

THE CONTRIBUTION OF CAMEL MILK PRODUCTION AS A LIVELIHOOD STRATEGY FOR BUILDING PASTORAL RESILIENCE IN THE DRYLANDS OF KENYA

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DECLARATION AND APPROVAL

This thesis titled “**The contribution of camel milk production as a livelihood strategy for building pastoral resilience in the drylands of Kenya**” is my original work and has never been presented for a degree in any other University.

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Date

APPROVAL

This thesis has been submitted with our approval as university supervisors

Professor Dickson M. Nyariki

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Date

DEDICATION

This work is dedicated to my father, Dr. Ahmed Elhadi, my beloved mother, Mazaheer, and my brothers and sisters for their support and sacrifice during my academic study.

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TABLE OF CONTENTS

DECLARATION AND APPROVAL	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS.....	v
LIST OF TABLES	x
LIST OF FIGURES	xi
ACRONYMS.....	xii
ABSTRACT.....	xiv
CHAPTER 1	1
INTRODUCTION	1
1.1 SUMMARY.....	1
1.2 BACKGROUND	1
1.3 STATEMENT OF THE PROBLEM.....	4
1.4 JUSTIFICATION	5
1.5 OBJECTIVES.....	6
1.5.1 Overall Objective	6
1.5.2 Specific Objectives.....	6
1.6 HYPOTHESES.....	6
1.7 LIMITATIONS OF THE STUDY	7
1.8 THESIS ORGANISATION	7
REFERENCES	10
CHAPTER 2	13
LITERATURE REVIEW	13
2.1 SUMMARY.....	13
2.2 CONCEPTUAL FRAMEWORK.....	13
2.3 THE HYPOTHESIZED CHANGE TOWARDS PASTORAL HOUSEHOLD RESILIENCE	17
2.4 LIVESTOCK SECTOR IN KENYA.....	20
2.5 PASTORAL LIVESTOCK PRODUCTION IN KENYA.....	22
2.6 THE ROLE OF LIVESTOCK IN PASTORAL ECONOMY	24
2.7 CAMEL PRODUCTION IN KENYA	27
2.8 THE ROLE OF CAMEL PRODUCTION IN A VARIABLE AND CHANGING CLIMATE	29
2.9 CAMEL MILK VALUE CHAIN IN KENYA.....	32
2.10 POLICY AND ORGANIZATIONAL FRAMEWORK FOR CAMEL SUB-SECTOR.....	36
2.11 RESEARCH GAPS	38
REFERENCES	38

CHAPTER 3	46
DESCRIPTION OF THE STUDY AREA.....	46
3.1 SUMMARY.....	46
3.2 INTRODUCTION	46
3.3 LOCATION AND TOPOGRAPHY	46
3.4 POPULATION	50
3.5 CLIMATE	52
3.5.1 Rainfall.....	52
3.5.2 Temperature	53
3.5.3 Drought Occurrence	54
3.6 SOILS AND VEGETATION	55
3.7 LIVELIHOODS.....	58
3.8 CONCLUSION	62
REFERENCES	62
CHAPTER 4	65
RESEARCH METHODOLOGY	65
4.1 SUMMARY.....	65
4.2 INTRODUCTION	65
4.3 SAMPLING PROCEDURE	66
4.4 DATA COLLECTION METHODS.....	67
4.4.1 Household Interviews.....	68
4.4.2 Focus Group Discussions (FGDs).....	69
4.4.3 Key Informant’s Interviews (KII)	69
4.4.4 Secondary Data	70
4.5 SURVEY PROCEDURES	70
4.5.1 Reconnaissance Survey	71
4.5.2 Questionnaire Preparation	71
4.5.3 Training of Enumerators	72
4.5.4 Pilot Study	72
4.6 DATA ANALYSIS	73
4.6.1 Descriptive Statistics	73
4.6.2 Household Food Basket Analysis.....	73
4.6.3 Value Chain Analysis.....	74
4.6.4 Efficiency of Marketing Channels	76
4.6.5 Simultaneous Equation Model (SEM)	78
4.6.6 Measurement of Variables Used in Simultaneous Equation model	80

4.6.7 The Multinomial Logistic Model (MNL).....	87
4.6.8 Measurement of Variables Used in Multinomial Logistic Model.....	90
REFERENCES	95
CHAPTER 5	100
THE ROLE OF CAMEL MILK IN PASTORAL HOUSEHOLD LIVELIHOODS IN THE DRYLANDS OF KENYA	100
5.1 SUMMARY	100
5.2 INTRODUCTION	100
5.3 METHODOLOGY	103
5.3.1 Study Area	103
5.3.2 Data Collection	104
5.3.3 Data Analysis.....	105
5.4 RESULTS AND DISCUSSION	106
5.4.1 Household Characteristics	106
5.4.2 Contribution of Camel Milk to Household Food Basket.....	109
5.4.3 Contribution of Camel Milk to Household Income	118
5.5 CONCLUSIONS AND POLICY IMPLICATIONS	122
REFERENCES	123
CHAPTER 6	128
FUNCTIONALITY, PROFITABILITY AND EFFICIENCY OF CAMEL MILK VALUE CHAIN IN SEMI-ARID AREAS OF KENYA.....	128
6.1 SUMMARY	128
6.2 INTRODUCTION	129
6.3 METHODOLOGY	132
6.3.1 Study Area	132
6.3.2 Data Collection	132
6.3.3 Data Analysis.....	133
6.4 RESULTS AND DISCUSSION	136
6.4.1 Mapping of Camel Milk Marketing Channels.....	137
6.4.2 Efficiency of Camel Milk Marketing Channels.....	140
6.4.3 Analysis of Camel Milk Value Chain Actors	143
6.4.3.1 <i>Functional analysis of camel milk actors</i>	143
6.4.3.2 <i>Characteristics of camel milk value chain actors</i>	146
6.4.4 Market Performance of Camel Milk Value Chain.....	151
6.4.5 Production and Marketing Constraints along the Camel Milk Value Chain	156
6.5 CONCLUSIONS AND POLICY IMPLICATIONS	160
REFERENCES	162

CHAPTER 7	165
FACTORS INFLUENCING CAMEL MILK PRODUCTION IN THE DRYLANDS OF KENYA	165
7.1 SUMMARY	165
7.2 INTRODUCTION	166
7.3 METHODOLOGY	167
7.3.1 Study Area	167
7.3.2 Data Collection	168
7.3.3 Data Analysis.....	169
7.4 RESULTS AND DISCUSSION	174
7.4.1 Descriptive Analysis.....	174
7.4.2 Identification, simultaneity and exogeneity tests.....	176
7.4.2.1 Test for identification.....	176
7.4.2.2 Test for simultaneity	177
7.4.2.3 Test for exogeneity.....	178
7.4.3 Simultaneous Equation Model Results	179
7.5 CONCLUSIONS AND POLICY IMPLICATIONS	183
REFERENCES	184
CHAPTER 8	187
MODELLING THE CHOICE OF MARKET OUTLETS BY CAMEL MILK PRODUCERS IN THE DRYLANDS OF KENYA.....	187
8.1 SUMMARY	187
8.2 INTRODUCTION	188
8.3 METHODOLOGY	189
8.3.1 Study Area	189
8.3.2 Data Collection	190
8.3.3 Data Analysis.....	191
8.4 RESULTS AND DISCUSSION	194
8.4.1 Descriptive Analysis.....	194
8.4.2 Determinants of the Choice of Marketing Outlets	196
8.5 CONCLUSIONS AND POLICY IMPLICATIONS	203
REFERENCES	204
CHAPTER 9	209
SUMMARY CONCLUSIONS AND POLICY IMPLICATIONS	209
9.1 INTRODUCTION	209
9.2. SUMMARY OF KEY RESEARCH FINDINGS	210
9.2.1 Camel Milk Contribute Significantly to Pastoral Household Diet and Income	210
9.2.2 Camel Milk Value Chain is Functional, Profitable and Efficient	210

9.2.3 Daily Milk Production is Significantly Determined by Production and Non-Production Related Factors.....	211
9.2.4 The Choice of Milk Market Outlet is driven by Management Practices and Institutional and Marketing Factors	212
9.3 CONCLUSIONS AND POLICY IMPLICATIONS	212
9.3.1 Integrating Camel Milk in Drought Adaptation and Mitigation Policies.....	213
9.3.2 Enhancing Functionality and Specialisation along the Milk Value Chain.....	213
9.3.3 Improving Camel Milk Marketing.....	213
9.3.4 Enhancing camel milk profitability and efficiency	214
9.3.5 Interventions to Increase Camel Milk Production	214
9.3.6 Improving the Participation of Camel Milk Producers in High End Urban Market	215
9.4 FURTHER RESEARCH	215
REFERENCES	216
APPENDICES	217
I. CAMEL MILK PRODUCER QUESTIONNAIRE.....	217
II. CAMEL MILK TRANSPORTER QUESTION GUIDE	223
III. CAMEL MILK TRADERS AND MIDDLEMEN QUESTIONNAIRE	224
IV. CAMEL MILK COOLING HUB QUESTION GUIDE	225
V. CAMEL MILK COOPERATIVES QUESTION GUIDE	227
VI. CAMEL MILK RETAILERS QUESTION GUIDE	230
VII. FOCUS GROUP DISCUSSION GUIDE.....	231
VIII. KEY INFORMANT INTERVIEW GUIDE	232
IX. COLLINEARITY STATISTICS: VARIANCE INFLATION FACTORS	233
X. PRODUCTION AND MARKETING COSTS	235

LIST OF TABLES

Table 5.1: Social and demographic characteristics	107
Table 5.2: Household composition	108
Table 5.3: Camel herd structure.....	108
Table 5.4: Pastoral household food basket	110
Table 5.5: Pastoral household food basket during wet and dry seasons	113
Table 5.6: Frequency and forms of camel milk usage	117
Table 5.7: Pastoral household livelihood activities during wet and dry season	120
Table 6.1: Marketing margins of camel milk channels.....	141
Table 6.2: Characteristics of camel milk producers.....	147
Table 6.3: Characteristics of camel milk marketing agents.....	149
Table 6.4: Attributes of camel milk marketing agents.....	149
Table 6.5: Gross margins analysis of camel milk producers	152
Table 6.6: Gross margins analysis of bulking and cooling agent	153
Table 6.7: Financial analysis of marketing agents.....	155
Table 6.8: Constraints faced by camel milk production agents	157
Table 6.9: Constraints faced by camel milk marketing agents	159
Table 7.1: Summary of variables used in the simultaneous equation model.....	175
Table 7.2: Order condition of identifiability.....	176
Table 7.3: Coefficients of variables in the SEM.....	176
Table 7.4: Factors influencing daily camel milk production	179
Table 8.1: Hypothesized variables used in the Multinomial Logistic Model	195
Table 8.2: Factors influencing the choice of market outlet	198

LIST OF FIGURES

Figure 2.1: Conceptual framework for camel milk commodification as a strategy for building pastoral household resilience	15
Figure 2.2: Theory of change model for camel milk commodification as a strategy for building pastoral household resilience	19
Figure 3.1: Counties of Kenya	48
Figure 3.2: Location of the data collection areas	49
Figure 3.3: Population density in Isiolo County	51
Figure 3.4: Total seasonal rainfall for Isiolo County from 1979/80 to 1985/96	53
Figure 3.5: Monthly maximum temperature for Isiolo Couty	54
Figure 3.6: Vegetation type in Isiolo County	57
Figure 3.7: Livelihood zones in Isiolo County	59
Figure 3.8: Distribution of camels in Isiolo County	61
Figure 6.1: Camel milk marketing channels in the study area	138
Figure 6.2: Camel milk value chain map in Isiolo County	145

ACRONYMS

2SLS	Two Stage Least Squares
ALRMP	Arid Lands Resource Management Project
ASALs	Arid and Semi-Arid Areas
DDC	Drylands Development Centre
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GoK	Government of Kenya
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environmental Development
ILCA	International Livestock Centre for Africa
ITCZ	Inter-Tropical Convergence Zone
KARI	Kenya Agricultural Research Institute
KCA	Kenya Camel Association
KDLDP	Kenya Dryland Livestock Development Project
KII	Key Informant Interview
KLMC	Kenya Livestock Marketing Council
KMD	Kenya Meteorological Department
MLD	Ministry of Livestock Development
MLM	Multinomial Logistic Model
MT	Metric Tonne
NGO	Non-Governmental Organization

OLS	Ordinary Least Squares
OSSREA	Organization for Social Science Research in Eastern and Southern Africa
PANESA	Pasture Network for Eastern and Southern Africa
PINEP	Pastoral Information Network Programme
SEM	Simultaneous Equation Model
SPSS	Statistical Package for the Social Sciences
UNDP	United Nation Development Program
VCA	Value Chain Analysis

ABSTRACT

Pastoral production system in Kenya is facing many challenges such as high livestock mortality, high incidence of malnutrition and marginalisation. This has been worsened by the impact of climate variability and change which has rendered most of the traditional coping strategies ineffective, leading to vulnerable and insecure pastoral livelihood systems. One of the main pastoral adaptations to the increasingly unpredictable climate and diminishing grazing resources has been adoption of drought tolerant livestock species such as the camel. Despite the indications of the capability to alleviate the vulnerability of pastoral communities to droughts and emerging climate extremes associated with climate change, the potential of camel production is yet to be fully exploited. This may be partly attributed to dearth of information to guide the development of the sub-sector.

This study was motivated by the lack of empirical evidence on the potential of camel milk production to build resilience of pastoral households' livelihoods in the drylands of Kenya. The study used a multistage sampling approach to collect data, through a semi-structured questionnaire. The food basket approach was used to determine the contribution of camel milk to household food basket. Value chain analysis was carried out to determine the functionality and profitability of the milk chain. Further, the study adopted a simultaneous equation model, through a two-stage least squares approach, to determine the factors influencing camel milk production, and a multinomial logistic model to estimate the determinants of the choice of camel milk market outlets.

The food basket analysis showed that camel milk contributes significantly ($P \leq 0.05$) to the pastoral household food basket and income during the wet and dry seasons. Additionally, the value chain results showed that camel milk trade is profitable and thus has the ability to derive pastoral household income. However, actors along the chain were faced with various constraints such as poor hygiene practices, poor infrastructure, high cost of inputs and poor prices. This study found that daily camel milk production was positively significantly ($P \leq 0.05$), affected by camel herd size, education level of the producer, household size, distance to grazing point, labour, and access to climate information and extension services. The same was negatively and significantly ($P \leq 0.05$) influenced by the distance to the water point. Furthermore, the results

indicate that the likelihood of selling milk to bulking centres was negatively and significantly ($P \leq 0.05$) influenced by access to market information, experience of camel milk producer and distance to bulking centre, and positively influenced by the camel herd size and daily milk production. On the other hand, selling to wholesaler marketing outlets was positively and significantly ($P \leq 0.05$) influenced by the age of the producer, camel herd size, daily milk production and the price offered at the wholesaler outlets, while it was negatively and significantly influenced by the experience of camel milk producers and the distance covered to wholesaler marketing outlets.

Based on the food basket analysis, there is need to invest in the camel milk subsector by creating enabling policies that enhance milk production, consumption and marketing, and to mainstream the use of camel products as a way to strengthen households' resilience to climatic variability and change. As suggested by value chain results, there is need for a holistic intervention that includes proper marketing development, general infrastructure development and investing in technologies that reduce input and handling costs. Furthermore, any efforts to improve camel milk production must consider investing in herding labour and the camel herd through strategies such as proper breeding, provision of suitable veterinary and extension services and climate information. Moreover, investment in integration of the otherwise subsistence pastoral production into the mainstream market economy will help facilitate the access of better markets by camel milk producers. This approach will ensure that the remote areas open up thereby exposing pastoralists to wider choices from the existing array of established markets. These interventions, among others, will strengthen the ability of camel milk producers to participate effectively in those markets with higher benefits, which will consequently improve their income security and, therefore, enhance pastoral household resilience.

CHAPTER 1

INTRODUCTION

1.1 SUMMARY

This chapter provides the context of the study by providing general information on the livestock sector. The chapter captures the importance of the livestock sector in supporting millions of people across the dryland of Kenya in the face of various challenges such as climate variability and change. It also provides an overview of the potential of camel milk and its role in enhancing food security and alleviation of poverty, particularly in the context of recurrent drought and other extreme weather events. Furthermore, the chapter provides the scope of the study including the assessment of the potential of camel milk as an alternative livelihood for building pastoral household resilience using the existing production system and post-production activities.

1.2 BACKGROUND

Livestock constitute 40% of the global value of agricultural output and support the food security and livelihood of billions of people (Caceres, 2011). In Africa, livestock-derived food items contribute up to 30% of agricultural Gross Domestic Product (GDP). This excludes non-food livestock products such as draught power and manure, which enhance the productivity of crop production (FAO, 2009). Livestock form an integral part of the mixed farming system and play important roles such as provision of employment and store of wealth, being a form of insurance, and contributing to gender equality by generating opportunities for women. With such significant socio-economic and cultural importance, livestock are key enhancers of livelihoods, food security and poverty reduction in the continent (Randolph *et al.*, 2007).

Livestock production constitutes the main source of livelihood for more than 10 million people living in Arid and Semi-arid Lands (ASAL) in Kenya. Three livestock production systems are commonly distinguished in these areas, namely, commercial ranching, pastoralism and agro-pastoralism (Desta and Coppock, 2004). The operation and efficiency of pastoralism depend to a large extent on independent family units that regularly exploit common rangeland resources through well adapted strategies that are deliberately designed to maximise the use of existing dryland resources (Gachathi and Eriksen, 2011). These strategies, among others, include herd diversification, mobility, maximization of stock numbers, splitting of herds, redistribution of assets, and reserve of rich-patch vegetation areas (Roth, 1996).

Pastoralism is a highly flexible system, which has evolved over time as the most efficient means of exploiting transient resources under ecologically marginal conditions and the prevailing economy (Lelon *et al.*, 2010). In the recent years, pastoralists in the drylands have been constantly devastated by serious droughts and diseases mostly associated with the climate change (Hussen, 2008). However, many governments in Africa, including Kenya, and international development agencies have taken measures to ameliorate this situation (Shinya, 1997). These measures include development programs and policies to enhance pastoral livelihood and increase resilience. So far, these efforts are neither sustainable nor effective (Johnson and Wambile, 2011).

Recurrent droughts in North-Eastern Kenya have caused severe damage to pastoral household livelihoods resulting in a rise of diseases among animals as well as wasting and malnutrition, leading to high mortalities of livestock of 40% and reaching up to 70% in some areas (Serna,

2011). It can be argued that climate variability and change will increase the vulnerability of the existing livestock systems and thus make it less effective as a sustainable livelihood option (Sere *et al.*, 2008). Despite very high losses of cattle, sheep and goats associated with environmental changes, there are few records of losses in camels. For instance, in Niger there was 100% cattle mortality, 50% sheep and goat mortality and only 20% mortality in camels (Yagil, 1982). However, despite the ability to survive under harsh climatic conditions and the potential to enhance pastoral household livelihoods under stressful environments (Ahmed *et al.*, 2002), camel production in Kenya is yet to be exploited to its full potential.

It is estimated that Kenya has the fifth largest camel herd in the world after Somalia, Sudan, Ethiopia and Mauritania (Farah *et al.*, 2004). In 2007, camels found in Kenya were estimated at 1.06 million of dromedary (one humped) type, traditionally kept by the Somali, Rendille, Gabbra and Turkana communities living in the country's harshest ASALs of northern and north-eastern Kenya (GoK, 2010). The region is also ranked as the poorest part of the country (Farah and Fischer, 2004). However, there is a growing interest in the camel and its products across the dry areas of Kenya (Lore *et al.*, 2005). This is due to various factors that include the fact that camel milk fetches higher prices than cow milk. Camels have proven that they can survive drought and continue to produce milk (Belay and Mangi, 2005). In this regard, camel milk has the potential to increase pastoral resilience, alleviate poverty and enhance pastoral household food security.

Against this background, this study explored the contribution of camel production as a livelihood strategy and a way of increasing pastoral household resilience to climate variability, climate change, and environmental stresses and shocks. The study focused on four areas of assessment.

First, it examined the contribution of the existing camel milk sub-sector to the household well-being, through consumption and income generation at the camel milk producer household level. Second, the study assessed the role and contribution of different actors involved in camel milk value chain in order to determine their profitability and identify constraints faced by the chain actors. Third, it determined the factors that might enhance or hinder camel milk production in order to provide sufficient information on what should be considered to promote camel milk production. Finally, the study assessed the determinants of the choice of marketing outlets by camel milk producers in order to identify the most profitable milk marketing outlets that would enhance pastoral households' income and food security.

1.3 STATEMENT OF THE PROBLEM

The adverse effects of climate variability and change in Kenya have directly weakened the pastoral system and made it less effective as a livelihood option (Chikamai and Eriksen, 2011). This can be clearly seen in the arid and semi-arid areas in Kenya where most pastoral households base their livelihoods on consumption and sale of livestock and livestock products, mostly cattle but also goats, sheep and camels. In North-Eastern Kenya, extreme climatic events, especially droughts, have undermined the ability of cattle and goats in supporting pastoral household food security. This has led to weakened resilience of pastoral households which are more exposed and vulnerable to different natural and artificial shocks that perpetuate poverty. Given the camel's tolerance to extreme climatic events, On the other hand, camel can offer a suitable pathway to pastoral household resilience. However, little is known about the contribution of camel milk production to in building resilience of pastoral livelihoods against the prevailing climate variability and change.

1.4 JUSTIFICATION

In Kenya, vulnerability to climate variability and change is exacerbated by inappropriate government policy interventions, at both national and local levels, thus leading to massive livestock and income losses (Davies, 2008). Hence, supporting pastoral households to diversify their livelihoods is critical for the purpose of building their resilience against climatic shocks (Farah, 1996). In the recent past, camel production has gained popularity as an alternative livelihood in the pastoral areas of Kenya due to its drought and disease tolerance traits. Generally, camels thrive in the harshest environmental conditions in the arid areas of Kenya and withstand frequent droughts which decimate cattle, goats and sheep populations, and yet continue to produce decent quantities of milk and meat (Farah *et al.*, 2004). Camel milk production therefore may offer a sustainable alternative livelihood in the face of changing climate and environment in the drylands of Kenya.

Whereas it is already known that camel can survive the hardest climatic and environmental conditions (Yagil and Etzion, 1980; Yagil, 1982; Farah *et al.*, 2004; Schwartz *et al.*, 1992; Farah *et al.*, 2004; Mehari *et al.*, 2007), it is important to have location-specific information and data to inform policy makers at the national and local levels. The purpose of this study is, therefore, to assess the potential of camel milk as an alternative livelihood for building pastoral household resilience in the drylands of Kenya. The study was conducted in Isiolo County of Kenya with special focus on the camel producing areas. The information generated from this study will be used to guide climate variability and change adaptation policies and specifically the adoption of camel rearing in the drylands of Kenya.

1.5 OBJECTIVES

1.5.1 Overall Objective

The overall objective of this study was to assess the role of camel milk production as a livelihood strategy for building pastoral household resilience in the face of climate variability and change in the drylands of Kenya.

1.5.2 Specific Objectives

The specific objectives were to:

1. Assess the contribution of camel milk to the pastoral household food basket and income in the study area.
2. Determine the functionality, profitability, efficiency and constraints of camel milk value chain in the study area.
3. Determine the factors affecting camel milk production in the study area.
4. Determine the factors influencing the choice of marketing outlets by camel milk producers in the study area.

1.6 HYPOTHESES

1. There is significant contribution of camel milk production to the pastoral household food basket and income in the study area.
2. The camel milk production and trade is profitable in the study area.
3. Production and non-production related factors influence camel milk production in the study area.

4. Production, demographic, institutional and marketing factors influence the choice of a marketing outlet by camel milk producers in the study area.

1.7 LIMITATIONS OF THE STUDY

The study examined the contribution of camel milk to household food consumption and income within the pastoral setup of Kenya. However, consumption of camel milk is further influenced by cultural and social factors; therefore, every community is unique and differs from the rest in the extent to which it will consider including camel milk as a source of protein and nutrient. Furthermore, the factors affecting camel milk production vary within the drylands of Kenya. Thus the results of this study might only be applicable to areas which have the same climatic and topographic characteristics as those of the study area. Additionally, the factors that influence the choice of marketing outlets are highly dynamic and change with changes in political and institutional setup within and beyond the study area. Therefore, the use of these results should be supplemented by additional information on the existing political and institutional frameworks.

1.8 THESIS ORGANISATION

This thesis is organised into nine chapters. The first chapter provides the general introduction of the study. It presents the background of the study, research problem, significance of the study, objectives, hypotheses tested and the limitations of the study. The chapter provides an overview of the current contribution of the livestock sector to the national economy of Kenya, the situation in the pastoral areas which needs urgent attention as well as the potential of camel milk in addressing the vulnerability of pastoral production economy.

The second chapter provides the literature review. The chapter gives an overview of the livestock sector in Kenya as well as the relationship between climate variability, climate change and livestock production with special focus on camel production under pastoralism in the drylands. Furthermore, it provides a review of the concept of value chain and how this is applied to livestock products as well as differentiating between livestock value chain and livestock supply chain. The chapter also reviews camel milk production and consumption in Kenya, camel milk value chain and the factors affecting camel milk production. The methodologies used in previous studies are reviewed in order to identify the existing gaps that should be addressed. The description of the study area and its relevance to the topic under study is given in Chapter Three. It describes the study boundaries, location, population, climate, environment, soil, vegetation and the livelihoods of the inhabitants of the study area.

Chapter Four discusses the various methodologies that were adopted to generate results to achieve the objectives of this study. These include the study design, sampling methodology and procedure, data sources, methods of data collection and the procedure undertaken before and during data collection. The chapter also provides an overview of different models and how suitable they are in achieving the objectives of the study.

Chapter Five presents finding related to the first objective of the study. The chapter starts by describing household characteristics in the study area. The chapter further examines the contribution of camel milk to household food basket in terms of the quantity of various foods consumed and the share of camel milk in the average pastoral household budget. The chapter examines the contribution of camel milk to the household food basket and income in both wet

and dry seasons. Furthermore, it examines the contribution of camel milk to household income, in terms of the proportion of income derived from activities related to camel milk production and marketing. This chapter is followed by Chapter Six which addresses the functionality, marketing channels efficiency and profitability of camel milk value chain in terms of characterisation of the actors involved, their profit margins and product transformation of camel milk. The chapter also provides a visual representation of the value chain from the production level up until the consumption level. Further, the chapter examines the challenges and constraints faced by various actors involved in the milk value chain.

Chapter Seven addresses the factors that affecting camel milk production in the study area. Using Simultaneous Equation Model (SEM), the study examined camel production-based factors such as pastoral household herd size, herd composition, labour, and distance to pasture and water. Also examined are non-production based factors such as socio-economic and demographic characteristics of the camel milk producers that are closely related to the production of camel milk as well as production supporting factors which include among others extension service, distance to market and security. This chapter is followed by Chapter Eight which focuses on modelling the choice of marketing outlets by camel milk producers. Using the Multinomial Logistic Model, the study assessed the influence of various factors on the choice of milk outlets. These include production factors such as camel milk herd size, daily milk production, and distance to water points and grazing; demographic factors which include gender of the camel milk producer, education level, household size and age of the camel milk producer; institutional factors which include access to climatic information, veterinary services, extension services and access to credit among camel milk producers in Isiolo County; and the marketing factors such as

prices offered at different marketing outlets and distance to the preferred market. A summary, conclusion and policy implications of the study are provided in the last chapter.

REFERENCES

- Ahmed, A., A. Azeze, M. Babiker, and D. Tsegaye (2002). Post-drought recovery strategies among the pastoral households in the Horn of Africa: A review. *Development Research Report Series No. 3*. OSSREA (Organization for Social Science Research in Eastern and Southern Africa), Addis Ababa. pp 80.
- Belay, K. and W. Manig (2005). Coping with drought among pastoral and agro-pastoral communities in eastern Ethiopia. *Journal of Rural Development*, **28** (2), 185-210.
- Caceres, S. (2011). Climatic changes, infectious diseases, and livestock production. *Livestock Research for Rural Development*, **23** (9).
- Chikamai, N. and S. Eriksen (2011). Gums and resins: The potential for supporting sustainable adaptation in Kenya's drylands. *Climate and Development*, **3** (1), 59-70.
- Davies, J. (2008) Turning the tide: Enabling sustainable development for Africa's mobile pastoralists, *Natural Resources Forum*, **32** (1), 175-184.
- Desta, S. and D. Coppock (2004). Pastoralism under pressure: Tracking system change in southern Ethiopia. *Human Ecology*, **32** (4), 465-486.
- Farah, O. (1996). Management and development of the arid communal rangelands in North-Eastern Kenya: A critical analysis of the past and the present. *The African Pastoral Forum, Working Paper Series No.7*, June, 1996. PINEP (Pastoral Information Network Programme), University of Nairobi, Nairobi, Kenya.
- Farah, O., D. Nyariki, R. Ngugi, I. Noor and A. Guliye (2004). The Somali and the camel: Ecology, management and economics. *Anthropologist*, **6** (1), 45-55.
- Farah, Z. and A. Fischer (2004). *The camel (C. dromedarius) as a Meat and Milk Animal: Handbook and Product Development*. Vdf Hochschulverlag. Sitz, Zürich www.camelgate.com. Accessed on 2nd of January 2012.
- Farah, Z., T. Streiff and R. Bachmann (2004). Preparation and consumer acceptability tests of fermented camel milk in Kenya. *Journal of Dairy Research*, **57** (2), 281-283.
- FAO. (Food and Agriculture Organization) (2009). The state of food and agriculture; livestock in balance. Food and Agriculture Organization of the United Nations, Rome, Italy, <http://www.fao.org/docrep/012/i0680e/i0680e.pdf>. Accessed on 1st of March 2012.

- Gachathi, F. N. and S. Eriksen. (2011). Gums and resins: The potential for supporting sustainable adaptation in Kenya's drylands. *Climate and Development*, **3** (1), 59-70.
- GoK. (Government of Kenya)(2010). Agricultural sector development strategy 2010–2022. Ministry of Agriculture. *Government printer*, Nairobi, Kenya.
- Hussen, K., A. Tegegne, M. Yousuf and B. Gebremedhin (2008). Cow and camel milk production and marketing in agro-pastoral and mixed crop-livestock systems in Ethiopia. *Proceedings of Tropentag 2008, 7–9 October, 2008, University of Hohenheim, Germany*.
- Johnson, N. and A. Wambile (Eds.) (2011). The impacts of the Arid Lands Resource Management Project (ALRMPII) on livelihoods and vulnerability in the arid and semi-arid lands of Kenya. *ILRI Research Report 25*. Nairobi, Kenya.
- Lelon, J., I. Jumba, J. Keter, W. Chemuku and O. Oduor (2010). Assessment of physical properties of gum arabic from *Acacia senegal* varieties in Baringo District, Kenya. *African Journal of Plant Science*, **4** (4), 95-98.
- Lore, A., S. Mbugua and J. Wangoh (2005). Enumeration and identification of micro-flora in suusac, a Kenyan traditional fermented camel milk product. *Lebensmittel Wissenschaft und Technologie, LWT-Food Science and Technology*, **38** (2), 125-130.
- Mehari, Y., Z. Mekuriaw and G. Gebru (2007). Potentials of camel production in Babilie and Kebribeyah woredas of the Jijiga Zone, Somali Region, Ethiopia. *Livestock Research for Rural Development*, **19** (4).
- Randolph, F., E. Schelling, D. Grace, C. Nicholson, J. Leroy, D. Cole, M. Demment, A. Omore, J. Zinsstag and M. Ruel (2007). Invited review: Role of livestock in human nutrition and health for poverty reduction in developing countries. *Journal of Animal Science*, **85** (10), 2788–2800.
- Roth, E. (1996). Traditional pastoral strategies in a modern world: An example from northern Kenya. *Human Organization*, **55** (2), 219-224.
- Schwartz, H., M. Dioli, R. Stimmelmayer and M. Walsh (1992). *The one-humped camel (Camelus dromedarius) in eastern Africa. A pictorial guide to diseases, health care and management*. Verlag Josef Margraf. Weikersheim, Germany.
- Sere, C., A. Ayantunde, A. Duncan, B. Freeman, A. Herrero S. Tarawali and I. Wright (2008). Livestock production and poverty alleviation, challenges and opportunities in arid and semi-arid tropical rangeland based systems. *Workshop report*. ILRI, Nairobi, Kenya.
- Serna, J. (2011). Drought assessment in north-eastern Kenya (Wajir East, South and Mandera). Save the children, publication. <http://www.disasterriskreduction.net>. Accessed on 19th of September 2012.
- Shinya, K. (1997). The Samburu Livestock Market in North Central Kenya. *African Study Monographs*, **18** (3, 4), 137-155.

Yagil, R. (1982). Camels and camel milk. *FAO Anim. Production Health. Paper No. 26*, 1- 69.

Yagil, R. and Z. Etzion (1980). The effect of drought conditions on the quality of camels' milk. *Journal of Dairy Research*, **47** (2), 159-166.

CHAPTER 2

LITERATURE REVIEW

2.1 SUMMARY

This chapter presents a literature on pastoral production system and pastoral household livelihoods with a particular focus on camel milk production and marketing. The chapter starts with a conceptual framework demonstrating the role of camel milk production in building pastoral household resilience and the hypothesised change towards achieving pastoral household resilience. This is followed by an overview of the livestock sector in Kenya and the concept of livestock value chain. A review of the pastoral household food basket and the relationship between climate variability and camel milk production are also presented. The chapter further presents an overview of camel production in Kenya and camel milk value chain. It also reviews the policy and institutional frameworks in the camel milk subsector. Finally, the conclusion is drawn on the missing gaps in knowledge and methodologies.

2.2 CONCEPTUAL FRAMEWORK

Livelihood studies are based on livelihood framework that encompasses a complex interaction between political, economic, social and environmental factors (Plummer and Armitage, 2007; Ratner *et al.*, 2013; Ifejika *et al.*, 2014). This framework focuses on the adaptive capacity of households and communities that are determined access to assets, transformative structures and processes as well as diverse and reliable livelihood strategies (Frankenberger *et al.*, 2012). However, in the face of climatic extremes, the resilience framework is more relevant because it integrates the livelihood framework with components on disaster risk management and climate change adaptation (Frankel-Reed *et al.*, 2011). This integrated framework addresses the

underlying causes that include institutional, structural, socio-economic and environmental factors that contribute to vulnerability. The framework lays the basis for understanding the adaptive capacity of individuals, households and communities to respond to disturbances such as drought, floods, rapid increase of prices and conflict. It also forms the basis of understanding how such disturbances affect livelihood security and exposure to risk, which result either in increased vulnerability or increased adaptive capacity over time (Tschakert and Dietrich, 2010). The resilience framework comprises seven elements, namely, the context; disturbance; exposure; adaptive capacity, sensitivity; resilience and vulnerability pathways; and livelihood outcomes (Figure 2.1).

The context refers to the environmental, political, social, economic, historical, demographic and policy conditions that affect households, communities and governments, and which determine the extent to which they are able to cope with risks. The context is dynamic, rather than static, and changes according to the adaptive capacity of a unit in response to risks and disasters (Alinovi *et al.*, 2010). Therefore, any change in adaptive capacity will result in changing at least some contextual factors, which impacts either positively or negatively the ability of a unit to cope with future risks and disasters. Disturbance refers to any rapid or slow onset shocks such as earthquakes, floods, drought, human disease epidemics, plant pest outbreaks, and conflict, or longer-term stresses such as environmental degradation, political instability, conflict and price inflation (Pasteur, 2011). However, some disturbances are idiosyncratic meaning they affect only certain individuals or households, whereas others are covariate and therefore affect an entire population or geographic area.

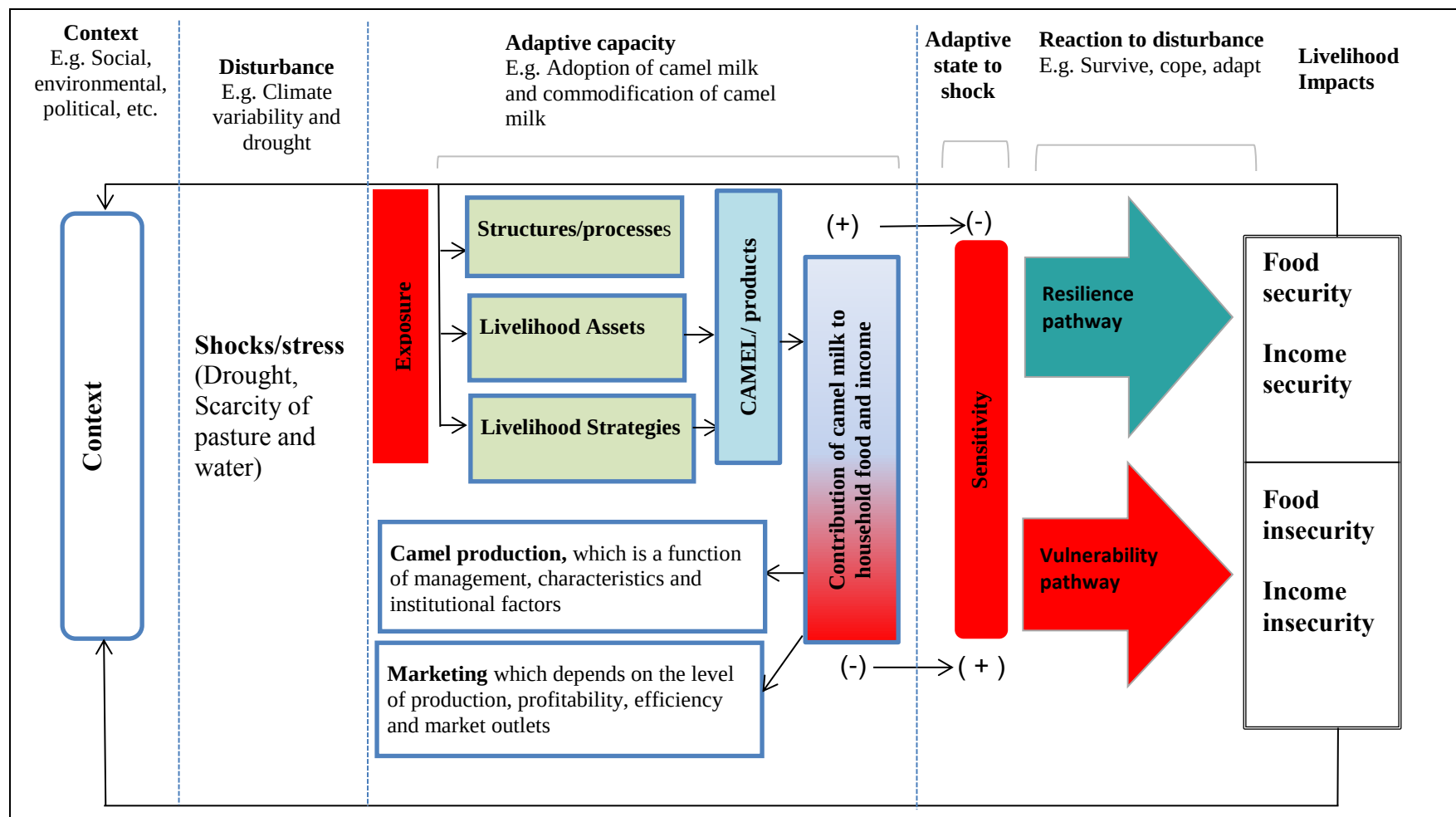


Figure 2.1: Conceptual framework for camel milk commodification as a strategy for building pastoral household resilience

Source: Adapted from Frankel-Reed *et al.* (2011)

Exposure in the context of resilience is a function of the magnitude, frequency, and duration of a shock or stress. Many stresses or shocks are seasonal and include floods, pest outbreaks, and unemployment. The inability to cope with seasonal shocks or stresses can make already vulnerable households even more vulnerable to disasters by increasing their risk of exposure to future hazards (Pasteur, 2011). Adaptive capacity, on the other hand, is the nature and extent of access to and use of resources in order to deal not only with disturbances but also with stresses and long-term change dynamics. It can be thought of as both the processes and assets that enable a unit or system to adapt rather than the act of adapting, or its outcome (Ludi *et al.*, 2011).

In the resilience framework, adaptive capacity comprises three basic, but interrelated elements: livelihood assets; transforming structures and processes; and livelihood strategies (Frankel-Reed *et al.*, 2011). Sensitivity to shocks refers to the degree to which an individual, household or community will be affected by a given shock or stress. Vulnerability is a function of exposure, adaptive capacity, and sensitivity (Pasteur, 2011). Resilience and vulnerability pathways are viewed as processes rather than static states. Households or communities that are able to use their adaptive capacity to manage the shocks or stresses they are exposed to are less sensitive and are on a resilience pathway. Households that are not able to use their adaptive capacity to manage shocks or stresses are sensitive to shocks and are likely to go down a vulnerability pathway (Ludi *et al.*, 2011).

Livelihood outcomes refer to the needs and objectives that households are pursuing. Resilient individuals, communities and households will be able to meet their food security needs, will have access to adequate nutrition, their environment will be protected, they will have income and

health security, and they will be able to participate in the decisions that affect their lives (Alinovi *et al.*, 2009).

2.3 THE HYPOTHESIZED CHANGE TOWARDS PASTORAL HOUSEHOLD RESILIENCE

The current study utilizes the resilience framework to explain the theory of change involving commodification of camel milk by pastoral households as a resilience pathway in response to increasing climate variability. Climatic extremes, particularly recurrent droughts have resulted in scarcity of water and pasture, which are the main input for pastoral production systems (Hussen, 2008; Serna, 2011). Hence, livestock herd diversification by households in order to benefit from the inherent insurance against climate-related risks afforded by mixed-species herds, although a traditional practice, is gaining popularity among pastoral communities. Rearing of camels along other livestock species is seen as a possible way of building resilience of the pastoral production systems against climate variability and change (Jones and Thornton, 2008). The enhanced resilience of pastoral livelihoods is envisaged in the contribution of camel milk to the pastoral household food and income. This is because camel milk production is seen as having the potential to smoothen seasonal fluctuations in household food consumption and nutrition. This is based on the fact that camels can tolerate prolonged dry conditions as well as droughts (Belay *et al.*, 2005), and therefore are an important source of milk during such times when other livestock species can no longer provide the much needed milk.

Camel milk production is not only important for subsistence but also for commercialization to earn income to secure other basic needs. This way the adoption or promotion of camel milk

production serves to strengthen the otherwise traditional livelihood, as well as provide a pathway for diversifying asset portfolios. However, as shown in Figure 2.1, the contribution of camel milk to households' well-being is influenced by many factors, most of them being the same factors that influence the larger resilience context, namely, social, economic, ecological and political factors. These factors are those that are intrinsic to individual pastoral households such as herd management, access to various production related services, socio-demographic, institutional and policy factors.

Marketing factors are also critical in influencing the contribution of camel milk to household income. Such factors include market infrastructure, level of profitability of various chain actors and efficiency of various marketing outlets. In this study, the envisaged change model for building resilience of pastoral households is shown in Figure 2.2. It comprises four major change pathways, namely, income and food security, functional and efficient market, access to profitable market outlets, and improved milk production.

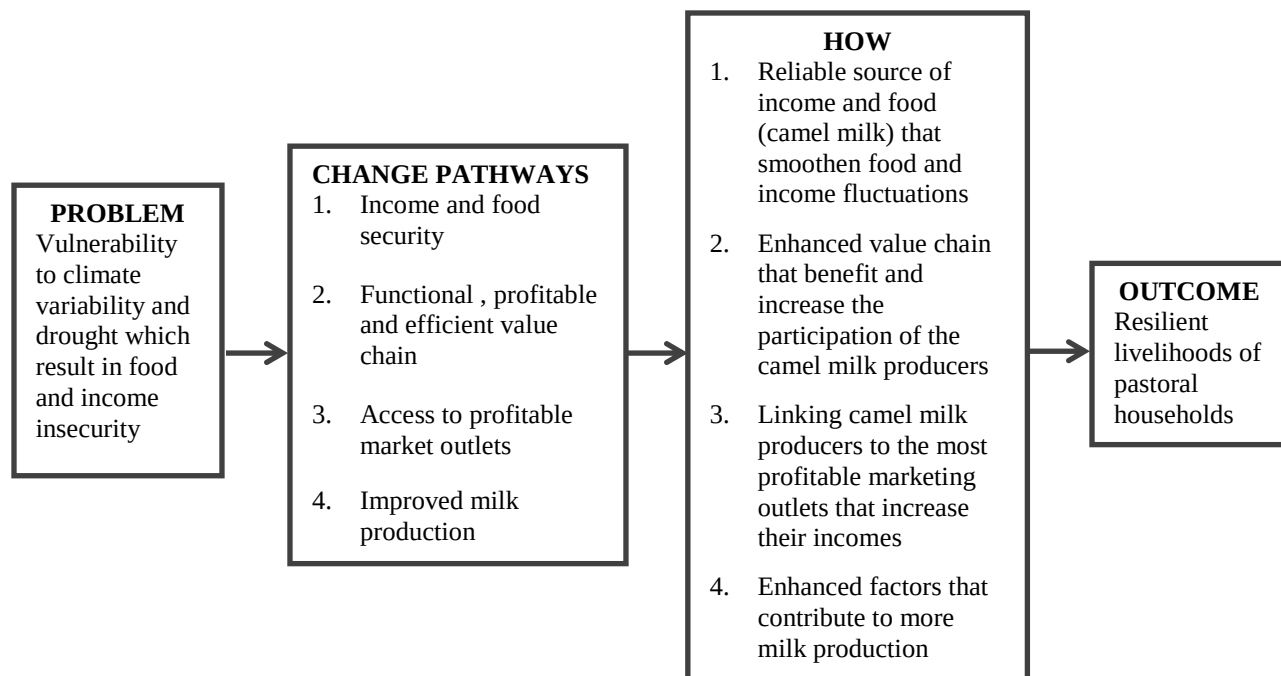


Figure 2.2: Theory of change model for camel milk commodification as a strategy for building pastoral household resilience

During prolonged dry seasons and droughts, camel milk can confer resilience to pastoral livelihoods by offering a possibility of bridging the deficits in the supply of foodstuff and income from other livestock species and their products (Anderson *et al.*, 2012). A functional, profitable and efficient value chain contributes to pastoral household resilience through the provision of reliable market structures that offer outlets for pastoral products and increase participation of pastoral households in the market (Degen, 2011). Access to profitable market outlets, on the other hand, enhances pastoral household profits, which have a direct contribution to their income security. Therefore, factors such as producer socio-demographic characteristics and institutional and marketing dynamics are critical in enhancing such market access. Other factors that would determine camel milk production and therefore contribution to household diet and food are herd management and access to production related services.

Besides the known capability and tolerance of camels to harsh conditions typical of pastoral ecosystems, understanding the aforesaid factors in the pastoral context is key to determining the contribution of camel milk production to the pastoral livelihoods resilience against climate variability and change.

2.4 LIVESTOCK SECTOR IN KENYA

Kenya, like other African countries, heavily depends on agriculture for food and economic growth. According to the Agricultural Sector Development Strategy 2010–2012, the agricultural sector contributes about 25% of the country's GDP and employs 75% of the national agricultural labour force and 90% of the ASAL workforce (GoK, 2010). This sector also provides about 95% of the incomes in the pastoral areas of Kenya. In 2009 the livestock resources were estimated at 105 million tropical livestock units comprising 17.5 million cattle, 17.1 million sheep, 27.8 million goats, 2.9 million camels, 1.8 million donkeys, 31.8 million indigenous and exotic chicken, and 6.1 million pigs. The amount of beef and milk from cattle was estimated at 320,000 MT and 3 million MT per annum, respectively (Perry and Grace, 2009). Although Kenya is generally self-sufficient in terms of livestock products, the country is a net importer of meat. Hence, cattle are trekked across the borders of neighbouring countries, mostly, Tanzania, Ethiopia and Somalia (Thornton, 2010).

