PERCEIVED EFFECTS OF SELECTED FACTORS ON CAMEL PRODUCTIVITY IN MANDERA COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented to any other University for award of any degree.

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AGR-3-0032-1-2021

RECOMMENDATION

This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

Dedicated to my mother Timika Sheikh Ali,my wife Nurai Yussuf, My daughters Basra, Rahma, Asmahan, Salwa, Lazna and my sons Munir, Ali, Najib and Salman.

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ABSTRACT

Camels contribute to the diet of pastoralists by producing food, especially milk, which is considered naturally imperfect but nearly complete. However, the amount of camel milk produced in Mandera County has decreased over time, and to make matters worse, only about 9% of that milk is traded, with most of it being sold at fairly low prices locally and only about 4% being processed. This served as the basis for this study to establish perceived effects of some selected factors on productivity of camels in Mandera County. Particularly, the study sought to establish whether and how camel breeds, animal care, road conditions and government extension services affected camel productivity in Mandera County. The study was guided by the Basic Needs Theory, Resilience and Food Production Theory and Livelihood Diversification Theory. The study adopted descriptive survey research design. The target population comprised 43,691 camel keeping households in Mandera County from which a sample of 396 households was established through Slovin Formula. However, since only three of the six sub counties in the county were purposefully selected for the study, the sample size was reduced to 300 respondents, one per household. The distribution of the questionnaires was guided by the perceived level of engagement of respondents in camel rearing. Further, to corroborate the responses from camel dealers on the variables of study, qualitative studies were carried out through interview schedules from government officers in animal production and veterinary care that normally assisted camel dealers. Data was collected through drop and pick and analyzed by use of SPSS version 26. Validity and reliability of the questionnaire constructs was confirmed before its use. Tests for normality, autocorrelation and absence of multicollinearity were conducted before multivariate regression analysis. A reliability coefficient of Cronbach alpha of over 0.7 was returned for all constructs of the independent variables. Descriptive statistics were used to explain the findings while information from government officers was analyzed qualitatively through in-depth and contextual insights. The study achieved a response rate of 74.3 percent. All the key variables tested against camel productivity returned mean scores above 3.5 with a standard deviation ranging from 0.08 to 1.08. These data implied that the respondents agreed with most of the statements on the 5-point Likert type scale. The low standard deviations below 2 meant low variability in the responses. Correlation analysis revealed that camel breed, animal care, road conditions and government extension services were positively and significantly correlated to camel productivity. Regression analysis results indicated that the factors under study explained 62.9% of the variation in camel productivity in Mandera County with effects of camel breeds being statistically significant ($\beta=0.201$; $p=0.032$) as were effects of animal care ($\beta=0.370$, $p=0.005$) and those of road conditions ($\beta=0.305$; $p=0.000$) and government extension services ($\beta=0.413$; $p=0.000$). The ANOVA results confirmed that the model was significant in predicting camel productivity. It was concluded that all the independent variables singly and collectively influenced camel productivity which was corroborated by government officers. It was recommended that government at national and county levels invest in improved camel breeds and availability of adequate breeding bulls, provide more animal care services and an enabling environment for private sector to provide other services through road access and cold storage for camel milk and meat among other interventions. Future research should consider other aspects of camel productivity, diseases, nutrition,

marketing, value addition and even promotion of trade. Also, it would be useful to carry out the same type of research in other counties and compare results.

TABLE OF CONTENTS

DECLARATION AND RECOMMENDATION ..... **ii**

COPYRIGHT ..... **iii**

DEDICATION ..... **iv**

ACKNOWLEDGEMENT ..... **v**

ABSTRACT ..... **vi**

LIST OF TABLES ..... **xii**

LIST OF ABBREVIATIONS AND ACRONYMS ..... **xiii**

CHAPTER ONE **1**

INTRODUCTION **1**

1.1 Background of the Study 1

1.2. Camel production and Productivity 3

1.3. Camel breeds and their importance 5

1.4. Mandera County 6

1.5. Infrastructure and Camel productivity 7

1.6. Government Support to Camel Rearing 7

1.7. Research gaps 7

1.8 Statement of the Problem 9

1.9 Objectives of the Study 10

1.10 Research Hypotheses 10

1.11 Justification of the Study 11

1.12 Limitations of the Study 12

1.13 Delimitation of the Study 12

1.14 Assumptions of the Study 12

1.15 Operational Definition of Terms 14

CHAPTER TWO **15**

LITERATURE REVIEW **15**

2.1 Introduction 15

2.2 Camel Productivity 15

2.3 Camel Breeds and Camel Productivity 17

2.4 Animal Care and Camel Productivity 20

2.5 Road Conditions other infrastructural requirements for Camel Productivity 24

2.6 Extension Services and Camel Productivity 26
2.7 Theoretical Framework 28
2.8 Conceptual Framework. 32
CHAPTER THREE 34
RESEARCH METHODOLOGY 34
3.1 Introduction 34
3.2 Research Design 34
3.3 Target population 34
3.4 Sample Size and Sampling Procedures 35
3.5 Data Collection Instruments 36
3.6 Validity and Reliability of Data collection instruments 36
3.7 Data Collection Procedure 38
3.8 Data Analysis 38
3.9 Multivariate regression analysis 39
3.10 Ethical Issues 40
CHAPTER FOUR 42
RESULTS AND DISCUSSION 42
4.1 Introduction 42
4.2. Response Rate 42
4.3 Reliability Results 43
4.5 Effects of Camel Breed Preferences on Camel Productivity 45
4.6 Effect of Animal Care on Camel Productivity in Mandera County 48
4.7 Effect of Infrastructure on Camel Productivity in Mandera County 53
4.8 Effects of Government support on Camel Productivity in Mandera County 57
4.9 Camel Productivity– Aspects of the dependent variable 59
4.10 Analytical Model Diagnostic Tests 62
4.11 Inferential Analysis 65
CHAPTER FIVE 71
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 71
5.1 Introduction 71
5.2 Summary of Findings and conclusions 71
5.3 Recommendations 74

5.4 Implications for policy and Recommendation for Further Studies..... 75
REFERENCES..... 77
APPENDICES..... 87

LIST OF FIGURES

Figure 1. 1: Mandera County Map..... 7

Figure 2. 1: Conceptual Framework 34

LIST OF TABLES

Table 4.1…Response rate……..…45

Table 4.2 Summary of combach's alpha reliability coefficient……...45

Table 4.3Response Gender……..46

Table 4.4Duration in Camel business…….……..47

Table 4.5Effect of camel productivity in mandera county……..48

Table 4.6 Effect of animal care on camel productivity in mandera county……..52

Table 4.7Effects of infrastructure on camel productivity in mandera county……57

Table 4.8 Effect of Government support on camel productivity in mandera county……62

Table 4.9 Camel productivity response from mandera county…….65

Table 4.10 Collinearity statistics……..68

Table 4.11 Kolmogorov-smirnov test…….69

Table 4.12 Autocorrelation Test…….69

Table 4.13 Correlations of the study variables with dependent variables……70

Table 4.14 ANOVA for mandera county……71

Table 4.15 Model summary…….72

LIST OF ABBREVIATIONS AND ACRONYMS

ASAL	Arid and Semiarid Areas
CAHW	Community Animal Health Workers
CBOS	Community Based Organization
CFW	Cash for Work
DM	Dry Matter
FAO	Food Agricultural Organizations
GDP	Gross Domestic Product
GoK	Government of Kenya
IGA	Income Generating Activities
KALRO	Kenya Agricultural Livestock Research Organization
KNBS	Kenya National Bureau of Statistics
NGOs	Non-Governmental Organization
SPSS	Statistical Package for Social Sciences
VET	Veterinary Departments

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The livelihoods of inhabitants in the Northern Kenyan County of Mandera are significantly influenced by the production and commerce of camels. Many families in these areas, which are characterized by harsh climatic conditions and environments with limited access to water and other resources, depend on camels as a source of milk, meat, hides and revenue. Camel breeding typically takes place among nomadic pastoralist groups in Mandera County, who depend on their herds for both subsistence and income. The camels are utilized for food, clothing, and transportation. Camel milk is a crucial source of sustenance, especially for children and expectant mothers, and it is also used in customary rituals and celebrations (Isako & Kimindu, 2019).

