of KShs 660 per month, per head (Table 6.11). The largest cost component (60%) for this category of producers was labour. The remaining proportion (40%) of total costs constituted supplements, dipping and veterinary services. Large-scale ranches did not purchase pasture because they had sufficient pasture throughout the year attributed mainly to proper pasture and herd management.

Gross margins

Pastoralists who did not incur cost on pasture had a gross margin of Kshs 9,480 whereas those who incurred cost on pasture had a lower gross margin of Kshs 6,480 (Table 6.11). The cost of production at the time of sale was approximately KShs 23,760 for large-scale ranches, that is, average cost per month multiplied by the age of the steer at sale (Table 6.11). With the steers weighing approximately 400 kilograms and selling at KShs 167 per kilogram, the large-scale ranches made a revenue of KSh 66,800 per steer, returning a good margin (KShs 43,000) on sale. A comparison of gross margins shows that large-scale ranches obtained higher (up to six times) gross margins than pastoralists.

6.4.2 Costs and gross margins of beef traders and distributors

The main costs for a beef trader include purchase of cattle, transport and charges at the slaughter house. The study estimates the average total cost of purchasing, transporting, slaughtering and delivering a beef carcass to a retailer at approximately KShs 28,710 (Table 6.12). Purchase of cattle constituted the largest (90%) cost component for the beef trader. The beef trader received revenue not only from sale of beef carcass but also from the sale of other edible (offals, liver, head and legs) and non-edible saleable products (skin) of a cow.

Sale of beef carcass contribute majority (89%) share of beef trader's total revenue while the edible and non-edible cow products account for a lesser share (11%). The study estimates the gross margins of a beef trader at KShs 12,245 (Table 6.12). However, traders delivering high quality beef cattle to private processors can earn a margin of up to KShs 18,000 per head of cattle. Beef traders interviewed estimated their margins at between KShs 6,000 and 10,000 per

head, lower than the study's estimate. This could be attributed to failure by the traders to consider revenue obtained from selling other body parts in addition to the carcass.

Table 6.12. Beef traders' costs, revenue and gross margin

Parameter	**(KShs)**
Revenue	
Sale of : Beef 135kg @ KShs 270 per kg	36,450
Skin	420
Offals	2,275
Head and legs	1,000
Liver	810
Total revenue	40,955
Cost component	Cost per head (KShs)
Purchase of cattle	25,790
Transport to the slaughterhouse	1,170
Permit	100
Cess	100
Labour at the auction market	50
Unofficial fees and levies	300
Slaughtering and related charges	1,000
Transport of carcass	200
Total cost	28,710
Gross margin	12,245

Source: Researcher, 2021

6.4.3 Costs and gross margins of beef processors

Two types of slaughterhouses and abattoirs emerged from the study. First, are slaughterhouses that offer slaughtering services without engaging in the business of selling the products thereafter. Most of these slaughterhouses are government owned. Second, are slaughterhouses and abattoirs that undertake processing and sale of beef and beef products, majority of which are private owned. The first category of slaughterhouses covers their operating costs by charging a slaughtering fee. Such operating costs include veterinary inspection fee, cleaning and washing, fraying, loading and holding area costs and certification for transport. The study has considered the slaughtering charges under the traders' cost because traders are the main clients utilizing this service. Table 6.13 gives an account of revenue, costs and margin for a private beef processor.

Table 6.13. Processors costs, revenue and gross margin (per head of cattle)

Parameter	(KShs)
Revenue	
Sale of: lean beef 122.5kg @ KShs 540 per kg	66,150
other products and by-products[1]	5,719
Total revenue	71,869
Costs	
Purchase of cattle: 175kg @ KShs 335 per kg	58,625
Operating costs	
Labour	3,010
Other costs[2]	2,709
Total cost	64,344
Gross margin	7,525

[1]Other products and by-products: bones, skin, low grade beef, liver, offals
[2]Other costs: transport, machinery, packaging, handling, utilities
Source: Researcher, 2021

The calculation uses an animal weighing 350kg which when slaughtered gives a carcass weighing 175kg. Out of this carcass the processor reported recovering and selling 70% as lean beef. Costs for the private beef processor include purchase of cattle and operating costs such as labour, maintenance of machinery, transport, utilities (electricity, water), handling and packaging. Interviews with private processors established that they take a margin of between 20 and 30% of the difference in buying and selling price. The balance (70%) caters for operating costs. An interview with a private processor revealed that sale of beef products and by-products such as bones, skin, liver and offals contributes more to the gross margin compared to sale of lean beef.

6.4.4 Costs and gross margins of beef retailers

The study estimates the gross margin of the beef retailer (butchery) at KShs 4,106. The gross margin is calculated using a 175kg beef carcass, that is, cattle that weigh 350kg live weight. Retailers reported incurring waste of between 2-3% of the carcass weight on account of shrinkage, fat and non-saleable bones. Taking this into consideration, the saleable carcass weight is reduced by this proportion (3%) to 170kg. Revenue is thus calculated as the saleable or recovered carcass multiplied by the average selling price. The costs for the retailer include cost of purchasing the carcass, rent, transport, labour, electricity, water, business permit and packaging. Purchase of carcass constitutes the large share (75%) of total cost (Table 6.14).

Labour and rent are key operational costs for the beef retailer both contributing 20% to the total cost.

Table 6.14. Costs, revenue and gross margins for beef retailers (per head of cattle)

Parameter	**(KShs)**
Revenue	
Sale of beef 170kg @ KShs 409 per kg	69,530
Costs	
Purchase of cattle: 175kg @ KShs 280 per kg	49,000
Operating costs	
Labour	8,212
Rent	4,927
Other costs[1]	3,285
Total cost	65,424
Gross margin	4,106

[1]Other costs: transport, business permit, electricity, water, packaging
Source: Researcher, 2021

6.4.5 Gross margins along the beef value chain

Gross margin estimates show that large-scale ranches attain the highest gross margin per kilogram of beef sold in the value chain (Table 6.15). Beef traders achieve the second highest margin per kilogram in the value chain. High margins among the large-scale ranchers can be attributed to their ability to keep production costs low while producing high quality beef cattle that fetches high prices. Traders add value to beef cattle in the value chain through slaughtering cattle. However, their ability to obtain cattle from pastoralists at relatively low prices and then sell at higher prices contributes to their high margins too.

Table 6.15. Gross margins per kilogram for actors along the beef value chain.

Actor	**Gross margin (KShs)**	**Kilograms sold**	**Gross margin per kilogram (KShs)**
Pastoralist1	6,481	300	21.6
Pastoralist2	9,481	300	31.6
Large-scale ranch	43,040	400	107.6
Trader	12,245	135	90.7
Processor	7,525	175	43.0
Retailer	4,106	175	23.5

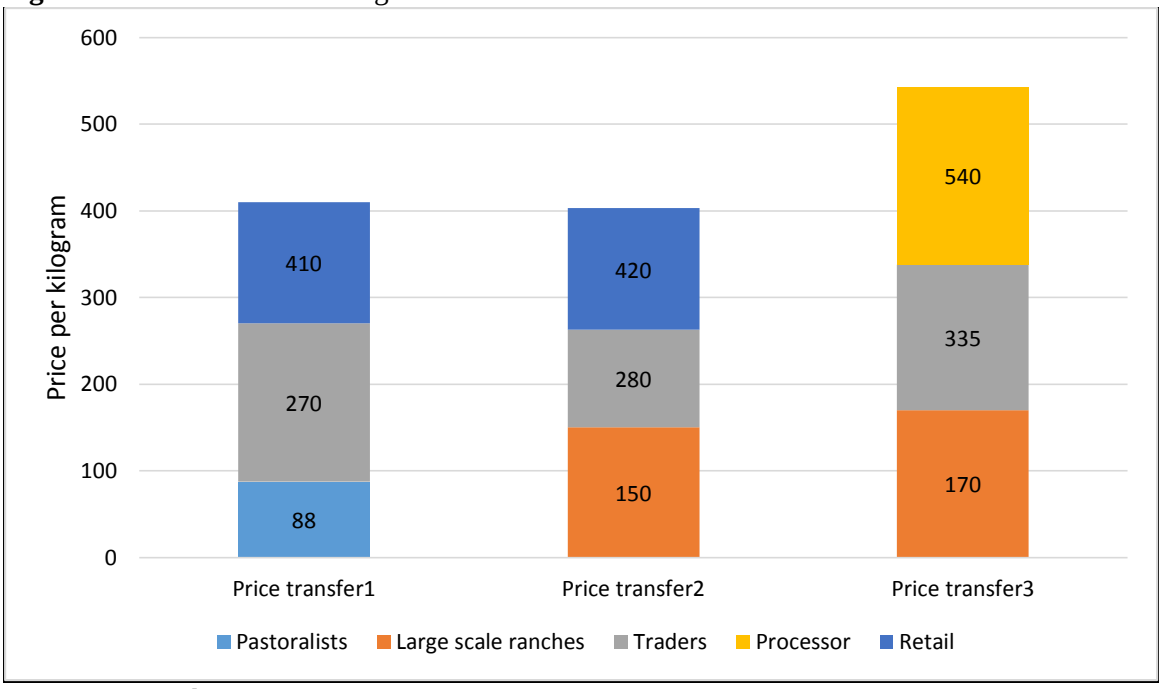
Source: Researcher, 2021

Pastoralists who incurred cost on pasture (Pastolists1) had a gross margin of KShs 22 per kilogram (the lowest in the value chain) compared to KShs 32 for pastoralists who did not incur cost on pasture (Pastolists2). This underscores the need for pastoralists to access free pasture. The gross margin variance between the two beef production systems reveal huge potential for improvement in the quality of the pastoralist's cattle.

6.4.6 Price transfer along the beef value chain

The quality of beef, often associated with the source, either from pastoralists or large-scale ranches determines to a great extent the prices along the beef value chain. This study explains price transfer along the beef value chain using three beef marketing chains. The first referred to as price transfer1 depicts change in price beginning with the pastoralists (the source) to the traders and finally retailers (Figure 6.5). Price transfer2 shows how price changes from the large-scale ranches to the traders and eventually at the retail level, while price transfer3 depicts transfer of the price from the large-scale ranches to the processors or through the trader.

Figure 6.5. Price transfer among actors in the beef value chain



Source: Researcher, 2021

At the livestock markets, pastoralists obtained approximately KShs 26,300 per head of cattle. The prices were negotiated and agreed upon between the transacting parties (buyer and seller), mainly the trader and pastoralist. However, a broker may be involved when the seller does not

want to deal directly with the buyer or in the presence of language barrier. Usually, the buyer (trader) almost always determined the final price which they reported was based on the animal's physical appearance and a rough estimate of the live weight. The highest price paid for a cow at the livestock market from the sampled pastoralists was KShs 60,000 and the lowest KShs 7,500. Higher prices (KShs 70,000) were reported for fattened cattle sold through large-scale ranches. At an estimated weight of 300kg, which converts to about 135-150kg of carcass weight depending on the quality of the cow, the price per kilogram of the live cattle obtained was KShs 88 (Figure 6.5, Price transfer 1). Traders sold to retailers beef carcass of animals obtained from pastoralists at an average price of KShs 270 per kilogram. The lowest price traders sold a carcass to a retailer was established at KShs 250. The price at which the trader sold live cattle or carcass meat was dependent on the quality of beef. In the marketing chain, price transfer1, retailers sold a kilogram of beef at an average price of KShs 410 to consumers.

As noted before, steers reared by large-scale ranches weighed on average 400 kilograms and were well finished thus resulting in high carcass weight. Beef steers realized approximately KShs 170 per kilogram live weight (Figure 6.5, Price transfer3), and some sold as high as KShs 200 per kilogram live weight. Majority of these cattle were bought by private processors for their premium cuts. Processors bought the steers either from traders or directly from large-scale ranches at about KShs 335 per kilogram of carcass weight (Figure 6.5, Price transfer3).

Processors purchase price is based on the quality of carcass obtained. Processors grade beef carcasses into different categories with different prices: premium or prime, high grade, fair average quality (FAQ), standard and commercial grade. Premium grade is the highest grade of carcass paid at KShs 350 per kilogram while commercial is the lowest fetching about KShs 185 per kilogram. Processors sold prime beef cuts at an average price of KShs 540 largely to institutional consumers like hotels but also to retailers such as supermarkets and high-end butcheries. Processors beef prices ranged from KShs 450 to KShs 1,800 per kilogram depending on the cut and market (local or export). Meat and meat products for export were priced higher than those for the local market.

Culled cows at the large-scale ranches were sold at between KShs 120 and 160 per kilogram because they had a lower live weight and were aged compared to steers. Cull cows were a

popular buy for traders and retailers as they considered them of better quality than pastoralist's cows and were priced lower than the steers. Traders sold the beef carcass of cull cows to butcheries at a slightly higher price (KShs 280) compared to those obtained from pastoralists. (Figure 6.5, Price transfer2). Butcheries (retailers) selling this category of beef in turn sold at a higher average price of KShs 420, with some retailing even higher at KShs 440 per kilogram. Retailers noted that meat prices are generally stable, except during drought when meat prices adjust upwards albeit marginally. At the time of this study, retail prices had risen by about 5% commensurate with the rise in purchase prices occasioned by the low supply of cattle due to drought.

6.5 Summary of Chapter

Gross margin analysis has revealed the value each actor obtains from participating in the value chains. The analysis has also shown the extent to which gross margins differ along the value chains and among actors at the same level. In the wheat value chain, large-scale farmers capture the highest value as measured by gross margins in the value chain followed by wheat millers, smallholder farmers, retailers, wholesalers and finally wheat traders. At the production level, large-scale wheat farmers obtained one and a half times more gross margin for every kilogram of wheat produced compared to smallholder farmers. Still there were wide variations in gross margins among the smallholder wheat farmers. Differences in yields, production costs and farm gate prices explain the gross margin variations between smallholder and large-scale farmers and among smallholder farmers too. Similar to previous studies, interviews revealed traders as price givers. They are also perceived by smallholder farmers as exploitative, hence attaining high profits. Unexpectedly, wheat traders had the lowest gross margins in the wheat value chain. However, despite this, wheat traders transact in large volumes hence receiving higher revenues than smallholder farmers.

Large-scale dairy farmers obtained the highest gross margins in the milk value chain both in the formal or informal marketing chain, attributed to higher selling prices and low costs of production. In the informal milk value chain, the smallholder farmers obtained the second highest gross margins followed by the retailers then traders. In the formal milk marketing chain, processors obtained the second highest gross margins followed by smallholder dairy farmers, retailers and finally wholesalers. Dairy processors obtained higher gross margins in the formal

milk marketing chain when they purchase milk from smallholder farmers. Despite dairy traders having influence on milk pricing in the informal marketing chains, they had lower gross margins compared to smallholder dairy farmers. Milk wholesalers had the lowest margins in the formal milk marketing chain. At production level, similar to the wheat value chain, differences exist in yields, production costs and farm gate prices between the smallholder and large-scale farmers, accounting for the differences in gross margins. At the trade level of the dairy value chain, milk traders generated sufficient revenue to cover for their costs. There were wide variations of up to KShs 14 between the highest and lowest gross margins generated by milk traders. The differences can be explained by the variations in the buying and selling prices of milk, volume of milk collected/sold and the channel through which milk was sold. The gross margin accruing to milk processors was shared between the processors, distributor and retailer in the formal milk value chain.

Large-scale ranches attain the highest gross margin per kilogram of beef sold in the beef value chain followed by beef traders, processors, pastoralists and then retailers. However, pastoralists were grouped into two: those who purchase pasture during drought and those who do not. Pastoralists who incurred cost on purchase of pasture attained the least value in the beef value chain. Large-scale ranches obtained high gross margins than pastoralists, due to their ability to keep production costs low while producing high quality beef cattle that fetches high prices. Quality differences in terms of weight and overall body condition of the cattle contributed greatly to the difference in margins between the two beef production systems. In a similar trend to the informal milk marketing chain, beef traders achieved higher margins when trading in cattle sourced from pastoralists. This can be attributed to the trader's tendencies of purchasing cattle at a lower price from the pastoralists facilitated by lack of weighing cattle.

While traders add value to beef cattle through slaughtering, processors add more value by grading and producing different beef products. However, beef traders had higher margins than processors perhaps due to lower costs of processing (slaughter). Moreover, traders attained better gross margins by supplying quality cattle to processors compared to supplying beef carcass to butcheries. In addition, beef traders received revenue not only from sale of beef carcass but also from the sale of other edible (offals, liver, head and legs) and non-edible saleable products (skin) of a cow. Sale of edible and non-edible saleable cow products was also identified as an important

revenue stream for the private processors. Majority of the beef retailers (butcheries) add minimal value to beef as they sell beef on bone. However, they attributed low margins to wastage on account of shrinkage, fat and non-saleable bones.

Gross margin analysis illuminated differences in yields, cost of production, prices and marketing between production systems in the three value chains. Analysis of producer's yields in all three value chains revealed that large-scale farmers and ranches have higher yields than smallholder farmers and pastoralists. In the wheat value chain, large-scale farmers obtained double the yields obtained by smallholders. This was the case too for the dairy value chain where large-scale farmers attained higher average milk yields than that of smallholder dairy farmers. Similarly, large-scale ranches were able to sell beef cattle weighing 100 kilograms more than those of pastoralists. These results call for more support for the smallholder farmers and pastoralists to close on potential yield gaps.

Analysis of cost of production at the production stage of the value chains revealed varied results. Compared to large-scale dairy farmers, smallholders had a higher cost of production. In contrast, wheat smallholder farmers and pastoralists had a lower cost of production compared to their large-scale counterparts. The highest production cost for the smallholder wheat farmer related to hire of machinery while cost of chemicals constituted the largest proportion for the large-scale wheat farmer. Cost of feed was the highest cost component for dairy farmers and pastoralists. Interestingly, while feed was the most important cost for the pastoralists, it was the least among large-scale ranches who reported labour as the most significant cost. Although, smallholder farmers and pastoralists achieved lower costs of production, it did not necessarily translate into higher gross margins. In fact, it seemed to compromise on their yields. This resulted in low selling prices associated with low quality of produce.

Large-scale farmers and ranches attained higher selling prices compared to smallholder counterparts in all three agro-food value chains. High quality, large volumes and consistency of produce gave large-scale farmers and ranches bargaining power. Along the value chains, there were significant changes in prices at the processing stage as a result of the value added through transformation of raw produce. However, this was not the case for the informal marketing chain of milk. A key finding that emerged from analysis of price transfer among the value chains was their marketing structure. Characteristically, each value chain had formal and informal marketing

channel(s) through which products flowed, value added and price transferred. The formal marketing structures were defined largely by processing of raw produce into various products for a wider market, mostly urban. The informal marketing chains were largely defined by sale of raw produce with minimal value addition. There were fewer actors and prices were lower compared to the formal value chains. Traders seemed more dominant in the informal marketing value chains where they made higher margins.

CHAPTER 7. GOVERNANCE AND CONSTRAINTS IN THE WHEAT, DAIRYAND BEEF VALUE CHAINS

7.1 Introduction

The results presented in this chapter seeks to achieve the third objective of the study on the governance and constraints in the wheat, dairy and beef value chains in North West Mt. Kenya. The chapter is divided into three main sections that presents detailed analysis on governance and constraints for each value chain. Governance is discussed in terms of linkages, relationships and power. Linkages identifies which actors are linked to each other, the reason for the linkages and whether they are beneficial. The chapter discerns whether the linkages are formal (with contractual agreements), informal (without contractual agreements), between actors along the value chains (vertical) or between actors at the same level (horizontal). Radar charts are used to show the horizontal and vertical linkages at production level where more actors are involved. Relationships are discussed from the social connection between the value chain actors, while power was determined by the ability of actors to influence or dominate other actors in the agro-food value chain. An understanding of the linkages and relationships between the different actors lays the platform for understanding the constraints and opportunities for improvement. As such, the chapter presents the constraints identified by actors and key informants along the value chains.

7.2 Governance and Constraints in the Wheat Value Chain

7.2.1 Linkages, relationships and power in the wheat value chain

Linkages along the wheat value chain are mainly defined by the activities and actors that together combine to cause the flow of wheat from production through the stages of transformation to consumption. Actors are linked to each other in buyer-seller vertical relationships with each actor aiming at maximizing their benefits. The nature of transactions amongst actors in the different stages of the wheat value chain exhibits both characteristics of spot and persistent relations. Transactions between wheat farmers and traders were mainly spot transactions, involving one off sell-buy transaction. Nonetheless, some smallholder wheat farmers transacted with the same trader every season. Aspects of persistent transactions were observed between traders, processors and wholesalers who engaged in repeat transactions. Despite this, there were no contractual relationships identified between actors.

Smallholder wheat producers have particularly weak linkages and relationships with other actors within the value chain and external supporting actors (Figure 7.1). At least half (55%) of the smallholder wheat farmers did not belong to any farmers group or association, an indicator of low social capital. Although smallholder farmer interviewed were in close proximity to large-scale wheat farmers, only 41% reported being in contact with large-scale farmers. Further, the relationship between such smallholder and large-scale wheat farmers is an arms-length relationship whereby smallholders purchase wheat for seed from large-scale farmers and occasionally attend training through farmers field days hosted in large-scale wheat farms. The study noted low institutional support for the smallholder farmers with few (less than 40%) being in contact with projects, government or non-governmental organizations that provide support for wheat production through provision of knowledge, information, training, support in marketing and inputs acquisition. Additionally, only 26% of the smallholder farmers had access to credit facilities undermining their financial capability.