Livestock trade in Kenya is a complex marketing system involving a set of interactions between Kenya and the neighbouring countries, as well as the livestock market in the Middle East and their respective demand and market prices (Barrett *et al.*, 2003). As part of the regional market, livestock flow according to market price differentials in a liberalised system throughout the

region as a whole where Nairobi represents a focus of demand for the region (Barrett *et al.*, 1999). This focus is driven by factors such as an increase in population and income in Kenya.

Despite its contribution to the national economy, the livestock sector in Kenya is faced by multiple challenges, include frequent disease outbreaks, poor market structure and trade linkages, and feed shortage (Sere, 2008). This scenario is exacerbated by extreme climatic events, chiefly drought, which has a devastating effect on pastoral livelihoods. It has been argued that climate variability and change will exacerbate the vulnerability of extensive livestock systems by reinforcing the factors that undermine the resilience of the livestock sector and particularly that of pastoral systems. These factors are previewed to be those that put pressure on the natural resource base. These includes; rise in population and economic growth, increased demand for food (including livestock) and products and increased conflict over scarce resources. Generally, droughts affect the quality and quantity of water and grazing resources particularly in the drylands, thereby undermining pastoral livestock production, which eventually leads to reduced incomes and aggravated poverty. The same droughts may also trigger a series of events that includes conflicts, cattle raids, loss of human life and livestock, and land degradation (Eriksen and Lind, 2009). Berston and Jacobs (1983) report three types of drought occurring in Maasai pastoral lands; a mild drought that comes every 3 to 5 years, a very severe drought that comes every 7 to 8 years, and a devastating drought that comes every 11 to 15 years. Thus, there is hardly a year a 15 year span that one type of drought will not hit Maasai land. The drought are also reported to be followed by severe insect infestation coming with the first rains, affecting both people and livestock health.

2.5 PASTORAL LIVESTOCK PRODUCTION IN KENYA

Pastoral livestock production is practiced in almost 80% of the land mass in Kenya. This system involves independent family units exploiting common resource such as water and grazing land through privately owned and managed livestock herds (Fernandez-Gimenez, 2002). The most common pastoral systems practiced in Kenya are sedentary (settled) pastoralism, nomadic pastoralism and transhumance. Sedentary pastoralism is mostly practiced in areas where mobility is restricted. The common practices include small scale irrigated agriculture along various rivers in the drylands, converting key grazing ranges into croplands and keeping cattle and small stock such as goats (Wasonga, 2009). According to Koocheki and Gliessman (2005), nomadic pastoralism is the oldest form of pastoralism and is still the common practice in many parts of Kenya. The traditional strategies and practices for nomadic pastoralists include flexible and mobile responses to highly variable and often stressful environment (Wasonga, 2009). The elders exercise control over rangeland use by deciding which areas are to be opened for dry season grazing. Nomadic pastoralists are undergoing a transition to settled lifestyle resulting to transhumance as the dominant type of pastoralism in most drylands of Kenya.

Transhumance can be considered a strategic move for pastoralists to cope with the ever decreasing pastoral family income levels, changing land use patterns and weather conditions. This type of pastoralism is characterized by herd splitting in which lactating stock are left behind and the dry ones are moved in search of appropriate feed and water resources (Dieye and Roy, 2012). In this system, pastoral producers with large herd sizes usually split them into small groups for proper management during movements and stay in different grazing zones. The frequent movement of herds between grazing units helps to avoid overuse of a single pasture

resource area and reduce transmission of diseases (Bhasin, 2011). This is a highly flexible system, which has evolved over time as the most efficient means of exploiting transient water and pasture under ecologically marginal conditions, available technologies and the prevailing economy (Chikamai and Eriksen, 2011). However, frequent, prolonged and severe droughts are posing great challenges to Kenya's pastoral livestock production systems.

Drought has a devastating effect on pastoral livelihoods arising from animal wasting and malnutrition, leading to a high mortality rates of livestock of between 40% and 70% in some areas in Kenya (Serna, 2011). Extreme climate events increase vulnerability of pastoralists who are already grappling with the negative impact of marginalization and inappropriate interventions such as sedentarisation, which curtailed herd mobility (Mattee and Shem, 2006). These was a result of a combination of policies and development interventions aimed at settling pastoral populations and introduction of non-livestock economic activities such as farming or fishing (Hogg, 1987; Heald, 1999; Owour *et al.*, 2011). Insecurity and lack of veterinary and other livestock support services have increased the difficulty to recover and restock after livestock losses, leaving an increasing number of people with small herds or no herds at all (Eriksen and Lind, 2009). Under such conditions, sustainability of pastoralism as a livelihood option faces a number of hurdles. The current situation in many pastoral areas in Kenya requires appropriate interventions such as up-scaling the use of more drought tolerant livestock species, such as the camel, which can survive under the harsh climatic conditions and have the ability to enhance pastoral household livelihoods, considering the important role played by livestock in pastoral households in terms of provision of food and non-food items.

2.6 THE ROLE OF LIVESTOCK IN PASTORAL ECONOMY

The pastoral production system supports the livelihoods of more than 10 million people in Kenya, which is roughly 25% of the country's population (Mbogoh and Shaabani, 1999; Little *et al.*, 2006). Pastoral production system is entirely built around livestock and thus the major providers of household income and food (Ifejika *et al.*, 2008). The provision of income is mostly through the sale of live animals and other livestock products such as milk, hides and skins (Nduma *et al.*, 2001). The offtake of live animals and the disposal of livestock products are influenced to a great extent by seasonality, particularly of milk. The dry season is usually associated with water and fodder shortage stresses which leads to a decrease in income generated from livestock production activities. Therefore, pastoral households engage in off-farm activities to sustain their livelihood. Off-farm income sources during the dry season included bee keeping, petty trade, and wage employment, to ease the pressure on the pastoral system (Elhadi *et al.*, 2012). However, off-farm activities are partially limited by several factors such as the capacity of pastoral households, the available resources and infrastructure such as access to markets. Therefore, most pastoralists fall into the trap of poverty and food insecurity during such periods (Berhanu *et al.*, 2007). Hence, it is critical to examine the contribution of all income generating activities to the households and the sustainability of such activities and their contribution to pastoral household food basket.

Pastoral household food basket is mostly made up of livestock products and other non-livestock products. The food basket can be defined in many ways. For instance, Flores and Bents (1980) defined family food basket as a mixture of basic products which make up the usual diet of a population in sufficient amounts to cover adequately the energy requirements of each member of

the family. Lareo *et al.* (1990) defined a food basket as a group of foods that is consumed by important population segments of the community, contributes a substantial portion of the calories and proteins purchased, and is responsible for a significant proportion of the food budget. FAO (2012) defined food basket on a regional and/or national level with a particular focused on staple crops, i.e. the crops that constitute a dominant part of the diet and supply a major proportion of the energy and nutrient needs by individuals in a given country. Øyen (1999) defines a food basket as the calculated price of a set of basic foodstuffs standardized according to percentage of expenditure on food and size of household. This study adopted the definition of Øyen (1999), which is based on the calculated prices on the foodstuffs, where estimation of the monetary value of the basket is used as the basis for establishment of minimum wages for different socioeconomic groups (Flores and Bents, 1980).

In Kenya, most pastoralists depend on livestock and livestock products such as milk, blood and meat for their subsistence. The extent to which any of these products is consumed depends on many factors such as culture, availability of alternative sources of energy and protein, as well as the distance to the nearest trading centre. In peri-urban areas, the food basket of the pastoralists not only comprises livestock products, but also cereals, sugar, oil and rice. This is because households living near trading centres are more likely to access other foodstuff to supplement livestock products. On the other hand, some herders usually supplement livestock products with imported grain of maize or sorghum. Others households consume mainly livestock products in the herding camps and eat more grains in the settlements (Sato, 1997).

Most pastoralists sell or exchange livestock and their products to be able to meet the non-livestock essential food items. The exchange processes mostly subject them to a seasonal and long term shifts in terms of exchange of their products such as live animal and dairy product with food grain. The availability of these products fluctuates in absolute and relative terms as a result of seasonal variation effect. This variation in most cases might result in a food supply gap, particularly during prolonged dry season and drought. This is because, different and interrelated factors such as those related to the deteriorated condition of livestock and a scarcity of water and pasture are more pronounced (Witsenburg and Adano, 2009). Therefore, animals fail to produce enough products for domestic use and for exchange; thus food security and malnutrition become inevitable.

Pastoralists have developed several strategies to deal with the uncertainties of climatic fluctuations. These strategies include engaging in non-land-based livelihood options, entering or withdrawing from livestock market and, most importantly, livestock herd diversification (Orindi *et al.*, 2007). Taking into account the limited off-farm livelihood activities and the condition of livestock during harsh periods, access to adequate food through production and purchases is always limited (Elhadi *et al.*, 2012). Therefore, diversification is by far the most suitable strategy, not only for survival and spreading risks during such periods, but also for optimising use of spatially and temporally varied resources. Herd diversification is increasingly gaining importance as the need to stock more drought tolerant species become apparent (Roth, 1996; Fratkin, 2001; Yosef *et al.*, 2013). This trend has seen the spread of camel adoption even among communities that are traditionally not known to keep camels. The current high demand for its

milk and meat in urban centres has added to the incentive of keeping camels by both traditional and non-traditional camel keepers (Anderson *et al.*, 2012; Akweya *et al.*, 2012).

2.7 CAMEL PRODUCTION IN KENYA

Kenya has an estimated population of about 1.5 million camels (GoK, 2010). They are normally found in the former north-eastern province (54%), eastern province comprising Marsabit, Moyale and Isiolo Districts (29%), Rift Valley (13%) and coast province (4%). Humidity is generally considered as the main factor limiting the distribution of camels to other parts of the country. The southern limit of the dromedary's (*Camelus dromedarius*) range is said to be approximate the 400-500mm isohyets (Fehri, 1987). In Eastern Africa, 3°S was commonly considered the southern extent of dromedary (Wilson and Bourzat, 1988). Over time, camel rearing zone has shifted further south following adoption by other livestock keeping communities in Kenya. This trend shows that camels are gaining importance in areas where until recently cattle were the only large domestic herbivore species kept. The species have been successfully introduced to areas outside their traditional range including Kajiado, Samburu, Kilifi, Kitui, Mwingi, Narok, West Pokot and Laikipia (Huho *et al.*, 2011; Kuria *et al.*, 2011; GoK, 2010).

The camel is considered an important source of food in pastoral areas (Schwartz *et al.*, 1992). Unique physiological, anatomical and ecological adaptations enable the camel to produce and supply milk to pastoral households throughout the year (Farah, 1996). The species also provide meat, blood, recreation, wool and fibre production, draught power and transport, leather production, dung for fuel, urine as disinfectant, and bones for manufacture of jewellery. Camels

also have cultural and religious significance among the communities keeping them. In terms of food security, camel is considered to be superior to all other livestock species (Fratkin, 1991). Camels have a longer lactation period and yield more milk over the period in comparison to cattle and goats (Getahun, and Belay 2002). In Kenya, the current production of camel is estimated at 7,000 tonnes of meat worth KSh. 1 billion, and 200 million litres of milk worth KSh. 2 billion annually. Already, camel keeping has extended to the South Rift region and is expected to extend to other parts of the country in the coming decades (GoK, 2010b). Culturally, camels are highly revered animals by various camel keeping communities. For instance, among the Rendille community, camels are not just important for subsistence and transport, but also for religious and social reasons. This community refer to camel as the “other half of God” where they use camels to pay fines and dowry (Simpkin and Guturo, 1995).

The contribution of camels to the human welfare in developing countries, including Kenya, is generally obscured by a combination of several factors, which tend to underestimate their true value. First, the estimates of camel populations are usually inaccurate due to lack of regular census. Secondly, their products seldom enter a formal marketing system; thus their contribution to subsistence and the national economy tends to be grossly underestimated (Farah *et al.*, 2004). As a consequence, less attention has been given to camel improvement for many years when planning national development. In Kenya camel husbandry under pastoral conditions is subsistence oriented, and is mostly an extensive low-external input system. This system is based on the indigenous knowledge, and it is subject to harsh environmental conditions, characterised by spatial and temporal variability of rainfall and forage.

As indicated by Farah *et al.* (2004) pastoral camel production is under pressure because of multiple changes in the production environment. Increasing human population pressure on pastoral grazing areas and the economic implications resulting from diseases and lack of veterinary services are some of the factors that adversely affect traditional camel production (Desta and Coppock, 2004). Additionally, reproductive performance is low in camels due to late first parturition, long parturition intervals, and high calf mortality (Olukoye, 2003). Improvement of the reproductive performance and reduction of camel losses through management measures appear to offer possibilities of increasing camel productivity and enhance its capacity to support the increasing human population in pastoral areas. However, this calls for an assessment of the current management strategies used by pastoralists and identification of critical production and non-production factors that are directly influencing milk production and the entire camel milk value chain in the ever changing climatic conditions.

2.8 THE ROLE OF CAMEL PRODUCTION IN A VARIABLE AND CHANGING CLIMATE

The intensity of climate variability and change is already being experienced by many communities across the world. However, while climate change will affect everyone, it is expected to have a devastating effect on those living under poverty in the developing countries, and particularly the livestock keepers in marginal environments (Thomas and Twyman, 2005). Generally, climate change will have far-reaching consequences for dairy, meat and wool production, mainly arising from its impact on grassland and rangeland productivity in the drier areas worldwide (Orindi and Murray, 2005; Rowlinson, 2008; Thornton, 2010). As noted by Cohen *et al.* (2002), heat distress that is suffered by animals will reduce the rate of animal feed

intake resulting to poor performance. On the other hand, intensified droughts in certain areas will lead to a loss of forage resources. Consequently, as exemplified by many African countries, existing food insecurity and conflict over scarce resources will be escalated.

In pastoral and agro-pastoral systems, livestock is a key asset particularly for the poor people, fulfilling multiple economic, social and risk management functions (Ikeme, 2003). The impact of climate change is expected to heighten the vulnerability of livestock systems and reinforce existing factors that are affecting livestock production systems, such as rapid population and economic growth, rising demand for food (including livestock) and products and conflict over scarce resources. For pastoral communities, losing livestock assets could trigger a collapse into chronic poverty and this will have a lasting effect on livelihoods (Hahn and Morgan, 1999). Some of the direct effects of climate change will include higher temperatures and changing rainfall patterns, which could translate into increased spread of existing vector-borne diseases and macro-parasites accompanied by the emergence and circulation of new diseases (Rowlinson, 2008).

Climate affects animal production in four main ways: first, the impact of changes in livestock feed availability and price. Secondly, the impacts on livestock forage production and quality. Thirdly, changes in the spread of livestock diseases and pests and finally the direct effects of weather and extreme events on animal health, growth and reproduction (Smit *et al.*, 1996). The indirect effects of climate-driven changes on animal performance result mainly from alterations in the nutritional environment. Research suggests that changes in climate would affect the quality and quantity of forage produced (Baker and Viglizzo, 1998). The impact of climate change on

pastures and rangelands may include deterioration of pasture quality as a result of increased temperatures and less moisture (Campbell *et al.*, 1995). However, there could also be a potential increases in yield and possible expansion of grassland area if climate change become favourable, resulting to increase in carbon dioxide. Consequently, the increase in pasture availability, may improve livestock productivity (Baker *et al.*, 1993).

As climate change drastically alters the livestock production landscape, camels could replace other livestock in the hardest hit arid areas of East Africa that are no longer suitable for conventional livestock keeping (Jones and Thornton, 2008). Animals respond differently to changing climatic conditions, which is to some extent dependent on the ability of the animal to withstand the severe change in temperature and rainfall as well as the subsequent change in feeding conditions particularly in the arid environment. This effect is more pronounced during prolonged dry seasons and drought where increased losses of animals are usually observed. For instance, in Niger during the drought periods of 1980, there was 100% cattle mortality, 50% sheep and goat mortality and only 20% mortality in camel (Yagil, 1982). This is an indicative of the camel's ability to survive under harsh climatic conditions.

The low effect of drought on camel can be explained by the fact that it has low feeding and watering requirements (Gauthier-Pilters, 1979). On average, camels require a daily feed intake of about 7 to 8 kg of dry matter, which is rather low compared to other animals such as the cattle in arid areas which requires an average of 15 kg (Leeuw and Tothill, 1990). Camels can thrive for months by eating only 5 kg of dry fodder daily. The minimum ration is about 2 kg a day, recorded in the drought of 1973 (Gauthier-Pilters, 1979). Yagil *et al.* (1978) reported in Algeria,

camels can survive for more than 10 days without water. The traits that enable the camel to go for a long period without water are those that allow low rate of water loss and the high tolerance to dehydration (Schmidt-Nielsen *et al.*, 1967). These traits give camel the ability to survive under the harsh climatic conditions. This can be explored to make pastoral production systems more resilient in the face of the rapidly changing climatic conditions. As reported by Musinga *et al.* (2008) camel milk is at the centre of camel value chain development. The demand for camel milk among certain urban populace is seen as the driving factors behind commodification of camel and its products (Anderson *et al.*, 2012). This is evident in the expansion of camel milk market to the urban centres in non- camel producing zones in Kenya such as Nakuru, Meru and markets in Central Kenya. (Guliye *et al.*, 2007; Noor *et al.*, 2012; Akweya *et al.*, 2012).

2.9 CAMEL MILK VALUE CHAIN IN KENYA

According to Kaplinsky and Morris (2001) a value chain is defined as the full range of activities that are required to bring a product (service) from conception through the different phases of production, to delivery to final consumers and disposal after use. The concept of value chain provides a useful framework to understand the production, transformation and distribution of a commodity or group of commodities. Value Chain Analysis (VCA) has been widely used to describe and analyse the opportunities and challenges of products and their impact on income distribution. The value chain approach has been used to trace flow of products, show value addition at different stages, and identify key actors and their relationships along the chain.

The VCA is also used to identify enterprises that contribute to production, services and required institutional support while identify the bottlenecks preventing progress. It provides a framework

for sector-specific action and identifies strategies to help local enterprises to compete and to improve earning opportunities. In addition, VCA is used to identify relevant stakeholders for planning and formulation of policies and programs, and helps to understand how local enterprises fit into the global economy (Baker, 2006). This study adopted the definition of Kaplinsky and Morris (2001). Antonio and Sperandini (2010) indicated that value chain analysis is essential for understanding markets, their linkages, the participation of different actors, and the critical constraints that limit the growth of livestock production and consequently the competitiveness of livestock producers (Ngugi *et al.*, 2007).

The pastoral livestock value chain is faced by various constraints at the production level particularly in Africa (Thornton, 2010). These constraints include low production, poor animal genetics, and limited access to proper animal feed and poor management practices that all contribute to the low productivity levels in both meat and milk production. In Kenya, the meat value chain is poorly commercialised because most of the produce comes from the pastoral areas (DDC, 2006). The major challenges that face meat value chain include a ban on Kenyan meat products from international and regional markets, extreme deterioration of marketing infrastructure, drought and monopolistic behaviour that take advantage of pastoralists during drought periods (Pelrine, 2009). For dairy producers and other actors along the value chain, the challenges are mostly related to access to suitable and profitable markets, transportation and high transaction costs (McDermott *et al.*, 2010).

Generally, pastoral livestock producers in Kenya are currently receiving a small fraction of the ultimate value of their products (Kitalyi *et al.*, 2006). On the other hand, access to markets and

distribution of risks and benefits along different stages of livestock value chains including camel milk vary with the gender of producers (Berdegue *et al.*, 2008). This can be seen in terms of rights to income generated from livestock. The aforesaid challenges have further been worsened by the gradual change from using traditional market channels to more coordinated links among producers, processors, retailers and other actors (FAO, 2007). These linkages may disadvantage the pastoral livestock keepers since they usually receive smaller benefits from the livestock value chain (Antonio and Sperandini, 2010). However, this is not the case for highly demanded livestock products such as camel milk. The rising demand for camel and camel products in Kenya presents a great opportunity for pastoralists to benefit from the existing trade. This can be exploited as a long-term strategy to enhance livestock pro-poor policy where the high marginal effect of improving livestock value chain will directly enhance the food security situation in the dryland areas.

National annual camel milk production in Kenya is estimated at 340 million litres valued at KSh 8 billion (Davies, 2007). Only about 12- 20% of this output is marketed, 38% is consumed at home while about 50% does not reach markets. Despite this low marketed quantities, camel rearing is gaining popularity due to the economic prospects in the commercialisation of its milk. Additionally, there is increased demand for more drought tolerant livestock species as a coping mechanism against recurrent drought. Camel milk fetches KSh. 60-80 per litre as compared to cow milk which is sold at KSh. 30 per litre in Isiolo County. Due to its ability to withstand droughts, camel provides an option for smoothing household consumption through supply of milk during such distress periods (Musinga *et al.*, 2008).

According to KARI (2011), camel milk in Isiolo District is traded through three channels. The first channel involves producers selling to major towns in Kenya. The second channel includes producers selling directly to consumers in rural areas and trading centres. The third channel is where producers supply milk to processing facilities. About 70% of the total marketed milk passes directly from individual producers to retail traders in major cities. In this channel, small quantities of milk from individual producers are collected, bulked and transported to urban centres and this is mainly done by women. The second channel constitutes about 25% of the marketed milk and composes producers who sell milk directly to consumers in rural and urban centres. The third handles about 5% of the marketed milk in which producers deliver milk to processor such as Vital Camel Milk Limited in Nanyuki and Nairobi, who produces pasteurized milk, yoghurt and other products for local and export markets.

The demand for fresh camel milk in Kenya is far exceeds the supply where most consumers prefer fresh milk. Despite the high potential for camel milk production in the pastoral areas there are many challenges facing camel milk production and marketing (Kuria *et al.*, 2011). These challenges include low milk yield due to forage scarcity, low quality of milk, poor organization of actors along the milk chain, inadequate physical and institutional support and poor market development (Musinga *et al.*, 2008). These challenges, however, are compounded by external factors mainly the recurrent droughts that increase forage scarcity leading to high level of food insecurity in the pastoral areas (McMichael *et al.*, 2007). Therefore, as a prerequisite for proper camel milk value chain development, there is need for research to evaluate the efficiency and functionality of camel milk value chain as well as the profitability to the camel milk producers.

This will ascertain the sustainability and the suitability of the subsector as a viable livelihood option for pastoral household in the context of extreme climatic conditions.

2.10 POLICY AND ORGANIZATIONAL FRAMEWORK FOR CAMEL SUB-SECTOR

Organizational and policy frameworks are key factors that determine the business environment under which enterprises within a specific value chain operate, which in turn determines the potential growth and overall competitiveness of the value chain (Schwab, 2010). The GoK is involved in improving the camel milk subsector through policies and activities of a diverse group of agencies working within the government structure. This includes, Ministry of Livestock Development (MLD), Ministry of State for Development of Northern Kenya and Other Arid Lands, Ministry of Trade and Ministry of Industrialization. For instance, MLD through the Kenya Drylands Livestock Development Program (KDLDP) developed a vaccination strategy to enhance the camel milk value chain in dryland areas and supported other projects such as the integrated camel management, Reducing Impact on Drought and Enhance Livelihoods in the Mandera Triangle (Musinga *et al.*, 2008). The County Integrated Development plan of Isiolo County for 2013/2014 put strong emphases on the camel sub-sector. The plans indicates that camel milk subsector will receive support in terms of provision of health services, promotion of camel derby, capacity building for cooperative societies and development of proper market infrastructure for camel and other livestock products (CIDP, 2013). According to Musinga *et al.* (2008) the key organizations that support the camel milk value chain include Kenya Camel Association (KCA), Kenya Livestock Marketing Council (KLMC) and Association of Pastoralists.

KCA was founded in 1995 and its main role is to articulate and lobby on issues relating to camel development in the country and regionally including lobbying and driving key policy issues such as Kenya camel policy as well as capacity building interventions to enhance camel and camel products production and marketing. Since its inception, KCA has carried out a number of projects in conjunction with MLD and other government departments. These include, restocking projects, capacity building and dissemination of best production and marketing practices in Kenya and East and Central African region.

The Kenya Livestock Marketing Council (KLMC) was established in 2000 as a private sector; non-profit-making service organization dedicated to the improvement and development of livelihoods of livestock-producing communities, and contributes to the economic development of Kenya.

The Association of Pastoralists exists to lobby and advocate on issues affecting livestock and livestock products. For instance, the three organizations lobbied to have camel recognized in the formulation of livestock policies. These organizations together with government policies are very important in providing an enabling environment of livestock sector for growth particularly under the current climatic conditions. The enabling environment is critical as many pastoral communities in Kenya are facing great challenges to cope with the recurrent and severe droughts. In this context, various development agencies and organization have directed more efforts towards the tapping of the potential of camel and camel products as an adaptation strategy to mitigate the negative effect of climatic variability and change (Kuria *et al.*, 2011; Musinga *et al.*, 2008).

2.11 RESEARCH GAPS

The literature review reveals various gaps that need to be addressed. First, empirical studies on the contribution of camel milk to household food and income securities are scanty. Secondly, there is lack of empirical studies on the evaluation of camel milk value chain in terms of functionality, marketing channels efficiency profitability. Thirdly, further research is needed on camel production, especially on the factors that influence production and marketing, as well as location-specific information on the contribution of camel products to pastoral household resilience in the face of climate variability and change. Finally, there is lack of information on sustainable and suitable livelihoods that are less sensitive to climatic variability and environmental changes.

REFERENCES

- Akweya, B., C. Gitao and M. Okoth (2012). The acceptability of camel milk and milk products from North-eastern Province in some urban areas of Kenya. *African Journal of Food Science*, **6** (19), 465-473.
- Alinovi, L., D'Errico, M., Mane, E., and D. Romano (2010). Livelihoods strategies and household resilience to food insecurity: an empirical analysis to Kenya. Paper prepared for the Conference on "Promoting Resilience through Social Protection in Sub-Saharan Africa", organised by the European Report of Development in Dakar, Senegal, 28-30 June, 2010.
- Alinovi, L., Mane, E., and D. Romano (2009). Measuring household resilience to food insecurity: Application to Palestinian households. Working Paper, January 2009. EC-FAO Food Security Programme. Rome: Italy.
- Anderson, D., H. Elliott, H. Kochore and E. Lochery (2012). Camel herders, middle women, and urban milk bars: The commodification of camel milk in Kenya. *Journal of Eastern African Studies*, **6** (3), 383-404.
- Antonio R. and S. Sperandini (2010). Value chains, linking producers to the markets. International Fund for Agricultural Development (IFAD). Rome, Italy.
- Baker B., J. Viglizzo (1998). Rangelands and livestock. Chapter 9 in: J. Feenstra, I. Burton, J. Smith and R. Tol (eds.) *Handbook of methods for climate change impact assessment and*

adaptation strategies. UNEP Publication Version 2.0. <http://130.37.129.100/ivm/pdf/handbookrange.pdf>. Accessed on 21st of October 2012.

- Baker, B., J. Hanson, R. Bourdon and J. Eckert (1993). The potential effects of climate change on ecosystem processes and cattle production on United State rangelands. *Climatic Change*, **25** (2), 97-117.
- Baker, D. (2006). Agriculture value chains: Overview of concepts and value chain approach. Bangkok: Presentation prepared for the FAO, Regional Workshop for Asia. Bangkok, Thailand.
- Barrett, B., F. Chabari, D. Bailey P. Little and L. Coppock (2003). Livestock pricing in the northern Kenyan rangelands. *Journal of African Economies*, **12** (2), 127-155.
- Barrett, C., P. Little and F. Chabari (1999). *Livestock markets and risk management among East African pastoralists: A review and research agenda*. Department of Economics, Utah State University, USA.
- Berdegue, A., E. Bienabe and L. Peppelenbos (2008). Keys to inclusion of small-scale producers in dynamic markets: Innovative practice in connecting small-scale producers with dynamic markets, *Re-governing Markets Innovative Practice series*, IIED (International Institute for Environmental Development), London, United Kingdom.
- Berhanu, W., D. Colman and B. Fayissa (2007). Diversification and livelihood sustainability in a semi-arid environment: A case study from Southern Ethiopia. *Journal of Development Studies*, **43** (5), 871-889.
- Bernsten, R. and A Jacobs (1983). Socioeconomic aspect of range research in Kenya: A plan for reaching the ultimate target groups. Winrock international,
- Bhasin, V. (2011). Pastoralists of Himalayas. *Journal of Human Ecology*, **33** (3), 147-177.
- Campbell, B., G. McGeon, R. Gifford, H. Clark, D. Stafford, P. Newton and J. Lutze (1995). Impacts of atmospheric composition and climate change on temperate and tropical pastoral agriculture, In: Pearman, G.; Manning, M. (eds.) *Greenhouse 94*. CSIRO, Canberra, Australia.
- Chikamai, N. and S. Eriksen (2011). Gums and resins: The potential for supporting sustainable adaptation in Kenya's drylands. *Climate and Development*, **3** (1), 59-70.
- Cohen, R., C. Sykes, E. Wheaton and J. Stevens (2002). Evaluation of the effects of climate change on forage and livestock production and assessment of adaptation strategies on the Canadian prairies. University of Saskatchewan, Saskatoon, Canada.
- Davies, J. (2008) Turning the tide: Enabling sustainable development for Africa's mobile pastoralists, *Natural Resources Forum*, **32** (1), 175-184.

- Desta, S. and D. Coppock (2004). Pastoralism under pressure: Tracking system change in southern Ethiopia. *Human Ecology*, **32** (4), 465-486.
- Dieye, A. and P. Roy (2012). A Study of rural Senegalese attitudes and perceptions of their behaviour to changes in the climate. *Environmental management*, **50** (5), 929-941.
- DDC. (Dryland Development Centre) (2006). Improving market access for drylands commodities, UNDP (United Nation Development Program). *Regional Policy Workshop Report*. Nairobi, Kenya.
- Elhadi, Y., D. Nyariki, V. Wasonga and W. Ekaya (2012). Factors influencing transient poverty among agro-pastoralists in semi-arid areas of Kenya. *African Crop Science Journal*, **20** (1), 113-122.
- Eriksen, S. and, J. Lind (2009). Adaptation as a political process: adjusting to drought and conflict in Kenya's drylands. *Environmental Management*, **43** (1), 817-835.
- FAO. (Food and Agriculture Organization) (2007). Approaches to linking producers to markets. *Agricultural Management, Marketing and Finance Occasional Paper No.13*. FAO. Rome, Italy.
- Farah O., M. Nyariki, K. Ngugi, I. Noor and Y. Guliye (2004). The Somali and the camel: Ecology, management and economics. *Anthropologist*, **6** (1), 45-55.
- Farah, O. (1996) Management and development of the arid communal rangelands in North-Eastern Kenya: A critical analysis of the past and the present. *The African Pastoral Forum, Working Paper Series No.7*, June, 1996. PINEP (Pastoral Information Network Programme), University of Nairobi, Nairobi. Kenya.
- Fehri, F. (1987). Diseases of camels. *Rev. sci. tech. Off. int. Epiz*, **6** (2), 337-354.
- Fernandez-Gimenez, M. E. (2002). Spatial and social boundaries and the paradox of pastoral land tenure: a case study from post-socialist Mongolia. *Human Ecology*, **30** (1), 49-78.
- Flores, M. and V. Bent (1980). Family food basket; definition and methods. *Archivos latinoamericanos de Nutricion*, **30** (1), 58-74.
- Frankel-Reed, J., N. Brooks, P. Kurukulasuriya and B. Lim (2011). A framework for evaluating adaptation to climate change: Evaluating climate change and development. *Evaluating Climate Change and Development Paper No. 8*.
- Frankenberger, T., M. Langworthy, T. Spangler, S. Nelson, J. Campbell and J. Njoka (2012). Enhancing Resilience to Food Security Shocks. TANGO International, Tucson.
- Fratkin, E. (1991). Surviving drought and development: Ariaal pastoralists of Northern Kenya. *West view Press Oxford*, 37-56.

- Fratkin, E. (2001). East African pastoralism in transition: Maasai, Boran, and Rendille cases. *African Studies Review*, **44** (3), 1-25.
- Gauthier-Pilters, H. (1979). Some ecological aspects of the camel in Western Sahara. In: Camels. IFS Symposium, Sudan. pp. 387–398.
- Getahun, T. and K. Belay (2002). Camel husbandry practices in Ethiopia: The case of Jijiga and Shinile Zones, *Nom. Peop.* **6**, 158-178.
- GoK. (Government of Kenya) (2013). Isiolo County integrated development plan 2013 – 2017. *Government Printer*, Nairobi, Kenya.
- GoK. (2010). Agricultural sector development strategy 2010–202. Ministry of Agriculture. Nairobi, Kenya.
- Guliye, A., I. Noor, B. Bebe and I. Kosgey (2007). Role of camels (*Camelus dromedarius*) in the traditional lifestyle of Somali pastoralists in northern Kenya. *Outlook on Agriculture*, **36** (1), 29-34.
- Hahn, G. and T. Morgan (1999). Potential consequences of climate change on ruminant livestock production In: *Proceedings of workshop on Global Change Impacts in the Great Plains*, Feb. 25, 1999, Omaha, NE, USA.
- Heald, S. (1999). Agricultural intensification and the decline of pastoralism: A case study from Kenya. *Africa*, **69** (2), 213–237.
- Hogg, R. (1987). Settlement, pastoralism and the commons: The ideology and practice of irrigation development in Northern Kenya. *Conservation in Africa: People, Policies and Practice*, D. Anderson and R. Grove (eds). *Cambridge University Press*, Cambridge, UK. 293–306.
- Huho, J., J. Ngaira and H. Ogindo (2011). Living with drought: The case of the Maasai pastoralists of Northern Kenya. *Educational Research*, **2** (1), 779-789.
- Ifejika Speranza, C., U. Wiesmann and S. Rist (2014). An indicator framework for assessing livelihood resilience in the context of social–ecological dynamics. *Global Environmental Change*, **28** (2) 109-119.
- Ifejika, S., B. Kiteme and U. Wiesmann (2008). Droughts and famines: The underlying factors and the causal links among agro-pastoral households in semi-arid Makueni District, Kenya. *Global Environmental Change*, **18** (1), 220-233.
- Ikeme, J. (2003). Climate change adaptation deficiencies in developing countries: The case of Sub-Saharan Africa. *Mitigation and Adaptation Strategies for Global Change*, **8**, 29–52.
- Jones, P. G. and P. Thornton (2009). Croppers to livestock keepers: Livelihood transitions to 2050 in Africa due to climate change. *Environmental Science & Policy*, **12** (4), 427-437.

- Kaplinsky, R. and M. Morris (2001). *A manual for Value Chain Research*. Brighton, 212. International Development Research Centre (IDRC). Ottawa, Canada.
- KARI. (Kenya Agriculture Research Institute) (2011). Camel product value chain upgrading strategies. *Workshop Proceeding*, Garissa. Kenya.
- Kitalyi A., S. Mwebaze, H. Muriuki, C. Mutagwaba, M. Mgema and O. Lungu (2006) The role of livestock in integrated land management: RELMA's (Regional Land Management Unit) Experiences in Eastern and Southern Africa, *Working Paper* no. 25. World Agroforestry Centre. Nairobi, Kenya.
- Koocheki, A. and R. Gliessman (2005). Pastoral nomadism, a sustainable system for grazing land management in arid areas. *Journal of sustainable agriculture*, **25** (4), 113-131.
- Kuria S., I Tura, S. Amboga, H. Walaga and J. Lesuper (2011). The current status of camel (*Camelus dromedarius*) calf management among pastoral communities of northern Kenya. *Livestock Research for Rural Development*, **23** (7).
- Lareo, L., B. Gracia, L. Fajardo, L. Romero, G. Acciarri, A. Pradilla and C. Daza (1990). From food basket to food security: The food factor in nutritional surveillance. *Archivos latinoamericanos de nutrición*, **40** (1), 1-22.
- Leeuw, P. N. and J. Tothill (1990). *The concept of rangeland carrying capacity in sub-Saharan Africa: Myth or reality*. London: Overseas Development Institute, Pastoral Development Network. London, United Kingdom.
- Little, P., C. McPeak, B. Barrett and P. Kristjanson (2006). The Multiple dimensions of poverty in pastoral areas of East Africa. A paper was prepared for the conference on 'Pastoralism and Poverty Reduction in East Africa: A Policy research conference' held in June 27-28, 2006 in Nairobi, Kenya.
- Ludi, E., M. Getnet, K. Wilson, K. Tesfaye, B. Shimelis, S. Levine and L. Jones. (2011). From Preparing for the future? Understanding the influence of development interventions on adaptive capacity at local level in Ethiopia. Africa Climate Change Resilience Alliance (ACCRA) Ethiopia Synthesis Report.
- Mattee, Z., and M. Shem (2006). Ambivalence and Contradiction: A Review of the policy environment in Tanzania in relation to pastoralism." *Issue Paper* No. 140, IIED (International Institute for Environment and Development). London, United Kingdom.
- Mbogoh S. and S. Shaabani (1999). Socio-economic study on characterization of recommendation domains for pasture improvement in pastoral and agro-pastoral production systems in Kenya. Part II Consultancy Report. KARI/EU ARSP II. KARI, Nairobi, Kenya.
- McDermott, J., S. Staal, H. Freeman, M. Herrero and J. Van de Steeg (2010). Sustaining intensification of smallholder livestock systems in the tropics. *Livestock Science*, **130** (1), 95-109.

- McMichael, A. J., J. Powles, C. Butler and R. Uauy (2007). Food, livestock production, energy, climate change, and health. *The lancet*, **370** (9594), 1253-1263.
- Musinga M., D. Kimenye and P. Kivolonz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets. Nairobi, Kenya.
- Ngugi, K. and D. Nyariki (2005). Rural livelihoods in the arid and semi-arid environments of Kenya: Sustainable alternatives and challenges. *Agriculture and human values*, **22** (1), 65-71.
- Ngugi, K., R. Gitau, J. Nyoro (2007). Access to high value markets by smallholder farmers of African indigenous vegetables in Kenya, *Re-governing Markets Innovative Practice series*, IIED, London, United Kingdom.
- Noor, I., B. Bebe and A. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, Northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.
- Olukoye, A., W. Wamicha, J. Kinyamario and M. Van Eckert (2003), Impacts and management of drought in a nomadic livestock production system in North Horr, Marsabit District of Northern Kenya.
- Orindi, V. and L. Murray (2005) Adapting to climate change in East Africa: A strategic approach. *Gatekeeper Series* No. 117. IIED. London, United Kingdom.
- Owour, B., W. Mauta and S. Eriksen (2011). Strengthening sustainable adaptation: Examining interactions between pastoral and agro-pastoral groups in dryland Kenya. *Climate and Development*, **3** (1), 42-58.
- Øyen, E. (1999). The politics of poverty reduction. *International Social Science Journal*, **51** (162), 459-465.
- Pasteur, K. (2011). From vulnerability to resilience: A framework for analysis and action to build community resilience. Rugby: Practical Action.
- Pelrine, R. (2009). Agricultural value chain financing in Kenya: Assessment of potential opportunities for growth. A report to the Kenya Value Chain Finance Centre by Inspired International. Nairobi, Kenya.
- Perry, B. and D. Grace (2009). The impacts of livestock diseases and their control on growth and development processes that are pro-poor. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **364** (1530), 2643-2655.
- Plummer, R. and D. Armitage (2007). A resilience-based framework for evaluating adaptive co-management: Linking ecology, economics and society in a complex world. *Ecological economics*, **61** (1), 62-74.

- Ratner, B. D., R. Meinzen-Dick, C. May and E. Haglund (2013). Resource conflict, collective action, and resilience: an analytical framework. *International Journal of the Commons*, **7** (1), 183-208.
- Roth, E. A. (1996). Traditional pastoral strategies in a modern world: An example from northern Kenya. *Human Organization*, **55** (2), 219-224.
- Rowlinson, P. (2008). Adapting Livestock Production Systems to Climate Change in temperate zones. Livestock and Global Change conference proceeding. May 2008, Tunisia, Tunis.
- Sato, S. (1997). How the East African pastoral nomads, especially the Rendille, respond to the encroaching market economy. *African Study Monographs*, **18** (3, 4), 121-135.
- Schmidt-Nielsen, K., E. Crawford, A. Newsome, K. Rawson and H. Hammel. (1967). Metabolic rate of camels: Effect of body temperature and dehydration. *Am. J. Physiol.*, **212** (56), 341-346.
- Schwab, K. (Ed.) (2010). The global competitiveness Report 2010-2011. Genf: *World Competitiveness Forum*.
- Schwartz, J. (1992). The camel (*Camelus dromedarius*) in eastern Africa. In: H.J. Schwartz and M. Dioli (Eds.): The One-humped camel in eastern Africa. A Pictorial Guide to Diseases, Health Care and Management. Verlag Josef Margraf, FR Germany.
- Sere, C., A. Ayantunde, A. Duncan, B. Freeman, A. Herrero S. Tarawali and I. Wright (2008). Livestock production and poverty alleviation: Challenges and opportunities in arid and semi-arid tropical rangeland based systems. *ILRI Workshop Report*. Nairobi, Kenya.
- Serna, J. (2011). Drought assessment Northern Eastern Kenya (Wajir East, South and Mandera). Save the children, publication. <http://www.disasterriskreduction.net>. Accessed on 19th of September 2012.
- Simpkin P., and F. Guturo (1995). Camel management amongst the Rendille. In: J. O. Evans, S. P. Simpkin, and D. J. Atkins (Eds.) Camel keeping in Kenya, *Range Management Handbook of Kenya*, Volume III, 8. pp. 5:22-5:26. Ministry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya.
- Smit, B., B. McNab and J. Smihers (1996). Agricultural adaptation to climatic variation. *Climatic Change*, **33** (1), 7-29.
- Thomas, D. S. and C. Twyman (2005). Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environmental Change*, **15** (2), 115-124.
- Thornton, P. (2010). Livestock production: Recent trends and future prospects. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **365** (1554), 2853-2867.
- Tschakert, P., and K. Dietrich (2010). Anticipatory learning for climate change adaptation and resilience. *Ecology and society*, **15** (2), 11-37.

- Wasonga, V. O. (2009). Linkages between land-use, land degradation and poverty in semi-arid rangelands of Kenya: The case of Baringo district. Doctoral Thesis, University of Nairobi, Department of Land Resource Management and Agricultural Technology. Nairobi, Kenya.
- Witsenburg, K. and W. Adano (2009). Of rain and raids: Violent livestock raiding in northern Kenya. *Civil Wars*, **11** (4), 514-538.
- Yagil, R. (1982). Camels and camel milk. *FAO Anim. Production Health*, **26** (20), 1- 69.
- Yagil, R., Z. Etzion. and J. Ganani (1978). Camel thyroid metabolism, effect of heat and dehydration. *J. Appl. Physiol.*, **67** (45) 540–544.
- Yosef, T., U. Mengistu, A. Solomon, Y. Mohammed and K. Kefelegn (2013). Camel and cattle population dynamics and livelihood diversification as a response to climate change in pastoral areas of Ethiopia. *Livestock Research for Rural Development*, **25** (9).

CHAPTER 3

DESCRIPTION OF THE STUDY AREA

3.1 SUMMARY

This chapter describe the study area. The chapter starts with an introduction of the study area, followed by the location and size of the county. The population, climate and livelihoods are described. Finally, the chapter includes the justification for conducting the study in Isiolo County.

3.2 INTRODUCTION

This study was conducted in Isiolo County of Kenya. The study area is semi-arid and is characterised by unpredictable rainfall patterns, frequent dry spells and drought. The county has diverse land use systems ranging from nomadic pastoralism to urban and pre-urban land use system. However, the dominant land use system is pastoralism. In the last decade, the County has gained popularity in camel milk production and marketing. It was therefore easy to obtain relevant information on camel milk production, consumption and marketing for this study such as the contribution of camel milk to household income and food, and various actors along the milk chain. In addition, the county accounts for more than 90% of the urban marketed milk. Therefore, a proper value chain analysis can be carried out.

3.3 LOCATION AND TOPOGRAPHY

Isiolo County is located in the upper eastern region of Kenya covering approximately 25,000 square kilometres. The altitude ranges between 200m and 300m above sea level. Most of the county is flat, low lying plains with altitudes ranging between 180m above sea level at Lorian

Swamp in the northern part and 1,000m above sea level in the southern part (Noor *et al.*, 2012). The county is classified as arid and semi-arid (FAO, 2007). There are three ecological zones: semi-arid occupying 5% of the area, arid (30%) and very arid (65%) (Herlocker *et al.*, 1993; Sombroek *et al.*, 1982). The county borders Marsabit County to the north, Wajir and Garissa Counties to the east, Tana River and Meru Counties to the south and Samburu and Laikipia Counties to the west (Figure 3.1). The county comprises three sub-counties, namely Isiolo, Merti and Garbatulla. It is further sub-divided into ten administrative wards, namely Ol-donyiro, Ngaremara, Isiolo East, Bulapesa, Burat, Kinna, Garbatula, Sericho, Chari and Cherab (GoK, 2013).

The study area is predominantly flat. To the west are volcanic hills and foothill slopes of Mount Kenya and Nyambene Hills (GoK, 2005). There are four perennial rivers, namely Ewaso Nyiro which originates in Mount Kenya and Aberdare ranges, and Kinna and Bisanadi which originates in Nyambene Hills. The study was conducted in Isiolo and Garbatulla sub-counties (Figure 3.2). This is because the two sub-counties account for more than 90% of the camel population in the county (Musinga *et al.*, 2008).

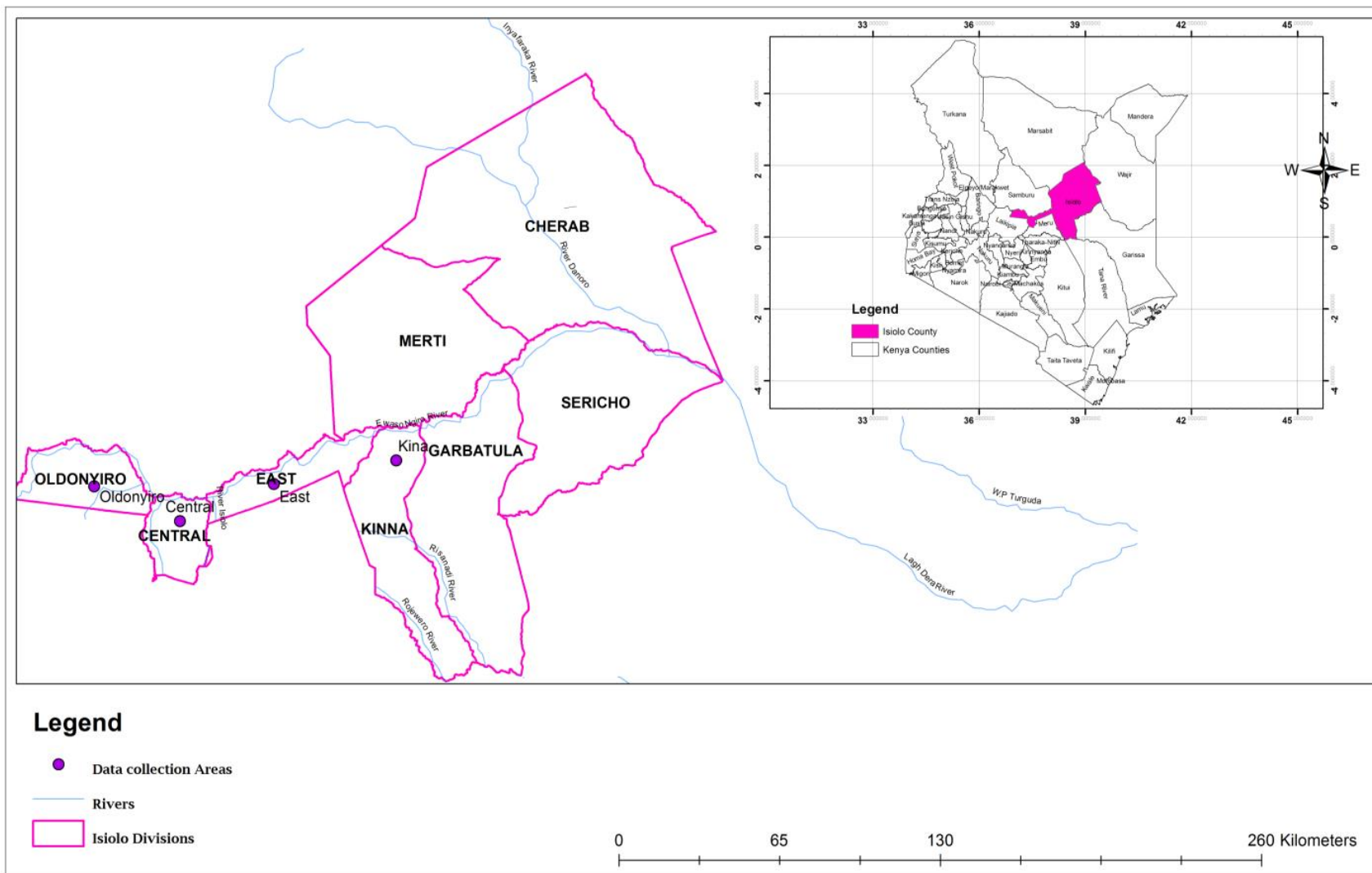


Figure 3.2: Location of the data collection areas
Source: Adapted from GoK (2013)

3.4 POPULATION

Isiolo County had an estimated population of 143,294 persons (GoK, 2010). The sex distribution in the study area shows that there are relatively more males than females; male constitute 51% while the female constitute 49% of the total population. In comparison, overall, Kenya has 49.7% males and 50.3% females (GoK, 2013). The population density in the county was 5.6 persons per square kilometre in 2010. The population density across the county is shown in Figure 3.3. According to the GoK (2010), Isiolo County has registered an annual population growth rate of 1.45%. The study area is inhabited by various ethnic groups, the majority being the Borana, Somali, Turkana, Samburu and Meru.