Mandera county camel trade has expanded recently, with camels being sold to other parts of Kenya and to bordering nations like Somalia and Ethiopia. For many families, this trade has been a reliable source of revenue that has enabled them to invest in their livestock herds, buy food and other essentials, and send their children to school. However, a number of difficulties like violence and insecurity, disease outbreaks and market volatility confront the camel trade in Mandera. Despite these difficulties, camel farming plays a significant role in the livelihoods of many communities in Northern Kenya, and initiatives are being taken to advance resilient and sustainable production methods in the industry (Schwartz et al., 1983).

Communities in Mandera County depend on the production of camels to support their way of life. Because they camels can survive in difficult, arid environments and provide milk, meat, and transportation, they are highly prized by nomadic pastoralist groups in the area. In Mandera, camel milk is a crucial source of nutrition since it offers vital vitamins and minerals, especially to growing youngsters and pregnant women. Additionally, being excellent source of protein, camel flesh is highly valuable to the

pastoralists (Catley & Aklilu, 2013). For many families, this trade has been a reliable source of revenue that has enabled them to invest in their livestock herds, buy food and other essentials, and send their children to school. Camel production in Mandera suffers a lot of difficulties despite the economic advantages, including effects of violence and insecurity, disease outbreaks and market swings. However, camel rearing continues to play a significant role in the livelihoods of many communities in Mandera County, and initiatives are being undertaken to improve production a productivity in the industry (Oselu, 2022).

In their study on the socioeconomic value of camels, Mehmood et al. (2017) noted that camels play a significant socioeconomic role throughout large regions of the industrializing world. In these places, camels are used to transport salt, fuel wood, agricultural produce, and household goods together with plows, land levelers, grinders for grinding cereals like wheat and corn, and sugarcane crushers. Mini-mills also use camels to extract oil from oil seeds.

Given that contemporary husbandry techniques and animal care are added to traditional management methods, studies tend to indicate that the camel can significantly improve the livelihoods of those who raise it. In addition to providing draught power and transportation, camels are used not only in the most arid regions of the world, but also in several urban locations throughout many different countries. Camels can withstand adverse effects of severe drought. Comparing adult camels to small and big genuine ruminants, adult camels have a comparatively low mortality rate during dry conditions (Faraz et al., 2013). The lives of African nomads, who mostly rely on breeding camels as a means of subsistence, can be improved by better camel husbandry practices. Given the ongoing and increasing global warming, the most safe and resilient mammal to keep is the camel. Besides providing food, a substantial camel industry focusses on camel racing which occurs in the Middle East Countries around the Arabian Gulf. Twelve years ago, the price of a successful camel race winner in Sudan was between 2 and 6 million dirhams (DHS), while a racing camel might fetch a high price of up to 15 million dirhams. A plain camel might fetch between USD 817 and 1634 for a male and a female respectively, in the open market (Thompson, 2014).

1.2. Camel production and Productivity

Pakistan produces 0.24 million tons of camel milk annually, with a market value of 2.4 billion rupees. A yearly production of 50,000 tons of camel meat valued at 250 million rupees is also reported (Debowicz et al., 2012). The native camel is able to support itself with relatively few inputs under the control of pastoralists, nomads, and small farmers, usually in challenging and drought-stricken places and mountainous locations where the long-term survival of other animals does not appear to be viable. The local economy benefits directly while the national economy benefits indirectly (Debowicz et al., 2012). Pakistan harvests 22,500 camel hides annually to make saddles, sandals, and other valuable decorative items, some of which are exported. The 20,000 tons of camel hair Pakistan generates each year is also used to make blankets, floor mats, ropes, and tent fabric. The silky, woolly fleece of a camel calf is presented at birth and is typically sheared only once and combined with hair to create blankets (Khan et al., 2003). Products made from camel milk include butter, ghee, and fermented milk.

Although there's a widespread misconception in South Asia that camel milk cannot be utilized to manufacture butter or ghee because the fat globules are so small, several local and foreign employees have come up with ways to do so (Raziq et al., 2019). Dahi (yogurt), lassi (sour milk), and kurth (cheese) are the most widely consumed products derived from camel milk in Northern and Eastern Baluchistan.

Camels primarily produce milk and labor, while meat is often a by-product of a camel system and among societies that do not herd camels, there seems to be an increasing demand for camel meat. The majority of castrated males are not raised primarily for slaughter but end up being converted to meat after use. Camel meat produced in Pakistan each year is estimated at 250 million rupees (Khan et al., 2003). For the sole purpose of slaughtering them as sacrifices during rituals or annual holidays, many people breed camels. The markets for camel meat are not well developed, with the exception of Sudan, although there is rewarding export potential to Egypt, Libya, Saudi Arabia, and the Gulf States. Arab governments have given camel meat ratings that are at par with or higher

than those given to beef (Khan et al., 2003). The resilient camel has long been a source of food and financial security for the communities living in the most seriously climatically impacted areas of Northern Kenya. In this region, the majority of camel herding is still done using age-old, conventional methods that have been handed down through the centuries and generations. Even though camels are tough, knowledge of modern animal husbandry could significantly increase camel output as well as the quality and quantity of its products offered for sale. The communities' lack of awareness of camel nutrition and veterinary requirements, among many other things, is the cause of the animals' poor condition and a diminishing trend in breeds. Their trade is hampered since their milk and meat products lose quality as a result.

To revolutionize camel husbandry, camel rising must become more socially and economically acceptable and be embraced by the majority of the keepers. Kenya, which produced 876,224 metric tons of milk in 2017, was the subsequent-largest producer of camel milk in the world after Somalia, according to the UN Food and Agricultural Organization (FAO). Nonetheless, there is not much commerce associated with the camel products in Kenya. The majority of products made from camels are used locally in the areas where they are produced. Camel rising is a low-level economic activity due to the limited product market and frequent intermediary exploitation of farmers (Almutairi et al., 2009) by middlemen. About 2500 liters of milk are produced and marketed daily in each county, much below the potential.

Most of the milk made in Kenya is consumed locally, and the remainder gets spoilt and hence is wasted. As for hides, because there is no developed facility for tanning or value addition, they often get wasted although their value is great if properly used and would create employment and income generation for the youth. Dung from camels can be used to make paper or as a natural source of crop manure. Additionally, it can be used to create biogas, which will lessen the need for wood fuel in rural areas. This lessens generation of properly utilized, waste decomposition increases soil fertility, so people create small gardens to supplement their diets (Abdel-Rahman et al., 2020).

1.3. Camel breeds and their importance

According to estimates, there are 19 million camels worldwide, fifteen million of which are thought to reside in Africa and 4 million in Asia (Berheet al., 2017). Due to the fact that their bodies are designed to survive in harsh desert environments, they mostly occur in semiarid and arid areas of Africa. The one-humped dromedary makes up 94% of the animal's global population, while the two-humped wild Bactrian breed is at risk of going extinct (Chuluunbat et al., 2014).

In Kenya, there is just one species and four breeds of humped dromedaries kept by communities such as Somali, Rendille and Gabbra as well as Turkana, and the recently imported Pakistani breed (in the 1990s into Laikipia ranches) (Mohamed et al., 2019). Cross-breeding between two camel breeds, as well as between distinct species, can produce breeds with altered or combined traits. According to Freitas et al. (2017), livestock contributes 40% of the value of the world's farming production and ensures the livelihoods and diet security of billions of people. Food products derived from livestock account for up to 30% of the agricultural gross domestic product in Africa (GDP). This does not include non-food livestock products like draught power and manure that increase crop productivity (Food and Agriculture Organization [FAO], 2019). Kenya, after Chad, Somalia, and Sudan, has the fourth-largest camel population in the world, with numbers of over 4,640,085 camels, according to data from the Kenya Agricultural and Livestock Research Organization (KALRO). According to a nationwide census conducted in 2019, Mandera had the most camels per county (1,828,665), followed by Wajir (1,176,532) and Garissa (816,057) (Kenya National Bureau of Statistic [KNBS], 2019).