Figure 7.1. Linkages between wheat farmers with internal and external actors in the wheat value chain

Source: Researcher, 2021

Conversely, large-scale wheat farmers had better linkages between themselves and other actors within and without the wheat value chain. They had access to credit facilities and government services like seed development. All large-scale farmers reported relating with smallholder wheat farmers through sharing knowledge and skills. Most (70%) large-scale farmers belonged to a

farmers group or association that helped in access to information and negotiation of prices for both wheat and inputs. They wield power in the value chain through concentration of capital, land, access to financial credit and production of large volumes of wheat grain. Their economies of scale enable them to capture high margins in the value chain. In fact, due to the large volumes, they (large-scale farmers) can deliver straight to the millers unlike smallholder farmers who have sell through traders.

Smallholder farmers perceive traders as wielding a lot of power. This can be explained by the high degree of dependence on traders and the trader's monopoly of information. Traders dominate transport and distribution of wheat grain. They are an important link for the smallholders to the market (millers). Although they are not organized into formal groups they are familiar with each other and tend to have territorial boundaries amongst themselves. They are well informed of the market and the needs and preferences of the millers. However, this information does not cascade down to the smallholder farmers as to cause impacts on production decisions of smallholder farmers. Instead, traders used it to their advantage, for example, by offering a standard price for all types of wheat, while millers purchase from them preferred type of wheat at a higher price.

Provision of extension services by agrochemical companies, an emerging role by agrochemical companies beyond their key role of supplying chemical inputs, has the potential of causing changes in the current wheat value chain governance. In the absence of government extension services, the study observed that agrochemical companies are increasingly taking up the role of providing advisory services either directly to the farmers using their sales agents or through agrovets. However, the advisory services basically market the use of their products and this has a major influence on the inputs that farmers use.

The power center in the wheat value chain lies with the millers. Their crucial role of transforming wheat grain to flour puts them in a key position to capture significant value. The millers create an oligopolistic market that gives them significant power in determining the price of wheat. Their purchase price per bag of wheat grain directly affects the farm gate price, while their set wheat flour selling price determines the consumer price up the chain. The wheat millers influence the type of wheat grown through preferred purchase of certain types of wheat as well

as determining the standards of wheat grain by setting guidelines (for example moisture content) for acceptable grain. Millers are organized into a lobby group and thus capable of influencing policy decisions. They are key actors in wheat importation capable of causing market distortion through massive wheat imports. However, despite this kind of power, it does not necessarily infer abuse. Millers reported taking into consideration international market prices, local competition and cost of production in price setting decisions. Still, the state controls importation and prices of staples such as wheat thus regulating uncompetitive advantage.

7.2.2 Constraints to wheat production

This section presents the constraints which were mentioned by the wheat farmers with an emphasis on the smallholder wheat farmers. Table 7.1 presents a summary of the constraints. The major constraints which shall be discussed in detail are: inadequate and unpredictable rainfall, costly inputs, low and fluctuating prices, unavailability and high cost of machinery services, weeds, diseases and birds.

Table 7.1. Constraints to production identified by smallholder and large-scale wheat farmers

Constraint	**Smallholder farmers (n=58)**		**Large scale farmers (n=7)**
	(n)	(%)	(n)
Inadequate and unpredictable rainfall	34	59	4
Low market prices and bargaining power	31	53	0
Costly inputs	28	48	2
Unavailability and high cost of machinery services	21	36	0
Birds, insects and wild animals	18	31	2
Diseases and stubborn weeds	18	31	3
Limited access to credit	5	9	0
Low productivity	4	7	0
Low and fluctuating market prices	0	0	4
Slow seed reproduction	0	0	1
Fluctuating exchange rates	0	0	1
Lack of market	0	0	1
Lack of skilled labour	0	0	1

Source: Researcher, 2021

Wheat production in study area is predominantly rain fed. As a result, variations in rainfall patterns and amount received impacts production directly. Farmers reported an increase in the length of dry months/periods, which has been associated with changing climate. These changes

have subsequent effects on production. In addition, large-scale farmers were concerned that unpredictable rains affected proper planning.

Wheat production is input intensive, requiring appropriate application of seed, fertilizer and pesticides (herbicides, fungicide, insecticides). With the exception of government provided fertilizer, inputs are not subsidized. However, despite the government's effort to provide subsidized fertilizer, frequent delays in delivery, bureaucratic procedure of registering and accessing the fertilizer, insufficient quantities, hamper efficient delivery. Costly inputs drives some smallholder farmers to under apply or fail altogether to apply pesticides and fertilizers. Moreover, in an attempt to keep the cost of pesticides low, some smallholder farmers purchased the cheapest chemicals available in the market whose quality and effectiveness was not guaranteed. Such practices contributed to low productivity. Large-scale wheat farmer's associated high cost of inputs to fluctuating foreign exchange rates.

Half of the smallholder farmers stated that farm gate prices were low, and could barely cover their production costs. Although, there are other factors which contributed to smallholder farmer's loss making or low revenues, price was considered a significant constraint. Smallholder farmers lacked the power of group negotiation largely because many (more than half) were not members of a farmers group. In addition, selling through traders who negotiated for the lowest buying price possible and poor quality of wheat grain contributed to low prices. Moreover, smallholder farmers sold a large proportion their wheat upon harvest when there is an oversupply of wheat and thus prices low. Farmers linked lower prices to wheat import competition on price. Moreover, they linked fluctuating wheat prices with the often changing international wheat prices.

Most activities in wheat production, including land preparation, spraying, planting, and harvesting, require use of machinery. Smallholder farmers reported delayed farming activities such as ploughing, harrowing, planting and harvesting due to unavailability of machinery. Subsequently, they turned to manual tillage, planting using broadcasting method and harvesting using hand appliances like sickles, requiring additional time and labour (Photo 7.1). Notably, unavailability of machinery was a great contributor to high cost of machinery hire. Poor condition of hired machinery was associated with wheat loss during harvest. Also, combine

harvesters were blamed for dispersing weeds between farms. The challenges related to mechanization can also be partly attributed to increasing land subdivision. Smallholder farmers with parcels of land less than one acre paid the machinery hire fee equivalent to an acre, subsequently incurring higher production costs. Still, service providers preferred and gave priority to farmers with considerably larger parcels of land.

Photo 7.1. Manual harvesting of wheat

(Photo credit: Researcher, 2021)

Wheat rust disease, weeds such as wild oat and brome grass, aphids, birds and wildlife posed persistent challenges to wheat production. Management of wheat rust required timely application of fungicides. Smallholder farmers risked and in some instances reported crop failure because of delays or failure in diseases control. Poor management of diseases and pests was also attributed to limited capital and knowledge on aspects such as timely identification of diseases in addition to weak and lacking agricultural extension services. The study established that only a third of the farmers accessed extension services. Farmers pointed to the difficulty in management of brome grass due to its resistance to herbicides and high seed dormancy. It thus required frequent spraying, making it expensive to eliminate. Smallholder farmers associated damage to wheat fields by the Quelea bird to either early or late planting.

Whereas some constraints were similar with both categories of wheat farmers, the study noted that large-scale farmers seem to deal with the constraints better hence remaining profitable. For example, large-scale farmers (50%) stated adapting minimum tillage in order conserve soil moisture and hence deal with insufficient rainfall. However, some constraints were unique either to the smallholder or large-scale farmers. Challenges related to access of machinery, credit and low productivity were identified by smallholder farmers and not mentioned by the large-scale farmers. Whereas constraints such as slow seed reproduction and fluctuating exchange rates were unique to large-scale farmers. Moreover, whereas smallholder farmers identified lack of labour as a constraint, large-scale farmer's concern was lack of skilled labour, underscoring the differences in the two production systems.

7.2.3 Constraints to wheat traders, transporters, processors, wholesalers and retailers

The most pressing concern for the wheat traders was rejection of grain or having to sell wheat at a lower price at the mill due to poor quality. Quality of wheat grain was assessed by its moisture content, bushel weight and general cleanliness. Traders received a reduction in weight or price on poor quality grain at the mill. Trader's lack of equipment to measure the moisture content of the wheat grain increased their possibility of purchasing grain with high moisture content. Poor roads and long distances covered in collecting wheat from many smallholder farmers tend to increase the cost of transport for traders. Power (electrical) outage and unsatisfactory quality of local wheat were the main challenges for medium-scale wheat millers. Power outages were associated with losses as a result of inability to process wheat. Dirt in wheat obtained from smallholder farmers led to losses of between 2 and 3 kilograms out of a 90kg bag. Key concerns for the retailers were related to price fluctuations and quality of packaging material. Paper packaging, the most common type of local wheat packaging material, is susceptible to tear particularly while off-loading flour or arranging the flour on the shelves for sale and may lead to losses.

7.3 Governance and Constraints in the Milk Value Chain

7.3.1 Linkages, relationships and power in the milk value chain

The governance structure of the milk value chain is largely defined by its marketing structure which is distinctly dual. The informal marketing chain mainly involves farmers, traders, retailers and consumers. The formal marketing chain is longer, involving more actors: farmers, traders,

dairy cooperatives, processors, wholesalers and distributors, retailers and consumers. Actors are linked with each other through supply-demand relationships. The frequency of milk production and its perishability necessitates frequent interactions between actors. Hence, creating persistent network relations where actors transact time and time again. There is a high degree of dependence on each successive actor in the value chain to take up the product within a given time period to avoid losses.

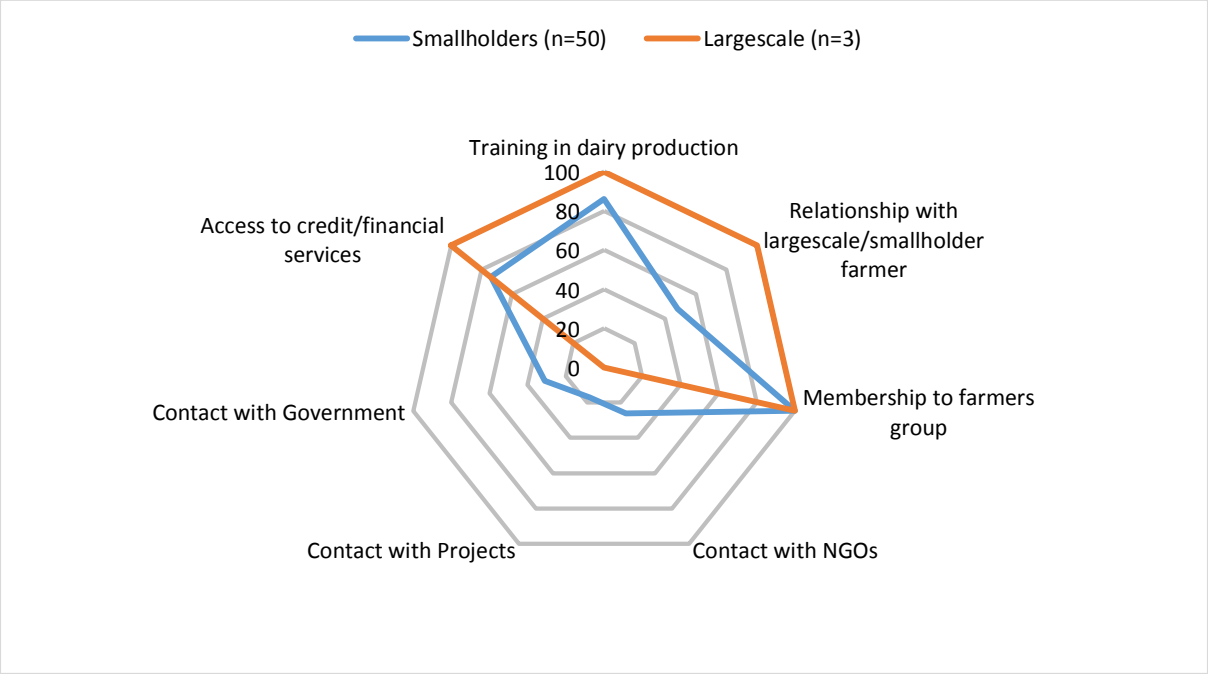
However, despite persistent interactions, transactions in the dairy value chain are mainly verbal, based on trust and mutual agreements on supply, delivery, time and mode of payment. An exception to this are transactions with processors which are formalized with clear set of rules, guidelines and standards. Compliance with transaction terms are enforced through contracts. However, in the informal value chain, compliance with transaction terms is effected largely through mutual trust but also by fear of exclusion thus guarding against malpractices such as milk adulteration or non-payment.

The formal milk marketing chain exhibits strong vertical integration where actors are more organized and closely linked to the lead actor (processor). The strong vertical integration in the formal marketing chain is motivated by the need to control supply and distribution while increasing market share. Previous literature (e.g Kiriti Nganga and Mugo, 2018) has shown that historically, the formal value chain has held a smaller market share. The informal milk value chain is less coordinated with weak vertical integration. Subsequently, there is minimal compliance with industry regulations, a factor that has encouraged the thriving of the informal milk marketing chain.

Strong associations are mainly at the production level, where horizontal integration is strong among smallholder dairy farmers. Smallholder dairy farmers are increasingly getting organized into farmers groups. All the smallholder dairy farmers belonged to a dairy cooperative (Figure 7.2). Dairy cooperatives have become an important driver in the growth of the formal milk distribution channel by strengthening farmer's organization and with its establishment of contractual agreements in the dairy value chain. Dairy cooperatives provide the vertical linkage between the farmers and the processors, hence connecting smallholder farmers to the national market. In addition to market assurance, smallholder farmers benefit from training, access to

veterinary and insemination services on credit (extension services) and access to financial credit. A large proportion (86%) of smallholder farmers had received some form of training in dairy production organized by the processors and dairy cooperatives. Less than half (46%) had access to credit through the Savings and Credit Cooperative Organizations (SACCO) that receives farmer's monthly milk payments. Majority (90%) of them identified membership to a dairy cooperative as a key factor facilitating access to credit.

Figure 7.2. Linkages between dairy farmers with internal and external actors in the dairy value chain



Source: Researcher, 2021

Large-scale dairy farmers are equally organized into farmer groups through which they exchange information and knowledge, formulate own animal feed or access quality feed at negotiated prices. Interaction between the two categories of dairy producers were in three main ways: obtaining fodder (wheat and barley straws, hay) for their animals either at a fee or free, purchasing of quality breeds and training. Large-scale farms were utilized as demonstration farms for farmer training. The relationship between dairy farmers with most external actors such as government and non-governmental institutions is poor. There is minimal provision of services from the government in terms of extension services. However, large-scale farmers had a good relationship with financial institutions through which they could access credit.

The governance structure of the dairy value chain has three power centres: large-scale dairy farmers, milk traders and the processors. Large-scale dairy farmers achieve high gross margins when selling milk in both marketing chains (formal and informal). Their dominance is enabled by access to key production assets such as capital and credit. Consequently, their consistent high production of quality milk enables access to markets and negotiating power. Large-scale farmers received a better price compared to smallholder farmers. Their milk was collected from the farm thus saving on expenses such as transport, cooling or storage.

Traders are key actors in the informal milk value chain. Their dominance is manifested through price determination, control of market information and distribution of large volumes of milk. High dependence by smallholder farmers on the traders affirms their dominance in the informal milk chain. A large proportion of the milk in the informal milk value chain is distributed by the traders. Traders have access to market information which they use to their advantage. Traders also act as financiers to smallholder farmers by providing convenient credit. The traders determine the smallholder farm gate price and their selling price, with only due regard to competition. Wide differences in prices and gross margins among milk traders affirm the arbitrary nature in which they set milk prices and their opportunistic behavior aimed at maximizing profit.

The milk processor is the lead actor in the dairy agro-food value chain. The power of milk processors emanates from three factors: 1) there are few milk processors in the market with a large supply and demand base; 2) they dictate pricing decisions in the value chain; and 3) they have great influence milk quality. Subsequently, milk processors capture the second highest value in the dairy value chain. As a lead actor, the processor allocates value generated to subsequent actors. This was visible in allocation of margins to distributors, wholesalers and retailers. Lead actors such as milk processors may exert power or make decisions either in cooperation with other actors or without their consent. It therefore becomes necessary that dairy cooperatives should increase the negotiating power of farmers through economies of scale. Granting that they provide various benefits to the smallholders, majority felt that they do not get a favorable price for their milk.

Dairy cooperatives largely implement the processors decisions. Processors determine the farmer's farm gate price. Their pricing mechanism is not clear, they dictate the price leaving smallholder farmers with little bargaining power. Processors also recommend the milk retail price to the retailers, although retailers are not bound to comply. Processors set private milk standards in addition to government regulations which farmers, dairy cooperatives and traders must comply with. Processors strictly enforce milk standards with non-compliance leading to rejection of milk with consequent losses to the farmer.

However, the role of enforcing milk standards and regulations lies with the dairy regulatory board. The relationship between the regulatory board and actors such as milk traders has been sour and characterized by mistrust. The regulatory environment is not conducive for milk traders. In fact, it is a constraint to greater efficiency and growth of the dairy value chain. Milk traders perceive the regulatory authority as a policing actor rather than a supportive actor, while the regulatory authority views traders as the weak link in achieving improved milk quality.

7.3.2 Constraints to milk production

This section presents the constraints that were identified by dairy farmers with an emphasis on the smallholder dairy farmers. Table 7.2 presents a summary of the constraints. The major constraints which shall be discussed in detail are: unavailability of feed, high cost of feed and supplements, inadequate water, low milk prices and unreliable and expensive artificial insemination services.

Both categories of dairy farmers found it difficult to access adequate fodder during the dry season because pasture and green fodder becomes limited with reduced rainfall. Furthermore, most smallholder farmers do not store fodder for the dry season. Consequently, they resort to reducing the amount and quality of livestock feed which in turn affects the quantity and quality of milk during the dry season. Fodder and feed concentrates comprise the largest component of dairy production costs. For smallholder farmers failure to store fodder for the dry season compelled them to purchase fodder during the dry season at higher prices. Dairy farmers perceived the price of feed concentrates as high. High cost of feeds and supplements affected proper livestock feeding particularly for smallholders. However, large-scale farmers resorted to constituting their own feed concentrates, though this decision was also driven by lack of quality assurance on the livestock feeds available in the market.

Table 7.2. Constraints to production identified by smallholder and large-scale dairy farmers

Constraint	Smallholder farmers (n=50)		Large scale farmers (n=3)
	(n)	(%)	(n)
Unavailability of feed	30	60	2
High cost of feeds & supplements	12	24	1
Inadequate water	10	20	1
Low milk prices	7	14	1
Unreliable and expensive A.I services	7	14	0
Drought	6	12	0
Diseases	4	8	1
Loss from rejection of milk	4	8	0
Inadequate capital	4	8	0
Unaffordability of quality breeds	3	6	0
Low milk production	3	6	0
Poor roads	2	4	0
Lack of government extension services	2	4	0
Unreliable labour	0	0	1

Source: Researcher, 2021

Water scarcity is a historical challenge in the area and is particularly exacerbated during the dry season. Previous studies in the study area have highlighted this problem. Inadequate water and drought are closely related to inadequate fodder because farmers are not able to grow fodder throught the year hence affecting consitent milk production. Milk prices fluctuate seasonally. During the peak (wet) season, farm gate prices tend to fall with increased milk production due to improved availability of fodder. On the contrary, farm gate prices rise during the dry season due to reduced milk production. Although dairy farmers mentioned low milk prices among their major constraints, gross margin analysis shows they are able to cover for their cost of production and obtain a positive gross margin on milk production. However, the underlying problem could perhaps be the share of value that smallholder farmers attain from the total value added on milk.

Low availability of artificial insemination services was attributed to few service providers. In addition, artificial insemination services were considered costly particulary in instances of repeat insemination following unsuccessful attempts. Moreover, farmers revealed low levels of trust on the quality of breeds offered by artificial insemination service providers. In fact, frequent complaints related to artificial insemination services had caused dairy cooperatives to cease from facilitating the service to their members.

Key informants (agrovets, livestock officers, dairy cooperative officers) also identified some constraints facing smallholder dairy farmers. They include feed and feeding related constraints such as unavailability of feed, poor livestock feeding practices, inability to purchase feed concentrates, failure to store livestock feed, failure to grow nutrient rich fodder, lack of knowledge on correct composition of feed concentrates, lack of quality feeds and high cost of feed inputs. In addition, lack of record keeping, lack of skilled labour, poor pest and disease control, diseases like mastitis and foot and mouth, unavailability of quality artificial insemination services and lack of adoption of pedigree cows were also mentioned.

7.3.3 Constraints to milk traders, processors, wholesalers and retailers

Milk traders identified milk spoilage, poor roads and milk shortage in the dry season as their main challenges. Milk spoilage was particularly high during the wet season when production was high. Traders associated milk spoilage to smallholder farmers mixing evening and morning milk to reduce on losses; and milking sick cows unknowingly. Milk traders did not test for the quality of milk while collecting and bulking. Thus, contaminated milk from an individual farmer had the possibility of causing losses on large volumes of bulked milk. Moreover, milk traders can take up to six hours from the points of milk collection to delivery or selling points hence compromising the quality of milk. Trader's preference for carrying milk in plastic containers also contributes to milk spoilage. Poor road infrastructure affects distribution and delivery of milk because majority of the roads connecting rural farmers are unpaved. During the wet season, wet and muddy roads make transportation more difficult.

High cost of electricity, power outage, competition from raw milk, milk shortage in the dry season, seasonal changes in quality of milk and mismanagement of organized groups delivering milk were some of the constraints identified by milk processors. Milk cooling and processing plants rely entirely on electricity for their operations and as such, power outages which are more common during the rainy season causes losses due to inability to cool or process milk. Mismanagement of organized groups such as dairy cooperatives and self-help groups potentially affects the amount of milk delivered to the processors, yet they are the main suppliers of milk to the processors. Stiff competition for raw milk from the informal milk value chain also affects the volume of milk processors obtain particularly during the dry season when supply is low. In fact, during the dry season, processors operate as low as a third of their capacity resulting in

inefficiencies in processing. Seasonal milk fluctuations are also characterized by changes in milk quality due to changes in cattle feed.