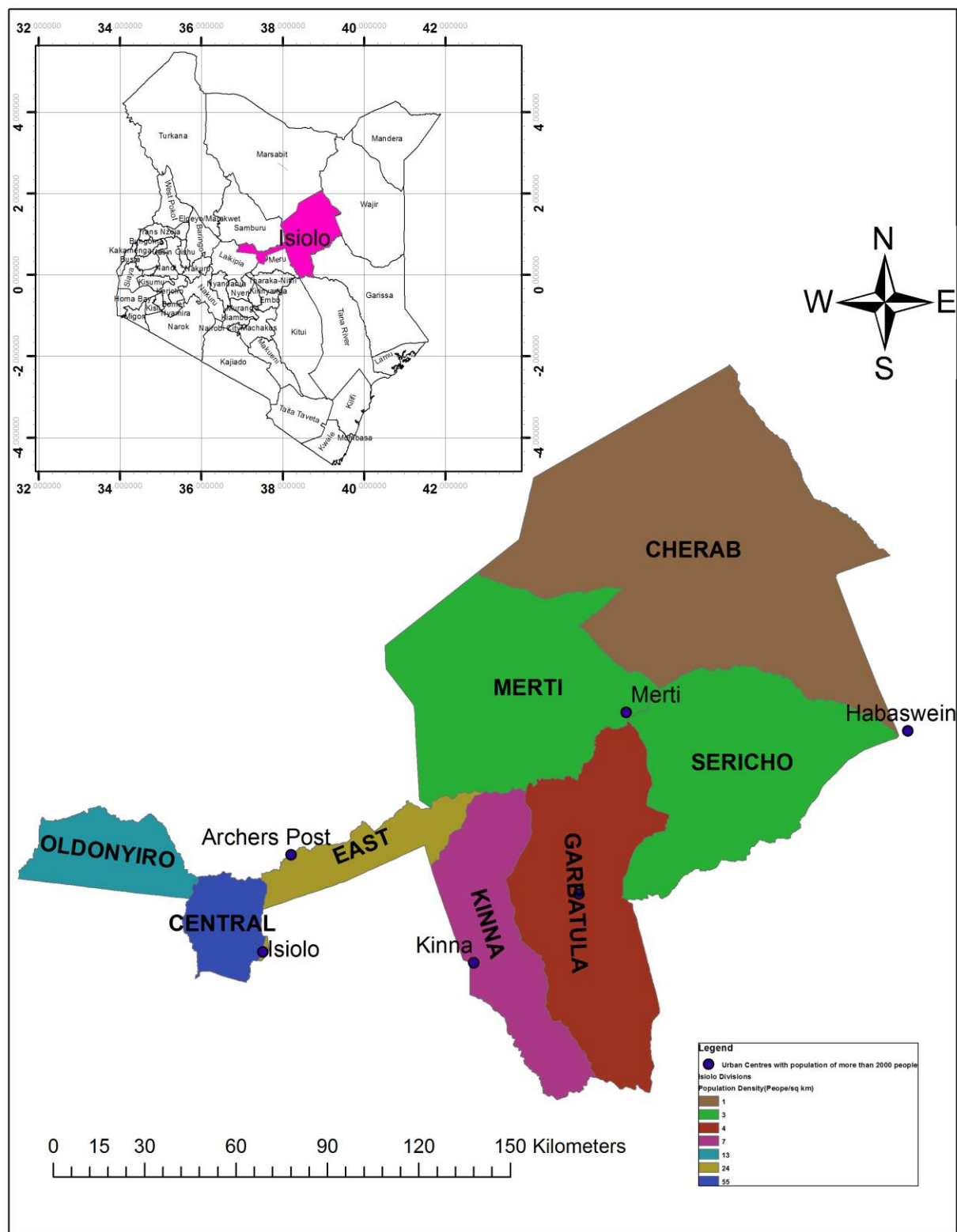


Figure 3.3: Population density in Isiolo County
Source: Adapted from GoK (2013)

3.5 CLIMATE

3.5.1 Rainfall

Rainfall in Kenya depicts very complex patterns, which are related to the equally complex physical features. Large variations occur in time and space. Low, erratic and unpredictable rainfall characterizes the ASAL regions (Ngaira, 2009). The general annual rainfall variation in Isiolo County follows the passage of the Inter-Tropical Convergence Zone (ITCZ) and the changes in wind directions, which are accompanied by dramatic shifts in precipitation regimes between very dry and very rainy. The rainfall regime is dominated by two dry and two rainy seasons. The rainy seasons are known as the “long rains” which last for three months from around mid-March and contribute about 40% of the total precipitation. The short rains last for two to three months, usually starting in October, and contribute 60% of the total precipitation (GoK, 2005). However, in reality, the local precipitation patterns in Isiolo County are more complex because of the influence of Mount Kenya and the Rift Valley.

The monthly rainfall distribution in the study area mainly follows the typical bimodal pattern. The study area receives an annual rainfall between 600mm and 350mm maximum and minimum respectively (Herlocker *et al.*, 1993). The rainfall pattern follows the monsoon and therefore highly seasonal (Francine and Hughest, 1984). Figure 3.4 provides a summary for total seasonal rainfall from 1980 to 1996 in Isiolo County. With the rains being erratic, the study area experiences drought almost every year due to high temporal and spatial variations of precipitation. The frequent droughts have led to devastating loss of livestock and human lives in the study area (GoK, 1997).

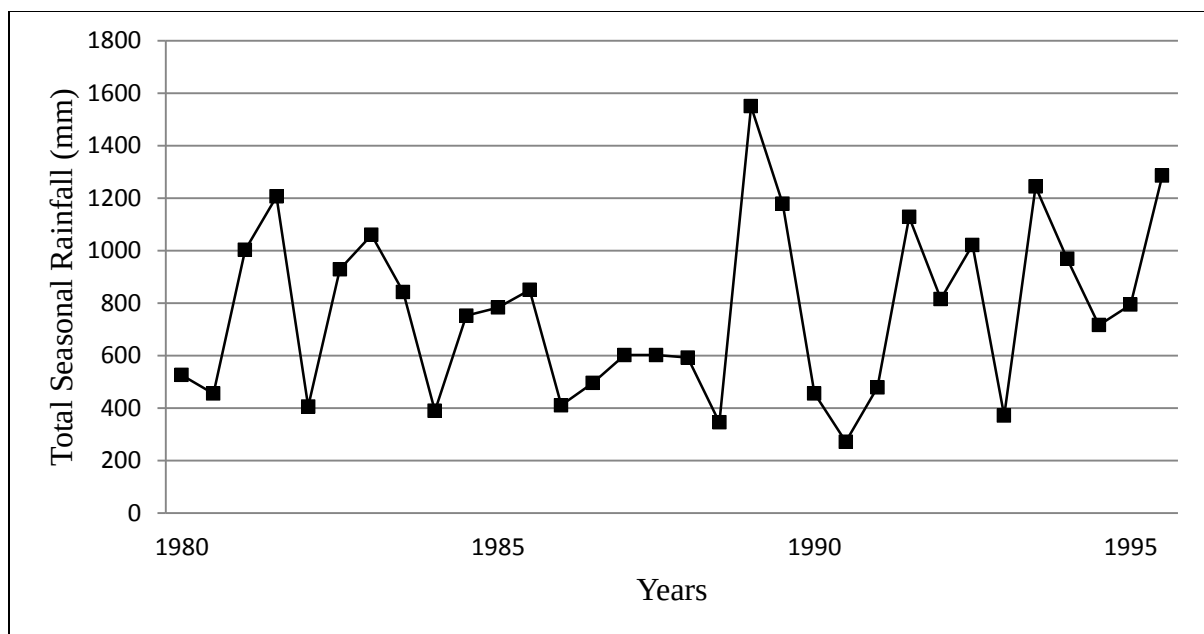


Figure 3.4: Total seasonal rainfall for Isiolo County from 1979/80 to 1985/96

Source of data: KMD (2012)

3.5.2 Temperature

The temperature in Isiolo County is hot and dry most of the year, with a maximum of about 36.1°C usually experienced in February and a minimum of 21.8°C in December every year (Herlocker *et al.*, 1993). The mean average temperatures are usually above 26°C. Figure 3.5 provides a summary of the maximum, minimum and mean temperatures from 1979 to 2010 in Isiolo County. Under these conditions, rain-fed agriculture is unsustainable (Jaetzold and Schmidt, 1983). Therefore, pastoralism is the main viable livelihood option in most of the county.

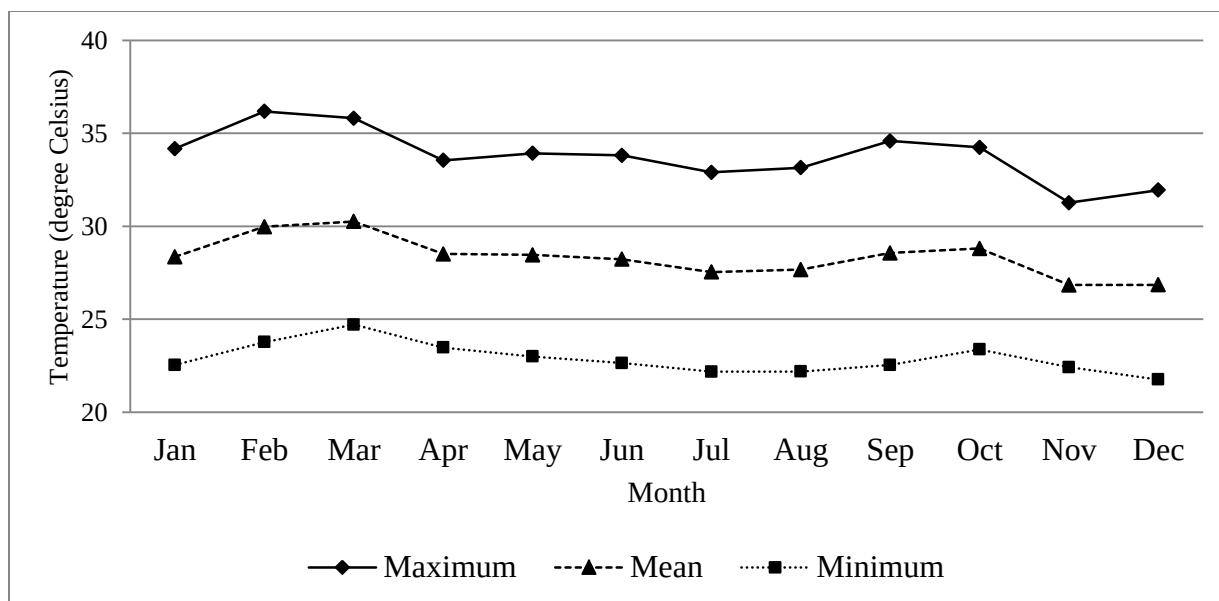


Figure 3.5: Monthly maximum temperature for Isiolo Couty

Source of data: KMD (2012)

3.5.3 Drought Occurrence

Over 70% of the natural disasters in Kenya are related to extreme weather and climate events such as strong winds, droughts, and floods (Smucker and Wisner, 2008). Drought is by far the most devastating event particularly in ASALs (Huho *et al.*, 2011). The drought cycle in Kenya dates back to more than three decades ago. In 1991/92, 1.5 million people were affected by drought in ASALs, Isiolo County included. It was reported that widespread drought affected 1.4 million people in 1995/96, and in 1999/2000, famine affected close to 4.4 million people. In 2004, 3 million people were in dire need of relief aid (Mude *et al.*, 2007). The drought in 2008 affected 1.4 million people. In the late 2009 and early 2010, 10 million people were at the risk of hunger after harvests failed due to drought. These droughts resulted in a food crisis and water shortages, with the pastoral communities in the ASALs being the hardest hit. One of the areas within the ASALs that have experienced severe drought impacts is Isiolo County.

Like other counties in the ASAL areas, Isiolo County is vulnerable to numerous hazards such as drought, raids and floods, mostly driven by the continuous competition over scarce resources such as water, pasture and arable land. The recurrent droughts have resulted in low vegetation cover and contributed to a wide range of biodiversity loss. Increased migration in search of water and pasture has accelerated environmental degradation processes as several tracks of land are cleared to provide temporary settlements (GoK, 1997). Furthermore, the uncontrolled cutting of trees and human settlements have exposed the land cover to severe soil, water and wind erosion. This situation has been worsened by the concentration of human and animal population around the few reliable water points which end up degrading the environment around them.

3.6 SOILS AND VEGETATION

The soils in Isiolo County are primarily sandy, though pockets of black cotton and red soils that can sustain agriculture exist in some parts of the county. Less than 1% of the total land area of the county is considered arable. The county consists of three ecological zones: Zones IV – VI. Zone IV covers about 5% of the total area. This zone is appropriate for small scale dryland farming. Zone V accounts for 30% of the county and can support only a variety of grasses and few shrubs. The main livelihood activity in this zone is livestock keeping. Zone VI occupies 65% land mass in the county (Herlocker *et al.*, 1993; Sombroek *et al.*, 1982). The zone is mainly barren, has scanty vegetation and mainly supports browsers such as the camel. There are no gazetted forests in the area but the hills cover about 9,933 ha and have good potential for wildlife conservation. Figure 3.6 shows the vegetation type in the study area.

Grasses in the county are dominated by *Themeda triandra*, *Panicum maximum*, *Cenchrus ciliaris*, *Sporobolus marginatus*, *Panicum coloratum*, *Chloris roxburghiana* and *Cynodon dactylon* (PANESA, 1988). The areas which have been overgrazed around Garbatulla and Isiolo central are dominated by *Aristida papposa* and *Digitaria velutina*. The woody plants are dominated by stunted thorny bushes of *Commiphora africana*, while the area around Kulamawe through to the Shaba Game Reserve is dominated by *Acacia* spp. (Herlocker, 1979). The areas around Ewaso Ngiro river basin are dominated by perennial grasses such as *Panicum coloratum*, *Sporobolus* spp., *Aristida adoensis*, *Rhynchetrum* spp., *Enteropogon macrostachys* and *Eragrostis caespitosa* (PANESA, 1988). Figure 3.6 shows vegetation type in Isiolo County.

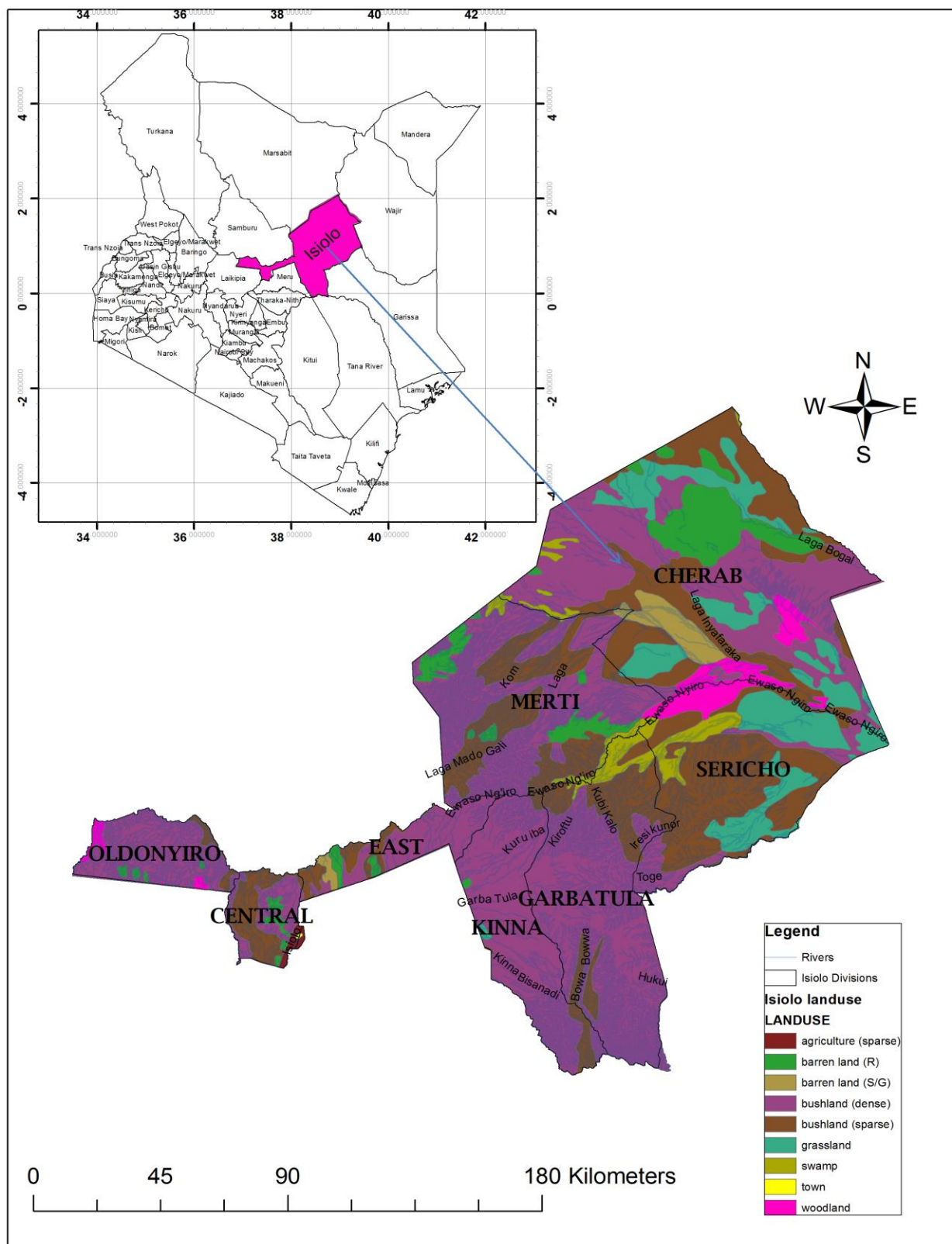


Figure 3.6: Vegetation type in Isiolo County

Source: Adapted from East and Central Africa Disaster Risk Reduction Programme (2013)

3.7 LIVELIHOODS

The poverty level in the study area is very high. It is estimated that 70% of the total population live below the poverty line of KSh 68.5 (Kamunyan *et al.*, 2013). Livelihood activities in the county include pastoralism, firewood/charcoal burning and casual wage labour (Figure 3.7). Livestock production contributes 80%, 45%, 44% and 15% to cash incomes in pastoral, agro pastoral, firewood/charcoal burning and casual labour livelihood zones respectively (Musinga *et al.*, 2008). In the study area, the livestock species kept include cattle, goats, sheep, camels, donkeys, rabbits and chicken. These livestock contribute towards provision of livestock products (milk, blood, and meat), transport (donkey and camels), marriage and social obligations/traditions, paying fines, and capital investment/savings and insurance, among other uses.

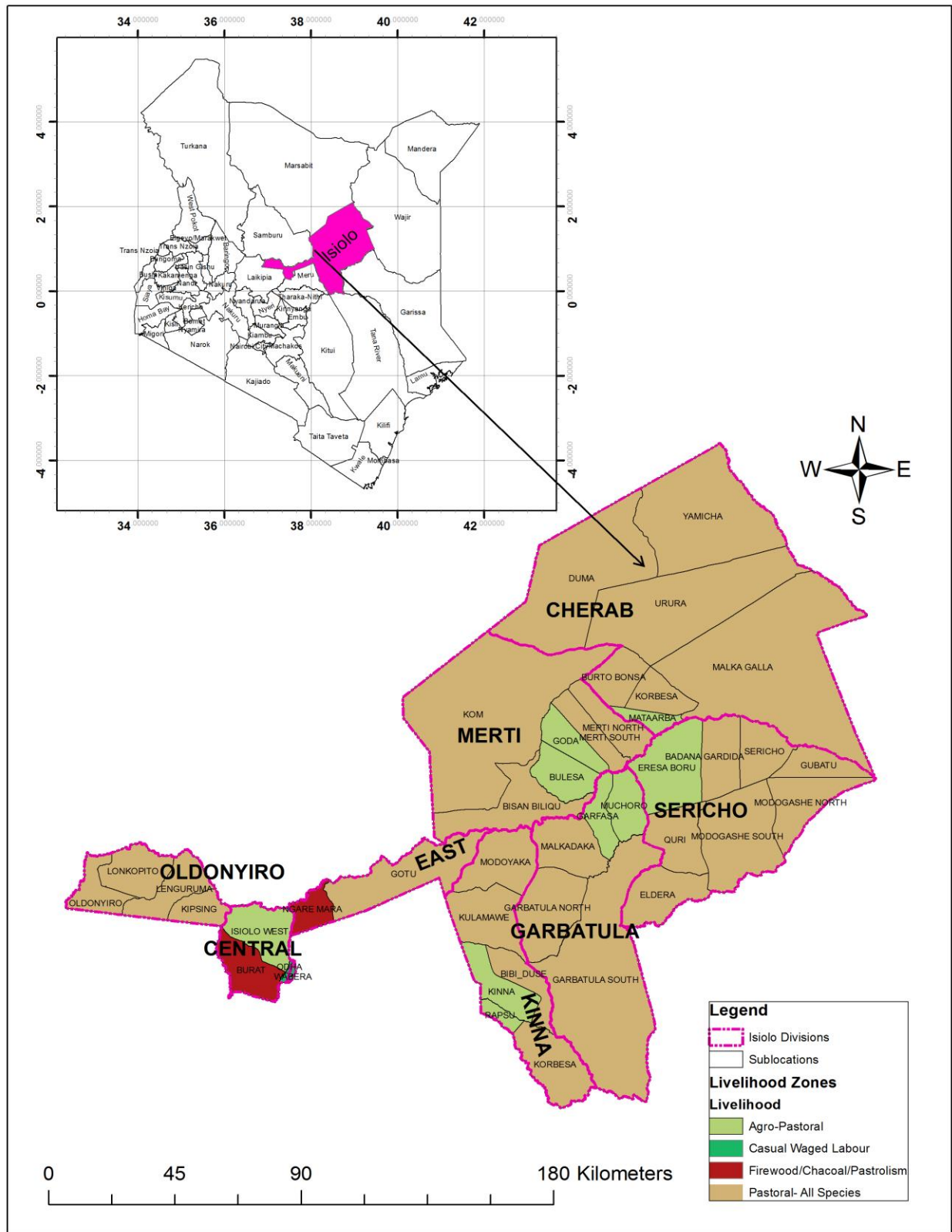


Figure 3.7: Livelihood zones in Isiolo County

Source: Adapted from East and Central Africa Disaster Risk Reduction Programme (2013)

Isiolo County is a predominantly cattle keeping area. Camels were largely introduced only in the last two to three decades (Tablino, 1999). The total population of camels in Isiolo District was estimated at 39,081 in 2010 making it the seventh largest camel population in Kenya (GoK, 2010). Even with the seventh position, the county currently contributes to more than 90% of marketed camel milk reaching national urban markets. Camel population within the county is largely found in Central Isiolo, Kinna (with Kulamawe location) and Garbatulla area (Figure 3.8).

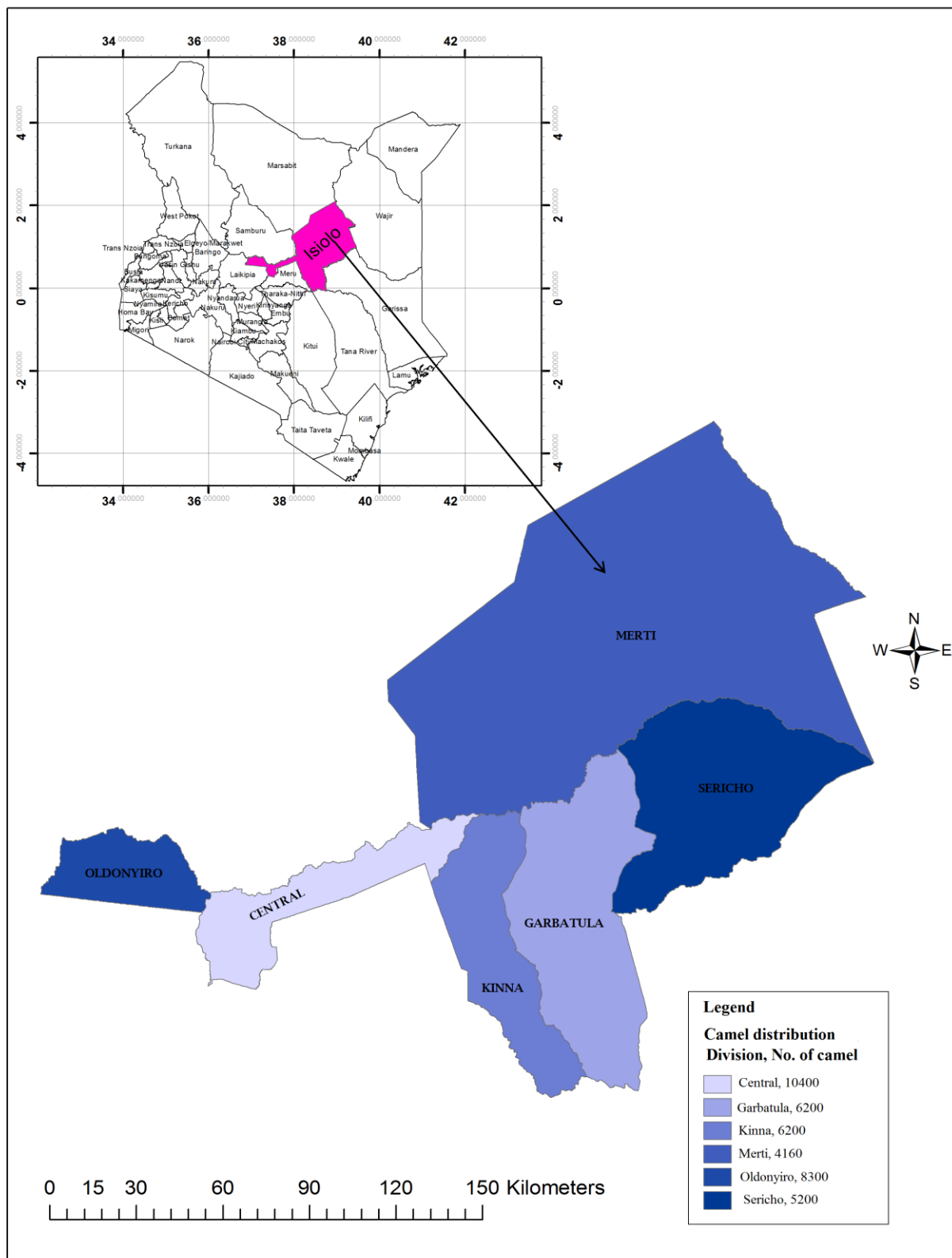


Figure 3.8: Distribution of camels in Isiolo County
 Source: Adapted from Musinga et al. (2008)

3.8 CONCLUSION

Isiolo County falls under the semi-arid and arid zones and is characterised by variable and erratic rainfall patterns, dry spells and droughts. These characteristics are suitable for camel rearing (Yagil and Etzion, 1980; Yagil, 1982; Farah *et al.*, 2004; Schwartz, 1992; Farah *et al.*, 2004; Mehari *et al.*, 2007). The rationale behind selecting Isiolo County as the study area was that the county has a prominent peri-urban camel population and a thriving camel milk business. The county currently contributes more than 90% of marketed camel milk reaching national urban markets. Further, camel milk contributes markedly to the pastoral household income and food intake in the study area. Since the focus of the study was on the assessment of camel milk subsector as a proposed strategy to mitigate the adverse effect of climate variability and change and provide a suitable pathway to pastoral production resilience, it was likely to obtain the relevant information from the county.

REFERENCES

- East and Central Africa Disaster Risk Reduction Programme (2013). Location, livelihood and administrative layers of Kenyan Districts <http://www.disasterriskreduction.net/east-central-africa-old/en/>. Accessed on 13th of August 2012.
- FAO. (Food and Agriculture Organization) (2007). Food security district profiles for 23 districts in Kenya, Nairobi, Kenya.
- Farah, O., D. Nyariki, R. Ngugi, I. Noor and Y. Guliye (2004). The Somali and the camel: Ecology, management and economics. *Anthropologist*, **6** (1), 45-55.
- Farah, Z., T. Streiff and R. Bachmann (2004). Preparation and consumer acceptability tests of fermented camel milk in Kenya. *Journal of Dairy Research*, **57** (3) 281-283.
- Francine, M. and R. Hughes (1984). A comment on the impact of development schemes on the floodplain forests of the Tana River of Kenya. *The Geographical Journal*, **150** (2), 230-244.
- GoK. (Government of Kenya) (1997). Isiolo District Development Plan for 1997-2001. *Government Printers*, Nairobi, Kenya.

- GoK. (2005). Isiolo District Vision and Strategy: 2005-2015. *Government Printer*, Nairobi, Kenya.
- GoK. (2010). Kenya 2009 Population and Housing Census. Ministry of State for Planning, National Development and Vision 2030 Division, Nairobi, Kenya.
- GoK. (2013). Isiolo County: Long rains 2013 assessment report from 29 July–2August 2013, Nairobi, Kenya.
- Herlocker, D. (1979). *Vegetation of south-western Marsabit district, Kenya*. UNEP MAB Integrated Project in Arid Lands. *IPAL Technical Report*, pp. 68.
- Herlocker, D., S. Shaaban and S. Wilkes (1993). *Range Management Handbook of Kenya*. Volume II, 5. Isiolo District. Ministry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya.
- Huho, J., J. Ngaira and H. Ogindo (2011). Living with drought: the case of the Maasai pastoralists of northern Kenya. *Educational Research*, **2** (1), 779-789.
- Jaetzold, R., and H. Schmidt (1983). *Farm Management Handbook of Kenya: Natural Conditions and Farm Management Information, Central Kenya: (Rift Valley and Central Provinces)*. Ministry of Agriculture, Nairobi, Kenya.
- Kamunyan, C., G. Cheserek, M. Kiptui and E. Arusei (2013). Causes and effects of post-election violence on agricultural production in Kesses Division, Uasin Gishu County, Kenya. *Journal of Emerging Trends in Economics and Management Sciences*, **4** (1).
- KMD.(2012). Annual rainfall and temperature of Isiolo County, Nairobi, Kenya.
- Mehari, Y., Z. Mekuriaw and G. Gebru (2007). Potentials of camel production in Babilie and Kebribeyah woredas of the Jijiga Zone, Somali Region, Ethiopia. *Livestock Research for Rural Development*, **19** (4).
- Mude, A., R. Ouma, J. Van de Steeg, J. Kaiuki, D. Opiyo and A. Tipilda (2007). Kenya adaptation to climate change in the arid lands: Anticipating, adapting to and coping with climate risks in Kenya - Operational recommendations for KACCAL. *ILRI Research Report 18*, pp. 135.
- Musinga, M., D. Kimenye and P. Kivolonz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets, Nairobi, Kenya.
- Ngaira, J. (2009). Challenges of water resource management and food production in a changing climate in Kenya. *Journal of Geography and Regional Planning*, **2** (4), 97-103.
- Noor, M., O. Bebe and A. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.

- PANESA. (Pasture Network for Eastern and Southern Africa) (1988). *African forage plant genetic resources, evaluation of forage germplasm and extensive livestock production systems*. The third workshop held at the International Centre, Arush, Tanzania, 27-30 April 1987. ILCA, Addis Ababa, Ethiopia.
- Schwartz, J. (1992). Introduction: The camel (*Camelus dromedarius*) in eastern Africa. In: H.J. Schwartz and M. Dioli (Eds.). Verlag Josef Margraf, Weikersheim, Germany.
- Smucker, T. and B. Wisner (2008). Changing household responses to drought in Tharaka, Kenya: vulnerability, persistence and challenge. *Disasters*, **32** (2), 190-215.
- Sombroek, G., H. Braun, and P. Vander (1982). The explanatory soil map and agro-climatic zone map of Kenya. Report No 5. E.I. Kenya Soil Survey, Nairobi, Kenya.
- Tablino, P. (1999). *The Gabra: camel nomads of northern Kenya* (No. 4). Paulines Publications Africa. Nairobi, Kenya.
- Yagil, R. (1982). Camels and camel milk. *FAO Anim. Production Health*, **26** (20), 1- 69.
- Yagil, R. and Z. Etzion (1980). The effect of drought conditions on the quality of camels' milk. *Journal of Dairy Research*. **47** (4), 159-166.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 SUMMARY

This chapter presents the methodology used in this study. The first part of the chapter discusses the sampling procedures employed in the study. This is followed by a description of data collection methods. This section presents various techniques used in data collection and how they complement each other. The chapter also gives an overview of the survey procedures used as well as procedures employed to ensure data validity and reliability. Finally, the chapter discusses data analysis. This includes a thorough explanation of the different techniques used, that is, descriptive statistics, value chain analysis and regression models.

4.2 INTRODUCTION

The study used a pre-tested semi-structured questionnaire to collect primary data. Focus group discussions and key informant interviews were used to supplement the collected data. Secondary data were collected from government and NGO records and reports. The contribution of camel milk to pastoral household livelihood was examined using descriptive statistics. A Simultaneous Equation Model (SEM) was used to determine the factors influencing camel milk production while value chain analysis was used to examine the camel milk value chain actors in terms of roles, responsibilities, profit and strategies used to manage the camel milk value chain. A Multinomial Logistic Model was used to determine the factors affecting the choice of camel milk market outlets.

4.3 SAMPLING PROCEDURE

The target population consisted of all actors along the camel milk value chain in Isiolo County, i.e. camel input suppliers (agro-vets, feed producers and healthcare agencies), camel keepers, middlemen, camel milk traders, retailers and consumers. Information on different roles and responsibilities in camel milk value chain enabled the target population to be defined more precisely. Purposive and multistage sampling procedures were used to collect primary data from camel milk producers, while other actors were subjectively traced and interviewed. The multistage sampling involved collecting data from several stages of sampling. These included three main stages, namely, Isiolo County, specific locations in the county where camel production is practised, households that practise camel production and finally the selected households which were included in the final sample size. However, the study employed purposive sampling procedure to select certain respondents such as village collectors, wholesalers and retailers.

To determine the sample size, the study looked at the relative numbers of actors along the value chain. Many studies have shown that camel milk producers and traders (consisting of middlemen, camel milk traders and retailers) are large in numbers along the value chain (Farah *et al.*, 2004; Kaplinsky and Morris, 2001; Baker, 2006; Musinga *et al.*, 2008; Antonio and Sperandini, 2010). Thus, to determine the number of actors to be interviewed within these categories, the study used the probability proportional to size formula suggested by Yates and Grundy (1953):

$$n = \frac{Z^2(1-p)p}{e^2} \quad (4.1)$$

Where n is the sample size, Z is the desired Z-value yielding the desired degree of confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher is willing to permit. In this study a p-value of 0.2 was used. This is because of the fact that almost 80% of the population in the study area are camel keepers. The study used 95 percent level of confidence. Using p-value the Z value is 1.96 (two tailed), with an allowable error of 0.05. Using the above stated formula, the sample size was 353 respondents, composed of 202 respondents drawn from camel milk producers, 30 from milk assemblers, 30 from bulking and cooling agents, 50 from wholesalers and 41 from camel milk retailers. The sample size was representative of the study population because the roles and responsibilities were similar within the same category; hence variations in data within the study population were minimal.

4.4 DATA COLLECTION METHODS

Data collection tools are methods used to obtain data from a population or sample. The procedures, on the other hand, are the processes or mechanisms adopted, using the tools, to solicit the data (Nyariki, 2009). The procedures and tools depend to some extent on the sources of data. The basic tools and procedures in socio-economic research are questionnaires, Key Informant Interviews and Focus Group Discussions.

Primary and secondary data were collected in this study. Secondary data were obtained from relevant sources, such as livestock census, NGOs, and various ministries. These included livestock numbers over the years (mostly camel, cattle, goats and sheep), livestock prices and estimated number of actors along the livestock value chain. The study used both qualitative and quantitative methods of data collection. Quantitative methods used included semi-structured

questionnaires (Appendices I to VI), while qualitative methods include FGDs (Appendix VII) and KIIs (Appendix VIII). The FGDs were used to collect narrative data, which were used to design the questionnaire for further investigation.

4.4.1 Household Interviews

Face to face interviews were conducted. This is one of the various data collection techniques that involve oral questioning of respondents, either individually or as a group (Varkevisser *et al.*, 2003). The interviews were conducted from August to November 2012 using a pretested semi-structured questionnaire. The camel milk producer (in case of the absence of the producer, any member of the family who is involved in camel milk value chain) was interviewed. The semi-structured questionnaire consisted of closed, partially structured and open ended questions. It was pretested and piloted to prevent instrumentation bias. The questions were coded in order to simplify data entry and analysis. The majority of respondents in the study area were illiterate; hence, it was more appropriate to interview them than using a self-administered questionnaire (Sabbah *et al.*, 2003).

Additionally, the researcher was able to clarify questions, which could not be possible with a self-administered questionnaire. The other advantage is that interviews generally have a higher response rate than self-administered questionnaires. In this study, the response rate was 100%. However, the disadvantage is that with structured questionnaires, spontaneous remarks by respondents are not explored (Reid *et al.*, 2008). This method was used to collect data on camel milk production, camel milk marketing, sources of livelihood, total income, land size, utilization

of resources, patterns of camel milk production in regard to seasonality, challenges and problems facing the target population, and demographic characteristics, among others.

4.4.2 Focus Group Discussions (FGDs)

A Focus Group Discussion can be defined as “a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research” (Powell *et al.*, 1996). In this study there were two FGDs. The first FGD was conducted with the camel milk producers. The second FGD was conducted with the camel milk traders and the middlemen. The number of participants was (10). The number was based on the recommended range of each Focus Group Discussions which is between 8 and 12 (Morgan and Spanish, 1984).

The criteria for selecting the participants were their role and responsibility along the camel milk value chain. A FGD question guide was used in focus group discussions and probing questions were included to get an in-depth understanding and knowledge on the impacts of climate variability and change and related issues along the camel milk value chain. A moderator and note-taker were recruited to facilitate the FGDs. Data from FGDs were used in developing questionnaire for individual interviews as well as in clarifying some issues after the quantitative data were collected. The focus group discussions were conducted from 22nd to 31st of July 2012.

4.4.3 Key Informant's Interviews (KII)

A Key Informant Interview is a standard data collection tool. This method is widely used in social science, economic studies and anthropological studies, among others (Barker *et al.*, 2005).

A KII question guide was used as a tool for data collection. Key informants included individuals with first-hand knowledge from each category along the camel milk value chain. Data collected included issues on camel population changes, price changes, market structure and development over the years. KIIs were conducted between November and December 2012.

4.4.4 Secondary Data

This study required long term rainfall, temperature and other time series data to show the trend in these climate parameters. These data could not be available through primary sources. Secondary data gathering encompassed reviewing the existing information on the variables under study. Climate parameters were collected from metrological stations in the study area, whereas data concerning livestock parameters such as livestock numbers and prices were collected from the Ministry of Livestock and other sources to validate the collected data.

4.5 SURVEY PROCEDURES

This study followed a detailed procedure before data were collected in order to ensure reliability and validity of data collection through questionnaire survey. These procedures aid in determining the final sample size as well as collecting valid data and information. Additionally, this procedure provided an opportunity to build rapport, train research assistants and refine the data collection tools. The process included a reconnaissance survey, questionnaire preparation, pilot study and training of enumerators.

4.5.1 Reconnaissance Survey

A reconnaissance survey is an examination of all or part of the study area in order to obtain sufficient details about the study topic. It is also used to determine the various variables that may be important to be addressed by the study. This is mostly helpful in making generalizations as well as determining the suitable type of data collection tools (Davison, 2003). Since the researcher had little knowledge about the study area in terms of distribution and diversity of respondents, a reconnaissance survey was important. Field inspection helped the researcher to identify study locations and key informants, and generate a sampling frame. Additionally, it helped in determining the number of participants to be included in FGDs.

4.5.2 Questionnaire Preparation

A draft questionnaire taking into account the objectives and the hypotheses was constructed before setting out to the field. The questionnaire contained dichotomous, multiple choice and open-ended questions. This was necessary because of diverse issues that were being investigated. There was an effort to make each question simple and phrased in a manner that would imply the same meaning to all that were to be interviewed; that is, questions that would carry more than one meaning were avoided. Leading questions were avoided as they usually suggest the answer the interviewer wants to hear, and the respondent may agree with the interviewer simply because that is the expected response (Nyariki, 2008).

Sequencing of questions was such that the more sensitive ones such as those inquiring about family size, age and property ownership came later. These were held back until the time when the interviewer should have struck a rapport with the interviewee. Many questions were

constructed in a way that allowed adequate room to make considered choices, so as to avoid forcing answers. The possibility for no response was born in mind. An effort was made to make the questionnaire as short as possible, including only the questions pertinent to the objectives of the study to avoid people becoming bored after answering list of unending questions, which may also lead to incorrect answers (Nyariki, 1997).

4.5.3 Training of Enumerators

Ten enumerators were used comprising seven males and three females. Enumerators were recruited to assist with data collection. The eligibility was based on their previous experience as research assistants, qualification (a minimum of University degree) and knowledge of the local language. Training was conducted for three days to familiarise the enumerators with the objectives of the study, methods and tools to be used. They were also sensitised on research ethics and the rights of the respondents. The enumerators were exposed to written exercises and role play. Also, they were engaged in pre-testing as part of their training in order to familiarise them with the questions and build confidence in questioning.

4.5.4 Pilot Study

The questionnaire was tested in a pilot study involving ten households before it was used in the main study. The ten households were selected from the study area but did not come from the main sample size of each group. The main reasons for pre-testing the questionnaire were to decide on whether or not to exclude or modify some of the questions. This was done to ensure that the final questionnaire had only relevant and appropriately phrased questions to be put to the respondent.

4.6 DATA ANALYSIS

Both qualitative and quantitative data analysis techniques were employed. Statistical Package for the Social Sciences (SPSS) and value chain analysis (VCA) softwares were used to analyse the collected data. SPSS was used to generate descriptive statistics and for regression analysis. VCA software was used to generate camel milk value chain map and profit margin along the value chain. The study used descriptive statistics to examine the contribution of camel milk to pastoral household livelihood. Additionally, the study used a Simultaneous Equation Model to determine the factors affecting camel milk production. Furthermore, a Multinomial Logistic Model was used to determine the factors influencing the choice of the marketing outlets by camel milk producers.

4.6.1 Descriptive Statistics

Descriptive statistics were used to analyze the respondent characteristics and the camel milk value chain. This involved computation of mean, frequencies and standard deviation. The results were presented in tables, charts and graphs.

4.6.2 Household Food Basket Analysis

Food basket has been defined differently by many authors. For instance, Flores and Bents (1980) defined family food basket as a mixture of basic products which make up the usual diet of a population in sufficient amounts to cover adequately the energy requirements of each member of the family. On the other hand, Lareo *et al.* (1990) define food basket as the group of foods that meet certain characteristics such as: being consumed by important population segments of the community; and contributing a substantial portion of the calories and proteins purchased, and is

responsible for an important proportion of the food budget. Øyen (1999) define a food basket as the calculated price of a set of basic foodstuffs and standardized according to percentage of expenditure on food and size of household. This study adopted the definition of Øyen (1999) which is based on the calculated prices on the foodstuffs. This because the money value estimation of the basket is used as the basis for establishment of minimum wages for different socioeconomic group (Flores and Bents, 1980).

To determine the contribution of camel milk to the household food basket, the study used the basic food consumed by a household to arrive at different food proportions. The basic food consumed by a pastoral household in Isiolo County included milk (from cows, goats and camels), meat(from cows, goats and camels), maize, beans, maize meal, green vegetables such as cabbage, tomatoes, oil, rice, spaghetti, eggs, watermelon, bananas, potatoes, honey and sugar. All the items that constitute the pastoral household food basket were measured by their standard unit of measurement. These proportions were then multiplied by their current market prices and their share in pastoral household food expenditure was derived. Finally, these shares were converted to percentages using the total cost of the reported food basket.

4.6.3 Value Chain Analysis

Functional analysis, flowchart and value chain mapping methodologies were used to characterize the camel milk value chain. This was carried out using the FAO value chain analysis framework developed by Bellu (2013). Functional analysis was used to characterise the chain actors, their relationship and interaction as well as assess the physical movement of milk through various channels and nodes. Value chain mapping involved the collection of information (qualitative and quantitative) to enable graphical representation of the material flows and relationships within and

between actors that constitute the value chain from production to final consumption. Furthermore, evaluation of the marketing costs, profit margin distribution among the different actors in the chain was achieved through market performance analysis. VCA is particularly useful for intricate chains, as it allows for data standardization, automatic computation of various margins and indicators, automatic comparison of various scenarios and other analyses.

Camel milk producers were categorised into three groups, namely, small scale camel milk producers, medium-scale milk producers and large-scale camel milk producers. Categorisation of livestock producers are mostly based on the numbers of livestock holding (Sirak *et al.*, 2007). These categories were based on the camel herd size. Small scale producers were defined as those who own between 1 and 20 female camels. Medium-scale producers own 21 to 40 female camels and Large-scale producers own more than 40 female camels.

The market performance of intermediaries was based on the analysis of price margins and operating expenses. This study followed the approach by Nyariki (2009) and Lund (2014) in computing market margins, net margins and return to working capital. Market margins were obtained by subtracting the camel milk buying price from the camel milk selling price. The net margins were derived by subtracting market margin from the operating costs. The return on working capital was calculated using the following formula:

$$ROC = \frac{NM}{OC+BP} \quad (4.2)$$

Where ROC is return on working capital, NM is the net margin, OC is the operating cost (marketing cost) and BP is buying price.

4.6.4 Efficiency of Marketing Channels

The marketing efficiency is directly related to the cost involved in moving goods from the commodity producers to the consumer and quantity of service offered (Thamizhselvan and Murugan, 2012). In analysing the efficiency of the marketing channels, marketing margins was commonly used to judge the efficiency of various channels (Shepherd, 1962; Sedaghat, 2009; Thamizhselvan and Murugan, 2012). As suggested by Shepherd (1962), the efficiency of the marketing channels can be expressed in terms of a ratio of the total value of goods sold in the market and the total marketing cost, therefore, the greater the ratio, the higher the efficiency. The limitation of this approach is that parameters such as the producer's share in the consumer's price are not accounted for. Producer's share in consumer prices is an important indicator that is used to judge the market performance (Hayami and Herdt, 1977; Lamine, 2005; Nyariki, 2009). Since Shepherd (1962) approach ignored an important indicator, an alternative approach was suggested by Ramakumar (2001).

Ramakumar (2001) suggested that marketing channel efficiency can be judged based on four indicators, namely, volume of goods handled, rate of return to investment, marketing margins of intermediaries and producer's share in the consumer's money. This study used the efficiency framework proposed by Ramakumar (2001). As indicated in a number of studies (Timmer *et al.*, 1983; Eleni, 2001; Das and Prakash, 2002), it is advisable to complement marketing margin with

other measures of efficiency. Hence, in this study four parameters are included to judge the efficiency of the market channels.