Over 80% of Kenya is made up of rangeland, which is mostly used for pastoral farming, which provides enough fodder for upkeep and production throughout the rainy season. Certainly, forage quantity has a significant role in the production of camel milk and meat. Camels consume 30–40 kg of fresh feed with 80% water content. They also consume 8–12 kg of dry matter (DM) per day. According to Mohamed et al. (2021), camel diets are

dominated by trees, shrubs, and dwarf shrubs throughout the wet season, whereas their proportions decrease during the dry seasons when the fresh leaves have shredded.

Due to the scarcity of viable economic opportunities in these harsh, underdeveloped areas, camel herding has become increasingly popular. The acceptance of former farmers, agropastoralists, and pastoralists who are not typically camel keepers (such as the Samburu, Borana, Karamoja, etc.) contributes to the continuous rise of camel husbandry. The camels are considered by pastoralist as an insurance for financial stability and access to food. The semiarid and arid regions of Northern, Northeastern, and Southern Kenya are characterized by high temperatures and unpredictable precipitation.

1.4. Mandera County

Mandera County is found at latitude 3.38738 and longitude 40.645879. The county is bordered to the North by Ethiopia, to the East by Somalia, and to the South West by Wajir County. The county has 1,200,890 people living there and covers 25,939.8 square kilometers, according to the 2019 census. Mandera town is where most people live. In addition to trade with Ethiopia, mining, beekeeping, and agriculture along the Daua River, Mandera county's primary economic activity is pastoralism. There are 30 administrative wards in the county, together with the 6 sub-counties of Mandera West, Mandera South, Banisa, Mandera North, and Mandera East. Mandera County has the most camels in the nation of Kenya. Communities in these areas have figured out how to use the varied resources this animal provides as a source of economic gain. While their hides and skins are looked into for clothes, beds, and coverings against the cold, other products include milk, blood, and flesh as food (Elhadial et al., 2015).

1.5. Infrastructure and Camel productivity

The underdeveloped road systems make it difficult to move goods quickly between locations, which lead to degradation of quality of perishable goods like milk and meat. The condition of live animals that are transported for marketing is impacted by poor road infrastructure both inside and outside of the counties and lack of refrigeration systems which would guarantee freshness hence products reach markets in low quality or having deteriorated and wasted. Refrigeration is crucial in maintaining milk and meat quality before marketing, guaranteeing better products for customers, and minimizing losses from spoilage yet such facilities are lacking in Mandera County (Sisay, & Awoke, 2015). There are no processing facilities to improve on the value of milk, meat, and hides; not even on a modest scale. Due to high rates of deterioration and waste, Mandera County gets little economic benefit from marketing of camel or camel products. In order to capitalize on the potential, the county government is moving in the direction of allocating small sums of money to start abattoirs, mini dairies, and leather tanning businesses.

1.6. Government Support to Camel Rearing

There are no or few extension workers, and the majority of them might not have adequate knowledge on camel husbandry hence may not give useful advice. Only during mass vaccination campaigns especially against zoonotic diseases do pastoralists in these areas come into contact with extension agents who may be veterinarians. Additionally, these agents lack the logistical resources to reach the pastoralist; however, there are a few for-hire private service providers who may be unaffordable by the majority of camel farmers.

1.7. Research gaps

There are no pedigree records kept by the camel herders that reflect the output of each animal. For several years, the farmers maintained small bulls for breeding which led to depression caused by inbreeding. After a few years, the bulls must be culled, and better bulls must be introduced. In addition to affecting production, zoonotic diseases like brucellosis and tuberculosis can be transmitted from the camels to humans. In addition to

these problems, farmers administer various antibiotic treatments to their animals and sell milk to unsuspecting and often desperate customers without taking into account the long-term consequences like resistance to antibiotics and consequent vulnerability to bacterial diseases. Due to the distance to nearby centers, farmers occasionally lack access to agrovets to buy veterinary drugs which results in the death of livestock (Dokata, 2014). The aforementioned problems all lead to low productivity, which has an impact on the trade of camels and camel products, and consequently, low profit margins. Nevertheless, the county and national governments frequently have a choice regarding which should be prioritized first given their restricted budgets.

In order to make suggestions for how the present situation might be improved, empirically generated data and information is needed yet little research has been conducted in the fields of camel productivity, particularly in Mandera County. The enormous populace that heavily depends on camels for survival has reason to be hopeful because of the fact that there has been very little government and non-governmental intervention in the husbandry of camels yet they have survived that long. With a little effort in the right direction, the industry can be a booming business and that is the purpose of this study. Issues of inadequate breeding, acquisition of inputs, and market sensitization, were considered in this study. In order to expand the markets for camel milk and the selling of live animals at better rates, value addition issues must be addressed in public and private segments. A semi-intensive system that uses supplements to improve output with the aim of profit, as opposed to a pastoral system where the camels are raised on a free-range system using natural forage is preferred. There is a commercial farming system close to homesteads, and motorcycles are used to collect the milk and deliver it to marketplaces in significant towns.

Mandera County offers enormous, expansive rangelands for camel production, but because of poor infrastructure, lack of value addition, animal diseases, and droughts, they have restricted access to the market for their camels and its products. This must be addressed if the livelihoods of the many people that depend on the camel are to be improved.

1.8 Statement of the Problem

Kenya has a great potential in maximizing camel productivity in terms of milk and meat at par with the best producers in the world like Pakistan where over 20 litres per day have been recorded. The meat and hides from camels are also highly valuable for both socio-economic and livelihood support. However, the level of production of camels and camel products in Kenya is pathetically low and potential remains unexploited. Efforts at exploiting the immense potential of this animal have been made but a lot remains to be done if camel productivity is to be maximized, especially in Mandera County. The off take is between 15 and 30 camels per day which is still very low. Camel meat costs about Ksh. 500 (USD 3.8) per kilogram on average. Between 50 and 200 live animals are sold each week in Mandera County. Currently, prices for camels range between Ksh. 22,500 (USD 170) for small animals to Ksh. 78,000 (USD 585) for large animals. These animals are sold to buyers in Moyale then trucked to Addis Ababa and then to Djabouti or Mogadishu where they are shipped for export to Middle Eastern nations. These low prices do not positively impact on the people who keep camels for livelihoods as the prices for live animals and their products do not inspire growth of the venture. Furthermore, the prices are low due to inbreeding depression leading to low genetic potential, low production and poor husbandry practices. According to the Director of livestock production in the county, the low milk production is due to poor feeding, limited supplementation in terms of commercial feeds, lack of mineral salts, poor or no veterinary care, shortage of water, poor milking techniques and poor breeding bulls which have been overused. The grazing pattern has been affected by drought and overgrazing leading to denudation of rangelands as a result of overstocking. Camel diseases are also rampant including trypanosomiasis, rift valley fever, mastitis and worm infestation which have direct economic consequences on production, productivity and income. There are limited numbers of veterinary staff both public and private. There are limited stores supplying supplementary feeds in the area like hay and range cubes.

Although a number of studies have been carried out on production and feeding (Dakota, 2014; Njoroge, 2022; Isako, 2023). They did not focus on factors influencing camel productivity in Mandera County. It was also difficult to get secondary data on some of

the predictor variables in this study hence the research sought to fill this gap by getting perceived influence of the selected variables on camel productivity in Mandera County, Kenya.

1.9 Objectives of the Study

The main objective of the study was to analyze perceived effects of selected factors on productivity of Camels in Mandera County, Kenya.

1.9.1 Specific Objectives

The study sought to achieve the following objectives:

i. To establish perceived effects of camel breeds on camel productivity in Mandera County.
ii. To establish perceived effects of animal care on productivity of camels in Mandera County.
iii. To establish perceived effects of road conditions on productivity of camels in Mandera County.
iv. To establish perceived effects of government interventions on productivity of camels in Mandera County

1.10 Research Hypotheses

The study tested the following hypotheses:

H_{o1}: There was no statistically significant relationship between perceived effects of camel breeds on camel productivity in Mandera County.