The major concern for wholesalers and retailers was high perishability of milk which was more common in the wet season of high supply. Poor milk handling by workers at retail points, mixing of evening and morning milk by farmers, milk from animals under treatment and failure by farmers and traders to clean milk containers properly were some of the reasons retailers in the informal marketing chain attributed to milk spoilage. Furthermore, retailers of raw milk lacked equipment to check for quality of milk. Wholesalers and retailers in the formal value chain reported minimal occurrences of milk spoilage and leakage. Milk shortage in the dry season resulted in suppressed sales and income, particularly for retailers such as milk bars that focused on sale of milk and milk products. In the formal value chain, milk shortage was characterized by unavailability of popular brands leaving customers with limited choices.

7.4 Governance and Constraints in the Beef Value Chain

7.4.1 Linkages, relationships and power in the beef value chain

The governance structure of the beef value chain is greatly influenced by the dualistic marketing structure which can be described as formal versus informal. The formal beef value chain involves grading and processing of meat into various beef cuts and products. It is also defined by high quality standards and use of cold chain. Consequently, the chain targets the high-end market. The informal beef value is a shorter chain involving interactions mainly between pastoralists, traders and butcheries (retailers). The product of the informal value chain is homogenous, with minimal or no grading at all. However, despite the differences in the two beef marketing chains, they are interlinked with actors such as traders performing similar functions across the two chains.

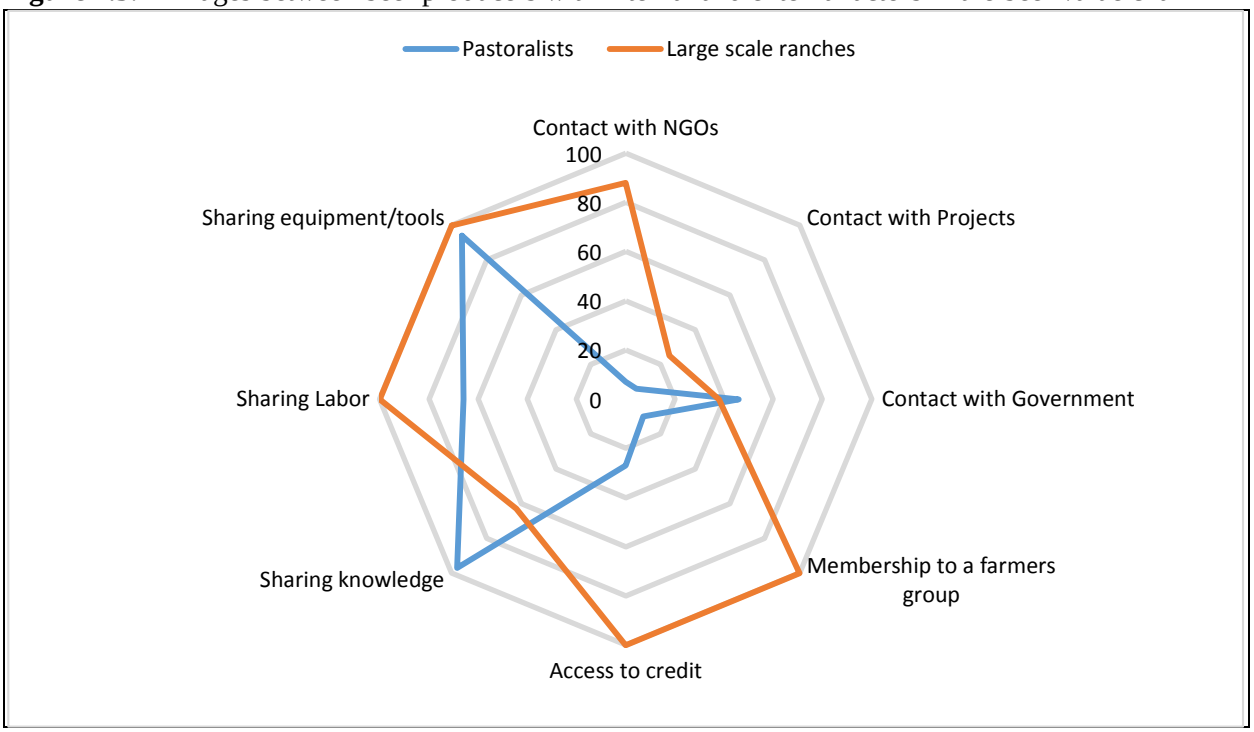
Weak vertical and horizontal linkages characterize the beef value chain and potentially hamper growth of the value chain. Vertically, actors are restricted to buy-sell relationships. The nature and frequency of production and interaction contributes to weak linkages. For example, on average a pastoralist sells three heads of cattle annually, implying that they interact with the traders only three times in a year. In the absence of repeat transactions and such low frequency of interaction, vertical integration becomes difficult and unnecessary. Most of the relations are spot

relations with one-off transactions between the actors. There are no contractual arrangements between actors in spot relations.

Even then, simple documentation of transaction exists between actors confirming occurrence of sale and purchase. However, the processing level of the formal beef marketing chain exhibits characteristics of persistent relations between private processors and traders. Private processors seem to deal with the same traders time and time again due to product specification, which also acts as an entry barrier. Nevertheless, even in such cases of persistent relations, contractual agreements are lacking with the buyer issuing a supply order and supplier delivering as per the terms.

Horizontal linkages are weak at almost all levels owing to the self-seeking nature of actors. At production level, lack of organization among the pastoralists in the value chain is conspicuous. Majority (90%) of the pastoralists did not belong to any producer organization (Figure 7.3). This may be contributing to the beef traders' advantage in pricing and negotiation power at the livestock markets. Interestingly, pastoralists shared knowledge and information, labour, equipment and tools among themselves. Majority (81%) of the pastoralists related with their neighboring large-scale ranches primarily through accessing pasture in the ranches during the dry season. In addition, large-scale ranches engaged pastoralists in cattle fattening and marketing programs, provided quality bulls for breeding to the pastoralist community for free and offered employment opportunities. However, these relationships are necessitated by the need for peaceful co-existence between the two production systems.

Figure 7.3. Linkages between beef producers with internal and external actors in the beef value chain



Source: Researcher, 2021

Pastoralists have limited interactions and support with external value chain actors such as non-governmental organizations, financial service providers and government services. Most (73%) pastoralists did not have access to credit facilities, hindered by the failure to belong to a producers group and lack of knowledge on where to access credit facilities. Only 7% of the pastoralists had contact with any non-governmental organization, which could imply their absence or failure to reach majority of the pastoralists. Still only half of the pastoralists had any form of contact with government services which was solely during annual mass vaccinations of livestock against contagious diseases like foot and mouth.

On the contrary, there is strong horizontal integration among the large-scale ranches. Large-scale ranches belong to producer organizations and lobby groups through which they share and exchange information and knowledge. For example, majority belong to the cattle breeders society through which they showcase and share information on different cattle breeds. They are also members of lobby groups through which they voice ideas and complaints to the government. In addition, large-scale ranches were part of a group that assisted in marketing. Large-scale ranches have strong relations with external value chain actors such as non-governmental

organizations through which they participate in community projects. They also had access to access to credit facilities.

Beef traders were vertically integrated in the informal marketing chain, both downwards as producers and upwards as retailers. Moreover, they have close business relationships among themselves and are organized in a trader's welfare organization that assist each other in need. However, through the same organization traders acquire advantages of economies of scale by cost sharing facilities such as cattle holding grounds, services such as herding and transportation of cattle from livestock markets. However, the study did not establish any form of organized relationships among beef processors. This can be attributed to the fact that they are few and sparsely distributed with minimal physical interactions, if any.

There are 3 actors in the beef value chain whose position, multiple roles, level of concentration and access to key assets, ability to capture more value and ability to set prices make them dominant in the chain. These are private processors, traders and large-scale ranches. Economies of scale, quality of production, organization and ability to be in direct contact with buyers gives large-scale ranches market advantage and high value in the value chain. Large-scale ranches have concentration of a key production resource: pasture. Large-scale ranches capture the highest gross margin in the beef value chain due to economies of scale. Traders are key agents both in the formal and informal beef marketing chains. They transport live cattle to processors and slaughterhouses. They also facilitate slaughter and deliver beef carcasses to retailers (butcheries). At least half of the traders also owned butcheries.

At the livestock markets, traders are the ultimate price determiners. Despite, the lengthy back and forth negotiations that characterize transactions at the livestock markets, traders have the final word. The livestock markets exhibit characteristics of an oligopsony with few traders dominating a market with many sellers. Pastoralists rely almost entirely on the traders as livestock buyers. Similarly, butcheries are dependent on traders as their main suppliers of beef carcasses. The multiple roles of beef traders in the value chain enable their vertical integration, making them dominant. In other words, high dependency on traders, their ability to set prices both at the livestock markets and after slaughter makes the beef trader a very powerful actor in the informal beef value chain. However, they do not exude the same power in the formal value

chain where prices are determined by the large-scale ranches and private processors. Processors exercise their power in the value chain through pricing and quality standards. They strictly apply high standards of beef quality and set prices for their finished products differentiating various beef cuts and beef products.

7.4.2 Constraints to beef production

This section presents the constraints which were identified by beef producers with an emphasis on the pastoralists. Table 7.3 presents a summary of the constraints. The major constraints which shall be discussed in detail are: drought, livestock diseases, plant invasive species (*Opuntia spp*), lack of water, attacks on livestock by wildlife and insecurity.

Table 7.3. Constraints to production identified by pastoralists and large-scale ranches

Constraint	**Pastoralists (n = 67)**		**Large-scale ranches (n = 7)**
	(n)	(%)	(n)
Drought	63	94	1
Livestock diseases	36	54	0
Pasture invasive plants	28	42	0
Lack of water	17	25	0
Attacks by wildlife	11	16	5
Livestock raids	10	15	0
Low and fluctuating cattle prices	8	12	1
Inability to purchase livestock drugs	5	7	0
Unpredictable rainfall patterns	3	4	0
Scarcity of pasture	3	4	0
Invasion of pasture by pastoralists livestock	0	0	4
Lack of government support	0	0	2
Lack of good markets for well finished cattle	0	0	1
Unavailability of effective livestock drugs	0	0	1

Source: Researcher, 2021

Drought was the most pressing challenge for pastoralists. Pastoralists perceived dry periods to be more extended, resulting to minimal recovery time. Drought also resulted to low water availability, shortage of pasture and loss of livestock. At least one third of the pastoralists reported having lost livestock to drought at the time of the study. The pastoralists area is categorized among the arid and semi-arid areas in the country with annual rainfall not exceeding 400mm. Therefore, pastoralists experience limited water supply most months of the year. The

situation is aggravated by drought as majority (84%) of pastoralists rely on boreholes, seasonal rivers and dams as their main source of water.

The problem of livestock diseases is multifaceted and involves interrelated issues of lack and low coverage of animal vaccination, poor and limited extension services, transmission of diseases between herds or through interaction with wildlife, and costly livestock drugs. Interaction of livestock with wildlife in shared pastures lead to transmission of diseases and ticks. Moreover, the migratory nature of pastoralists exposes livestock to diseases and ticks with the possibility of spreading the same along their migratory paths. Other factors such as pastoralist's lack of adherence with movement permits and slow government response to disease outbreaks were identified as contributing to spread of diseases. Despite annual provision of livestock vaccines by the government only half (54%) of the pastoralists reported accessing the service. Government officers providing such services were scarce with limited resources that made it impossible to cover large areas. Moreover private service providers were almost non-existent. Majority of them were found in towns, 50 kilometers away. As a result of this complex challenge, pastoralists turned to treating sick animals with the risk of administering a drug under dose or over dose or even making a misdiagnosis.

Attacks on livestock by wildlife is associated with the role of ranches as wildlife conservancies which are involved in tourism and wildlife protection. Majority of community ranches (9 of 10) and large-scale ranches (6 of 7) are either part or full conservancies. As such, the risk of livestock attacks by the wildlife roaming freely in the conservancies is high. In addition, wildlife transmits diseases and ticks.

The plant invasive species, *Opuntia* (Photo 7.2) is increasingly becoming a menace in the rangelands. Efforts to biologically eradicate the prickly pear plant by use of the cochineal insect and manually by uprooting have not been successful. The plant invasive species causes degradation of grass due to its ability to grow fast and endure dry conditions. In addition, the prickly hairs of its fruit tend to stick in the livestock's mouth and eyes resulting in difficulty in feeding and possible blindness. Although neighboring large-scale ranches reported having the same plant invasive species, they seem to have managed it better than the pastoralists.

Photo 7.2. Growth of *Opuntia* in the rangelands

(Photo credit: Researcher, 2021)

Livestock raids were viewed as a persistent cause of insecurity. Historically, literature has documented a tradition of livestock raiding among pastoralist communities through which communities acquired more livestock. Unfortunately this practice has continued to date. Government and community efforts to completely resolve this persistent problem have not succeeded. On the other hand, invasion of pasture in large-scale ranches by livestock from the pastoralist community were a cause of insecurity and a source of tension and conflict between the two production systems. This occurred particularly during pasture scarce months (dry periods). For the large-scale producers, it affected proper pasture planning and possibility of degradation through overgrazing. Large-scale ranches affected by this seasonal problem complained of government failure to put in place effective measures to control the invasions.

7.4.3 Constraints to beef traders, processors and retailers

The main concerns for beef traders were lack of well finished cattle particularly during drought, loss of cattle during transportation and the risk of buying stolen cattle. The study observed that trucks used to transport cattle were not specially designed for cattle transportation. Consequently, cattle were more likely to get injuries in transit. Loss of cattle during transportation was a result of either death or theft. Death of cattle reportedly occurred when a trader unknowingly purchased a sick animal while cattle theft, though rare, occurred when animals were trekked as opposed to

transporting using trucks. The study observed some challenges related to the structure and operation of the livestock markets that could hinder development of the value chain. Livestock markets lack proper infrastructure; some lack proper cattle holding pens, loading ramps (Photo 7.3) and weighing scale. The absence of proper infrastructure necessitated the assistance of several people to load cattle unto trucks. The roads connecting to the livestock markets are dilapidated. Traders particularly find it challenging to transport livestock during the rainy season when roads become muddy and extremely difficult to navigate causing possible damage to trucks and thus higher transport costs.

Photo 7.3. A makeshift loading ramp for bought cattle.

(Photo credit: Researcher, 2021)

The sampled government owned slaughterhouses had old infrastructure that has not been upgraded or renovated. Consequently, they are limited in terms of their slaughter capacity and variety of beef products they can process. Traders using the slaughterhouses expressed the desire for upgraded slaughterhouses that would enable more value addition through production of different beef products and treatment of hides and skins. Due to financial constraints slaughterhouses had difficulty obtaining sufficient cleaning and useable materials, proper lighting and upgrading of machinery. This results in unhygienic operating conditions, limitation of operating working hours to daylight and inefficient services. Low supply of quality beef

during the dry months when proper cattle finishing is constrained by insufficient feed results in inefficiency in processing as processors operate at lower capacities of up to 50%.

Butcheries, the primary retailers of beef, identified losses emanating from spoilage and waste as their major constraint. Majority of the butcheries hang beef carcasses openly inside the butchery. This results in shrinkage of beef carcass and reduced weight due to loss of water. Low quality carcasses, excess fat and cutting beef into small quantities also contributes to possible losses. Inconsistency in supply of quality beef particularly during the dry season beef was an important concern for retailers. Granting the price of beef was generally considered stable, seasonal fluctuations in beef supply results in price fluctuations. Survey results indicated that half of the sampled retailers had increased beef retail prices by an average of 6% on account of low availability of quality cattle due to drought.

7.5 Summary of Chapter

The governance structure of the agro-food value chains is greatly influenced by their marketing structure. All three agro-food value chains exhibit a dualistic marketing structure with both formal and informal components. This informality and formality shapes the linkages, relationships and power within the value chains. The wheat and beef value chains exhibited weak vertical linkages which potentially hamper growth of the value chains. Vertically, actors are restricted to buy-sell relationships with each actor aiming at maximizing their benefits from the interactions. However, the high frequency of dealings among the dairy value chain actors contributes to stronger vertical linkages. However, this only applies to the formal dairy marketing chain. The informal marketing chain just like in the informal beef and wheat value chains are characterized by weak vertical linkages. However, mutual trust among actors in the informal marketing chains makes the transactions efficient. Horizontal integration among actors at the same level was strong among large-scale producers, smallholder dairy farmers and wheat processors in the three value chains. On the other hand, traders and smallholder producers in the wheat and beef value chain had weak horizontal integration, while wholesale and retail levels of the value chains had near non-existent horizontal integration.

In all value chains, the nature of transactions among actors at the different levels of the value chains exhibited characteristics of both spot and persistent relations. However, spot relations

were dominant due to widespread informality in the linkages between actors. Transactions between farmers, pastoralists and traders were mainly spot transactions, involving one off sell-buy transactions. Such transactions were based on trust and mutual agreements on supply, delivery, time and mode of payment. Aspects of persistent transactions were observed between traders, processors and wholesalers who engaged in repeat transactions as well as with some smallholder farmers who transacted with the same trader every season or day. Nevertheless, despite such persistent transactions, contractual arrangements were lacking between most actors. An exception to this were transactions between processors and other actors which were formalized through contracts. Such contracts enforced compliance with set rules, guidelines and standards.

The governance structure of the value chains revealed three power centres; large-scale producers, traders and processors. Subsequently, these actors have dominant roles in the value chains. Traders are uniquely dominant in the informal value chains, processors in the formal value chains and large-scale producers in both. Position and multiple roles in the value chains, level of concentration and access to key assets, ability to control prices, volumes, information, impose standards and command a high share of value makes these three actors dominant in the value chains. Dominance of large-scale producers is enabled by concentration and access to important production resources for instance land, pasture, credit and machinery. Processors exercise their power in the value chains through pricing and quality standards. Their crucial role of transforming farm produce to processed products puts them in a key position to capture significant value in the value chains. Processors tend to be few, in comparison to other actors, thus creating an oligopolistic market that gives them significant power in determining prices. Lastly, traders are key agents in the formal and informal marketing chains of the three agro-food value chains. Their dominance is manifested through price determination, control of market information and distribution of large volumes of farm produce. Traders' multiple roles confers them with power in the value chains. The high dependence on traders by smallholder farmers affirms their dominance in the informal value chains.

Analysis of constraints has, to some extent, provided an explanation to the differences in quality, prices and gross margins. Generally, at the production level issues related to drought and lack of water, pests and diseases, weeds, high cost of inputs, livestock feed, government services and

marketing need to be addressed for sustainable production. Whereas some constraints were similar between the smallholder farmers, pastoralists and large-scale producers, there were disparities that seem to suggest that large-scale producers manage constraints to production better. However, it is also necessary to pay attention to the constraints stated by the large-scale producers in order to achieve improved actor relations, and overall value chain growth and efficiency.

At the trade and transportation level, constraints mainly related to poor infrastructure, spoilage of produce, shortage of produce in the dry seasons and poor quality of produce from smallholder farmers. At the processing level, processors concerns related to high cost of electricity thereby increasing cost of processing, low quality of smallholder farmers produce and seasonal fluctuations in the local supply of produce. Wholesalers and retailers identified seasonal fluctuations of price and products as their main constraints. The constraints identified by actors both internal and external to the value chains need to be holistically addressed to boost value chain productivity. In addition, the constraints present opportunities for addressing specific actors or activities where more impact on improvements can be achieved in the value chain.

CHAPTER 8. HOUSEHOLD FOOD SECURITY AND POVERTY STATUS IN THE WHEAT, DAIRY AND BEEF VALUE CHAINS

8.1 Introduction

This chapter analyses the implication of value chain participation on household food security and poverty status. The results presented in this chapter seek to achieve the fourth objective of the study on the status and determinants of household food security and poverty in the wheat, dairy and beef value chains in North West Mt. Kenya. To do this, analysis is done at the production level for smallholder farmers and pastoralists because it was possible collect production data at the household level. As such, the smallholder farmers and pastoralists are divided into four categories of households based on their participation in the three agro-food value chains. These are 1) beef producing pastoralist households; 2) smallholder dairy farming households; 3) smallholder wheat farming households; and 4) smallholder wheat and dairy farming households (i.e. participating in both wheat and dairy value chains). The fourth category aims to establish if smallholder farmers participating in both wheat and dairy production are significantly better in the context of poverty and food security. In short, the chapter strives to answer if a farmer's participation in a specific agro-food value chain determines his/her household's food security and poverty situation. To guide the discussions, the chapter is divided into three major sections. The first section highlights selected characteristics of the sampled households. The second section presents the status of household food security and poverty, while the third section provides an analysis of the determinants of household food security and poverty.

8.2 Socio-economic characteristics of sampled households

Table 8.1 presents selected characteristics of the sampled households that are important in analyzing the determinants of household food security and poverty. In this chapter, as mentioned earlier, the sample of producing households was divided into four: beef producing pastoralist households (67); smallholder dairy farming households (28); smallholder wheat farming households (24); and smallholder wheat and dairy farming households (56) (i.e. participating in both wheat and dairy value chains). Beef producing pastoralist households own at least twice as much the average number of cattle owned by households in other value chain categories.