In this study, four indicators were used, namely, volume of milk handled, rate of return to investment, marketing margins of intermediaries and producer's share in the consumer's price as suggested by Ramakumar (2001). Each one of these indicators was calculated and assigned a rank, the higher the value of the indicator, the lower the rank. For instance, a channel which handled the highest amount of milk was given score 1 while those that handled less milk were given higher score. Similarly, a channel that had the highest rate of return was given score 1 and those with less rate of return were given a higher score.

The volume of milk handled was calculated based on the information reported by the camel milk producers and was measured in litres. The rate of return to investment was obtained by dividing marketing margin by the total marketing cost (variable cost). The marketing margin was derived by subtracting producer price from consumer price. The gross marketing margin was calculated using the following formula:

$$GMM = \frac{TR - TVC}{TR} \times 100 \quad (4.3)$$

Where GMM is gross marketing margin, TR total revenue (consumer price) and TVR is total variable cost (marketing cost).

Producer's share in the consumer's price was computed using the following formula:

$$PS = \frac{PP}{RP} = 1 - \frac{MM}{RP} \quad (4.4)$$

Where PS is producer's share, PP is producer's price, RP is retailer's price, and MM is marketing margin.

These indicators are simultaneously used to develop an overall indicator of channel efficiency as proposed by Ramakumar (2001). The overall efficiency of the channel is calculated as follows:

$$R_j = \frac{R_i}{N_i} \quad (4.5)$$

Where R_j is an overall rank of a channel for all performance indicators (namely, volume of milk handled, rate of return to investment, marketing margins of intermediaries and producer's share in the consumer's price), R_i is rank of a channel per single indicator, and N_i is number of performance indicators. R_i was calculated as a total score of each channel. The total score was determined by adding the respective ranks in each channel. The mean scores were calculated for each channel. The channel was considered efficient when the mean score was less (Thamizhselvan and Murugan, 2012).

4.6.5 Simultaneous Equation Model (SEM)

The Simultaneous Equation Model is one of the most remarkable developments in econometrics (Hausman, 1983). It is a form of statistical model which was further developed by econometricians in terms of application and linking its use to economic theory in terms of operation and the simultaneous determination of economic variables (Erdogdu, 2007). SEMs are used to explain two-way relationships in which the dependent variables are determined by the

independent variables and some of the independent variables are, in turn, determined by the dependent variables. That is to say, a set of variables is determined simultaneously by the remaining set of variables (Kakota, 2011). In this model there are two types of variables, endogenous and exogenous. The endogenous variables are determined within the model while exogenous variables are predetermined outside the model (Rickman, 2010).

In these models there is more than one equation, one for each of the mutually, or jointly, dependent or endogenous variables. Hence, the parameters may not be estimated in a single equation without considering the information provided by other equations in the system (Doonan *et al.*, 2005). The number of equations in the SEM system is equal to the number of endogenous variables in the system. The SEM system is built on two assumptions: first, that there exists a feedback relationship between one/or more of the independent and dependent variables; and second, that the independent and dependent variables correlate with the error. Consequently, the use of Ordinary Least Squares might provide inconsistent estimation. Therefore, a two-stage least squares (2SLS) approach via the reduced form coefficients were used to estimate the parameters in the model. To test the simultaneity and exogeneity of variables, the study used Hausman specification test. Before estimating the parameters, an identification process was conducted in all the equations in the system using order and rank tests (Gujarat and Sangeetha, 2007).

Camel milk production and its determinant factors are interrelated. The quantity of camel milk produced is a function of production-based factors as well as non-production-based factors. Some of these factors are latent and interdependent and are endogenous in the model. They are

influenced by exogenous causes or a set of institutional, economic and demographic factors. Thus, the relationship is two-way in which a set of variables is determined simultaneously by the remaining set of variables. A SEM model with three endogenous variables (Gujarat and Sangeetha, 2007) can be expressed as follows:

$$Y_{1i} = \beta_{10} + \beta_{11}Y_{2i} + \beta_{12}Y_{3i} + \lambda_{1k}X_{1k} + \mu_{1i} \quad (4.6)$$

$$Y_{2i} = \beta_{20} + \beta_{21}Y_{1i} + \beta_{22}Y_{3i} + \lambda_{2k}X_{2k} + \delta_{2k}Z_{2k} + \mu_{2i} \quad (4.7)$$

$$Y_{3i} = \beta_{30} + \beta_{31}Y_{2i} + \lambda_{3k}X_{3k} + \delta_{3k}Z_{3k} + \mu_{3i} \quad (4.8)$$

Where Y_1 is a dependent variable, Y_2 and Y_3 are endogenous variables or jointly dependent variables, X_{1k} , X_{2k} and X_{3k} are observed exogenous variables or predetermined variables associated with given equations, Z_{2k} and Z_{3k} are observed exogenous variables influencing only endogenous variables, β_{10} , β_{20} and β_{30} are constants, β 's are coefficients for endogenous variables (Y), λ 's are coefficients for exogenous variables (X), δ 's are coefficients for exogenous variables (Z), μ_{1i} , μ_{2i} and μ_{3i} are stochastic disturbances and i is the total number of observations.

4.6.6 Measurement of Variables Used in Simultaneous Equation model

The study hypothesised the following variables to influence the daily milk production. However, the existence of multicollinearity was suspected. Since the SEM system comprised three equations, Variance Inflation factors (VIF) was carried out to test for multicollinearity for each equation as suggested by Duloy (1964). The results of the test are in Appendix IX (1, 2 and 3).

Daily milk production: Average daily camel milk production was measured in litres and was used in SEM. The dependant variable was hypothesized to be influenced by endogenous variables such as camel herd size, access to veterinary services, and exogenous variables such as access to climatic information, distance to water and pasture, and access to extension services.

Camel herd size: In most pastoral communities in Africa, wealth and well-being are measured in terms of the number of livestock owned. Among pastoral communities in Isiolo County, camel herds play a significant role in the provision of milk and milk products, and as a store of wealth and a symbol of status. The camel is also used as a means of income, especially from the point of view of the sale of milk and live animals, and ceremonial and cultural purposes such as payment of bridal price during marriage ceremonies and slaughter during wedding and funeral ceremonies. Daily camel milk production is likely to be directly proportional to the camel herd size whereby the larger the herd the higher the milk production; hence it is expected to exist a two-way relationship. However, camel herd size is also influenced by many factors, such as access to veterinary services, distance to water and pasture, experience in camel rearing, education level of the camel milk producer, and access to extension services. These were determined within the model as endogenous variables. Camel herd size was presumed to be an endogenous variable; hence Hausman test was conducted to test if the variable was truly endogenous. Camel herd size was measured directly as the number of total adult camels. These include male camels, lactating females and dry females.

Distance to pasture: Herd movement is a critical strategy in the African drylands for the efficient management of heterogeneous forage availability and highly variable precipitation

(Baker and Hoffman, 2006). Forage availability determines the direction and distance of the opportunistic movements by the African pastoralists to make use of different ecological niches (Elhadi *et al.*, 2012). The assumption in this study is that the distance travelled in search of pasture is an indicator of forage availability and a reflection of range condition and, therefore, directly influences camel milk daily production. High milk production can only be attained when resources needed are available and accessible. This leads to the hypothesis that the longer the distance to pasture, the lower the camel milk production. Daily distance travelled by a camel herder in search of pasture was measured in kilometres.

Distance to water points: Water resources in ASALs are scarce and erratic in availability (Sussan and Arriens, 2003). Water is crucial for livestock production and therefore water availability influences camel milk productivity and consequently the welfare of camel milk producers. It was hypothesized that the longer the distance to water, the lower the production. This is because covering a longer distance results in extra stress that directly reduces the quantity of camel milk produced. The distance to water points was expected to negatively influence daily camel milk production. Daily distance travelled by a herder and camels to access water was measured in kilometres.

Access to veterinary services: Access to veterinary services plays an important role in livestock productivity (Oladele, 2004; Farah *et al.*, 2007; Ahmad *et al.*, 2012). This role is particularly critical in pastoral areas where access to veterinary care is often inadequate to ensure the optimum health of the herds (Schwartz *et al.*, 1983; Gameel *et al.*, 1993; Faye, 2004). Daily milk production may have an influence on access to veterinary services whereby camel milk

producers with high quantity of milk may afford to purchase drugs and access to veterinary services. However, access to such services is also influenced by many other factors such as camel herd size, education level of the camel milk producer, and access to extension services. These were determined within the model as endogenous variables. Access to veterinary services was presumed to be an endogenous variable; hence Hausman test was conducted to confirm its endogeneity. Access to veterinary services was coded as a binary variable where the value of 2 was assigned to producers that had access to such services and 1 to those that did not access veterinary services.

Access to extension services: Extension services cover information delivery and training in new technology (Moris, 1991). These services are usually provided by the government, NGOs and traditional institutions. The extension services are expected to influence critical decisions concerning production, sale and the whole process of camel milk production management, particularly the level of camel milk production and marketing. Milk producers who have a chance to be trained or receive production and marketing related information are likely to have high milk production compared with those without access. This is because those who plan their activities according to the extension information have higher chances of making the right decisions at the right time, thereby reducing the risk and uncertainties associated with production (Elhadi *et al.*, 2012). Extension service was coded as a binary variable where the value of 2 was assigned to producer that received extension information and 1 to those that did not receive extension information.

Access to climate information: Climate information is important in making decisions on production technologies and planning for various production related activities. Camel milk producers with access to climate information (offered through local radio stations in Isiolo County) can make better decisions on the grazing plans and other technologies to use to ensure sustainable milk production in case of climate variability or extreme weather events. Such producers have an opportunity to have knowledge on how to adjust their production strategies to variations in climatic conditions. Access to climate information is hypothesized to have a positive influence on daily camel milk production. It is used as a predictor and instrument in the 2SLS model. This variable is measured as a binary variable where it assumes a value of 2 if the milk producer had access and a value of 1 if the producer had no access.

Gender of milk producer: The head of a household in most pastoral communities in Kenya is a male. The bundles of resources which are vital for a household's food security are controlled by men who are not yet ready to share ownership with women (Samba, 2010). Such rights are not readily transferable to women even in cases where they are rendered heads of households when their husbands are employed elsewhere or dead (Wasonga, 2009). This implies that women headed households may not be directly involved in making decisions regarding camel milk production and marketing. It is hypothesized in this study that gender has a positive influence on daily camel milk production. The variable is used as an endogenous variable. The gender of a camel milk producer was a binary variable where a value of 2 was allocated to male producer and 1 to female producer.

Education level of milk producer: Educated milk producers are exposed to skills, new ideas, information and levels of opportunities which improve their milk production. The producer who has attained a certain level of education can use production information more efficiently than one who does not have any formal education. Educated producers are likely to produce more as a result of their access to relevant production information and technologies compared to uneducated producers. Education level might also influence the access to vital production services such as credit and veterinary services. Such access will definitely influence camel milk daily production (Waters-Bayer and Bayer, 1994). It is hypothesized in this study that the education level of a milk producer will have a positive influence on daily camel milk production. The variable is used as an endogenous variable. The level of education of the household head was measured in categories where absence of formal education was given a value of 1, primary a value of 2, secondary a value of 3 and postsecondary a value of 4.

Age of milk producer: Age reflects the number of years an individual has lived. Age is one of the factors that affect daily camel milk production through the ability of the producer to carryout daily production activities such as daily movement, milking and marketing of camel milk. Age can influence production through adoption of technologies, long experience and access to vital production related information. However, age can have both negative and positive influences on daily milk production (Ataun *et al.*, 1994). The positive influence can be seen as the experience gathered over the years while the negative influence results due to the increased inability to adopt new production approaches as well as technologies. Age was used as an instrumental variable influencing access to veterinary services. The variable was measured in years.

Household size: Household size represents the number of people living in a household and who are dependent on the resources and income of the head of household (Elhadi *et al.*, 2012). This variable is expected to positively influence camel milk production. The larger the household size the more the labour available for milk production. Besides, adult household members can have diverse sources of livelihood which can be used in increasing camel milk production.

Membership in Self-Help Group: Pastoralists traditionally use their livestock to make social bonds within and beyond their territories. These social ties form the basis of risk spreading, and post-drought herd rebuilding. Nyariki and Ngugi (2002) referring to the pastoral social networks as the “economy of affection”, pointed out that the social alliances built through livestock transfers to friends and relatives as loans serve as post-drought insurance. Besides the positive effects of spreading grazing pressure, strong social linkages such as self-help groups are expected to improve camel herd production. This variable was given a value of 2 if the camel milk producer was a member of such a group and 1 if the producer was not a member.

Experience in camel rearing: Experience in camel rearing was measured directly by the number of years a producer spends in camel milk production. This was hypothesised to positively influence daily camel milk production. This is because producers with more experience are likely to practise more sound husbandry and management compared to those with less experience. Experience in camel rearing was used as an instrumental variable influencing camel herd size.

Access to credit facilities: Credit in combination with other inputs plays a significant role in improving production. Access to credit is considered a vital tool for increasing animal productivity and reducing poverty (Finan *et al.*, 2005). Access to credit also plays a crucial role in adoption of new technologies and especially in arid and semi-arid areas. Pastoral communities generally do not have access to credit services, mainly because they lack the required collateral, which makes them very poor credit risks (Dercon, 1998). Other factors that hinder livestock keepers in pastoral areas access to credit include high interest rates and the lengthy and cumbersome formalities required to access credit. It is hypothesized in this study that access to credit facilities (loans) will have a positive influence daily milk production. This variable is measured as a binary variable where it is given a value of 2 if the milk producer had access and 1 if the producer had no access.

4.6.7 The Multinomial Logistic Model (MNL)

The econometric models that are commonly used in decision studies involving multiple choices are the Multinomial Logistic Model and Multinomial Probit Models (Greene *et al.*, 1996; Hassan and Nhemachena, 2008; Deressa *et al.*, 2008; Changpetch and Lin, 2013). Both models are important for analysing producers' choice. This study used a Multinomial Logistic Model to determine the factors influencing the choice of camel milk marketing outlets by milk producers. This model provides a convenient form for underlying choice probabilities. Hence, it does not require multivariate integration, making it simple to compute choice situations characterised by many alternatives (Hausman and McFadden, 1984). Multivariate integration is a mathematical procedure used to compute the probability in Model and Multinomial Probit. For more information on multivariate integration see Woźniakowski (2003). On the other hand, the

Multinomial Probit requires that the multivariate normal integrals must be evaluated to estimate the unknown parameters. This complexity makes the latter an inconvenient specification test (Hassan and Nhemachena, 2008). However, one of the limitations of Multinomial Logistic as indicated by Hausman and McFadden (1984) is the assumption of the Independence of Irrelevant Alternatives (IIA) i.e. proportional substitution pattern. In this study the IIA assumption was not considered because, the camel milk producers in the study area were partially limited in their choice by many factors such as distance to the market outlet, transportation costs and market information, therefore, the possibility of any market outlet serving as a substitute was minimal.

Camel milk producers are faced by multiple choices regarding where to sell their milk. These choices include selling to individual consumers, rural assemblers, bulking centres, wholesalers, and retailers. Out of the five marketing outlets, only three of them were considered in this study, namely consumer, bulking centre, and wholesaler marketing outlets. This is because the amount of camel milk that is usually handled through rural assemblers and retailers is markedly low compared to other marketing outlets (Musinga *et al.*, 2008; Kuma *et al.*, 2013). In this study only 9% of the sampled producers sold to assemblers, and 4% to retailers. Further, the buying prices offered at the bulking centre and wholesaler marketing outlets are relatively higher than other marketing outlets. Thus, producers that choose to sell their milk through these outlets earn higher profit margins. In this study, any milk producer qualified to be participating in a particular marketing outlet if he sold more than 50% of his milk to that particular outlet.

The independent variables hypothesised to influence the producers' choices were: producers' demographic characteristics such as age, education level and household size; production factors such as camel herd size, daily milk production, and expertise in camel rearing; institutional factors such as access to marketing information, credit facilities and extension services; marketing factors such as distance to the preferred market and selling prices. The general form of the Multinomial Logistic Model as proposed by McKelvey and Zavoina (1975), and cited in Fiebig *et al.* (2010) and Ahmed *et al.* (2013), is:

$$Pr_{ki} = \frac{\exp(X_i'\beta_j)}{\sum_{k=1}^J \exp(X_i'\beta_j)} \quad (4.9)$$

Where Pr is the probability that a camel milk producer i chooses to sell at j milk marketing outlet from k milk marketing outlet choices; X is a vector of explanatory variables that contains the set of factors about camel milk producers' attributes and socioeconomic and demographic characteristics; and β_j is a vector of parameters relating explanatory variables to the valuation of K outlets ($K = 1, 2, 3$).

Equation 4.9 has indeterminacy (is the existence of a non-trivial (non-zero) solution to the homogeneous system of equilibrium equations), so that only J parameter vectors are needed to determine the $J+1$ probability. This indeterminacy is removed through normalization of one of the marketing outlets which assumes that $\beta_0 = 0$ so that corresponding probabilities can be estimated as:

$$\Pr(Y_i = j/X_i) = \frac{\exp(X' \beta_j)}{1 + \sum_{k=1}^J \exp(X' \beta_k)} \quad (4.10)$$

$$j = 0, 2, \dots, J, B_0=0$$

Estimating the above equation yields the J log-odds ratios given below as:

$$\ln \left[\frac{P_{ij}}{P_{ik}} \right] = X_i (\beta_j - \beta_k) = X_i \beta_j \quad (4.11)$$

if k = 0 (the base category)

$$\begin{aligned} \ln \left[\frac{P_{ij}}{P_{ik}} \right] = & \beta_0 + \beta_1 PG + \beta_2 PE + \beta_3 MS + \beta_4 AE + \beta_5 AM - \beta_6 PA + \beta_7 HZ + \beta_8 EC + \beta_9 HS + \\ & \beta_{10} DP + \beta_{11} MP + \beta_{12} DM + \mu \end{aligned} \quad (4.12)$$

Where PG is producers' gender, PE is producers' education, MS is membership in a self-help group, AE is access to extension services, AM is access to market information, PA is producers' age, HZ is household size, EC is experience in camel rearing, HS is camel herd size, DP is daily milk production, MP is milk selling prices, DM is distance to the preferred market and μ is error term.

4.6.8 Measurement of Variables Used in Multinomial Logistic Model

Variance Inflation Factors (VIF) was carried out to test for multicollinearity for all variables hypothesised to influence the decision on camel milk marketing outlet and the results are presented in Appendix IX (4).

Camel milk marketing outlet: Camel milk marketing outlet was used as the dependent variable in the Multinomial Logistic Model and was expected to be influenced by a set of factors, including production factors, intuitional factors and marketing related factors. In this study, the choices considered for analysis included selling to individual consumer, bulking centre, and wholesaler outlets. The camel milk marketing outlets were categorized where selling to individual consumers was given a value of 0, selling to bulking centres a value of 1, and selling to wholesalers a value of 2.

Camel herd size: Among pastoral communities in Isiolo County, camel herds play a significant role in the provision of milk and milk products, and as store of wealth and symbol of status. The camel is also used as a source of income, especially from sale of milk and live animals. This factor was hypothesised to positively influence the choice of marketing outlet. This is because the larger the herd size the more the milk production and hence the more the likelihood of selling to various markets. Camel herd size was measured directly as the number of total adult camels. These included male camels, lactating females and dry females.

Access to extension services: Extension services include information delivery and training in new technology, which comprise marketing skills and market linkages (Moris, 1991). Access to extension services is likely to increase milk production as well as access to various profitable markets, hence the positive influence on marketing outlet. Extension services were considered a binary variable where the value of 2 was assigned to producers that received extension information and 1 to those that did not receive extension information.

Daily milk production: Average daily camel milk production was measured in litres. The daily milk production was hypothesised to influence the choice of marketing outlet since the more the milk produced, the higher the likelihood of the producer selling to a market that maximizes economic returns, and vice versa, hence the positive influence on camel milk marketing outlet.

Gender of milk producer: In all pastoral communities, critical decision are mostly made by the men, who also own most of the productive resources. Therefore, male-headed households are likely to exhibit flexibility and dynamism in choices of marketing outlets. They are therefore expected to access farther markets and take risks such as high marketing costs than their female-headed counterparts (Samba, 2010). The gender of a camel milk producer was a binary variable where a value of 2 was allocated to male producers and 1 to female producers.

Education level of milk producer: Education is an essential element in making choices in any production system. This was expected to have a positive impact on the choice of the market by the producers. This is because educated producers are expected to be more exposed and to have access to market information, which enable them to make rational choices on where to sell. The level of education of the household head was categorized where absence of formal education was given a value of 1, primary a value of 2, secondary a value of 3 and post-secondary a value of 4.

Age of milk producer: Age of the household is associated with the producers' experience. However, in the rural areas age is mostly associated with illiteracy, implying that the older producers may not be aware of the various opportunities as well as information on various markets and therefore may not make rational choices on where to sell. Therefore, it was

hypothesized that age negatively influences the choice of marketing outlet. The variable was measured in number of years.

Household size: A household is defined as all people living in one place and are subjected to decisions made by the household head (Elhadi *et al.*, 2012). The larger the household size the more the labour available for milk marketing, and vice versa. This implies that a larger household is likely to provide the much needed labour to access a wider choice of markets, and therefore fetch better prices for their milk, hence the positive influence on choice of market.

Membership of Self-Help Group: A self-help group is expected to positively influence the choice of camel milk marketing outlet by offering vital marketing information and strengthening the bargaining power of its members (Upton, 2004). This variable was given a value of 2 if the camel milk producer was a member of such a group and 1 if the producer was not a member.

Experience in camel rearing: Experience in camel rearing was measured directly by the number of years a producer has spent in camel milk production. Experience was hypothesised to positively influence the choice of marketing outlet by camel milk producers. This is because producers with long experience in camel milk production tend to realise higher milk production as a result of accumulated productive assets such as large camel herd and better knowledge, skills and practice on camel husbandry; hence the higher the production, the more the likelihood of selling to various market.

Access to market information: Producers' marketing decisions are based on information of market prices and demand (Srivastava *et al.*, 1998). It was hypothesized that access to market information positively influenced the choice of where to sell. This is because milk producers that have access to market information are likely to take advantage of existing demand on camel milk as compared to those with less access. Access to market information was measured as a binary variable taking a value of 2 if the milk producer had access to market information and 1 if he had no access.

Milk selling prices: Producer price for any given agricultural commodity has a direct relationship with the marketable supply. Furthermore, a price offered at the selling point is an important factor that influences the decision by milk producers on where to sell their produce. Therefore, producers that are targeting profit maximisation are likely to sell to the market with a high economic return compared to those who are producing for subsistence. Milk selling prices were measured in Kenya Shillings (KSh) per litre.

Distance to the preferred market: Distance to the preferred market is a continuous variable that was measured as distance covered in kilometres from the production site to the market. This was expected to positively influence the choice of the market, implying that producers who are close to trading centres are likely to sell to the market with high economic returns compared to those located away from trading centres (Little *et al.*, 2001; Kosgey *et al.*, 2008; Tessema *et al.*, 2013). Furthermore, producers that are located closer to market centres incur less marketing costs given their proximity to information as well as the markets (Bennett *et al.*, 1999).

REFERENCES

- Ahmad, S., M. Yaqoob, M. Bilal, G. Muhammad, L. Yang, M. Khan and M. Tariq (2012). Risk factors associated with prevalence and major bacterial causes of mastitis in dromedary camels (*Camelus dromedarius*) under different production systems. *Tropical Animal Health and Production*, **44** (1), 107-112.
- Ahmed, I., R. Onwonga, D. Mburu and Y. Elhadi (2013). Evaluation of types and factors influencing adoption of rainwater harvesting techniques in Yatta District, Kenya. *International Journal for Education and Research*, **1** (1) 1-14.
- Antonio, R. and S. Sperandini (2010). Value chains, linking producers to the markets. International Fund for Agricultural Development (IFAD). Rome, Italy.
- Baker, D. (2006). Agriculture value chains: Overview of concepts and value chain approach. Presentation Prepared For The FAO, Regional Workshop For Asia, Bangkok, Thailand.
- Baker, L. and M. Hoffman (2006). Herding strategies in communal rangelands of semi-arid Namaqualand, South Africa. *Human Ecology*, **34** (6), 765-784.
- Barker, K., C. Bosco and I. Oandasan (2005). Factors in implementing inter-professional education and collaborative practice initiatives: Findings from key informant interviews. *Journal of Inter-professional Care*, **19** (S1), 166-176.
- Bass, F. (1969). A simultaneous equation regression study of advertising and sales of cigarettes. *Journal of Marketing Research*, **6** (3) 291-300.
- Bellu, L. G. (2013). Value chain analysis for policy making: Methodological guidelines and country cases for a quantitative approach. FAO publication, *EasyPol Series* 129.
- Bennett, R., D. Graham and W. Bratton (1999). The location and concentration of businesses in Britain: Business clusters, business services, market coverage and local economic development. *Transactions of the Institute of British Geographers*, **24** (4), 393-420.
- Changpetch, P., and D. Lin (2013). Selection of multinomial logit models via association rules analysis. *Wiley Interdisciplinary Reviews: Computational Statistics*, **5** (1), 68-77.
- Das, J. and O. Prakash (2002). Measuring marketing channel efficiency and strategy to improve income to local communities dependent on tropical forests. *Journal of Sustainable Forestry*, **15**(4), 27-52.
- Davison, G. (2003). The social survey and the puzzle of Australian sociology. *Australian Historical Studies*, **34** (121), 139-162.
- Debertin, L. (1992). *Agricultural Production Economics*. Oxford: Oxford University Press.
- Dercon, S. (1998). Wealth, risk and activity choice: Cattle in Western Tanzania. *Journal of Development Economics*, **55** (1), 1-42.

- Deressa, T. T., R. Hassan, C. Ringler, T. Alemu and M. Yesuf (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, **19** (2), 248-255.
- Doonan, J., P. Lanoie and B. Laplante (2005). Determinants of environmental performance in the Canadian pulp and paper industry: An assessment from inside the industry. *Ecological Economics*, **55** (1), 73-84.
- Duloy, H. (1964). Simultaneous-equations bias and agricultural production function estimation. *Australian Journal of Agricultural Economics*, **34** (2), 161-168.
- Elhadi, Y., D. Nyariki, O. Wasonga and W. Ekaya (2012). Factors influencing transient poverty among agro-pastoralists in semi-arid areas of Kenya. *African Crop Science Journal*, **20** (1), 113-122.
- Erdogdu, E. (2007). Electricity demand analysis using cointegration and ARIMA modelling: A case study of Turkey. *Energy Policy*, **35** (2), 1129-1146.
- Farah, Z., A. Streiff and R. Bachmann (2004). Preparation and consumer acceptability tests of fermented camel milk in Kenya. *Journal of Dairy Research*, **57** (3), 281-283.
- Farah, Z., M. Mollet, M. Younan and R. Dahir (2007). Camel dairy in Somalia: Limiting factors and development potential. *Livestock Science*, **110** (1), 187-191.
- Faye, B. (2004). Dairy productivity potential of camels: *ICAR Technical Series* No. 11.
- Fiebig, D. G., M. Keane, J. Louviere and N. Wasi (2010). The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. *Marketing Science*, **29** (3), 393-421.
- Finan, F., E. Sadoulet and A. de Janvry (2005). Measuring the poverty reduction potential of land in rural Mexico. *Journal of Development Economics*, **77** (1), 27-51.
- Flores, M. and V. Bent (1980). Family food basket; definition and methods. *Archivos latinoamericanos de Nutricion*, **30** (1), 58-74.
- Gameel, S., S. Mohamed, A. Mustafa and M. Azwai (1993). Prevalence of camel brucellosis in Libya. *Tropical Animal Health and Production*, **25** (2), 91-93.
- Greene, G., D. Sunding, D. Zilberman and D. Parker (1996). Explaining irrigation technology choices: A micro-parameter approach. *American Journal of Agricultural Economics*, **78** (4), 1064 -1072.
- Gujarati, D. (1992). *Essentials of Econometrics*. McGraw-Hill. New York, USA.
- Gujarati, D. (1995). *Basic Econometrics*. 3rd edition. McGraw-Hill. New York, USA.

- Gujarati, D. and N. Sangeetha (2007). *Basic Econometrics* 4th Edition. McGraw-Hill, New Delhi, India.
- Hassan, R., and C. Nhemachena (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agricultural and Resource Economics*, **2** (1), 83-104.
- Hausman, J. (1983). Specification and estimation of simultaneous equation models. *Handbook of Econometrics*, **1** (1), 391-448.
- Hausman, J. and D. McFadden (1984). Specification tests for the multinomial logit model. *Econometrica: Journal of the Econometric Society*, **52** (5), 1219-1240.
- Hayami, Y. and R. Herdt (1977). Market price effects of technological change on income distribution in semi-subsistence agriculture. *American Journal of Agricultural Economics*, **59** (2), 245-256.
- Kakota, T. (2011). The impact of climate variability and extreme weather events on gender and household vulnerability to food insecurity. Doctoral Thesis, University of Nairobi, Kenya.
- Kaplinsky, R. and M. Morris (2001). *A Handbook for Value Chain Research*, Brighton, IDRC. Ottawa, Canada.
- Kosgey, I., G. Rowlands, J. Van Arendonk and R. Baker (2008). Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. *Small Ruminant Research*, **77** (1), 11-24.
- Kuma, B., D. Baker, K. Getnet and B. Kassa (2013). Factors affecting milk market outlet choices in Wolaita zone, Ethiopia. *African Journal of Agricultural Research*, **8** (21), 2493-2501.
- Lamine, C. (2005). Settling shared uncertainties: Local partnerships between producers and consumers. *Sociologia ruralis*, **45** (4), 324-345.
- Lareo, L., B. Gracia, L. Fajardo, L. Romero, G. Acciarri, A. Pradilla and C. Daza (1990). From food basket to food security: The food factor in nutritional surveillance. *Archivos latinoamericanos de nutrición*, **40** (1), 1-22.
- Little, P., K. Smith, B. Cellarius, D. Coppock and C. Barrett (2001). Avoiding disaster: Diversification and risk management among East African herders. *Development and Change*, **32** (3), 401-433.
- McKelvey, R. and W. Zavoina (1975). A statistical model for the analysis of ordinal level dependent variables. *Journal of mathematical sociology*, **4** (1), 103-120.
- Morgan, L. and T. Spanish (1984). Focus groups: A new tool for qualitative research, *Qualitative Sociology*, **7**(3), 253-270.

- Musinga, M., D. Kimenye and P. Kivionz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets. Nairobi Kenya.
- Nyariki, D. (1997). Resource availability and productivity, farmer efficiency, and household food security in semi-arid Kenya. Doctoral Thesis, University of Reading. United Kingdom.
- Nyariki, D. (2008). Price response of herd off-take under market liberalization in a developing cattle sector: panel analysis applied to Kenya's ranching. *Environment and Development Economics*, **14** (2), 263-280.
- Nyariki, D. (2009). Household data collection for socio-economic research in agriculture: approaches and challenges in developing countries. *Journal of Social Science*, **19** (2), 91-99.
- Nyariki, D. (2009). Impacts of policy reforms on the livestock industry in Kenya: The case of the dairy sector. *Livestock Research for Rural Development*, **21** (10).
- Nyariki, D. M. and R. Ngugi (2002). A review of African pastoral production systems: Approaches to their understanding and development. *Journal of Human Ecology*, **13** (3), 237-250.
- Oladele, O. (2004). Livestock farmers' awareness, access and benefits of veterinary extension services in South-western, Nigeria. *Livestock Research for Rural Development*, **16** (6).
- Øyen, E. (1999). The politics of poverty reduction. *International Social Science Journal*, **51** (162), 459-465.
- Porter, M. (2001). Strategic management of the value chain. *Harvard Business Review*, United Kingdom, 63-79.
- Powell, R., H. Single and K. Lloyd (1996). Focus groups in mental health research: Enhancing the validity of user and provider questionnaires. *International Journal of Social Psychology*, **42** (3), 193-206.
- Reid, A., P. Petocz and S. Gordon (2008). Research interviews in cyberspace. *Qualitative Research Journal*, **8** (1), 47-62.
- Rickman, D. (2010). Modern macroeconomics and regional economic modelling. *Journal of Regional Science*, **50** (1), 23-41.
- Sabbah, I., N. Drouby, S. Sabbah, N. Retel-Rude and M. Mercier (2003). Quality of life in rural and urban populations in Lebanon using SF-36 health survey. *Health and Quality of Life Outcomes*, **1** (1), 1-30.

- Samba, A. (2010). Men are an influential factor in households and community food security in the Centre Region of Cameroon. <http://www.monitor.upeace.org/innerpg.cfm?idarticle=718>. Accessed on 5th of May 2013.
- Schwartz, H., R. Dolan and A. Wilson (1983). Camel production in Kenya and its constraints. *Tropical Animal Health and Production*, **15** (3), 169-178.
- Sedaghat, R. (2009). A comparative study on Pistachio marketing in Iran's tropics. *Agricultura Tropica et Subtropica*, **42** (4), 204-208.
- Shepherd, G. (1965): Marketing farm product economic analysis. Iowa state University Press, Iowa. Washington, D.C, USA.
- Srivastava, R., T.Shervani, and L. Fahey (1998). Market-based assets and shareholder value: A framework for analysis. *The Journal of Marketing*, **62** (1).
- Sussan, J., and L. Arriens (2003). Poverty and water security. Asian Development Bank. <http://www.adb.org/water/theme/poverty.aspx>. Accessed on 9th of June 2013.
- Tessema, W., P. Ingenbleek and C. Van-trijp (2013). Pastoralism, sustainability, and marketing. A review. *Agronomy for Sustainable Development*, **1** (18).
- Thamizhselvan, K. and P. Murugan (2012). Marketing of grapes in Theni district. *International Journals of Marketing and Technology*, **2** (9), 96-111.
- Upton, M. (2004). The role of livestock in economic development and poverty reduction. *Pro-Poor Livestock Policy Initiative Working Paper*, 10.
- Varkevisser, C., I. Pathmanathan and T. Brownlee (2003). *Designing and Conducting Health Systems Research Projects*. IDRC, Ottawa, Canada.
- Waters-Bayer, A., and W. Bayer (1994). Planning with pastoralists: PRA and more. *A Review of Methods Focused on Africa*. Eschborn: GTZ, OE, 422, 153.
- Woźniakowski, H. (2003). Open problems for tractability of multivariate integration. *Journal of Complexity*, **19**(3), 434-444.
- Yates, F., and P. Grundy (1953). Selection without replacement from within strata with probability proportional to size. *Journal of the Royal Statistical Society, Series B (Methodological)*, **15** (2), 253-261.

CHAPTER 5

THE ROLE OF CAMEL MILK IN PASTORAL HOUSEHOLD LIVELIHOODS IN THE DRYLANDS OF KENYA

5.1 SUMMARY

The pastoral ecosystem in Kenya is experiencing unusual climatic variability as evidenced by the unpredictable rainfall and drought occurrences. This has rendered most of the traditional coping strategies ineffective leading to vulnerable and insecure livelihood systems. Despite having the potential to alleviate the vulnerability of pastoral communities by continuous provision of milk and other products, the potential of camel milk is yet to be exploited to the full. This study was carried out to examine the contribution of camel milk to the pastoral household food basket and income. The study used a semi-structured questionnaire to collect relevant information targeting camel milk producers in Isiolo County. The results from the analysis of household data showed that camel milk constitutes a significant proportion of the pastoral household food basket. The contribution of camel milk to the food basket was significant ($P \leq 0.05$) during the dry season compared to the wet season. Further, the study revealed that camel milk sales contribute significantly ($P \leq 0.05$) to household income throughout the year. These results highlight the need for proper policies and interventions to increase the use of camel milk by the wider pastoral community in Kenya as this can strengthen household resilience to climate variability and change.

5.2 INTRODUCTION

Pastoral production is the mainstay of approximately 26 million people in Africa. This system makes a sustainable use of about 50% of the total surface of the East African region (Kratli *et al.*,

2013). This sector further contributes significantly to the agricultural GDP of many countries within the region. For instance in Kenya, Ethiopia and Uganda, the sector accounts for more than 50%, 40% and 17% of agricultural GDP, respectively (Scarpa *et al.*, 2003). The system is based on consumption and sale of livestock and livestock products, mostly cattle, goats, sheep and camels. The flexibility of this system permits its existence as the only efficient means of exploiting available resources under ecologically marginal conditions, available technologies and the prevailing economic constraints (Chikamai and Eriksen, 2011).

Pastoral production system in Kenya is facing numerous problems, among them matching erratic and seasonal patterns of forage availability with more or less continuous feed requirement of live animals to achieve a regular supply of food and non-food requirements (Leng *et al.*, 2010). Hence, the challenge facing pastoral communities is to maintain this balance to ensure adequate food using their exiting production system (Fratkin and Mearns, 2003). This, however, is exacerbated by the extreme climatic variability, increased human population, insecurity, underdevelopment, and political marginalization which have sharply exposed the layers of poverty and food insecurity (Elhadi *et al.*, 2012).

In the last two decades, pastoral ecosystems have experienced an unusual variability in climate manifested in unpredictable rainfall and drought occurrences (Hussen *et al.*, 2008). Consequently, the current livelihoods and resource use patterns in the drylands are insecure and can no longer maintain the living standards of pastoralists in these areas. This can be clearly seen in Kenyan drylands, where recurrent droughts have undermined the ability of cattle and small stock in supporting pastoral household livelihoods. The effect of drought is largely beyond the

basic water and grazing resources (Musinga *et al.*, 2008). Among others, drought limits the available land-based livelihood options, triggers conflict and loss of life and accelerates land degradation processes in an already fragile ecosystem (Eriksen and Lind, 2009). For instance, in Kenya, the reported mortality rate in the drought 2011 ranged between 40% and 70% for cattle and goats/sheep respectively (Serna, 2011). This has consequently weakened the resilience of pastoral production system, which is more exposed and vulnerable to different natural and artificial shocks than any other land use system in Kenya.

Many livelihood options have been proposed and implemented by different agencies and institutions to alleviate the situation and revive the pastoral production system. Among these are dryland farming, apiculture, intensified investment in animal health, livestock marketing, and non-land-based livelihoods (Cooper *et al.*, 2008; Homewood *et al.*, 2009; Elhadi *et al.*, 2012). These interventions, however, have failed to provide sustainable and reliable pathways to a resilient pastoral production system. One of the existing options is the camel and camel products; as the camel is considered an important animal source of food in some pastoral areas (Zeng and Edwards, 2010). This is because the camel has unique physiological, anatomical and ecological characteristics. These characteristics permit it to produce and supply milk to pastoral households throughout the year (Farah, 1996). Despite these abilities to enhance pastoral livelihoods under the harsh climatic conditions, the camel has received little focus in comparison to other species in the field of scientific research and development. This could mostly be attributed to the fact the camel is mostly found in areas where poor nutrition and husbandry are major challenges (Mehaia, 1994).

In their study on replacing pastoralism with irrigated agriculture in Ethiopia, Behnke and Kerven (2011) reported that the camel is superior to all other livestock species in terms of food security in arid areas. The reason behind this is that camels have longer lactation period and yield more milk over the lactation period, in comparison to cattle and goats in arid areas (Getahun and Belay, 2002). In Kenya, the camel population is expanding southwards. This is evident in areas of southern rangelands where more pastoralists are adopting camel rearing to generate more income. This has been driven by the high price offered in the surrounding market (Mathias *et al.*, 2010). The camel belt expansion is expected to extend to other parts of the country in the coming decades (GoK, 2010). On the other hand, there is an increasing acceptability of camel milk as an energy source among non-traditional camel keepers as sometimes the milk turns to be the only one available option during prolonged dry season and droughts (Yagil, 1982; Alhadrami, 2003).

Whereas it is acknowledged that camel production may offer a pathway to a resilient pastoral production system by providing milk to level-off fluctuations in food and income during harsh times, no studies have been undertaken to determine the role of the camel milk in pastoral livelihoods. Isiolo County was therefore used as case study to generate evidence on the contribution of camel milk to pastoral household food basket and income in the drylands of Kenya.

5.3 METHODOLOGY

5.3.1 Study Area

This study was conducted in Isiolo County which is located in the upper eastern region of Kenya covering approximately 25,000 square kilometres. The altitude in the area ranges between 200m

and 300m above sea level (Noor *et al.*, 2012). The area borders Marsabit County to the north, Wajir and Garissa Counties to the east, Tana River and Meru Counties to the south, and Samburu and Laikipia Counties to the west. The county is classified as arid and semi-arid with low, bimodal, and erratic rainfall amounting between 350mm and 600mm per year (Herlocker *et al.*, 1993). The county is hot throughout the year with mean annual temperatures ranging from 24°C - 30°C (Jaetzold and Schmidt, 1983). With the rains being erratic, droughts that lead to devastating loss of livestock and human lives are a common occurrence in the County (GoK, 1997). The poverty level in the area is high, estimated at 70% (Kamunyan *et al.*, 2013). Livelihood activities in the county include pastoralism, firewood/charcoal burning and casual wage labour. With the current climatic changes, most of the aforesaid livelihoods are rather ineffective. Recently, camel milk production and marketing has gained popularity as one of the major livelihood activities in the county (Noor *et al.*, 2012). It is estimated that Isiolo County has about 40,300 camels with a daily milk production of about 50,000 litres. About 87.5% is consumed at either local trading centres or for subsistent at the household level (Musinga *et al.*, 2008).

5.3.2 Data Collection

A multistage sampling procedure was used to collect primary data from camel milk producers in the study area. The sampling procedure involved collecting data at three main levels. The first level was Isiolo County. This was purposively selected based on the level of camel production and the market orientation of the camel producers compared to other camel milk producing counties (Noor *et al.*, 2012). Secondly, two sub-counties were sampled, based on the number of camels, intensity of milk production and level of marketing. Thirdly, three sub-locations were randomly sampled. Finally, 202 households were randomly selected from twenty villages. This

sample size was determined using the probability proportional to size formula suggested by Yates and Grundy (1953):

$$n = \frac{Z^2(1-p)p}{e^2} \quad (5.1)$$

Where n is the sample size, Z is the desired Z-value yielding the desired degree of confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher is willing to permit.

The study used a semi-structured questionnaire to collect data such as demographic characteristics, camel milk production, camel milk marketing, income sources and amount, household food consumption, and available resources such as land and other livestock species. The study further used Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). Six FGDs were conducted, two per location. FGDs and KIIs were carried out to clarify and shed more light on aspects such as camel milk production, consumption and marketing. Household interviews were conducted from August to November 2012.

5.3.3 Data Analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to generate percentages, frequencies, averages and standard deviations. Further, the study used a t-test to determine the significance of the differences between the contribution of camel milk to the household food basket and income during the wet and dry

seasons. The main purpose of using descriptive statistics was to derive the contribution of camel milk to pastoral household food basket and income during the wet and dry seasons. To determine the contribution of camel milk to household food basket, the study used the basic food consumed by a household to arrive at different food proportions. These proportions were then multiplied by their current market prices and their share in household food expenditure derived. Finally, these shares were converted to percentages using the total cost of the reported food basket. The contribution of camel milk to household income was directly derived from the total household income.

5.4 RESULTS AND DISCUSSION

The results are summarized based on three aspects, namely, the characteristics of the sampled population, the contribution of camel milk to the pastoral household food basket, and the contribution of camel milk to pastoral household income.

5.4.1 Household Characteristics

In this study a household was defined as ‘all people living under one roof and are subject to decisions made by the household head.’ A household head was defined as one who owns and controls the major resources, makes critical decisions and provides the basic needs for the household members (Elhadi *et al.*, 2012). Table 5.1 shows the social and demographic characteristics of the sampled population. Most (80.7%) of the interviewed households were male headed. The majority (73.3%) of respondents were between 30 and 60 years old. The respondents under 30 years were 4.0%, while those over 60 years were 22.8%.

The proportion of household heads that did not go through formal education was 81.2%, while only 1.5% of the respondents had attained post-secondary education. These results show illiteracy levels of more than twice the national average (38.5%). (GoK, 2010). Education is an important entry point for empowerment of pastoral communities and an instrument to sustain development. In this context, the education level of pastoral households may have a significant importance in identifying and determining the right type of development and extension service approaches. Education is understood to influence household income, technology adoption and, as a whole, the socio-economic status of the family (Ejigu *et al.*, 2009).

Table 5.1: Social and demographic characteristics

Variable	Category	Frequency	Percentage
Gender of the household head	Male	163	80.7
	Female	39	19.3
Age of household head	Under 30 years	8	4.0
	Between 30-60 years	148	73.3
	Over 60 years	46	22.8
Education level	None	164	81.2
	Primary	24	11.9
	Secondary	11	5.4
	Post-Secondary	3	1.5

The average household size of the sampled population (Table 5.2) was 6.5, with 3.3 and 3.4 being the average number of females and males, respectively. However, the average household size is rather high as compared to the national average household of 4.4 in Kenya (GoK, 2010). Household size in the pastoral setup is considered one of the most important resources for labour. This, among other factors, might directly or indirectly determine the level of nutrition security and consequently the household ability to cope with various natural and man-made hazards in the

dryland areas. Also, household size and availability of family labour are closely related to the number of animals kept by a certain household.

Table 5.2: Household composition

Variable	Minimum	Maximum	Mean (Std. Dev.)	Proportion (%)
Number of males	1	10	3.4 (1.68)	50.7
Number of females	0.0	9	3.3 (1.60)	49.3
Family size	0.0	17	6.5 (2.56)	100.0

The average number of camels owned by a pastoral household was 30 heads (Table 5.3). Among the total number of camels owned by a given household, the number of female camels exceeded that of male camels, with 21 females and 3 males. This formed 68.3% and 10.8% of the total herd respectively. This number of camels is relatively high compared to the number in other pastoral areas in northern Kenya (Musinga *et al.*, 2008). This can be an indicator of how important the camels are in the study area. Similar to other pastoral areas, the proportion of lactating camels kept by a household is relatively higher than the male camels. This suggests that the main reason for keeping the camels is milk production (Noor *et al.*, 2012).

Table 5.3: Camel herd structure

Variable (n %)	Minimum	Maximum	Mean (Std. Dev.)	Proportion (%)
Male camels (91.6)	0.0	40.0	3.3 (4.00)	10.8
Female camels (100.0)	2.0	80.0	20.9 (15.70)	68.3
Calves (87.6)	0.0	40.0	6.4 (5.50)	20.9
Total number of camels	2.0	101	29.7 (21.10)	100.0

n: Percentage of the sampled population that owned a certain number of animals

5.4.2 Contribution of Camel Milk to Household Food Basket

Food basket is defined as the calculated price of a set of basic foodstuffs, standardized according to the percentage of expenditure on food and size of household (Øyen, 1999). The basic pastoral household food basket in the study area consists of livestock products, grain and their products, vegetables and sugar. Each of these items was consumed by at least 30% of the interviewed pastoral households (Table 5.4). The reported consumed items were measured in their respective units of measurement and the consumption of various items was based on the average household size. Some of these items were produced and consumed at home. The study used the current market price to obtain their monetary value. The average cost of the reported pastoral household food basket was KSh721.11 (equivalent to 8.48 US dollars at 1:85 exchange rate). This was mostly spent on livestock related foodstuff, namely meat and milk items.

