FACTORS INFLUENCING CAMEL MILK PRODUCTION IN CENTRAL DIVISION OF ISIOLO DISTRICT: A CASE OF THREE CAMEL MILK WOMEN SELF HELP GROUPS IN ISIOLO COUNTY, KENYA.

BY

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DECLARATION

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

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L50/71924/2011

This research project report has been submitted with our approval as University supervisors.

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DEDICATION

This project report is dedicated to my wife Amina and sons Diba, Dokata and Abdikher and to my daughter Lana.

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ABBREVIATIONS AND ACRONYMS

A.I	Artificial Insemination
ABS	American Breeders Society
ADF	African Development Fund
AEZ	Agro Ecological Zone
ASAL	Arid and Semi-Arid Lands
BF	Butter Fat
CAIS	Central Artificial Insemination Station
CBOs	Community Based Organizations
CBS	Central Bureau of Statistics
COMESA	Common Market for Eastern and Southern Africa
DLPO	District Livestock Production Officer.
DRC	Democratic Republic of Congo
DSMP	Dried Skimmed Milk Powder
DWMP	Dried Whole Milk Powder
ENNDA	Ewaso Ng'iro North Development Authority
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GoK	Government of Kenya
HIV/AIDS	Human Immune Virus/ Acquired Immuno Deficiency Syndrome
ILRI	International Livestock Research Institute
KARI	Kenya Agricultural Research Institute
KDB	Kenya Dairy Board
KEBS	Kenya Bureau of Standards
KEMRI	Kenya Medical Research Institute
KNAIS	Kenya National Artificial Insemination Service
KRA	Kenya Revenue Authority
KRZI	Kunder Richardson
MOARD	Ministry of Agriculture and Rural Development

MoLD	Ministry of Livestock Development
NAEP	National Agriculture Extension Policy
NCPB	National Cereals and Produce Board
NGO	Non-Governmental Organizations
NIE	New Institutional Economics
NRCC	National Research Centre for Camels
SCP	Structure Conduct and Performance
SNV	Swedish Development Agency
UAE	United Arabs Emirates
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
VSF	Veterinary San Frontiers.

ABSTRACT

This study was conducted in Central Division of Isiolo District in Isiolo County, Kenya. The objectives of the study were to determine how camel feeds influence camel milk production, to establish how camel milk marketing and infrastructure influence camel milk production, to establish how camel breeds influence camel milk production and to assess how extension services influence camel milk production in Central Division of Isiolo District. The study was undertaken in the three purposively selected Camel milk Self help Groups and these were Anolei Camel Milk Cooperative Society, Tawakal Women Self Help Group and Defe Camel Milk Self Help Group. The target population of the study was 140 members of the women camel milk self help groups. Census method was used to collect primary data from the three camel milk self help groups. Census sampling technique was used for the study and all the 140 members of the three camel milk groups were sampled for the study. The study was limited to Central Division of Isiolo District and to the three camel milk groups. The study adopted a descriptive survey design and data was collected using structured and semi-structured questionnaires. The data was also collected from the three women groups by focus group discussions and personal interviews. The results of the study show that majority of the camel milk producers used full grazing and browsing as their main grazing system. The most common feed for feeding camels were native browses (Trees and shrubs). It was also revealed that most of the farmers don't grow fodder because of insufficient information and insufficient rains. For few who grow fodder, the mostly grown fodder forage was grass. The main feed supplement bought was found to be mineral supplements like mineral licks. These feed supplements are bought most of the time for the lactating camels. It was also revealed that the feed supplements were bought from private agro veterinary retailers in Isiolo. The study revealed that the main source of water for camels was the nearby river and wells were used sparingly. It was also found that the farmers brought camels to the rivers and water scarcity was found to be the main water related problem in the area. It was found that farmers kept mostly single humped camels for milk production because they produce higher volumes of milk. It was also shown that farmers used natural mating breeding technique because they have no access to artificial insemination. The findings also show there is also high demand for camel milk by consumers and there is lack of cooling facilities in the area. The findings also show that the common causes of camel losses were diseases, drought and camel rustling. The farmers also use herbal remedies because veterinary services were not readily accessible and were expensive. The generated data from the study will be useful to the camel farmers, Government officers and other stake holders.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Camels are used as multifunctional animals in pastoral production systems of East Africa with the general aim of producing; milk, meat, blood, hides and skins, provision of transport, barter trade (sale and exchange) and social and cultural functions (Kaufman and Binder,2002). The Food and Agriculture Organization (FAO, 2012) reports that with savvier packaging and more investment in camel milk production, camel's milk could become a $10-billion annual global industry and that camels produce more milk when compared with cattle and small stocks under the same harsh environmental conditions and its lactation persists well into the dry seasons and rarely ceases even during extended dry spells.

According to Schwartz (1992) the camel (camelus dromedaries, one – humped camel) is an important livestock species uniquely adapted to hot and arid environments and mainly kept by migratory pastoralists in subsistence production systems with emphasis on milk production. Due to urbanization the camel has undergone a change of image from "ship of the desert" to "food security animal" hence the need to put to full use its milk production capabilities through better management practices. The world camel population is estimated at 19 million, with the vast majority of these (about 15 million) being found in Africa and 4 million in Asia (Farah et al., 2007).

Somalia (with over 6 million camels) has the largest camel population in the world, perhaps representing one-third of all dromedary camels (Farah et al., 2007). They are found mainly in arid and semi-arid areas where the average rainfall is less than 350 mm per year. The four neighboring countries ; Somalia, Sudan, Ethiopia and Kenya have a combined camel population comprising 99% of the camels in the Greater Horn of Africa, 97% of all camels in Africa and 75% of all camels in the world (Field, 2005).

The consumption of milk and milk products varies between the urban and the rural areas and the level of urbanization (Ahmed *et al.,* 2003). In the urban areas, all segment of the population consumes dairy products while in the rural areas the major consumers are primarily, children and some vulnerable groups such as the elderly and women (Ahmed *et al.,* 2003). Consumption of processed dairy products was observed even less frequently among the rural low-income households, indicating that the majority of the populations do not consume processed products (butter) to any substantial degree (Lemma *et al.,* 2005). In Isiolo, Camel fresh milk is distributed through both the informal and formal marketing systems. The informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood and sales to itinerant traders or individuals in nearby towns (Siegefreid, 2001).

Marketing of milk in the rural areas of Isiolo region is mostly of traditional nature. There are also a number of informal milk traders, agents, retailers, and self-help milk groups from the farmers that are involved in milk delivery channel. The differences in distance to different milk market places affect the price of milk (Kurtu, 2004). Milk is transported to Isiolo town on foot, by donkey, or by public transport, and commands a higher price there than when sold in the neighborhood (Siegefreid 2001).

Three milk retailer women groups (Anolei camel milk cooperative society, Tawakal women self help group and Defe camel milk self help group) in Isiolo town buys milk from the camel pastoralists in Central Division of Isiolo District. The women groups sell some of the milk in Isiolo from their dairies and transport some of it to Nairobi every morning by using public service means mainly buses. Isiolo town is the headquarters of the County. The three camel milk groups face the challenges of fluctuating milk production due to the seasonal nature of rainfall in the area, lack of camel milk processing and cooling facilities and poor road networks in the pastoral areas. The groups income can be improved through improved road networks and means of transport, developing camel milk processing and preservation facilities which enables camel producers and the camel milk women groups to transport milk to Isiolo town thus

enhancing groups income through increasing camel milk shelf-life and value addition of camel milk.

1.2 Statement of the Problem

In Isiolo County for many decades the pastoralists have depended on cattle and goats milk for food and social- economic needs. In the recent years the arid regions of Kenya including that of Isiolo County like much of north east Africa has been hit with less predictable and more intense and frequent droughts hindering camel milk production. Therefore, there is need to continue sustaining pastoral economies and livelihoods and this can be achieved through promotion of camel milk production. Camels can serve the best useful addition to the food supply chain in terms of milk, meat and other products. In the context of advancing urbanization, camel milk is increasingly commercialized and consumed in urban areas. However, the main constraints of this emerging milk market are; poor hygienic quality of the commercialized milk and lack of milk processing technologies to improve shelf life and expand production and sales Matofari et al.,(2013).

Only about 12% of the Kenyan camel milk is marketed, the bulk of which is sold in raw form to rural consumers (10%) and only 2% reaches the urban consumers (Akweya et al., 2010a). However, camel milk has become increasingly popular due to its reported medicinal value. Regular consumption is said to help in managing diabetes and in controlling high blood pressure. Therefore, there is need to increase camel milk production as camels milk demand continue to rise as food, medicine and sustaining pastoral economies and livelihoods. This study will consider three camel milk camel milk self-help groups of Anolei Camel Milk Cooperative Society, Tawakal and Defe Self Help Group to establish the influence of camel milk production in relation to seasonal variations of milk supply due to frequent droughts, camel feeds, transport constraints, distance to market, camel breeds and veterinary extension services.

1.3 Purpose of the Study

The purpose of the study was to establish factors influencing the production of camel milk in Central Division of Isiolo District of Isiolo County.

1.4 Research Objectives

The following were the objectives of the study:

1. To determine how camel feeds influence camel milk production in Central Division of Isiolo District.
2. To establish how camel milk marketing and infrastructure influence camel milk production in Central Division of Isiolo District
3. To assess how camel breeds influence camel milk production in Central Division of Isiolo District.
4. To establish how extension services influence camel milk production in Central Division of Isiolo District.

1.5 Research Questions

To meet the study objectives, the following research questions were used during the study:

1. How does camel feeds influence camel milk production in Central Division of Isiolo District?
2. How does camel milk marketing and infrastructure influence camel milk production in Central Division of Isiolo District?
3. How does camel breeds influence camel milk production in Central Division of Isiolo District?
4. How does extension services influence camel milk production in Central Division of Isiolo District?

1.6 Significance of the Study

The findings of this study will be used by different stakeholders in different ways. The findings will be used by the County and Central Governments to determine whether camel keeping can economically empower the county residents who hitherto have solely depended on pastoral farming of cattle and goats. The findings will enable the Governments to examine ways and means of improving camel milk production, develop policies and programmes which will enhance the living standards of the pastoralists and achieve the goal of empowering them as vehicles of attaining high levels of development

in their areas. It will be used by the nomadic tribes across the country to embrace nomadic participation in productive activities so as to improve per capita income and create employment opportunities which will enhance the general development of the people found in arid areas and or pre-urban areas like Isiolo. The study also intend to address the perennial insecurity in Isiolo County and other ASAL Counties brought about by loss of livestock to drought leading to raids for restocking or fighting over grazing lands by shifting priority from cattle and goat rearing to camel rearing. The study can also be used to improve camel milk marketing in the County and address marketing challenges faced by the three women camel milk groups and enable the groups to improve their services and income.

1.7 Limitation of the Study

The study was limited to Central Division of Isiolo District in Isiolo County and to the members of the three women camel milk self help groups. Some of the respondents were not easily available for the study and this caused delays in data collection.

1.8 Delimitation of the Study

The study concentrated on the factors which influence camel milk production in Central Division of Isiolo District and to the three camel milk women groups of Anolei Camel milk Cooperative Society, Tawakal and Defe Camel milk Self Help groups. All the 140 members of the three women groups participated in the study.

1.9 Basic Assumptions of the Study

The study was based on the assumption that the information from the respondents was true and unbiased and that the members of the three women camel self help groups would be available for the study.

1.10 Definition of Significant Terms

The following terms are used prominently in the study.

Agricultural extension Is a general term meaning the application of scientific research and new knowledge to agricultural practices through farmer education. The field of 'extension' now encompasses a wider range of communication and learning activities organized for rural people by educators from different disciplines, including agriculture, agricultural marketing, health, and business studies.

Camel Breed Refers to different species of camels. A breeding branch of animal husbandry concerned with the raising and use of camels developed in desert, semi-desert, and arid steppe zones.

Camel Feed: Refers to feed for camels essential for growth maintenance or operation. Food especially for farm animals used for nourishment. The diet of a camel includes grass, grains, wheat and oats. When they are in the desert, they usually feed on dried leaves, seeds, and thorny twigs. If these diets are not available, these animals can eat anything including bones, fish, meat, leather, and even their owner's tent.

Infrastructure Is basic physical and organizational structures needed for the operation of a society or enterprise or reproductive system, or the services and facilities necessary for an economy to function. It can be generally defined as the set of interconnected structural elements that provide framework supporting an entire structure of development. The term typically refers to the technical structures that support a society, such as roads, bridges, water supply, sewers, electrical grids, telecommunications, and so forth, and can be defined as "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions." Viewed functionally, infrastructure facilitates the production of goods and services, and also the distribution of finished products to markets, as well as basic social services such as schools and hospitals; for example, roads enable the transport of raw materials to a factory.

Milk Marketing It is the process of communicating the value of a product or service to customers. It is a critical business function for attracting customers. From a societal point of view, marketing is the link between a society’s material requirements and its economic patterns of response. Marketing satisfies these needs and wants through

exchange processes and building long term relationships. The process of communicating the value of a product or service through positioning to customers.

Milk Production Refers to secretion of milk by the mammary epithelium. The fluid secretion of the mammary gland forming the natural food of young mammals.

1.11 Organization of the Study

Chapter One contains background to the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study, limitation of the study, delimitation of the study, basic assumptions of the study and definitions of significant terms. Chapter Two contains introduction, literature on camel feeds, camel milk marketing and infrastructure, camel breeds and camel extension services Chapter Three contains Introduction, Research design, Location of the study, Target population, Sampling techniques, Data collection Instruments and procedures, validity of the research instrument, Reliability of the research instruments, Data analysis methods, Ethical issues and Operationalization of study variables. Chapter Four contains Data Analysis, Presentation and Interpretation. Chapter Five consists of Summary of Findings, Discussion, Conclusions and recommendations. The References and Appendices are also given.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The chapter will discuss literature on camel feeds, camel milk marketing and infrastructure, camel breeds and extension services. The chapter will also address some important and related literature on camel milk, milk yields and lactation length. It will also quote various authors and their sources of literature.

2.2 Overview on Camel Production

The world camel population is estimated at 19 million, with the vast majority of these (about 15 million) being found in Africa and 4 million in Asia (Farah et al., 2007). Somalia (with over 6 million camels) has the largest camel population in the world, perhaps representing one-third of all dromedary camels (Farah et al., 2007). They are found mainly in arid and semi-arid areas where the average rainfall is less than 350 mm per year. The four neighboring countries ; Somalia, Sudan, Ethiopia and Kenya have a combined camel population comprising 99% of the camels in the Greater Horn of Africa, 97% of all camels in Africa and 75% of all camels in the world (Field, 2005). Kenya has only one-humped (dromedary) camels, which is an important component of the livestock sector in the arid and semi-arid lands (ASALs) of northern Kenya where 66% of the population live below the poverty line (ADF, 2003). In the past, because of lack of regular census, Kenya's camel population was estimated at below the one million mark.

However, according to the results of 2009 livestock census, the national camel population is estimated at 2.97 million (KNBS, 2010). The dromedary camel is a multipurpose animal primarily kept for milk and meat production as well as transportation. It is also a financial reserve (asset) and security (against drought related losses) for pastoralists and plays an important role in social status and wealth (Guliye et al., 2007). For example, customarily, camels are the most important indicator of wealth and a determinant of status within the Somali society (Mahmoud, 2010).