Table 8.1. Selected characteristics of the sampled households

	Beef producing pastoralist households (n=67)	Smallholder dairy farming households (n=28)	Smallholder wheat farming households (n=24)	Smallholder dairy & wheat farming households (n=56)	Households in all the value chains (n=175)
Mean values of household assets					
TLU	15	3	2	4	6
Number of cattle	14	4	2	5	8
Daily income (total of all income streams, KShs)	575	3,479	1,408	2,366	1,957
Number of income streams	2	4	4	5	4
Household members	6	4	4	4	5
Average distance to selling point (km)	6	1	0	0	1
Access to economic services (%)					
Access to credit	26.9	39.3	16.7	37.5	30.9
Access to electricity	1.5	53.6	29.2	51.8	29.7
Borrow to meet family needs	85.1	39.3	37.5	55.4	61.7
Enough income to save	35.8	82.1	75.0	76.8	61.7
Membership to farmers group	10.4	92.9	29.2	69.6	45.1
Contact with NGOs	7.5	14.3	20.8	30.4	17.7
Contact with government	46.3	32.1	29.2	32.1	37.1
Share equipment and tools	94.0	10.7	8.3	7.1	41.1
Share knowledge	97.0	82.0	79.0	93.0	91.0
Access to extension services	53.7	57.1	25.0	41.1	46.3
Ownership of assets (%)					
Own solar panel	40.3	75.0	58.3	69.6	57.7
Own mobile phone	85.1	100	100	100	94.3
Own television	20.9	78.6	83.3	91.1	61.1
Own bicycle	4.5	57.1	37.5	50.0	32.0
Own motorcycle	22.4	21.4	41.7	26.8	26.3

Source: Researcher, 2021

The smallholders had a minimum of 4 different income sources ranging from livestock keeping, production of various crops, income from various business enterprises, off-farm activities and employment. In comparison, pastoralists had fewer income sources (2), mainly from livestock production, employment and business enterprises. Farm income had the highest share (60-70%) of total income in all value chains, making it key for household income. However, this was more significant for pastoralists as it constituted 60% of total income as compared to 21% and 17%

contribution to dairy and wheat farmer's income respectively. This result could confirm that pastoralists rely more on beef production whereas smallholders benefit from diversified production of crops and livestock, hence less dependence on wheat and dairy production for income.

The mean daily income for all households was approximately KShs 1,960. The beef producing pastoralist households had the lowest daily income (KShs 575), while the smallholder dairy farming households had the highest (KShs 3,480). More than half (62%) of the households stated lacking sufficient income to make a saving and sometimes had to borrow to meet their needs. In addition, only a third of households in the three value chain reported having accessed credit. Households own diverse assets, with the most owned (94%) type of asset being a mobile phone. Results further show that about half (55%) of the smallholders and pastoralists do not belong to any farmer or producer group. However, compared to dairy and wheat smallholder farmers, the pastoralists have more contact with the government (46%) through extension services such as vaccination.

Although the proportion of beef and dairy producing households accessing extension services is not significantly different, it must be noted that the pastoralists access extension services from the government while dairy farmers access private extension services primarily through the dairy cooperatives. The strong presence of dairy cooperatives explains why majority (93%) of the dairy smallholder farmers are members of a farmers group compared to 10% and 29% of the pastoralists and smallholder wheat farmers respectively.

Based on the absolute distance traveled, dairy farmers travelled 1 kilometer whereas pastoralists travelled a longer distance of 6 kilometers to their selling points. Wheat and both dairy and wheat value chains had an average distance of zero to their market, implying sale of produce on the farm. Pastoralists have near nil access to electricity (1.5%) and still the lowest proportion (40%) of households with ownership of solar panels. Yet they live in the drier areas that have more sun hours and intensity compared to the humid areas occupied by the wheat and dairy smallholder farmers.

8.3 Household Food Security and Poverty Status

8.3.1 Household food security status

The household food security status has been analyzed using two Household Food Insecurity Access Scale indicators: HFIAS Score and HFIAP. The HFIAS score results in a score of the household food insecurity status, while HFIAP results in the categorization of households into four mutually exclusive food security categories.

Household Food Insecurity Access Scale (HFIAS) Score

The proportion of smallholders in the wheat, dairy and both dairy and wheat categorizations that had the minimum HFIAS score of zero was 67%, 61% and 52% respectively (Table 8.2). On the other hand, half (52%) of the pastoralist households had the maximum obtainable HFIAS score of 16. In fact, the difference in the HFIAS score for beef producing pastoralist households compared to other household categories was six times more.

Table 8.2. Household Food Insecurity Access Scale Scores (%)

HFIAS score	Beef producing pastoralist households (n=67)	Smallholder dairy farming households (n=28)	Smallholder wheat farming households (n=24)	Smallholder dairy & wheat farming households (n=56)	Households in all the value chains (n=175)
0	4.5	60.7	66.7	51.8	37.1
1	0.0	3.6	4.2	1.8	1.7
2	1.5	10.7	4.2	10.7	6.3
3	0.0	0.0	8.3	1.8	1.7
4	3.0	7.1	8.3	8.9	6.3
5	0.0	0.0	0.0	0.0	0.0
6	7.5	3.6	0.0	5.4	5.1
7	0.0	0.0	0.0	5.4	1.7
8	7.5	7.1	0.0	0.0	4.0
9	0.0	0.0	0.0	0.0	0.0
10	1.5	7.1	4.2	8.9	5.1
11	1.5	0.0	0.0	1.8	1.1
12	4.5	0.0	0.0	1.8	2.3
13	7.5	0.0	0.0	1.8	3.4
14	6.0	0.0	4.2	0.0	2.9
15	3.0	0.0	0.0	0.0	1.1
16	52.2	0.0	0.0	0.0	20.0

Source: Researcher, 2021

Pastoralists had a HFIAS score of 13 whereas smallholders in dairy, wheat, and both dairy and wheat categories had three, two and two respectively. This implies that smallholder farming households experienced less food insecurity, while pastoralist households were more food insecure. Overall, without regard to the categorization of households, the higher proportion of households were either in the minimum or maximum score.

Household Food Insecurity Access Prevalence (HFIAP)

The HFIAP indicator results revealed that 46% of the households were severely food insecure, 39% were food secure and a lesser proportion (15%) were either mild or moderately food insecure (Table 8.3). Severe food insecurity meant that households were cutting down on meals both in terms of quantity and frequency, and also experiencing the most severe conditions of food insecurity like running out of food, and completely missing meal a whole day or night (Coates et al., 2007). In contrast, food secure households were not experiencing any of the conditions associated to food insecurity or they rarely worried about lack of food. The beef producing pastoralists had the largest proportion (90%) of their households in the severely food insecure category. In contrast, majority of the smallholder farming households were food secure: dairy (64%), wheat (71%) and both dairy and wheat (54%). This trend is similar to the HFIAS scores.

Table 8.3. Household Food Insecurity Access Prevalence (%)

	Beef producing pastoralist households (n=67)	**Smallholder dairy farming households (n=28)**	**Smallholder wheat farming households (n=24)**	**Smallholder dairy & wheat farming households (n=56)**	**Households in all the value chains (n=175)**
Food secure	4	64	71	54	39
Mildly food insecure	0	11	4	11	5
Moderately food insecure	6	11	13	13	10
Severely food insecure	90	14	13	23	46

Source: Researcher, 2021

Mildly or moderately food insecure households meant they were not consuming the desired food quality and had to compromise, sometimes or often, but seldom were cutting back on food quantity (Coates et al., 2007). As noted earlier, the study collected data during a prolonged dry period, which helps to explain why many of the pastoralist households were in the severe

category of food insecurity. At that time, majority of the pastoralist households had adapted coping strategies against hunger like cutting back on quantity and frequency of daily meals. Moreover, the pastoralists live in the drier semi-arid areas vis-à-vis the humid and semi-humid areas occupied by the smallholder wheat and dairy farmers.

8.3.2 Household poverty status

The household poverty status was determined using the Foster-Greer-Thorbecke Poverty (FGT) Indices. While doing this, household incomes (expenditure used as proxy) were benchmarked against the country's rural poverty line to determine if a household is poor or not. Based on the Foster-Greer-Thorbecke Poverty (FGT) Indices, the proportion of the poor households in all the value chains was 12% (Table 8.4, Headcount ratio). The beef producing pastoralist households had the highest poverty rate of 15% while smallholder wheat households had the lowest (4%). In other words, beef producing households had the highest share of poor households contrasted to the other household sub-groups.

The average normalized poverty gap (depth of poverty) was 0.022, while the average squared normalized poverty gap (severity of poverty) was 0.006 (Table 8.4). These two indicators account for the relative size of income deficit per household in relation to the poverty line. It therefore means the higher the indicator the more income needed to get a household to the poverty line. Smallholder dairy and wheat farming households had the highest indicators of the average normalized poverty gap (0.038) and average squared normalized gap (0.014). Beef producing pastoralist has the lowest average squared normalized poverty gap (0.002) which could imply lower inequality between the beef producing pastoralist households with large and small income shortfalls from the poverty line.

Table 8.4. Foster-Greer-Thorbecke Poverty Indices

Household/value chain category	Headcount ratio (% poor)	Average normalized poverty gap	Average squared normalized poverty gap
Beef producing pastoralists	0.149	0.015	0.002
Smallholder dairy farming	0.071	0.015	0.005
Smallholder wheat farming	0.042	0.010	0.003
Smallholder dairy & wheat farming	0.143	0.038	0.014
Households in all the value chains	0.120	0.022	0.006

Source: Researcher, 2021

The beef producing pastoralist households had the lowest mean income (expenditure used as proxy) of KShs 5,928, while the smallholder dairy farming households had the highest at KShs 9,669 (Table 8.5). Given that the beef producing pastoralist households had the highest poverty rate of 15%, this could indicate an association between low income and poverty. Although the mean income of the beef producing pastoralist households was lower than the smallholder wheat farming and smallholder dairy farming households, they had the highest mean income (KShs 2,934) and lowest mean income gap (KShs 318) among the poor households (Table 8.5). This explains why although their poverty share is the highest (headcount ratio=47.60), the severity of poverty measure is the lowest, that is, their poverty risk is smaller (0.324) with the measures that are sensitive to how poor the poor people are (Table 8.6).

Households in the sub-groups of wheat and both dairy and wheat exhibit very high mean gaps among their poor. This could point to high income inequality among smallholders than pastoralists. It would thus take more effort to bring the poor smallholder wheat and dairy farmers at par with their group mean income than it would with the poor pastoralists. Smallholder dairy and wheat farming households had the highest share of average normalized poverty gap (57%) and average squared normalized gap (70%) (Table 8.6). Consequently, they had the highest poverty risk measures that are sensitive to how poor the poor households are, that is, the normalized poverty gap (1.772) and the average squared normalized gap (2.187).

Table 8.5. Household category and poverty variables

Household/value chain category	% of total households	Mean income	Mean income poor	Mean gap poor
Beef producing pastoralists	38.3	5928.4	2934.2	317.8
Smallholder dairy farming	16.0	9669.5	2587.0	664.0
Smallholder wheat farming	13.7	9421.4	2447.7	804.3
Smallholder dairy & wheat farming	32.0	9561.1	2382.0	869.0

Source: Researcher, 2021

Table 8.6. Poverty share and risk

Household/value chain category	poverty 'share'			poverty 'risk'		
	FGT (0)	FGT (1)	FGT (2)	FGT (0)	FGT (1)	FGT (2)
Beef producing pastoralists	47.60	0.259	0.124	1.244	0.676	0.324
Smallholder dairy farming	9.50	0.108	0.120	0.595	0.677	0.750
Smallholder wheat farming	4.80	0.066	0.056	0.347	0.478	0.407
Smallholder dairy & wheat farming	38.10	0.567	0.700	1.190	1.772	2.187

Note: FGT (0) is headcount ratio, FGT(1) is average normalized poverty gap, FGT(2) is average squared normalized poverty gap
Source: Researcher, 2021

8.4 Determinants of Household Food Security and Poverty Status

8.4.1 Determinants of household food security

The determinants of household food security have been achieved using the poisson and multinomial regression models.

Poisson Regression Analysis

The estimated parameters for the determinants of food security are presented in Table 8.7. For the model, $p = 0.000$, is less than $\alpha = 0.05$, therefore, we fail to accept the first null hypothesis and conclude that one or more of the independent variables can predict the odds that a household is food secure. The negative binomial model used 175 observations for the analysis. The Wald chi-square statistic (LR chi2 (23)) for the model was equal to 131.16. The p-value (Prob > chi2=0.00) for the chi-square confirmed that the model was statistically significant. The likelihood ratio test had an associated chi-squared value of 94.98 with one degree of freedom strongly suggested that the negative binomial model was more appropriate that the poisson model.

The short model, also referred to as the parsimonious model, has 4 independent variables: beef producing pastoralists, households in dairy value chains, households in wheat value chains and households in dairy and wheat value chains. Its aim was to show the general behavior of the household sub-groups. The short model suggested that smallholders in the all three categorizations were less likely to be food insecure contrasted with the pastoralists. The full model, showed that smallholders in wheat farming were less likely to experience food insecurity. Income, saving, borrowing for household needs, household size, having a bicycle, belonging to a farmer groups (social capital), and capacity to access energy were significant factors explaining

food security for the households. For these variables, their coefficients had p values less than the alpha and were considered statistically significant at α values of 0.01, 0.05 or 0.1.

Table 8.7. Poisson Regression Analysis

	Parsimonious model		**Full model**	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
Households in dairy value chain	-1.827***	0.276	0.003	0.600
Households in wheat value chain	-2.003***	0.300	-1.173**	0.539
Households in dairy & wheat value chains	-1.482***	0.212	-0.112	0.548
Number of household members			0.128***	0.047
Income diversity			-0.034	0.078
Log daily income			-0.333***	0.115
Access to credit			0.079	0.190
Borrow to meet family needs			0.499**	0.195
Enough Income to save			-0.510***	0.165
Number of cattle			0.010	0.010
Own bicycle			-0.423*	0.241
Own mobile phone			0.285	0.309
Own television			-0.051	0.260
Own motorcycle			0.164	0.198
Farmer group membership			-0.402*	0.232
Extension services access			-0.384	0.237
Contact with NGOs			0.201	0.262
Share equipment and tools			-0.517	0.360
Distance to selling point			0.018	0.033
Access to electricity			-0.587**	0.258
Contact with government			0.398	0.247
Own solar panel			-0.558***	0.206
Share knowledge			0.321	0.300
_cons	2.538***	0.135	3.512***	0.878
Lnalpha _cons	0.131	0.176	-0.561**	0.220
N	175		175	
chi^2	65.266		131.163	
r^2_p	0.066		0.133	
P	0.000		0.000	

Significance level * 0.10 ** 0.05 *** 0.01; beef value chain (base category)
Source: Researcher, 2021

Using the results in Table 8.7, the poisson regression equation is:

$$HFIAS = 0.321 + 0.003DVC - 1.173WVC - 0.112DWVC + 0.128HH - 0.034ID - 0.333LDI + 0.079AC + 0.499BF - 0.510EI + 0.010C - 0.423B + 0.285P - 0.051T + 0.164M - 0.402FG - 0.384ES + 0.201N - 0.517E + 0.018SP - 0.587E + 0.398G - 0.558S + 0.321K$$

Where HFIAS is household food insecurity access score; *DVC* is households in dairy value chain; *WVC* is households in wheat value chain; *DWVC* is households in dairy & wheat value chains value chain type; *HH* is number of household members; *ID* is income diversity; *LDI* is log daily income; *AC* is access to credit; *BF* is borrow to meet family needs; *EI* is enough income to save, *C* is number of cattle; *B* is own bicycle; *P* is own mobile phone; *T* is own television; *M* is own motorcycle; *FG* is farmer group membership; *ES* is extension services; *N* is contact with NGOs; *E* is share equipment and tools; *SP* is distance to selling point; *E* is access to electricity; *G* is contact with government; *S* is own solar panel; and *K* is sharing knowledge.

Household size had a coefficient of 0.128 and was significant at 99% confidence level. Meaning that for one unit increase in household members, the expected log count of food insecurity increases by 0.012. In fact, household size increased with decreasing food security. Food secure households had four members, mild and moderately food insecure had five persons each whereas severely food insecure households had the highest household size of six.

Income, savings and borrowing for family needs were significant at 99%, 99% and 95% confidence levels, respectively. The coefficient of log daily income was -0.333 indicating that, if log of daily income were to increase by one percent, the difference in the expected log count of food insecurity would decrease by 0.333, other variables held constant. Similarly, if the ability to save were to increase by one point, the change in the logs of expected counts in food insecurity would be expected to decrease by 0.510 units, other variables held constant.

The average daily income of food secure households was KShs 3,195 which decreased to KShs 1,440 in the mild and moderate categories and further decreased to KShs 568 among severely food insecure households. Comparatively, the contribution of income from beef production to farm income among pastoralist households was much higher (59%) compared to the wheat and

dairy (17-21%). The survey results showed that 62% of households in all three value chains could put aside some money as savings. However, fewer (35%) pastoralist households could make savings compared to the other value chains where at least 75% reported being able to save. Households that reported borrowing for their household needs were more likely to experience food insecurity. About one-third (38%) of the households reported borrowing money to meet their family needs. Majority (85%) of such households were in the beef value chain, while the least (38%) were in the wheat value chain.

Owning a bicycle was significant (at 0.10) for food security. For a one unit increase in the ownership of a bicycle, the difference in the expected log count of food insecurity decreases by 0.423, other variables remaining constant. Solar panels and electricity were significant in the model at 99% and 95% confidence levels respectively. A unit increase in electricity access would result in a decrease in the difference of the logs of expected counts in food insecurity by 0.587 units, other variables remaining constant. Similarly, a one point increase in owning a solar panel would lead to a decrease in the difference in the logs of expected counts in food insecurity by 0.558 units, other variables remaining the same.

Belonging to a farmer group (social networking) was significant at 90% confidence level. Households who belonged to a farmer's group were less likely to experience food insecurity. The dairy value chain had majority (93%) of the households belonging to producer groups (dairy cooperatives). The study identified several benefits of group membership including linkage to larger urban markets, better access inputs, credit, training and extension services. The variables income diversity, sharing of production assets and access to extension services were not significant in the model but had negative coefficients.

Multinomial Regression Analysis

The results of the multinomial regression analysis (Table 8.8) seeks to establish the effect of the agro-food value chains on household food security. The dependent variable is the HFIAP status indicator, a categorical variable, taking the form of four categories: food secure, mildly food insecure, moderately food insecure and severely food insecure. Food secure is the base category among the dependent variables. The independent variables of interest are the four sub-categories of households: households in dairy value chain, households in the wheat value chain, households

in beef value chain and households in the dairy and wheat value chain. Households in the beef value chain is the base category. The results show that log daily income, savings, number of household members, borrowing to meet family needs, ownership of television and access to credit facilities significantly determine household food security.

Table 8.8. Multinomial Regression Analysis

	Mildly food insecure		**Moderately food insecure**		**Severely food insecure**	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Households in dairy value chain	16.273	774.992	-0.706	2.022	-1.661	1.518
Households in wheat value chain	13.331	774.992	-2.341	1.800	-2.627*	1.488
Households in dairy and wheat value chains	16.556	774.993	-1.390	1.815	-0.618	1.397
Contact with NGOs	-1.580	1.561	1.220	0.935	-0.335	0.869
Number of cattle	-0.447	0.391	0.006	0.051	-0.002	0.042
Distance to selling point	0.267	0.338	-0.444	0.306	0.128	0.164
Membership to farmers group	-0.659	1.225	-0.013	0.981	-0.143	0.789
Contact with government	-1.493	1.366	-0.604	0.848	0.993	0.678
Own television	0.828	1.595	2.211	1.438	-1.408*	0.856
Log daily Income	-1.403*	0.777	-1.306**	0.534	-1.119**	0.477
Enough income to save	-1.548	1.012	-1.349*	0.797	-1.770**	0.696
Number of household members	0.412	0.280	0.502***	0.185	0.323**	0.159
Borrow to meet family needs	-0.275	1.134	1.325*	0.768	0.717	0.631
Access to credit	3.122**	1.287	0.086	0.912	-0.833	0.826
_cons	-8.594	775.001	5.029	3.635	8.606***	3.091
N	175					
Chi^2	198.117					
R^2_p	0.508					
p-value	0.000					

Significance level * 0.10 ** 0.05 *** 0.01; base outcome categories – food secure, beef value chain
Source: Researcher, 2021

The log likelihood of the fitted model was -96.10. The number of observations used in the model were 175, which were all the cases. The likelihood ratio chi-square (LR chi2(42)) equals 198.12. The model p-value (Prob>chi2 = 0.000) was less than alpha (α=0.05), thus indicating that at least one or more of the coefficients in the model is greater than zero. The McFaddens Pseudo R2 was equal to 0.5076.

Ownership of television, log daily income, savings and number of household members were significant at 90%, 95%, 95% and 95% confidence levels, respectively, in determining severe

food insecurity. If ownership of television were to increase by one point, the multinomial log-odds for severely food insecure to food secure would be predicted to decrease by 1.408 units other variables remaining constant. Also, a one unit rise in the log of daily income would be associated with a 1.119 decrease in the multinomial log odds of being severely food insecure vis-à-vis food secure, other variables remaining constant. Similarly, if the household size were to rise by a unit, the multinomial log-odds for severely food insecure to food secure would be expected to increase by 0.323 units, other variables being constant.

Households in the wheat value chain were less likely to be severely food insecure, perhaps, because participation in the wheat value chain requires a higher capital outlay than the other value chains. As such, only farmers with the financial ability can productively engage in wheat production. It would, therefore, be unlikely that farmers who can afford such capital requirements would be food insecure. Results in this category also indicate that big households are likely to experience severe form of food insecurity. This confirms the findings of the HFIAP indicators where the beef value chain had large households (6) and were more severely food insecure compared to the wheat and dairy value chains with relatively smaller (4) households.