Table 5.4: Pastoral household food basket

Foodstuff	Proportion of respondents (%)	Daily consumption (kg or litre) per household	Equivalent in kcal			Food basket measured in KSh.	
			Kcal/kg or litre	Consumption/ kcal	Average Price (KSh)	Expenditure (KSh)	Proportion (%)
Cow milk	87.6	1.08	1,514.00	1627.55	49.70	53.4275	7.41
Camel milk	60.9	2.29	632.00	1447.28	64.30	147.247	20.42
Cow meat	30.2	0.38	1,587.00	595.125	280	105	14.56
Goat meat	32.2	0.38	1,430.00	543.40	333.30	126.654	17.56
Camel meat	30.7	0.59	980.00	578.20	300.00	177	24.55
Maize meal	74.8	0.47	3630.00	1706.10	68.80	32.336	4.48
Vegetables	65.8	0.32	480.00	153.60	19.00	6.08	0.84
Oil	89.1	0.12	8,370.00	962.55	129.90	14.9385	2.07
Rice	59.4	0.12	1,230.00	147.60	76.70	9.204	1.28
Spaghetti	51.5	0.14	1,580.00	213.30	75.80	10.233	1.42
Sugar	100.0	0.34	3,831.00	1283.385	116.40	38.994	5.41
Total						721.11	100.00

The consumption of the reported items varied among sampled households. For example, sugar, oil and cow milk were consumed by almost the entire sampled population. The level of consumption was 30.2%, 32.2% and 30.7% for cow, goat and camel meat respectively. Camel milk was consumed by 60.9% of the sampled population. This, therefore, shows that milk is one of the most important contributors to the pastoral household food basket. Similarly, the expenditure on the reported foodstuffs varied among the interviewed households. Most households tended to spend more on essential and relatively cheap foodstuff such as milk.

Camel meat had the highest contribution (24.6%) followed by camel milk (20.4%), this is an equivalent of 578.2 and 1447.3 kcal, respectively. Goat meat and cow meat contributed 17.6% and 14.7%, which is equivalent to 543.4 and 595.1 kcal, respectively. Sugar contributed 5.4%, an equivalent of 1,283.4 kcal, while maize meal contributed 4.5%, equivalent to 1,706.1 kcal. Rice and vegetables had the least contribution to the food basket of the sampled population, with 1.4% and 0.8%, respectively.

Most pastoralists in Eastern Africa rely heavily on livestock products such as milk, blood and meat for their subsistence. In peri-urban areas of Kenya, the food basket of the pastoralists not only comprises livestock products, but also to some extent cereals, sugar, oil and rice. The extent to which any of these items is consumed depends on many factors, such as culture, availability of alternative sources of energy and protein, as well as the distance to the nearest trading centre. This can be explained by the fact that pastoral households are distributed between herders' camps and settled households within or near towns. For instance, herders usually supplement livestock products with imported grain of maize or sorghum. Others have mainly livestock

products in the herding camps and eat more grain in the settlements (Sato, 1997). Most pastoralists sell or exchange livestock and their products to be able to purchase the essential non-livestock food items.

Table 5.5 presents the pastoral household food basket during wet and dry seasons. The average daily expenditure on the pastoral household food basket during the wet and dry seasons was KSh 763 and KSh 674 respectively (equivalent to 9 and 7.9 US dollars respectively). The quantities of foodstuffs consumed varied between wet and dry season. During the wet season the average quantities of milk consumed per average household was 1.6 and 2 litres for cow milk and camel milk respectively. The average quantity of meat products varied, with 0.5kg of cow meat, 0.4kg of goat meat and 0.6kg of camel meat. During the dry season, households reported a decrease in cow milk consumption (0.5 litres) and an increase in camel milk consumption (2.5 litres). Meat products showed a decrease in quantity consumed during the dry season, with 0.2kg, 0.3kg and 0.5kg for cow, goat and camel meat respectively. The average quantities of non-livestock products such as maize meal, vegetables, oil, rice, spaghetti and sugar remained the same during the wet and dry seasons.

Table 5.5: Pastoral household food basket during wet and dry seasons

Foodstuff	Wet season				Dry season				Chi Square
	Daily consumption (kg or litre)	Average prices/Kg or litre	Expenditure (KSh)	Proportion (%)	Daily consumption (kg or litre)	Average prices/Kg or litre	Expenditure (KSh)	Proportion (%)	
Cow milk	1.63	48.69	79.36	10.40	0.52	50.71	26.37	3.91	2.278
Camel milk	2.04	53.80	109.75	14.38	2.54	74.80	189.99	28.19	4.887**
Cow meat	0.54	266.00	143.64	18.83	0.21	294.00	61.74	9.16	3.071
Goat meat	0.43	308.25	132.55	17.37	0.33	358.35	118.26	17.55	0.028
Camel meat	0.64	278.50	178.24	23.36	0.54	321.50	173.61	25.76	0.053
Maize meal	0.52	70.20	36.50	4.78	0.42	67.40	28.31	4.20	0.019
Vegetables	0.30	21.33	6.40	0.84	0.34	16.67	5.67	0.84	0.630
Oil	0.13	122.80	15.96	2.09	0.1	137.00	13.70	2.03	0.202
Rice	0.13	81.00	10.53	1.38	0.11	72.40	7.96	1.18	0.249
Spaghetti	0.14	75.30	10.54	1.38	0.13	76.30	9.92	1.47	0.283
Sugar	0.34	116.20	39.51	5.18	0.33	116.60	38.48	5.71	0.024
Total			762.99	100.00			674.00	100.00	

** Significant at 5%

Livestock products had the highest contribution, with 61.1% during the wet season and 88.2% during the dry season. During the wet season, camel meat had the highest contribution (23.4%) followed by cow meat (18.8%) and goat meat (17.4%). Milk products had the least contribution among livestock related products, with 14.4% and 10.4% for camel milk and cow milk respectively. Rice, spaghetti and vegetables had the least contribution to the household food basket during the wet season, 1.4%, 1.4% and 0.8% respectively.

During the dry season, the contribution of different foodstuffs to pastoral household food basket changed dramatically, with a general trend of increasing in the contribution of livestock products and decreasing in non-livestock products. Camel milk had the highest contribution (28.2%) followed by camel meat (25.8%) and goat meat (17.6%). Cow meat and milk contributed 9.2% and 3.9% respectively. The contribution of maize meal was 4.2%, while that of sugar was 5.7%. Rice contributed only 1.2% of the food basket. The contribution of camel milk increased significantly ($P \leq 0.05$) during the dry season.

The decrease in the average expenditure of household food basket during the dry season is an indicator that pastoral households spend less on food during the dry spells. This is possibly as a results of less income generated from land-based livelihood activities as well as the relative increase in prices during such period. For instance, dry periods are mostly associated with inadequate pasture and water which are the primary inputs for livestock production; thus the output of this system is usually affected negatively. The income generated from livestock production is also affected negatively, this coupled with the relative increase in prices, forcing households which rely heavily on livestock as the main source of income to cut their

expenditures on food by amounts that are equivalent to the reduction in their incomes and the increase of various foodstuff prices. In other words, pastoral households tend to consume less whenever they experience any reduction in their incomes and increase in foodstuff prices.

In many pastoral areas in Kenya, the availability of food depends on seasonal fluctuations. This mostly subjects pastoralists to seasonal and long term shifts in terms of trade between the main local commodities of live animals, dairy products and food grains, which fluctuate in absolute terms and relative to each other (Grace *et al.*, 2013). This in most cases might result in a food supply gap, particularly during prolonged dry season and drought, whereby the animals fail to produce enough products for domestic use as well as for exchange. Thus, food insecurity and malnutrition become inevitable (Calow *et al.*, 2010). Despite the continuous food supply fluctuation, pastoralists have developed strategies to deal with food shortages. These include, among others, engaging in non-land-based livelihood options (such as casual labour and petty trade) and entering or withdrawing from livestock and exchange markets (Orindi *et al.*, 2007). These options, however, are limited in part by the seasonal availability of one of their main products, namely milk. The seasonal shortages and surpluses of milk therefore pose a great challenge to their food security. A similar trend was observed in the study area whereby the food basket items vary in terms of contribution, prices and availability with regards to seasonal climatic variation.

The contribution of different food items to the household food basket changed drastically in respect to seasonality. Meat items had the highest contribution across seasons, with 59.7% and 52.5% during the wet and dry seasons respectively. During the dry season camel milk

contributed significantly to the household food basket (as measured in KSh.) compared to the wet season. This confirms the hypothesis of this study that camel milk indeed contributes significantly to the household food basket in the dryland areas of Kenya. The significant contribution of camel milk to the pastoral household food basket implies that camel milk plays a vital role in the pastoral household diet, particularly during the dry season. This is similar to the findings of Emukule *et al.* (2011) who reported that camel milk contributes more than 50% of the nutrient intake of the pastoralists in Marsabit District in Kenya. This can be further explained by the fact that the camel is least affected by the dry season compared to other livestock species, therefore, most of the time it's the only animals around the household as other livestock species move further away in search of pasture and water.

In typically prolonged dry seasons and drought periods, most animals are significantly affected by the lack of water and feed resources. Most of the time cattle are adversely affected compared to camels; despite the fact that cattle are the main livestock species in most pastoral production systems in Kenya. This is supported by many studies that have compared the effect of drought and prolonged dry season across all species that constitute the pastoral production system (Farah *et al.*, 2004; Schwartz, 1992; Farah *et al.*, 2004; Mehari *et al.*, 2007 and Serna, 2011). This is because the camel has the ability to withstand harsh climatic conditions and has high ability to cope with shortage of water and feed during prolonged dry season. Despite the aforementioned limitation, the camel has the ability to supply household with milk during such periods.

Hunger among pastoral households in the study area is mostly associated with the dry season. This is a result of different interrelated factors, among them, those related to the deteriorated

condition of livestock and a scarcity of water and pasture (Witsenburg and Adano, 2009). During the dry season, milk production, which forms an essential component of the pastoral household diet in the wet seasons, is drastically reduced (Ilatsia *et al.*, 2007). It has been observed, especially among pastoralists, that when access to milk is reduced, acute malnutrition rates tend to increase, but decline when access to milk is increased (Sadler *et al.*, 2009). This shows that milk is an important source of protein and various vitamins and provides a significant amount of other nutrients necessary for body growth, hence contributing to the health of consumers (Njarui *et al.*, 2009).

The contribution of camel milk to household food basket and thus food security, particularly in arid and semi-arid areas of Kenya, is now evident. Therefore, it is critical to examine the patterns of camel milk consumption among interviewed pastoral households. This information is particularly important to key stakeholders involved in the production, processing and marketing of camel milk. Table 5.5 shows the frequency and forms of camel milk usage at the household level across the sampled population.

Table 5.6: Frequency and forms of camel milk consumption

Variable	Category	Frequency	Percentage
Consumption frequencies	Once	12	10.2
	Twice	52	49.0
	Three times	36	35.7
	Four times	7	5.1
Consumption forms	Fresh	104	97.6
	Sour	3	2.4

The consumption patterns of camel milk differ from one household to another. Across the sampled respondent, the highest consumption frequency was twice per day (49%) followed by three times a day (35.7%), once a day (10.2%) and four times a day (5.1%). Camel milk is traditionally consumed raw by pastoralists. This study shows that 97.6% of the surveyed households consumed milk in fresh form while 2.4% of them consumed the milk in sour form. The consumption form, however, varied between households. For instance, the majority of households interviewed consumed camel milk either with tea or grain. Similar results were reported by Sato (1997) who observed that most communities in Isiolo District consumed camel milk in raw and fresh form, with more than 50% consuming milk twice a day. On their part, Akweya *et al.* (2012) reported that more than 75% of the households in Garissa District use camel milk in its raw forms and more than 60% consume milk twice a day.

The consumption patterns in terms of frequency and forms suggest that camel milk plays an essential role in pastoral household daily nutritional intake. This finding, coupled with the significant contribution of camel milk to pastoral household food basket, shows that camel milk can provide a reliable pathway to resilience of pastoral production systems in the drylands of Kenya.

5.4.3 Contribution of Camel Milk to Household Income

Pastoral production system is entirely built around livestock which are thus the major providers of household income and food (Ifejika *et al.*, 2008). Although different communities have different strategies to manage their system and drive the desired benefits, many studies have argued that livelihood diversification is a prerequisite to the sustainability of the pastoral

production system. Diversification eases pressure on the system by focusing more on off-farm livelihood activities such as petty trade and wages (Nduma *et al.*, 2001). This can be valid for some areas and not others, and largely varies from one season to another, since most household livelihood activities are land-based and are thus highly affected by climatic variability and change (Berhanu *et al.*, 2007). Therefore, it is useful to examine the contribution of all income generating activities to the household income. The same scenario was observed in the study area whereby the contribution of different activities to the household income varied with seasonality.

Pastoral household livelihood activities are presented in Table 5.6. Sale of camel milk was the highest contributor to household average monthly income, with 38.7% followed by sale of livestock (27.6%) and petty trade (14.4%). The contribution of casual labour, sales of charcoal and salary from formal employment was 7.4%, 7.2% and 3.2% respectively. Sales of cow milk had the least contribution with 1.6%. Although livestock contributed less to the pastoral household income during dry season compared to the wet season, livestock was still the major contributor to the income during dry season.

The results show that camel milk was the major contributor to household income during both the wet and dry seasons by 40.9% and 35.7% respectively. This is followed by sales of live animals mostly goats and sheep in both the wet season (32.0%) and the dry season (21.5%). Petty trade was third, with 12.3% during the wet season and 17.3% during the dry season. Other activities such as sales of charcoal contributed 4.3% and 11.1% during the wet and dry season respectively.

Table 5.7: Pastoral household livelihood activities during wet and dry season

Livelihood activity	Average		Wet Season		Dry season	
	Income (KSh)/month	%of average income	Income (KSh)/month	% of average income	Income (KSh)/month	% of average income
Sales of camel milk (n= 197)	27,376.55	38.70	33,578.20	40.85	21,174.90	35.72
Sales of livestock (n=57)	19,537.20	27.62	26,333.30	32.04	12,741.10	21.49
Sales of cow milk (n = 37)	1,132.55	1.60	1,209.30	1.47	1,055.80	1.78
Sales of charcoal (n = 14)	5,057.50	7.15	3,536.40	4.30	6,578.60	11.10
Petty trade (n= 39)	10,178.20	14.39	10,076.90	12.26	10,279.50	17.34
Casual labour (n= 11)	5,227.30	7.39	5,227.30	6.36	5,227.30	8.82
Formal employment (salary) (n=20)	2,230.00	3.15	2,230.00	2.71	2,230.00	3.76
Total	70739.3	100.00	82,191.40	100.00	59,287.20	100.00

n: Proportion of the sampled population

The dominant contribution of livestock to household income across seasons implies that pastoral households continue to produce different livestock throughout the year despite water stress and pasture scarcity, which are the main inputs to the pastoral production system. This finding is contrary to the finding of Elhadi *et al.* (2012) who observed that during the dry season in the semi-arid areas of Baringo District of Kenya, the contribution of livestock to total household income reduces dramatically compared to that during the wet season. Thus, households engage more in off-farm activities. This contradiction may be explained by the fact that in Isiolo County the livestock herd is mostly made up of camels. This herd has the ability to produce milk throughout the year, which contributes significantly to pastoral household income irrespective of the season. This is true particularly taking into account that camel production is less affected by

climatic fluctuation and, unlike other livestock species, is less suppressed by lack of water and pasture.

In northern Kenya, the important role of camel milk in providing income have long been recognised and this is evident by the fact that camel milk sales clearly have dominated other income sources (Guliye *et al.*, 2007). Thus, sales of camel milk are not only a way of disposing of milk surpluses during the wet season, but an integral part of the way by which households generate income necessary for purchasing other essential food items, especially during the dry season. This, however, shows that households are faced with tough decisions either to adapt to the new situation or risk having no sustainable income.

The high contribution of camel milk to household income compared to off-farm activities can be further explained by the behaviour of households who live near market sites. Most of these households engage in milk trade and, therefore, are less dependent on off-farm activities. The close proximity of households to market centres encourages them to sell available animal products rather than search for off-farm activities. As reported by Seifu (2011), living near town has encouraged pastoralists to participate more in camel milk chain in Ethiopia so that in most camel owning households, camel milk sales dominate in their total cash income. Although most traditional camel keepers rear camel for subsistence, many non-traditional camel keepers are moving into camel milk business in the study area as it offers an opportunity for sustainable income throughout the year. This shows the importance of camel milk in smoothening inter-seasonal household income.

5.5 CONCLUSIONS AND POLICY IMPLICATIONS

The pastoral production system in north-eastern Kenya is predominantly practised in communally owned land, mainly by subsistence pastoralists. Because of recurrent drought, conflict, curtailed mobility and inappropriate policies, among other factors, pastoralists are no longer able to derive maximum benefits from their land-based resources. This directly weakens the pastoral production system and makes it less effective as a livelihood option, which consequently leads to a high level of poverty and food insecurity. One of the main pastoral coping strategies has been adoption of drought tolerant livestock species such as camels. This study analysed the contribution of camel milk to the pastoral household food basket and income. Further, the study examined these contributions across wet and dry seasons. The contribution of camel milk to household food expenditure was significant during the dry season. Similarly, camel milk was the major contributor to pastoral household income during both the wet and dry seasons. In the context of recurrent drought, and diminishing grazing and water resources, alternatives such as rearing camels can provide a pathway to a sustainable livelihood. Based on these findings, there is need to invest in the camel milk subsector by creating an enabling policy environment to enhance milk productivity and marketing. Furthermore, policies that target improved pastoral production should consider promoting camel milk production as a suitable strategy to build pastoral household resilience. Since, as reported, camel milk contribute markedly to household income, policies and interventions should be directed towards improving camel milk production and marketing by establishing production and marketing systems that ensure balanced inputs, proper transport and value addition in order to attract more pastoral households to engage in camel milk production and marketing. In addition, livestock interventions in drylands should include providing camels for restocking alongside other

livestock species and also necessary training to build appropriate skills for sound camel husbandry to fully exploit the latent potential of camel production in addressing nutrition security and food poverty.

REFERENCES

- Akweya, B., C. Gitao and M. Okoth (2012). The acceptability of camel milk and milk products from North-eastern Province in some urban areas of Kenya. *African Journal of Food Science*, **6** (19), 465-473.
- Alhadrami, G A. (2003). Camel. *Encyclopedia of Dairy Sciences*. In Roginski H, J. Fuquay and P. Fox (Eds.). Academic Press, Amsterdam, Netherland.
- Anderson, D., H Elliott, H. Kochore and E. Lochery (2012). Camel herders, middle women, and urban milk bars: The commodification of camel milk in Kenya. *Journal of Eastern African Studies*, **6** (3), 383-404.
- Behnke, R., and C. Kerven (2011). Replacing pastoralism with irrigated agriculture in the Awash Valley, north-eastern Ethiopia: Counting the costs. *Proceeding of the International Conference on the Future of Pastoralism*, 21-23.
- Berhanu, W., D. Colman and B. Fayissa (2007). Diversification and livelihood sustainability in a semi-arid environment: A case study from southern Ethiopia. *Journal of Development Studies*, **43** (5), 871-889.
- Calow, R., A. MacDonald, A. Nicol, and N. Robins (2010). Ground water security and drought in Africa: Linking availability, access, and demand. *Groundwater*, **48** (2), 246-256.
- Chikamai, N. and S. Eriksen (2011). Gums and resins: The potential for supporting sustainable adaptation in Kenya's drylands. *Climate and Development*, **3** (1), 59-70.
- Cooper, P., J. Dimes, K. Rao, B. Shapiro, B. Shiferaw and S. Twomlow (2008). Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change. *Agriculture, Ecosystems and Environment*, **126** (1), 24-35.
- Davies, J. and R. Bennett (2007). Livelihood adaptation to risk: Constraints and opportunities for pastoral development in Ethiopia's Afar Region. *Journal of Development Studies*, **43** (3), 490-511.
- Ejigu, K., T. Gebey and T. Preston (2009). Constraints and prospects for apiculture research and development in Amhara region, Ethiopia. *Livestock Research for Rural Development*, **21** (10).

- Elhadi, Y., D. Nyariki, V. Wasonga and W. Ekaya (2012). Factors influencing transient poverty among agro-pastoralists in semi-arid areas of Kenya. *African Crop Science Journal*, **20** (1), 113-122.
- Emukule, J, M. Ngigi and A. Guliye (2011). Analysis of socio-economic factors influencing willingness to pay for camel milk in Nakuru District, Kenya. *Livestock Research for Rural Development*, **23** (1).
- Eriksen, S. and J. Lind (2009). Adaptation as a political process: Adjusting to drought and conflict in Kenya's drylands. *Environmental Management*, **43** (5), 817-835.
- FAO. (Food and Agriculture Organization) (2007). Food security district profiles for 23 districts in Kenya. FAO of Kenya, Nairobi, Kenya.
- FAO. (2012). Availability and use of main staple crops. Bioenergy report. Rome. Italy. <http://www.fao.org/bioenergy/26183-0229a7fe04ac8667f9ad0f0ea17b454a1.pdf>. Accessed on 23rd of August 2013.
- Farah, K. O. (1996). Management and development of the arid communal rangelands in North-eastern Kenya: A Critical Analysis of the Past and the Present. *The African Pastoral Forum, Working Paper Series* No.7, June, 1996. PINEP (Pastoral Information Network Programme), University of Nairobi, Nairobi. Kenya.
- Farah, K., D. Nyariki, R. Ngugi, I. Noor and A. Guliye (2004). The Somali and the camel: Ecology, management and economics. *Anthropologist*, **6** (1), 45-55.
- Francine, M. and R. Hughes (1984). A Comment on the Impact of development schemes on the floodplain forests of the Tana River of Kenya. *The Geographical Journal*, **150** (2), 230-244.
- Fratkin, E. and R. Mearns (2003). Sustainability and pastoral livelihoods: Lessons from East African Maasai and Mongolia. *Human Organization*, **62** (2), 112-122.
- Getahun, T., and K. Belay (2002). Camel husbandry practices in Eastern Ethiopia: The case of Jijiga and Shinile zones. *Nomadic Peoples*, **6** (1), 158-179.
- GoK. (Government of Kenya) (1997). Isiolo District development plan for 1997-2001. *Government Printer*, Nairobi, Kenya.
- GoK. (2005). Isiolo District Vision and Strategy: 2005-2015. *Government Printer*, Nairobi, Kenya.
- GoK. (2010). Agricultural sector development strategy 2010–2020. Ministry of Agriculture. Nairobi, Kenya.
- GoK. (2010). Kenya 2009 Population and Housing Census. Ministry of State for Planning, National Development and Vision 2030 Division, Nairobi, Kenya.

- Grace, K., M. Brown and A. McNally (2013). Examining the link between food prices and food insecurity: A multi-level analysis of maize price and birth-weight in Kenya. *Food Policy*, **46** (2), 56-65.
- Guliye, A., I. Noor, B. Bebe and I. Kosgey (2007). Role of camels (*Camelus dromedarius*) in the traditional lifestyle of Somali pastoralists in northern Kenya. *Outlook on Agriculture*, **36** (1), 29-34.
- Herlocker, D., S. Shaaban and S. Wilkes (1993). *Range Management Handbook of Kenya*. Volume II, 5. Isiolo District. Ministry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya.
- Homewood, K., P. Kristjanson, and P. Trench (Eds.) (2009). *Staying Maasai? Livelihoods, Conservation and Development in East African Rangelands* (Vol. 5). Springer, New York, United State of America.
- Hussen, K., A. Tegegne, M. Yousuf and B. Gebremedhin (2008). Cow and camel milk production and marketing in agro-pastoral and mixed crop-livestock systems in Ethiopia. *Proceedings of Tropentag 2008, 7–9 October, 2008, University of Hohenheim, Germany*.
- Ifejika, S., B. Kiteme and U. Wiesmann (2008). Droughts and famines: The underlying factors and the causal links among agro-pastoral households in semi-arid Makueni District, Kenya. *Global Environmental Change*, **18** (1), 220-233.
- Ilatsia, E., T. Muasya, W. Muhuyi and A. Kahi (2007). Milk production and reproductive performance of Sahiwal cattle in semi-arid Kenya. *Tropical Science*, **47** (3), 120-127.
- Jaetzold, R. and H. Schmidt (1983). *Farm Management Handbook of Kenya: Natural Conditions and Farm Management Information*. vol. II. Ministry of Agriculture, Nairobi, Kenya.
- Kamunyan, C., G. Cheserek, M. Kiptui and E. Arusei (2013). Causes and Effects of post-election Violence on agricultural production in Kesses Division, Uasin Gishu County, Kenya. *Journal of Emerging Trends in Economics and Management Sciences*, **4** (1), 62-70.
- Kratli, S., C. Hulsebusch, S. Brooks and B. Kaufmann (2013). Pastoralism: A critical asset for food security under global climate change. *Animal Frontiers*, **3** (1), 42-50.
- Leng, R., N. Odongo, M. Garcia and G. Viljoen (2010). Decline in available world resources: implications for livestock production systems. *Sustainable Improvement of Animal Production and Health*, 11-19, FAO, Rome, Italy.
- Mathias, E., P. Mundy and I. Köhler-Rollefson (2010). Marketing products from local livestock breeds: An analysis of eight cases. *Animal Genetic Resources*, **47** (1), 59-72.
- Mehaia, M. (1994). Vitamin C and riboflavin content in camels milk: Effects of heat treatments. *Food Chemistry*, **50** (2), 153-155.

- Mehari, Y., Z. Mekuriaw and G. Gebru (2007). Potentials of camel production in Babilie and Kebribeyah Woredas of the Jijiga Zone, Somali Region, Ethiopia. *Livestock Research for Rural Development*, **19** (4).
- Musinga, M., D. Kimenye and P. Kivolonz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets. Nairobi Kenya.
- Nduma, I., P. Kristjanson and J. McPeak (2001). Diversity in income-generating activities for sedentarized pastoral women in northern Kenya. *Human Organization*, **60** (4), 319-325.
- Njarui, D., M. Gatheru, J. Wambua, S. Nguluu, D. Mwangi and G. Keya (2009). Dairy cattle value chain assessment: Characterization of milk production in semi-arid Kenya. Working document, *Kenya Arid and Semi-Arid Land Programme (KASAL)*, Nairobi, Kenya.
- Noor, I., B. Bebe and A. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.
- Orindi, V, A. Nyong and M. Herrero (2007). Pastoral livelihood adaptation to drought and institutional interventions in Kenya. *Human Development Report Office*, Occasional Paper, 54.
- Øyen, E. (1999). The politics of poverty reduction. *International Social Science Journal*, **51** (162), 459-465.
- Sadler, K., C. Kerven, M. Calo, M. Manske and A. Catley (2009). *Milk Matters. A literature review of pastoralist nutrition and programming responses*. Feinstein International Centre, Tufts University and Save the Children. Addis Ababa, Ethiopia.
- Sato, S. (1997). How the East African pastoral nomads, especially the Rendille, respond to the encroaching market economy. *African Study Monographs*, **18** (3/4), 121-135.
- Scarpa, R., E. Ruto, P. Kristjanson, M. Radeny, A. Drucker and J. Rege (2003). Valuing indigenous cattle breeds in Kenya: an empirical comparison of stated and revealed preference value estimates. *Ecological Economics*, **45**(3), 409-426.
- Schwartz, H., M. Dioli, R. Stimmelmayer and M. Walsh (1992). *The one-humped camel (Camelus dromedarius) in eastern Africa. A pictorial guide to diseases, health care and management*. Verlag Josef Margraf. Weikersheim, Germany.
- Seifu, E. (2011). Analysis on the contributions of and constraints to camel production in Shinile and Jijiga zones, eastern Ethiopia. *Journal of Agriculture and Environment for International Development*, **103** (3), 213-224.
- Serna, J. (2011). Drought assessment in north-eastern Kenya (Wajir East, South and Mandera). Save the children, publication. <http://www.disasterriskreduction.net>. Accessed on 19th of September 2012.

- Sombroek, G., H. Braun, and Van der Pouw (1982). The explanatory soil map and agro-climatic zone map of Kenya. Report No 5. E.I. Kenya Soil Survey, Nairobi, Kenya.
- Wasonga, V. O. (2009). Linkages between land-use, land degradation and poverty in semi-arid rangelands of Kenya: The case of Baringo District. Doctoral Thesis, University of Nairobi, Department of Land Resource Management and Agricultural Technology. Nairobi, Kenya.
- Witsenburg, K. and W. Adano (2009). Of rain and raids: Violent livestock raiding in northern Kenya. *Civil Wars*, **11** (4), 514-538.
- Yagil, R. (1982). Camels and camel milk. *FAO Animal Production Health. Paper No. 26* pp. 1-69.
- Zeng, B. and G. Edwards (2010). Perceptions of pastoralists and conservation reserve managers on managing feral camels and their impacts. *The Rangeland Journal*, **32** (1), 63-72.

CHAPTER 6

FUNCTIONALITY, PROFITABILITY AND EFFICIENCY OF CAMEL MILK VALUE CHAIN IN SEMI-ARID AREAS OF KENYA

6.1 SUMMARY

In Kenya, pastoral areas are ranked among the poorest parts of the country, facing many challenges such as high livestock mortality, high incidence of malnutrition, government negligence and marginalisation, and high dependency on external aid. This has been worsened by the impact of climate variability and change which has weakened the pastoral coping mechanism and pushed the pastoralists to look for alternative livelihoods such as camel milk trade. This study was carried out to examine camel milk value chain with the aim of characterising the chain actors, their relationship and functions, efficiency of marketing channels and the profitability of the chain. The study used a semi-structured questionnaire to collect relevant information targeting the camel milk value chain actors in Isiolo County. The actors along the value chain comprised camel milk producers, village assemblers, bulking and cooling agents, wholesalers, and urban and rural retailers.

Functional analysis revealed lack of specialisation along the value chain which might hinder efforts to improve the performance of the overall value chain. Market performance analysis showed that camel milk value chain was a profitable venture in the current form of production and marketing. The efficiency analysis of channels showed that the channel that directly sells to producers and the channel encompassing camel milk producers, village assemblers, bulking and cooling agents, wholesalers, and urban retailers are the most efficient. Additionally, the study

revealed that the major constraints faced by actors include poor hygiene practices, poor milk quality, disease, poor storage facilities, poor infrastructure, lack of credit facilities, high cost of input, milk supply fluctuation, and poor prices.

The findings suggested the need for holistic interventions that include proper marketing development, general infrastructure development, investing in technologies that reduce input and handling costs and stabilise milk supply fluctuations. There is also need to put in place a proper policy and regulatory framework targeting development of acceptable standards. These are critical if camel milk value chain is expected to achieve its potential in contributing to pastoral household income and providing a sustainable livelihood in the context of increasingly changing climatic conditions.

6.2 INTRODUCTION

The pastoral regions in Africa are ranked among the poorest parts of the continent and most communities inhabiting these areas are faced with many challenges. These challenges include high livestock mortality, high incidence of malnutrition, government negligence and marginalisation, and dependency on external aid (Farah and Fischer, 2004). This has to some extent contributed to the devastating situation in many pastoral areas. Over the years, many pastoralists have developed mechanisms to overcome these challenges. These strategies include herd mobility, herd diversification and commercialization of their products (Elhadi *et al.*, 2012). Adopting more hardy species such as the camel has recently emerged as a way to cope with the aforesaid challenges and the changing climatic condition.

The total population of camels in the world is estimated at 22 million, of which 89% are one humped dromedary camels (*Camelus dromedarius*) and the remaining 11% are two-humped, generally found in the cold deserts of Asia (Elrobh *et al.*, 2011). Over 80% of the world's camel population is found in Africa with the highest concentration in North East Africa. This accounts for 63% of the world camel population (Kratli *et al.*, 2013). Kenya is estimated to have the fifth largest camel herd in the world after Somalia, Sudan, Ethiopia and Mauritania (Farah *et al.*, 2007). In 2009, camels in Kenya were estimated at 1.06 million, all of which were one-hum type. The camel in Kenya is traditionally kept by the Somali, Rendille, Gabbra, and Turkana communities living in the country's harshest arid and semi-arid lands of northern and north-eastern Kenya (GoK, 2010). Among the traditional camel keepers, camel milk is largely used for subsistence purposes (Noor *et al.*, 2012). This has changed in the recent past, as many communities are slowly changing their production objective from pure subsistence to commercial production by engaging in camel milk trade.

The increasing participation in the market by camel milk producers has been driven by the growing interest in the camel and its products across the dry areas of Kenya (Lore *et al.*, 2005). This is due to various factors, such as higher prices for camel than cow milk. Camels have proven that they can survive drought and continue to produce milk (Belay *et al.*, 2005). In this regard, camel milk has the potential to increase pastoral resilience, alleviate poverty and enhance pastoral household food security, particularly in the context of changing climate and limited option for pastoralists in these areas (Degen, 2011). Therefore, it can be argued that pastoralists in many areas are changing from tracking pasture to tracking markets. This is evident as many pastoralists have been recently observed to keep large numbers of cattle, goats, sheep and camels

around major cities in Kenya, forming a large peri-urban livestock production system. The objective of the emerging peri-urban production system is to supply the market with various livestock products (Noor *et al.*, 2012).

Camel milk production and marketing in Isiolo County can be considered a leading example of peri-urban pastoral production model in the ASAL areas of Kenya. Camel milk trade in the study area is characterised by continuous growth and rapid expansion. Currently, camel milk produced in Isiolo County accounts for more than 90% of the total marketed camel milk in Kenya (Musinga *et al.*, 2008). Despite the high contribution to the national camel milk market, only a small proportion of the potential of the camel milk produced is currently exploited (Mathias *et al.*, 2010). This is more often than not a direct result of various factors such as poor marketing strategies and infrastructure, inappropriate husbandry practice which results in poor milk quality. This ultimately results in numerous economic losses (Noor *et al.*, 2012). On the other hand, this potential can be exploited through improving camel milk production and marketing systems.

Despite the fact that camel milk trade has the potential to alleviate pastoral household nutrition and income insecurities, very little focus has been directed towards assessing the camel milk value chain in Kenya. The objectives of this chapter were to: i) examine the camel milk value chain actors in terms of their characteristics, functions, relationships and interaction; ii) examine the efficiency of the camel milk marketing channels; and iii) assess the viability of camel milk actors in terms of their market performance to ascertain the profitability of the camel milk value chain. This knowledge is important to improve the camel milk subsector, especially in designing

appropriate policies and interventions that would enhance the efficiency and competitiveness of the subsector.

6.3 METHODOLOGY

6.3.1 Study Area

This study was conducted in the arid areas of Isiolo County in Kenya. The study area is mostly flat with low lying plains (Herlocker *et al.*, 1993; Sombroek *et al.*, 1982). Being an arid and semi-arid area, rainfall in the area is low and unpredictable with mean annual temperatures ranging from 24°C to 30°C (Jaetzold and Schmidt, 1983). The population of the county is 143,294 persons and the poverty level is estimated at 70%, which is rather high compared with other counties in the ASALs (Kamunyan *et al.*, 2013). The main economic activities in the county are based on livestock production as more than 70% of the population is involved in this type of production either directly or indirectly. The main livestock types comprise cattle, goats, sheep and camel. Recently, camel milk production and marketing have gained popularity and have become major livelihood activities in the county. Over the last few years, the county has developed the most prominent peri-urban camel population and thriving camel milk marketing in Kenya (Noor *et al.*, 2012). This has made the county contribute more than 90% of the marketed camel milk across national urban markets (Musinga *et al.*, 2008).

6.3.2 Data Collection

This study used purposive and multistage sampling procedures. A purposive sampling procedure was used because the study was targeting specific actors along the camel milk value chain. The camel milk marketing actors involved were village assemblers, rural and urban retailers, cooling and bulking centres and wholesalers. A multistage sampling procedure is mostly used where the

population of interest exists in two or more hierarchical levels (stages). In this study, there were three main stages, namely, Isiolo County, specific locations in the county where camel production is practised, households that practise camel production, and the selected households which were included in the final sample size. The survey was carried out in August to October 2012 using a semi-structured questionnaire to collect data pertaining to camel milk marketing. To determine the number of actors interviewed, the study used the probability proportional to size formula suggested by Yates and Grundy (1953):

$$n = \frac{Z^2(1-p)p}{e^2} \quad (6.1)$$

Where n is the sample size, Z is the desired Z-value yielding the desired degree of confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher is willing to permit. Using the above formula, a total of 202 milk producers, 30 camel milk assemblers, 30 milk bulking and cooling agents, 50 camel milk wholesalers and 41 camel milk retailers were selected and interviewed. The collected information included both qualitative and quantitative data.

6.3.3 Data Analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS) and the Value Chain Analysis (VCA) software version 2013. This study adopted FAO value chain analytical framework developed by Bellu (2013). This framework can be divided into functional, financial and economic analyses. This study used functional analysis to effectively characterise the chain actors, their relationship, and interaction as well as the physical movement of milk

through various channels and nodes. Camel milk producers were categorised into three groups, namely, small scale camel milk producers, medium-scale milk producers and large-scale camel milk producers. Categorisation of livestock producers are mostly based on the numbers of livestock holding (Sirak *et al.*, 2007). These categories were based on the camel herd size. Small scale producers were defined as those who own between 1 and 20 female camels. Medium-scale producers own 21 to 40 female camels and Large-scale producers own more than 40 female camels.

The market performance of intermediaries was based on the analysis of price margins and operating expenses. This study followed Nyariki (2009) and Lund (2014) in computing market margins, net margins and return to working capital. Market margins were obtained by subtracting the camel milk buying price from the camel milk selling price. The net margins were derived by subtracting market margin from the operating costs. The return on working capital was calculated using the following formula:

$$ROC = \frac{NM}{OC+BP} \quad (6.2)$$

Where ROC is return on working capital, NM is the net margin, OC operating cost (marketing cost) and BP is buying price.

To examine the efficiency of camel milk marketing channels, the study used the efficiency framework established by Ramakumar (2001) to determine the most efficient channel along the milk value chain. This framework involved using four indicators, namely, volume of milk

handled, rate of return to investment, marketing margins of intermediaries and producer's share in the consumer's money. Each one of these indicators was calculated and assigned a rank, the higher the value of the indicator, the lower the rank. For instance, a channel which handled the highest amount of milk was given score 1 while those handled less milk were given higher score. Similarly, a channel that had the highest rate of return was given score 1 and those with less rate of return were given higher score. The volume of milk handled was calculated based on the information reported by the camel milk producers and was measured in litres. The rate of return to investment was obtained by dividing marketing margin by the total marketing cost (variable cost). The marketing margin was derived by subtracting producer price from consumer price. The gross marketing margin is calculated using the following formula:

$$GMM = \frac{TR - TVC}{TR} \times 100 \quad (6.3)$$

Where GMM is gross marketing margin, TR total revenue (consumer price) and TVR is total variable cost (marketing cost).

Producer's share in the consumer's price was computed using the following formula:

$$PS = \frac{PP}{RP} = 1 - \frac{MM}{RP} \quad (6.4)$$

Where PS is producer's share, PP is producer's price, RP is retailer's price, and MM is marketing margin.

These indicators are simultaneously used to develop an overall indicator of channel efficiency as proposed by Ramakumar (2001). The overall efficiency of the channel is calculated as follows:

$$R_j = \frac{R_i}{N_i} \quad (6.5)$$

Where R_j is an overall rank of a channel for all performance indicators (namely, volume of milk handled, rate of return to investment, marketing margins of intermediaries and producer's share in the consumer's money), R_i is rank of a channel per single indicator, and N_i is number of performance indicators. R_i was calculated as a total score of each channel. The total score was found by adding the respective ranks in each channel. The mean scores are calculated for each channel. Where the mean score is less, it is efficient channel (Thamizhselvan and Murugan, 2012).

6.4 RESULTS AND DISCUSSION

The results of the analysis on fresh camel milk value chain in the study area are presented. The camel milk produced in the study area was sold in raw or unprocessed form. The results are summarised as follows: First, mapping of camel milk channels was done, which involves physical flows of camel milk through various nodes along the value chain. Secondly, various camel milk value chain actors were characterised. Thirdly, the efficiency of camel milk marketing channels was determined. Finally, camel milk market performance analysis was done to determine the profitability of various actors along the camel milk value chain.

6.4.1 Mapping of Camel Milk Marketing Channels

A marketing channel is a sequence of enterprises by which a product is moved from producers to consumers (Dolan and Humphrey, 2000). Marketing channel analysis therefore involves identifying all points on the chain, prices and functions performed at each point (Laforet and Chen, 2012). Hence, camel milk marketing channels encompass all agents and activities performed to deliver camel milk from producers to consumers and their dynamic relationships and interactions. This includes mapping of the value chain and identifying various channels used from source to terminal market. Figure 6.1 shows the camel milk value chain map. This is a visual highlight of the complexity of the interactions and the physical flows of milk between various actors as well as the prices at each stage. The annual camel milk production was derived using the amount of daily milk production given by camel milk producers. The average of daily milk production was obtained by using the daily milk production during wet and dry season. This daily average milk production was multiplied by the 360. Milk losses were calculated as the difference between milk produced minus milk consumed and marketed.

Like any other commodity, camel milk typically moves in various channels. Fifty seven and forty one percent of small scale camel milk producers sold their milk to village assemblers and rural consumers respectively. Medium scale producers sold 64.7% of their milk to the bulking centres. Large scale producers sold half of their milk to wholesalers and the other half to bulking centres. Village assemblers sold 50%, 30% and 20% to bulking centres, rural consumers and rural retailers respectively. Bulking and cooling agents sold 88% to wholesalers and 12% directly to rural consumers. Wholesalers, on the other hand, sold 94% and 6% of their milk to the urban retailers and urban consumers respectively.

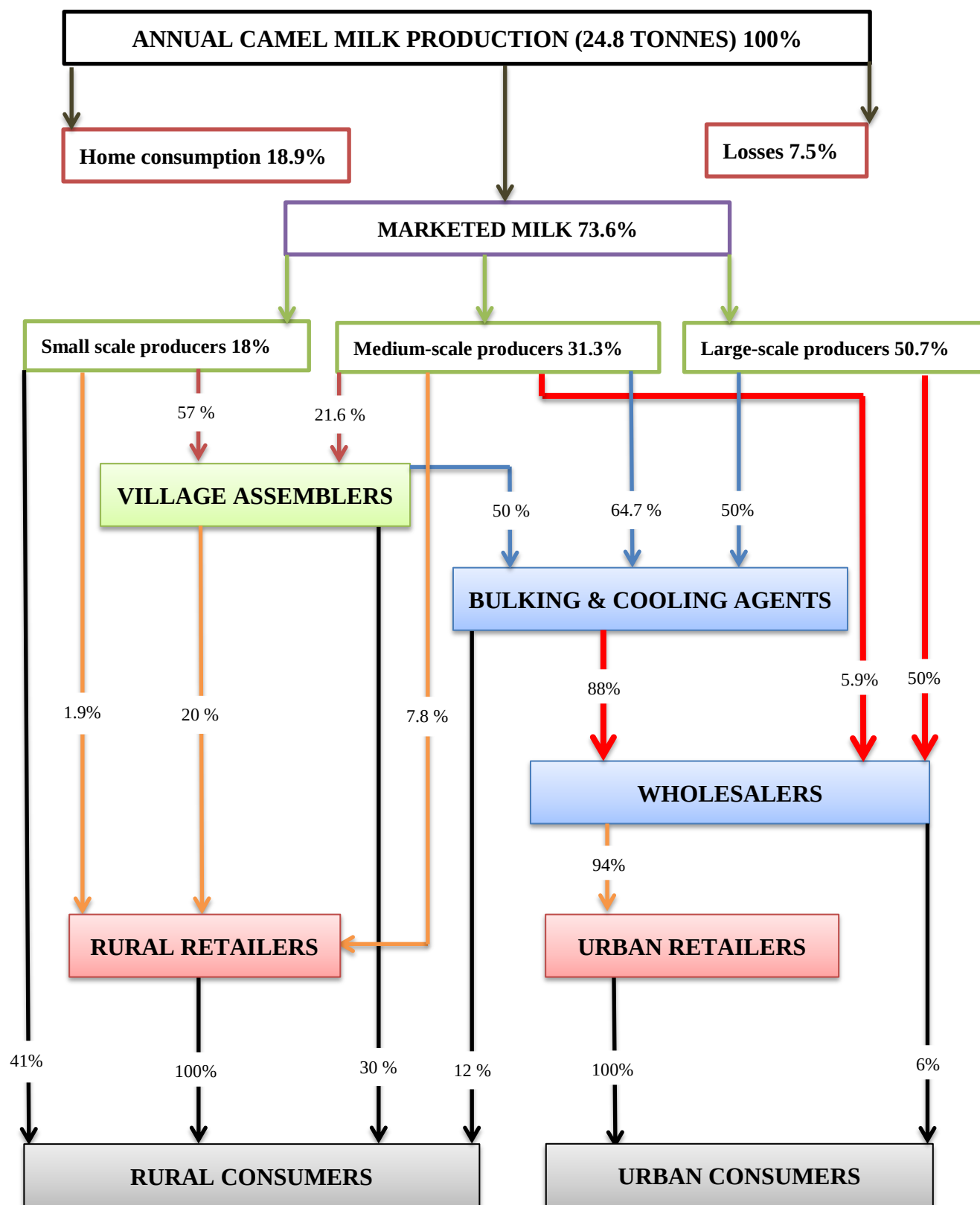


Figure 6.1: Camel milk marketing channels in the study area

A distinction can be made regarding camel milk movement along the value chain. Camel milk moves in two major channels; the first channel involves moving camel milk from producers to rural consumers while the second channel involves moving camel milk from producers to urban consumers. The latter accounts for 77.3% of the total marketed milk in the study area, this can be explained by the fact that the urban market in Nairobi offers better prices compared to the rural market. Similar results were noted by Musinga *et al.* (2008), who estimated the volume of milk moved from Isiolo District to Nairobi market at 70% of the total marketed milk. These suggest that actors involved in this chain may have a better profit margin than their counterpart.

The identified main camel milk channels can be further categorised in order to examine the actual physical movement of the commodity from one actor to another. In this regard, eight channels were identified as follows:

Channel 1 (CH1): small scale Producer → rural consumer

Channel 2 (CH2): small scale Producer → rural retailer → rural consumer

Channel 3 (CH3): small scale Producer → village assembler → rural consumer

Channel 4 (CH4): small scale Producer → village assembler → rural retailer → rural consumer

Channel 5 (CH5): Medium scale Producer → bulking and cooling → rural consumer

Channel 6 (CH6): Medium scale Producer → Wholesaler → urban consumer

Channel 7 (CH7): Medium and large Producer → village assembler → bulking and cooling → Wholesaler → urban consumer

Channel 8 (CH8): Medium and large Producer → village assembler → bulking and cooling → Wholesaler → urban retailer → urban consumer

The first two channels (CH1 and CH2) deliver milk to rural consumers around villages and small urban centres such as Kulamawe, Mlango, Burat and Moliti. Channels 3, 4 and 5 deliver milk to

Isiolo Town through village assemblers, bulking centres and rural retailers. The last three channels (CH6, CH7 and CH8) deliver milk to the urban market (Eastleigh market). Channels 8 was the longest channels, involving five marketing actors, namely bulking and cooling agent, wholesalers, urban retailers and consumers.

6.4.2 Efficiency of Camel Milk Marketing Channels

In this study an efficient channel was defined as a channel that had the lowest mean score, which was calculated from a total score, which was arrived at by adding the respective score of each channel. The total score involved calculating a separate score for various parameters that included, the volume handled, total marketing margin, producers' share, and rate of return. For instance, a channel which handled the highest amount of milk was give score 1 while those handled less milk were give larger score. The same applied to other performance indicators. The eight identified channels were evaluated to determine their efficiency (Table 6.1)

The first parameter used was the volume handled. The longest channel (CH8) which involved 6 stages was the most efficient channel with an average of 8,019.3 litres. This was followed by the shortest channel (CH1) with an average of 1,016.8 litres. The most inefficient channel was CH6 with an average of 193.2 litres, which accounted for only 1.6% of the total marketed camel milk in the study area. The result indicated that CH1 and CH8 are the most used channels by the camel milk producers with terminal markets being rural and urban, respectively. This suggests that camel milk consumption at the local level is equally important compared to the high end urban market. This finding is consistent with the finding of Anderson *et al.* (2012) that camel

milk trade in Isiolo District is evolving with the current expansion in trade within the district and the markets in urban areas.