In Kenya, camels are important livelihood assets for food security and wealth creation in the ASALs. Camels provide income to the household through sale of milk, meat, hides, transport services, riding and tourism which is essential to pastoral subsistence economy (Glücks, 2007; Njanja, 2007). Milk from camel is highly ranked as an important utilization at the household level as a source of food and income (Njanja, 2007; Guliye *et al.*, 2007). To Somali pastoralists camels act as security against drought and diseases (Farah *et al*., 2004). Pastoralist more often sell camels when there is urgent need for cash and not when prices are optimal as they meet to satisfy finance, insurance and status roles. Therefore, livestock keepers' sell livestock when faced with pressing cash needs (Moll, 2005).

2.3 Camel Feeds and camel milk production

The camel is, by preference, a browser of a broad spectrum of fodder plants, including trees, shrubs, and sometimes hard-thorny, bitter and halophytic (salty) plants that grow naturally in the desert and other semi-arid areas (Field, 2003). They generally browse leaves, young twigs/shoots, fruits, flowers and pods. Under natural conditions camels have the capacity to choose their forages efficiently, grazing more on forage trees than grasses (Field, 1993). Leaves from trees are generally richer in minerals than grasses (Kuria et al., 2004). An important feature of camels browsing habits is that they are not in direct competition with other domestic animals either in terms of the type of feed eaten or in the height at which they eat above the ground (Wilson, 1989).

The greatest competition for feed resources is found between camels and goats, with 47.5% dietary overlap in the dry season and 12.4% in the green (wet) season (Wilson, 1998). From an extensive set of feeding observations in five different range types in Marsabit County of northern Kenya, Field (2005) calculated the average composition of the diet of camels as follows: Trees (25%), Dwarf shrubs (50%), Herbs (14%) and Grasses (11%). The predominant forage species consumed by camels in northern Kenya include *Acacia*, *Cordia*, *Duosperma*, *Euphorbia*, *Grewia*, *Indigofera* and *Salvadora* (Onjoro, 2004).

Field (1995) noted seasonal variations such that trees, shrubs and dwarf shrubs dominated camel diet in wet season but the percentage of trees and shrubs noticeably declined during the dry season when most of these species shed off their leaves. During drought, there is a tendency for camels to concentrate on evergreen shrubs and trees such as *Dobera glabra, Salvadora persica* and certain *Euphorbia* species (Field, 1995). There is still little known about the amounts of feed eaten by camels, especially under free-ranging conditions. Published results are, to some extent, conflicting but it does appear that intakes of feed per unit of body weight are low compared to other domestic species (Field, 1995; Wilson, 1998).

Reasons for the observed differences in food intake for camels and other livestock may relate to their lower metabolic rate and their more nutritious diet (Field, 1995). The quantity of feed eaten by a camel depends on the water content of the forage. If a camel eats 30 – 40 Kg of fresh fodder which has a water content of 80%, then the intake is only 6-8 Kg dry matter (Yagil, 1994). Camels feed intake also depends on its selective feeding of a wide variety of vegetation and different parts of browse which differ in quality (Wilson, 1989; Hashi et al., 1995).

For example, ingestion rates can be rapid where preferred or selected browse is plentiful but are much slower on thorny species that have little leaf. Kassily (2010) also states that forage quality influences feeding activity patterns in camels and that under adverse pasture conditions, the time available for grazing would be a limiting factor for their total dry matter and nutrient intake. Detailed nutritional studies in the arid lands of northern Kenya have shown that the small-bodied Rendille/Gabbra camels consume daily 1.67% of their live weight. Consequently, the daily dry matter intake (DMI) calculated by multiplying this figure by actual mean live weight resulted in 5.02 kg per day (Field, 2005). To allow for production costs, the DMI calculation for camels should be increased by 10%, thus giving 5.52 kg per day (Field, 2005).

However, according to Wilson (1989), camels total dry matter intake needs to be about 4% of body weight and that feeding times required to satisfy this requirement may be as

much as 15 or more hours per day. Consequently, a mature camel weighing 650 Kg would require about 26 Kg of dry matter, which might represent between 80 and 100 Kg of total food intake of plants with high moisture contents. The camel's habitat is characterized by lack of water and high temperatures. There is a considerable seasonal variation in the availability of the amount and variety of forage in Isiolo Division. Pastoralists are well aware of the need for efficient utilization of their grazing land. In Isiolo camels are fed both by browsing on low bushes, shrubs and trees and by grazing on grasses. During dry and unfavorable conditions camels survive on drought tolerant and succulent plant species.

Camel watering in Isiolo Division is a laborious activity usually conducted jointly by a number of herders, especially when using well water. In the Isiolo Division, intermittent rivers and riverbeds are the most important sources of water. Watering frequency depends on the availability of water sources, season and the capacity of the herders to pay money to the privately owned wells or ponds. Camels are watered every 10-15 days if a water source is nearby, however they can survive up to 30 days without being watered if no water source is nearby. During the rainy season camels may not drink water for 1-2 months because the moisture of the plants is sufficient to meet their water requirement. Pastoral (nomadic) camel production system is characterized by herd mobility and seasonal migration in communal rangelands in search of better quality resources (pastures, water and mineral licks).

The system is highly efficient and has been used by camel herders for centuries. For example, Dereje and Uden (2005) state that in traditional long-range nomadic systems, the diet of camels with mixed feeding behaviour can be extraordinarily varied. This habit limits the risks of nutritional deficiencies and the vegetation selected is also of a fairly good quality (Dereje and Uden, 2005). Wilson (1998) states that camel pastoralists have a sophisticated resource-use system that uses mobility, social cooperation and intensive labour inputs as part of their survival strategies. However, increasing human population pressure on pastoral grazing areas (Farah et al., 2004) have almost certainly resulted in environmental degradation and dwindling of feed resources (Wison, 1998).

Pastoral camel herders in northern Kenya adopt rational and goal-oriented camel management strategies in utilizing their rangeland environments (Farah et al., 2004). Such strategies include movement of their animals in the range in order to locate ideal grazing areas and water resources, and also establish suitable patterns of movements. Another strategy is that of herd splitting in order to cope with production resource constraints and spread risks. Under peri-urban (sedentary) camel production systems, the once desirable mixed exposure and intake to feed is being lost (Dereje and Uden, 2005).

A number of factors can be attributed to the low productivity observed, but feed shortage, both in quality and quantity, is probably the most important single factor (Dereje and Uden, 2005). The reason for this is that, unlike in pastoral system, peri-urban system does not allow seasonal herd mobility in the rangelands for greater exploitation of the scarce resources. The shift from pastoral to peri-urban camel production restricts camels to limited feed resource base.

This is particularly evident in Isiolo, northern Kenya, during dry season and droughts where there is pressure on feed resources forcing camel keepers to feed their camels on *Euphorbia tirucalli* (Field, 1995; Maundu and Tengnas, 2005), a succulent non-conventional forage for camels, whose nutritive value and its effect on milk quality is unknown. An additional effect of feed resource pressure is rampant enclosure and unlawful privatization of communal rangelands by different communities. In Isiolo peri-urban area this has at times resulted in inter-tribal conflicts, necessitating quick intervention by the provincial administration arm of the Kenyan Government. In view of the trend towards peri-urban systems, there is an urgent need to establish ways of improving the nutritional conditions of the camels in order to increase milk production and thereby improve the life of camel producers.

The underlying assumption is that improvements can be achieved by introducing energy and protein-based diets that are relatively cheap and locally available supplementary feeds. Furthermore, in the absence of development of scientifically proven nutritional guidelines for camels, some trial and error will need to be carried out to determine for

any particular area which are the best feeds and in which proportions, while giving due consideration to the important question of cost (Wilson, 1998). Despite mounting interest in camels and camel production research witnessed in the last two to three decades, knowledge of camel's nutritional requirements to provide sufficient information necessary for systematic feeding for efficient and profitable production is still limited (Farid, 1995; Wilson, 1998).

This can be explained by the fact that, for long, the camel was rarely managed for commercial purposes. More research is therefore required on feeding and nutrition (Wardeh, 1994). There has so far been little experimentation on feeding standards for camels performing different functions (Wilson, 1989). Guidelines for camel feeding have often been extrapolated from the feeding standards for cattle, assuming that the digestibility of foods by camels and their efficiency of utilization of nutrients for various functions do not differ significantly from those of true ruminants (Hashi et al., 1995). Energy and protein are the most limiting nutritional factors. Both are required for maintenance and production. The demands for milk production are high in terms of energy. The requirement for one litre of milk is equivalent to almost 10% of the maintenance requirement. In terms of protein, milk is even more demanding of nutrients and one litre requires about 20% of the maintenance requirement of a 400 Kg female camel (Wilson, 1989).

According to Wilson (1989), for example, the daily requirements for 15 Kg of milk could not be met from free-range grazing and a concentrated feed would be required. However, work by Hashi et al., (1995) suggests that camels have lower energy requirements and/or extract more from fibrous feeds. In addition, camels producing milk have a need for large quantities of water (milk is about 90% water) (Wilson, 1998). Camels are free-ranging animals and under many circumstances need little of additional food if not performing extra work or producing large quantities of milk (Wilson, 1998).

Work animals usually require more energy in their diets while milking animals require more protein (Yagil, 1994). The traditional camel herdsmen rarely provide supplementary

feeds to their camels, other than salt (sodium chloride) or allowing access to salty water and halophytes (salty plants) (Elmi, 1991; Farah et al, 2004). Thus, there is lack of information on how the evolving peri-urban production system influences the feeding management strategies, and the constraints and opportunities that camel producers face.

Simpkin (1995) states that supplementary feeding or zero grazing of camels would only be worth implementing in the more arid areas, using high producing animals, in locations where supplementary fodder is locally available, and where there is a local market for the milk. When choosing supplementary feeds for camels, feed availability, its nutritive value and cost should form the guiding principle. Supplementary feed for camels can be provided in the form of pods of certain trees, such as *Acacia* trees. Other supplementary feeds can be millet, straw, sorghum, cottonseed, hay, oats, dates and other energy-giving fodder (Yagil, 1994; Wilson, 1989). According to Hashi et al. (1995) consumption of low quality roughages and total feed intake by camels can be improved with supplementary feeding. For example, a concentrate feeding experiment resulted in a highly significant improvement (by as much as 16%) in oat hay consumption, while lactating camels in another feeding experiment formulated so that it would be appropriate for true ruminants had an average production of 6 litres and showed a positive live weight change (140 g per day).

However, calculations of feed requirements for the camel still rely heavily on data and constants generated with cattle, and, therefore, more practical field experimentation work is needed before reliable feed budgets can be developed within defined production patterns (Hashi et al., 1995). Only then, will it be possible to design solutions (i.e. supplementation protocol) for the nutritional constraints that limit increased and sustained productivity. There are no documented deficiencies of minerals in the diets of camels. However, clinical symptoms of skin and bone diseases suggest that in some areas the fodder is deficient and mineral supplementation is required (Yagil, 1994), and this can be achieved by providing a mineral lick that contains the necessary elements (Wilson, 1998). As stated earlier, with the exception of Dereje and Uden (2005), little work has been done to study milk production in camels under supplementary feeding regimes.

In their study, Dereje and Uden (2005s) reported that lactating camels on range in Eastern Ethiopia substantially increased milk yield when supplemented with protein or energy feeds. The main use of camel's milk will of course be for drinking. However, as soon as production is higher than consumption, other ways of preserving and marketing camel's milk products must be found. Soured milk products are the most common milk products of all mammals. Pasteurization or not? One of the questions about camel's milk is whether it should be pasteurized or not. Often unfounded statements are made that pasteurization is"must" for camel's milk, probably based on the fact that camels are normally dusty and their environment dirty-looking. However, the literature does not reveal milk-borne diseases among camel-milk drinkers while many stories have been told about the medicinal properties.

Camel meat and milk can be sold to Kenyan hospitals, where demand is high due to its health benefits for patients. Camel meat contains less fat and more fluid than beef. Research has shown that camel milk can help keep diabetes under control. Leading scientists at the Kenya Medical Research Institute (KEMRI, 2007) detected a protein similar to insulin in the milk in Kenya and Germany a few years ago. According to 2007 figures, Kenya has over 5 million diabetics. Clinical trials carried out by KEMRI in Nairobi have also shown that tuberculosis patients enjoy a quick recovery rate after consuming camel meat and milk.

Therefore the main customers of camel milk could be hospitals, milk processing companies and individual customers. Health and nutritional benefits of camel milk had encouraged pastoralists to keep more camels and also encouraged more people to feed on camel milk. There are several medicinal benefits which can be attributed to camel milk, due to enrichment of several minerals and vitamins in the milk, hence proving to be beneficial in treatment of several illnesses. The components present in camels milk are highly dependent upon the species and feed of the camel. The basic nutritional components of camels milk include iron (extremely high as compared to cow's milk), vitamin B, vitamin C, protein, immunoglobins, low fat content, low cholesterol content, anti viral features, anti inflammatory properties, anti bacterial characteristics, and fatty

acids (of 6 different types with lanolin acid being the primary one). The composition of camel milk depends on its feed and species: Bactrian milk has a higher fat content than dromedary milk. The health related aspect of camel milk cannot be ignored where the milk has been in use for several years to treat various ailments and diseases.

2.4 Camel Milk Marketing, Infrastructure and camel milk production

Market refers to a set of buyers and sellers who interact and influence price. However, the existence of the market by itself does not ensure an exchange to take place. There should be a channel. In pastoral area milk production is seasonal while consumption is throughout the season (IPS, 2000). Moreover, there is no preservation and processing techniques, and physical infrastructure, like roads and market facilities are limited (Jabbar *et al.*, 1997). However, where there is access to market, dairying is preferred to meat production since it makes more efficient use of feed resources and provides regular income to the producer (De Leeuw, 1999). The consumption of milk and milk products varies between the urban and the rural areas and the level of urbanization (Ahmed *et al.,* 2003).

In the urban areas, all segment of the population consumes dairy products while in the rural areas the major consumers are primarily, children and some vulnerable groups such as the elderly and women (Ahmed *et al.,* 2003). Consumption of processed dairy products was observed even less frequently among the rural low-income households, indicating that the majority of the populations do not consume processed products (butter) to any substantial degree (Lemma *et al.,* 2005). The limited consumption of butter may be due to the higher price associated with it and the need for cash income to buy some necessities. Butter is often consumed on holydays and special occasions in rural low-income households because it fetches routine cash income (Lemma *et al.,* 2005).

Butter fetches a higher price compared to other milk products. In Isiolo, Camel fresh milk is distributed through both the informal and formal marketing systems. The informal market involves direct delivery of fresh milk by producers to consumers in the immediate

neighborhood and sales to itinerant traders or individuals in nearby towns (Siegefreid, 2001). Marketing of milk in the rural areas of Isiolo region is mostly of traditional nature. There are also a number of informal milk traders, agents, retailers, and self-help (rural women milk cooperative groups) milk groups from the farmers that are involved in milk delivery channel. The differences in distance to different milk market places affect the price of milk (Kurtu, 2004). Milk is transported to Isiolo town on foot, by donkey, or by public transport, and commands a higher price there than when sold in the neighborhood (Siegefreid 2001).