Similar results are echoed in the factors determining moderate food insecurity with log daily income, savings, number of household members and borrowing to meet family needs being significant at 95%, 90%, 99% and 90% confidence levels, respectively. If the household size were to increase by a unit, the multinomial log-odds for moderately food insecure to food secure would be estimated to increase by 0.502 units, other variables held constant. Likewise, a one unit increase in the log of daily income is associated with a 1.306 decrease in the multinomial log odds of being moderately food insecure vis-à-vis food secure, other variables being constant. Also, a one unit increase in the household borrowing to meet family needs is associated with a 1.325 increase in the multinomial log odds of being moderately food insecure vis-à-vis food secure, other variables remaining constant.

Log daily income was significant in determining mild food insecurity at 90% confidence levels. A one unit increase in the log of daily income is associated with a 1.403 decrease in the multinomial log odds of being mild food insecure vis-à-vis food secure, other variables held constant. Access to credit returned unexpected significant results implying that a one unit increase in access to credit is accompanied by a 3.122 increase in the multinomial log odds of

being mild food insecure vis-à-vis food secure. This could suggest that households did not necessarily put the credit obtained into productive use.

8.4.2 Determinants of household poverty

The estimated variables for the determinants of household poverty using logit regression analysis are presented in Table 8.9. The model p-value = 0.000 is less than α= 0.05, therefore, we fail to accept the second null hypothesis which states that the relationship between the social, economic and demographic variables and household poverty status is not significant. Hence, we conclude that the relationship between the independent variables (household value chain sub-groups, social, economic and demographic variables) and poverty is statistically significant.

Table 8.9. Logit Regression Analysis

	Coefficient	**Standard Error**
Households in dairy value chain	4.917**	2.376
Households in wheat value chain	1.182	1.922
Households in dairy and wheat value chain	5.274**	2.157
Number of household members	0.506**	0.205
Income diversity	0.110	0.251
Log daily Income	-1.468**	0.551
Access to credit	0.296	0.793
Borrow to meet family needs	-1.737**	0.855
Enough Income to save	-0.697	0.725
Number of cattle	-0.138	0.084
Own bicycle	-1.057	1.062
Own mobile phone	0.367	1.140
Own television	-1.596	1.177
Own motorcycle	-0.760	0.933
Farmer group membership	-2.297**	1.060
Extension services access	1.517*	0.777
Contact with NGOs	1.077	1.111
Share equipment and tools	1.970*	1.116
Distance to selling point	-0.127	0.149
Access to electricity	-0.068	1.014
_cons	3.901	3.151
N	175	
chi^2	46.554	
r^2_p	0.363	
p-value	0.001	

Significance level * 0.10 ** 0.05 *** 0.01; beef value chain (base outcome)
Source: Researcher, 2021

The log likelihood of the fitted model was -40.935. A total number of 175 observations were used in the analysis; there were no missing values for any of the variables specified for the logistic regression. The likelihood ratio chi-square with 20 degrees of freedom (LR chi2(20)) equals 46.55. The model p-value (Prob>chi2 = 0.0007) was less than the critical value (0.05) indicating, model is statistically significant. The McFaddens Pseudo R2 was equal to 0.3625.

Using the results in Table 8.9, the logistic regression is:

$$FGT = 3.901 + 4.917DVC + 1.182\,WVC + 5.274DWVC + 0.506HH + 0.110ID - 1.468LDI + 0.296AC - 1.737BF - 0.697EI - 0.138C - 1.057B + 0.367P - 1.596T - 0.760M - 2.297FG + 1.517ES + 1.077N + 1.970^{*}E - 0.127SP - 0.067E$$

Where *FGT* is the head count poverty index; DVC is households in dairy value chain; WVC is households in wheat value chain; DWVC is households in dairy and wheat value chain; *HH* is number of household members; *ID* is income diversity; *LDI* is log daily income; *AC* is access to credit; *BF* is borrow to meet family needs; *EI* is enough income to save, *C* is number of cattle; *B* is own bicycle; *P* is own mobile phone; *T* is own television; *M* is own motorcycle; *FG* is farmer group membership; *ES* is extension services; *N* is contact with NGOs; *E* is share equipment and tools; *SP* is distance to selling point; and *E* is access to electricity.

Household size, income, borrowing to meet family needs, membership to farmer groups, extension services and sharing of equipment and tools were significant determinant of poverty. Household size returned significant results at 95% confidence level. The results indicated that, for a one unit increase, we expect a 0.506 increase in the log-odds of a household being poor, other variables held constant. Pastoralists had more household members (6) than the smallholders who had an average of 4 members. This result confirms the findings of the FGT indices that revealed high poverty rates among the pastoralist households.

The variable income was significant at 95% confidence level. For a one unit increase in the log of daily income, we expect a 1.468 decrease in the log-odds of a household being poor, other variables held constant. This results also suggests that higher income level was associated with a lower likelihood of being poor. Households in dairy and wheat value chains had a mean income (KShs 9,561) comparable to households in the wheat (KShs 9,421) or dairy value chains (KShs

9,670). However, their poverty rate (14.5%) was higher than households in the wheat (4%) or dairy (7%) value chains and almost at par with that of beef producing pastoralists (14.9%). Although this result seems contradictory, it could imply that participating in two value chains does not necessarily make a household less poor.

Affiliation to a farmer group was significant at 95%. For a one unit increase in membership to a farmers group, we expect a 2.297 decrease in the log-odds of a household being poor, other variables remaining constant. Households who belonged to a farmer's group were less likely to be poor. The dairy value chain showed high levels of social networking with several advantages such as access to larger urban markets, financial credit, credit on agricultural inputs, veterinary services and training. Ability to acquire extension services was significant at 90%, but unexpectedly had a positive relationship with poverty. This could imply that households seeking government extension services were more likely to be poor while better off households sought private services. Whereas access to credit was not significant in the model, its relationship was with poverty was unexpectedly positive. As mentioned earlier, this could perhaps point to the possibility households did not necessarily put the credit into productive use. And so, the amount of money used in repaying the credit became less available income for procurement of food. Another unexpected and contradictory result was the positive relationship between smallholder household categories to poverty. The result implies that households belonging to these value chains are more likely to be poor compared to pastoralists household category. On the contrary, results of the FGT indices showed that pastoralist households were poorer.

8.5 Summary of Chapter

Analysis of social and economic characteristics of households in the value chains showed that pastoralists and smallholder farmers participated in several economic activities as an income diversification strategy. However, smallholders had more income sources from crop growing, livestock production and off-farm activities compared to pastoralists. On the other hand, pastoralists owned up to three times cattle than smallholders. Pastoralists had the lowest daily income and smallholders the highest. About half of the pastoralist and smallholders did not belong to a producer's group.

Poverty analysis revealed that beef producing pastoralist households had the highest poverty rate while smallholder wheat households had the lowest. However, smallholder dairy and wheat

farming households had the highest indicators of the average normalized poverty gap and average squared normalized gap. The beef producing pastoralist households had the lowest mean income, while the smallholder dairy farming households had the highest. Although the mean income of the beef producing pastoralist households was lowest, they had the highest mean income and lowest mean income gap among their poor households. This explains why although their poverty share is the highest, the severity of poverty measure is the lowest. Households in the category of wheat and those in both dairy and wheat exhibit very high mean gaps among their poor. It would therefore take them more effort to bring their poor households at par with their group mean income than it would with the poor pastoralists.

The correlation between household poverty and the selected social, economic and demographic variables was statistically significant. Household size, income, borrowing for family needs, belonging to a farmer group and accessing extension services were significant in determining household poverty. The likelihood of being poor increased with increasing household size and decreased with higher incomes and affiliation to a farmer group. Owning a bicycle, mobile phone and television, distance to selling points, access to electricity and credit were not significant determinants of household poverty.

Household food security analysis suggest that majority of the smallholder farmers experienced very low levels of food insecurity, whereas majority of the pastoralists experienced higher levels of food insecurity. Generally, most of the households in the value chains fell in the minimum or maximum HFIAS scores. The average HFIAS score for pastoralists was six times more than that of smallholder dairy and wheat farmers. Furthermore, the HFIAP indicator revealed that majority of pastoralist households experienced severe form of food insecurity contrary to smallholders, most of whom were food secure.

Poisson regression analysis revealed presence of association between food security and selected social, economic and demographic variables was statistically significant. These variables included household size, savings, borrowing for family needs, owning a bicycles, belonging to a farmer group, ability to own a solar panel and having electricity. Household size increased with increasing severity of food insecurity. Households with higher income levels, able to save money and belonging to a farmer group had a lower likelihood of experiencing food insecurity. Group

membership was particularly striking in the dairy value chain where most of the smallholders belonged to a dairy cooperative.

Multinomial regression analysis revealed that income, households that were capable of saving, number of household members, borrowing to meet family needs and access to credit facilities significantly determine household food security. Ownership of television, savings, size of the household and income were significant in determining severe food insecurity. Households that owned a television and had enough income to save were less likely to experience severe form of food insecurity.

CHAPTER 9. SUMMARY OF RESEARCH FINDINGS, CONCLUSION AND RECOMMENDATIONS

9.1 Introduction

This chapter presents a summary of the research findings, conclusion and recommendations based on the results of the specific objectives. The specific objectives of the study were 1) to examine the activities, actors and product flow in the wheat, dairy and beef value chains in North West Mt. Kenya; 2) to establish value added and its distribution among actors in the three agro-food value chains; 3) to assess the governance and constraints in the three agro-food value chains; and 4) to evaluate the status and determinants of household food security and poverty in the three agro-food value chains. The first objective was achieved by mapping the actors, activities and product flows in the value chains. The second objective was achieved through a quantitative analysis of the gross margins of each actor in the value chain. The third objective was achieved through an analysis of the governance structure and constraints in the value chains. Lastly, the fourth objective was achieved by using FGT Indices, HFIAS indicators and Regression Analysis.

9.2 Summary of Research Findings

9.2.1 Value chain activities, actors and product flows in the value chains

The study identified five main value chain activities that are linked to cause the flow of products (wheat, milk and beef) from production to consumption. These are; input supply and production, trade and transportation, processing, wholesale and retail. The primary actor in input supply across all value chain are the agrovets. This is more so for smallholder farmers and pastoralists since large-scale farmers can access agricultural inputs directly from agro-chemical companies. Agrovets are the most popular source of agriculture inputs such as seeds, fertilizer, chemical inputs, livestock feed and drugs. In addition, agrovets play an important role in providing advice to smallholder farmers. Other input suppliers include livestock and veterinary officers providing veterinary and artificial insemination services to smallholder farmers and pastoralists. The government through NCPB also acts an input supplier by providing subsidized fertilizer to smallholder wheat farmers.

Farmers are the primary actors at the production level of the agro-food value chains. They were categorized on method and scale of production. That is, small, medium and large-scale farmers

for wheat and dairy value chains and pastoralists and large-scale ranches in the beef value chain. For all agro-food value chains, the study considered small-scale and large-scale producers for analysis. Differences exist between large-scale and smallholder farmers across all value chains. In the wheat value chain, large-scale farmers are few, have mechanized farming operations and produce up to 3,000 tonnes of wheat on land averaging 3,900 acres per farmer. Conversely, smallholders are more in number, cultivating on average 10 acres of land. Unlike large-scale wheat farmers, most smallholders sold a large share of their harvested wheat through traders. In the dairy value chain, smallholders kept 5 cows while their large counterparts kept as many as 450 dairy cows, primarily of the Holstein Friesian breed. In the beef value chain, the average TLU for a pastoralist was 15 while that of large-scale ranches was 2,015. Majority of the pastoralists preferred keeping the zebu breed while large-scale ranches favored the Boran breed.

Traders are an important link between farmers and the markets in all three agro-food value chains. They move farm produce from the farm and livestock markets to processors in the formal marketing chains and to retailers and consumers in the informal value chains. Traders provide financial credit to smallholders. Moreover, they are an essential originators of information for the smallholder farmers. In the wheat value chain, traders were differentiated as either large or small, based on the volume of wheat purchased and transportation capacity. In addition to traders, dairy cooperatives play a trade and transportation role in the dairy value chain. They are involved in collecting, distributing and delivering raw milk from as many as a thousand smallholder dairy farmers to processors. Moreover, they boost farmers growth and productivity through provision of training, financial credit, and credit or subsidy on inputs and services. In the beef value chain, several secondary actors are involved in the trade and transportation of live cattle. They include brokers, transporters, officials of the livestock marketing cooperative society, county officials, veterinary and livestock officers. Brokers assist in the purchase negotiations in instances of language barrier or lack of trust between the two primary transacting parties. The county council owns the livestock markets while the livestock marketing cooperative society collects transactional fees and validates the transactions by issuing a receipt to transacting parties.

The processing stage of the three agro-food value chains involves fewer number of actors compared to other levels of the value chains. Extensive processing of wheat, milk and beef takes place in the formal marketing chain with private processors being the key actors. The informal

milk and beef marketing chains have minimal, if any, processing taking place. In the wheat value chain, processors obtain about a third of their wheat requirements locally, with the bulk being imported. Wheat millers convert wheat to various flour for different purposes while also generating by-products such as bran and pollard that are used as livestock feed. In the dairy value chain, processors, who are either government or privately owned, obtain all their milk requirements locally. Although raw milk is processed into various products, fresh milk constitutes the main product. In the beef value chain, slaughterhouses and abattoirs carry out processing of cattle. Majority of the slaughterhouses are government owned and engage is slaughter of livestock only. In addition to slaughtering, abattoirs grade and process meat into a variety of beef products.

Wholesale and distribution of products in the three value chains is the forte of distributors, wholesalers and retailers. However, distributors and wholesalers are part of the formal marketing chains and are largely absent in the informal marketing chains. In other words, they are involved in moving the processed products from the processors to the retailers. The difference between distributors and wholesalers lies in their capacity for distribution, determined by their capital ability. Distributors have a higher financial capacity to purchase and transport high volumes of food products compared to wholesalers. Distribution of processed products to retailers is also undertaken by the processors through their sales or marketing departments.

Retail points for the informal and formal marketing chains of the agro-value chains differ based on the end product. The end products of the informal marketing chain are sold raw or having undergone minimal processing while the end products of the formal marketing chain are processed. In the milk value chain, supermarkets, shops and kiosks constitute the main retail outlets for processed milk and milk products. On the other hand, milk bars, shops, kiosks, market stalls and restaurants retail unprocessed milk. Farmers also sell unprocessed milk to consumers. In the beef value chain, butcheries form the main retail points for non-graded and unprocessed beef. However, supermarkets and high-end butcheries stock various beef products including graded beef cuts. In the wheat value chain, supermarkets and shops stock different types of fine milled wheat flour. However, small-scale millers located in rural towns and shopping centres sell whole wheat flour.

9.2.2 Value addition and its distribution in the value chains

Value chain actors add value to the products as they are transferred along the chain from production to consumption. The value added is not equal among all actors; some add more value than others. Analysis of value addition revealed that factors such as yield, costs, revenue and prices determine how much value, a value chain actor obtains.

In the wheat value chain, large-scale farmers captured the highest value as measured by gross margins in the value chain followed by wheat millers, smallholder farmers, retailers, wholesalers and finally wheat traders. At the production level, large-scale wheat farmers obtained one and a half times more gross margin for every kilogram of wheat produced compared to smallholder farmers. Still there were wide variations in gross margins among the smallholder wheat farmers. Differences in yields, production costs and farm gate prices explain the differences in gross margins between smallholder and large-scale farmers and among smallholders too. The yield per acre for large-scale wheat farmers was almost double that of smallholder farmers. In addition, farm gate prices were relatively higher for large-scale farmers. Significant differences were also present in terms of production costs between the two wheat producers. Land preparation took the largest percentage of total production costs for the smallholders, whereas chemical cost was the largest cost component for the large-scale farmers.

In the dairy value chain, actors obtained different value in three different channels through which milk was marketed. In the informal milk value chain, the smallholder farmer obtained the largest share of value followed by the retailers then traders. In the formal milk marketing chain, large-scale dairy farmers obtained the highest gross margins followed by processors, smallholder dairy farmers, retailers and finally wholesalers. At the production level, similar to the wheat value chain, differences exist in yields, production costs and farm gate prices between the smallholders and large-scale farmers, accounting for the differences in gross margins. At the trade level, milk traders generated sufficient revenue to cover for their costs. There were wide variations of up to KShs 14 between the highest and lowest gross margins generated by milk traders. The differences can be explained by the variations in the buying and selling prices of milk, volume of milk collected/sold and the channel through which milk was sold. The gross margin accruing to milk processors was shared between the processors, distributors and retailers in the formal milk value chain.

In the beef value chain, gross margin estimates show that large-scale ranches attain the highest gross margin per kilogram of beef sold in the value chain followed by beef traders, processors, pastoralists and then retailers. However, pastoralists were grouped into two: those who procure pasture during the dry season and those having access to free pasture throughout. Pastoralists who incurred cost on pasture attained the least value in the beef value chain. Large-scale ranches had higher gross margins than pastoralists, due to their ability to keep production costs low while producing high quality beef cattle that fetches high prices. Quality differences in terms of weight and general body condition of the cattle contributed greatly to the difference in margins between the two categories of beef producers. Cattle from large-scale ranches weighed up to 100 kilograms more than cattle from pastoralists and were preferred by private beef processors.

While traders add value to beef cattle through slaughtering, processors add more value by grading and producing different beef products. However, traders had higher margins than processors perhaps due to lower costs of processing (slaughter). Moreover, traders attained better gross margins by supplying quality cattle to processors compared to supplying beef carcass to butcheries. In addition, beef traders received revenue not only from sale of beef carcass but also from the sale of other edible (offals, liver, head and legs) and non-edible saleable products (skin) of a cow. Sale of edible and non-edible saleable cow products was also identified as an important revenue stream for the private processors. Majority of the beef retailers (butcheries) add minimal value to beef as they sell beef on bone. However, they attributed low margins to wastage on account of shrinkage, fat and non-saleable bones.

9.2.3 Governance and constraints in the value chains

The governance structure of the agro-food value chains is greatly influenced by their marketing structure. All three agro-food value chains exhibit a dualistic marketing structure with both formal and informal components. The informality and formality of the value chains shape the linkages, relationships and power within them. The wheat and beef value chains exhibited weak vertical linkages which potentially hamper growth of the value chains. Vertically, actors are restricted to buy-sell relationships with each actor aiming at maximizing their benefits from the interactions. However, the high frequency of interaction amongst actors in the dairy value chain contributes to stronger vertical linkages. However, this only applies to the formal marketing chain. The informal marketing chain just like the informal beef and wheat value chains are

characterized by weak vertical linkages. However, mutual trust among actors in the informal value chains makes the transactions efficient. Horizontal integration amongst actors at the same level was strong among large-scale producers, smallholder dairy producers and wheat processors in the three value chains. On the other hand, traders and smallholder producers in the wheat and beef value chain had weak horizontal integration, while wholesale and retail levels of the value chains had near non-existent horizontal integration.

In the value chains, the nature of transactions among actors at the different levels of the value chains exhibited characteristics of both spot and persistent relations. However, spot relations were dominant due to widespread informality in the linkages between actors. Transactions between farmers, pastoralists and traders were mainly spot transactions, involving one off sell-buy transactions. Such transactions were based on trust and mutual agreements on supply, delivery, time and mode of payment. Aspects of persistent transactions were observed between traders, processors and wholesalers who engaged in repeat transactions as well as with some smallholder farmers who transacted with the same trader every season or day. Nevertheless, despite such persistent transactions, contractual arrangements were lacking between most actors. An exception to this were transactions between processors and other actors which were formalized through contracts. Such contracts enforced compliance with set rules, guidelines and standards.

The governance structure of the value chains revealed three power centres; large-scale producers, traders and processors. Subsequently, these actors have dominant roles in the value chains. Traders are uniquely dominant in the informal value chains, processors in the formal value chains and large-scale producers in both. Position and multiple roles in the value chains, level of concentration and access to key assets, ability to control prices, volumes, information, impose standards and command a high share of value makes these three actors dominant in the value chains. Dominance of large-scale producers is enabled by concentration and access to key production resources. Processors exercise their power in the value chains through pricing and quality standards. Their crucial role of transforming farm produce to processed products puts them in a key position to capture significant value. Processors tend to be few thus creating an oligopolistic market that gives them significant power in determining prices. Lastly, traders are key agents in the formal and informal marketing chains of the three agro-food value chains.

Their dominance is manifested through price determination, control of market information and distribution of large volumes of farm produce. Traders' multiple roles confers them with power in the value chains. The high dependence on traders by smallholder farmers affirms their dominance in the informal value chains.

Constraints in the value chains were identified at every level of the value chain. However, the production level seemed to have more constraints compared to other levels of the value chain. Smallholder producers and pastoralists identified several factors limiting their productivity. In the wheat value chain, the most pressing constraints to production identified by smallholder farmers related to insufficient and unpredictable rainfall, low and fluctuating prices, limited bargaining power, costly machinery services and inputs, unavailability of machinery, diseases and weeds. In the dairy value chain, insufficient and high cost of feed, inadequate water, low milk prices, unrealiable and expensive artificial insemination services and drought were the major concerns for smallholder dairy farmers. In the beef value chain, key constraints were drought and lack of water, invasive plant species, livestock diseases, attacks on livestock by wildlife and insecurity. Whereas some constraints were similar between the smallholder farmers, pastoralists and large-scale producers, there were disparities that seem to suggest that large-scale producers manage constraints to production better.