Table 6.1: Marketing margins of camel milk channels

Parameter	Channel							
	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
1. Volume handled (litres)	1,062.8	386.5	676.3	483.1	773.0	193.2	676.3	8,019.3
Rank by volume (Rv)	2	6	4	5	3	7	4	1
2. Total marketing margin								
Producers								
Price (KSh/litre)	44.6	42.2	38.8	38.8	50.0	133.6	50.0	50.0
Marketing cost (KSh/litre)	0	20.5	-	20.5	20.5	22.4	11.6	11.6
Rural Assemblers								
Price (KSh/litre)			46.8	44.3				
Marketing cost (KSh/litre)			11.6	11.6				
Bulking centres								
Price (KSh/litre)					60		118.8	118.8
Marketing cost (KSh)					18.3		18.3	18.3
Wholesalers								
Price (KSh/litre)						160	160	140
Marketing cost (KSh//litre)						8.2	8.2	8.2
Retailers								
Price (KSh/litre)		48.7		48.7				160
Marketing cost (KSh//litre)		3.2		3.2				8.8
Consumer price (Ksh)	44.6	48.7	46.8	48.7	60	160	160	160
Total Marketing cost (KSh)	0	23.7	11.6	14.8	38.8	30.6	38.1	46.9
Total marketing margin	44.6	6.5	8.0	9.9	10.0	26.4	110	110
Gross marketing margin %	100	50.9	75.1	69.6	35.3	80.8	76.2	70.7
Rank by GMM	1	7	4	6	8	2	3	5
3. Producers' share (Ps)	100	86.7	82.9	79.7	83.3	83.5	31.3	31.3
Rank by (Ps)	1	2	5	6	4	3	7	7
4. Rate of return (Rr= margin/cost)	0	0.27	1.5	1.1	0.26	1.4	3.4	2.7
Rank by (Rr)	8	7	3	5	6	4	1	2
5. Average of all ranks	3.0	5.5	4.0	5.5	5.3	4.0	3.6	3.6
Overall rank	1	5	3	5	4	3	2	2

Taking gross marketing margin into consideration, CH1 was the best channel with 100% gross marketing margin. This was followed by CH6, CH7 and CH3 with 80.8%, 76.2% and 75.1% respectively. The channel that sold to consumers through the bulking agent (CH5) was the most inefficient, with 35.3% gross marketing margin. On the other hand, CH1 was the most efficient

channel when considering producers' share, with producers using this channel receiving a 100% share in the consumers' money. This was followed by CH2, CH6 and CH5 with 86.6%, 83.5% and 83.3% respectively. CH7 and CH8 were the most inefficient channels as producers supply to these channels only got 31.3% of the final price. As expected, the producers' share was considerably higher along channels that delivered milk to the rural market compared to those that delivered to the urban market. Nevertheless, considering the volume, these channels were much smaller compared to the total milk marketed.

The rate of return on marketing activities was derived by dividing the total marketing margin by the total marketing cost in order to show the rate of return to working capital. The result showed that CH7 was the best, with a rate of return of KSh 3.40 per litre. Nonetheless, the volume hosted in this channel was small compared to other channels in the same urban market. The lowest return on marketing activities was observed in CH1 with zero rate of return.

The overall assessment of parameters showed that CH1 was the most efficient channel, followed by CH7 and CH8. In the latter two channels all actors involved in camel milk value chain are present. This finding can be explained by the fact that camel milk producers sell directly to the rural consumers with minimum or no cost at all. This permits them to retain 100% of the final price compared to other channels along the milk value chain. The end users of the milk handled by CH7 and CH8 are the urban consumers, who offer the highest price (KSh 160/litre) compared to other prices offered along the marketing chain. The high price observed in the urban market is a direct result of many value added activities performed by various actors involved in these channels, which include bulking, cooling and transportation.

The outcome of the camel milk marketing efficiency analysis has major implications in terms of formulation of development policy and intervention. Based on the marketing efficiency analysis of this study, any intervention to improve camel milk producers' livelihood should target the most efficient channel (CH1) alongside CH7 and CH8. This is however, not the case with respect to the current interventions where efforts are directed towards linking producers to urban markets (CH7 and CH8), without any effort to invest in the local market (local consumer). This is evident as many development agents and government policies aim at linking the milk producers to the urban and high end market (Farah *et al.*, 2007; London *et al.*, 2010; Faye and Konuspayeva, 2012). However, caution should be taken when formulating such policies and interventions because, despite the high price received, the producers' share in these two channels had the lowest rank compared to other channels. Thus, investing in linking the producers to the urban market without carefully designing viable strategies (such as investing equally in the local market) to increase the producer's share might not make much improvement in terms of income generated, and consequently poverty reduction and food security.

6.4.3 Analysis of Camel Milk Value Chain Actors

6.4.3.1 Functional analysis of camel milk actors

Functional analysis shows the activities performed by various agents in the marketing system in changing a product of the producers into a product desired by various consumers (Bendoly *et al.*, 2012). The functions performed can be categorised into exchange, physical and facilitating functions to create a particular utility. Camel milk functional analysis includes a description of the main functions performed by various agents along the supply chain.

Figure 6.2 shows the camel milk value chain map. The main stages are input, production, bulking, marketing and consumption. The map also includes the functions in the camel milk chain and activities associated with these functions, agents carrying out these functions and the products at various levels delivered to the next stage of the chain. At the first stage there are input providers. These include agro-vets, veterinary doctors and animal health practitioners. Services offered at the first stage include, among others, provision of salt and veterinary services. At the second stage there are small, medium and large scale producers. These agents carry out production, primary marketing and transportation. The agents under the first stage operate mainly within Isiolo County and they mostly deal with fresh milk.

The third stage of the camel milk value chain is the bulking stage. Two groups of bulking and cooling agents normally operate in this stage. These include independent bulking and cooling agents and cooperatives such as Anolei Camel Milk Cooperative and Isiolo Camel Milk Cooperative. Functions along the value chain for this group comprise bulking of milk, cooling the bulked milk over-night (using deep-freezers), transporting the milk to the main market in Nairobi and marketing the milk within Isiolo Town. Retailers and wholesalers of fresh milk mainly operate under the marketing stage of the camel milk value chain. The functions of these groups are mainly transportation and final sales of camel milk to various consumers. These comprise rural and urban consumers, who mainly consume fresh and soured milk.

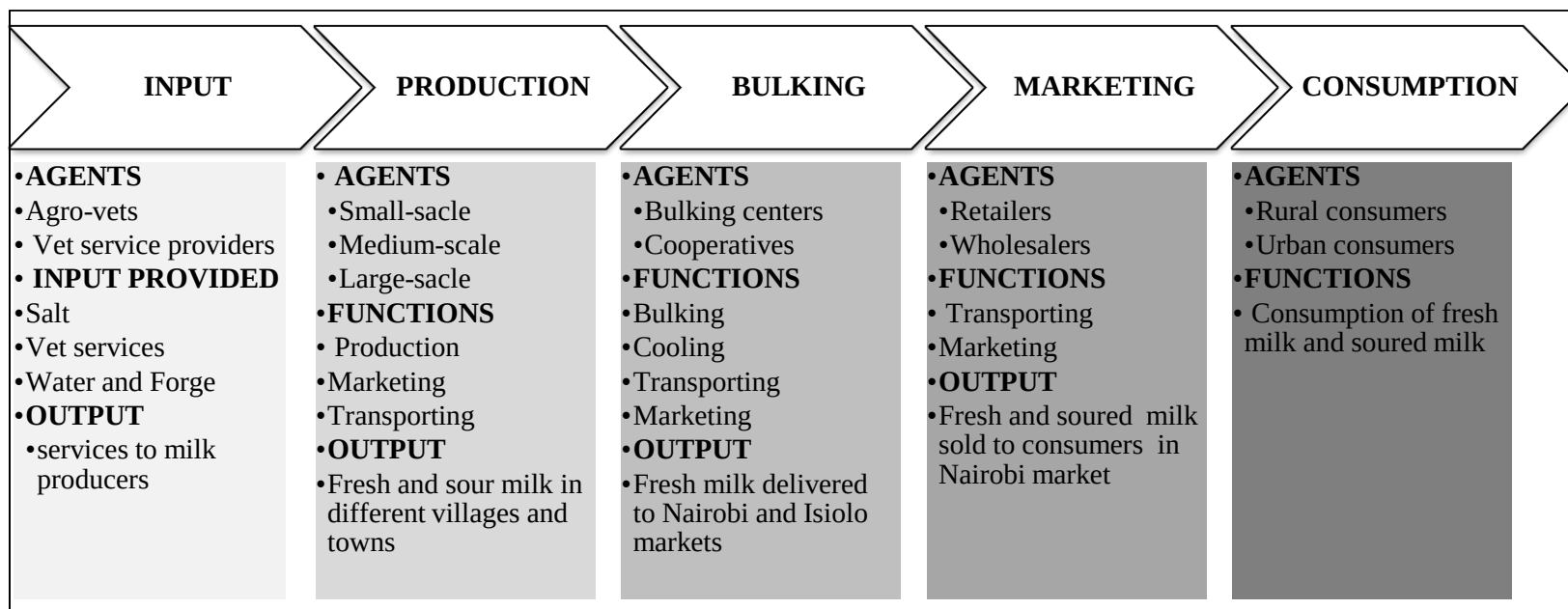


Figure 6.2: Camel milk value chain map in Isiolo County

Marketing of camel milk is a common function shared across the value chain. This can be an indication that in camel milk value chain there are no specialised agents. This can be further supported by the fact that most of the agents along the chain are engaged in camel milk production. This vertical multi-functionality can gradually affect the performance of the value chain. The lack of specialisation along the value chain might hinder any effort to improve the performance of the overall value chain and consequently weaken the competitiveness of camel milk in the national food market in Kenya. This result is similar to the findings of Musinga *et al.* (2008), who reported that most of the actors along the camel milk value chain in Isiolo and Laikipia Districts perform multiple functions except for a few ranches in Laikipia District which are specialised in camel milk production. Although other studies on the most food value chain encourage multi-functionalities (Conto *et al.*, 2010), such studies are focused on well-established food related value chain with appropriate functional institutions and regulatory frameworks, such as maize, wheat and cotton. Their argument is built on the fact that any agent along the chain and particularly the producers can diversify their function to expand opportunities for more income. But in the case of camel milk value chain in the study area, these multi-functionalities might hinder the performance of the chain. Since the value chain lacks the regulatory functional instantiations.

6.4.3.2 Characteristics of camel milk value chain actors

In any value chain, production is the foundational segment that influences the growth and competitiveness of the entire chain (Soosay *et al.*, 2012). Therefore, if this fundamental segment is poorly established, any effort to enhance efficiency at other levels is bound to bear an insignificant impact on the whole chain. Camel milk producers constitute the majority of the

value chain actors. A milk producer, in this study, is defined as a person who makes the final decision about issues related to camel milk production such as herding, health care, milking and disposal of the final produce. As indicated by the standard deviation, the reported values are closer to the mean, implying that the values are closely concentrated around the mean of the data. Small scale producers account for 58% of the sampled population. Medium and large scale producers account for 25.2% and 15.8% of the interviewed producers respectively (Table 6.2).

Table 6.2: Characteristics of camel milk producers

Attribute	Small scale (n= 119)		Medium-scale (n = 51)		Large-scale (n = 32)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Herd size	16.4	8.0	37.8	9.8	66.5	12.1
No of male	2.5	4.2	3.5	3.1	5.0	3.7
No. Female	10.5	4.7	27.5	5.7	50.2	10.3
Lactating animals	5.7	4.8	13.3	3.7	23.3	10.3
Daily milk production (litres)	10.8	7.9	21.4	6.1	34.3	13.6
Daily consumption	2.3	1.9	3.8	2.0	6.5	1.5
Daily sales (litres)	7.8	6.89	15.4	5.5	25.7	16.1
Loses (litres)	0.7	-	0.2	-	2.1	-
Annual sales (tonnes)	2.9	2.1	5.8	2.3	9.7	5.8

n: number of producers

Std. Dev.: Standard deviation

Small scale producers had an average herd size of 16.4 which comprised an average of 2.5 male and 10.5 female of which 5.7 were lactating camels, with an average daily production of 10.8 litres. The medium and large scale camel milk producers had an average of 37.8 and 66.5 camels comprised an average of 3.5 and 5.0 male camel and 27.5 and 50.2 female camel of which an average of 13.3 and 23.3 were lactating animals respectively. Daily camel milk production followed the same trend, with 21.4 litres and 34.3 litres for medium and large scale producers

respectively. The daily home consumption was 2.3, 3.8 and 6.5 litres for small, medium and large scale producers respectively. Small-scale producers sold 7.8 litres on average, while medium and large scale producers sold on average 15.4 litres and 25.7 litres respectively.

Camel milk assemblers are the first link between producers and other agents along the camel milk marketing chain. The camel milk assemblers in Isiolo County can be grouped into two, namely peri-urban and village milk collectors. The peri-urban milk collectors collect milk from areas around Isiolo Central Division while village collectors collect milk from villages around Kulamawe Division. Tables 6.3 and 6.4 show the characteristics of camel milk assemblers. The majority (56.7%) of camel milk assemblers were found to be females. The proportion of milk assemblers that did not go through formal education was 70%, while only 6.7% of the respondents attained secondary school level. The average age of the respondents under this category was 42.6 years.

Camel milk assemblers were involved in the milk chain in two ways. First, they produced small quantities of milk. Second, they collected milk from neighbouring producers and then delivered it to the next milk outlet. This group handled 20.5 litres daily, and covered an average of 40 km in their daily journey to collect milk from various camel milk producers. In general, however, they cover an average of 15.1 km to deliver their milk to various marketing outlets. Half of the village assemblers sold their milk to bulking and cooling agents within Isiolo Town. The main sources of marketing information were their clients. The most common mode of transportation under this category was vehicles (63.3%) followed by donkeys (20%) and motorcycles (16.7%).

Table 6.3: Characteristics of camel milk marketing agents

Variable	Category	Assemblers(n= 30)		Bulking/Cooling agents(n= 30)		Retailers(n= 41)	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Gender	Male	13	43.3	17	34.0	3	7.3
	Female	17	56.7	33	66.0	38	92.7
Education level	None	21	70.0	45	90.0	35	71.4
	Primary	7	23.3	4	8.0	5	28.6
	Secondary	2	6.7	1	2.0	-	-
Camel milk production	Yes	20	66.7	38	76.0	9	22.5
	No	10	33.3	12	24.0	31	77.5
Mode of transport	Vehicle	19	63.3	50	100.0	11	27.5
	Donkeys	6	20.0	-	-	13	32.5
	Motorcycle	5	16.7	-	-	26	40.0

Table 6.4: Attributes of camel milk marketing agents

Variable	Assemblers		Bulking/Cooling agents		Retailers	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Age	42.6	12.5	45.9	10.9	38.6	18.6
Amount of milk handled (litres)	20.5	17.9	42.3	17.9	19.2	14.2
Number of years in the chain	8.7	8.5	5.8	4.7	11.2	8.1
Distance to milk source	40.0	22.2	32.4	6.2	10.4	6.8
Distance to milk outlet	15.1	11.1	294.8	75.7	-	-

Std. Dev.: Standard deviation

Bulking and cooling agents are only found in Isiolo Town. They play a significant role in price formation and communication of vital information about the required milk quantities and current prices. They can be categorized into two, namely independent bulking and cooling agents (independent agents) and cooperatives which were only two. Independent agents are those that perform their functions independently. These functions include three value adding activities that

camel milk goes through once it reaches Isiolo Town on the route to the terminal markets in Nairobi. These include grading, bulking and cold storage. As indicated in Table 6.2, 66% of the respondents under this category were female, with the majority (90%) of them having no formal education. Apart from the aforesaid functions, 76% of them were engaged in camel milk production and hence were part of the milk production system. This group handled 42.3 litres daily and mainly used vehicles (buses) to transport milk from Isiolo Town to the main market in Nairobi, which is approximately 300 km away.

Camel milk retailers were more than bulking and cooling agents and assemblers in terms of numbers. These are the final link in the chain that delivers camel milk to consumers. Retailers sold small quantities of milk either directly to individuals, households, or institutional consumers. Their functions are largely dependent on the points of sale along the value chain. The retailers included traders at roadsides and market places, stalls and supermarkets in Isiolo Town and Nairobi market and handled 19.2 litres daily.

The dominant actors in milk retailing business were women (92.7%). The education level of this group followed the same trend as the assemblers group with 71.4% of them having no formal education. Unlike the assemblers and the bulking and cooling agents, only 22.5% of milk retailers engaged in its production. These were mostly small-scale producers who sold milk to their neighbours or at the markets in the village. The mode of transport under this group varies, with 40%, 32.5% and 27.5% using motorcycle, donkeys and vehicles respectively.

6.4.4 Market Performance of Camel Milk Value Chain

Market performance of various value chains are mostly based on the analysis of price margins and operating costs (Nyariki, 2009; Lund, 2014). As shown in Table 6.6, the main actors considered for the financial analysis included camel milk producers, bulking centres, village assemblers, wholesalers, and rural and urban retailers. Camel milk input providers such as veterinary service providers, transporters, and milking equipment providers performed multiple functions and therefore were too complex to be analysed. Furthermore, this study focused on main actors involved in the camel milk value chain. The study analysed prices margins and operating costs based on a litre of milk.

The main costs for camel milk production agents comprised herding labour, and cost of water, salt, veterinary service and drugs. The market performance analysis of production agents is best done under three main categories of producers, namely small scale, medium scale and large scale producers, as shown in Table 6.5. The producers' mean farm gate milk selling price was KSh 38.80. Like most of the dairy products in arid and semi-arid areas of Kenya, fresh camel milk is often sold at the farm gate or local market in the production areas (Nyariki, 2009).

The major cost of producers turned out to be hired labour as reflected in monthly costs presented in Appendix X. This cost item accounts for 54.4% (KSh 14.98), 55.1% (KSh 12.83) and 51.5% (KSh 10.42) of the total cost for small, medium and large scale camel milk producers respectively. The cost of paid labour encompasses herders' food, other provisions and monthly payments. Other costs such as those of water, salt and veterinary services vary with the production scale. The second contributor to the production cost was veterinary service, which

accounts for 17.1%, 17.8% and 12.9% for small, medium and large camel milk producers respectively. Other costs showed the same trend, with that of drugs being the least contributor to the total production cost.

Table 6.5: Gross margin analysis of camel milk producers

Variable	Small-scale (n=119)	Medium-scale (n=51)	Large-scale (n=32)
Costs			
Watering	1.89	1.94	2.85
Labour	14.98	12.83	10.42
Salt	2.26	1.33	1.32
Veterinary services	4.71	4.14	2.6
Drugs (Acaricides)	1.7	1.02	1.17
Total Cost (a)	25.54	21.26	18.36
Mean buying price (b)	0	0	0
Mean selling price (c)	38.83	38.83	38.83
Margin (d = c – b)	38.83	38.83	38.83
Net margin (e = d – a)	13.29	17.57	20.47
Return on working capital, % (f = e/(a+b))	52.04	82.64	97.48

Note: Mean selling price was the average farm gate price/litre of the year 2012.

The results showed that camel milk business was profitable in the current form of production. The small-scale producers realised an average net margin (net profit) of KSh 13.29 in each litre of milk they had sold, while medium and large scale producers realised an average net margin of KSh 17.57 and KSh 20.47 per month respectively. Further examination of the return on working capital of the camel milk business at the production level showed that small-scale producers had the lowest return to capital of 52 %, compared to medium and large-scale producers which had enjoyed returns to their working capital of 82.6% and 97.5% respectively. This finding implies that camel milk is profitable at the production level, as all milk producers realised a positive net margin and had the highest return to working capital compared to other actors along the camel milk value chain. This, therefore, suggests that camel milk producers and particularly small-scale

ones, can accumulate enough capital to improve their production scale, and therefore increase their net profits.

The bulking centres were categorised into two, (i) independent agents operated by individuals and, (ii) cooperative group, Anoley Women Group. The activities carried out by these two types of agents are indistinguishable, this because, the members of the cooperatives mostly operates independently. Therefore, the gross margin analysis was carried out for bulking centres regardless of their mode of operation. At the bulking level, there were three distinct activities that camel milk went through before it reached Nairobi market. These value adding activities included grading and bulking, cold storage, and transportation. As a result of these distinct value added activities, the gross margin analysis of this agent was conducted separately from other marketing segments. The gross margin of this agent is shown in Table 6.6.

Table 6.6: Gross margin analysis of bulking and cooling agent

Variable	Bulking Centre (n= 30)
Costs	
Labour	1.95
Rent	5.91
Local transport	0.99
Cleaning	2.10
Money delivery charge	2.37
Communication	1.00
Freezers	6.31
Electricity	9.46
Transport to Nairobi	2.48
Total Cost (a)	32.57
Mean buying price (b)	60.0
Mean selling price (c)	118.84
Margin ($d = c - b$)	58.84
Net margin ($e = d - a$)	26.27
Return on working capital, % ($f = e/(a+b)$)	28.38

Note: Mean buying and selling prices were the average price/litre of the year 2012.

Bulking and cooling agents incurred various costs, namely paid labour, rent, local transport (wheelbarrow), cleaning and related hygiene cost, money delivery charge (money paid to the bus drivers for delivering the money of the sold milk to the bulking centres), communication, cost of renting freezers, electricity cost and cross county transportation. The major sources of cost for these agents were electricity and capital investment and rent, with KSh 9.46, KSh 6.31 and KSh 5.91 per litre respectively. These items account for 66.6% of the total monthly cost used by bulking and cooling agents. Contrary to what was expected, transportation and labour were among the least contributors to the total cost with 7.6% and 6% respectively.

The mean buying price was KSh 60.0, while the mean selling price was KSh 118.80. At a glance, the difference between buying price and selling price (marketing margin) is markedly high. Nevertheless, this marketing margin can be misleading since not all of this income is pure profit. This is true when considering the cost involved in adding value and change of ownership. Therefore, the net margin for bulking centres was KSh 26.38 with return on working capital of 28.4%. The net margin (net profit) is higher compared to that made by camel milk production agents, while return on working capital is markedly low. This is a direct result of a high marketing and handling costs incurred in the processes of transacting their camel milk business. The high cost incurred can be explained by the fact that the highest demand for camel milk in Kenya is in its fresh form (Anderson *et al.*, 2012); therefore, it is important that milk reaches consumers in this form. To do so, these agents acquire milk overnight from various milk suppliers. The milk is then put in cold storage and transported to Nairobi in the morning. The cold storage activity accounts for the biggest share (48.8%) per litre of milk. Therefore, any attempt aimed at improving the performance of this agent should consider decreasing the cost of

electricity (29.1% of the total operating costs) and cost of renting freezers (19.4% of the total operating costs).

Table 6.7 shows the gross margin analysis of marketing agents. Camel milk prices varied from one agent to another. The mean buying and selling prices for village assemblers were KSh 38.83 (farm gate price) and KSh 45.55 respectively, with a net margin of KSh 2.5 per litre. The mean buying prices for wholesalers, urban retailers and rural retailers were KSh 11.8.8, KSh 40.5 and KSh 140.0, respectively. The selling prices were KSh 150.0, KSh 48.7 and KSh 160.0 for wholesalers, urban retailers and rural retailers respectively. Wholesalers realised a net margin of KSh 28.30, while rural and urban retailers had a net margin of KSh 5.85 and KSh 18.96 per litre, respectively.

Table 6.7: Gross margin analysis of marketing agents

Variable	Assemblers (n=30)	Wholesalers (n=50)	Rural Retailer (n=41)	Urban Retailer (n=41)
Costs				
Transfer expenses	0	0.72	0	0
Taxes	0	0.67	0	0.71
Communication	1.07	0.17	1.43	0.12
Hygiene	0.55	0.30	0.92	0.21
Transport	2.60	1.05	0	0
Total Cost (a)	4.22	2.90	2.35	1.04
Mean buying price (b)	38.83	118.8	40.50	140
Mean selling price (c)	45.55	150.0	48.7	160
Margin (d = c – b)	6.72	31.20	8.20	20.0
Net margin (e = d – a)	2.50	28.30	5.85	18.96
Return on working capital, % (f = e/(a+b))	5.81	14.76	13.65	13.44

Note: Mean buying and selling prices were the average price/litre of the year 2012.

Village assemblers incurred only three kinds of cost, namely transportation from the production site to the collection bulking points and to the local market in Isiolo Town (accounting for 61.7% of the total cost), communication (accounting for 25.2%) and hygiene related costs (accounting

for 13.1%). The major costs incurred by wholesalers were transport cost, transfer expenses and taxes, with 36.2%, 24.9% and 23% respectively. Rural retailers spent 60.7% of their cost on communication and the rest on hygiene related costs. On the other hand, urban retailers spent 68.3% of their cost on taxes, 19.9% on hygiene related costs and the rest on communication.

The return on working capital among marketing agents varies drastically. Assemblies had the lowest return on working capital among marketing agents, with 5.8%. This is a result of high cost of input particularly transport and communication. Wholesalers enjoyed high return on working capital (14.8%) compared to rural and urban retailers with 13.7% and 13.4% respectively. These findings indicate that camel milk is a profitable business venture for all marketing agents. Similar results were reported by Musinga *et al.* (2008) on profit margins for milk producers and marketing agents in Isiolo and Laikipia Districts, although their analysis was based on average quantities traded per month.

6.4.5 Production and Marketing Constraints along the Camel Milk Value Chain

To exploit the full potential of camel milk, particularly in a changing climate in the arid and semi-arid areas of Kenya, it is important to examine the major constraints faced and possible remedies to facilitate sustainable growth and development in the subsector. Thus, the analysis of major constraints faced by the main camel milk value chain agents is critical for policy and development interventions to enhance the profitability of the chain and consequently enhance the livelihoods of chain participants and ultimately reduce poverty and enhance food security. The constraints facing the camel milk subsector as perceived by the actors along the milk value chain can be broadly categorised into two, namely production and marketing constraints.

Table 6.8 presents the major constraints faced by camel milk producers. Insecurity incidences are the biggest constraints (27.7%), followed by drought (22.3%), poor hygiene practices (16.8) and prevalence of diseases (9.4%). Other constraints include poor breed, inadequate information, poor milk quality, poor storage facilities, and high cost of labour. The preceding constraints may act solely or in combination. For instance, drought and prevalence of diseases might triggers insecurity as a results access to grazing areas is curtailed and consequently milk production drops. The reduction in milk yield, combined with other factors, affects the whole chain. Hence, less milk production is seen as a central constraint that must be dealt with for the entire value chain to expand and become profitable for all actors.

Table 6.8: Constraints faced by camel milk production agents

Constraint	Frequency	Percentage
Insecurity	56	27.7
Drought	45	22.3
Poor hygiene practices	34	16.8
Diseases	19	9.4
Poor breeds	14	6.9
Poor milk quality	12	5.9
Poor storage facilities	10	5.0
Inadequate information	6	3.0
High cost of labour	6	3.0

Milk production is a function of the breed (genetic potential of the animals), milking practices and, more importantly, the nutrition and health status of the animal. If the potential of camel milk is to be realised, the aforesaid factors must be addressed. The results showed that poor milking practices directly affect the quality of milk produced. Poor milking practices include unclean udder due to lack of washing the udder before milking, unclean hands, poor personal hygiene and health status, unclean (plastic) milking containers due to lack of clean water, unclean

milking sites, (worsened by milking sick animals specially when the camel suffers from subclinical mastitis), and zoonotic infections. These results are similar to those of Worku *et al.* (2014). That the major constraints of camel milk commercialisation in Ethipoa, were the poor handling practices such as using unclean milk containers.

Poor milk production can also be explained by the fact that most camel herders do not extract all the milk from their animals. Low milk extraction is driven by various factors, chief of them market access and availability of labour for milking. Other factors may include prices, distance to water and pasture resources. Low milk extraction was also observed among pastoralists in Puntland as reported by Nori (2010) that low extraction was mostly driven by low access to market and lack of sufficient number of herders.

Table 6.9 presents the major constraints faced by camel milk marketing agents. Marketing constraints were similar among marketing agents. In other words, constraints at one segment of the chain were manifested in other segments, yet there were other constraints that affected a particular segment which were closely related to their nature of operation. For instance, poor prices were cited by village assemblers (26.7%), wholesalers (8%), and retailers (7.3%). The constraints faced by village assemblers included poor infrastructure (40%), poor marketing information flow (20%) and poor quality (13.3%). These results concur with those of Seifu (2007) who reported that poor prices were common among various marketing segments in Jijiga Zones in eastern Ethiopia, particularly among milk wholesalers and retailers.

Table 6.9: Constraints faced by camel milk marketing agents

Agent	Constraint	Frequency	Percentage
Village assemblers	Poor infrastructure	12	40.0
	Low prices	8	26.7
	Poor information flow	6	20.0
	Low milk quality	4	13.3
Bulking and cooling agents	High cost of electricity	14	46.7
	Perishability of camel milk	9	30.0
	Poor infrastructure	5	16.7
	Drought	2	6.7
Wholesalers	Poor market infrastructure	11	22.0
	Poor prices	4	8.0
	Lack of credit facilities	3	6.0
	Poor quality of milk	7	14.0
	High taxation rate	16	32.0
	Unreliable transportation	2	4.0
	Poor organization of wholesalers	4	8.0
	Poor marketing information	3	6.0
Retailers	Poor prices	3	7.3
	High taxation rate	13	31.7
	Poor quality of milk	15	36.6
	Unreliable milk supply	6	14.6
	Poor market infrastructure	4	9.8

The major constraints faced by bulking and cooling agents were, high cost of electricity (46.7%) and perishability of camel milk (30%). Others included poor infrastructure (16.7%) and recurrent drought (6.7%). On the other hand, the major constraints faced by wholesalers and retailers were the high rate of taxation (32% and 31.7% respectively) and poor market infrastructure (22% and 9.8% respectively). Other constraints faced by wholesalers included lack of credit facilities (6%), poor milk quality (14%), unreliable transportation (4%), poor marketing information (22%) and poor organization at the wholesale level (8%). Perishability of camel milk is a common challenge across camel milk markets in the drylands of East Africa (Seifu, 2007; Worku *et al.*,

2004; Nori *et al.*, 2010). This is mostly a result of lack of preservative technologies that can increase the shelf life of the milk (Appendini and Hotchkiss, 2002; Kamau, 2010).

Retailers were faced with constraints such as poor quality of supplied milk (36.6%), unreliable milk supply (14.6%) and poor market infrastructure (9.8%). Poor quality of supplied milk is mostly a result of poor hygiene practices and the effect of temperature that alter the fresh camel milk properties (Kamau, 2010). Milk supply fluctuation is mostly a result of seasonal milk fluctuation due to lack of input at the production level. However, other factors such as poor infrastructure and lack of reliable transport can also contribute to supply fluctuation (Holloway, 2000).

6.5 CONCLUSIONS AND POLICY IMPLICATIONS

This chapter analysed the camel milk value chain with the aim of characterising the chain actors, their relationship and functions, and the profitability of actors along the chain as well as the efficiency of marketing channels and constraints faced by actors along the camel milk chain. The study found that the actors along the value chain comprised camel milk producers, village assemblers, bulking and cooling agents, wholesalers, and urban and rural retailers. The functional analysis of camel milk actors revealed lack of specialization along the value chain. Hence a negative impact on the profitability and competitiveness of the chain is expected in the long run. Further, mapping the value chain indicated that the local market is as important as the high end urban markets in terms of the volume of milk traded. Thus, any intervention aimed at improving camel milk marketing and trade in Isiolo County must pay equal attention to the local market in terms of market infrastructure development.

The analysis of the efficiency of camel milk channels showed that the channel that sold directly to local consumers was the most efficient channel. This was followed by the channels that sold to consumers in the urban market. Based on the current development practices, most efforts are targeting to link the camel milk producers to the urban market. Nevertheless, caution should be taken when formulating such interventions, as these channels return a very small portion of the total price to the camel milk producers involved. Therefore, investing in linking camel milk producers to the urban market without carefully designing viable strategies to increase the producers' share of the final product value might not make much improvement in terms of income generated, and consequently poverty reduction and food security.

The market performance analysis revealed that camel milk is a profitable business venture, with all the actors realising positive net margin. Despite this, the net margin realised small-scale producers was low compared to medium and large-scale producers. To increase the net margin of small-scale producers and others in the study area, strategies such as changing the herd structure to increase the number of lactating camels will increase the total milk produced. Further, investing in measures to increase milk yield per animal, such as investing in proper veterinary services and the adoption of better husbandry and management practices, is important. Generally, to address camel milk production and marketing constraints, it is important to adopt holistic interventions that include proper marketing development, general infrastructure development, investing in technologies that reduce input cost and stabilise milk supply fluctuations. This is important if the camel milk sub-sector is to achieve its potential in contributing to pastoral household income, and thus, enhancing the resilience of pastoralists in the context of increasingly changing climatic conditions.

REFERENCES

- Anderson, D., H. Elliott, H. Kochore and E. Lochery (2012). Camel herders, middle-women, and urban milk bars: The commodification of camel milk in Kenya. *Journal of Eastern African Studies*, **6** (3), 383-404.
- Appendini, P., and J. Hotchkiss (2002). Review of antimicrobial food packaging. *Innovative Food Science & Emerging Technologies*, **3** (2), 113-126.
- Belay, K., B. Beyene and W. Manig (2005). Coping with drought among pastoral and agro-pastoral communities in eastern Ethiopia. *Journal of Rural Development*, **28** (2), 185-210.
- Bellu, L. G. (2013). Value chain analysis for policy making: Methodological guidelines and country cases for a quantitative approach. FAO publication, *EasyPol Series* 129.
- Bendoly, E., A. Bharadwaj and S. Bharadwaj (2012). Complementary drivers of new product development performance: Cross functional coordination, information system capability, and intelligence quality. *Production and Operations Management*, **21** (4), 653-667.
- Conto, F., P. La Sala and P. Papapietro (2010). Rural development in the area of Pollino: Integrated design of an “atypical” chain. In 118th Seminar of *European Association of Agricultural Economists*, No. 95310, August 25-27, 2010, Ljubljana, Slovenia.
- Degen, A. (2011). Transformation of Borana from nomadic pastoralists to agro-pastoralists and shift of livestock from cattle to include more goats, camels and sheep in southern Ethiopia. *International Journal of Business and Globalisation*, **6** (3), 292-312.
- Dolan, C., and J. Humphrey (2000). Governance and trade in fresh vegetables: The impact of UK supermarkets on the African horticulture industry. *Journal of Development Studies*, **37** (2), 147-176.
- Elhadi, Y., D. Nyariki, O. Wasonga and W. Ekaya (2012). Factors influencing transient poverty among agro-pastoralists in semi-arid areas of Kenya. *African Crop Science Journal*, **20** (1), 113-122.
- Elrobh, S., SAlanazi, W. Khan, Z. Abduljaleel, A. Al-Amri and M. Bazzi (2011). Molecular cloning and characterization of DNA encoding a putative stress-induced heat-shock protein from *Camelus dromedarius*. *International Journal of Molecular Sciences*, **12** (7), 4214-4236.
- FAO. (Food and Agriculture Organization) (2007). Food security district profiles for 23 districts in Kenya, Nairobi.
- Farah, Z. and A. Fischer (2004). *The camel (C. dromedarius) as a Meat and Milk Animal: Handbook and Product Development*. Vdf Hochschulverlag. Sitz, Zürich
www.camelgate.com. Accessed on 12th of July 2013.

- Farah, Z., M. Mollet, M. Younan and R. Dahir (2007). Camel dairy in Somalia: Limiting factors and development potential. *Livestock Science*, **110** (1), 187-191.
- Francine, M. and R. Hughes (1984). A Comment on the Impact of development schemes on the floodplain forests of the Tana River of Kenya. *The Geographical Journal*, **150** (2), 230-244.
- GoK. (Government of Kenya) (1997). Isiolo District development plan for 1997-2001. *Government Printers*, Nairobi, Kenya.
- GoK. (2005). Isiolo District vision and strategy: 2005-2015. *Government Printer*, Nairobi, Kenya.
- GoK. (2010). Agricultural sector development strategy 2010-202. Ministry of Agriculture. *Government Printer*, Nairobi, Kenya.
- Herlocker, D., S. Shaaban and S. Wilkes (1993). *Range Management Handbook of Kenya*. Volume II, 5. Isiolo District. Ministry of Agriculture, Livestock Development and Marketing, Nairobi, Kenya.
- Holloway, G., C. Nicholson, C. Delgado S. Staal, and S. Ehui (2000). Agro-industrialization through institutional innovation Transaction costs, cooperatives and milk market development in the east African highlands. *Agricultural economics*, **23**(3), 279-288.
- Jaetzold, R., and H. Schmidt (1983). *Farm Management Handbook of Kenya: Natural Conditions and Farm Management Information, Central Kenya: (Rift Valley and Central Provinces)*. Ministry of Agriculture, Nairobi, Kenya.
- Kamau, P., P. Lamuka, and J. Wangoh (2010). Effect of lactoperoxidase-thiocyanate-hydrogen peroxide system and storage temperature on keeping quality of raw camel milk. *African Journal of Food, Agriculture, Nutrition and Development*, **10** (10).
- Kamunyan, C., G. Cheserek, M. Kiptui and E. Arusei (2013). Causes and effects of post-election violence on agricultural production in Kesses Division, Uasin Gishu County, Kenya. *Journal of Emerging Trends in Economics and Management Sciences*, **4** (1).
- Krätli, S., C. Hulsebusch, S. Brooks and B. Kaufmann (2013). Pastoralism: A critical asset for food security under global climate change. *Animal Frontiers*, **3** (1), 42-50.
- Laforet, S., and J. Chen (2012). Chinese and British consumers' evaluation of Chinese and international brands and factors affecting their choice. *Journal of World Business*, **47** (1), 54-63.
- Lore, A., S. Mbugua and J. Wangoh (2005). Enumeration and identification of microflora in suusac, a Kenyan traditional fermented camel milk product. *Lebensmittel Wissenschaft und Technologie*, **38** (5), 125-130.

- Lund, P. D. (2014). How fast can businesses in the new energy sector grow? An analysis of critical factors. *Renewable Energy*, **66** (2) 33-40.
- Mathias, E., P. Mundy and R. Kohler (2010). Marketing products from local livestock breeds: An analysis of eight cases. *Animal Genetic Resources*, **47** (9), 59-72.
- Musinga, M., D. Kimenye and P. Kivolonz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets. Nairobi Kenya.
- Noor, M., O. Bebe and Y. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.
- Nori, M. (2010). Along the milk way: Marketing camel milk in Puntland, Somalia. *European Journal of Development Research*, **22** (5), 696-714.
- Nyariki, D. (2009). Impacts of policy reforms on the livestock industry in Kenya: The case of the dairy sector. *Livestock Research for Rural Development*, **21** (10).
- Seifu, E. (2007). Handling, preservation and utilization of camel milk and camel milk products in Shinile and Jijiga Zones, eastern Ethiopia. *Marketing*, **10** (4)13-7.
- Sirak,T., A. Bahta and S. Bauer (2007). Analysis of the determinants of market participation within the South African small-scale livestock sector. Tropentag paper, October 9-11, 2007, Witzenhausen, Germany.
- Sombroek, G., H. Braun and V. derPouw (1982). The explanatory soil map and agro-climatic zone map of Kenya. Report No 5. E.I. Kenya Soil Survey, Nairobi, Kenya.
- Soosay, C., A. Fearne and B. Dent (2012). Sustainable value chain analysis: A case study of Oxford Landing from “vine to dine”. *Supply Chain Management: An International Journal*, **17** (1), 68-77.
- Thamizhselvan, K. and P. Murugan (2012). Marketing of grapes in Theni district. *International Journals of Marketing and Technology*, **2** (9), 96-111.
- Worku, T., E. Negera, A. Nurfeta and H. Welearegay (2014). Milk handling practices and its challenges in Borana Pastoral Community, Ethiopia. *African Journal of Agricultural Research*, **9** (15), 1192-1199.
- Yates, F., and P. Grundy (1953). Selection without replacement from within strata with probability proportional to size. *Journal of the Royal Statistical Society, Series B (Methodological)*, **15** (2), 253-261.

CHAPTER 7

FACTORS INFLUENCING CAMEL MILK PRODUCTION IN THE DRYLANDS OF KENYA

7.1 SUMMARY

Camel milk production in the drylands of Kenya has recently received considerable attention as many pastoral communities around urban areas are venturing into camel rearing. This has been considered by many experts as a way to cope with the changing pastoral production environment and utilize the existing opportunity to meet the demand for camel milk in urban areas. However, information on factors affecting camel milk production is scanty. Hence, this study was conducted to determine the factors influencing camel milk production in Isiolo County. A sample of 202 camel milk producers was selected and interviewed using a semi-structured questionnaire. The study applied a simultaneous equation model, using a two-stage least squares approach to determine the factors influencing camel milk production. The study revealed that daily camel milk production is influenced significantly ($P \leq 0.05$) by camel herd size, distance to water point, distance to pasture, number of herders employed, household size, access to climate information, extension services and education level of milk producers. The findings suggest that efforts to improve camel milk production must consider investing in improving the size of herding labour and in increasing the camel herd size through strategies such as proper breeding, provision of suitable veterinary services, and improving rangeland condition to be more suitable for camel milk production. This will increase camel milk production and ultimately enhance food security.

7.2 INTRODUCTION

More than 60% of the world's dromedary camel population is concentrated in East Africa (Farah *et al.*, 2007). There are about 1.06 million camels in the dryland of Kenya. Camel milk contributes up to 12% of the total domestic milk production (Musinga *et al.*, 2008). Camel milk production per annum is estimated at 340 million litres and valued at 8 billion Kenya Shillings (Akweya *et al.*, 2012). This outstanding milk production is produced in harsh environmental conditions. The fact that camels can thrive in the harshest conditions of arid and semi-arid areas, withstanding recurrent droughts and other unfavourable climatic stresses, makes them the most suitable to utilize these areas in meeting pastoral communities' sustainable livelihoods (Musinga *et al.*, 2008).

Camel rearing in Kenya is practised by both pastoral and ranching systems (Morton, 1984). Among pastoralists, such as the Somali, Borana, Turkana, Gabbra and Rendille, camel milk is traditionally produced for subsistence purposes (Noor *et al.*, 2012). Under this traditional management system, the camel excels in dairy production. Many pastoralists rely heavily on milk as the main diet during the dry seasons. It has been reported that during long droughts, cattle and goats cease to lactate at a much greater proportion than camels (Kaufmann, 1998). Therefore, the reported percentage of camel milk consumed by pastoral households during this period is close to 100% (Adongo *et al.*, 2013). Camel milk yield varies with respect to the production system and nutritional management regime and has been estimated to be between 3 and 40 litres per day (Farah *et al.*, 2004; Bekele *et al.*, 2002; Lore *et al.*, 2005; Jans *et al.*, 2012; Adongo *et al.*, 2013). This variation in milk production has been attributed to genetic differences, feeding and management practices, climatic variation, diseases, and the ability to access services

that are vital for milk production among other factors that influence camel milk production (Khan and Eqbal, 2001).

Although substantial focus has been directed towards camel milk production, most studies are descriptive and centred on the amount of camel milk produced (Alhadrami, 2003; Kuria *et al.*, 2011; Gall, 2013) and general constraints and challenges (Schwartz *et al.*, 1983; Bekele *et al.*, 2002; Faye, 2004; Farah *et al.*, 2007 Musinga *et al.*, 2008). Therefore, empirical studies on factors affecting camel milk production are scanty. This study addressed this gap by examining the factors that influence daily camel milk production in Isiolo County. This information is expected to guide the formulation of appropriate policies and development interventions to increase camel milk production for enhanced food and livelihood security.

7.3 METHODOLOGY

7.3.1 Study Area

This study was conducted in Isiolo County, Kenya. The study area is predominantly flat with low lying plains. The altitude ranges between 200m and 300m above sea level. The county is classified as arid and semi-arid (FAO, 2007). The county comprises three ecological zones: semi-arid occupying 5% of the area, arid occupying 30% and very arid occupying 65% (Herlocker *et al.*, 1993; Sombroek *et al.*, 1982). Rainfall is low, bimodal, and erratic. Annual rainfall ranges between 350mm and 600mm per year (Herlocker *et al.*, 1993). It follows the monsoon and therefore highly seasonal (Francine and Hughes, 1984). The long rains last for three months from around mid-March and the short rains last for two to three months, usually starting in October (GoK, 2005). With the rains being erratic, droughts that lead to devastating

loss of livestock and human lives are common occurrence in the county (GoK, 1997). The county is hot throughout the year with mean annual temperatures ranging from 24°C - 30°C. Under these conditions, rain-fed agriculture is unsustainable (Jaetzold and Schmidt, 1983).

The population of Isiolo County is 143,294 persons and the poverty level is estimated at 70%, which is rather high compared with other counties in the ASALs (Kamunyan *et al.*, 2013). The main economic activities in the county are livestock production. More than 70% of the population is involved in livestock production either directly or indirectly. The main livestock production systems comprise cattle, goats, sheep and camels. The county is a predominantly cattle keeping area where camels were largely introduced only in the last two to three decades (Tablino, 1999). The total population of camels in Isiolo District was estimated at 39,081 in 2009, making the county the seventh largest camel producing area in Kenya (GoK, 2010). The county currently contributes more than 90% of marketed camel milk reaching urban markets (Noor *et al.*, 2012). Camel population within the county is largely found in Central Isiolo, Kinna and Garbatulla area.

7.3.2 Data Collection

This study used a multistage sampling procedure to collect data from camel milk producers. A multistage sampling procedure is mostly used where the population of interest exists in two or more hierarchical levels or stages (O'Connell and Reed, 2012). There were three main stages in this study, namely Isiolo County, specific locations in the county where camel production was practised, households that practised camel production, and the selected households which were included in the final sample size. The survey was carried out in August to October 2012 using a

semi-structured questionnaire to collect data pertaining to camel milk production. A total of 202 milk producers were selected using the probability proportional to size formula suggested by Yates and Grundy (1953):

$$n = \frac{Z^2(1-p)p}{e^2} \quad (7.1)$$

Where n is the sample size, Z is the desired Z -value yielding the desired degree of confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher is willing to permit.

7.3.3 Data Analysis

A simultaneous equation model was used to assess the factors influencing camel milk production. The dependent variable was the daily camel milk production, measured in litres. The independent variables hypothesized to influence camel milk production included, first, production factors, such as camel herd size, number of herders, and distance to water and pasture; secondly, characteristics of camel milk producers such as household size, education level of the camel milk producer and gender of the camel milk producer; and thirdly, other enabling factors, such as access to credit facilities, access to extension services, access to climate information and membership of self-help group. Most of the explanatory variables are production related variables and thus may have a two-way relationship, such as milk production and camel herd size. Therefore, the simultaneity problem was expected in the model; hence, the choice of a simultaneous equation model. The assumption was that there are exogenous and

endogenous variables in the model, which could not be estimated by Ordinary Least Squares (OLS). Therefore, a Two-Stage Least Squares (2SLS) approach was used to estimate the model. To confirm the simultaneity problem, the Hausman specification test was used.

A simultaneous equation model conceptualised camel milk production to be influenced by production factors and non-production factors. However, climate parameters were not included in the model because there was no variation among camel milk producers since climate is a common factor. Genetic variation was also excluded from the model because all the interviewed camel milk producers reared the same camel breed, namely the Somali breed.

Camel herd size and access to veterinary services were presumed endogenous variables since they are influenced by other factors such as experience in camel rearing, education of the camel milk producer and gender of the milk producer, which are also explanatory variables in the model. Therefore, they were likely to correlate with the error term. However, Hausman test for exogeneity was conducted to confirm the endogeneity of the variables as suggested by Gujarati and Sangeetha (2007). The assumption in the model was that camel milk production is influenced by two main endogenous variables, that is, camel herd size and access to veterinary services, in addition to other exogenous variables. Nonetheless, camel herd size and access to veterinary services also influence each other and are in turn influenced by camel milk production and some of the exogenous variables which are not included in the main equation. For instance, producers with large camel herds are likely to invest more in veterinary services compared to those with small ones. The model can be expressed as:

$$Y_{1i} = \beta_{10} + \beta_{11}Y_{2i} + \beta_{12}Y_{3i} + \lambda_{1k}X_{1k} + \mu_{1i} \quad (7.2)$$

$$Y_{2i} = \beta_{20} + \beta_{21}Y_{1i} + \beta_{22}Y_{3i} + \lambda_{2k}X_{2k} + \delta_{2k}Z_{2k} + \mu_{2i} \quad (7.3)$$

$$Y_{3i} = \beta_{30} + \beta_{31}Y_{2i} + \lambda_{3k}X_{3k} + \delta_{3k}Z_{3k} + \mu_{3i} \quad (7.4)$$

Where Y_1 is a dependent variable, Y_2 and Y_3 are endogenous variables or jointly dependent variables, X_{1k} , X_{2k} and X_{3k} are observed exogenous variables or predetermined variables associated with given equations, Z_{2k} and Z_{3k} are observed exogenous variables influencing only endogenous variables, β_{10} , β_{20} and β_{30} are constants, β 's are coefficients for endogenous variables (Y), λ 's are coefficients for exogenous variables (X), δ 's are coefficients for exogenous variables (Z), μ_{1i} , μ_{2i} and μ_{3i} are stochastic disturbances, and i is the total number of observations.