There are generally three different milk outlets identified in North Eastern, namely traditional milk associations or groups, milk collectors (traders) and the producer themselves (Kurtu, 2004). In Somalia pastoralist, fluid milk is sold on road side or directly supplied to the individual consumer and hotel owners near the town (IPS, 2000). It is estimated that the Kenyan camel population is capable of producing between 340 and 350 million litres of milk (Faye, 2007; Akweya et al., 2010) and 10,000 tonnes of meat a year (Faye, 2007). The health-promoting properties of camel milk are a strong boost for sales and, in certain regions such as the Middle East, they are the driver for intensification of camel dairying (Faye, 2007).

In recent years, commercial exploitation of camel milk in Kenya has grown tremendously (Matofari et al., 2007). In the context of advancing urbanization, camel milk is increasingly commercialized and consumed in urban areas. However, the main constraints of this emerging milk market are; poor hygienic quality of the commercialized milk and lack of milk processing technologies to improve shelf life and expand production and sales (Matofari et al., 2007; Matofari et al., 2013). Only about 12% of the Kenyan camel milk is marketed, the bulk of which is sold in raw form to rural consumers (10%) and only 2% reaches the urban consumers (Akweya et al., 2010). The same authors state that from the remaining milk (88%) that does not reach the market, 38% is directly used by camel keeping households and their herders as part of their food requirements and the remaining 50% (or 170 million litres) goes to waste.

Muliro (2007) also states that during the rainy season, much of the surplus camel milk goes to waste. There is, therefore, a great opportunity for commercialization and enhanced incomes for camel keeping pastoral communities (Muliro, 2007; Akweya et al., 2010). In this regard, the camel milk industry potential in Kenya has already been picked up by one local firm, Vital Camel Milk, which has broken new ground by setting up a plant to process camel milk.

The plant was commissioned in 2005 in Nanyuki town. It produces pasteurized milk which it sales to Supermarkets in Nairobi as a health-promoting product. The initiative by this company has compelled the Kenya Bureau of Standards (KEBS) to start working with stakeholders in the dairy industry to establish the code of hygienic practice and handling of camel milk (Muliro, 2007). The Kenya government has also recognized the potential contribution of dairy livestock such as camels and goats in addition to cattle in the overall milk production by including them in the dairy development policy currently undergoing review (Muliro, 2007). Enhancing the development of stallholder farmers to reach markets and engage them in marketing activities poses a pressing development challenge. Difficulty in market access restricts opportunities for income generation. Remoteness results in reduced farm gate prices increased input costs and lower returns to labour and capital.

This in turn, reduces incentives to participate in economic transaction and results in subsistent rather than market oriented production systems (Ahmed *et al.,* 2003). In Isiolo milk marketing system is not well developed (Ahmed *et al.,* 2003) especially, market access in pastoral production system is a critical factor (Tsehay, 2002). This has resulted in difficulties of marketing fresh milk where infrastructures are extremely limited and market channel has not been developed. In the absence of organization rural fresh milk market, marketing in any volume is restricted to peri-urban areas. Milk being perishable and demand being high for urban consumption, efficiency in collection and transportation of this bulk from widely scattered rural sources, requires a well-defined method of preservation and distribution. This would impact on the amount that would be available for consumption through losses in quality (Ahmed *et al.,* 2003).

Dairy product marketing is limited by the distance of the market from producers, lack of transport facility, and seasonal variation in the volume of milk production which leads to seasonal fluctuation in prices. The scattered nature of the production units, the poor communication system, and the low rate of urbanization and low infrastructure of road facilities may also not warrant the establishment of processing plants (IPS, 2000). A pastoral community depends mainly on milk and milk products for its survival and therefore, these items are not perceived to be for commercial purposes. Thus it's only the households who are in a walking distance from the urban centers who sell milk and milk products to urban consumers (IPS, 2000). In few cases, however, small assemblers go to water points and buy directly from the pastoralist and sell to the next urban areas.

They use donkey as a means of transport to carry milk from the water points to the urban center. In general, in pastoral and agro-pastoral area of Somalia region, milk is the main diet to households and also it is affected by season of the year, and even during the rainy season this production system is affected by the absence of transport facilities to markets (IPS, 2000). Milking and milk processing activities are usually performed by female members of the family (wives and daughters). Calves are allowed to suckle prior to milking. Milking is usually not complete in order to leave some milk for the calf (Zelalem and Inger, 2000). Farmers' practice hand milking as in the case throughout rural Africa (Brokken and Senait,1992). In somalia, majority of the women (85.5%) follows limited sanitary procedure before and after milking, only few women (14.5%) wash the udder of the camel before milking (Lemma, *et al.*, 2005).

In areas where the climate is hot and humid, the raw milk is spoiled easily during storage. Therefore, the smallholder with non-access to the modern preservative and cooling mechanism should seek products with a better shelf life by converting milk in to a more stable product like butter or by treating it with traditional preservatives. When milk production increases during the rainy season, the only available option for preserving milk is converting it in to longer shelf life products such as butter and sour milk (Coppock, 1994). Under traditional pastoral production systems, camel production is mainly for subsistence.

Consequently, the economic contribution of camel systems to national production (GDP) in the countries of Eastern Africa is not often known. In Kenya, for example, detailed information is available on exports of cattle, sheep and goats but the large numbers of camels that are known to be exported to the Middle East do not seem to appear in official statistics.

A recent study (Mahmoud, 2010) has confirmed the existence of a vibrant and lucrative live camel market in the northern Kenya border town of Moyale where several market actors (herders, traders, brokers) are making good gains. While cattle have largely remained commodity for local consumption, camels are being exported to the Middle Eastern countries in large numbers (Mahmoud, 2010). It is only recently that some formal marketing of live camels has started to emerge. Live camel offtake is estimated at between 1% and 5% (Simpkin, 1993). Camel meat is an important product mainly as a source of income. Sale of live camels, usually males and unproductive females for slaughter, is very common in Kenya and there are now increasing numbers of camel butcheries in many urban centres (Farah, 2004a).

There are a number of impediments to livestock marketing for producers from northern Kenya. These include: poor quality roads, lack of reliable market information, stock rustling and general insecurity, absence of consistent livestock marketing policies, and hence dependency on private traders (Chabari and Njiru, 1991). A major constraint to camel marketing is the lack of information concerning market prices due to the remoteness of camel rearing areas and associated poor communication infrastructure (Simpkin, 1993). However, Isiolo town is now a prominent camel market outlet for pastoral and peri-urban camel producers (Heath, 1997). Camel milk, which has been consumed for centuries by nomadic people for its nutritional values and medicinal properties, is now experiencing greater awareness in the western world (Wernery and Wernery, 2010).

2.5 Camel Breeds and camel milk production

Camel's milk has supported Bedouin, nomad and pastoral cultures since the domestication of camels millennia ago. Herders may for periods survive solely on the milk when taking the camels on long distances to graze in desert and arid environments. Camel dairy farming is an alternative to cow milk in dry regions of the world where bovine farming consumes large amounts of water and electricity to power air-conditioned halls and cooling sprinkler systems. Camel farming, by utilizing a native species well-adapted to arid regions, able to eat salty desert plants, has been linked to de-desertification by UNESCO.

Camel milk can be found in supermarkets in the UAE, Saudi Arabia and Mauritania. USA has imported population of 5,000 camels. Several farms owning collections of breeding camels are adopting camel milking programs in the states of Michigan, Missouri, Oklahoma, Pennsylvania, Indiana, North Carolina, Ohio, with new milking programs set to open in Louisiana, Virginia, Georgia, Texas, Idaho, Tennessee, and Florida. Most of the camel dairies in the US are small, with four to 20 camels, each producing a minimum of five litres per day. Pakistani and Afghani camels are supposed to produce the highest yields of milk, up to 30 litres per day. The Bactrian camel, produces 5 litres per day and the dromedary produces an average of 20 litres per day. Intensive breeding of cows has created animals that can produce 40 litres per day in ideal conditions.

Camels, with their ability to go 21 days without drinking water, and produce milk even when feeding on low-quality fodder, are a sustainable option for food security in difficult environments. All camels in Kenya are dromedaries or one-humped Arabian camels. Without camels, human survival in dry environments would be much less sustainable. Camels are thought to have been introduced into East Africa by Somali speaking communities over 1000 years ago. These early pastoralists also had cattle, sheep and goats, but camels were better adapted to the dry climate and deteriorating rangeland of Northern Kenya. Historically camels arrived in the region only after deserts had been created by overgrazing and the following land degradation.

Perhaps had the camels come before the desert would not have followed, as camels do not deteriorate lands at the same rates as other livestock? They have no hoofs to destroy the fragile soils and they are mainly browsers, meaning grasslands do not become depleted where camels have fed. Camels produce milk throughout the lactation period, whereas cows and small stock dry up during droughts and prolonged drys pells.

In China the two-humped Bactrian camel is used mostly as a working animal (Dong Wei, 1979). The lactation period is 14–16 months, and the amount of daily milk production averages 5 kg per animal; although some animals can give as much as 15–20 kg per day. Normally, only about 2 kg are milked; the rest is suckled by the calf. In Russia milking capabilities of the Bactrian, the dromedary, and the hybrid of these two types of camels were examined (Kheraskov, 1955, 1961, 1965; Lakosa & Shokin, 1964; Dzhumagulov, 1976). The dromedary gave more milk than the Bactrian or the hybrids. In the Horn of Africa, milking of camels is not only an act of work, but has become an integral part of the local culture and heritage. Only boys, unmarried women or ritually clean men are allowed to milk the animals (Hartley, 1979). No treatment of the milk is allowed. The milk is either consumed fresh or when just soured. In some tribes the herd boys subsist on camel milk alone.

They drink water only after the camels are watered. Two teats are left for the calf, while the other two are milked-out for the tent dwellers. These latter two teats are tied up with soft bark fibres. In North Kenya camels produce more milk than the local cows. The Sakuye camel produces an average of 4 kg milk daily with a maximum of 12 kg. The cow produces 0.5–1.5 kg per day. Camels lactate for about a year. In areas with only one rainy season lactation finishes at the end of the dry season; this is thought to be caused by the shortage of feed during this period. In areas of northern Kenya, where the nomads subsist almost entirely on camel milk, there are two rainy period. Field (1979a and 1979b) reported lactation studies lasting three lactations. The duration of lactation was 47–67 weeks. Lactation ended 4–8 weeks following conception. Daily milk production reached 21 kg in the first week, declining to 4.8 kg in the 16th week of lactation.

There was an average daily milk yield of 13 kg for the first 10 weeks (1.8–50.2 kg) and 3 kg for the remainder of the lactation. Total production averaged 1 897 kg per animal. In the lactation studies the lowest milk yields were those given by camels without calves. These animals also had much shorter lactation periods, even though they were milked 5–7 times a day. Four milkings per day yielded more milk than twice a day milkings: seven liters compared with six (Evans and Powys, 1979; Shalash, 1979). The three main breeds of camel found in Kenya are Somali, Rendille/Gabbra and Turkana. These are kept by communities who bear the same names as those of the breed.

There is a fourth breed of camel called Pakistani which was imported from Pakistani into Laikipia ranches in Kenya in the early 1990s. However, only a few pure Pakistan camels exist while crosses with Somali or Turkana breeds have since moved out of Laikipia to Samburu, East Pokot, Kajiado, Northern Tanzania, Mandera and Marsabit districts. In Isiolo District the Somali and Turkana breeds are kept. The livestock genetic resources of Isiolo have involved largely as a result of natural Selection influenced by environmental factors. This has made the stock better conditioned to withstand feed and water shortages, diseases challenges and harsh climates. But the capacity for the high level of production has remained low (IPS, 2000).

The consequence of the low genetic potential of indigenous breed for productive traits makes total milk production to be low. It is difficult to estimate the daily milk yield of a camel under pastoralist conditions owing to the inconsistency of milking frequency. Milk yield is the most controversial subject concerning camels. For example, Herren (1992) observed that the majority of literature on camel milk production is controversial and often muddled by a failure to distinguish between two different issues: total (milked-out) yield and actual off take for human consumption that still allows the calf to survive and grow. In the present study, the term milk yield is used to mean total milk yield (i.e. milked-out, complete extraction of the milk).

In one of the very few long-term studies covering full lactation periods, Bekele et al. (2002) demonstrated the potential of camels as dairy animals under traditional pastoral

management. Seasonal variations in camel milk production are high (Bekele et al., 2002; Muliro, 2007). A number of factors influence milk production and may be responsible for the large differences in the reported figures. These factors include: feed quantity and quality, breed, climate, watering frequency, stage of lactation and frequency of milking (Ramet, 2001; Bekele et al., 2002; Farah, 2004). Camels are usually milked twice a day – morning and evening; however, if the need arises they can be milked every 2 – 3 hours (Farah et al., 2004). Bekele et al. (2002) reported the number of milkings per day ranged from 1 to 4 for camels under traditional pastoral management. Wernery (2003) states that camels must be milked 4 to 6 times a day to gain optimal milk yield.

In Kenya, it is highly likely that the reported milk production levels fall below the genetic potential of the camels (Onjoro, 2004). (Simpkin, 1995) indicated the following as some of the reasons for low milk yields in Kenyan camels: Camels in Kenya are kept in marginal areas and receive no feed supplementation, there is little or no disease control, and camels have been kept for subsistence rather than commercial purposes, hence there has been little quality control. The producers considered the quantity rather than quality of the animals as being more important. The available data are highly speculative and should be considered as guidelines for milk yields under pastoral conditions. It should also be noted that throughout lactation, calves are still suckling and therefore the actual volumes of milk secreted are likely to be higher than the figures reported. Milk production levels have been reported in various publications, mainly in the form of estimates.

Although there are fewer long-term studies covering full lactation period, it is widely recognized that, in absolute terms, the camel produces more milk and for a longer period of time than other livestock species under harsh environmental conditions (Farah et al., 2007). In dry lands under average grazing conditions, a camel can produce 1,900 litres of milk a year for human consumption (Stiles, 1995). Schwartz and Walsh (1992) estimated lactation yield for East African camels at between 1,500 and 2,500 litres.

According to Wernery (2003) good milkers can produce 20 to 30 litres daily. Average daily milk yield of the Somali breed camels is reported to range from 5 to 8 litres (Bekele et al., 2002; Farah, 2004; Farah et al., 2004). Under exceptionally favourable conditions, Somali camels can potentially produce more than 15 litres of milk a day during the peak of their lactation (Farah et al., 2004). Ramet (2001) had also reported that under more intensive systems camels can yield up to 12 to 20 litres a day. In Kenya, different daily milk yield figures have been reported for camels under traditional pastoral management systems.