H_{o2}: There was no statistically significant relationship between perceived effects of animal care on productivity of camels in Mandera County.

H_{03}: The perceived effects of Infrastructure did not have a statistically significant effect on productivity of camels in Mandera County.

H_{O4}: Perceived effects of government extension services did not have a statistically significant effect on productivity of camels in Mandera County.

1.11 Justification of the Study

The Northern Eastern parts of Kenya including Mandera County are traditionally inhabited by Somalis of the Degodia, Ajuran, Gurreh, Murrule and Ogaden clans. Mandera and Wajir counties are home to two thirds of the country's population of camels, to the tune of 3,005,197 (KNBS, 2019). The inhabitant communities have their cultural and social life greatly knitted with camel husbandry often featuring in song and poetry. Camel milk is strongly associated with good times and peace, and feast is deemed incomplete without camel meat. Furthermore, even where camels produce milk, meat and hides, the potential is very low compared to what is expected of commercial productivity. There is huge untapped potential for increased productivity of camels. The returns per unit input are below standards hence the need to enhance productivity through practical means of improving camel husbandry. This study was carried out to establish factors that inhabit exploitation of this potential in Mandera County.

With the coming of devolution, the government had increased opportunities to ameliorate the sector through various interventions from funded county government programs. The devolved counties also got a provision of funded County departments that would enhance education and improvement of this sector of the region's economy. This study was a factfinding mission that would help come up with insights and possible solutions of the stalled and declining camel economy. This was important in helping the county and national governments along with partner NGOs to make informed decisions towards enhancing food and economic security in the region. The study findings were critical in informing the County and National Government of the need to invest more resources in camel productivity enhancement for improved socio-economic and livelihood sustainability. The need to exploit the vast potential inherent in the camel as a multi-purpose animal for the county where fewer alternatives exist, could not be over emphasized. Further research on how to advance the study in specific areas of the camel industry would also be recommended to relevant stakeholders.

1.12 Limitations of the Study

This research was narrowed to Mandera County and to pastoralists practicing camel husbandry. Therefore, application of the findings across the vast Northern Kenya counties that raise camels would be a valid assumption since it was not possible to cover them but given their agro-climatic conditions that match those of Mandera County, it is imperative that the findings would be applicable to the rest of Northern Kenya where camels are kept.

The study was dependent on responses from local residents who, due to the low education level for most of them, were expected to have a difficulty in accurately giving the desired information. This, coupled with the vast expanse of the county and insecurity, limited the data collection. Inaccessibility to remote places of the county where camel husbandry was practiced proved challenging due to poor infrastructure and insecurity and some were left out narrowing to only three sub counties out of the possible six.

1.13 Delimitation of the Study

Due to geographical and agro-climatic similarities of the Northern Kenya Counties, the applicability of the research findings was assumed to be practically possible. On overcoming challenges of data collection, the study tried to use middle-aged fairly educated pastoralists as its respondents, since they stood a higher chance of being a bit learned as beneficiaries of the recently introduced free education. The study also allocated sufficient timelines for possible delays due to accessibility hardships. Focused group discussions with camel cooperative members enabled pastoralists to contribute to verbal discussions instead of asking them to fill in structured questionnaires hence information was gotten from wide range of respondents besides those that were literate. Local administrators like chiefs and their assistants were used to identify respondents' families.

1.14 Assumptions of the Study

The inhabitant community had its cultural and social life greatly knitted with camel husbandry and was willing to gracefully offer requisite information. The other

assumption was that the importance of camels was so great in the chosen county of study and surrounding areas and those respondents would be able, willing and forthright in giving critical information through the questionnaires or through group discussions.

1.15 Operational Definition of Terms

Camel breeds : Type of camel breed kept for example Somali, Gabrra, Turkana Rendille and Pakistan Breeds.

Animal Care : Refers to animal husbandry in terms of feeding and veterinary care. Provision of fundamental physical requirements of the animals for survival and production including wholesome feed, pure water, veterinary treatment.

Camel Productivity : The output per unit of input in camel husbandry. For example, amount of milk per camel per day.

Extension services : Is a catch-all term for the application of new information and findings from scientific research to agricultural practices with the help of farmer education. Educators from a variety of disciplines, including agriculture, agricultural marketing, health, and business studies, have developed a wide range of educational and communication programs for rural populations that are referred to as "extension" today.

Road Conditions : Refers to the state of the road that is wet, dusty, murrum, paved, etc

Government Interventions Provision of support services by Government in terms of technical advisory (extension services) and veterinary care.

Infrastructure Public goods like roads and cold chains for farmers to access markets, transport inputs and store their produce

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter reviews scholarly work done in the past looking at the factors affecting camel production and trade in Mandera County of Northern Kenya. The chapter covers theoretical and empirical review sections, as well as summary of literature, conceptual framework, and operational framework and research gaps.

2.2 Camel Productivity

According to estimates, there are 19 million camels in the globe, with 15 million of them living in Africa and 4 million in Asia (Farah et al., 2007). The largest camel population in the world, Somalia (with over 6 million camels), may account for one-third of all dromedary camels (Farah et al., 2007). They are mostly found in dry and semi-arid regions with annual rainfall averages of less than 350 mm. 99% of the camels in the Greater Horn of Africa, 97% of all camels in Africa, and 75% of all camels worldwide live in the four adjacent countries of Somalia, Sudan, Ethiopia, and Kenya combined (Field, 2000).

Only one-humped (dromedary) camels are found in Kenya, although they are a crucial part of the livestock industry in the ASALs of Northern Kenya, where 66% of the population lives in poverty (ADF, 2003). Kenya's camel population was previously thought to be under one million due to the absence of frequent censuses (Alhadrami & Faye, 2022). However, the national camel population is projected to be 2.97 million based on the findings of the 2009 livestock census (KNBS, 2017). The dromedary camel is a versatile animal that is primarily raised for the production of milk and meat as well as transportation. It also serves as a financial buffer (asset) and insurance for pastoralists against drought-related losses, and it has a significant impact on social standing and wealth (Guliye et al., 2021). For instance, camels are typically seen as the most significant sign of wealth and a gauge of rank in Somali society.

Camels are significant sources of income for the ASALs in Kenya, contributing to both wealth generation and food security. The sale of milk, meat, skins, transportation services, horseback riding, and tourism on camels generates income for the household and is crucial to the pastoral subsistence economy. According to Guliye et al. (2021), camel milk is evaluated highly as a crucial household resource for food and income. Camel protection from illnesses and drought is important to Somali pastoralists (Farah et al., 2007). Pastoralists typically sell camels when they need money fast rather than when the price is best because they must fulfill their responsibilities in areas of finance, insurance, and status. Therefore, when faced with urgent financial requirements, livestock keepers sell their livestock.

According to Kemboi et al. (2017), it is very possible that camels in Kenya are not producing milk to their genetic capacity. Simpkin (1995) listed the following as a few causes of Kenyan camels' low milk yields: In Kenya, camels are raised for subsistence rather than for sale, thus there has been minimal quality control. Camels are housed in remote places with little additional feed, and there is little to no disease treatment. The quantity of the animals was more significant to the producers than their quality. The data that are currently available should only be used as guides for milk yields in pastoral settings because they are highly speculative. Additionally, calves continue to suckle throughout lactation, thus the actual amounts of milk secreted is higher than the amounts recorded. Numerous publications have reported on milk production levels, primarily as estimations.

The camel produces more milk and for a longer period of time than other livestock species under challenging environmental conditions, despite the fact that there are fewer long-term research reports encompassing the entire lactation period (Farah et al., 2007). A camel may generate 1,900 litres of milk annually for human use in dry areas with typical grazing conditions (Stiles, 1995). Between 1,500 and 2,500 litres were the estimated lactation production for East African camels by Walsh & Schwartz (1992).

Good milkers can yield 20 to 30 litres per day, claims Wernery (2006). According to Bekele (2008) and Farah et al. (2007) the Somali breed camels produce an average of 5

to 8 litres of milk each day. During the height of their lactation, Somali camels may be able to produce more than 15 liters of milk per day under unusually favorable

circumstances (Farah et al., 2007). Camels can produce up to 12 to 20 litres per day under more intense systems, according to Ramet (2001). Different camel milk yield estimates per day under conventional pastoral management systems have been recorded in Kenya.