At the trade and transportation level, constraints mainly related to poor infrastructure, spoilage of produce, shortage of produce in the dry seasons and poor quality of produce from smallholder farmers. At the processing level, processors concerns related to high cost of electricity thereby increasing cost of processing, low quality of smallholder farmers produce and seasonal fluctuations in the local supply of produce. The major concern for wholesalers and retailers were seasonal fluctuations in the quality, quantity and price of products and perishability of milk and meat products. The constraints identified by actors both internal and external to the value chains need to be holistically addressed to boost the efficiency and productivity of the value chains. In addition, the constraints present opportunities for addressing specific actors or activities where more impact on improvements can be achieved in the value chains.

9.2.4 Household food Security and poverty status in the value chains

Analysis of social and economic characteristics of households in the wheat, dairy and beef value chains showed that pastoralists and smallholders combined several economic activities as an income diversification strategy. However, smallholders had more income sources from various economic activities compared to pastoralists. On the other hand, pastoralists had more (almost thrice) cattle than smallholder wheat and dairy farmers. Furthermore, pastoralists had the lowest daily income whereas smallholders in dairy farming had the highest. Half of the pastoralist and smallholder wheat and dairy farming households were in contact with government and non-governmental organizations and about half did not belong to a producer group.

Poverty analysis revealed that beef producing pastoralist households had the highest poverty rate while smallholder wheat households had the lowest. However, smallholder dairy and wheat farming households had the highest indicators of the relative size of income deficit per household relative to the poverty line The beef producing pastoralist households had the lowest mean income, while the smallholder dairy farming households had the highest. Although the mean income of the beef producing pastoralist households was lowest, they had the highest mean income and lowest mean income gap among their poor households. This explains why although their poverty share is the highest, the severity of poverty measure is the lowest. Households in the wheat, and those in both dairy and wheat value chains exhibit very high mean gaps among their poor. It would therefore take them more effort to bring their poor households at par with their group mean income than it would with the poor pastoralists.

The logistic regression model showed that the correlation between household poverty and the selected social, economic and demographic variables was statistically significant. Household size, income, borrowing to meet family needs, number of cattle, and belonging to farmer groups were significant in determining household poverty. Higher income levels and belonging to farmer groups decreased the likelihood of a household being poor. In addition, with increasing numbers of livestock, a household was less likely to be poor. Ownership of bicycle, mobile phone and television, distance to selling points, access to electricity and credit were not significant determinants of household poverty.

Similar to the results on household poverty analysis, pastoralist households were found to experience more food insecurity in comparison to smallholders. Majority of the pastoralist households fell under the maximum HFIAS score which implied that they experienced the most severe form of food insecurity. Whereas, majority of smallholder wheat and dairy households fell under the minimum score suggesting that they were food secure. In fact, the average HFIAS score for pastoralist households was six times more than that of smallholder dairy and wheat households. The same results were reflected in the HFIAP indicator, where majority of the pastoralist households fell under the severely food insecure category.

Poisson regression model showed that the association between food security and the selected social, economic and demographic variables were statistically significant. The model revealed that household size, savings, group membership, borrowing for household needs, access to energy and transport assets were important determinants of household food security. These variables suggested that higher incomes, savings, farmer group membership, access to transport and energy decreased the likelihood of a household being food insecure. The significance of these indicators for food security were confirmed by the multinomial model which showed that daily income, households that were capable of making savings, number of household members, borrowing to meet family needs and access to credit facilities significantly determine household food security. Ownership of television, savings and borrowing for domestic needs were important in determining severe food insecurity. Households that owned a television and had enough income to save were less likely to be severely food insecure. However, access to credit returned unexpected results for both the poisson and multinomial regression, implying that households with access to credit had a higher likelihood of being food insecure.

9.3 Conclusion

There are five value chain activities that are linked and through which wheat, milk and beef products flow and are transformed for final consumption. These are input supply and production, trade and transportation, processing, wholesale and retail. The actors involved in these value chain activities are input suppliers; farmers (smallholder, medium and large-scale farmers, pastoralists and large-scale ranches); traders and brokers; processors; distributors; wholesalers and retailers. The value added by each value chain actor as the products flow in each subsequent stage is not equal. The differences are determined by yields, costs, revenue and prices. Actors

such as large-scale farmers, ranches, processors and traders obtain higher margins in the value chains compared to other actors.

Governance of the value chains is shaped by the linkages, relationships and power. Value chain actors are connected through vertical and horizontal linkages. Vertical linkages exist in the form of buyer seller kind of relationships whereas horizontal linkages occur through associations and groups amongst same level actors. The wheat and beef value chains exhibit weak vertical linkages compared to the dairy value chain. Horizontal linkages tend to be strong at the production level among large-scale farmers and ranches in all value chains and among smallholder milk famers.

The nature of transactions among actors at the different levels of the value chains exhibit characteristics of both spot and persistent relations in the three agro-food value chains. However, even in cases of persistent transactions, contractual arrangements are largely absent. The marketing structure of the value chains, formal or informal, influence the governance structure of the three agro-food value chains. The formal value chain tends to operate under certain rules, regulations and standards, resulting in better co-ordination and integration, as well as high quality products compared to the informal marketing chains. The governance analysis revealed multiple power centers. The large-scale producers, traders and processors tend to be dominant in the agro-food value chains due to their position, multiple roles, level of concentration and access to key assets, ability to capture more value or ability to set prices.

Constraints to value chain efficiency and growth exist at every level of the value chains. Smallholder producers and pastoralists seem to face multiple constraints than other actors. In addition, they have less capability to tackle the challenges they face compared to their larger counterparts. Whereas some constraints to smallholder and large-scale farmers seemed similar in nature, others were unique to each production system. In all agro-food value chains, wholesalers and retailers seem to have fewer constraints.

Poverty analysis showed that pastoralists have a higher poverty rate compared to smallholder wheat and dairy farmers. A household's poverty status was largely determined by the household size, income, borrowing, number of cattle and membership to farmer groups. Similarly, food security analysis showed that pastoralists experience more food insecurity in comparison to

smallholder wheat and dairy farmers. Important factors determining household food security included household size, income, transport assets, belonging to a farmer group and access to energy.

9.4 Recommendations

This study proposes several recommendations for policy makers and for future research. The policy recommendations aim at easing constraints in the value chains, improving value chain efficiency, increasing actor's productivity and value, improving food security and reducing poverty. Recommendations for policy makers are presented for each value chain.

9.4.1 For policy makers

Wheat value chain

At the production level, we recommend:

1) Supporting smallholders to establish strong producer groups in order to improve their trading power, access to affordable inputs, machinery, credit and training.
2) Strategies that aim at providing farmers with water for irrigation have the possibility of improving farmers' productivity and reducing over reliance on rain-fed production.
3) Encourage agricultural practices that not only boost soil productivity and water preservation, but also improve farmers' response to climate change.
4) Innovate credit products that are affordable and suit the unique needs of smallholders, and with less prohibiting factors of collateral and interest rates.
5) Developing high yielding wheat breeds that have resistance to local diseases, environmental stress and weeds.
6) Strengthening extension services to provide more efficient services in terms of training and knowledge transfer as well as attain broader coverage and frequent interactions with smallholder farmers.
7) Review the government fertilizer subsidy program with the aim of addressing the numerous inefficiencies that impede access to fertilizers. In addition, the program should consider provision of subsidized chemical inputs.

At the trade and transportation level, we recommend:

1) Improvement in road infrastructure to enhance movement and distribution of farm produce.

2) Encourage perfect competition with the view of improving farm gate prices for the smallholder farmers.
3) Harmonize inter-county fees and levies to avoid duplication of charges and for ease of trade and transportation across counties.

At the processing level:

1) Encourage vertical integration of the millers with smallholder farmers for improved flow of market information, direct market linkages and participation in pricing.

Milk Value Chain

At the production level, we recommend:

1) Provision of subsidies on livestock feed concentrates with the aim of reducing cost of feeds.
2) Provide training and support to farmers to enable them produce high quality livestock feeds with the view of maintaining production quality and quantity consistency throughout the year.
3) Strengthening government extension and veterinary services to provide efficient artificial insemination services, livestock treatment and vaccination as well as achieve wider coverage and frequent interactions with smallholder dairy farmers.
4) Allocating more resources to the research and development of high-quality dairy breeds that are affordable to the farmers.

At the trade and transportation level, we recommend:

1) Improvement in the road infrastructure to enhance movement and distribution of milk.
2) Investment in the expansion of the cold chain distribution to maintain quality of product.
3) Provision of training and financial support to milk traders to enable compliance with milk transport and distribution safety regulations.
4) Review the role of the regulatory authority to a more supportive role with the view of improving the strained relations with traders and creating a better trading environment.
5) Encourage milk testing and quality control through provision of simple and affordable milk testing equipment.

At the processing level, we recommend:

1) Strengthening the farmers' dairy cooperatives to engage in storage, cooling and processing of raw milk to improve the value obtained by smallholder farmers.
2) Increased involvement and representation of farmer cooperatives in processor's pricing decisions.
3) Competitive milk pricing by processors to encourage growth of the formal milk value chain.

Beef Value Chain

At production level, we recommend:

1) Support in training and rangeland management programmes that encourage optimal use of pasture and management of invasive plants.
2) Develop government and private partnerships that improve delivery of veterinary and extension services, extensive vaccination programmes and affordable livestock feed and supplements.
3) Encourage inter-community meetings and activities that promote conflict management and peace building with a view of minimizing raids.
4) Create strong pastoralists associations or groups to enhance the power of negotiation, access to affordable credit, training and linkages to high-end markets.
5) Create or enhance programmes that encourage pastoralists to fatten cattle before sale.

At the trade and transport level, we recommend:

1) Strengthening government and non-government livestock off-take programmes to cushion pastoralists against livestock losses from weather extremities.
2) Improving the livestock market infrastructure to ensure proper loading ramps and cattle holding pens.
3) Encourage use of weighing scales for determination of fair market prices.
4) Upgrading the road infrastructure to enhance transportation of cattle.
5) Harmonization of inter-county fees and charges to avoid duplication across county boundaries.
6) Strengthen livestock extension services to provide wider coverage, extensive vaccination programmes and control of livestock diseases and pests.

At the processing level, we recommend:

1) Upgrading the infrastructure at the slaughterhouses to offer more efficient services and increase the ability to process more beef products.
2) Support and encourage pastoralists groups to engage in processing beef and cold chain distribution in order to attain more value and possibly penetrate local and international niche markets.

Generally, smallholder farmers and pastoralists seem the most challenged actors. They obtain the least value in comparison to other actors, have weak associations, minimal market power, and their participation in the value chains seem more constrained. This study has built a case for more support to this category of actors in order to achieve increased productivity, better incomes, and to meet the current and future food demands. However, based on the food security and poverty analysis more focus should be directed to the pastoralists where impact from intervention is likely to greater.

The importance of income as a determining factor of household poverty and food security indicates that improving farmers' income can have an enormous effect on reducing poverty and food insecurity. The recommendations put forward by this study have the prospect of improving food security and reducing poverty by enhancing production and revenue. All the same, other factors such as household size, social capital and access to household energy, that are important in explaining the variations and vulnerability of different households to food insecurity should be considered while designing interventions and policies.

9.4.2 For future research

This study suggests the following areas for further research:

- Innovative programmes that enhance farmers' associations.
- The role and potential of value chain supporting actors such as the financial sector.
- Medium-scale farmers in the agro-food value chains.
- Financial models that support provision of capital and credit to smallholder farmers and pastoralists.
- In-depth analysis of the governance structures and how they shapes the value chains.

- Use of panel data on the agro-food value chains analysis to account for seasonality of production.
- Research on household food security and poverty of workers in the trade and transportation, processing, wholesale and retail level of the value chains.
- By-product value chains of the wheat and sub-value chains of milk and beef value chains.

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APPENDICES

Appendix A1. Sampling of pastoralist community ranches and households

Community group ranch	Estimated number of households	Targeted sample size	Number analyzed
Ilpolei*	265	10	9
Munishoi*	265	10	10
Musul*	300	10	11
Kijabe*	400	15	14
Tiamamut	250		
Koija	400		
Ilmotiok	400		
Nkiloriti	150		
Murupusi	400		
Makurian*	400	15	14
Kurikuri*	200	10	9
Lekuruki	150		
Ilgwesi	400		

*Sampled community group ranches

Appendix A2. Cost components of wheat production

Cost components (per acre)
Land Preparation costs
1st Plough
2nd Plough
1st Harrow
2nd Harrow
(+ broadcasting where applicable)
Planter Hire
Seed costs
Seed rate*cost per unit
Seed transport
Fertilizer costs
Fertilizer rate*cost per unit
Fertilizer cost
Chemical costs
Herbicide (Application rate*cost per unit)
Fungicide (Application rate*cost per unit)
Foliar feed (Application rate*cost per unit)
Insecticide (Application rate*cost per unit)
Harvesting costs
Harvester hire
Other harvesting costs (gunny bags, stitching, loading)
Labour costs

Spraying	
Handling to store	
Handling to market	
Other labour costs (e.g weeding)	
Total costs	

Appendix A3. Case study 1 of cost calculations for a smallholder dairy farmer

Cost component	**Price per unit (KShs)**	**Consumption per month (3 cows)**	**Cost of consumed quantity (3 cows per month KShs)**
Fodder (Hay)	120 for 1 bail	13bails	1,560
Dairy Meal	2,600 for 70kg	93kg	3,467
Mineral salts	1300 for 5kg	5kg	1,300
Deworming	800 for 500mls	37mls	59
Spraying	170 for 25mls	45mls	1,12.5
Labour			4,580
TOTAL			11,078.5
Cost per day (3 cows)			369
Cost per day (2 cows)			246
Output (Litres per day, 2 cows)			26
Cost of producing 1L			9.5

Notes: Farmer has total of 3 cows, milking 2

Appendix A4. Case study 2 of cost calculations for a smallholder dairy farmer

Cost component	**Price per unit (KShs)**	**Consumption per month (2 cows)**	**Cost of consumed quantity (2 cows per month KShs)**
Fodder (hay)	180 for 1 bail	35bails	6,300
Dairy Meal	2,100 for 70kg	93kg	2,800
Mineral salts	250 for 1kg	800g	200
Supplements - Canola cake	860 for 20kgs	27kg	1,147
Supplements - Bran	1,000 for 70kgs	93kg	1,333
Deworming	220 for 100mls	67mls	147
Spraying	170 for 25mls	50mls	340
Labour			4,580
TOTAL			16,847
Cost per day			562
Output (litres per day, 2 cows)			34
Cost of producing 1 litre			16.5

Notes: Farmer has 2 cows, milking 2

Appendix A5. Food Insecurity Experience Scale

In the past three months,	**No=0 Yes= 1 DK*= 3 DA**=4**	**If yes, how often did this happen 1 = Once per month 2 = More than once per month**	**Domains of the food insecurity construct**	**Assumed severity of food security**
1 Did you worry that your household would not have enough food due to lack of money or other resources?			Uncertainty and worry about food	Mild
2 Did your household lack food due to lack of money or other resources?			Insufficient food quantity	Moderate
3 Did your household not eat healthy food due to lack of money or other resources?			Inadequate food quality	Mild
4 Did you or any household member eat a low diversity of foods due to lack of resources to obtain other types of food?			Inadequate food quality	Mild
5 Did you or any household member skip breakfast, lunch or dinner because there was not enough food, lack of money or other resources?			Insufficient food quantity	Moderate
6 Did you or any other household member eat less than he/she should because there was not enough food, lack of money or other resources?			Insufficient food quantity	Moderate
7 Did you or any household member feel hungry but did not eat because of lack of food, money or other resources?			Insufficient food quantity	Severe
8 Did you or any household member eat only once a day or go a whole day without eating anything because there was not enough food, lack of money or other resources?			Insufficient food quantity	Severe

Source: Adopted from Ballard et al., (2013); and Coates et al. (2007)
Notes: *DK – Don't Know, **DA – Didn't Answer

Appendix A6. List of variables for the determinants of poverty and food insecurity models

Variable	**Definition and measurement**
vc_type	Value chain type (1 =beef, 2=dairy, 3=wheat, 4=wheat & dairy)
no_cattle	Number of cattle
dist_sellingpoint	Distance to the selling point (km)
access_extservices_yesno	Access to extension services (1=yes, 0=otherwise)
membership_org	Membership to farmers group (1=yes, 0=otherwise)
contact_ngos	Contact with Non-governmental organizations (1=yes, 0=otherwise)
contact_government	Contact with Government (1=yes, 0=otherwise)
share_equipmentstools	Sharing equipment and tools (1=yes, 0=otherwise)

share_knowledge	Sharing knowledge (1=yes, 0=otherwise)
access_credit_yesno	Access to financial credit (1=yes, 0=otherwise)
daily_income	Daily Income (KES)
income_diversity	Number of Income streams
no_hhmembers	Number of household members
access_electricity	Access to electricity (1=yes, 0=otherwise)
enough_income2save	Enough Income to make a saving (1=yes, 0=otherwise)
borrowto_meet_family_needs	Does household borrow to meet needs (1=yes, 0=otherwise)
own_solarpanel	Own solar panel (1=yes, 0=otherwise)
own_mobilephone	Own mobile phone (1=yes, 0=otherwise)
own_bicycle	Own bicycle (1=yes, 0=otherwise)
own_motorcycle	Own motorcycle (1=yes, 0=otherwise)
own_television	Own television (1=yes, 0=otherwise)
poor	Poor or not (1=poor, 0=otherwise)
HFIASscore	Food Insecurity score (range 0 - 16)
hfia_categories	Food Insecurity categories (1=food secure, 2=mildly food insecure, 3=moderately food insecure, 4=severely food insecure)

Appendix A7. Case study of cost calculations for a large-scale dairy farmer

Cost component	**Price (KShs)**	**Consumption**	**Daily cost of consumed quantity (KShs)**
Fodder (silage)	2.040 for 3600kg	780kg per day	442
Dairy Meal	2,300 for 70kg	156kg per day	5.125
Mineral salts	2.700 for 20kg	1.040g per day	1.40.4
Deworming[3]			115
Spraying	1400 for 1L	142ml per month	6.6
Labour[4]			568
TOTAL cost per day			6.397
Output (litres per day)			550
Cost of producing 1 litre			11.6

Notes: [1]Farmer has total of 61 cows, milking 26 cows
[2]Cost calculation for 26 milking cows. Each fed on 30kg silage, 6kg dairy meal, 40g salt
[3] Kshs 400 for 1 cow, quarterly
[4]5 Workers caring for 61 cows paid approximately KShs 40,000 per month

Appendix A8. Gross margin and cost calculations for a milk trader

	Trader1	**Trader2**	**Trader3**
Revenue			
Sale of milk (Litres in a day)	250L (sold to different customers: 133,10, 12, 95)	80	150
Price per litre (KShs)	145L @ KShs 45, 10L @ KShs 60, 95L @ KShs 50	50	50

Total sale	11,875	4,000	7,500
Costs (KShs)			
Milk purchase (litres)	250	80	150
Price per litre	30	35	35
Total milk cost	7500	2800	5,250
Other expenses			
Transport	540	300	300
Movement permit	4.4	4.4	4.4
Medical certificate			1.6
Casual labour			166.7
Total expenditure	8,044.40	3,104.4	5,722.7
Gross margin	3,831	895.6	1777
Gross margin per litre	15.3	11.2	11.85

Appendix A9. Questionnaire for input suppliers in the wheat value chain

QUESTIONNAIRE – Input suppliers wheat		
This questionnaire is part of research being carried out on the Wheat Value Chain in North West Mt. Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated	Date of interview	
	Name of interviewer	
	Business name of supplier	
	Physical location	
	Name and position of interviewee	
	Contact details	

1. How long have you been engaged in this business?

2. Business ownership?

3. Wheat inputs sold

Category of Input	Name	Source company	Application rate per acre	Cost per unit (current)	Price last year
Seed					
Fertilizer					
Herbicide					
Fungicide					
Insecticide					
Foliar Feed					

(If supplier of seed, indicate if treated or not)

4. Are any of the inputs you supply subsidized in price?
   (If yes, state which and by how much)

5. Do you have any form of training regarding the inputs you sell?
   (If yes, state last training received, when, by whom)

6. What kind of advice do wheat farmers ask for at your agro vet?

7. Is it free or chargeable?

8. How far do the farmers whom you serve travel?

9. Are you involved in any other activity in the wheat value chain except supplying inputs?

10. Are you part of any organization in the wheat supply chain?
(If yes, name and purpose of organization)

11. Are there challenges you face as an input supplier?

12. What are some of the challenges that you have identified facing wheat farmers in this area?

13. What would you suggest to solve the challenges stated in No. 12 above?

Appendix A10. Questionnaire for wheat producers

QUESTIONNAIRE – Wheat Producer (Farmer)		
This questionnaire is part of research being carried out on the Wheat Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date	
	Sub location	
	Name of Interviewer	
	Name of respondent	
	Contact details	

1. GENERAL INFORMATION

For small and medium scale farmers - Position in household *(Male, Female, Daughter, Son ,Others___ specify)* ***For large scale farmers*** - Position in farm	Level of Education *(Postgraduate, graduate, secondary, Primary)*	Main activity in the Value chain	Other activities in the value chain (*trader, broker, retailer, provider of credit, trainer of farmers etc)*

1b.if engaging in more than one value chain activity in the past 5 years, reason?

2. LAND SIZE, TENURE

Land size *(acres)*		Land ownership *(Owned, Hired)*	If owned, how was it acquired *(Purchased, Inherited, Others__(state)*	No. of livestock		
				Q. How have you divided your land amongst various land use activities (*specify each in acres*)	Wheat	
No. of years in wheat production						
		Hire *(Indicate rent per acre)*				
Change in land size	Increase – *state what*			Change in productive land	*Reason*	

in last 5 years	*made it possible*		under wheat cultivation (*Increase/decrease*)	
	Decrease-*reason*			

ii. What determines allocation of land to different activities?