For example, Simpkin (1996) gave a range of 2.4 to 4 litres per day while Simpkin et al (1996) estimated the yield at between 3 to 7 litres per day. Onjoro (2004) states that the yield can be improve to over 10 litres per day with better feeding. In the neighbouring Eastern Ethiopia, Baars (2000) reported camels daily milk yield range between 3.6 and 6.5 litres per day while Bekele et al (2002) estimated the mean daily yield for camels under pastoral management in semi-arid eastern Ethiopia at 4.14 litres per day. In addition, Bekele et al (2002) observed that the daily milk yield varied according to the number of milkings per day and ranged from 1.26 litres per day for one time milking to 6.77 litres per day for four times milking. With the exception of Dereje and Uden (2005), little has been done to study milk production under supplementary feeding regimes. Low milk production in pastoral camel system may be due to inadequate quantity and quality forages (Onjoro, 2004).

There appear to be two peaks (Aloo et al., 2010) in the lactation curve, the first is very marked and occurs in the first 6 to 10 weeks of lactation; the second corresponds to the following wet season when forage is again plentiful. However, Bekele et al (2002) reported that daily yields peak between 10-20 weeks after parturition, thereafter tailing off to give very low yields at the end of lactation. Estimates of lactation periods vary from 9 to 18 months (Ramet, 2001; Bekele et al., 2002). Duration of lactation also depends on a number of factors, for example, the survival of the calf. Camels whose calf dies produce less milk and lactate for a shorter period (Bekele et al., 2002). Pregnancy also influences the duration of lactation, and according to (Bekele et al., 2002). Lactation

usually ceases 4-8 weeks after conception; while Schwartz et al., (1998) estimate this at 12-16 weeks post-conception.

2.6 Camel Extension Services and camel milk production

Camel health care and improved health management is also one of the major constraints of camel development in Isiolo, which causes poor performance across the production system. Many of the problems result from the interaction among the technical and non-technical constraints themselves. For instance, poorly fed Camels have low disease resistance, fertility problems, partly because the Camel health care system relies heavily on veterinary measures and services. Moreover, poor grazing management systems continue to cause high mortality and morbidity (e.g. internal parasites), many of the diseases constraints which effect supply are also a consequence of the non-technical constraints, for example, insufficient money to purchase drugs or vaccines (Ibrahim and Olaloku, 2002).

Contact of livestock brought from varies localities through the use of communal pastures and watering as well as marketing places play an important role in the transmission of economically significant infectious and parasite diseases. Such livestock movements could be the cause of direct or indirect transmission of varies economically important camel diseases (Zinash, 2004). The low veterinary service performance in the lowlands is the outcome of the government-monopolized services. Government veterinary staffs are few in number and cannot cover such a vast area to adequately address the veterinary needs of livestock keepers. Besides government staffs need adequate mobile facilities, for which currently the government does not have the capacity to provide (Tafesse, 2001).

According to the Ministry of Agriculture and Rural Development National Agriculture Extension Policy (NAEP) of December, 2001 Agriculture Extension Service is a two – way communication/ training process involving adult learning techniques whose aim is to improve knowledge; change attitude/behavior; lead to adoption of new technologies; and improve skills for both farmers and extension worker's, with a view of increasing and improving farmers' incomes and productivity on a sustainable basis.

Adult learning techniques apply to youths also. The above broad definition refers to services provided by both public and private sector and encompasses activities relating to education, transfer of technology, change of attitudes, human resources development and the collection and dissemination of information. It has important implication in terms of support to agricultural extension for the farmers, the researcher and the extension worker. In the case of the farmer, extension will have more impact if attention is given to environmental and extension facilitating factors (non-extension factors) that may limit the utilization of extension messenges.

The extension worker and the researcher require not only material support, but also training and other opportunities to enhance their learning from farmers and the creation of the necessary level of confidence that is critical, between extension workers, researchers and farmers for effective exchange of skills and knowledge. The definition includes both on-farm and off-farm activities of farmers and allied players in agricultural industry.

The objectives of extension policy are to facilitate the development of pluralism in service delivery, improve the efficiency and effectiveness of extension services provision from public and private sectors and put in place a regulatory system to guide services and provide modalities of setting operational standards, quality and norms. The major categories of stakeholders in agricultural extension services include farmers, farmer's organizations, extension agents, extension service provider, inputs supplies, agro-processors, researchers, research organizations, CBO'S, NGO'S, local government, relevant central government departments, training institutions and development partners.

2.7 Theoretical Framework

This theory is based on Basic Needs Theory (Abraham Maslow, 1943) in an attempt to explain the factors that influence camel milk production, performance and income of the groups. According to this theory there are certain minimum requirements that are essential to a decent standard of living. These are known as physiological needs. They include food, shelter, health and clothing. They are primary needs and have to be catered

for before other needs such as security, sense of belonging and affection, love, esteem and finally self-actualization are pursued.

Therefore, in this study poor camel milk production, lack of well-developed road transport network in the pastoral areas, lack of camel milk processing plants to enhance value of camel milk and also very poor state of camel milk preservation methods such as cold chains, freezers, coolers and milk testing equipments negatively contribute to the women groups, milk stock, camel milk shelf-life and income of the group. The above factors determine and affect the groups' basic survival needs hence leading to unpredictable milk productions due to seasonal nature of rainfall in Isiolo, reduced shelf-life of camel milk, poor road network and lack of value of camel milk.

2.8 Conceptual Framework

The study was guided by the conceptual framework shown in Figure 1 that relates both independent and dependent variables. Figure 1 shows conceptual framework.

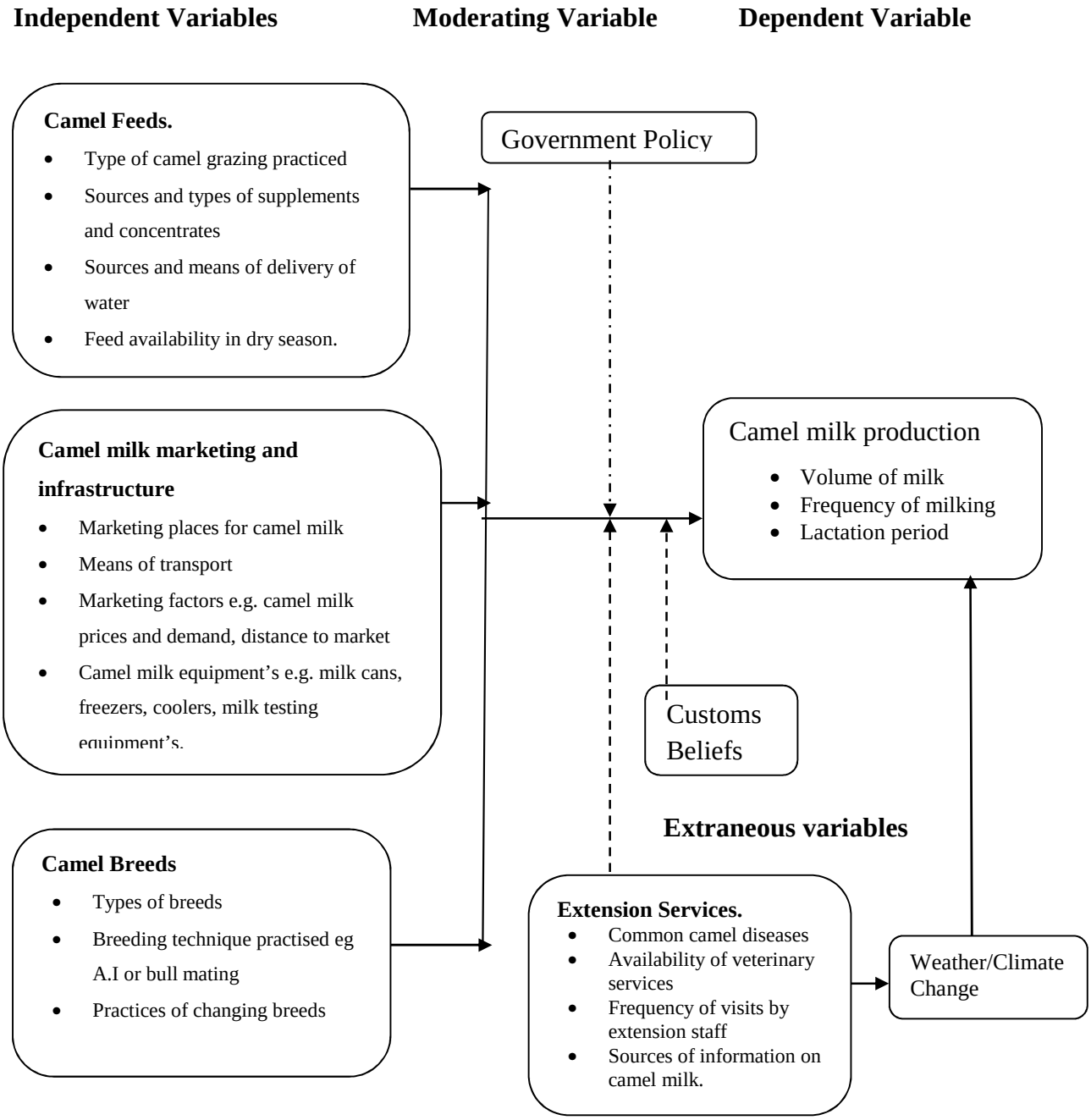

Figure 1: Conceptual Framework

2.9 Explanation of the variables:

In this research camel milk production is the independent variable and camel feeds, camel milk marketing and infrastructure, camel breeds and extension services are dependent variables. The variables relate to each other. Availability of camel feeds improve camel milk production and hence a major determinant of seasonal variations of camel milk production which affects the three camel milk women self-help groups of Anolei Camel Milk Cooperative Society, Tawakal and Defe Self Help groups in terms of their milk supply and income from sale of camel milk. During the rainy season the group buys more camel milk which allows them to sell enough camel milk both locally and in Nairobi improving the groups' income. During drought camel milk production declines and the groups income also declines as camel milk sales decline.

Camel milk marketing and infrastructure is an important variable in camel milk production. Availability of markets, for camel milk, good prices of camel, of camel milk, high demand for camel milk and availability of good road network in camel milk producing areas and availability of camel milk processing and preservation technologies improves camel milk shelf life, hygiene and expand production and sales thus greatly improving the income of the three women self help groups. Lack of or poor camel milk marketing and infrastructure reduces camel milk shelf life, life, reduces sales and income to the groups.

Camel breeds also play important role in camel milk production and income to the women groups. Camel breeds like Somali and Pakistan produce more milk than the Turkana and Gabra breeds. The type of breeds kept by the camel milk producers determines camel milk production, availability of camel milk and milk sales.

Availability of Extension Services improves camel pastoralist's knowledge and skills on camel production and health which assist the camel keepers in disease treatment, disease control, other management techniques, clean milk production and camel milk shelf life and milk sales. Lack of these services will have negative effect on camel milk production, hygiene, milk sales and income.

2.10 Knowledge Gap

The Following are the knowledge gaps of the study;

1. Whether camel feeds, camel milk marketing and infrastructure, camel breeds and camel extension services affect camel milk production
2. Whether the camel keepers and the camel milk women self help groups of Anolei, Tawakal and Defe in Isiolo Central feed the above four variables affect camel milk production.
3. There is need for the study to find out whether the four variables affect camel milk production in Isiolo Central and other parts of the world.

2.11 Summary

The camel feeds discussed included camel fodder plants, dry matter intake, watering frequency, rangeland utilization strategies by pastoral camel herders and supplementary feeds of camels. Camel milk marketing and infrastructure covered included camel milk marketing, consumption of milk and dairy products, milk transport and outlets and milking and milk processing activities. Camel production discussed included camel breeds in different parts of the world, amount of milk produced by different breeds and frequency of milking and length of lactation. In extension services section, benefits and constraints were discussed. The chapter also contains theoretical framework of the study, explanation of the variables and knowledge gap of the study.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a description of the research design and the methods the researcher used to determine the factors influencing production of camel milk in central division of Isiolo district, Isiolo County in Kenya. It closely examined the research design that was used to determine the factors influencing production of camel milk while also looking at the individual research questions posed in the study, the participants and the instruments that was used to collect the data, the procedures for gathering the data, and data analysis procedures.

3.2 Research Design

The research was conducted using a descriptive survey design. A survey is a means of gathering information about a particular population by sampling some of its members, usually through a system of standardized questions. In this study, the survey was conducted using questionnaires, focus group discussions and personal interview. The survey methods was in the three camel milk self help groups (Anolei camel milk cooperative society, Tawakal women self help group and Defe camel milk self help group) in Isiolo district. The primary purpose of the survey was to elicit information, which after evaluation, would result in a profile or statistical characterization of the population to be sampled. The questions were related to the objectives of the study which included: - to establish how camel feeds influence camel milk production, to establish how camel milk marketing and infrastructure influence camel milk production, to establish how camel breeds influence camel milk production and to establish how extension services influence camel milk production in Central Division of Isiolo District.

3.3 Location of the Study

The study was conducted in Burat, Mulango, LMD, Chumvi Yare and Kulamawe which are located in Central Division of Isiolo District, a typical ASAL area in northern Kenya, purposively selected for the study because of the presence of camel farming. The

researcher specifically targeted three camel milk self help groups (Anolei camel milk cooperative society, Tawakal women self help group and Defe camel milk self help group) in Isiolo town which buys milk from the above study areas. The women groups sell some of the milk in Isiolo from their dairies and transport some of it to Nairobi every morning by using public service means mainly buses. Isiolo town is the headquarters of the County. It is a semi-arid area that experiences frequent droughts with devastating losses of livestock. The County has bimodal rainfall pattern, but unpredictable and erratic in distribution. Long rains come in late March through May and short rains in November to December, with most parts of the County having mean annual temperatures between 24^{o}C and 30^{o}C (Herlocker et al., 1993). Under these conditions, rain-fed agriculture is unsustainable.

Isiolo County falls within three agro-climatic zones: semi-arid, occupying 5% of the area, arid, occupying 30%, and very arid, occupying 65% of the area (Sombroek et al., 1982; 26) The County is generally flat, low lying plains with altitudes ranging between 180 m above sea level at Lorian Swamp in the northern part to 1000 m above sea level in the southern part. Volcanic hills formed as a result of volcanic activities of the now dormant Mt. Kenya form the western part of the County.

3.4 Target population of the Study

The target population of this study was 140 members of camel milk self help groups. The population consisted of 100 members of Anolei Camel Milk Cooperative Society, 25 members of Tawakal Women Self Help Group and 15 members of Defe Camel Milk Self Help Group. Census method was used to collect primary data from the target population. Census method provides a true measure of the population because it eliminates sampling errors.

Table 3.1 shows target population of the study.

Table 3.1 Target population of the Study

Retailer Group	No. of Members
Anolei Camel Milk Cooperative Society	100
Tawakal Women Self Help Group	25
Defe Camel Milk Self Help Group	15
Total	**140**

Source: Anolei, Tawakal and Defe Women Self Help Groups

3.5 Sample size and sampling procedures

This study used census and all members of the three camel milk women self help groups used. First a purposive sampling was used to select the three camel milk self help groups (Anolei camel milk cooperative society, Tawakal women self help group and Defe camel milk self help group) for the study due to the characteristic of the groups. Then a census was carried out on the three milk camel milk self help groups. The census survey used questionnaires, interviews and focus group discussions to collect data from the milk camel milk self help groups. A total sample of 140 respondents was used in the study (Table 3.1).