In contrast to Simpkin (1996), who estimated the yield to be between 3 and 7 litres per day, Simpkin (1996) offered a range of 2.4 to 4 litres per day. According to Kemboi (2017), with better feeding, the yield might increase to above 10 liters per day. Bekele (2008) calculated the mean daily yield for camels under pastoral management in semi-arid eastern Ethiopia at 4.14 litres per day. In the neighboring Eastern Ethiopia, Baars (2000) found camels daily milk yield ranged between 3.6 and 6.5 litres per day.

According to Aloo et al. (2017), the lactation curve appears to have two peaks. The first peak, which is extremely distinct and occurs in the first 6 to 10 weeks of lactation, coincides to the subsequent wet season, when fodder is once more abundant. However, Bekele (2008) showed that daily yields reach their peak between 10- and 20-weeks following parturition, after which they begin to decline and eventually reach very low yields at lactation's end. According to estimates, lactation lasts from 9 to 18 months (Bekele, 2008; Ramet, 2001).

Another variable that affects milk levels is breastfeeding by calves among other things. Less milk is produced and the lactation period is shorter in camels whose calf dies (Bekele, 2008). In contrast to Schwartz et al.'s (1998) prediction of 12–16 weeks post–conception, lactation often ends 4–8 weeks after conception.

2.3 Camel Breeds and Camel Productivity

Since camels were domesticated thousands of years ago, camel milk has supported Bedouin, nomad, and pastoral societies. When traveling great distances with their camels to graze in deserts and other arid areas, herders may occasionally be able to survive purely on milk. In dry areas of the world, camel dairy farming offers an alternative to cattle farming, which uses a lot of water and electricity to run air-conditioned buildings

and sprinkler systems. Camel farming has been connected to de-desertification by UNESCO because it makes use of a local species that is well adapted to dry climates and can feed on salty desert flora.

The United Arab Emirates (UAE), Saudi Arabia and Mauritania all have supermarkets where camel milk is sold. Over 5,000 imported camels live in the United States. In the states of Michigan, Missouri, Oklahoma, Pennsylvania, Indiana, North Carolina, and Ohio, numerous farms with breeding camel collections and have adopted camel milking programs with prospects for expansion into Louisiana, Virginia, Georgia, Texas, Idaho, Tennessee, and Florida. The majority of camel farms in the US are modest operations with four to twenty animals that each produce at least five liters per day. According to legend, Pakistani and Afghani camels can generate up to 30 liters of milk per day, the greatest milk yields. The dromedary generates an average of 20 liters per day, compared to the 5 liters produced daily by the Bactrian camel.

Camels are a viable alternative for food security in challenging situations since they can last 21 days without drinking water and still produce milk when fed low-quality forage. All camels in Kenya are one-humped Arabian camels or dromedaries. Human existence in dry climates would be considerably less feasible without camels. It is believed that Somali-speaking groups brought camels to East Africa more than 1000 years ago. These early pastoralists also kept cattle, sheep, and goats, but camels fared better in Northern Kenya's arid environment and eroding rangeland.

The two-humped Bactrian camel is mostly utilized for labor in China (Dong et al., 2018). The average daily milk production per animal is 5 kilograms, although some animals can produce as much as 15-20 kg per day over the lactation period of 14 to 16 months. Typically, only 2 kg of milk are produced; the remainder is suckled by the calf. In Russia, the dromedary, the Bactrian, and a hybrid of these three types of camels were all tested for their ability to produce milk (Dokata, 2014).

Compared to the Bactrian or the hybrids, the dromedary produced more milk. Camel milking is not only a necessary task in the Horn of Africa; it also plays a significant role in the regional culture and history. The only people who are permitted to milk the

animals are boys, unmarried women, and ritually pure males. The milk cannot be treated in any way. Either fresh milk or milk that has recently soured is drank. Herd boys in some tribes only consume camel milk.

There are two wet seasons in parts of northern Kenya where nomads rely nearly solely on camel milk. Three lactations were covered by Field's lactation study (2018a, 2018b). The lactation period lasted 47–67 weeks. Four to eight weeks after conception, lactation ended. In the first week, daily milk output peaked at 21 kg before dropping to 4.8 kg in the sixteenth week of lactation.

For the first 10 weeks (1.8-50.2 kg), the average daily milk yield was 13 kg, and it was 3 kg for the last 10 weeks of lactation. 1 897 kg per animal on average were produced overall. The camels that didn't have calves produced the least amount of milk during lactation experiments. Despite being milked five to seven times daily, these animals also had substantially shorter lactation periods. According to Evans (2021), four daily milkings produced seven liters of milk as opposed to two daily milkings' six. Somali, Rendille/Gabbra, and Turkana are the three principal camel breeds in Kenya.

A fourth type of camel, known as a Pakistani, was brought into Kenya's Laikipia ranches in the early 1990s from Pakistan. There are, however, relatively few Somali or Turkana-crossed camels, which have now left Laikipia and relocated to the Samburu, East Pokot, Kajiado, Northern Tanzania, Mandera, and Marsabit areas. The Somali and Turkana breeds are raised in the Isiolo District. Isiolo's genetic resources for livestock have been heavily impacted by natural selection as a result of environmental variables. The stock is now better prepared to handle shortages of feed and water, challenges from illnesses, and adverse weather conditions. However, the ability to produce at a high level has remained limited.

Total milk production is poor as a result of the native breeds' limited genetic potential for productive features. Because camels are milked irregularly in pastoralist settings, it is challenging to determine their daily milk production. The topic that causes the most debate when it comes to camels is milk yield. For instance, Herren (1992) noted that the

majority of the literature on camel milk production lacks clarity and frequently confuses two distinct issues: total (milked-out) yield and actual offtake for human consumption

that still permits the calf to live and grow. In the current study, the phrase "milk yield" is used to refer to total milk yield, which is the milk completely extracted after it has been milked.

2.4 Animal Care and Camel Productivity

According to FAO (2019), camels feed an average 5-10 kg of dry matter per day. The feeding practices for most pastoralists are usually unstandardized, but follow seasonal patterns depending on the climatic season. Most of the camel keepers rely solely on naturally growing forage of trees and shrubs. However, this source is only reliable during the wet season. During droughts, the camel keepers have to embark on pilgrimages in search of feed for their animals. Yu et al. (2017) proposed investing in fodder to substitute forage during the dry seasons. They further recommended introducing plants into the grazing areas to ensure more productivity and profitability all year round.

The production and trading of camels on a global scale can be significantly impacted by the standard of animal care. Well-cared-for camels are typically healthier, more productive, and more valuable, which can enhance the effectiveness and profitability of the sector. The health and productivity of camels can be enhanced via the use of good animal care techniques, such as providing sufficient feed and water, suitable housing, and prompt veterinarian care. Improvements in fertility and survival rates, as well as enhanced milk and meat output, may result from this. The welfare of camels can also be improved through the provision of proper animal care, which is a crucial ethical and moral factor. Being well cared-for can help to guarantee that camels are treated humanely because they are typically less stressed, less prone to illness, and more productive. Poor animal care procedures, however, have unfavorable outcomes, including diminished productivity and health, increased disease transmission, and diminished consumer confidence in camel derived goods. The effectiveness and profitability of the sector, as well as its standing and long-term viability, may suffer as a result (Bediye et al., 2018).

The health, productivity, and general well-being of camels is greatly impacted by proper care and management, which also has an impact on the industry's profitability and

sustainability. Good animal care procedures lessen the need for veterinary intervention and the possibility of losses brought on by morbidity and mortality by assisting in the prevention of diseases and injuries. The general health and productivity of the camels is improved by providing them with the proper shelter, nourishment, and hygiene. Camels give better yields when their feeding is done simultaneously with supplements hence improved productivity of both milk and meat per unit.