3. OUTPUT (per acre)

Total no. of 90 kg bags harvested	Output per acre	No. of acres harvested	Seasons per year	Buyer (*Broker, Miller, others_ specify*)	Price per bag	Distance to point of sale (*in km*)	Form in which it is sold *Grain, Flour, others (specify)*

Amount retained	Form in which it is retained *(Grain, flour, others-specify)*	Reason for retention (*Seed, Others _ specify)*	Who mills the retained grain for consumption

Amount purchased other than own production	No. of bags purchased	Price per bag	From whom	Form in which it is purchased (G*rain, Flour, Others - specify)*	Reason for purchase

4. INPUTS

Type of input	Name	Source	Distance to source
Seed			
Fertilizer			
Chemicals: Herbicide			
Fungicide			
Insecticide			
Foliar feed			
Others:			

5. COSTS (per acre)

6a. Labour		6b. Land preparation costs		6c. Seed costs		6d. Fertilizer costs		6e. Chemical Spray	1st	2nd
Spraying		1st Plough		Seed type		Fertilizer type		i)Herbicide: Type		
		2nd Plough		Seed rate (kg/acre)		Fertilizer rate (kg/acre)		Rate (lt/acre)		
Handling to store		1st Harrow		Seed cost (kg)		Fert. Price per 50kg bag		Cost/Unit		
Handling to		2nd Harrow		Seed transport		Fert. transport		ii)Fungicide: Type		

market						per bag				
Other labour costs (*specify*)		Planter hire /ox-plough/seed row						Rate (lt/acre)		
		Other costs (specify)		Other seed costs (*specify*)				Cost/Unit		
Method of spraying *1=hand spray 2= tractor 3=aerial spray*			6f. Harvesting costs					iii)Foliar feed: Type		
			Harvester hire (kes/acre)					Rate (lt/acre)		
			Other harvesting costs					Cost/Unit		
								iv)Insecticide: Type		
								Rate (lt/acre)		
								Cost/Unit		
Other costs not captured above										
Total costs (per acre)										
Working capital										

6. Are you aware of miller's wheat preferences?

7. Does it influence what you grow?

8. What other factors inform the wheat variety you grow?

9. Do you employ workers?

(If yes, fill in table below)

No. of workers	Gender	Pay (in range)	Terms (permanent, temporary, casuals)

10. INFORMATION AND KNOWLEDGE

Source of information regarding :	
Inputs to use	
Where to sell	
New wheat varieties	

11. INSTITUTIONAL SUPPORT AND TRAINING

Institution (*Government, others_ name*)	Support/service received (*e.g training, subsidies, extension services*)	Period services received	*Level of satisfaction				
			5	4	3	2	1

**5- very high, 4-high, 3-medium, 2- low, 1-very low*

ii. Are you a member of any farmer organization or cooperative?
(*If yes, state purpose and benefits received*)

iii. Are you in contact with NGO's, projects or governments services who help to develop economic activities?

iv. Do you share equipment, tools, labour or knowledge with other community members or family members?

v. Do you participate in decision making regarding land, water, infrastructure and food in your community or working environment

12. ACCESS TO CREDIT

Provider	No. of disbursements in the last 1 year	Amount	Conditions (*Collateral, interest, period, others*)	Factors that facilitated access (*Government, NGO, Co-operative, others*)

ii. Any challenges in accessing credit?

13. STORAGE FACILITIES

Do you have any storage facilities? (*Yes/No*)	Capacity	How long do you store the wheat?	What determines the storage period? (*market conditions etc*)

14. MACHINERY, EQUIPMENT AND TOOLS

Machinery, equipment and tools	Number	Owned or hired	Year purchased	Cost	Means of acquisition (*credit, co-operative, inheritance, savings, sale of xx crops/inheritance*)

15. INCOME (***monthly***)
Are you engaged in other economic activities apart from farming?
(*If yes, specify*)

Sources of Income	Amount	% contribution to total income
Pension		
Cash transfer		
Wheat		

16. How much time do you spend in activities related to wheat production?

17. What would be the alternate crop to wheat growing? Why?

18. What are the challenges you encounter as a wheat farmer?

19. What possible solutions or interventions would you suggest that would improve wheat farming?

20. In what ways do you relate with small/large scale farmers?

Other food security related questions (for small scale farmers)

Household members (Indicate marital status)	Age (years in range of 5)

21. HOUSEHOLD EXPENDITURE (Monthly)

i. What is your total monthly expenditure?

Housing Component	Amount
Food	
Education	
Clothes	
Rent	
Health	
Electricity*	
Water*	
Domestic labour	
Cash transfers	
Entertainment	

* Indicate if household has access to electricity, drinking water in house, and water for irrigation

iii. What is you most important source of income contributing to offsetting the above mentioned costs?

iv. Do you have enough income to save money?

v. Do you sometimes have to borrow to meet the needs of your family?

22. OWNERSHIP OF CONSUMER GOODS AND ASSETS

i. Do you own the following goods?

Item	Yes/No	Importance source of funds used for buying good (savings, sale of xx crop, sale of livestock, others)
Solar Panel		
Mobile phone		
Bicycle		
Motorcycle		
Television		
Radio		
Truck/ lorry, pick up or other cars		
Refrigerator		
Furniture		

ii. Indicate materials used for the following housing components; wall, floor and roofing

23. FOOD SECURITY ASSESSMENT

In the past three months,	No =0 Yes= 1 DK= 3 DA=4	If yes, how often did this happen 1 = *Once per month* *2 = More than once per month*	Reason
1 Did you worry that your household would not have enough food due to lack of money or other resources?			
2 Did your household lack food due to lack of money or other resources?			
3 Did your household not eat healthy due to lack of money or other resources?			
4 Did you or any household member eat a low diversity of foods due to lack of resources to obtain			

other types of food?			
5 Did you or any household member skip breakfast, lunch or dinner because there was not enough food, lack of money or other resources?			
6 Did you or any other household member eat less than he/she should because there was not enough food, lack of money or other resources?			
7 Did you or any household member feel hungry because he/she did not eat due to lack of food, money or other resources?			
8 Did you or any household member eat only once a day or go a whole day without eating anything because there was not enough food, lack of money or other resources?			

Do you recall episodes of not enough food (skipping breakfast, lunch or dinner) in the last 1 or 3 years?

Appendix A11. Questionnaire for wheat traders

Questionnaire – Wheat traders		
This questionnaire is part of research being carried out on the Wheat Value Chain in North West Mt. Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated	Date of interview	
	Name of interviewer	
	Name of trader	
	Physical location	
	Contact details	

1. How long have you been engaged in this business?

2. Where (area) do you source wheat from?

3. Who supplies you with wheat (*small scale, large scale farmers, other traders*)? (*Indicate percentage supplied by each*)

4. Which wheat varieties did you buy last season?

5. Do you have a preference for any variety and why?

6. What determines the wheat you buy?

7. How much do you buy and sell in a day or a season?

8. At what price did you buy the wheat last season?

9. At what price did you sell the wheat last season?

10. Where did you sell the wheat?

11. Do you have any supply arrangements with the buyer(s)/miller(s)?

12. What means of transport did you use to transport the wheat?

13. What was the capacity of the motor vehicle used?

14. Was it owned or hired

15. If hired, what were the terms of hire?

16. Do you transport the wheat to the buyer immediately after buying or do you sometimes store?

17. If you store, what is your storage capacity?

18. For how long do you store the wheat?

19. What determines the storage period?

20. How long (*hours, days*) does it take to transport wheat from the point of purchase to delivery? (*Indicate the point of purchase and delivery*)

21. In what form do you transport the wheat? (*Grain, flour, others_ specify*)

22. Are there any losses incurred from the point of purchase to the point of sale?

23. What informs your decision on whom to buy the wheat from?

24. What informs your decision on whom to sell the wheat to?

25. What costs did you incur from the point of purchase to delivery (*transport costs, taxes/fees, cess, etc*)?

26. How many employees do you engage in a season and what are the terms of engagement?

27. Are you involved in any other activity in the wheat value chain?

28. Are you involved as a trader in any other agricultural value chain?

29. Are you part of any organization in the wheat supply chain? *(If yes, name and purpose of organization)*

30. Are there other institutions that support you as a trader?

31. Do you purchase the wheat on credit? Or do you access credit facilities to enable you purchase wheat as a trader?

32. What are the challenges you face as a trader?

Appendix A12. Questionnaire for wheat millers

QUESTIONNAIRE – Wheat Miller		
This questionnaire is part of research being carried out on the Wheat Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated	Date of Interview	
	Name of Interviewer	
	Name of Miller:	
	Physical location of Miller	
	Name of respondent:	
	Position in Org.:	
	Contact: Telephone/email address	

1. BUSINESS EXISTENCE AND CAPACITY
   a. How many years has your business been in existence?

   b. Who owns the business?

   c. What is your installed capacity?

   d. Are you operating at your installed capacity?
   (*If, NOT, why?)*

   e. Has your installed capacity changed in the last 5 years?
   (*If yes, what was the reason for the change?)*

   f. What was your daily average amount of wheat processed in the last 6 months?

Average amount of wheat processed daily in the past 6 months					
Sep	Oct	Nov	Dec 2016	Jan	Feb

2. SOURCE OF WHEAT

Source	Area/Country sourced from	% local to Imported wheat	Wheat variety/type	Price per unit
Local				
Imported				

b. Who are your suppliers? (*small, medium or large scale farmers, traders/brokers*)
If a combination, what percentage is supplied by each?

c. Do you have any arrangements with your suppliers?

d. Do you have preference for any wheat variety?
If yes, why?

3. PRODUCTS

Name of product	Amount /no. of units produced (***per day***)	Percentage of wheat that goes into making the product	Storage life (***Months***)	Price (***per unit***)	Market (whom do you sell to)	If more than one buyer, state percentage to each
State, by products if any						

i. Any of the products introduced in the last three years?

ii. Any improvements made in the quality of the products in the last 3 years

4. Are there any losses incurred while milling?
   (*State nature and extent of loss*)

5. What informs your decision on:
   i. Whom to buy the wheat from?

   ii. Where to sell your product?

   iii. Price of your product?

   iv. Type of product to sell?

   v. Are you aware of consumer wheat preferences?

6. How do you transport your products to retail points?

7. COSTS (per ton)
   What costs do you incur?

Wheat Grain		Labour costs	
Electricity		Depreciation	
Fuel		Water	
Additional materials		Other costs	

8. LABOUR

Nature of employment (casual, contract, temporary, permanent)	No. of employees	Gender	Wage (*can be stated in income categories*)

9. Are you involved in any other activity in the wheat value chain?
   (If yes, specify)

10. Are you part of any miller's organization?
    (If yes, name and purpose of organization)

11. Do you receive any support from the government or other non-governmental organizations as a miller? *(If yes, specify)*

12. Do you have access to credit facilities as a miller?
    (*If yes, state nature of facility. If No, state challenges)*

13. i. What is your storage capacity?

    ii. How long do you store the wheat grain before milling?

    iii. What determines the storage period?

14. What are the safety measure you take to ensure that your products are safe for consumption?

15. Are there challenges you face as a wheat miller?

16. What would you suggest to solve the challenges stated?

Appendix A13. Questionnaire for wheat retailers

QUESTIONNAIRE – Wheat retailers		
This questionnaire is part of research being carried out on the Wheat Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date of interview	
	Name of interviewer	
	Name of retail outlet	
	Type of retail outlet	
	Physical location	
	Name of respondent	
	Position of respondent	
	Contact	

1. How long has your business been in operation?

2. Wheat products on sale

Product type	Supplier	Brand name	Package quantity	Vol. sold in a day	Buying price	How often do you restock	Product shelf life	Sale price (in the last 6 months)				
								Feb 17	Jan 17	Dec 16	Nov 16	Oct 16

**check for physical availability of products*

3. Are any of the products above subsidized in price?

4. Do you incur transport costs to bring the products to the shop?

5. Are there other costs?

6. What determines the wheat products you stock?

7. Is the supply of wheat products consistent throughout the year?

8. Do you have any sale agreements/arrangements with the supplier?
(*If yes, state nature of arrangement)*

9. Who are your customers?

10. From how far do they come from?

11. Do you have any employees?
(*If yes, fill in table*)

No. of workers	Nature of employment	Wages paid (*daily or monthly rate*)

12. Are you involved in any other activity in the wheat value chain?
(If yes, specify)

13. Are you part of any organization in the wheat supply chain?
(If yes, state name and purpose of organization)

14. Do you receive any support from the government or other institutions as a retailer of wheat?
(If yes, specify)

15. Do you have access to credit facilities (loans, payment of goods at a later date) as a retailer?
(*If yes, state nature of facility. If No, state challenges*)

16. What are the challenges you face as a retailer?

17. What would you suggest to solve the challenges stated?

Appendix A14. Questionnaire for input supplier dairy value chain

Questionnaire – Input suppliers dairy		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt. Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated	Date of interview	
	Name of interviewer	
	Business name of supplier	
	Physical location	
	Name and position of interviewee	
	Contact details	

1. How long have you been engaged in this business?

2. Business ownership?

3. Dairy inputs sold

Category of Input	Name	Source company	Cost per unit (current)	Price last year
Feed				
Supplements and salts				

4. Are any of the inputs you supply subsidized in price?
(If yes, state which and by how much)

5. Do you provide veterinary services
(*If yes, at what cost)*

6. Do you provide Artificial Insemination (A.I) services
(*If yes, at what cost)*

7. Do you have any form of training regarding the inputs/services you sell?
(If yes, state last training received, when, by whom)

8. What kind of advice do dairy farmers ask for at your agro vet?

9. Is it free or chargeable?

10. How far do the farmers whom you serve travel?

11. Are you involved in any other activity in the dairy value chain except supplying inputs?

12. Are you part of any organization in the dairy supply chain?
(If yes, name and purpose of organization)

13. Are there challenges you face as an input supplier?

14. What are some of the challenges that you have identified facing dairy farmers in this area?

15. What would you suggest to solve the challenges stated in No. 12 above?

Appendix A15. Questionnaire for dairy producers

QUESTIONNAIRE – Dairy Producer (Farmer)		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date	
	Sub location	
	Name of Interviewer	
	Name of respondent	
	Contact details	

1. GENERAL INFORMATION

For small and medium scale farmers - Position in household *(Male, Female, Daughter, Son ,Others___ specify)* ***For large scale farmers -*** Position in farm	Level of Education *(Postgraduate, graduate, secondary, Primary)*	Main activity in the Value chain	Other activities in the value chain (*trader, broker, retailer, provider of credit, trainer of farmers etc)*

2. How many dairy cattle do you have on the farm and what are the breeds?

Breed	Total Number	No. being milked	No. not being milked	Reason for not milking

3. OUTPUT/PRODUCTION

Time of milking in a day	Quantity	Amount sold	Amount retained	Reason for retention	Price per litre	Whom do you sell the milk to?

4. Do you transport the milk or is it collected at the farm?
(*If transported, fill table below)*

Means of transport	Distance to point of sale	Transport costs

5. Do you process any milk on the farm?
(*If yes fill in table below*)

Amount of milk processed	Product	Price per unit	Buyer (sold to)

6. Do you employ any workers on the farm?
(*If yes, fill in table*)

No. of workers	Nature of employment	Wages paid (*daily or monthly rate*)

7. COSTS (per head)

Type of feed (daily) And supplements	Source of feed and supplements	Cost of feed and supplements	Distance to source of feed and supplements *(km)*
Veterinary costs (vaccinations, medications, deworming, dipping			Cost

8. Who provides you with artificial insemination (A.I) services?

9. How much time do you spend in activities related to dairy production?

10. What would be your alternate economic activity to dairy production? Why?

11. Are you a member of any farmer's organization or cooperative?
(*If yes, state name and purpose of organization*)

12. Have you received any form of training in dairy production?
(*If yes, state when and by whom*)

13. Are there any other institutions that support you as a dairy producer?
(*If yes, fill in table below*)

Institution *(Government, others-name)*	**Support/service received** **(***e.g training services, subsidies, extension services)*	Period services received	*Level of satisfaction				
			5	4	3	2	1

**5-very high, 4-high, 3-medium, 2-low, 1-very low*

ii. Are you in contact with NGO's, projects or government services who help to develop economic activities?

iii. Do you share equipment, tools, labour or knowledge with other community or family members?

iv. Do you participate in decision making regarding land, water, infrastructure and food in your community or working environment?

14. Do you have access to credit facilities?
(*If yes, fill in table below)*

Provider	No. of disbursements in last 1 year	Amount	Conditions *(collateral, interest, period, others*)	Factors that facilitated access (*government, NGO, cooperative, others)*

ii. If No, are there challenges or factors that hinder your access to credit?

15. What are the challenges you encounter as a dairy producer?

16. What possible solutions or interventions would you suggest to the challenges you have stated?

17. In what ways do you relate with small/large scale farmers?

18. INCOME *(Monthly)*
Are you engaged in other economic activities apart from farming?
(If yes, specify)

Sources of Income	Amount	% contribution to total Income
Pension		
Cash transfers		
Dairy farming		

Other food security related questions (for small scale farmers)

Household members (indicate marital status)	Age (in range of 5 years)

19. HOUSEHOLD EXPENDITURE (Monthly)

i. What is your total monthly expenditure?

Housing Component	Amount
Food	
Education	
Clothes	
Rent	
Health	
Electricity*	
Water*	
Domestic labour	
Cash transfers	
Entertainment	

*Indicate if household has access to electricity, drinking water in house, and water for irrigation

ii. What is you most important source of income contributing to offsetting the above mentioned costs?

iii. Do you have enough income to save money?

iv. Do you sometimes have to borrow to meet the needs of your family or economic activities?

20. OWNERSHIP OF CONSUMER GOODS AND ASSETS

i. Do you own the following goods?

Item	Yes/No	Importance source of funds used for buying good (savings, sale of xx crop, sale of livestock, others)
Solar Panel		
Mobile phone		
Bicycle		
Motorcycle		
Television		
Radio		
Truck/Lorry/Pickup		
Refrigerator		
Furniture		

ii. Indicate materials use for the following housing components; wall, floor and roofing

21. FOOD SECURITY ASSESSMENT

In the past three months,	No =0 Yes= 1 DK= 3 DA=4	If yes, how often did this happen *1 = Once per month* *2 = More than once per month*	Reason
Did you worry that your household would not have enough food due to lack of money or other resources?			

Did your household lack food due to lack of money or other resources?			
Did your household not eat healthy due to lack of money or other resources?			
Did you or any household member eat a low diversity of foods due to lack of resources to obtain other types of food?			
Did you or any household member skip breakfast, lunch or dinner because there was not enough food, lack of money or other resources?			
Did you or any other household member eat less than he/she should because there was not enough food, lack of money or other resources?			
Did you or any household member feel hungry because he/she did not eat due to lack of food, money or other resources?			
Did you or any household member eat only once a day or go a whole day without eating anything because there was not enough food, lack of money or other resources?			

Do you recall episodes of not enough food (skipping breakfast, lunch or dinner) in the last 1 or 3 years?

Appendix A16. Questionnaire for dairy traders

Questionnaire – Traders (Collectors, Brokers, Middlemen)		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date	
	Name of interviewer	
	Name of respondent	
	Level of education	
	Contact details	
	Area of operation	

1. What is your main activity in the dairy value chain?
   (*Explain nature of trade/business*)

2. How long have you been a trader in milk?

3. Are you involved in any other activity in the dairy value chain except the one stated in No.1? *(if yes, state for how long and reason for involvement in the second activity*)

4. Where do you source the milk? (*area and from whom*)

5. How much do you collect in a day?

6. At what price do you buy the milk?

7. Has this price changed in the past 6 months?

8. Do you have any supply arrangements with your suppliers?
   (*If yes, state nature of agreement*)

9. Are there fluctuations in the amount of milk you are able to collect in a day?

10. Whom do you sell to?
    (*Indicate distance to point of sale*)

11. At what price do you sell the milk?

12. Has this price changed in the last 6 months?

13. Do you have any supply arrangements with your buyers?
    (*If yes, state nature of agreement*)

14. Do you process/add value to the milk you collect?

15. Are there instances when the milk you collect goes bad before reaching the point of sale?

16. What measures do you take to ensure that the milk you deliver does not go bad?

17. What means of transport do you use?

18. What are your transport costs?
    (*Indicate costs per km*)

19. Do you pay any fees, levies or taxes in relation to your business as a trader?
    (*Indicate both official and unofficial fees*)

20. Are there any other costs which you incur as a milk trader?

21. Are you a member of any organization of milk traders?
    (*If yes, indicate name and purpose of organization*)

22. Do you receive any government support as a trader?
    (*If yes, how*)

23. Are there other institutions that support you as a milk trader?
    (If yes, which ones and how)

21. From whom do you obtain information on where to source for milk and where to sell?

22. What percentage of your total income is attributable to being a milk trader?

23. What are the challenges you encounter as a milk trader?

24. What would you suggest as solutions to the challenges that you have given?

Appendix A17. Questionnaire for milk cooling points

Questionnaire for milk cooling points		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date	
	Name of interviewer	
	Name of coll. point	
	Name of respondent	
	Position in org	
	Contact details	
	Area of operation	

1. What is your main activity in the dairy value chain?
   (*Explain nature of trade/business*)

2. Are you involved in any other activity in the dairy value chain except the one stated in No.1? *(if yes, state for how long and reason for involvement in the second activity*)

3. Who owns and runs this milk collection point?
   (Indicate no of coop members)

4. How long have you been collecting milk?

5. Where do you source the milk?

6. Do you have any supply arrangements with your suppliers?
   (*If yes, state nature of agreement*)

7. How much are you currently collecting in a day?

8. Has this changed in the past 6 months

9. How long do you store the milk after collecting/bulking?

10. At what price do you buy the milk?

11. Whom do you sell/deliver to?
    (*Indicate distance to point of sale/delivery*)

12. At what price do you sell the milk?

13. Do you have any supply arrangements with your buyers?
    (*If yes, state nature of agreement*)

14. What means of transport do you use?

15. What are your transport costs?
    (*Indicate costs per km*)

16. Do you pay any fees, levies or taxes in relation to your business as a collection point?
(*Indicate both official and unofficial fees*)

17. Are there any other costs which you incur as a milk collecting point?

18. Do you incur any milk losses at the milk collecting point?
19. What measures do you take to ensure the safety of the milk?