3.6 Data Collection Instrument and procedures

A questionnaire was used to collect data. A questionnaire was chosen since it is a useful tool for standardized data collection especially when each respondent is to be exposed to the same questions and the same system of coding responses. The aim here is to try to ensure that differences in responses to questions can be interpreted as reflecting differences among respondents, rather than differences in the processes that produced the answers.

The other technique which was used to collect data is focus groups. This is necessary because focus groups combine elements of both interviewing and participant observation. The focus group session is, indeed, an interview, not a discussion group, problem-solving

session, or decision-making group. At the same time, focus groups are useful in capitalizing on group dynamics. The hallmark of focus groups is the explicit use of the group interaction to generate data and insights that would be unlikely to emerge otherwise. The focus groups consisted of gathering of 12 people from the cooperative societies because they share some characteristics relevant to the evaluation of factors influencing production of camel milk in central division of Isiolo district. Finally, personal interviews a schedule was used to collect data from three officials of the camel milk self help groups, one from each group. The researcher included the officials because he has the assumption that they have meaningful information that could improve the success of the study. Such in-person interview, rather than a paper and pencil survey, is important when interpersonal contact is likely to yield more accurate information and when opportunities for follow up of interesting comments are desired.

3.7 Validity of the research instrument

Validity is a measure of how well a test measures what is supposed to measures. (Kombo Tromp (2006) and the instruments were piloted so as to give the respondents a chance to point out any ambiguities. The researcher requested the supervisor to check the instruments for contents and he made suggestions and comments which were very useful to the researcher. Twenty questionnaires were distributed to the three women camel milk groups to identify any ambiguity.

3.8 Reliability of the research instrument

Reliability is a measure of how consistent the results from a test are (Kombo and Tromp (2006)). It’s the repeatability of a research measurement. In this study Cronbach's Alpha was used to compute correlation values among the responses of the questions of the questionnaire. Cronbach's alpha splits all the responses of a questionnaire and computes correlation values for them all. In the end, the computer output generates one number for Cronbach's alpha and just like a correlation coefficient, the closer the Cronbach's alpha value it is to one, the higher the reliability estimate of the research instrument. It is important to note that reliability is not measured, it is estimated.

The primary purpose of Cronbach's alpha is to provide an indicator of the internal reliability or consistency of items in a multiple item scale or index (Vogt, 1999). For scales, higher levels of a reliability coefficient are associated with lower random error and greater measurement of the true score. Since it is based on the number of items included in the scale, reliability will increase as the number of items increases. Reliability coefficient values greater than (or equal to) 0.7 are generally accepted as indicative of a reliable scale, while those less than 0.7 are generally not considered a reliable scale.

3.9 Data Analysis Methods

The data obtained from the questionnaires was compiled, coded and entered into a computer spreadsheet. The data was cleaned to detect any data entry errors and response errors. Data analysis was done using statistical package for social sciences version 17 for windows. Descriptive statistics was used especially on qualitative data and inferential statistics performed on quantitative data. The findings presented percentages, means and frequencies in tables.

3.10 Ethical Issues

Ethical considerations in research can be defined as ensuring that the researcher conforms to the standards of conduct of the authorities in the area of research. Examples of ethical issues that may arise are voluntary participation of respondents, deception to participants, anonymity and confidentiality of information given, analysis and reporting, harm or danger to participants and any other professional code of ethics expected. To ensure that the research was done in an ethical manner according to the expectations of all authorities, the researcher first obtained an introductory letter from the University of Nairobi to collect data from camel milk self help groups in Isiolo district. The researcher has a moral obligation to treat the sensitive information with utmost decorum. The researcher informed the respondents that the instruments being administered was for research purposes only. For those respondents who were reluctant to disclose some information, the researcher reassured such respondents that the information will be treated with confidentiality.

3.11 Operationalization of Variables

Operationalization is the process of defining variables into measurable factors. It consists of identification of variables and measurement procedure for each variable. This operationalization framework identifies the various variables which will be measured in the study as shown in table 3.1.

Table 3.1 shows the operationalization of variables.

Table 3.1: Operationalization of Variables

Objectives	**Variables Independent**	**Indicators**	**Measurement**	**Measurement scale**	**Data Analysis**
To establish how camel feeds influence camel milk production in Central Division of Isiolo District.	Camel Feeds availability	• Type of camel grazing practiced • Sources and types of supplements and concentrates • Source of water	• Type of grazing season • Type and amount of supplement • Distance to watering point	Nominal	Descriptive
To establish how camel milk marketing and infrastructure influence camel milk production in Central Division of Isiolo District	Camel Milk Marketing and Infrastructure	• Market places for camel milk • Means of milk transport • Factors to consider before choosing camel milk markets • Market factors eg camel milk prices and demand, market distance. • Camel milk equipments eg milk cans, freezers, coolers and milk testing equipments.	• Name and number of markets • Types of transport-vehicle, footing • Milk prices • Name and number of cooling equipments	Nominal	Descriptive

Objectives	**Variables Independent**	**Indicators**	**Measurement**	**Measurement scale**	**Data Analysis**
To determine how camel breeds influence camel milk production in Central Division of Isiolo District.	Camel Breeds	• Types of breeds • Breeding techniques practiced eg A.I, Bull mating • Practices of changing breeds.	• Name of breeds • Name of breeding techniques eg A.I, bull mating • Sources of breeds- local, external	Nominal	Descriptive
To determine how extension services influence camel milk production in Central Division of Isiolo District.	Extension Services	• Common camel diseases • Availability of veterinary services • Frequency of visits by extension officers • Sources of camel production information	• Type of camel diseases • Distance to veterinary office • Sources of extension services- Government, others	Ratio	Descriptive
	Dependent Camel milk production	Volume of milk produced	• Amount of milk produced • Amount of milk sold	Ratio	Descriptive

CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

The study assessed the factors influencing camel milk production in Central Isiolo District with a case study of three camel milk women groups in Isiolo County, Kenya. The first section presents the demographic data of the respondents. The second section presents data on the influence of camel feeds on milk production in Central Isiolo District. Third section of the chapter presents data on the influence of camel milk marketing and infrastructure has on production of camel milk in Central Isiolo District. Finally the fourth section covers data on the influence of camel breeds and extension services on camel milk production in Central Isiolo District. A total of 140 respondents were reached; 100 from Anolei camel milk cooperative society, 25 from Tawakal women self help group and 15 from Defe camel milk self help group.

4.2 Social-economic characteristics

The study assessed the demographic data of the respondents including gender and education level and the data was presented in the Table 4.1 (Gender) and Table 4.2 (education level). Table 4.1 shows gender distribution of the respondents.

Table 4.1 Gender distribution of the respondents

Demographic factor	Study group	Variable	Frequency	Percentage
Gender	**Anolei**	Male	7	7
		Female	93	93
	Tawakal	Male	8	32
		Female	17	65.4
	Defe	Male	7	46.7
		Female	8	53.3

Table 4.1 shows that majority of the members of the groups are females. For Anolei, 92.6% and 7.4% were females and males respectively; Tawakal 65.4% and 34.6% while Defe 53.3% and 46.7% were females and males respectively. This reveals that men are unwilling to join the self help groups maybe because they spend most of their time away with the camels looking for pasture. Table 4.2 shows education level of the respondents.

Table 4.2 Education Level of the respondents

Demographic factor	**Study group**	**Variable**	**Frequency**	**Percentage**
Education level	**Anolei**	University degree	0	0.0
		Secondary	2	2.0
		Primary	33	33.0
		No school at all	65	65.0
	Tawakal	University degree	0	0.0
		Secondary	2	8.0
		Primary	13	52.0
		No school at all	10	40
	Defe	University degree	1	6.7
		Secondary	3	20.0
		Primary	6	40.0
		No school at all	5	33.3

Table (4.2) shows the education level of the respondents is wanting. 65% of the members of Anolei cooperative society, 40% of Tawakal and 33.3% of Defe never went to school. Primary graduates consisted of 33%, 52% and 4% of the groups respectively. A few members reached secondary level that is 2%, 8% and 20% respectively. Only one member (6.7%) of Defe group had a university degree. The low education level of the respondents can be attributed to the inability to access the services given the nature of the area (semi-

arid) and the belief that the farming activity doesn't require special skills to operate. Also the inadequate income from the activity isn't enough to educate children to higher levels. However, this trend is changing given the introduction of free primary and secondary education and the requirement by law that all children should get basic education at least up to the secondary level. The study involved 100 members of Anolei, 25 of Tawakal and 15 members of Defe camel milk cooperative societies respectively.

4.3 Camel feeds

The yield of milk produced by the camels is depended on the availability of feeds. The study sought to find out the feeding habits commonly used by the camel milk producers and the results are displayed in the Tables.

Firstly, the researcher assessed the grazing system used by the respondents and the following information realized is as shown in the Table 4.3.

Table 4.3 Grazing system used

Demographic factor	Study group	Variable	Frequency	Percentage
Grazing system	**Anolei**	Zero grazing	1	1
		Semi-grazing	0	0
		Full grazing and browsing	99	99
	Tawakal	Zero grazing	0	0
		Semi-grazing	0	0
		Full grazing and browsing	25	100
	Defe	Zero grazing	5	33.3
		Semi-grazing	1	6.7
		Full grazing and browsing	9	60

Table 4.3 shows that the full grazing system is overwhelmingly used by the members of Anolei and Tawakal groups comprising 99% and 100% respectively. 60% of those in Defe self help group also practice full grazing, 33.3% zero grazing and a mere 6.7% do zero grazing. This results concurs well with the literature review information that pastoral (nomadic) system which is characterized by migration in communal rangelands in search of resources (especially pasture and water) is highly practiced by camel milk producers in Isiolo County. In the literature review it was found that Pastoral camel herders in northern Kenya adopt rational and goal-oriented camel management strategies in utilizing their rangeland environments (Farah et al., 2004).

Secondly, common feeds for the camels were also assessed and the following results obtained as shown in Table 4.4 which shows common feeds for feeding camels.

Table 4.4 Common feeds for feeding camels

Study group	Common feeds	Frequency	Percentage
Anolei	Native browses (Trees and shrubs)	99	99
	Others	1	1
Tawakal	Native browses (Trees and shrubs)	24	96
	Native grasses	1	1
Defe	Native browses (Trees and shrubs)	14	93.3
	Native grasses	1	6.7

Table 4.4 shows that a majority of the respondents feed their camels on native browses (trees and shrubs) as revealed by the 99%, 96% and 93.3% of the Anolei, Tawakal and Defe groups respectively. A mere 1% from each group use native grasses to feed camels. This concurs with the following findings in the literature review. The camel is, by preference, a browser of a broad spectrum of fodder plants, including trees, shrubs, and sometimes hard-thorny, bitter and halophytic (salty) plants that grow naturally in the desert and other semi-arid areas (Field, 2003). The predominant forage species consumed by camels in northern Kenya include *Acacia*, *Cordia, Duosperma, Euphorbia, Grewia, Indigofera* and *Salvadora* (Onjoro, 2004).

Field (1995) noted seasonal variations such that trees, shrubs and dwarf shrubs dominated camel diet in wet season but the percentage of trees and shrubs noticeably declined during the dry season when most of these species shed off their leaves. . Onjoro (2004) states that the yield can be improve to over 10 litres per day with better feeding. Low milk production in pastoral camel system may be due to inadequate quantity and quality forages (Onjoro, 2004).

Respondents were asked whether they grow fodder which can be used to feed their camels and the following results were obtained. Table 4.5 shows whether fodder is grown by the women groups.

Table 4.5 Whether fodder is grown

Study group	Grow fodder	Frequency	Percentage
Anolei	Yes	2	2
	No	98	98
Tawakal	Yes	0	0
	No	25	100
Defe	Yes	0	0
	No	15	100

Table 4.5 reveals that the herdsmen depend on other feeds probably native browses and have no time to grow fodder since they practice nomadism. All the members of Defe and Tawakal groups don't grow fodder and only 2% of those in Anolei do. This explains why they rely mostly on mobile grazing system as was realized above. The following was said in the literature review. The shift from pastoral to peri-urban camel production restricts camels to limited feed resource base. This is particularly evident in Isiolo, northern Kenya, during dry season and droughts where there is pressure on feed resources forcing camel keepers to feed their camels on *Euphorbia tirucalli* (Field, 1995; Maundu and Tengnas, 2005), a succulent non-conventional forage for camels, whose nutritive value and its effect on milk quality is unknown.

The reasons for not growing fodder were then assessed and the results tabulated in table 4.6. Table 4.6 shows major reasons for not growing fodder.

Table 4.6 Major Reasons for not growing fodder

Study group	Reasons for not growing fodder	Frequency	Percentage
Anolei	Insufficient land	20	20
	Insufficient labour	0	0
	Insufficient inputs (seeds,fertilizer and cash)	25	25
	Insufficient information	54	54
Tawakal	Insufficient land	0	0
	Feed for animal is adequate	1	4
	Insufficient inputs (seeds,fertilizer and cash)	5	20
	Insufficient information	19	76
Defe	Insufficient land	0	0
	Insufficient labour	0	0
	Insufficient inputs (seeds,fertilizer and cash)	6	40
	Insufficient information	9	60

Table 4.6 shows that the major reasons for not growing fodder included insufficient information comprising 54%, 76% and 60% of Anolei, Tawakal and Defe groups respectively; insufficient inputs (seeds, fertizer and cash) comprising 25%, 20% and 40% respectively and insufficient land with 20% respondents from the Anolei cooperative society. This agrees with the literature review in which despite mounting interest in camels and camel production research witnessed in the last two to three decades, knowledge of camel's nutritional requirements to provide sufficient information necessary for systematic feeding for efficient and profitable production is still limited (Farid, 1995; Wilson, 1998).

Table 4.7 shows whether feed supplements are bought, the types of feeds bought and the reasons for buying the specified feeds.

Table 4.7 Whether feed supplements are bought, the types of feeds bought and the reasons for buying the specified feeds

		Cooperative society					
Factor	**Variable**	**Anolei**		**Tawakal**		**Defe**	
Whether Feed supplements are bought		**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
	Yes	4	4	0	0	5	33.3
	No	96	96	25	100	6	40
Feed supplements bought		**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
	Hay	4	4	0	0	5	33.3
	Mineral supplements	96	96	25	100	6	40
	Concentrates	0	0	0	0	0	0
Reasons for buying feed supplements most of the time	For lactating camels	88	88	22	88	11	73.3
	For pregnant camels	6	6	2	8	0	0
	Other reasons	0	0	0	0	0	0
Where feeds are bought		**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
	From the farmers' cooperatives	3	3	0	0	5	33.3
	From private agro vet retailers in Isiolo	79	79	19	76	6	40
	From other agro vets	11	11	5	20	0	0

The respondents revealed, as shown in Table 4.7, that they do buy feed supplements with 92%, 96% and 73.3 percentages of respondents from Anolei, Tawakal and Defe groups respectively agreeing. Only 8%, 4% and 26.7% of the respondents from the groups respectively disagreed.

In addition to that, the specific feeds bought for the camels were identified and the results revealed that the respondents mostly purchase mineral supplements like mineral licks for their cattle. This is represented by 96%, 100% and 40% of the Anolei, Tawakal and Defe groups respectively. A few that is 4% and 33.3% of Anolei and Defe groups purchase hay for their camels.