Animal salts have been recommended by scholars as an essential complement to the animal feeds (Musaad, 2013). They have been widely used in other livestock such as cattle and goats. Animal salts contain plenty of minerals which, according to Babiker (2014), help maintain the mineral balance of animals at the right level. Salt makes up a significant portion of fluid in the blood, which also contains other vital trace minerals like calcium, magnesium, selenium, and phosphorus and roughly 0.17% each of sodium and chlorine. While salt aids in digestion, assimilation, and prevention of dehydration, all of these minerals are generally necessary for animal growth, productivity, and reproduction. Camels have their distinct nutritional needs that might not be completely similar to those of cattle and goats (Salim et al., 2011). Therefore, using animal salts that match the key mineral requirements for camels is paramount for high productivity. While Kuria et al. (2017) noted that most camel keepers used mineral salts meant for cattle and goats on camels –which lacked the key elements for camels, they recommend mixing of these different types of salts to bridge the gap.

Although camels are resilient to water shortages and can go for long without it, water is still an essential part of camel diet. Kagunyu and Wanjohi (2014) observed that most of the camel keepers follow their traditional practices of watering the camels at two-week intervals. However, optimum camel watering is not crisp, but dynamic with respect to a number of factors. According to Bekele (2008), camels would have varying water requirements depending on the nature of feed they eat. When feeding on dry fodder and from dry thickets, camels would need up to thirty liters of water per day. Alternately,

when feeding on green matter, they would need less water – an average of five liters a day (Dowelmadina et al., 2015). This knowledge on adequate and timely feeding

requirements is a science that, if imparted to camel keepers, would go a long way in enhancing camel productivity.

The camels' physiology increases milk generating hormone in order to meet the calf's feeding requirements. Camel calves are recommended to be allowed to suck long enough, for optimal growth, maturation and better health. Furthermore, giving camels enough room, access to clean water, and cover from the sun can assist to lower stress levels and improve their wellbeing. Increased milk output, greater growth rates, and improved reproductive efficiency can all result in better earnings for farmers and dealers. The ethical treatment of camels is influenced by animal welfare, which also affects customer perceptions of camel-derived goods such dairy, meat, and leather. Consumers are becoming more and more concerned with the welfare of farm animals, and they are more willing to buy goods from farmers and traders that take good care of their livestock. Milk is important to the calves in their first years of life, not only to meet their nutritional needs, but also to boost their immunity against diseases (Akweya et al., 2012). A well-informed practice of calving intervals is important in helping farmers leverage on their resources and maximize profit. Timely calving enhances growth of the camel herd, while upholding the health of child-bearing camels. Well informed practices on milking are also an important factor in camel productivity. According to Faraz et al. (2019), allowing a calf to first suckle its mother, stimulates hormones that increase milk flow to the teats. However, the farmer should be sure to perfect his milking speed, because a camel allows milk let-down for only two minutes. In fact, for efficiency, two people are recommended to do it simultaneously, to ensure all potential milk is drawn out (Elhadi et al., 2015).

Camel health management is a very crucial aspect that directly determines the productivity of camels, the quality of their products and hence their trade-worthiness. According to Lamuka et al. (2017), 23% of pastoralists had at least one member of their family or someone from the study region experiencing a camel-related health issue. These illnesses varied from brucellosis (TB), septic sore throats, and kidney failure to bloody diarrhoea. Humans who eat their flesh and milk are easily exposed to the diseases that

camels carry. These items cannot be sold internationally since they would fail laboratory tests, which would hinder the growth of the trade in camel products.

From their study in Isiolo County, Lamuka et al. (2017) observed the common animal pests and diseases facing farmers in the region were camel calf diarrhea, ticks and mastitis. Mastitis is a disease of the udder which could result from physical trauma, blocked milk ducts or bacterial /mycotic pathogens entering the udder through its milk ducts (Zulu et al., 2020; Wanjohi et al., 2013). The resulting infection could be problematic to also a suckling calf, risking chances for diarrhea. These, among other less common but serious diseases, pose higher mortality rates among the herd and reduce camel productivity. Once they occur in one of the camels, chances for transmission are very high, since most farmers in the Northern Kenya water their livestock at common water-points which have stagnant water (Redding et al., 2013).

Veterinary care in these regions is usually self-administered, where farmers prescribe medicines on their own. Woodford et al. (2017) recorded 45.8% of self-medication among farmers of Northern Kenya, 16.7% by Community-Based Animal Health Workers, 15.3% by Traditional Animal Health Service Providers, while 22.2% was done by certified private and public veterinary staff. Only 18.5% of pastoralists knew the proper veterinary medication to use, despite the high rate of self-medication. The majority of farmers in Northern Kenya self-prescribe animal medications from local agro-veterinary stores. Furthermore, these shops are staffed by personnel who know very little, or nothing, about clinical veterinary services (Redding et al., 2013).

Camels, like any other livestock, need to be vaccinated, alongside other veterinary care. They need to be periodically dewormed, have annual vaccinations for the clostridial diseases and tetanus (Mutambara et al., 2013). This is crucial for controlling diseases that would weaken the animal into low productivity, and reducing losses from high camel mortality rates. Keeping records of treatment for each camel is also an essential part of camel health management. It fosters specialized care, whereby the camel's needs are

addressed individually to enhance efficiency of the care, and also enhance consistency in care provision (Costagli et al., 2017).

2.5 Road Conditions other infrastructural requirements for Camel Productivity

On a worldwide scale, road is crucial to the production and commerce of camels. By easing the transportation, storage, and processing of camels and their products, it may have an impact on the effectiveness and profitability of the sector. For instance, having access to roads, airports, and ports can make it simpler for farmers and traders to move camels and their goods to market, increasing their access to a wider clientele and boosting their profitability. Additionally, having access to appropriate storage options, such refrigerated warehouses, can help preserve the quality of perishable goods like dairy and meat while lowering the likelihood of spoilage and waste. Camel keeping is mostly done in remote areas of Kenya's Arid and Semi-arid regions. These regions are usually undeveloped, having no permanent or semi-permanent roads. This makes accessibility to these areas a big challenge, which affects all other sectors of camel farming (Noor et al., 2013). While most of the veterinary doctors are usually centrally located, obtaining their services in various places of the region becomes a challenge due to poor transport infrastructure (Chema & Gathuma, 2017). This hampers advancement in implementing efficient camel health management system.

Milk marketing is to the milk groups or clubs, milk collectors (traders), and the producers themselves as the three different milk outlets in the North Eastern region (Berhe et al., 2017). In Somalia, milk is sold by the side of the road or is personally delivered to customers and hotel owners close to the town. Kenya's camel population has the potential to produce between 340 and 350 million liters of milk yearly and 10,000 tonnes of meat, according to estimates by Alhadrami and Faye (2022) and Akweya et al. (2012). Sales of camel milk are significantly increased by its health-promoting qualities, which are also the impetus behind increased camel dairying in some areas, such the Middle East (Alhadrami & Faye, 2022). Kenya has seen a dramatic increase in the commercial use of camel milk in recent years (Matofari et al., 2016).

A strong infrastructure can help the industry expand by encouraging investment and expansion. For instance, the building of processing plants, such as those for dairy products, might open up new possibilities for farmers and dealers to enhance the value of their goods and boost their profitability. Infrastructure can also help the sector deal with some of its problems, like disease outbreaks and changing climatic circumstances. For instance, having veterinary clinics and quarantine facilities on hand can help to prevent the spread of diseases, while drilling water wells and building pipelines can help to lessen the effects of droughts. Camel products are the main economic springs for residents in these regions, but poor infrastructure prevents them from leveraging on these resources. A greater proportion of the camel's products (milk and meat) are highly perishable, which necessitates that the lead time, between production and sale, be minimized as much as possible (Berhe et al., 2017). However, the rugged roads and the impassable ways – during rainy seasons, lengthen the lead time to hours and days.

A statement presented by the House Departmental Committee on Transport, Public Works and Housing in the year 2014, showed that Mandera and Wajir Counties had no single inch of tarmac roads by then. This, despite the country having 13,655.5 km of tarmacked roads throughout Kenya. Nairobi and the central region of Kenya took the lion's share of the tarmacked network –taking about 53%. The North-eastern region of Kenya had been marginalized since independence, receiving very minimal funding from the national government and almost no development projects allocated to it with an aim of growing the camel business. According to Chema and Gathuma (2017), the adoption of devolved County governments provides great opportunities of improvement for the infrastructural and economic states of this region.