20. Do you receive any institutional or government support?
(*If yes, how*)

21. Do you encounter any challenges as a milk collection point?

22. What would you suggest as solutions to the challenges that you have given?

Appendix A18. Questionnaire for dairy cooperatives

INTEVIEW SCHEDULE for Milk Cooperatives		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date	
	Name of interviewer	
	Name of Cooperative	
	Name of respondent	
	Position in Cooperative	
	Contact details	

1. What is your main activity in the dairy value chain?

2. What other services do you offer as a Cooperative?

3. When was the cooperative established and how many members do you have?

4. How is the cooperative structured?

5. How long have you been collecting milk?

6. Where do you source the milk?

7. How much do you collect in a day?

8. Do you have any supply arrangements with your suppliers?
(*If yes, state nature of agreement*)

9. Do you store the milk after collecting/bulking?

10. Do you process milk?
(If yes, state how much is processed and into what products)
11. At what price do you buy the milk?

12. Whom do you sell to?
(*Indicate distance to point of sale*)

13. At what price do you sell the milk?

14. Do you have any supply arrangements with your buyers?
(*If yes, state nature of agreement*)

15. What means of transport do you use?

16. What are your transport costs?
(*Indicate costs per km*)

17. Do you pay any fees, levies or taxes in relation to your business as a collection point?
(*Indicate both official and unofficial fees*)

18. Are there any other costs which you incur?

19. Do you incur any milk losses?

20. Do you receive any institutional or government support?
(*If yes, how*)

21. What are the challenges you encounter as a cooperative?

22. What would you suggest as solutions to the challenges that you have given?

Appendix A19. Questionnaire for dairy processors

QUESTIONNAIRE – Dairy Processor		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date	
	Name of interviewer	
	Name of milk processor	
	Physical location	
	Name of respondent	
	Position in organization	
	Contact details	
	Level of education:	

1. How many years has the business been in operation?

2. Who owns the business?

3. Are you involved in any other activity in the dairy value chain?

4. What is your processing capacity?
(*Litres per day*)

5. Is it fully utilized?
(*If No, why*?)

6. Has your capacity changed in the last 5 years?
(*If yes, indicate extent of change and reason*)

7. On average, how many litres of milk do you receive in a day?
(Please indicate average quantity of milk received in the last 6 months)

Aug	Sep	Oct	Nov	Dec 16	Jan 17

8. Do you have months with notable low supplies of milk or with milk glut?
(*If so, indicate which months and state coping strategy*)

9. On average, how many litres of milk do you process per day?
(*Indicate no. of days in a week business is in operation*)

Please indicate average amount of milk processed in the last 6 months

Aug	Sep	Oct	Nov	Dec 16	Jan 17

10. Do you incur any milk losses?
(*If yes, state at what stage, reason and how much, on average, per day*)

11. Who are your suppliers of milk?

12. Are there conditions that qualify one to be your supplier?

13. Do you have supply arrangements with the suppliers?
(*If yes, state nature of arrangement*)

14. At what price do you buy the milk?

15. Do you have a preference for milk from any particular area?
(*If yes, state which and reason*)

16. Who are your customers?
(*Areas supplied with milk/chain of supply)*

17. Milk products sold

Name of product	Unit Kg/L	Price per unit	Market (*if for export indicate country*)	Volume sold per day	Proportion of milk used to produce this product	Form in which the product is transported and sold	Perishability (*days*)	Litres of milk used to make 1 unit of product

Please indicate milk products that are not produced and reason

i. Is any of the products above subsidized in price?

ii. Has the price of your products indicated in no.15 above changed in the last one year?
(*If yes, indicate changes*)

iii. Any of the products introduced in the last three years?

iv. Any improvements made in the quality of the products in the last 3 years

18. What safety measures have you put in place to ensure that the products are safe for human consumption?

19. Employees in the firm

No. of workers	Gender	Nature of employment	Wages paid (*daily or monthly rate*)

20. Processing costs

Purchase of Milk	
Electricity	
Water	
Labour	
Rent	
Depreciation	
Transport	
Taxes, fees, levies	
Other costs	

21. Do you get any support from the government as a milk processor?
(*If yes, state how*)

22. Any other institutions that support you as a milk processor?
(*If yes, name institution and state how it supports*)

23. Do you have access to credit facilities as a milk processor?
(*If yes, state nature of facility. If No, state hindering factors*)

24. How do you get information regarding the milk market (where to source, where to sell)?

25. Describe your relationship with dairy producers (do you have forums for interaction)?

26. What are the challenges you encounter as a milk processor?

27. What would you suggest as solutions to the challenges that you have given?

Appendix A20. Questionnaire for dairy retailers (milk bars, restaurants)

Questionnaire – Dairy retailers (Milk bars, restaurants)		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date of interview	
	Name of interviewer	
	Name of retail outlet	
	Type of retail outlet	
	Physical location	
	Name of respondent	
	Position of respondent	
	Contact	

1. How long has your business been in operation?

2. What is your main activity in the dairy value chain?

3. Are you involved in any other activity in the dairy value chain except the one stated in No.1? *(if yes, state for how long and reason for involvement in the second activity*)

4. Which dairy products do you sell?

5. What determines the dairy products you sell?

6. At what price do you sell the dairy products?

7. Has this price changed in the last 6 months?
   (If yes, state reason for change)

8. Where do you source the milk? (*from whom, how many suppliers*)

9. How much are you supplied with in a day?

10. Are you able to sell all the milk supplied?

11. Is there a difference in quality from different suppliers?

12. At what price do you buy the milk?

13. Has this price changed in the past 6 months?

14. Do you have any supply arrangements with your suppliers?
    (*If yes, state nature of agreement*)

15. Are there fluctuations in the amount of milk you are able to collect in a day?

16. Whom do you sell to?

17. Do you have any supply arrangements with your buyers?
    (*If yes, state nature of agreement*)

18. Do you process/add value to the milk you collect?

19. Are there instances when the milk you collect goes bad before selling?

20. What measures do you take to ensure that the milk does not go bad?

21. Do you incur transport costs?
    (*Indicate costs per km*)
22. What other costs do you incur in relation to your business as a milk retailer?
    (*Indicate both official and unofficial*)

23. How many people are employed by this business?

24. Are you a member of any organization of milk retailers?
    (*If yes, indicate name and purpose of organization*)

25. Do you receive any support from the government or any other institution as a milk retailer?
(*If yes, how*)

25. Are you able to access credit facilities as a milk retailer in order to grow/improve your business?

26. Where do you obtain information on where to source for milk?

27. What percentage of your total income is attributable to being a milk retailer?

28. What are the challenges you encounter as a milk retailer?

29. Is there any kind of support that you would require to improve on retail of milk?

Appendix A21. Questionnaire for dairy retailers (shops, supermarkets)

QUESTIONNAIRE – Dairy retailers (shops, supermarkets)		
This questionnaire is part of research being carried out on the Dairy Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date of interview	
	Name of interviewer	
	Name of retail outlet	
	Type of retail outlet	
	Physical location	
	Name of respondent	
	Position of respondent	
	Contact	

1. How long has your business been in operation?

2. Dairy products on sale

Product type	Supplier	Brand name	Package quantity	Vol. sold in a day	Buying price	How often do you restock	Product shelf life	Sale price (in the last 6 months)				
								Feb 17	Jan 17	Dec 16	Nov 16	Oct 16

**check for physical availability of products*

3. Are any of the products above subsidized in price?

4. What determines the dairy products you stock?

5. Do you incur transport costs to bring the products to the shop?

6. Are there other costs?

7. Is the supply of all dairy products consistent throughout the year?
(*If No, indicate the products with inconsistent supply and reason*)

8. Do you have any supply arrangements with the suppliers?
(*If yes, state the arrangement*)

9. Whom do you sell the dairy products to?

10. From how far do they come from?

11. Do you have any employees?
(*If yes, fill in table*)

No. of workers	Nature of employment	Wages paid (*daily or monthly rate*)

12. Are you involved in any other activity in the dairy value chain?
(If yes, specify)

13. Are you part of any organization in the dairy supply chain?
(If yes, state name and purpose of organization)

14. Do you receive any support from the government or any other institutions as a retailer of dairy products?
(If yes, specify)

15. Do you have access to credit facilities as a retailer?

16. What are the challenges you face as a retailer of dairy products?

17. What would you suggest to solve the challenges stated?

Appendix A22. Questionnaire for beef producers (pastoralists)

QUESTIONNAIRE – Producer (Beef farmer)		
This questionnaire is part of research being carried out on the Beef Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated	Date	
	Group ranch	
	Name of interviewer	
	Name of respondent	
	Contact details	

1. GENERAL INFORMATION

Position in household *(Male, Female, Daughter, Son ,Others___ specify)*	Level of Education *(Postgraduate, graduate, secondary, Primary)*	Main activity in the Value chain	Other activities in the value chain (*trader, broker, retailer, provider of credit, trainer of farmers etc)*

2. How many cattle do you have and what are the breeds?

Breed	No of beef cattle (bulls)	No. of dairy cattle (female)

3. What other livestock do you have in addition to cattle?

4. Sale of cattle
   i. Are there specific times when you sell cattle and for what reason?

No. of cattle sold (month or year)	Average age of animal at the time of sale	Average live weight (kg)	Price per animal	Buyer/Market	Distance to point of sale
			Lowest price: Average: Highest price:		

5. i. Do you slaughter cattle at your household? How often? And reason?

   ii. What is the average age of cattle you slaughter on those occasions?

6. COSTS (per head)
   i. What type of feed and supplements do you give to your cattle?
   ii. Where do you source the feed and how much does it cost?

   iii. Do you have access to veterinary services?
   (If yes, indicate from whom and cost of accessing the service)

   iv. Do you have access to A.I services?
   (If yes, indicate from whom and cost of accessing the service)
7. How do you increase your herd?

8. Do you employ workers to look after the cattle?
   (*If yes, fill in table*)

No. of workers	Nature of employment	Wages paid (*daily or monthly rate*)

9. Are there institutions (government and others) that support or give you training as a beef producer?
   (*If yes, fill in table below*)

Institution (*Government, others_ name*)	Support/service received (*e.g training, subsidies, extension services*)	Period services received	*Level of satisfaction				
			5	4	3	2	1

**5- very high, 4-high, 3-medium, 2- low, 1-very low*

ii. Are you a member of any farmer organization or cooperative?
(*If yes, state purpose and benefits received*)

iii. Are you in contact with		who help to develop your economic activities?	Yes/No
	a. NGO's		
	b. Projects		
	c. Government services		
iv. Do you share		with community or family members?	Yes/No
	a. Equipment and tools		
	b. Labour		
	c. Knowledge		
v. Do you participate in decision making regarding		in your community?	Yes/No
	a. Land		
	b. water		
	c. infrastructure		
	d. food		

10. Do you have access to credit facilities?
(*If yes, fill in table below. If No, state hindering factors*)

Provider	No. of disbursements in the last 1 year	Amount	Conditions (*Collateral, interest, period, others*)	Factors that facilitated access (*Government, NGO, Co-operative, group membership, others*)

ii. Any challenges accessing credit?

11. What are the challenges you face as a beef producer?

12. What possible solutions or interventions would you suggest to the challenges you have stated?

13. How do you relate with the large scale beef producers/ranchers?

14. INCOME (***monthly***)
Are you engaged in other economic activities apart from livestock farming?
(If yes, specify)

Sources of Income	Amount
Sale of cattle	

15. How much time do you spend in activities related to cattle keeping?

16. What would be your alternate economic activity to cattle keeping? Why?

<u>Food security related questions</u>

Household members (Indicate marital status)	Age (years in range of 5)

17. HOUSEHOLD EXPENDITURE (Monthly)
i. What is your total monthly expenditure?

Housing Component	Amount
Food	
Education	
Clothes	
Rent	
Health	
Electricity*	
Water*	
Domestic labour	
Cash transfers	
Entertainment	

*Indicate if household has access to electricity, source of drinking water?

iii. What is your most important source of income contributing to offsetting the above mentioned costs?

iv. Do you have enough income to save money?

vi. Do you sometimes have to borrow to meet the needs of your family or economic activities?

18. OWNERSHIP OF CONSUMER GOODS AND ASSETS
i. Do you own the following goods?

Item	Yes/No	Importance source of funds used for buying good (savings, sale of xx crop, sale of livestock, others)
Solar Panel		
Mobile phone		
Bicycle		
Motorcycle		
Television		
Radio		
Motor vehicle		
Furniture		

ii. Indicate materials used for the following housing components; wall, floor and roofing

19. FOOD SECURITY ASSESSMENT

In the past three months,	No =0 Yes= 1 DK= 3 DA=4	If yes, how often did this happen 1 = *Once per month* *2 = More than once per month*	Reason
Did you worry that your household would not have enough food due to lack of money or other resources?			
Did your household lack food due to lack of money or other resources?			
Did your household not eat healthy due to lack of money or other resources?			
Did you or any household member eat a low diversity of foods due to lack of resources to obtain other types of food?			
Did you or any household member skip breakfast, lunch or dinner because there was not enough food, lack of money or other resources?			
Did you or any other household member eat less than he/she should because there was not enough food, lack of money or other resources?			
Did you or any household member feel hungry because he/she did not eat due to lack of food, money or other resources?			
Did you or any household member eat only once a day or go a whole day without eating anything because there was not enough food, lack of money or other resources?			

20. Do you recall episodes of not enough food (skipping breakfast, lunch or dinner) in the last 1 to 3 years?

Appendix A23. Questionnaire for beef producers (large-scale ranches)

QUESTIONNAIRE – Producer (Beef farmer)		
This questionnaire is part of research being carried out on the Beef Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated	Date	
	Name of interviewer	
	Name of farm	
	Name of respondent	
	Contact details	

1. GENERAL INFORMATION

Farm size	Position in farm	Level of Education	Main activity in VC	Other activities in the VC *trader, broker, retailer, provider of credit, trainer of farmers etc)*

2. How many beef cattle do you have on the farm and what are the breeds?

Breed	Number

3. Do you have other livestock on the farm in addition to the beef cattle?

4. Do you sell the beef cattle alive?
(If yes, fill in table 3. If No, go to Q.4)

No. of beef cattle sold in a month	Average age of animal at the time of sale	Average live weight (kg)	Price per animal	Buyer/Market	Distance to point of sale

5. Are the beef cattle slaughtered on farm?
(*If yes, fill in table 4*)

No. of beef cattle slaughtered per day	Average age of animal at slaughter time	Average live weight	Carcass weight	Price per Kg	Buyer/Market	Distance to point of sale

6. COSTS (per head)
   i. How much does it cost you to feed and care for the beef cattle (per head)?

   ii. What do you feed the beef cattle on and where do you source your feed?

   iii. Who provides you with veterinary services (medication, vaccinations), spraying and deworming services?

7. Where do you source your calves/young bulls from?

8. Do you employ any workers?
   (*If yes, fill in table*)

No. of workers	Nature of employment	Wages paid (*daily or monthly rate*)

9. Are there institutions (government and/or others) that support or give you training as a beef producer?

ii. Are you a member of any farmer organization or cooperative?
(*If yes, state purpose and benefits received*)

iii. Are you in contact with NGO's, projects or governments services who help to develop economic activities?

iv. Do you share equipment, tools, labour or knowledge with other community members?

v. Do you participate in decision making regarding land, water, infrastructure and food in your community or working environment

10. Do you have access to credit facilities, as a farm, to improve your production activities?
(*If No, state hindering factors*)

11. How do you relate/interact with the small scale beef producers?

12. Is the farm engaged in other economic activities apart from beef farming?

13. What percentage of your income is attributable to beef farming versus other sources of income?
14. What would be your alternate economic activity to beef production? Why?

15. What are the challenges you encounter as a beef producer?

16. What possible solutions or interventions would you suggest to the challenges you have stated?

Appendix A24. Questionnaire for beef traders

QUESTIONNAIRE – Trader (Brokers, Middlemen)		
This questionnaire is part of research being carried out on the Beef Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date of Interview	
	Name of interviewer	
	Name of respondent	
	Level of education	
	Contact details	

1. What is your main activity in the beef value chain?
(*Explain nature of trade/business*)

2. How long have you been a beef trader?

3. Are you involved in any other activity in the beef value chain except the one stated in No.1?
(If yes, state for how long and reason for involvement in the second activity)

4. What is your source of beef cattle?

5. At what price do you buy the beef cattle?

6. What determines the price?

7. Do you have preference for any breed of cattle?

8. Whom do you sell to? (*indicate distance to point of sale*)

9. At what price do you sell the beef cattle?

10. How many beef cattle do you buy and sell in a day?

11. Do you incur any transport costs?
(*Indicate costs per km*)

12. Do you pay any fees, levies or taxes in relation to your business as a trader?
(*Indicate both official and unofficial fees*)

13. Are there any other costs which you incur as a beef trader?

14. What percentage of your total income is attributable to being a beef trader?

15. Do you receive any support from the government or any other institution as a beef trader?
(*If yes, how*)

16. From whom do you obtain information on where to source for the cattle and where to sell?

17. Are you a member of any organization of beef traders?
(*If yes, indicate name and purpose of organization*)

18. What are the challenges you encounter as a beef cattle trader?

19. What would you suggest as solutions to the challenges that you have given?

Appendix A25. Questionnaire for beef processors

QUESTIONNAIRE – Beef processors (Slaughter houses and Abattoirs)		
This questionnaire is part of research being carried out on the Beef Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date of Interview	
	Name of interviewer	
	Name of processor	
	Physical location of the processor	
	Name of respondent	
	Position in organization	
	Level of education	
	Contact details	

1. How many years has the business been in operation?

2. Are you involved in any other activity in the beef value chain?

3. What is your slaughtering capacity?

4. Is it fully utilized?
(*If No, why*?)

5. Has your capacity changed in the last 5 years?
(*If yes, indicate extent of change and reason*)

6. On average, how many heads of cattle do you slaughter in day?
(*Indicate no. of days in a week business is in operation*)

7. Who are your suppliers of beef cattle?

8. At what price do you buy the beef cattle?

9. Do you have a preference for any breed of cattle?

10. On average what percentage of carcass is processed for consumption?

11. Beef products sold

Name of product	Price per Kg	Market (*if for export indicate country*)	Volume sold per day	Proportion of meat used to produce this product	Form in which the product is transported and sold	Perishability (*days*)

12. Has the price of your products changed in the last one year?
(*If yes, indicate changes*)
13. What safety measures have you put in place to ensure that the products are safe for human consumption?

14. Processing costs

Purchase of cattle	
Electricity	
Water	
Labour	
Rent	
Depreciation	
Transport	
Taxes, fees, levies	
Other costs	

15. Employees in the firm

No. of workers	Nature of employment	Wages paid (*daily or monthly rate*)

16. Do you get any support from the government or other institutions as a beef processor?
(*If yes, state how*)

17. Do you have access to credit facilities?
(*If yes, state nature of facility. If No, state hindering factors*)

18. How do you get information regarding the beef market (where to source, where to sell etc)?

19. What are the challenges you encounter as a beef processor?

20. What would you suggest as solutions to the challenges that you have given?

Appendix A26. Questionnaire for beef retailer

QUESTIONNAIRE – Beef retailers (butcheries, restaurants, supermarkets)		
This questionnaire is part of research being carried out on the Beef Value Chain in North West Mt Kenya by CETRAD, Kenya. The researcher is a PhD student at the University of Nairobi, Department of Geography and Environmental Studies. The information obtained will be used for academic purposes. The responses will be treated with confidentiality. You are requested to kindly help in filling the questionnaire to the best of your knowledge and ability. Your co-operation is highly appreciated.	Date of interview	
	Name of interviewer	
	Type of retail outlet	
	Physical location	
	Name of respondent	
	Position	
	Contact details: Tel	

1. How long has your business been in operation?

2. What is your main activity in the beef value chain?

3. Are you involved in any other activity in the beef value chain except the one stated in No.2? *(If yes, state for how long and reason for involvement in the second activity*)

4. Which beef products do you sell?

5. What determines the beef products you sell?

6. Whom do you sell the beef to?

7. At what price do you sell the beef products?

8. Has the price changed in the last 6 months?

9. Where do you source the beef?

10. Is the supply of beef consistent throughout the year?

11. At what price do you buy the beef?

12. Has the price changed in the last 6 months?

13. Do you have any sale agreements/arrangements with the supplier?
(If yes, state the arrangement)

14. Do you incur transport costs?
(*Indicate costs per km*)

15. What other costs do you incur in relation to your business as a retailer of beef?
(*Indicate both official and unofficial*)

16. How many people are employed by this business?

17. Are you part of any organization in the beef supply chain?
(If yes, state name and purpose of organization)

18. Do you receive any support from the government or any other institution as a beef retailer? *(If yes, specify)*

19. Do you have access to credit facilities as a retailer?

20. What are the challenges you face as a beef retailer?

21. What would you suggest to solve the challenges stated?