For those who buy the feeds, the study sought to find out the reasons feed supplements are bought most of the time and the information as represented in the Table 4.9 above shows that the feed supplements are bought mainly for lactating camels. This is represented by 88%, 88% and 73.3% of the Anolei, Tawakal and Defe groups. Only 6% and 8% of the members of Anolei and Defe groups buy feed supplements for pregnant camels and none for male and female calves.

Table 4.7shows that most feeds are bought from private agro vet retailers in Isiolo as portrayed by 79%, 76% and 40% of the Anolei, Tawakal and Defe groups. Some of the respondents buy camel feeds from farmers' cooperatives as depicted by 33.3% of Defe group members and 3% of Anolei group members. The result of the study concurs with the work of various authors in the literature review. Work animals usually require more energy in their diets while milking animals require more protein (Yagil, 1994). The traditional camel herdsmen rarely provide supplementary feeds to their camels, other than salt (sodium chloride) or allowing access to salty water and halophytes (salty plants) (Elmi, 1991; Farah et al, 2004).

Simpkin (1995) states that supplementary feeding or zero grazing of camels would only be worth implementing in the more arid areas, using high producing animals, in locations where supplementary fodder is locally available, and where there is a local market for the milk.

When choosing supplementary feeds for camels, feed availability, its nutritive value and cost should form the guiding principle. Supplementary feed for camels can be provided in the form of pods of certain trees, such as *Acacia* trees. Other supplementary feeds can be millet, straw, sorghum, cottonseed, hay, oats, dates and other energy-giving fodder (Yagil, 1994; Wilson, 1989). According to Hashi et al. (1995) consumption of low quality roughages and total feed intake by camels can be improved with supplementary feeding. In their study, Dereje and Uden (2005s) reported that lactating camels on range in Eastern Ethiopia substantially increased milk yield when supplemented with protein or energy feeds. Table 4.8 shows water related factors.

Table 4.8 Water related factors

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Sources of water for camels	Pipeline/tap	2	2	0	0	0	0
	The nearby river	91	91	20	80	13	86.7
	Ponds	3	3	0	0	2	13.3
	Wells	4	4	5	20	0	0
Water transported or camels taken to water sources	Transport the water	1	1	0	0	1	6.7
	Bring the camels	99	99	25	100	14	93.3
Main water related problem	Scarcity	98	98	21	84	15	100
	Parasites	1	1	0	0	0	0
	Unhygienic/impurity	1	1	4	16	0	0

Table 4.8 shows water related factors that influence camel milk production in Isiolo. The first factor assessed the sources of water used for their (respondents') camels. It was revealed that 91%, 81% and 86.7% of the group members get water from the nearby river. Even though Isiolo is a semi-arid area, wells and ponds are scarcely used. These water resources are used often during dry season. Only 3%, and 13.3% of Anolei and Defe sometimes use pond water while 4%, and 20% of Anolei and Tawakal use water from wells respectively. The camels are mostly taken to the water sources to drink water as represented by 99%, 100% and 93.3% of the group members of Anolei, Tawakal and Defe respectively.

In addition to that, it was also revealed that scarcity of water is the main water related problem experienced by the camel milk producers. This was depicted by 98%, 100% and 93.3% of the group members of the respondents respectively. Isiolo District is served mainly by three perennial rivers namely Ewaso Nyiro that drains into Lorian swamp, Isiolo River that originates from Mt. Kenya, and the Bisanadi that drains into River Tana. That explains why the camel milk producers mainly depend on nearby rivers as source of water. However, the district's climate is hot and dry and experiences two rainy seasons throughout the year. The long (around 9 hours) sunshine leads to high evaporation rate hence rendering the area unsuitable for agriculture. But most farmers use irrigation schemes found along the rivers. Strategic damming therefore needs to be done to help solve water problems in the area hence increase productivity of the land and other agricultural produce including camel milk. Camels producing milk have a need for large quantities of water (milk is about 90% water) (Wilson, 1998) and hence water is an important requirement in camels.

4.4 Camel milk marketing

Camel milk production is an income generating activity to the producers as most of them depend on it as their source of daily bread. The researcher therefore sought to unearth the factors affecting marketing of camel milk and the following results were obtained in table 4.9.

Table 4.9 Marketing factors that influence camel milk marketing

		Cooperative society					
Factor	**Variable**	**Anolei**		**Tawakal**		**Defe**	
		Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Demand of camel milk	Yes	100	100	25	100	13	86.7
	No	0	0	0	0	2	13.3
Purchasers of camel milk	To individuals	12	12	2	8	6	40
	To caterers	29	29	3	12	3	20
	To retailers	59	59	20	80	6	40
	To others	0	0	0	0	0	0
Milk marketing out let selection Criterion	Price of milk per litre	78	78	14	56	6	40
	Distance of market for milk	0	0	0	0	3	20
	Market reliability	20	20	11	44	6	40
	Long term contract	1	1	0	0	0	0

Table 4.9 shows that the demand for camel milk was high as revealed by 100% of the respondents from both Anolei and Tawakal groups and 86.7% of the Defe group members. Only 13.3% of Defe group members did not accept. This can be attributed to the economic, nutritional and cultural benefits of camel milk production. As a drought resistant animal, people in dry areas take advantage of the situation to keep camels in addition to the believe that the animal produces milk high in nutrients and closest to human milk. Also the high demand can be associated with the decrease in milk consumption within households during the dry season due primarily to lack of feed resources and general decline in the nutrition health of lactating animals. Camels are therefore important for household food security because the lactation period extends longer into the dry season.

Camel milk purchasers were found mainly to be retailers as depicted by 59%, 80% and 40% of the respondents from Anolei, Tawakal and Defe groups respectively. Some farmers sell camel milk to caterers (29%, 12% and 40%) respectively and few to individuals. This is because most individuals buy the milk from the retailers who buy from the farmers in large quantities. The retailers also transport camel milk via buses to urban and peri-urban centres. The assessment of the criterion mostly used in selecting milk marketing out let revealed that camel milk farmers used price of milk per litre.

This is shown by the 78%, 56% and 40% of the respondents from Anolei, Tawakal and Defe groups respectively. Others, 20%, 44% and 40% of the groups' members, rely on the market reliability as their market out let selection criteria. They select reliable suppliers to sell the camel milk probably on their behalf or at reasonable negotiation price as they have little time to reach consumers far away in urban areas to assess their demand. However, as stated in the literature review where there is access to market, dairying is preferred to meat production since it makes more efficient use of feed resources and provides regular income to the producer (De Leeuw, 1999).

Marketing also has its own challenges and the study sought to find out some of the major problems experienced in marketing of camel milk. The data is displayed in the tables below. Table 4.10 shows whether milk marketing problems have been experienced at any period.

Table 4.10 whether milk marketing problems have been experienced at any period

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Ever experienced Marketing problem	Yes	100	100	25	100	15	100
	No	0	0	0	0	0	0

All the respondents, as shown in the above table, admitted that they experience marketing problems. The study therefore assessed some of the challenges the milk marketing producers go through and the results were as shown in the table 4.11.

Table 4.11 Challenges faced in the marketing of camel milk

Study group	**Challenges faced in marketing**	**Most Important**		**Least Important**	
		Frequency	**%**	**Frequency**	**%**
Anolei	Inadequate transport means	56	56	6	6
	Poor roads	8	8	15	15
	Lack of cooling facilities	25	25	15	15
	No organized market or links	10	10	2	2
	Lack of capacity building	1	1	62	62
Tawakal	Inadequate transport means	1	4	8	32
	Poor roads	1	4	10	40
	Lack of cooling facilities	17	68	0	0
	No organized market or links	0	0	2	8
	Lack of capacity building	6	24	5	20
Defe	Inadequate transport means	3	20	3	20
	Poor roads	1	6.7	4	26.7
	Lack of cooling facilities	9	60	0	0
	No organized market or links	0	0	0	0
	Lack of capacity building	2	13.3	8	53.3

The challenges were ranked from the most important to the least important and the importance varied to some extent among the groups. Tawakal (68%) and Defe (60%) groups classified the lack of cooling facilities as their main important challenge. This is due to the nature of milk that is it his highly perishable and can easily spoil unless it is converted to other products. This is also the reason why a reliable marketing out let is chosen to supply milk. This is supported by the following findings in the literature review.

The scattered nature of the production units, the poor communication system, and the low rate of urbanization and low infrastructure of road facilities may also not warrant the establishment of processing plants (IPS, 2000). A pastoral community depends mainly on milk and milk products for its survival and therefore, these items are not perceived to be for commercial purposes. Thus it's only the households who are in a walking distance from the urban centers who sell milk and milk products to urban consumers (IPS, 2000).

The method used to deliver milk and means of transport used to transport milk tor sale most of the time were also assessed and the results tabulated as shown in table 4.12.

Table 4.12 Milk delivery methods and transport means used in the sale of camel milk

		Cooperative society					
Factor	**Variable**	**Anolei%**		**Tawakal%**		**Defe%**	
Milk delivery method	Delivery by family member	87	87	17	68	11	73.3
	Collected by cooperative society	0	0	0	0	0	0
	Collected by consumers or purchasers	13	13	8	32	4	26.7
Means of transport used in milk sale	Public transport (matatus/ buses)	92	92	16	64	12	80
	Private transport	6	6	3	12	3	20
	Traveling on foot	1	1	0	0	0	0
	Using pack animals	1	1	6	24	0	0

Table 4.12 reveals that the main deliver methods used to deliver milk for sale was the use of family members. This was specified by 87%, 68% and 73.3% of the members from Anolei, Tawakal and Defe groups respectively. Other (13%, 32% and 26.7% respectively) respondents specified that milk is collected by consumers or other purchasers.

The main means of transport used in transporting milk for sale was public transport (matatus/ buses) as they comprised of 92%, 64% and 80% of the respondents from Anolei, Tawakal and Defe groups respectively. This is because the public transport means are readily available and are quite cheap and fast. Private transport is scarcely used and is represented by 6%, 12% and 20% respectively. Only one person travels on foot and another respondent uses pack animals such as donkey carts both belonging to Anolei cooperative society. This concurs with literature review in which the informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood and sales to itinerant traders or individuals in nearby towns (Siegefreid, 2001). The differences in distance to different milk market places affect the price of milk (Kurtu, 2004).

4.5 Camel milk production performance

The camel milk production performance factors were assessed and the results are shown in Table 4.13 which shows number of times camels are milked per day, the milk produced per camel per day on average and the months of lactation.

Table 4.13 Number of times camels are milked per day, the milk produced per camel per day on average and the months of lactation

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Number of times camels are milked per day	Morning only	0	0	0	0	0	0
	Morning and evening	82	82	20	80	8	53.3
	Morning, mid day and evening	18	18	5	20	7	46.7
Milk produced per camel per day on the average	Less than 1 litre	0	0	0	0	0	0
	1-5 litres	20	20	8	32	2	13.3
	6-10 litres	68	68	15	60	10	66.7
	More than 10 litres	12	12	2	8	3	20
Months of lactation	1-3 months	0	0	0	0	3	20
	4-6 months	10	10	3	12	3	20
	7-9 months	81	81	22	88	7	46.7
	10 and above	9	9	0	0	2	13.3

Table 4.13 above shows that most of the time, camels, like other cattle (for instance cows), are milked in the morning and evening. This was responded to by 82%, 80% and 53.3% of Anolei,Tawakal and Defe society members. Few farmers milk their camels thrice (morning, midday and evening) a day. This explains why they produce quite large amounts of milk.

The milk produced per camel per day ranges from 6-10 litres. This was highlighted by 68%, 60% and 66.7% of the Anolei, Tawakal and Defe women groups. Some camels produce about 1-5 litres of milk each per day as represented by 20%, 32% and 13.3% of the respondents respectively. A few camels produce more than 10 litres. The milk production varies with seasonality which affect feeds availability and the lactation period. The lactation months were around 7-9 months as specified by 81%, 88% and 46.7% of the responses from the groups above respectively. Few animals had lactation periods of about 4-6 months and 10 months and above.

This is supported by the following findings in the literature review. It is estimated that the Kenyan camel population is capable of producing between 340 and 350 million litres of milk (Faye, 2007; Akweya et al., 2010) and 10,000 tonnes of meat a year (Faye, 2007). In Russia milking capabilities of the Bactrian, the dromedary, and the hybrid of these two types of camels were examined (Kheraskov, 1955, 1961, 1965; Lakosa & Shokin, 1964; Dzhumagulov, 1976). The dromedary gave more milk than the Bactrian or the hybrids. In one of the very few long-term studies covering full lactation periods, Bekele et al. (2002) demonstrated the potential of camels as dairy animals under traditional pastoral management. Seasonal variations in camel milk production are high (Bekele et al., 2002; Muliro, 2007). A number of factors influence milk production and may be responsible for the large differences in the reported figures. These factors include: feed quantity and quality, breed, climate, watering frequency, stage of lactation and frequency of milking (Ramet, 2001; Bekele et al., 2002; Farah, 2004).). Camels are usually milked twice a day – morning and evening; however, if the need arises they can be milked every 2 – 3 hours (Farah et al., 2004).

Bekele et al. (2002) reported the number of milkings per day ranged from 1 to 4 for camels under traditional pastoral management. Wernery (2003) states that camels must be milked 4 to 6 times a day to gain optimal milk yield. Although there are fewer long-term studies covering full lactation period, it is widely recognized that, in absolute terms, the camel produces more milk and for a longer period of time than other livestock species under harsh environmental conditions (Farah et al., 2007). Average daily milk yield of the Somali breed

camels is reported to range from 5 to 8 litres (Bekele et al., 2002; Farah, 2004; Farah et al., 2004). Under exceptionally favourable conditions, Somali camels can potentially produce more than 15 litres of milk a day during the peak of their lactation (Farah et al., 2004). Ramet (2001) had also reported that under more intensive systems camels can yield up to 12 to 20 litres a day. The constraints influencing camel milk production were assessed and the results displayed in the table 4.14.

Table 4.14 Constraints influencing camel milk production

Study group	Constraints	Most Important		Least Important	
		Frequency	%	Frequency	%
Anolei	Feed shortage	15	15	2	2
	High feed prices	1	1	32	32
	Diseases and parasites	50	50	2	2
	High medicament costs	4	4	26	26
	Shortage of land for grazing	2	2	4	4
	Lack of capital	2	2	17	17
	Lack of market for milk	26	26	3	3
	Inefficient breeding services	0	0	14	14
Tawakal	Feed shortage	0	0	1	4
	High feed prices	0	0	5	20
	Diseases and parasites	15	60	0	0
	High medicament costs	0	0	5	20
	Shortage of land for grazing	0	0	4	16
	Lack of capital	1	4	7	28
	Lack of market for milk	9	36	0	0
	Inefficient breeding services	0	0	3	12
Defe	Feed shortage	0	0	3	20
	High feed prices	0	0	0	0
	Diseases and parasites	7	46.7	0	0
	High medicament costs	4	26.7	1	6.7
	Shortage of land for grazing	0	0	1	6.7
	Lack of capital	0	0	8	53.3
	Lack of market for milk	4	26.7	1	6.7
	Inefficient breeding services	0	0	1	6.7

Table 4.14 shows that the most important constraints influencing camel milk production were varied among the respondents from the three groups. The most important constraint specified by the respondents was diseases and parasites. This is a big threat to camels in the area. This was specified by 50%, 60% and 46.7% of the Anolei, Tawakal and Defe groups respectively. Lack of market for milk is another constraint influencing the production of milk.