Camel products are perishable and very vulnerable to spoilage, especially under the high temperatures of the Northern region of Kenya. Fresh unprocessed Camel milk is prone to fermentation from 4 to 24 hours after milking (Kyule & Nguli, 2020) depending on its handling and underlying temperature. It is recommended that it be stored at conditions below 4 degrees Celsius immediately after milking, in order to increase its shelf-life which could then go up to 4 days without going bad. On the other hand, fresh unprocessed camel meat can stay fresh for up to 10 days when deep frozen below – 4 degrees Celsius (Abrhaley & Leta, 2018).

However, maintaining the quality (freshness and long shelf-life) of camel products is yet a great challenge for camel farmers in this region. Collection and buying centers for their produce are often very far from their homes and their transport infrastructure very poor to facilitate timely delivery (Noor et al., 2013). Most of them do the deliveries on foot or by animal carriages or the recently common motorcycles. All these modes have no cooling facilities to keep the produce fresh as it traverses on rugged roads and a scorching sun.

2.6 Extension Services and Camel Productivity

One of the main obstacles to camel development in Mandera County is lack camel health care and better feeding management, which results in subpar performance throughout the production chain. The interaction between the technical and nontechnical limitations themselves is the cause of many of the issues. Because the camel health care system mainly relies on veterinary measures and services, for example, improperly fed calves have low illness resistance and reproduction issues. A number of the diseases that have an impact on supply are also a result of non-technical constraints, such as a lack of funds to buy drugs or vaccines, which contributes to high mortality and morbidity (e.g., internal parasites) (Muloi et al., 2018).

Contact between cattle from different locations brought to Iran, Saudi Arabia, and Pakistan through the use of shared pastures and watering areas as well as marketing locations plays a key role in the transmission of economically common infectious and parasitic illnesses. Such movements of cattle may result in direct or indirect spread of a number of economically significant camel diseases. The government-monopolized services are to blame for the poor performance of veterinary services in the lowlands. Government veterinary staffs are scarce and unable to appropriately serve livestock keepers' veterinary needs over such a large geographic area. Additionally, government employees require suitable transportable facilities, which the government is now unable to supply (Tafesse, 2001).

Agriculture extension service is a two-way communication and training process that incorporates adult learning approaches, according to the National Agriculture Extension Policy (NAEP) of the Ministry of Agriculture and Rural Development, which was

enacted in December 2001. In order to raise and improve farmers' incomes and productivity over the long term, it aims to develop knowledge, change attitudes and behaviors, promote the adoption of new technology, and improve skills for both farmers and extension workers.

Kenyan youth can also use adult learning techniques. The aforementioned broad definition applies to services provided by both the public and private sectors and include initiatives linked to education, the transfer of technology, the modification of attitudes, the growth of human resources, and the gathering and dissemination of information. For farmers, researchers, and extension workers who support agricultural extension, it has enormous ramifications. Extension will have a larger impact if environmental and non-extension factors that may limit the use of extension messengers in the case of the farmer are taken into account.

In addition to financial assistance, extension personnel and researchers require education and other opportunities to enhance their interactions with farmers and to foster the crucial degree of trust required for a productive flow of information. The idea encompasses both on- and off-farm activities by farmers and other related agriculture business actors.

The objectives of extension policy are to increase the efficiency and effectiveness of extension services offered by the public and private sectors, to encourage the expansion of service delivery pluralism, to create a regulatory framework to guide services, and to provide strategies for establishing operational standards, quality standards, and norms. The primary stakeholder groups in agricultural extension services include farmers, farmer's organizations, extension agents, extension service providers, input suppliers, agroprocessors, researchers, research organizations, CBOs, NGOs, local government, relevant central government departments, training institutions, and development partners.

2.7 Theoretical Framework

The following theories anchored the study which includes basic need, lively hood ,diversification and resilience and fund product theorie

2.7.1 Basic Needs Theory

The development economist Mahbubul Haq first proposed the Basic Needs Theory in the 1970s. In order to promote human well-being and eradicate poverty, Haq contended that development policies and programs should be centered on providing fundamental human requirements such food, clothes, housing, and healthcare. The basic needs theory is a conceptual framework that emphasizes the significance of meeting specific basic human needs in order to satisfy human needs. According to the fundamental human needs hypothesis, the physiological needs such as food, water, health and shelter is the most basic of all human needs, and other like safety, love, and esteem, can only be taken care of after these physiological needs have been satisfied.

This theory can be applied to the production of camels to comprehend why people work in the sector and the difficulties they encounter. It might imply, for instance, that persons engaged in camel farming and trading depend on the ability to raise and trade camels in order to meet their fundamental needs for food and revenue. They might experience difficulties like poverty, starvation, and a lack of access to healthcare if they are unable to meet this basic need. The philosophy emphasizes the significance of attending to the fundamental requirements of the camels themselves. Camels must have access to food, water, and a secure habitat to survive and produce. Camels may become ill or suffer from malnutrition if these needs are not addressed, which may impair their capacity to give milk, generate wool, or function as a mode of transportation. To sum up, basic needs theory offers a helpful framework for comprehending the motivations and difficulties people working in the production of camels encounter as well as for addressing the fundamental needs of the camels themselves. It may be possible to develop a more nable

and just industry that benefits all parties involved by seeing to it that the basic needs of both humans and camels are addressed.

2.7.2. Livelihood Diversification Theory

The work of development economists and anthropologists in the 1980s and 1990s, who were eager to learn how rural populations in developing nations were able to deal with risks and shocks like natural disasters, economic downturns, and market fluctuations, is largely responsible for the development of the livelihood diversification theory. The anthropologist Hart (1973) proposed the idea of "the informal economy" and its function in sustaining livelihoods in the developing world, which was one of the first and most significant contributions to the development of livelihood diversification theory. According to the paradigm known as "livelihood diversification theory," people and communities should diversify their sources of income and resources to make themselves less vulnerable to risks and shocks like natural catastrophes, economic downturns, and market volatility. This theory can be used to understand how people participating in the sector may be using camel production as one of numerous strategies of producing income and protecting their livelihoods in the context of camel productivity. For instance, a pastoralist who produces camels for transportation, tourism, and the production of milk and meat may be better able to withstand hazards related to the camel trade, such as market swings or disease outbreaks, than a pastoralist who relies only on camels for food only.

The theory might also imply that people engaged in the camel trade would benefit from diversifying their markets and products in order to lessen their reliance on a single item or market and lower the dangers brought on by changes in demand. A camel merchant, for instance, who sells camels for transportation and tourist in foreign markets as well as for meat and hides in local markets, may be more resistant to changes in the demand for camels in any given market. The production and commerce of camels can be agreed in the background of a larger economic and social system using the notion of livelihood diversification. For instance, it can imply that raising and selling camels can help a region's economy diversify, create job opportunities, and assist the preservation of traditional pastoralist customs.

In conclusion, the livelihood diversification theory offers a helpful framework for comprehending how people involved in the production of camels may use the animals to diversify their sources of income and resources, and how this may help them become more resilient to unforeseen risks and shocks. It might be possible to develop a more resilient and sustainable economy that benefits both people and communities by encouraging livelihood diversification through camel production and commerce (Hart, 1973).

2.7.3. Resilience and Food Production Theory

The agro-ecologist Walker et al. (2004) created the notion of "ecosystem resilience" and its application to the study of food production systems, making it one of the first and most significant contributions to the development of resilience and food production theory. Understanding the role of trade can be done by applying the notions of resilience and food production theory. The term "resilience" describes a system's capacity to absorb shocks, such as natural disasters, economic downturns, and disease outbreaks, and to rebound. Examples of such systems include ecosystems and economies.

The ability of people and communities involved in the sector to endure and recover from risks and challenges, such as market fluctuations, disease outbreaks, and changes in demand for camels, may be referred to as resilience in the context of camel production and trading.