The model includes three main categories of variables, namely predictors, instrumental variables, and predictors and instrumental variables. Instrumental variables are exogenous variables that influence the endogenous variables in the model but are not included in the main equation of the model. Predictors and instrumental variables are exogenous variables that are included in the main equation in the model. The equations used in the model are:

$$MP = \alpha_0 + \alpha_{11}HS + \alpha_{12}AV + \lambda_{11}PE + \lambda_{12}HZ + \lambda_{13}LC + \lambda_{14}DP + \lambda_{15}DW + \lambda_{16}CF + \lambda_{17}AE + \lambda_{18}AC + \mu_0 \quad (7.5)$$

$$HS = \alpha_1 + \alpha_{21}MP + \alpha_{22}AV + \lambda_{21}DP + \lambda_{22}DW + \lambda_{23}LC + \lambda_{23}HZ + \delta_{21}EC + \delta_{22}MS + \mu_1 \quad (7.6)$$

$$AV = \alpha_2 + \alpha_{31}HS + \lambda_{31}HZ + \lambda_{32}AC + \delta_{31}PA + \delta_{32}PG + \delta_{33}EC + \delta_{34}MS + \mu_2 \quad (7.7)$$

Where MP is daily milk production, HS is camel herd size, AV is access to veterinary services, PE is producer's education level, HZ is household size, LC is labour used in camel rearing, DP is distance to pasture, DW is distance to water point, CF is access to credit facilities, AE is access to extension services, AC is access to climate information, EC is experience in camel rearing, MS is membership of self-help group, PA is producers age, PG is producers gender, α_0 , α_1 , α_2 , β_0 , β_1 and β_2 are constants, α 's and β 's are coefficients of endogenous variables, λ 's are coefficients of predictors and instrumental variables, δ 's are coefficients of instrumental variables, and μ 's are error terms.

The order condition requires that the number of exogenous variables excluded from an equation must not be less than the number of endogenous variables included in that equation less 1. This is given by the following:

$$K-k \geq m-1 \quad (7.8)$$

Where K is the number of exogenous variables in the model including the intercept, k is the number of exogenous variables in the given equation and m is the number of endogenous variables in a given equation.

In Equation 7.8, if $K-k = m-1$, the equation is exactly identified, but if $K-k > m-1$, the equation is over-identified. This was used as described by Gujarat and Sangeetha (2007), to find out if the

equations were exactly identified or over-identified. However, the order condition is a necessary condition but not a sufficient condition for identification. Hence a rank condition of identification was used because it is both a necessary and sufficient condition of identification. It states that: “In a model containing M equations, an equation is identified if and only if at least one non-zero determinant of order $(M-1)(M-1)$ can be constructed from the coefficients of the variables (both endogenous and exogenous) excluded from that particular equation but included in the other equations of the model” (Gujarat, 2004). The advantage of using both conditions is that the rank condition tells whether the equation is identified or not while the order condition tells whether the equation is exactly identified or over-identified. The 2SLS approach provides satisfactory estimates of parameters and is suitable for estimation of overidentified equations (Kolenikov, 2011). However, the methods of 2SLS give consistent and efficient estimates if there is simultaneity in the model.

Hausman specification error test was used to test for simultaneity. The presumed endogenous variables (camel herd size and access to veterinary services) were regressed on all exogenous variables in order to obtain estimated residuals. The dependent variable (daily camel milk production) was then regressed on all endogenous variables and the estimated residuals, after which a t-test was performed to examine if the coefficient was statistically zero. If the condition is satisfied, then there is no simultaneity in the model.

It was not obvious to determine the variables which were endogenous in the model. To confirm this, Hausman test was used, where each presumed endogenous variable was regressed on all exogenous variables in the model to obtain estimated endogenous variables and then the

dependent variable was regressed on the endogenous variables, estimated endogenous variables and exogenous variables. Thereafter, F-test was used to test the hypothesis that the coefficients of the estimated endogenous variables were equal to zero. If the hypothesis is rejected, the endogenous variables are truly endogenous.

7.4 RESULTS AND DISCUSSION

7.4.1 Descriptive Analysis

Table 7.1 presents the results of descriptive analysis and the hypotheses associated with the explanatory variables used in the simultaneous equation model. The average recorded daily camel milk production was 10.7 litres. The average age of the household head was 50.8 years and was expected to positively influence camel milk production. Similarly, the gender of the milk producers was expected to positively influence daily camel milk production. The majority (80.7%) of the interviewed camel milk producers were male. The analysis further showed that 81.2% of the interviewed camel milk producers did not go through formal education. Formal education was also expected to have a positive influence on milk production.

The average household size was 6.5 persons. The average number of herding labour was 3.1 which comprised hired and family labour. Experience in camel rearing was measured by the number of years spent in rearing camels and was 20.6 years on average among the interviewed producers. The camel herd size is directly related to camel milk production and hence is expected to have a significant and positive influence on the amount of milk produced on a daily basis.

Table 7.1: Summary of variables used in the simultaneous equation model

Variable	Definition	Average recorded	Hypothesized influence on dependent variable
Camel milk production (litres)	Average daily camel milk production	10.7	
Age of camel milk producer	Age in years	50.8	+
Gender of camel milk producer	Binary: 2 for male and 1 for female	80.7 for 2	+
Education of camel milk producer	Categorical: 1 for no education, 2 for primary, 3 for secondary and 3 for postsecondary	81.2 for 1	+
Household size	Number of family members currently living in the same house	6.5	+
Herding labour	Number of herders in given household	1.3	+
Experience in camel rearing	Number of years in camel rearing	20.6	+
Camel herd size	Number of camels owned	30.0	+
Distance to water points	Distance covered in km	8.6	-
Distance to pasture	Distance covered in km	9.2	-
Access to extension services	Binary: 2 for access and 1 for no access	33.2 for 2	+
Access to veterinary services	Binary: 2 for access and 1 for no access	41.6 for 2	+
Access to climate information	Binary: 2 for access and 1 for no access	62 for 2	+
Access to credit facilities	Binary: 2 for access and 1 for no access	11.4 for 2	+
Membership of self-help group	Binary: 2 for members and 1 for non-members	9.9 for 2	+

The average size of the camel herd was 30 per producer. Distances to water and pasture were expected to negatively influence milk production. The averages daily distances covered by herders to water and suitable pasture were 8.6 km and 9.2 km, respectively. The findings revealed that there is low participation in collective actions, as only 9.9% of the interviewed camel milk producers were members of self-help groups. This was also expected to positively

influence camel milk production. Access to extension services, veterinary services, credit facilities and climate information are critical in the livestock production process and were therefore expected to positively influence the daily milk production.

7.4.2 Identification, simultaneity and exogeneity tests

7.4.2.1 Test for identification

The order condition of identifiability analysis is presented in Table 7.2. The findings revealed that all the three equations (Equations 7.5, 7.6 and 7.7) were over-identified. Hence, it was appropriate to use the 2SLS. Further, the rank condition analysis was carried out to confirm if the equations were exactly identified. Table 7.3 presents the coefficients of all the variables used in the model.

Table 7.2: Order condition of identifiability

Equation	No. of Exogenous Variables Excluded (K – k)	No. of Endogenous Variables Included Less 1 (m – 1)	Decision on Identification
7.5	3	2	Over-identified
7.6	5	2	Over-identified
7.7	5	1	Over-identified

Table 7.3: Coefficients of variables in the SEM

Eqn	Intercept	MP	HS	AV	HE	HS	LC	DP	DW	CF	AE	AC	EC	MS	HG	HA
7.5	α_0	1	α_{11}	α_{12}	λ_{11}	λ_{12}	λ_{13}	λ_{14}	λ_{15}	λ_{16}	λ_{17}	λ_{18}	0	0	0	0
7.6	α_1	α_{21}	1	α_{22}	0	λ_{24}	λ_{23}	λ_{21}	λ_{22}	0	0	0	δ_{21}	δ_{22}	0	0
7.7	α_2	0	α_{31}	1	0	λ_{31}	0	0	0	0	0	λ_{32}	δ_{33}	δ_{34}	δ_{32}	δ_{31}

All the coefficients shown in Table 7.3 were used to construct a matrix to carry out the rank condition test. The order matrices constructed were 2 x 2 as follows:

$$\text{Determinant A} = \begin{vmatrix} \delta_{21} & \delta_{22} \\ \delta_{33} & \delta_{34} \end{vmatrix} \text{ or } \begin{vmatrix} \delta_{22} & 0 \\ \delta_{34} & \delta_{36} \end{vmatrix} \neq 0,$$

$$\text{Determinant B} = \begin{vmatrix} \lambda_{18} & 0 \\ \lambda_{32} & \delta_{34} \end{vmatrix} \text{ or } \begin{vmatrix} \lambda_{17} & 0 \\ 0 & \delta_{32} \end{vmatrix} \neq 0,$$

$$\text{Determinant C} = \begin{vmatrix} \lambda_{13} & \lambda_{14} \\ \lambda_{23} & \lambda_{21} \end{vmatrix} \text{ or } \begin{vmatrix} \lambda_{15} & \lambda_{16} \\ \lambda_{22} & 0 \end{vmatrix} \neq 0$$

Where A, B and C are 2 x 2 matrices for Equations 7.5, 7.6 and 7.7 respectively.

The findings show that there exists at least one non-zero determinant of order 2 x 2 from the coefficients of the variables excluded from a given equation but included in other equations. Therefore all the equations were identified.

7.4.2.2 Test for simultaneity

Hausman specification error test was used to test whether the endogenous variables were correlated with the disturbance terms. The reduced form equations were obtained from the endogenous variables in the model and were given in Equations 7.8 and 7.9. The endogenous variables were expressed in terms of all the exogenous variables (X_k, Z_k) in the model.

$$HS = \Pi_0 + \Pi_1 HG + \Pi_2 PA + \Pi_3 PE + \Pi_4 LC + \Pi_5 DG + \Pi_6 DW + \Pi_7 MS + \Pi_8 AE + \Pi_9 CF + \Pi_{10} AC + \Pi_{11} HS + \Pi_{12} EC + \nu \quad (7.9)$$

$$AV = \Pi_{13} + \Pi_{14} HG + \Pi_{15} P + \Pi_{16} PE + \Pi_{17} LC + \Pi_{18} DP + \Pi_{19} DW + \Pi_{20} MS + \Pi_{21} AE + \Pi_{22} CF + \Pi_{23} AC + \Pi_{24} HS + \Pi_{25} EC + \omega \quad (7.10)$$

The following results were obtained from the simultaneity test:

$$\begin{array}{rcl}
 \mathbf{MP=} & 34.300 & +12.2629\widehat{HS} \quad +0.942\widehat{VS} \quad -0.585PE \quad +0.336HS \quad -10.989LC \quad -0.041DP \\
 \mathbf{t =} & (12.264)** & (18.2426)** \quad (2.026)** \quad (0.108) \quad (2.227)** \quad (-11.717)** \quad (-0.463) \\
 & -0.417DW & -0.362CF \quad -2.554AE \quad -1.892AC \quad +0.881\hat{v} \quad -2.163\hat{\omega} \\
 & (-5.567)** & (-0.379) \quad (-3.097)** \quad (-2.103)** \quad (2.706)** \quad (-6.662)** \\
 & & & & & & (7.11)
 \end{array}$$

$$R^2 = 0.817 \quad \text{Adjusted } R^2 = 0.805 \quad F = 70.148** \quad N = 202$$

** Significant at 5%

The results show that at 5% level of significance, the coefficients of $\hat{v}$ (2.706) and $\hat{\omega}$ (-6.662) were statistically significant at 5%, indicating the presence of simultaneity problem.

7.4.2.3 Test for exogeneity

Hausman specification test was used to test for exogeneity. The following results were obtained:

$$\begin{array}{rcl}
 \mathbf{MP=} & 45.227 & +0.035HS \quad +0.185\widehat{HS} \quad +7.018VS \quad +2.204\widehat{VS} \quad +0.629PE \quad +0.406HS \\
 \mathbf{t =} & (13.370)** & (1.515) \quad (13.803)** \quad (6.799)** \quad (4.424)** \quad (1.267) \quad (2.680)** \\
 & -11.830LC & -0.070DG \quad -0.478DW \quad -0.252CF \quad +2.735AE \quad +2.112AC \\
 & (-12.659)** & (-0.036) \quad (-6.024)** \quad (-0.251) \quad (3.283)** \quad (2.358)** \\
 & & & & & & (7.12)
 \end{array}$$

$$R^2 = 0.901 \quad \text{Adjusted } R^2 = 0.811 \quad F = 67.740** \quad N = 202$$

** Significant at 5%

The results show that the coefficients of $\widehat{VS}$ and $\widehat{HS}$ are significant at 5% and are therefore statistically not equal to zero. This shows that camel herd size and access to veterinary services

are truly endogenous in the model. This implies that the choice of the SEM and the 2SLS approach for estimating the parameters was appropriate.

7.4.3 Simultaneous Equation Model Results

Table 7.4 presents the results of SEM. Eight out of the ten explanatory variables tested were statistically significant. Furthermore, the adjusted R^2 value of 0.46 implies that 46% of the total variation in camel milk production was explained by the explanatory variables. The F-statistic was significant at 5% level, indicating that the explanatory variables as a group had a significant effect on output. The results indicated that education level of the camel milk producer, household size, distance to pasture and access to extension services had a positive and significant ($P \leq 0.05$) influence on daily camel milk production. Camel herd size, number of herders employed and access to climate information showed a positive and significant ($P \leq 0.1$) influence on camel milk production. Distance to water point had a negative and significant ($P \leq 0.1$) influence on camel milk production.

Table 7.4: Factors influencing daily camel milk production

Variable	B	Std Error	T
Constant	-11.241	3.861	-3.043**
Camel herd size	0.228	0.131	1.749*
Access to veterinary services	-8.452	19.576	0.414
Education of the household head	1.327	0.586	2.266**
Household size	0.577	0.229	2.521**
Distance to grazing point	0.411	0.155	2.650**
Distance to water point	-0.375	0.123	-3.055**
Access to credit facilities	0.972	1.594	0.609
Access to climate information	1.308	1.051	1.844*
Herding labour	2.341	1.445	1.925*
Access to extension services	5.643	1.666	3.386**

Notes: ** Significant at 5%; * significant at 10%; $R^2 = 0.47$; Adj $R^2 = 0.45$; $F = 19.095^{**}$; $N = 202$

The positive and significant influence of herd size on daily milk production implies that the larger the camel herd size the more milk is produced, which was as hypothesized. This is true particularly if the proportion of lactating animals increases with the size of the herd. This finding is consistent with Herren (1990) that there is a significant difference in terms of milk production between herders with less than 5 camels and those with more than 40 camels in Somalia.

Herding labour was found to have a positive and significant influence on milk production. This implies that the more herders a camel milk producer employs the more the likelihood of producing more milk. This can be explained by the fact that milk production is directly a function of the extensification of labour. For example, if a camel herd is managed by warriors (Morans), it will have higher milk production than that managed by young children and women. This is because warriors are able to cover larger distances to explore the best pasture resources compared to young children and women. Therefore, the quality and size of herding labour are essential for the productivity of the camel herd. This is because numbers and quality of herding labour are vital in accessing good quality pasture and in watering, milking, and time spent feeding, among other management practices that are expected to translate into higher milk production. This result is consistent with that of Nori (2010) who reported an increase in camel milk production as the camel milk producers increased the number of herders employed in Somalia, particularly in areas where conflict and drought were recurrent events.

Education level attained by the camel milk producer had a positive and significant influence on daily camel milk production. This implies that educated producers are likely to produce more compared to the uneducated counterparts as a result of their access to relevant production

information. Education enhances producers' ability to make rational decisions compared to their counterparts with less formal education. Education level might also influence the access to vital production services such as credit and veterinary services. Such access will boost production through improving herd productivity, taking into account that a healthier herd would produce more milk.

Similarly, household size showed a positive and significant influence on milk production, implying that larger families are expected to provide enough herders and, therefore, can maintain a larger herd which would consequently have higher milk production than smaller households. This is contrary to the finding of Dahl and Hjort (1976) that there is no linear relationship between household size and herd size and consequently milk production. Their argument was based on the fact that households in pastoral areas are forced to strike a balance between labour requirements and total herd output particularly in terms of milk and live animals. This, however, may only be true in areas where the main objective of the production system is subsistence rather than commercial production, which might explain why household size has a positive and significant influence on daily camel milk production in the current study.

The distance covered by herders in search of forage had a positive and significant effect on daily camel milk production. These results are counter to a *priori* expectation that the longer the distance to pasture the lower the milk produced by a given camel herd. This can be explained by the fact that the distance travelled by herders in search of pasture is an indication of forage availability and a reflection of grazing resource condition and, hence, overall livestock productivity. This is consistent with Niamir (1998) that forage availability is partially determined

by the direction and distance of the opportunistic movements by most African pastoralists to make use of the dispersed and unpredictable grazing resources. On the other hand, distance to water point was found to be negatively and significantly affecting camel milk production. This implies that in order for producers to obtain high milk production, it is important to cover shorter distances to water points. This can be explained by the fact that the camel milk production system in the study area is mostly peri-urban; thus covering longer distance might result in extra stress that would directly reduce the quantity of milk produced.

Information on rainfall and temperatures is essential in the drylands as it enables livestock keepers to plan where to access fodder and water. Despite the fact that camels are less affected by the seasonal climatic variation compared to other animals (Yagil, 1982; Yagil *et al.*, 1994; Alhadrami, 2003), access to climate information showed a positive and significant effect on daily camel milk production, implying that producers with access to such information are likely to produce more milk compared to those with no access. Such access might positively influence milk production as a result of access to critical knowledge that is important in designing and adjusting milk production strategies. Thus, such a producer might likely make sound decisions on grazing plans and other production related technologies to achieve sustainable milk production in the context of the present climate fluctuation and extreme weather events.

As hypothesised, access to extension services showed a positive and significant influence on camel milk production, implying that producers with access to extension services are likely to have a higher milk production compared to those with no access. This is because extension services influence critical decisions concerning camel milk production and management. As a

result, producers with such access are likely to plan their activities according to the extension information and, thus, have a higher chance of making the right decisions at the right time, thereby reducing the risk and uncertainties associated with milk production. This result is contrary to the finding of Musinga *et al.* (2008) that extension services in camel husbandry are hardly used in Isiolo County due to the unavailability of skilled extension workers and poor quality of the extension services provided by government institutions and other extension organizations. This contradiction can be explained by the fact that extension services have improved with more focus being directed towards camel milk production and marketing in Isiolo County.

7.5 CONCLUSIONS AND POLICY IMPLICATIONS

This study shows that the key determinants of camel milk production were mainly the production-related factors such as household size, distance to water and pasture, number of employed herders, camel herd size, and access to extension services and climate information.

Based on the findings, interventions aimed at improving camel milk production should prioritise an enabling environment, investments and actions aimed at enhancing production resource base and producer information system. In addition, long term interventions need to focus on capacity building and awareness creation to producers on best practices on camel husbandry. Strategies to secure the resource base would include, among others, actions and processes that enhance access to critical grazing areas at times of scarcity, availing adequate herding labour; maintenance of viable herd structures, and accessing extension services to milk producers. This would enhance camel milk production and ultimately improve pastoral livelihoods.

REFERENCES

- Adongo, A., D. Coppock and F. Wayua (2013). Simple evaporative cooling method reduces bacterial content of traditionally marketed camel milk in Isiolo County, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, **13** (1), 7213-7224.
- Akweya, B. A., C. Gitao and M. Okoth (2012). The acceptability of camel milk and milk products from North Eastern Province in some urban areas of Kenya. *African Journal of Food Science*, **6** (19), 465-473.
- Alhadrami, A. (2003). Camel. *Encyclopedia of Dairy Sciences*. In: Roginski H, J. Fuquay and P. Fox (Eds.). Academic Press, Amsterdam, Netherland.
- Bekele, T., M. Zeleke and R. Baars (2002). Milk production performance of the one humped camel (*Camelus dromedaries*) under pastoral management in semi-arid eastern Ethiopia. *Livestock Production Science*, **76** (1), 37-44.
- Dahl, G. and A. Hjort (1976). Having herds: Pastoral herd growth and household economy. *Stockholm Studies in Social Anthropology*. Department of Social Anthropology, University of Stockholm. Stockholm, Sweden.
- FAO. (Food and Agriculture Organization) (2007). Food security district profiles for 23 districts in Kenya, Nairobi, Kenya.
- Farah, Z., M. Mollet, M. Younan and R. Dahir (2007). Camel dairy in Somalia: Limiting factors and development potential. *Livestock Science*, **110** (1), 187-191.
- Farah, Z., T. Streiff and M. Bachmann (2004). Preparation and consumer acceptability tests of fermented camel milk in Kenya. *Journal of Dairy Research*, **57** (2), 281-283.
- Faye, B. (2004). Dairy productivity potential of camels: *International Committee for Animal Recording (ICAR) Technical Series* No. 11.
- Francine, M. and R. Hughes (1984). A comment on the impact of development schemes on the floodplain forests of the Tana River of Kenya. *The Geographical Journal*, **150** (2), 230-244.
- Gall, C. F. (2013). Production Systems around the world. *Milk and Dairy Products in Human Nutrition: Production, Composition and Health*, **1** (1), 1-30.
- GoK. (Government of Kenya) (1997). Isiolo District development plan for 1997-2001. *Government Printers*, Nairobi, Kenya.
- GoK. (2005). Isiolo District Vision and Strategy: 2005-2015. *Government Printer*, Nairobi, Kenya.
- GoK. (2010). Agricultural sector development strategy 2010-202. Ministry of Agriculture. *Government Printer*, Nairobi, Kenya.

- Gujarati, D. (2004). *Basic econometrics* (ed.) McGraw-Hill. New York, United State of America.
- Gujarati, D. N. and S. Sangeetha (2007). *Basic Econometrics*. Tata McGraw Hill Publishing Company Limited, New Delhi, India.
- Herlocker, D., S. Shaaban and S. Wilkes (1993). *Range Management Handbook of Kenya*. Volume II, 5. Isiolo District. Ministry of Agriculture, Livestock Development and Marketing. Nairobi, Kenya.
- Herren, U. (1990). The commercial sale of camel milk from pastoral herds in the Mogadishu hinterland, Somalia. *Pastoral Development Network Paper No 30a*, Overseas Development Institute, London. United Kingdom.
- Jans, C., J. Bugnard, P. Njage, C. Lacroix and L. Meile (2012). Lactic acid bacteria diversity of African raw and fermented camel milk products reveals a highly competitive, potentially health-threatening predominant micro-flora. *LWT-Food Science and Technology*, **47** (2), 371-379.
- Jaetzold, R., and H. Schmidt (1983). *Farm Management Handbook of Kenya: Natural Conditions and Farm Management Information, Central Kenya: (Rift Valley and Central Provinces)*. Ministry of Agriculture, Nairobi Kenya.
- Kamunyan, C., G. Cheserek, M. Kiptui and E. Arusei (2013). Causes and effects of post-election violence on agricultural production in Kesses Division, Uasin Gishu County, Kenya. *Journal of Emerging Trends in Economics and Management Sciences*, **4** (1).
- Kaufmann, B. (1998). Analysis of pastoral camel husbandry in northern Kenya. *Hohenheim Tropical Agricultural Series*. No 5. Margraf, Weikersheim. Germany.
- Khan, B. and A. Iqbal (2001). Production and composition of camel milk: Review. *Pakistan Journal of Agricultural Sciences*, **38** (1), 64-68.
- Kolenikov, S. (2011). Biases of parameter estimates in miss-specified structural equation models. *Sociological Methodology*, **41** (1), 119-157.
- Kuria, S. G., I. Tura, S. Amboga, H. Walaga and J. Lesuper (2011). The current status of camel (*Camelus dromedarius*) calf management among pastoral communities of northern Kenya. *Livestock Research for Rural Development*, **23** (7).
- Lore, T., S. Mbugua and J. Wangoh (2005). Enumeration and identification of micro-flora in a Kenyan traditional fermented camel milk product. *LWT-Food Science and Technology*, **38** (2), 125-130.
- Morton, R. H. (1984). Camels for meat and milk production in Sub-Sahara Africa. *Journal of Dairy Science*, **67** (7), 1548-1553.

- Musinga, M., D. Kimenye and P. Kivionz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets. Nairobi Kenya.
- Niamir, F. M. (1998). *The resilience of pastoral herding in Sahelian Africa. Linking social and ecological systems: Management Practices and Social Mechanisms for Building Resilience*, 250-284.
- Noor, M., O. Bebe and Y. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.
- Nori, M. (2010). Along the Milky Way: Marketing camel milk in Puntland, Somalia. *European Journal of Development Research*, **22** (5), 696-714.
- O'Connell, A. and S. Reed (2012). Hierarchical data structures, institutional research, and multilevel modelling. *New Directions for Institutional Research*, **20** (154), 5-22.
- Schwartz, H. J., R. Dolan and A. Wilson (1983). Camel production in Kenya and its constraints. *Tropical Animal Health and Production*, **15** (3), 169-178.
- Sombroek, G., H. Braun and V. derPouw (1982). The explanatory soil map and agro-climatic zone map of Kenya. Report No 5. *E.I. Kenya Soil Survey Report*. No 5, Nairobi, Kenya.
- Tablino, P. (1999). *The Gabra: Camel nomads of northern Kenya* (No. 4). Paulines Publications Africa. Nairobi, Kenya.
- Yagil, R. (1982). Camels and camel milk. *FAO Animal Production Health*. Paper No. 26: 1- 69.
- Yagil, R., O. Zagorski, C. Van Creveld and A. Saran (1994). Science and camel's milk production. Chameuxet dromedaries, animeauxlaitiers. Ed. Saint Marin, G. Expansion *Scientifique Francais*, Paris, France. 75-89.
- Yates, F., and P. Grundy (1953). Selection without replacement from within strata with probability proportional to size. *Journal of the Royal Statistical Society, Series B (Methodological)*, **15**(2), 253-261.

CHAPTER 8

MODELLING THE CHOICE OF MARKET OUTLETS BY CAMEL MILK

PRODUCERS IN THE DRYLANDS OF KENYA

8.1 SUMMARY

Access to reliable and profitable markets is crucial in exploiting the potential of camel milk to contribute to enhanced livelihoods of pastoral households. This study assessed the factors influencing the choice of marketing outlets by camel milk producers in Isiolo County using a Multinomial Logistic regression model. A sample of 202 camel milk producers was selected using a multistage sampling procedure. The study used Multinomial Logistic regression model. The finding indicated that the likelihood of selling milk to bulking centres and wholesalers was negatively and significantly ($P \leq 0.05$) influenced by access to extension services, and market information and, household size, experience of camel milk producer and distance to bulking centre, and, positively influenced by the camel herd size and daily milk production. On the other hand selling to wholesaler marketing outlet was positively and significantly ($P \leq 0.05$) influenced by age of the producer, camel herd size, daily milk production and price offered at the wholesaler outlets, and, negatively and significantly by experience of camel milk producers and distance covered to wholesaler marketing outlets. Therefore, in order to enable camel milk producers to circumvent the constraints that denies them opportunities to benefit from the most profitable marketing outlets, it is essential to increase camel milk production and implement interventions that reduces the distance to the market I order for producers to benefit from participation in market that offers better returns, which would consequently enhance their income and increase their resilience.

8.2 INTRODUCTION

The demand for livestock products is rapidly rising in developing countries, mainly due to a rise in human population, increased income and urbanization (Thornton, 2010). However, livestock production is faced by major challenges including diseases, shrinking grazing land and poor infrastructure development. This situation has been worsened by recurrent droughts and inappropriate interventions, particularly in arid and semi-arid areas of Kenya where most of the livestock production takes place (Mainardi, 2012). Furthermore, inappropriate marketing and pricing policies have affected producers' incentives and the willingness of potential investors to participate in livestock development (Peeling and Holden, 2004). These, among other factors, have contributed to the current situation of livestock production and marketing in Kenya. Despite this discouraging picture, many pastoral communities in arid and semi-arid areas in sub-Saharan Africa have managed to cope with these challenges through strategies such as diversification of their herds (to include drought tolerant and multipurpose livestock species like the camel) in order to provide both food and non-food requirements.

Camels can thrive in the harshest arid and semi-arid areas and withstand recurrent droughts and other unfavourable climatic conditions (Yagil *et al.*, 1994; Nori, 2010; Noor *et al.*, 2012). Its adoption therefore provides a promising resilience pathway for pastoral livelihoods. The main purpose of camel keeping in Kenya has been for subsistence, mostly to produce milk to meet the nutrition needs for pastoral households (Anderson *et al.*, 2012). However, this is gradually changing as many communities such as the Borana and Somali are increasingly embracing market economy and have realised the opportunities offered by camel milk (Farah *et al.*, 2004; Adongo *et al.*, 2013; Noor *et al.*, 2012). Camel milk trade has created an enormous business

opportunity in major towns across the drylands of Kenya. For instance, herds that supply camel milk to urban markets are concentrated around the towns of Moyale, Isiolo, Garissa and Nanyuki. Isiolo County supplies about 600 litres, while Garissa and Nanyuki respectively supply 500 litres to Nairobi market daily (Matofari, 2013).

The camel milk value chain in Isiolo County comprises a large number of actors that include milk producers, village collectors, bulking agents, wholesalers, local and urban retailers (Musinga *et al.*, 2008). Access to reliable and profitable markets is crucial in exploiting the potential of camel milk to contribute to enhanced livelihoods of pastoral households (Herren, 1990; Mohamed *et al.*, 2003; Anderson *et al.*, 2012). Camel milk producers are faced with different market options such as individual consumers, village collectors, bulking centres, wholesalers and retailers. The factors that influence the choice of market outlet are largely unknown. This information is crucial for guiding the formulation of appropriate policies and development interventions to enhance producers' returns from camel milk trade and, therefore, their food and livelihood security. This study was, therefore, conducted to determine the factors influencing the choice of market outlets by camel milk producers in Isiolo County.

8.3 METHODOLOGY

8.3.1 Study Area

This study was conducted in Isiolo County of Kenya. The county is located in the upper eastern region, covering approximately 25,000 square kilometres. The study area is classified as arid and semi-arid with very arid environment (Herlocker *et al.*, 1993; Sombroek *et al.*, 1982). The rainfall patterns follow the monsoon and are therefore highly seasonal (Francine and Hughes,

1984). The average annual precipitation ranges between 350mm and 600mm (Herlocker *et al.*, 1993). The county is hot throughout the year with mean annual temperatures ranging from 24°C - 30°C. Under these conditions, rain-fed agriculture is unsustainable (Jaetzold and Schmidt, 1983).

The county has a population of 143,294. It is estimated that 72.6% of the population live below the poverty line of Ksh 68.50. This poverty level is rather high compared with other counties in the ASALs (Kamunyan *et al.*, 2013). Livelihood activities in the county include pastoralism, firewood/charcoal burning and casual wage labour. The main livestock kept are cattle, goats, sheep and camels. Camel milk production has gained popularity in the recent past and has become one of the major livelihood activities in the county. Over the last few years, the county has developed the most prominent peri-urban camel population and a thriving camel milk economy (Noor *et al.*, 2012). This has made the county a major contributor (more than 90%) of marketed camel milk across urban markets.

8.3.2 Data Collection

This study used a multistage sampling procedure to collect data from camel milk producers. This procedure is mainly used where the population of interest has two or more hierarchical levels or stages (O'Connell and Reed, 2012). In this study, there were three main stages, namely Isiolo County, specific locations in the county where camel production was practised, households that practised camel production and the selected households which were included in the final sample size. The survey was carried out in August to October 2012 using semi-structured questionnaires to collect data pertaining to camel milk production. A total of 202 milk producers were selected using the probability proportional to size formula suggested by Yates and Grundy (1953):

$$n = \frac{Z^2(1-p)p}{e^2} \quad (8.1)$$

Where n is the sample size, Z is the desired Z -value yielding the desired degree of confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher is willing to permit.

8.3.3 Data Analysis

The econometric models that are commonly used in studies involving multiple decision choices are the Multinomial Logistic and Multinomial Probit Models (Greene *et al.*, 1996; Hassan and Nhemachena, 2008; Deressa *et al.*, 2009; Changpetch and Lin, 2013). The Multinomial Logistic Model was preferred in this study because it provides a convenient form for underlying choice probabilities. Hence, it does not require multivariate integration, making it simple to compute choice situations characterised by many alternatives (Hausman and McFadden, 1984). On the other hand, the Multinomial Probit Model requires that the multivariate normal integrals must be evaluated to estimate the unknown parameters. This complexity makes the latter an inconvenient specification test (Chib and Greenberg, 1998).

Camel milk producers are faced with multiple choices regarding where to sell their milk. These choices include selling to individual consumers (consumers in the village), village assemblers, bulking centres, wholesalers, and retailers. Out of these five marketing outlets, only three of them were considered in this study, namely consumer, bulking centre, and wholesale outlets. This is because, the mount of camel milk handled by rural assemblers and retailers is markedly

lower compared to the selected marketing outlets (Musinga *et al.*, 2008; Kuma *et al.*, 2013). Further, the buying prices offered at the bulking centre and wholesale marketing outlets are relatively higher than other marketing outlets. Thus, producers that choose to sell their milk through these outlets earn high profit margin. In this study, any milk producer qualified to be participating in a particular marketing outlet if he sold more than 50% of his milk to that particular outlet.

The Multinomial Logistic Model was used to determine the factors that influence the choice of camel milk marketing outlets by camel milk producers. The variables were grouped into four categories, namely producers' demographic characteristics, production factors, institutional factors and marketing factors. Producers' demographic characteristics included age, education level and household size. Production factors included camel herd size, daily milk production, and experience in camel rearing. Institutional factors comprise access to marketing information, access to credit facilities and access to extension services, while marketing factors encompass distance to the preferred market and selling prices. The general form of the Multinomial Logistic Model as proposed by McKelvey and Zavoina (1975), and cited in Fiebig *et al.* (2010) and Ahmed *et al.* (2013), is:

$$Pr_{ki} = \frac{\exp(X'\beta_j)}{\sum_{k=1}^j \exp(X'\beta_j)} \quad (8.2)$$

Where Pr is the probability that a camel milk producer i chooses to sell through the j milk marketing outlet from k milk marketing outlet choices; X is a vector of explanatory variables that

contains the attributes of camel milk producers and institutions and marketing outlets; and β_j is a vector of parameters to be estimated.

Equation 8.2 has indeterminacy, so that only J parameter vectors are needed to determine the J+1 probability. This indeterminacy is removed through normalization of one of the marketing outlets which assumes that $\beta_0 = 0$ so that corresponding probabilities can be estimated as:

$$\Pr(Y_i = j/X_i) = \frac{\exp(X'_i \beta_j)}{1 + \sum_{k=1}^J \exp(X'_i \beta_k)} \quad (8.3)$$

$$j = 0, 2, \dots, J, B_0=0$$

Estimating the above equation yields the log-odds ratios given below as:

$$\ln \left[\frac{P_{ij}}{P_{ik}} \right] = X_i(\beta_j - \beta_k) = X_i \beta_j \quad (8.4)$$

if $k = 0$ (the base category)

The equation used in this study can be written as follows:

$$\ln \left[\frac{P_{ij}}{P_{ik}} \right] = \beta_0 + \beta_1 PG + \beta_2 PE + \beta_3 MS + \beta_4 AE + \beta_5 AM - \beta_6 PA + \beta_7 HZ + \beta_8 EC + \beta_9 HS + \beta_{10} DP + \beta_{11} MP + \beta_{12} DM + \mu \quad (8.5)$$

Where PG is producers' gender, PE is producers' education, MS is membership in a self-help group, AE is access to extension services, AM is access to market information, PA is producers' age, HZ is household size, EC is experience in camel rearing, HS is camel herd size, DP is daily

milk production, MP is milk selling prices, DM is distance to the preferred market and μ is error term.

8.4 RESULTS AND DISCUSSION

8.4.1 Descriptive Analysis

Table 8.1 shows descriptive statistics associated with the dependent and explanatory variables for each market outlet (selling point). Camel milk producers that sold to individual consumers comprised 41.4% of the total producers, while 42.3% and 16.6% of the producers sold to bulking centre and wholesale outlets respectively. The majority of producers that sold to individual consumers were male (72.9%). Also, the majority (85.4%, 83.7% and 78.9%) of producers were found to have no formal education across all marketing outlets. The level of education was hypothesized to positively influence the choice of marketing outlet.

The findings revealed that there is a very low participation in collective actions (self-help groups), as less than 10% of the interviewed producers were members of self-help groups. Participation in collective action was hypothesized to positively influence the choice of marketing outlet. Access to extension services was high among milk producers that sold to individual consumers (91.7%) and wholesalers (73.7%). Access to the same services was lower among producers that sold to bulking centres (20.4%). Access to extension services was expected to positively influence the choice of marketing outlet through the effect on the amount of milk produced. There was variation in access to marketing information among the producers. Those who sold to individual consumers had less access (33.3%) compared to those who sold to

bulking centres (69.4%) and wholesalers (78.9%). This variable was hypothesized to positively influence the choice of marketing outlet among camel milk producers.

Table 8.1: Hypothesized variables used in the Multinomial Logistic Model

Variable	Definition	Averages recorded for market outlets			Hypothesized influence on dependent variable
		Consumers	Bulking centres	Wholesalers	
Preferred market outlet	Selling point	41.4	42.3	16.6	
Gender of producer	Binary: 2 for male and 1 for female	72.9 for 2	85.7 for 2	78.9 for 2	+
Education level of producer	Categorical: 1 for no education, 2 for primary, 3 for secondary and 3 for postsecondary	85.4 for 2	83.7 for 1	78.9 for 1	+
Membership of self-help group	Binary: 2 for members and 1 for non-members	8.3 for 2	6.1 for 2	5.3 for 2	+
Access to extension services	Binary: 2 for access and 1 for no access	91.7 for 2	20.4 for 2	73.7 for 2	+
Access to market information	Binary: 2 for access and 1 for no access	33.3 for 2	69.4 for 2	78.9 for 2	+
Age of the producer	Age in years	49.3	52.1	53.5	-
Household size of producer	Number of family members currently living in the same house	5.3	6.6	6.0	+
Experience in camel rearing	Number of years in camel rearing	19.4	23.7	28.2	+
Size of camel herd	Number of camels owned	15.9	47.3	62.3	+
Camel daily milk production	Average daily camel milk production	7.5	24.7	39.3	+
Selling price of camel milk	Average selling price in KSh	35.0	50.3	112.9	+
Distance to the preferred market	Distance covered in km	4.6	29.1	324.2	+

The average age of the camel milk producers that had sold to individual consumers was 49 years while the age of those who sold to bulking centre and wholesaler were 52 and 54, respectively. The age of the producers is expected to negatively influence the choice of camel milk marketing outlet. This is because older producers are expected to sell to individual consumers compared with younger producers. The average household size was 5 members for producers that had sold to individual consumers, and 6 members for those that sold to bulking centres and wholesalers,

respectively. In addition, the results indicate that producers who sold to wholesalers were more experienced in rearing camels than their counterparts. The average household size and experience in camel rearing were hypothesized to positively influence the choice of marketing outlet.

The average herd size was smaller among producers that sold to individual consumers (16) than those that sold to bulking centres (47) and wholesalers (62). Similarly, those who produced little milk sold to individual consumers, while those who produced large quantities sold to bulking centres and wholesalers. Camel herd size and amount of milk produced were expected to positively influence the choice of marketing outlet. The wholesalers paid higher prices per litre (KSh 112.90) than the bulking centres (KSh 50.30) and the consumers (KSh 35). The distance to the preferred camel milk market was expected to positively influence the choice of marketing outlet. The distance travelled to the preferred market was longer among producers that sold to wholesalers (324.2 km) than among those that sold to individual consumers (4.6 km), implying that the producers living far away from markets tended to sell to individual consumers.

8.4.2 Determinants of the Choice of Marketing Outlets

In estimating the Multinomial Logistic Model, a normalizing procedure was used where selling to individual consumers was normalized and used as a reference point or base category with which the other marketing outlets (bulking centres and wholesalers) were compared. The log Pseudo Likelihood value of 454.642 shows that the explanatory variables included in the model jointly influenced camel milk producers' choice of alternative marketing outlets at 5%. The model also shows a good fit as indicated by the Pseudo R^2 of 0.415. As presented in Table 8.2,

out of 12 explanatory variables included in the model, seven explanatory variables significantly influenced selling to bulking centres, while six variables significantly influenced selling to wholesale marketing outlets.

Table 8.2: Factors influencing the choice of marketing outlet

Variable	Bulking centre outlet (n=74)				Wholesale outlet (n=30)			
	β	SE	Wald	Odd ratio	β	SE	Wald	Odd ratio
Intercept	-19.890	7.780	0.014	-	-4.937	1.829	0.753	-
Gender	1.610	0.883	1.126	1.679	0.137	0.794	0.030	1.610
Age	0.003	0.014	0.055	1.713	0.165	0.036	4.801**	16.901
Education	0.102	0.367	0.077	0.845	9.82	16.965	0.026	5.318
Membership of self-help group	-0.206	1.224	0.028	0.815	-0.854	0.705	1.468	0.933
Extension services	-1.817	0.521	12.182**	24.631	-1.004	0.709	1.004	11.543
Access to market information.	-2.210	0.769	8.252**	21.831	-0.335	0.506	0.439	1.089
HH size	-0.640	0.273	5.487**	0.512	-0.427	0.366	1.058	0.873
Experience in camel rearing	-0.035	0.012	8.087**	23.265	-0.158	0.056	7.936**	21.239
Herd size	0.032	0.018	6.238**	13.243	0.034	0.012	7.928**	29.034
Daily milk production	0.081	0.027	9.074**	9.823	0.023	0.033	5.482**	10.143
Selling prices at outlet	-0.025	0.031	0.656	0.764	0.106	0.047	1.987*	13.047
Distance to market	-0.017	0.010	3.402**	10.018	-0.026	0.010	6.764**	17.130

Notes: n = 202; **Significant at 5%; *Significant at 10%; Pearson Chi-Square = 132.468**; Deviance Chi-Square = 451.582**; Log Pseudo Likelihood = 454.642**; Pseudo R-Square = 0.415

The likelihood of producers selling to bulking centres was lower among camel milk producers that had access to extension services, market information, large household size, longer experience in camel rearing and covered longer distance to market. On other hand, the likelihood of selling to bulking centres was higher among producers with large herd size and high daily milk production. Access to extension services showed a negative and significant ($P \leq 0.05$) influence on the decision to sell to bulking centres. This suggests that producers with access to technical advice and information are likely to sell to individual consumers. This result is contrary to the finding of with those of Asfaw and Jabbar (2008) and Berhanu and Dirk (2008) that access to extension services had a direct and positive influence on marketing outlet for most livestock products. This contradiction can be explained by the fact that extension services in Isiolo County, was mostly focused in production related matters, rather than a holistic services that include marketing linkages.

Access to market information negatively and significantly influenced the sales to the bulking centre marketing outlet ($P \leq 0.05$), implying that producers with access to market information such as milk demanded and buying and selling prices were not likely to sell to bulking centres compared to those without access to such information. This result contradict the findings of Ellram *et al.* (2013) and Maskell and Lorenzen (2004) that access to market information has significant benefits for producers of commodities as these information play a crucial role in reducing the marketing risks such as those associated with losses in the process of marketing transactions. This anomaly can be explained by the fact that the majority of camel milk producers in Isiolo County were small-scale producers with limited resources, therefore, even if

they had access to such information, selling to bulking centres might be hindered by other factors such as distance and cost of transportation.

Similarly, the household size negatively and significantly ($P \leq 0.05$) influenced the choice to sell to bulking centre rather than to individual consumers. This suggests that producers with larger household were likely to sell to individual consumers. This can be explained by the fact that larger household are likely to consume to large amounts of milk and therefore sell less. This, therefore, may have limited their choice to sell to bulking centres where large milk quantities were mostly required. Similar results were reported by Anjani *et al.* (2011) that household size had a negative influence on the producers' decision to sell to modern marketing channels.

The experience of camel milk producers negatively and significantly ($P \leq 0.05$) influenced the sale to bulking centres, suggesting that producers with more experience in camel milk production were more likely to sell to nearby consumers than those with less experience in camel milk rearing. This may be partly attributed to the fact that most of the experienced producers were traditional camel keepers who mainly produced milk for subsistence and only sold the surplus (Mathias *et al.*, 2010) at the village level.

Camel herd size and daily milk production are closely related to each other. Hence, the probability of having a large herd size implies high daily milk production (Upton, 1986). Those two factors had a positive and significant ($P \leq 0.1$) influence on the sales to bulking centre marketing outlets. This implies that producers with larger herds and higher daily milk production tend to sell their product at the bulking centres than those with smaller herds and lower milk

production. These results concur with those of Kuma *et al.* (2013) who reported that producers with larger herd sizes and higher daily milk production were unlikely to sell to individual consumers in the dryland of Ethiopia.

The results indicated that the distance to the preferred market negatively and significantly ($P \leq 0.05$) influenced the choice to sell to bulking centre outlet, implying that the longer the distance covered to the market, the higher the likelihood of selling to individual consumers. This can be explained by the fact that distance is positively associated with marketing cost, therefore, any increase in the distance to the bulking centre attract transport cost. The producers may therefore choose to sell to individual consumers. This finding is supported by those of Omiti *et al.* (2009) that long distances to markets are associated with high transport costs and therefore most producers that are located far from the market tend to sell their produce locally.

Selling to wholesalers was positively influenced by age of camel milk producers, producers herd size, daily milk production and selling price at wholesaler outlet. The same was influenced negatively by experience of camel milk producers and distance covered to wholesale outlet. The age of the camel milk producer was found to positively and significantly ($P \leq 0.05$) influence the decision to sell to wholesalers, implying that older producers are likely to sell to wholesale outlets compared to the younger counterparts. This finding contradicts the findings of Vijay *et al.* (2009) who reported that the age of a producer is negatively influenced the decision to sell to modern dairy channels. This may be explained in the context of the study area, where many pastoralists (traditionally cattle keepers) are increasingly adopting camel milk production to supply the market, and in particular the wholesales in Nairobi.

Experience of camel milk producers negatively and significantly ($P \leq 0.05$) influenced the sale to wholesale outlet. This suggests that producers with less experience were likely to sell to wholesalers outlet compares to those with more experience. This finding can be explained similarly to that of selling to bulking centre, where most experienced producers were traditional camel milk keepers, therefore, the focus is more on the subsistence than selling the milk (Zaal, 2012; Gall, 2013).

Camel herd size had a positive and significant ($P \leq 0.1$) influence on the sales to wholesale, implies that the larger the herd, the higher the likelihood to sell to wholesale marketing outlet. Daily milk production had the same influence. This is likely because producers who produce huge volumes of milk would prefer a one-stop market with the capacity to handle such large amounts to avoid selling in small quantities to various markets. In contrast, those who produce a few litres of milk could simply sell to village level or at the farm gate to avoid high transport costs. Tsougiannis *et al.* (2008) in their study on marketing strategies of dairy producers in Greek noted that, the choice of milk market, especially urban markets was positively influenced by the volume of milk produced.

Distance to the market was negatively and significantly ($P \leq 0.05$) influenced by the choice to sell to wholesale marketing outlets, implying that the longer the distance covered to the market, the less the likelihood of selling to wholesale marketing outlet. This can be explained by the fact that most camel milk producers are small scale with very limited resources for marketing, particularly transportation. Taking this into account, small scale producers were unlikely to sell to wholesale markets which are approximately 300 km away from Isiolo County. Similar results

were reported by Artukoglu and Olgun (2008) that access to urban markets requires extra cost which limits small-scale dairy producers from accessing such markets.