This was specified by 26%, 36% and 26.7% of the group members of Anolei. Tawakal and Defe societies.). The constraints of marketing is supported by the following findings in the literature review. Only about 12% of the Kenyan camel milk is marketed, the bulk of which is sold in raw form to rural consumers (10%) and only 2% reaches the urban consumers (Akweya et al., 2010).

The same authors state that from the remaining milk (88%) that does not reach the market, 38% is directly used by camel keeping households and their herders as part of their food requirements and the remaining 50% (or 170 million litres) goes to waste. Muliro (2007) also states that during the rainy season, much of the surplus camel milk goes to waste. There is, therefore, a great opportunity for commercialization and enhanced incomes for camel keeping pastoral communities (Muliro, 2007; Akweya et al., 2010). In Isiolo milk marketing system is not well developed (Ahmed *et al.*, 2003) especially, market access in pastoral production system is a critical factor (Tsehay, 2002).

4.6 Camel breeds

Table 4.15 shows camel breeds kept by the women groups.

Table 4.15 Types of camel breeds kept

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Type of camels	Local/ indigenous	99	99	25	100	15	100
	Cross breeds	0	0	0	0	0	0
	Exotic breed	1	1	0	0	0	0
Breed that produces most milk	Local/ indigenous	42	42	6	24	9	60
	Cross breeds	3	3	2	8	0	0
	Exotic breed	55	55	17	68	6	40
Types of camels kept	Single humped	99	99	25	100	15	100
	Double humped	1	1	0	0	0	0
Reasons	They produce higher amount of milk	60	60	12	48	9	60
	They produce calves faster	2	2	0	0	1	6.7
	They grow better and faster	3	3	0	0	0	0
	They are easy to manage	8	8	1	4	0	0
	They are more resistant to diseases	26	26	12	48	5	33.3

Table 4.15 shows that most (99%, 100% and 100%) camel milk producers of the Anolei, Tawakal and Defe group members respectively prefer local/ indigenous breed as opposed to other breeds. This is due to claims that the other breeds especially the exotic and crossbreeds are susceptible to diseases.

The exotic breed is also quite expensive to maintain. However, the exotic breeds produce more milk as specified by 55%, 68% of the Anolei and Tawakal group members. Local/ indigenous breed also produce more milk than crossbreeds as 42%, and 24% of the respondents from Anolei and Tawakal groups indicated. Contrary to that, 60% of Defe groups' members specified that the exotic breed produces more milk than other breeds. This was closely followed by the exotic at 40%.

Majority of the respondents reported that single-humped camels are kept mainly because they produce higher amounts of milk. They (26%, 48% and 33.3% of the respondents respectively) also indicated that the single-humped camels are more resistant to diseases.
The single-humped camel grows a thick-coat of hair hence better suited to cooler climates than double humped. Table 4.16 which shows the breeding techniques, reason for the chosen breeding technique, reason for not using artificial breeding methods and the criterion of camel disposal.

Table 4.16 The breeding techniques, reason for the chosen breeding technique, reason for not using artificial breeding methods and the criterion of camel disposal.

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Breeding techniques	Artificial insemination	1	1	0	0	3	20
	Natural mating	99	99	25	100	12	80
Reasons for using AI	Have do have access to AI services	1	100	0	0	3	100
	Its simpler than raising a male camel	0	0	0	0	0	0
	It is more economical than a male camel	0	0	0	0	0	0
	I do not have a male camel for mating	0	0	0	0	0	0
Reasons for not using AI	I have no access to AI services	69	69	18	72	7	46.7
	AI service efficiency not good	1	1	1	4	0	0
	Cultural reasons	2	2	0	0	2	13.3
	I have a male camel	27	27	5	20	3	20
Criterion used to select camels to dispose off	Old age	78	78	24	96	11	73.3
	Sickness	3	3	1	4	0	0
	Low milk production	10	10	0	0	4	26.7
	Infertility	9	9	0	0	0	0

Table 4.16 shows that the mostly used breeding technique is Natural process at 99%(99 respondents of Anolei), 100% (25 respondents of Tawakal) and 80% (12 respondents of Defe) cooperatives .Artificial method of breeding is not commonly used with negligible percentage of 1%,0% and 20% for Anolei ,Tawakal and Defe cooperatives respectively.

Secondly table 4.16 indicates the reason for using AI for the camel farmers who opt for artificial breeding techniques. A majority of the farmers don't have access to AI services hence it explains why most of the entries in the above table is 0%.

Thirdly table 4.16 shows that most of the farmers don't use the AI services because they lack access to the services at more than 50% of the three cooperatives, others don't use it because they feel it is culturally out of place and lastly for a reason that they own the male camels.

It is also clear from the above table that the main criterion for the disposal of the animal on the higher benchmark for disposal is taken by Old age at 78%, 96% and 73.3% for the three cooperative Anolei, Tawakal and Defe cooperatives respectively. Table 4.17 shows most common camel diseases.

Table 4.17 Most common camel diseases

Factor	Variable	Cooperative society					
		Anolei		**Tawakal**		**Defe**	
		Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Most common camel diseases	Trypanosomiasis	52	52	7	28	4	26.7
	Camel pox	3	3	1	4	2	13.3
	Swollen glands	18	18	7	28	2	13.3
	Tick infestation	1	1	0	0	2	13.3
	Mastitis	19	19	5	20	1	6.7
	Gastro intestinal	1	1	0	0	3	20
	Anthrax	5	5	0	0	0	0
	Respiratory infection	1	1	5	20	1	0.1

Table 4.17 also shows that the most prevalent camel diseases are Trypanosomiasis for the three camel societies. Anolei recorded 52%, Tawakal 28% and Defe about 27% of Trypanosomiasis.

This was followed by Mastitis at 19% for Anolei, 20 % for Tawakal and 07% for Defe. It was also noted that swollen glands are also common at 18% in Anolei,19% in Tawakal and about 13 % in Defe.

Generally, Anthrax is the least concern for Pastoralists according to the study as Anolei recorded 5% prevalence while Tawakal and Defe had no incidence of anthrax reported. The problem of camel diseases is supported by the findings of the following two authors. Poorly fed Camels have low disease resistance, fertility problems, partly because the Camel health care system relies heavily on veterinary measures and services.

Moreover, poor grazing management systems continue to cause high mortality and morbidity (e.g. internal parasites), many of the diseases constraints which affect supply are also a consequence of the non-technical constraints, for example, insufficient money to purchase drugs or vaccines (Ibrahim and Olaloku, 2002). Contact of livestock brought from varies localities through the use of communal pastures and watering as well as marketing places play an important role in the transmission of economically significant infectious and parasite diseases. Such livestock movements could be the cause of direct or indirect transmission of varies economically important camel diseases (Zinash, 2004).

Table 4.18 shows frequency of Awareness of veterinary services.

Table 4.18 Frequency of Awareness of veterinary services

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Awareness of veterinary officer	Yes	46	46	23	92	12	80
	No	54	54	2	8	3	
Number of times visited by veterinary officer	Never visited	19	19	7	28	2	20
	Once a month	1	1	0	0	2	13.3
	Once in three months	0	0	0	0	3	13.3
	Once in six months	12	12	2	8	1	20
	Once in a year	14	14	14	56	5	6.7
Source of information on camel production	Radio	7	7	7	28	0	33.3
	Newspaper	0	0	0	0	0	0
	From farmers Association	43	43	0	0	0	0
	None	5	5	2	8	3	0
Usage of traditional herbal remedies	Yes	97	97	25	100	9	60
	No	3	3	0	0	6	40
Reason for herbal remedies	Veterinary services are not available	62	62	15	60	9	60
	Veterinary costs are high	30	30	9	36	6	40
	Veterinary medicaments are not efficient	7	7	1	4	0	0

The Table 4.18 shows that 54% of the Anolei farmers are not aware of the veterinary extension officers in Isiolo while a sharp contrast of awareness of 92% and 80% of Tawakal and Defe farmers respectively are aware of the camel veterinary extension officers. Interestingly the farmers are never visited by the extension officers.19%, 28% and 20% of Anolei, Tawakal and Defe cooperatives respectively were never visited out of the

farmers(46%) who are aware of the camel veterinary officers. It is also evident that the major source of information on camel dairy production is from farmers association registered at 43% for Anolei.

Radio is seen as second source of information with a majority from Defe cooperative 33.3% and 28% by Tawakal. When it comes to camel medication a higher percentage of farmers rely on herbal remedies at 97%, 100% and 60% for the Anolei, Tawakal and Defe cooperatives respectively. Most of the farmers prefer the herbal remedies just because the veterinary services are not available that is portrayed by 62%, 60% and 60% of the Anolei, Tawakal and Defe respondents respectively. In the literature review it was found that Government veterinary staffs are few in number and cannot cover such a vast area to adequately address the veterinary needs of livestock keepers. Besides Government staffs need adequate mobile facilities, for which currently the Government does not have the capacity to provide (Tafesse, 2001).

Table 4.19 shows frequency of utilization of veterinary services.

Table 4.19 Frequency of utilization of veterinary services

Factor	Variable	Cooperative society					
		Anolei		Tawakal		Defe	
		Frequency	%	Frequency	%	Frequency	%
Do you use veterinary services	Yes	53	53	20	80	12	80
	No	44	44	5	20	3	20
Where do you get veterinary services	Government veterinarians.	8	8	9	36	8	53.3
	Private Veterinarians.	28	28	4	16	1	6.7
	Animal Health Assistants	0	0	0	0	1	6.7
	NGOs Extension Services.	20	20	7	28	2	13.3
	Others	0	0	0	0	0	0
Have you lost your camel due to drought	Yes	65	65	17	68	12	80
	No	35	35	8	32	3	20
Initial percentage of camel which died	Less than 5%	54	54	15	60	9	60
	Between 5% - 10%	9	9	1	4	3	20
	Between 10% - 25%	1	1	1	4	0	0
	Between 25% - 50%	2	2	0	0	0	0
	Greater than 50%	0	0	0	0	0	0

Table 4.19 shows that when it comes to use of the veterinary services 53% of Anolei, 80% of Tawakal and 80% of Defe uses the veterinary services. Higher margins of farmers from Anolei don't use the veterinary services at 44%. The major providers of the veterinary services for the farmers are the private veterinary and the government. Anolei farmers mainly access the services from private veterinaries at 28% followed closely by NGO service

providers. For Tawakal and Defe farmers they majorly receive their veterinary services from the government at 36% and 53.3% respectively.

The camel loss by drought that is drought contributes 65%, 68% and 80% of Anolei, Tawakal and Defe camel loss to farmers respectively. This shows that most of the farmers have at a time lost their camel as a result of drought. Although the number of camels lost as a result of drought according to the farmers stands at Less than 5% of the farmers camel population across the divide an indication that camels are generally drought resistant or the species reared by the three categories of farmers are able to inhibit the extreme climate conditions.

CHAPTER FIVE
SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings of the study, discussion, conclusions and recommendations arrived at. The study assessed the factors influencing camel milk production in Central Division of Isiolo District. It established how camel feeds influence camel milk production; how camel milk marketing and infrastructure influence camel milk production and how camel breeds influence camel milk production in Central Isiolo. The study also examined how extension services influence camel milk production in Central Isiolo District. It sought to find ways through which camel milk production can be improved to benefit the farmers and other stakeholders. Suggestions for further studies are also considered.

5.2 Summary of Findings

The summary covers findings on camel feeds, camel milk marketing and infrastructure, camel breeds and extension services.

5.2.1 Camel feeds

The study found that majority of the camel milk producers use full grazing and browsing as their main grazing system. The most common feed for feeding camels were native browses (Trees and shrubs).

It was also revealed that most of the farmers don’t grow fodder because of insufficient information and insufficient rains. For few who grow fodder, the mostly grown fodder forage is grass.

Camel milk farmers do buy feed supplements for their camels. The main feed supplement bought was found to be mineral supplements like mineral licks. These feed supplements are bought most of the time for lactating camels. Some farmers buy them for pregnant camels. It

was also revealed that the feed supplements are bought from private agro vet retailers in Isiolo.

The study revealed that the main source of water for camels was the nearby river. Wells were also used sparingly. It was found that the farmers bring the camels to the rivers. In addition to that, water scarcity was found to be the main water elated problem in the area.

5.2.2 Camel milk marketing and infrastructure

The study found that there is high demand for camel milk among the consumers. The milk produced was sold mostly to retailers and some to individuals. Price of milk per litre was used mainly as the milk marketing out let selection criterion while market reliability also determined the criterion used to some extent. The respondents also admitted to experiencing problems while marketing their product (milk). The most important problem experienced was the lack of cooling facilities.

It was also revealed that the main means of transport used in transporting milk for sale was public transport which includes the use of matatus and buses. In addition to that, the milk was delivered mostly by family members to the market.

5.2.3 Camel breeds

The study found that the farmers mostly keep local/ indigenous breeds. The respondents then mentioned that the exotic breeds produce most milk even though some argued that the local breeds do.

It was also revealed that the type of camel kept is the single humped camel. The main reason for keeping the single humped camel was because the camels produce higher amounts of milk.

Furthermore, it was found that the breeding technique used mostly was natural mating reason being that most of the farmers don’t have access to artificial insemination services. Many farmers who don’t use the AI services indicated that they have no access to the services and

some have male camels. It was also revealed that old age was the main criterion considered in selecting camel to dispose off in relation to breeding.

5.2.4 Extension services

The study found out that the most common camel diseases or health complications were Tripanosomiasis, swollen glands/ Haemorrhagic septicaemia, mastitis and respiratory infection and Pneumonia. A large number of the respondents were not aware of the presence of veterinary extension officers in Isiolo although the ones who knew of their presence were never visited. The farmers who didn't know about the presence of veterinary officers indicated that they get information on camel dairy production from the farmers' cooperatives associations and some obtained it from the radio.

It was also realized that most of the farmers used traditional or herbal remedies for their camels because veterinary services were not available. The population studied showed that most of them don't use veterinary services but the few who use this service accessed the service from private veterinarians closely followed by government veterinarians.

Furthermore, the respondents mentioned that an average of 71 calves, 17 heifers, 36 milking camels and 45 male camels were lost annually as a result of diseases. It was then found that camels were also lost as a result of drought although the death percentage was less than 5% of the farmers' herd.

Finally, the respondents suggested that some ways in which camel loss could be reduced. These included controlling diseases, providing enough watering points for animals, curb insecurity (camel rustling), availing veterinary services to the farmers and providing insurance services.

5.3 Discussion of the results

A discussion of the findings is given.

5.3.1 Camel feeds

The study found that full grazing and browsing were the mostly used grazing systems with native browses as the main feeds. They purchase feed supplements mostly in form of mineral supplements and licks for their lactating and pregnant camels.

The study also found that the main source of water for the camels was from the nearby rivers. Wells were used sparingly. However, during dry spell, wells are mostly used as the rivers dry up. The camels were mostly taken to the rivers for watering. The farmers being nomads move with their cattle from one place to another in such of feeds and water.

The results above concur with a previous report (Field, 2005) that the camel is, by preference, a browser of a broad spectrum of fodder plants, including trees, shrubs, and sometimes hard-thorny, bitter and halophytic (salty) plants that grow naturally in the desert and other semi-arid areas. Isiolo is a semi-arid area too and most of the farmers don't have their own land hence use the communal rangeland to graze their cattle. This is contrary to other cattle types like cows which are selective while grazing.

5.3.2 Camel milk marketing

The study found that the farmers mostly use retailers to supply the camel milk to the environs and beyond. The main distribution channel used therefore is Farmer-Retailer-Consumer. The retailers bridge the gap between the busy nomads and the camel milk customers and the main means of transport used was public transport involving the use of matatus and buses to deliver camel milk to urban and peri-urban consumers. It was revealed that demand for camel milk was on high and this can be attributed to the nutritional and medicinal value of the milk.

The results coincide with leading scientists at the Kenya Medical Research Institute (KEMRI 2007) who detected a protein similar to insulin in the milk in Kenya and Germany a few years ago. According to 2007 figures, Kenya has over 5 million diabetics. Clinical trials

carried out by KEMRI in Nairobi have also shown that tuberculosis patients enjoy a quick recovery rate after consuming camel meat and milk.

5.3.3 Camel breeds

The study findings revealed that local/ indigenous breeds which includes Somali, Rendie/ Gabra and Turkana are mostly kept by the farmers mainly due to their belief that they produce more milk. The single-humped (dromedary) camels were the main camel breeds kept.

These results concur with a similar study in Russia on milking capabilities of the Bactrian camel, the dromedary camel and the hybrid of the two breeds of camels which were examined (Kheraskov, 1955, 1961, 1965; Lakosa & Shokin, 1964; Dzhumagulov, 1976). The dromedary camel gave more milk than the Bactrian or the hybrids. The study also revealed that natural mating was the main breeding technique used due to unavailability of artificial insemination services.

5.3.4 Extension services

It was shown from the study that the most common camel diseases or health complications were Trypanosomiasis, swollen glands/ Haemorrhagic septicaemia, mastitis and respiratory infections and Pneumonia. This was as a result of lack of awareness on Veterinary services and cost of drugs leading to the wide use of traditional veterinary remedies.

The respondents mentioned that the chief source of veterinary service provision was from private veterinary officers probably due to their availability and their view of the nomads as their clients. This shows lack of commitment from the government to provide veterinary extension services. The findings agrees with a previous report (Field,2005).

5.4 Conclusions of the Study

The following conclusions were made:-

1. The study found that several factors influenced camel milk production ranging from the production of milk to the consumption.
2. The main factors influencing camel milk production included camel feeds (grazing systems practiced, supplements and availability of water).
3. Camel milk marketing and infrastructure affects camel milk production. The most important problem experienced was lack of cooling facilities and that the main means of transport used in transporting camel milk for sale was public transport.
4. Camel breeds and breeding techniques influence camel milk production. The Dromedary Camel gave more milk than the Bactrian or Hybrid Camel.
5. The availability and provision of veterinary extension services improved awareness on camel diseases and that traditional veterinary remedies were used due to high cost of veterinary drugs.

5.5 Recommendations

It is evident that camel feeds, camel marketing, camel breeds and veterinary extension services influence the production of camel milk in Isiolo District in Isiolo County. To help in the realization of higher camel milk production, the following recommendations were made

1. Grazing systems should be organised in order to reduce conflicts arising from pastoralists who oftenly clash for pasture and plant fodder to supplement feeds especially during dry spells.
2. Construction of community based dams/pans should be done to reduce water shortage.
3. More wells/boreholes should be sunk or improved in order to make it easier to draw water.
4. Breeding practices should be modernized and improved.
5. An efficient system of marketing camel milk and its products should be established to ensure effective operations both during peak production periods and during periods of drought when the milk becomes vitally important.

6. A veterinary advisory programme should be drawn up to decide how to control and prevent prevalent diseases.

5.6 Suggestions for further study

The following suggestions for further studies were made:-

1. The study concentrated more on the factors affecting camel milk production but further studies should be done to unearth the nutrition content and hygienic level of the camel milk.
2. The Camel milk preservation methods used should also be investigated.
3. Another study can be done in other areas to compare findings.

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APPENDICES

APPENDIX 1: LETTER OF INTRODUCTION

Mohamed Diba
P.O. Box 101,
Isiolo.

Dear respondent,

RE: DATA COLLECTION

I am a student at the University of Nairobi pursuing a Masters of Arts Degree in Project Planning and Management. I would like to conduct a research project on the factors that influence the production of camel milk in Central Division of Isiolo District, a case of Anolei camel milk women Cooperative Society, Tawakal and Defe camel milk women self help groups. Kindly complete the attached questionnaire and give accurate information that will be used entirely for this research and outmost confidentiality will be observed. Your assistance is highly valued.

Thank you in advance.

Yours faithfully,

Mohamed Diba Dokata.
L50/71924/2011

APPENDIX 2: Questionnaire for respondents

Please tick in the relevant boxes and fill blank spaces.

Social economic characteristics (tick the appropriate response option)

1. What is your gender?

    1. Male ☐
    2. Female ☐

2. What is your education level?

    1. University degree ☐
    2. Secondary education ☐
    3. Primary education ☐
    4. No school at all ☐

4. Which is your cooperative society?

    1. Anolei camel milk cooperative society ☐
    2. Tawakal women self help group ☐
    3. Defe camel milk self help group ☐

Section A: Camel Feeds

1. What type of grazing system are you using?

    1. Zero grazing ☐
    2. Semi-grazing ☐
    3. Full grazing and browsing ☐

2. Which is the most common feed for feeding your camels?

    1. Native browses (Trees and shrubs) ☐
    2. Native grasses ☐
    3. Traditional plant roots, tubers and pods ☐
    4. Non-traditional feed resources e.g. Euphorbia ☐
    5. Purchased commercial feeds ☐
    6. Others (specify) ☐

2. Do you grow fodder forage?

    1. Yes ☐
    2. No ☐

3. If yes, which fodder forage?

1. Grass ☐
2. Cultivated forage ☐
3. Acacia trees and pods ☐

4. If NO, what are your major reasons for not growing fodder crops?

1. Insufficient land ☐
2. Insufficient labor ☐
3. Insufficient inputs (seed, fertilizer, and cash) ☐
4. Insufficient draft animal power ☐
5. Feed for animals is adequate ☐
6. Insufficient information ☐

5. Do you buy any feed supplements for your camels?

1. Yes ☐
2. No ☐

6. If YES, which feed supplements do you buy?

1. Hay ☐
2. Minerals supplements like mineral licks ☐
3. Concentrates like dairy cubes ☐

7. Why do you buy these feed supplements most of the time?

1. for lactating camels ☐
2. for pregnant camels ☐
3. for male calves ☐
4. for female calves ☐
5. for male camels ☐

8. From where do you buy your feeds?

1. from the farmers' cooperatives ☐
2. from private agro vet retailers in Isiolo ☐
3. from other agro vets ☐
4. Supplied by ministry ☐

9. Which sources of water do you use for your camels?

1. Piped/tap water ☐
2. The nearby river ☐
3. Ponds ☐
4. Wells ☐

10. Do you usually transport the water or bring the camels to the rivers or pond or tap water?

1. Transport the water ☐
2. Bringing the camels to the river, pond or tap water point ☐

11. What is your main water related problem?

1. Scarcity ☐
2. Parasites ☐
3. Unhygienic/impurity ☐

Section B: Camel milk marketing

1. Is there demand of camel milk?
   1. Yes ☐
   2. No ☐
2. Whom do you sell your camel milk to?
   1. to individuals ☐
   2. to caterers/hotels ☐
   3. to retailers ☐
   4. to Processing cooperatives ☐
   5. to others ☐
3. What criterion do you mostly use in selecting your camel milk marketing out let?
   1. Price of milk per litre ☐
   2. Distance of market for milk ☐
   3. Market reliability ☐
   4. Long term contract ☐
4. Is there any period you have problem of marketing your milk?
   1. Yes ☐
   2. No ☐

5. If yes, rank the challenges you face (1 most important and 5 least important)

1. Inadequate transport means for the camel milk. ☐
2. Poor roads which become impassable during the rainy seasons. ☐
3. Lack of cooling facilities/use of plastic jerricans. ☐
4. No organized market/ no linkage to other markets resulting to low milk prices. ☐
5. Lack of capacity building on clean milk production and camel milk value addition ☐

5. Which method are you using for the delivery of your milk?

1. I or another family member delivers it to the market ☐
2. Collected by cooperative society ☐
3. Collected by consumers or purchasers ☐

6. Which transport means are you using to transport your milk for sale most of the time?

1. Public transport (matatus/buses) ☐
2. Private transport (Motor bikes/Bodabodas/bicycles) ☐
3. Traveling on foot ☐
4. Using pack animals (Donkey carts) ☐

Section C: Camel milk production performance

1. How many times do you milk your camels per day?

1. Morning only ☐
2. Morning and evening ☐
3. Morning, mid day and evening ☐

2. How much milk is produced per camel per day in your herd on the average presently?

1. Less than 1 litre ☐
2. 1-5 litres ☐
3. 6-10 litres ☐
4. More than 10 liters ☐

3. How many months of lactation do you normally have?

1. 1-3 months ☐
2. 4-6 months ☐
3. 7-9 months ☐
4. 10 and above ☐

4. Please rank the following most important constraints influencing camel milk production (1 most important and 8 least important)

1. Feed shortage ☐
2. High feed prices ☐
3. Diseases and parasites ☐
4. High medicament costs ☐
5. Shortage of land for grazing ☐
6. Lack of capital ☐
7. Inefficient breeding services ☐
8. Lack of market for milk ☐

Section D: Camel breeds

1. Which types of camel breeds do you keep?

1. Local / indigenous ☐
2. Cross breeds ☐
3. Exotic breeds ☐

2. Which of the above breeds produces most milk?

1. Local / indigenous ☐
2. Cross breeds ☐
3. Exotic breeds ☐

3. Which of the following two types of camel do you keep?

1. Single humped ☐
2. Double humped ☐

4. Why do you keep the breed of camel mentioned in (1) above? (Only one best answer)

1. They produce higher amount of milk. ☐
2. They produce calves faster ☐
3. They grow better and faster. ☐
4. They are easy to manage ☐
5. They are more resistant to diseases ☐

3. What kind of breeding technique do you use mostly?

1. Artificial insemination ☐
2. Natural mating ☐

4. If you use AI, indicate why?

1. I do have access to AI services ☐
2. It is simpler than raising a male camel ☐
3. It is more economical than a male camel mating ☐
4. I do not have a male camel for mating ☐

5. If you do not use AI, indicate why?

1. I have no access to AI services ☐
2. The efficiency of AI service is not good ☐
3. I do not want to use AI services because of cultural reasons ☐
4. I have a male camel, which I can also use for other purposes like transport ☐

6. When you want to dispose your camels, what criterion do you use in selecting the one(s) to dispose in relation to breeding?

1. Old age ☐
2. Sickness ☐
3. Low milk production ☐
4. Infertility ☐

Section E. Extension services

1. What are the most common camel diseases or health complications in your herd?

1. Trypanosomiasis, *Dukan* (Somali); ☐
2. Camel Pox, *Furuk,* (Somali); ☐
3. Swollen Glands / Haemorrhagic Septicaemia, *Qarir, Kharar,* Kurri(somali) ☐
4. Tick infestation/paralysis, *Yakhal* (Somali); ☐
5. Mastitis, *Canda-barar* (Somali); ☐
6. Gastro-Intestinal Worm Infections *Bahala* (Somali); *Minyoo* (Swahili). ☐
7. Anthrax, *Kud, Khut* (Somali); ☐
8. Respiratory Infection and Pneumonia, *Dugub, Erghib, Kharid*, Ooof (Somali) ☐

2. Are you aware that there are camel veterinary extension officers in Isiolo district?

1. Yes ☐
2. No ☐

3. If yes, how often are you visited by veterinary/extension staff?

1. Never visited ☐
2. Once a month; ☐
3. Once in 3 months; ☐
4. Once in 6 months; ☐
5. Once in a year ☐

4. If NO, how did you get information on camel dairy production most of the time?

1. Radio ☐
2. Newspaper ☐
3. from farmer's association (cooperatives) ☐
4. None ☐

4. Do you use any traditional or herbal remedies for your camel?

1. Yes ☐
2. No ☐

5. If yes why?

1. Veterinary Services are not available ☐
2. Veterinary costs are high ☐
3. Veterinary medicaments are not effective for such disease ☐

6. Do you use any veterinary services?

1. Yes ☐
2. No ☐

7. From where do you get veterinary Services?

1. Government veterinaries ☐
2. Private Veterinarians. ☐
3. Animal Health Assistants ☐
4. NGOs extension services ☐
5. Others ☐

8. How many camels did you lose the last one-year because of diseases?

1. Calves ☐
2. Heifers ☐
3. Milking camels ☐
4. Male camels ☐

9. Have you lost your camels due to drought?

1. Yes ☐
2. No ☐

10. If yes give initial percentage of camels which died?

< 5% ☐
< 5% - 10% ☐
<10% - 25% ☐
<25% - 50% ☐
>50% ☐

11. Give two ways in which camel loss can be reduced/ prevented.

1.
2.

APPENDIX 3. Interview guide for the women groups

1. Camel feeds and feeding

a) What are the major feed resource you use for camel feeding, please specify according to Priority?

b) Do you provide any supplementary feeds?

Please specify

2. Camel feeds availability

a) Do you have feeds shortage problem for your camels?

b) What measures do you normally take when there is feed shortage for your camels?

c) Is there a different feeding management system at different season? Please specify

3. Milk production, processing and marketing

a) What type of camel breed do you use for milk production?

b) How many times a day do you usually milk per day?

c) Are there some special camels with exceptional high milk yield?

d) If yes please specify the type or breed of camels and how much milk they produce?

e) At what season of the year does your camel give more and less milk yield?

f) What are the major problems for small quantity of milk?

4. Milk products marketing

a) How many KM do you travel to sale camel milk and its products?

b) What is the main problem in disposal of milk and its products?

c) How is your market problem related to the different milk products?

5. Camel health

a) What are major camel health problems affecting your herd?

Please rank them (in decreasing order) and specify how to overcome the problem?

b) Are your camels vaccinated?, Against which diseases?, How often and who decide to vaccinate?

c) What are the major diseases mostly affecting your camels?

7. Extension services

a) Did you have access to livestock extensions services?

If yes, which main aspect of camel dairying are you advised on by livestock extortionist? And how often do you use them per year?

b) What measure do you take when your dairy Camels become sick?

If you consult veterinary services, how is the affordability of the service?

c) Do you have problem to access the veterinary services in the area?

If yes, please specify the type of problem you have

d) What is the lactation period for your camels?

6. Camel breed types

a) Which type of camel breed is mostly used for milk production?

b) Did you observe special good future of local camel than other breeds?

If yes, specify the camel breed and its good character?

c) What type of mating system do you use to reproduce your dairy animals?

d) Did you have experience in using selection for the improvement of milk production for different species of camels?