Camel milk prices offered at various marketing outlets positively and significantly ($P \leq 0.1$) influenced the sale to wholesale marketing outlets compared to individual consumer marketing outlets, implying that producers were attracted by high wholesale prices. Prices are usually the most important factor in determining the choice of marketing outlet in many agricultural and livestock commodities (Staal *et al.*, 1997; Hill and Lynchehaun, 2002; Ruben and Pender, 2004). For instance, Kuma *et al.* (2013) found that prices were a key factor in influencing the decision of dairy producers to either sell to cooperatives or non-cooperative outlets in Wolaita zone of Ethiopia.

8.5 CONCLUSIONS AND POLICY IMPLICATIONS

The findings of this study have shown that producers' decision to sell to the bulking centres is influenced negatively and significantly by access to extension services and market information, household size, experience of camel milk producer, and distance to bulking centre; and positively influenced by camel herd size and daily milk production. On the other hand, selling to wholesalers was positively and significantly influenced by age of the producer, camel herd size, daily milk production and price offered at the wholesale outlets; and negatively and significantly influenced by experience of camel milk producers and distance covered to wholesale outlets. Therefore, in order to enable camel milk producers to circumvent the constraints that deny them opportunities to benefit from the most profitable marketing outlets, it is essential to invest in proper market infrastructure. This may include improving rural road networks which will

directly reduce transportation costs and thus facilitate access to bulking and wholesale marketing outlets. In addition, establishment of reliable bulking points would help small scale producers to assemble large volumes of milk and therefore benefit from economies of scale to access desired urban markets.

Long experience in camel milk production was found to be one of the characteristics of traditional camel keepers. This was found to negatively influence the choice of producers to sell to bulking centres and wholesalers, thereby denying the producers the opportunity to benefit from the better prices offered at these marketing outlets. This calls for investment in the promotion of commoditisation of camel milk among traditional camel keepers as a way of integrating the otherwise subsistence livelihood into the market economy to ensure that producers benefit from participation in markets that offer better returns, which would consequently enhance their income and increase their resilience.

REFERENCES

- Abdullahi, A., S. Mohammed and A. Eid (2012). Town camels and milk villages. In, *Pastoralism and Development in Africa: Dynamic Change at the Margins*, Routledge. New York, United State of America, 119.
- Adongo, A. O., D. Coppock and F. Wayua (2013). Simple evaporative cooling method reduces bacterial content of traditionally marketed camel milk in Isiolo County, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, **13** (1), 7213-7224.
- Ahmed, I., R. Onwonga, D. Mburu and Y. Elhadi (2013). Evaluation of types and factors influencing adoption of rainwater harvesting techniques in Yatta District, Kenya. *International Journal for Education and Research*, **1** (1) 1-14.
- Anderson, D. M., H. Elliott, H. Kochore and E. Lochery (2012). Camel herders, middle-women, and urban milk bars: the commodification of camel milk in Kenya. *Journal of Eastern African Studies*, **6** (3), 383-404.

- Anjani, K., J. Steven, J. Staal and K. Dhiraj (2011). Smallholder dairy farmers' access to modern milk marketing chains in India. *Agricultural Economics Research Review*, **24** (2), 243-253.
- Artukoglu, M. and A. Olgun (2008). Cooperation tendencies and alternative milk marketing channels of dairy producers in Turkey: A case of Menemen. *Zemедelska Ekonomika-Praha*, **54** (1), 32-37.
- Berhanu, G. and. H. Dirk (2008). Market orientation of smallholders in selected grains in Ethiopia: Implications for enhancing commercial transformation of subsistence agriculture. *IPMS of Ethiopian farmers project working paper 11*. ILRI, Nairobi, Kenya. P44.
- Changpetch, P., and D. Lin (2013). Selection of multinomial logit models via association rules analysis. *Wiley Interdisciplinary Reviews: Computational Statistics*, **5** (1), 68-77.
- Chib, S., and E. Greenberg (1998). Analysis of multivariate Probit models. *Biometrika*, **85** (2), 347-361.
- Deressa, T. T., R. Hassan, C. Ringler, T. Alemu and M. Yesuf (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, **19** (2), 248-255.
- Ellram, L. M., W. Tate and E. Feitzinger (2013). Factor market rivalry and competition for supply chain resources. *Journal of Supply Chain Management*, **49** (1), 29-46.
- FAO. (Food and Agriculture Organization) (2007). Food security district profiles for 23 districts in Kenya, Nairobi, Kenya.
- Farah, K., D. Nyariki, R. Ngugi, I. Noor and A. Guliye (2004). The Somali and the camel: Ecology, management and economics. *Anthropologist*, **6** (1), 45-55.
- Fiebig, D. G., M. Keane, J. Louviere and N. Wasi (2010). The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. *Marketing Science*, **29** (3), 393-421.
- Francine, M. and. R. Hughes (1984). A Comment on the impact of development schemes on the floodplain forests of the Tana River of Kenya. *The Geographical Journal*, **150** (2), 230-244.
- Gall, C. (2013). Production systems around the world. *Milk and Dairy Products in Human Nutrition: Production, Composition and Health*, **1** (1), 1-30.
- GoK. (Government of Kenya) (1997). Isiolo District development plan for 1997-2001. *Government Printers*, Nairobi, Kenya
- GoK. (2005). Isiolo District vision and strategy: 2005-2015. *Government Printer*, Nairobi, Kenya.

- Greene, G., D. Sunding, D. Zilberman and D. Parker (1996). Explaining irrigation technology choices: A micro-parameter approach. *American Journal of Agricultural Economics*, **78** (4), 1064 -1072.
- Hassan, R., and C. Nhemachena (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agricultural and Resource Economics*, **2** (1), 83-104.
- Hausman, J., and D. McFadden (1984). Specification tests for the multinomial logit model. *Econometrica: Journal of the Econometric Society*, **52** (5) 1219-1240.
- Herlocker, D., S. S Shaaban and S. Wilkes (1993). *Range Management Handbook of Kenya*. Volume II, 5.Isiolo District. Ministry of Agriculture, Livestock Development and Marketing. Nairobi, Kenya.
- Herren, U. (1990). The commercial sale of camel milk from pastoral herds in the Mogadishu hinterland, Somalia. *Pastoral Development Network Paper No 30a*, Overseas Development Institute, London. United Kingdom.
- Hill, H., and F. Lynchehaun (2002). Organic milk: Attitudes and consumption patterns. *British Food Journal*, **104** (7), 526-542.
- Jaetzold, R., and H. Schmidt (1983). *Farm Management Handbook of Kenya: Natural Conditions and Farm Management Information, Central Kenya: (Rift Valley and Central Provinces)*. Ministry of Agriculture, Nairobi Kenya.
- Kamunyan, C., G. Cheserek, M. Kiptui and E. Arusei (2013). Causes and effects of post-election violence on agricultural production in Kesses Division, Uasin Gishu County, Kenya. *Journal of Emerging Trends in Economics and Management Sciences*, **4** (1).
- Kuma, B., D. Baker, K. Getnet and B. Kassa (2013). Factors affecting milk market outlet choices in Wolaita zone, Ethiopia. *African Journal of Agricultural Research*, **8** (21), 2493-2501.
- Mainardi, S. (2012). Duration dependence and dynamic conditional covariance of seasonal food price shocks in semi-arid African countries. *Food Security*, **4** (2), 235-252.
- Maskell, P. and M. Lorenzen (2004). The cluster as market organisation. *Urban Studies*, **41** (56), 991-1009.
- Mathias, E., P. Mundy and R. Kohler (2010). Marketing products from local livestock breeds: An analysis of eight cases. *Animal Genetic Resources*, **47** (9), 59-72.
- Matofari, J. (2013). *Analysis of microbial infections in camel (Camelus dromedarius) milk and implications in Kenya*. Doctoral Thesis, Egerton University. Nakuru, Kenya.
- McKelvey, R. and W. Zavoina (1975). A statistical model for the analysis of ordinal level dependent variables. *Journal of mathematical sociology*, **4** (1), 103-120.

- Mohamed, A., B. Hegde and B. Tafesse (2003). Traditional processing of camel meat and milk, and marketing of camels, milk and hide in After zone of Somali National Regional State, Ethiopia. *Challenges and Opportunities of Livestock Marketing in Ethiopia*, 201.
- Musinga, M., D. Kimenye and P. Kivolonz (2008). The camel milk industry in Kenya. Results of a study commissioned by SNV to explore the potential of camel milk from Isiolo District to access sustainable formal markets. Nairobi Kenya.
- Noor, M., O. Bebe and Y. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.
- Nori, M. (2010). Along the milk way: Marketing camel milk in Puntland, Somalia. *European Journal of Development Research*, **22** (5), 696-714.
- O'Connell, A., and S. Reed (2012). Hierarchical data structures, institutional research, and multilevel modelling. *New Directions for Institutional Research*, **20** (154), 5-22.
- Omiti, J., D. Otieno, T. Nyanamba and E. McCullough (2009). Factors influencing the intensity of market participation by smallholder farmers: A case study of rural and peri-urban areas of Kenya. Bill and Melinda Gates Foundation, Seattle, USA.
- Peeling, D., and S. Holden (2004). The effectiveness of community-based animal health workers, for the poor, for communities and for public safety. *Revue Scientifique et Technique-Office International des Epizooties*, **23** (1), 253-276.
- Ruben, R., and J. Pender (2004). Rural diversity and heterogeneity in less-favoured areas: The quest for policy targeting. *Food Policy*, **29** (4), 303-320.
- Schwartz, H., R. Dolan and A. Wilson (1983). Camel production in Kenya and its constraints. *Tropical Animal Health and Production*, **15** (3), 169-178.
- Sombroek, G., H. Braun and V. derPouw (1982). The explanatory soil map and agro-climatic zone map of Kenya. Report No 5. *E.I. Kenya Soil Survey Report*. No 5, Nairobi, Kenya.
- Staal, S., C. Delgado and C. Nicholson (1997). Smallholder dairying under transactions costs in East Africa. *World Development*, **25** (5), 779-794.
- Thornton, K. (2010). Livestock production: Recent trends and future prospects. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **365** (1554), 2853-2867.
- Tsourgiannis, L., J. Edison and M. Warren (2008). Factors affecting the marketing channel choice of sheep and goat farmers in the region of East Macedonia in Greece. *Canada and Central for Agribusiness Policy Studies*, **79** (1), 87-97.
- Upton, M. (1986). Production policies for pastoralists: The Borana case. *Agricultural Systems*, **20** (1), 17-35.

- Vijay, P.S., K. Kalpesh and V. Raj (2009). Determinants of small-scale farmer inclusion in emerging modern agri-food markets: A study of the dairy industry in India. Indian Institute of Management, Ahmedabad India, Working Paper.
- Woźniakowski, H. (2003). Open problems for tractability of multivariate integration. *Journal of Complexity*, **19** (3), 434-444.
- Yagil, R., O. Zagorski, C. Van Creveld and A. Saran (1994). Science and camel's milk production. Chameuxet dromedaries, animeauxlaitiers. Ed.Saint Marin, G. Expansion *Scientifique Francais*, Paris, France.75-89.
- Yates, F., and P. Grundy (1953).Selection without replacement from within strata with probability proportional to size. *Journal of the Royal Statistical Society, Series B (Methodological)*, **15** (2), 253-261.
- Zaal, F. (2012). Pastoral integration in East African livestock markets: Linkages to the livestock value chain for Maasai pastoral subsistence and accumulation. In: Gertel, J. and R. Heron (Eds.). Ashgate Publishing, Burlington, United State of America, 107.

CHAPTER 9

SUMMARY CONCLUSIONS AND POLICY IMPLICATIONS

9.1 INTRODUCTION

Over the last few decades, the pastoral production system has experienced a number of shocks most of them as a result of climatic variability and environmental changes (Guliye *et al.*, 2007; Serna 2011; Noor *et al.*, 2012). Among others, drought limits the available land-based livelihood options, triggers conflict and loss of life, and accelerates land degradation in an already fragile ecosystem (Eriksen and Lind, 2009). This has to some extent rendered most of the traditional coping strategies that form an integral part of this system ineffective, leading to incessant fluctuation in pastoral household food supply and income, which has left pastoral households exposed to natural and artificial shocks (Jaspars, 2006). Despite the potential role the camel plays in smoothing these fluctuations, through continuous supply of milk and high ability to tolerate drought and diseases, literature available shows no evidence of attempts to assess the contribution of camel milk to pastoral livelihood for building their resilience in the drylands of Kenya.

To assess the contribution of camel milk it was important to examine the current contribution of camel milk to household food basket and income. It was also to show the current level of profitability of the milk value chain and the efficiency of the milk marketing channels as well as the constraints and challenges that face the participants in the chain in order to point out areas of intervention to make camel milk a suitable alternative for enhanced pastoral household resilience. To show the contribution of camel milk in addressing pastoral household food

security, there was need to examine the factors that influence camel milk production in order to ensure continuous production as well as the factors that influence the choice of marketing outlet.

9.2. SUMMARY OF KEY RESEARCH FINDINGS

9.2.1 Camel Milk Contribute Significantly to Pastoral Household Diet and Income

A key finding from this study is that camel milk plays a critical role in pastoral household nutrition by constituting a significant proportion of pastoral household diet. The contribution to pastoral household food basket is more pronounced during the dry season than the wet season. This is because hunger among pastoral households in the study area was mostly associated with the dry season, which results in scarcity of water and pasture. With the severe shortage of key livestock production inputs, milk production, which forms an essential component of the pastoral household food intake in the dry seasons, is drastically reduced. The study also provides evidence that proportion of income generated from camel milk compared to other sources of income is significantly high during both wet and dry seasons. In this context of recurrent drought, diminishing grazing and water resources, alternatives such as rearing camel can provide a pathway to sustainable livelihood.

9.2.2 Camel Milk Value Chain is Functional, Profitable and Efficient

The functional analysis of camel milk actors revealed lack of specialization along the value chain which might hinder efforts to improve the performance of the overall value chain and consequently weaken the competitiveness of camel milk in the national food market of Kenya. The study also revealed that the local market at the village and small trading centres within Isiolo County is as important as the high end urban markets. This was supported by the efficiency

analysis of milk channels, whereby the most efficient channel was the channel that sold directly to local consumers followed by the channels that sold to consumers in the urban market. The study also showed that camel milk is a profitable business venture, with all the actors realising positive returns. The major constraints faced by camel milk value chain actors included insecurity, drought, poor hygiene practices, high cost of inputs, perishability of camel milk, poor market infrastructure and high taxation.

9.2.3 Daily Milk Production is Significantly Determined by Production and Non-Production Related Factors

Daily camel milk production was positively significantly affected by camel herd size, education level of the producer, household size, distance to grazing point, labour, and access to climate information and extension services. The same was negatively and significantly affected by the distance to water point. Households with larger camel herd size and more employed workers are likely to produce more milk than those with smaller herd sizes and few herders. Further, households that cover longer distances in search of water produce less milk compared to those that cover shorter distances. Producers with larger household sizes produce more milk than those with smaller sizes. As hypothesised, access to extension positively influenced daily camel milk production. The identified factors could be used as an entry point in any intervention that aims at improving camel milk production in the study area.

9.2.4 The Choice of Milk Market Outlet is driven by Management Practices and Institutional and Marketing Factors

The choice of market by camel milk producers was affected by production, demographic, institutional and marketing factors. The study revealed that selling to bulking centres is influenced negatively and significantly by the access to extension services and market information and, household size, experience of camel milk producer and distance to bulking centre. In addition, this choice is positively influenced by the camel herd size and daily milk production. On the other hand, choice to sell to wholesalers was positively and significantly influenced by age of the producer, camel herd size, daily milk production and price offered at the wholesaler outlets. Further, choice of this channel negatively and significantly influenced by experience of camel milk producers and distance covered to wholesale outlets. This implies that in order for the camel milk producers to benefit from the better prices offered by wholesalers and bulking centres, it is important to address the aforementioned variables that limit access to profitable markets.

9.3 CONCLUSIONS AND POLICY IMPLICATIONS

This study has shown that camel milk contributes significantly to pastoral household food intake and income. It also shows that camel milk value chain is functional and profitable, hence can be used to draw more pastoralists into the chain in order to build their resilience. It has established the factors that affect daily camel milk production and the choice of marketing outlets. In order for non-camel keepers to adopt camel milk as an alternative livelihood to build pastoral household resilience, adjustments to the current policies and interventions are required. The specific conclusions and policy implications are outlined below.

9.3.1 Integrating Camel Milk in Drought Adaptation and Mitigation Policies

The study shows that camel milk contributes significantly to the pastoral household food basket and income during the wet and dry seasons, which indicates the critical role that camel milk can play during drought and prolonged dry season. Therefore, camel milk is a suitable strategy to build pastoral household resilience. Based on this, there is need to invest in the camel milk subsector by creating enabling policies that would enhance the milk production and marketing as a way of mainstreaming camel products. Interventions should be directed towards encouraging non-camel keepers and camel milk production, marketing and consumption, thus fully exploiting the potential of camels in addressing pastoral household nutrition security and food poverty.

9.3.2 Enhancing Functionality and Specialisation along the Milk Value Chain

The functional analysis of camel milk value chain showed lack of specialisation along the value chain. This might hinder efforts to improve the performance of the overall value chain. Interventions should be directed at creation of specific roles of all actors involved in the camel milk value chain. This can be achieved by investing in capacity development of the chain actors through training and provision of necessary support such as credit facilities, necessary equipment and exposure visits to other specialised value chain actors.

9.3.3 Improving Camel Milk Marketing

This study has revealed that local and urban camel milk markets are of equally efficient. Thus, any intervention aimed at improving camel milk marketing and trade should pay equal attention to the both urban and local markets by investing in facilitating the participation of milk producers in the markets. Based on the current development practices, most efforts were

targeting to link camel milk producers to urban markets. Caution should however be taken when formulating such policies and interventions, as the marketing channels (urban markets) return a very small portion of the total price to the camel milk producers involved.

9.3.4 Enhancing camel milk profitability and efficiency

To increase the profit margin for all producers in the study area, strategies such as changing the herd structure to increase the number of lactating camels would increase the total milk produced. Investing in measures to increase milk yield per animal, such as investing adequately in veterinary services and the adoption of better husbandry and management practices, is also important. Policies aimed at improving camel milk marketing should adapt a holistic intervention that would include marketing development, general infrastructure development and investing in technologies that would stabilise milk supply fluctuations. This is important if the camel milk subsector is expected to achieve its potential in increasing pastoral household incomes, not only among traditional camel producers but also among many communities which are adopting camel rearing as a strategy to sustain their livelihoods.

9.3.5 Interventions to Increase Camel Milk Production

The quantity of camel milk produced is critical for the sustainability and growth of the camel milk value chain. This study has shown that daily camel milk production is affected by various factors that may be manipulated to improve the performance of the camel milk subsector in Kenya. Interventions aimed at improving camel milk production should consider investing in increasing herding labour size as these would directly translate into higher milk production. It is also important to increase the camel herd size in order to increase the amount of milk produced.

This can be achieved through strategies such as proper breeding plans, provision of suitable animal health care, strengthening of extension services and climate information dissemination system. Long term interventions should take into account the provision of education and investing in dissemination of best practices in terms of camel husbandry and management as these are expected to have a positive influence on camel milk production.

9.3.6 Improving the Participation of Camel Milk Producers in High End Urban Market

Bulking centres and wholesale market outlets were shown to be the more profitable marketing options as they offer higher prices compared to local consumers. Thus, with appropriate strategies in place, producers can increase their participation in those profitable markets. These strategies include improving rural road networks which would directly reduce the transportation costs and thus facilitate access to bulking and wholesale marketing outlets. In addition, establishment of reliable bulking points would help small scale producers to assemble large volumes of milk and therefore benefit from economies of scale to access desired urban markets.

9.4 FURTHER RESEARCH

This study identifies three major areas that require further research. First, the contribution of camel milk to household food diet and income was based on cross-sectional data. It is suggested that future studies include longitudinal data alongside cross-sectional data to generate stronger evidence. Secondly, camel milk value chain analysis did not assess the role of political and economic institutions that have recently emerged with the formation of the county governments on the performance of the chain. Thirdly, the study did not include genetic variation when assessing the determinants of camel milk production because of lack of genetic markers to

identify the best camel sub-breed in terms of milk production. All these could be included in future studies to improve the outcome of the analysis.

REFERENCES

- Eriksen, S., and J. Lind (2009). Adaptation as a political process: Adjusting to drought and conflict in Kenya's drylands. *Environmental Management*, **43** (5), 817-835.
- Guliye, A., I. Noor, B. Bebe and I. Kosgey (2007). Role of camels (*Camelus dromedarius*) in the traditional lifestyle of Somali pastoralists in northern Kenya. *Outlook on Agriculture*, **36** (1), 29-34.
- Jaspars, S. (2006). From food crisis to fair trade: Livelihoods analysis, protection and support in emergencies. *Oxfam Policy and Practice, Agriculture, Food and Land*, **6** (1), 1-68.
- Noor, I. M., B. Bebe and A. Guliye (2012). Analysis of an emerging peri-urban camel production in Isiolo County, northern Kenya. *Journal of Camelid Science*, **5** (1), 41-61.
- Serna, J. (2011). Drought assessment in north-eastern Kenya (Wajir East, South and Mandera). Save the children, publication. <http://www.disasterriskreduction.net>. Accessed on 19th of September 2012.

APPENDICES

I. CAMEL MILK PRODUCER QUESTIONNAIRE

1. General information

- 1.1 Date of interview:/...../..... Name of enumerator:
 1.2 Name of respondent: Sex: (1) Male..... (2) Female
 1.3 Location Sub-location Village.....
 1.4 Age:.....(1) Under 30 years.....(2) Between 30 – 60 years..... (3) Over 60 years.....
 1.5 Relationship of respondent to the household head? (1)Self (2). Spouse..... (3). Son.....
 (4). Daughter (5). Relative.....

2. Household head's information

- 2.1 Sex: 1) Male 2) Female 2.2 Age?
 2.3 Education:(1) None..... (2) Primary..... (3) Secondary (4) Post-Secondary.....
 2.4 Household Size/Composition No. of male..... No. of female
 2.5 General information on household members

Member (husband, wife/s children)	Sex (F/M)	Age	Education level

Codes for education: (1) None (2) Primary (3) Secondary (4) Post-secondary

- 2.6 What is your main occupation?
 2.7 How long have you been living at your current place? years
 2.8 Is any member of your family employed elsewhere? 1) Yes..... 2) No.
 2.9 If yes, how many are employed?
 2.10 Do you receive any remittance from them? 1) Yes (1) No.
 2.11 If yes, how much did you receive from them last month?
 2.12 Is that the normal? 1) Yes (1) No. If No? What is the normal?
 2.13 If not, the normal why?
 2.14 How many times do you receive the normal remittances in a year?
 2.15 Did you receive any food aid/ relief food last year? 1) Yes..... 2) No.....
 2.16 If yes, fill the table below?

Name of the Organization	How many times last year?	How much? Cash/ kind	Others

- 2.17 Do you own land in town? 1) Yes..... 2) No.....

2.18 If yes, what is the size of the land in town? Acres

2.19 Please list all the income generation activities and how much did you get from each per month

Source of income	Wet season amount (KSh) per month	Is that the normal? Yes/No, if No what is the normal?	Dry season amount (KSh) per month	Is that the normal? Yes/No, if No what is the normal?

2.20 How many meals do you consume per day during? The wet season..... The dry season The drought.....

2.21 What was the main food during the last? The wet season..... The dry season The drought.....

2.22 How much.....did you consume per day during wet season ? Please fill the table below with normal consumption:

Food item	Qty (Kg/litre/ KSh etc.)	Is that the normal? If no what was the normal?	Price (KSh/Kg /litre)	Food item	Qty (Kg/litre/ KSh etc.)	Is that the normal? If no what was the normal?	Price (KSh/Kg /litre)
Cow Milk				Oil			
Goat milk				Rice			
Camel milk				Banana			
Cow meat				Potatoes			
Goat meat				Eggs			
Camel meat				Watermelon			
Maize& Beans				Fruits			
Ugali				Honey			
Vegetables				Spaghetitis			
Tomatoes				Sugar			
Onion				Others (specify)			

2.23 How much.....did you consume per day during dry season ? Please fill the table below with normal consumption:

Food item	Qty (Kg/litre/ KSh etc.)	Is that the normal? If no what was the normal?	Price (KSh/Kg /litre)	Food item	Qty (Kg/litre/ KSh etc.)	Is that the normal? If no what was the normal?	Price (KSh/Kg /litre)
Cow Milk				Oil			
Goat milk				Rice			
Camel milk				Banana			
Cow meat				Potatoes			
Goat meat				Eggs			
Camel meat				Watermelon			

Maize& Beans				Fruits			
Ugali				Honey			
Vegetables				Spaghetitis			
Tomatoes				Sugar			
Onion				Others (specify)			

2.24 How much did you spend on the following items?

Item	Cost (KSh)	Item	Cost (KSh)
Food per day?		Electricity per month	
Clothing per year		Water per month	
Healthcare per year		Security per month	
School fees per year		Other cost	

3. Camel milk production and consumption

3.1 Did you inherit the camel rearing business or you started it? 1) Inherited 2) started.....

3.2 Why did you start keeping camel?.....

3.3 How many years have you been keeping camels? years.

3.4 What is your camel herd size? Please fill the table below?

	Number	Mortality last year?	Amount of salt supplied per day	Cost per day KSh/Kg	Cast of watering
Male					
Female					
Calf					

3.5 Do you keep your camel in an enclosure? 1) Yes..... 2) No.....

3.6 If yes, what is the size of the enclosure? Acres

3.7 How many permanent labourers (herders) did you have last year?

3.8 Is that the normal? 1) Yes 2) No If not, what is the normal

3.9 How much did you pay them per month? Cash/kind.....
.....

3.10 How many casual labourers did you have last dry season?

3.11 How many casual labourers did you have lase wet season?

3.12 What do you use for milking your camels?

3.13 How far did you go in search for feed yesterday? km

3.14 Is that the normal? 1) Yes 2) No If not, what is the normal km

3.15 If not, why?

3.16 How far did you go in search for water yesterday? km

3.17 Is that the normal? 1) Yes 2) No If not, what is the normal km

3.18 If not, why?

3.19 What livestock do you keep?

Animal type	Number	Breed	The purpose of keeping	Value in KSh per head
Camel				
Cattle				
Goats				
Sheep				
Donkey				

Purpose of keeping: 1) Milk 2) Meat 3) cultural 4) others (specify?)

Value of animal per head at 2012 market price

3.20 What is the main purpose of camel keeping? 1) Milk.... 2) Meat 3) Cultural ... 4) Others...

3.21 If the purpose is milk? How many litter of milk did you get yesterday?

3.22 Is this the normal amount? 1) Yes.... 2) No..... If not? What is the normal amount?

3.23 If not, why?

3.24 How much of what you produce did you use at home?

3.25 How much of what you produce did you sell?

3.26 Is this amount the normal? 1) Yes.... 2) No..... If no? What is the normal amount?

3.27 If not, why?

3.28 Does the milk consumption increase at home in last 5 years? 1) Yes..... 2) No.....

3.29 If yes, what is the reason?

3.30 How many times do you use camel milk per day?

3.31 How do you use the camel milk at home? 1) fresh? 2) soured? 3) mixed with other milk? 4) Others (specify).....

3.32 How much do you spend on the following per month in camel milk production?

Item	Herding salary	Miraa for herders	Food for herder	Watering	Supplementary feeds	Salts	De-wormers & Vet drugs	Acaricides	security	Others
Cost in (KSh) per month										

3.33 What methods do you use to preserve milk? 1) Washing and smoking the milk vessels? 2) Keeping the milk in cold place? 3) Souring the milk? 4) Boiling the milk? 5) Others (specify?).....

3.34 What is the cost (if any).....

3.35 Do you use your camel milk to produce another product? 1) Yes 2) No.....

3.36 If yes fill the table below

Product	Yes/No	Total cost per unit	Quantity per day	Frequency of production per month	Purpose? 1) sell 2) consumption 3) both
Chees					
Soured milk					
Other (specify?).....					

3.37 What were the major problems faced in camel milk production last year?

.....

4.0 Camel milk marketing

4.1 Do you sell your camel milk? 1) Yes..... 2)No.....

4.2 If yes, how many litres did you sell yesterday? litres

4.3 Is this the normal amount of milk you sell? 1) Yes 2) No.....

4.4 If not, what is the normal amount you sell daily? litres

4.5 If not, why?

4.6 What was the price per litter yesterday? KSh

4.7 What determine the amount of milk you sell?

4.8 Where do you sell your milk? Please fill the table below

Market name	Market type	Distance (KM)	Mode of transport	Hours spent (hrs)	Why? Give reason for your choice

4.9 How much do you spend (KSh) on the following per day dealing with camel milk marketing?

Container	Packaging price	Transport/loading	Off-loading	communication	Others
20 litres					
10 litres					
5 litres					
3 litres					
Others (specify).....					

4.10 Who determine the camel milk price?

4.11 Do you have access to market information? 1) Yes.....2) No.

4.12 If yes, what kind of information do you get?

4.13 If Yes, What are the source of the information.....

4.14 Do you belong to a self-help group? 1) Yes.....2) No.

4.15 What is the name of your group? when was it formed?

4.16 If yes are you able to get better price for you milk? 1) Yes..... 2) No.....

4.17 How many members are in your group? Male? Female?

4.18 What does the group offers you?

4.19 How do you obtain your information about prices/ demand?

4.20 What are the charges if any?

4.21 How do you use the market information?

4.22 Do you pass the information to your input suppliers? 1) Yes 2) No

4.23 Do you get any support to improve your camel milk business (extension services)? 1) Yes..... 2) No

4.24 If yes, provide the following information?

Organization	Services	Cost (KSh) involved	Frequency	Service delivery

Codes for service delivery: (1)very poor (2) poor (3) good (4) very good

4.25 What were the major problems faced in camel milk marketing last year?

5. Infrastructure

5.1 Do you have access to health care services 1) Yes..... 2) No.

5.2 If yes, how far is the nearest health center in km?

5.3 Do you have access to education? 1) Yes..... 2) No.

5.4 If yes, how far is the nearest school in km?

5.5 Do you have access to credit/financial support? Yes..... 2) No.

5.6 If not, Why?

6.0 Institutional capacity

6.1 Do you receive information concerning your camel milk production? 1) Yes..... 2) No.....

6.2 If yes who provide the information? what kind of information?

6.3 Has the information been beneficial? 1) Yes..... 2) No.....

6.4 Where do you receive information on weather dynamics from? 1) Yes 2) No.....

6.5 If yes, please fill the table below:

Source of information	Type of information	Frequency per month	Cost (KSh) involved

6.6 Do you plan your strategies according to the weather forecast?1) Yes 2) No.....

6.7 If yes, has it been beneficial?

II. CAMEL MILK TRANSPORTER QUESTION GUIDE

- 1.1 Date of interview:/...../.....
- 1.2 Name of respondent: Age
- 1.3 Location Sub-location Village.....
- 1.4 Vehicle type?
- 1.5 Do you own this vehicle? 1) Yes 2) No.....
- 1.6 For how many years have you been transporting camel milk?
- 1.7 How many litres of camel milk did you transport yesterday? litres
- 1.8 Is that the normal? 1) Yes 2) No If not, what is the normal litres
- 1.9 If not, why?
- 1.10 What is the total capacity of your vehicle? litres
- 1.11 Have you ever used the total capacity of your vehicle? 1) Yes 2) No.....
- 1.12 If yes, when was that?
- 1.13 What was the average volume transported during?
- 1.13.1 The wet season? litres
- 1.13.2 The dry season? litres
- 1.13.3 The drought? litres
- 1.14 Where did you transport the camel milk from/to?

Milk source?	Final destination	Distance (KM)	Hours spent (hrs)	Price per 20 litter jerrican	Price per 10 litter jerrican	Other cost

- 1.15 How much did you get yesterday from transporting camel milk? KSh
- 1.16 Is that the normal? 1) Yes 2) No If not, what is the normal KSh
- 1.17 If not, why?
- 1.18 What payment arrangement do you have with your camel milk clients?

Milk client	Quantity of milk transported	Frequency of payment	Payment mode

- 1.19 What are the challenges of transporting camel milk compared to other goods?
-
- 1.20 What are the major problems facing the camel milk transportation?
-
- 1.21 How can these problems be addressed?
-

III. CAMEL MILK TRADERS AND MIDDLEMEN QUESTIONNAIRE

1. General information

1.1 Date of interview:/...../..... Name of enumerator:

1.2 Name of respondent:

2. Household head's information

2.1 Sex: 1) Male 2) Female 2.2 Age?

2.3 Education: (1) None (2) Primary..... (3) Secondary..... (4) Post-Secondary

2.4 Household Size/Composition No. of male..... No. of female

1.3 Where did you get your milk from?

Milk source?	Yesterday Quantities	Price per 20 Jerrican litter
Isiolo		
Namanga		
Garrissa/Bangale		

1.4 What determine the amount of milk you buy daily?

.....

1.5 What determine the amount of milk you sell daily?

.....

1.6 How much did you spend on the following per day?

Item	Transform from the bus stage/20 liters	City council licenses	Communication	bus transfer expenses	Others
Cost in (KSh) per day					

1.7 Where do you sell your milk?

Milk client?	Yesterday Quantities	Price per 20 Jerrican litter
Retailers		
Restaurants		
Consumers		

1.8 What payment arrangement do you have with camel milk suppliers (Suppliers)?

Milk supplier	Quantity of milk supplied?	Frequency of payment	Payment mode

1.9 How do you make sure that you will always have enough milk?

.....

1.10 What payment arrangement do you have with your customers?

Milk clients?	Quantity of milk supplied?	Frequency of payment	Payment mode

1.11 What are the major problems by priorities facing you in camel milk marketing?

.....

.....

IV. CAMEL MILK COOLING HUB QUESTION GUIDE

- 1.1 Date of the interview:/...../..... Time of the interview?
- 1.2 Location Sub-location Village.....
- 1.3 Name of respondent:
- 1.4 Age Sex? 1) Male 2) Female
- 1.5 Do you own this shop? 1) Yes 2) No.....
- 1.6 If no, how much do you pay per month for rent? KSh
- 1.7 How many refrigerators do you have?
- 1.8 Do you own all the refrigerators? 1) Yes 2) No.....
- 1.9 If not, how many do you own?
- 1.10 Who owns the rest?
- 1.11 What are the charges per month per refrigerator?
- 1.12 What payment arrangement do you have with the owners?
- 1.13 For how many years have you been handling camel milk?
- 1.14 How many litres of fresh camel milk did you receive yesterday? litres
- 1.15 Is that the normal? 1) Yes 2) No If not, what is the normal litres
- 1.16 If not, why?
- 1.17 How many litres of soured camel milk did you receive yesterday? litres
- 1.18 Is that the normal? 1) Yes 2) No If not, what is the normal litres
- 1.19 If not why?
- 1.20 What is the total capacity of this hub? litres
- 1.21 Have you ever used the total capacity this hub? 1) Yes 2) No.....
- 1.22 If yes? When was that?
- 1.23 Do you sell camel milk at your shop? 1) Yes 2) No.....
- 1.24 If yes? How many litres did you sell yesterday? litres
- 1.25 Is that the normal? 1) Yes 2) No If not, what is the normal litres
- 1.26 If not, why?
- 1.27 What are the sources of the camel milk you sell locally?
- 1.28 How much did you pay per litter? KSh
- 1.29 How much did you sell locally per litter? KSh
- 1.30 What determine the amount of milk you buy daily?
- 1.31 What determine the amount of milk you sell daily?
- 1.32 How many permanent labourers did you have last month?
- 1.33 Is that the normal? 1) Yes 2) No If not, what is the normal
- 1.34 How much did you pay them per month in KSh?
- 1.35 How many casual labourers did you have last month?
- 1.36 Is that the normal? 1) Yes 2) No If not, what is the normal
- 1.37 How much did you pay them per month in KSh?
- 1.38 What methods do you use to confirm the volume of camel milk received?
- 1.39 What is the cost (if any).....
- 1.40 What methods do you use to test for milk quality?
- 1.41 What is the cost (if any).....
- 1.42 How much did you spend on the following per month?

Electricity	Water	Security	Transport	Containers	Cleaning	Other cost

- 1.43 How much do you charge per litter/20 litres? KSh

1.44 What was the average volume received during?

1.44.1 The wet season? litres

1.44.2 The dry season? litres

1.44.3 The drought? litres

1.45 How do you operate your camel milk business?

1.46 What payment arrangement do you have with your camel milk clients?

Milk client	Quantity of milk/ litter	Frequency of payment	Payment mode

1.47 Do you get any support to improve your camel milk business? 1) Yes..... 2) No

1.48 If yes, provide the following information?

Organization	Services	Fees in (KSh)	Service delivery

Codes for service delivery: (1)very poor (2) poor (3) good (4) very good

1.49 What are the challenges associate with storing and cooling of fresh camel milk?

1.50 What are the major problems facing the camel milk storing and cooling?

1.51 How can these problems be addressed?

V. CAMEL MILK COOPERATIVES QUESTION GUIDE

- 1.1 Date of interview:/...../..... Time of the interview?
 1.2 Location Sub-location Village.....
 1.3 Name of respondent:
 1.4 Age Sex? 1) Male 2) Female
 1.5 When was cooperative established?
 1.6 What is the vision of the cooperative?
 1.7 What is the group offering the members?

-
 1.8 How many members in this cooperative? Male Female
 1.9 How many are active members? Male Female
 1.10 Do you have inactive members? 1) Yes 2) No
 1.11 If yes? What are the inactive members doing when they are not active?

-
 1.12 If yes? Why are they not actives?

-
 1.13 What activates are carried out by the group?

-
 1.14 Do all the members own camel? 1) Yes 2) No
 1.15 If yes, how many are they?
 1.16 What is the average herd size per member?
 1.17 Do you handle your own milk as a cooperative? 1) Yes 2) No
 1.18 How do you charges your members per?
 1.18.1 20 litres.....
 1.18.2 10 litres.....
 1.18.3 5 litres.....
 1.18.4 3 litres.....
 1.19 What type of products do you handle?

Product	Quantity/day	Price/Unit	Transport cost	Labour cost	Other cost

- 1.20 To whom do you sell your milk?
 1.21 At how much per litter?
 1.22 Do own outlet locally to sell your milk (Milk Bar)? 1) Yes 2) No
 1.23 If yes, what is the capacity?
 1.24 Are you using the total capacity? 1) Yes 2) No
 1.25 If not, why?
 1.26 At how much do you sell per litter?
 1.27 Do you get milk/other products from non-members? 1) Yes 2) No
 1.28 If yes, what kind of product do you receive from them?

 1.29 What are the charges per?
 1.29.1 20 litres.....

- 1.29.2 10 litres.....
- 1.29.3 5 litres.....
- 1.29.4 3 litres.....
- 1.30 Do you sell your milk as a group? 1) Yes..... 2) No.....
- 1.31 If not, why?
- 1.32 If you don't sell as a group where do you sell your milk to?
-
- 1.33 How much did you spend on the following per day?

Item	Packaging	Transport	Communication	Off-loading	Tax	Others
Cost in (KSh) per day						

- 1.34 How do you obtain your information about prices/ demand?
- 1.35 What are the charges (if any)?
- 1.36 How do you use the market information?
- 1.37 What determine the amount of milk you buy daily?
- 1.38 What determine the amount of milk you sell daily?
- 1.39 How many permanent labourers did you have last month?
- 1.40 Is that the normal? 1) Yes 2) No If not, what is the normal
- 1.41 How much did you pay them per month in KSh?
- 1.42 How many casual labourers did you have last month?
- 1.43 Is that the normal? 1) Yes 2) No If not, what is the normal
- 1.44 How much did you pay them per month in KSh?
- 1.45 How much did you spend on the following per month?

Electricity	Water	Security	Transport	Containers	Cleaning	Other cost

- 1.46 What was the average volume received during?
- 1.46.1 The wet season? litres
- 1.46.2 The dry season? litres
- 1.46.3 The drought? litres
- 1.47 How do you operate your camel milk business?
-
- 1.48 What payment arrangement do you have with your camel milk suppliers?

Milk supplier	Quantity of milk/ litter	Price per litter	Frequency of payment	Payment mode

- 1.49 What payment arrangement do you have with your camel milk clients (customers)?

Milk supplier	Quantity of milk/ litter	Price per litter	Frequency of payment	Payment mode

1.50 How is your business affected by drought?

.....

1.51 How is your business affected by insecurity?

.....

1.52 Do you get any support to improve your camel milk business? 1) Yes..... 2) No

1.53 If yes provide the following information?

Organization	Services	Fees in (KSh)	Service delivery

Codes for service delivery: (1) very poor (2) poor (3) good (4) very good

1.54 What are the challenges faced by the cooperative.....

.....

1.55 What are the major problems facing by the cooperative?

.....

1.56 How can these problems be addressed?

.....

VI. CAMEL MILK RETAILERS QUESTION GUIDE

1. General information

1.1 Date of interview:/...../..... Name of enumerator:

1.2 Name of respondent:

2. Retailer's information

2.1 Sex: 1) Male 2) Female 2.2 Age?

2.3 Education: (1) None (2) Primary (3) Secondary (4) Post-Secondary

2.4 Household Size/Composition No. of male No. of female

1.3 Where did you get your milk from?

Milk source	Yesterday quantity	Price per litter (KSh)

1.4 What determine the amount of milk you buy daily?

.....

1.5 What determine the amount of milk you sell daily?

.....

1.6 How much did you spend on the following per day?

Item	Transport	City council licenses	Communication	Hygiene	Others
Cost in (KSh) per day					

1.7 Where do you sell your milk?

Milk client	Yesterday quantities	Price per litter

1.8 What payment arrangement do you have with camel milk suppliers (Suppliers)?

Milk supplier	Quantity of milk supplied?	Frequency of payment	Payment mode

1.9 How do you make sure that you will always have enough milk?

.....

1.10 What payment arrangement do you have with your customers?

Milk customer	Quantity of milk supplied	Frequency of payment	Payment mode

1.11 What are the major problems by priorities facing you in camel milk marketing?

.....

.....

THANK YOU

VII. FOCUS GROUP DISCUSSION GUIDE

- a) General information of the respondents
- b) What is the main source of livelihood in this area?
- c) How is the situation of food availability (main food, frequency, diet composition)?
- d) What types of animals are kept and how are they managed in terms of grazing, watering, herding, average herd size etc.?
- e) How many are traditional camel keepers, when did camel rearing started in your area?
- f) What is the size of camel herd in this area? (Why do you keep them?).
- g) How is camel herd managed, in terms of grazing, watering, calving, health?
- h) How many herders required for herding the average herd?
- i) How is herding the camel herd? (pastoralists or non-pastoralists)
- j) How far do you for water and grazing?
- k) What is the cost item and amount incurred in camel milk production?
- l) What is the average milk production during the wet season and during the dry season per animals?
- m) Do you consume camel milk at home? How frequent and in which form?
- n) What methods are used to preserved camel milk? Any cost incurred?
- o) Do you use camel milk to produce any other product such as Cheese? Please explain?
- p) What was the major problem faced in camel milk production last year?
- q) Where do you sell your camel milk? Give reason for your answer?
- r) How far is the market? Any cost incurred? How much
- s) How many litres in average were sold?
- t) At what price did you sell your camel milk? does the price vary between dry and wet season
- u) What types of payment arrangement are there?
- v) Are there any self-help groups that are focused on camel milk production or/and marketing?
- w) Do you have access to veterinary services? How frequent? In which form? Are they useful?
- x) Do you have access to extension services? How frequent? In which form? Are they useful?
- y) Do you have access to market information? How frequent? In which form? Are they useful?
- z) What are challenges faced in camel milk marketing? How did you overcome them?
- aa) What is required to make camel milk production and marketing better?

VIII. KEY INFORMANT INTERVIEW GUIDE

- a) General information? Name, affiliations? etc.
- b) What is the situation of livestock production in this area?
- c) How is the subsector organized?
- d) What institutions exist to support the livestock subsector in Isiolo County?
- e) Is there any specific organization that deals with camel and camel products?
- f) Are there any policies or laws that address camel and camel products in terms of regulations?
- g) What is the extent of milk production in this area? How milk production is organized?
- h) Are all the producers traditional camel producers? Are they new-comers?
- i) Which community is traditional and which other are non-traditional?
- j) What is the reason behind them moving to camel milk production?
- k) Tell me about the peri-urban milk production? How is organized?, The reason behind the adoption of these system?
- l) How is milk marketing organized in this County?
- m) Who are the actors of the camel milk value chain
- n) How many input provider are there?
- o) How is extension services organized to reach camel milk producers? What kind of extension service do you offer?
- p) How is the market information being transmitted to producers?
- q) Are there any programs to link producers with the market? Which ones? Are they effective?
- r) Are the producers able to access modern climate information? How? How effective?
- s) What do you think is the level of hygiene of milk along the value chain?
- t) What can be done to improve the level of milk hygiene along the value chain?
- u) 7What is the market size of camel milk marketing in this area?
- v) How can milk production be strengthened and formalized with retailers and service providers?
- w) What constraints/challenges are there in camel milk production?
- x) What constraints/challenges are there in camel milk marketing?

IX. COLLINEARITY STATISTICS: VARIANCE INFLATION FACTORS

1. Variance Inflation factors for Equation 7.5

Variable	VIF
Age of camel milk producer	1.10
Education of camel milk producer	1.18
Household size	1.10
Herding labour	1.60
Camel herd size	1.80
Distance to water points	1.37
Distance to pasture	1.46
Access to extension services	1.30
Access to veterinary services	1.23
Access to climate information	1.06
Access to credit facilities	1.10
Mean VIF	1.19

2. Variance Inflation factors for Equation 7.6

Variable	VIF
Camel milk production (litres)	1.47
Household size	1.11
Herding labour	1.19
Experience in camel rearing	1.05
Distance to water points	1.36
Distance to pasture	1.48
Access to veterinary services	1.27
Membership of self-help group	1.06
Mean VIF	1.23

3. Variance Inflation factors for Equation 7.8

Variable	VIF
Age of camel milk producer	1.12
Household size	1.06
Experience in camel rearing	1.10
Camel herd size	1.11
Access to credit facilities	1.04
Membership of self-help group	1.07
Mean VIF	1.08

4. Variance Inflation factors for variable used in Multinomial Logistic (Equation 8.7)

Variable	VIF
Gender	1.16
Age	1.17
Education	1.20
Membership of self-help group	1.19
Extension services	1.25
Access to market information.	1.25
HH size	1.06
Experience in camel rearing	1.13
Herd size	3.24
Daily milk production	3.23
Selling prices at outlet	2.06
Distance to market	1.45
Mean VIF	1.62

X. PRODUCTION AND MARKETING COSTS

1. Monthly average cost for camel milk producers

Cost item	Small (KSh)	Medium (KSh)	Large (KSh)
Watering	610.8	1,247.1	2931.0
Labour	4,851.9	8,235.3	10,720.0
Salt	731.6	855.2	1,354.2
Veterinary services	1,526.9	2,660.4	2,676.7
Drugs (Acaricides)	551.3	6,57.5	1,200.0
Capital investment (camel)	645	1,290	1,935

2. Monthly average cost for bulking and cooling agent

Cost item	Month/KSh.
Labour	2,470.0
Rent	7,500.0
Local transport	1,260.0
Cleaning	2,662.5
Money delivery charge	3,000.0
Communication	1,272.2
Capital investment (freezers)	8,000.0
Electricity	12,000.0
Transport to Nairobi	3,150.0

3. Monthly average cost for marketing agents

Cost item	Assemblers (KSh)	Wholesalers (KSh)	Rural Retailers (KSh)	Urban Retailers (KSh)
Transfer expenses	-	3,900.0	-	-
Taxes	-	3,600.0	-	3,600.0
Communication	1,272.2	893.3	480.6	630.8
Hygiene	661.2	1,604.2	310.6	1,050.0
Transport	3,109.1	5,672.1	-	-