On the other side, food production theory is a framework that looks at the elements that influence food production, such as the accessibility of resources, technology, and markets. Food production theory can be utilized in the context of camel production and commerce to comprehend the elements that affect the production of camels for food, such as access to pasture and water, the availability of veterinary services, and the demand for camel products in regional and global markets. It is possible to comprehend how the industry might support the resilience and food security of individuals and communities participating in the sector by applying these two theories to the context of camel production and trading. For instance, the sector may support the economic resilience of pastoralist communities and the food security of people in areas where camels are a

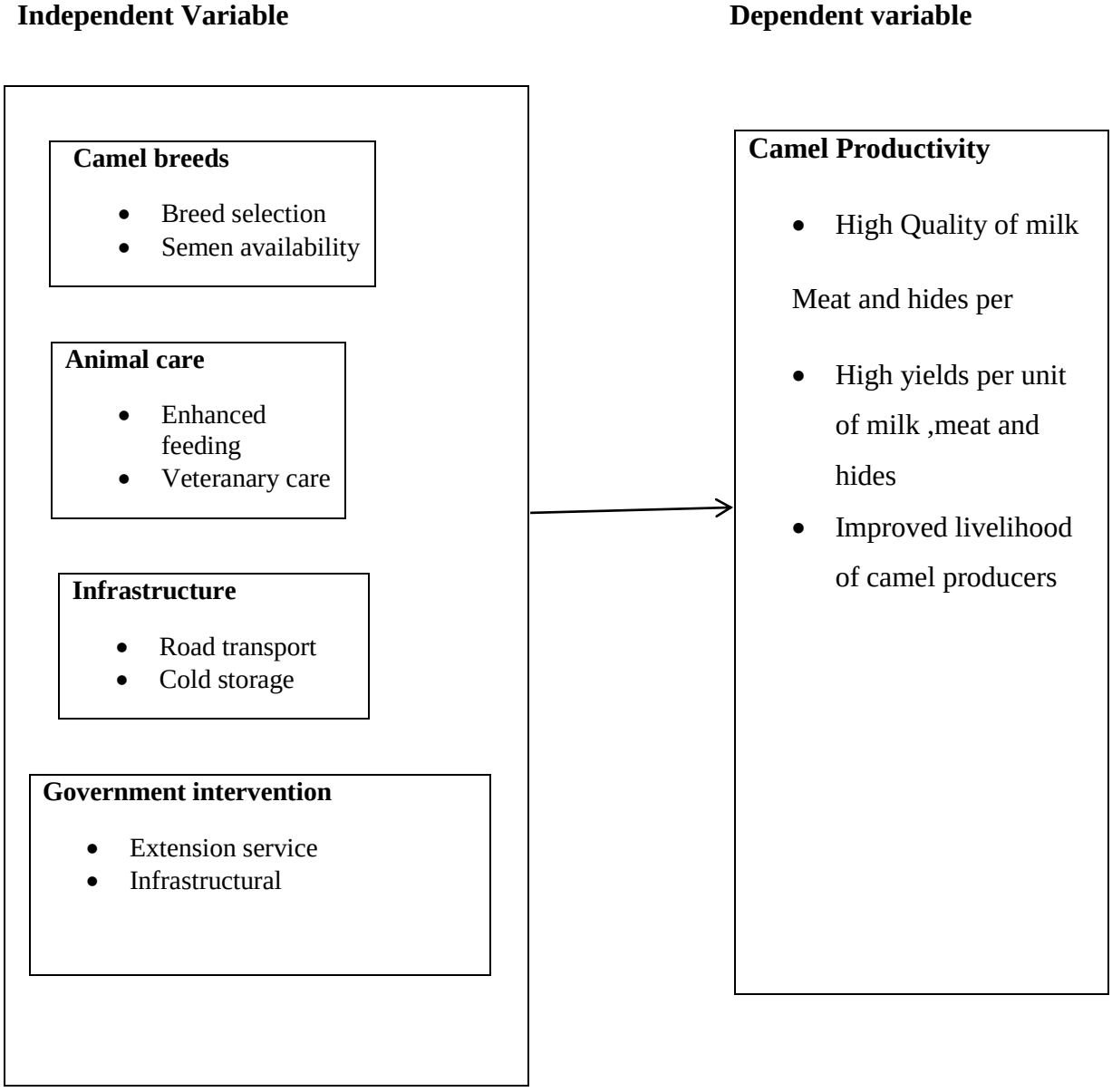
significant food source by promoting the sustainable production of camels for food and other products. In conclusion, the ideas of resilience and food production theory can be used to comprehend how camel production and trade give to the resilience and food security of people who work in the industry and to pinpoint the issues that need to be resolved in order to build a more resilient and sustainable sector (Walker et al., 2004). This theory underpins all the dependent variables in espousing the camel as the most resilient animal in arid and semi arid areas (Mandera County) which can withstand harsh climatic conditions and rough terrain where there is no transport and yet provide both milk, meat and hides for pastoralists despite limited breed diversity, limited animal care in terms of feed and veterinary services and poor road network for efficient transport. The resilience of communities despite limited government support is also espoused by this theory.

2.8 Conceptual Framework.

The conceptual framework is based on the relationship between the independent variables and the dependent variables

Figure 2. 1

Conceptual Framework



The dependent variable in this study is camel productivity, while the independent factors include effects of camel breeds, animal care, road and infrastructure and extension services on the dependent variable. The factors are connected to one another. Breeds of camels are crucial for camel milk production and generating revenue for camel herders. Compared to the Turkana and Gabra breeds of camels, Somali and Pakistani breeds produce more milk. Camel milk output, availability, and milk sales are all influenced by the breeds that camel milk producers keep. Improved animal care increases camel productivity, which is a key factor in the seasonal changes of pastures due to climatic variabilities. When there is a drought, camel milk sales fall, which also affects camel farmers income. Another significant factor in the productivity of camels in terms of milk and meat is infrastructure especially state of the roads and refrigerated services which determines whether products reach the market in time. The shelf life, life, sales, and income from camel milk are all decreased when there is a lack of or poor road network and storage facilities like refrigerators. The availability of Extension Services enhances camel pastoralists' knowledge and abilities about camel health and production, helping the keepers with disease treatment and prevention, other management strategies, clean milk production, and milk sales. The production of camel milk, hygiene, milk sales, and income will all suffer from the lack of these services.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The study's research design, target population, sampling methodologies, sample size, data gathering tools, reliability and validity of the tools, data collection methodology, data analysis, and research ethics are all described in this section.

3.2 Research Design

A basic concept of how to approach responding to the research question and successfully resolving the research topic is provided by the general approach or plan that a researcher chooses to integrate the numerous study components in an organized and straightforward way (Green, 2019). This study employed a descriptive research design in order to examine factors that influenced camel producitivity of milk, meat, hides and other products under in Mandera county. A descriptive study is used to learn more about the phenomenon's current state and to characterize "what exists" in terms of factors or situations. According to Sovacool et al. (2018), descriptive research design seeks to give an illustration of organizations, people's activities, events and settings in a causal approach. This is an expansion of descriptive research design integrating onto the aspects of what, when, where, which and how but also to the question of why in an expedition.

3.3 Target population

When a set of elements have similar qualities and are studied, they are referred to as the "target population" (Wang et al., 2018). The target population, according to Farag (2019), is the entire group of study subjects, or individuals who share one or more characteristics with other study subjects. The target population for this study was camel dealers (keepers/farmers and traders) in Mandera County. The population of the study was all the 43,691camel keeping households in Mandera County (Camel Keepers in Mandera County report, 2023). Further, government officers dealing with camel keepers

particularly in terms of breeds (livestock production) and animal health (veterinary care) were also included in the study to corroborate findings from camel dealers. The

population of government officers was however small (6 in number) two from each of the three sub-counties purposively selected from Mandera South, Mandera West and Banissa consisting of the Livestock Production Officer or their assistant and the Veterinary officer of their assistant.

3.4 Sample Size and Sampling Procedures

According to Etikan and Babtope (2019), sampling techniques involve the process of selecting a set of elements, people or items and sorting them as per their characteristics in a study. There are six sub-counties in Mandera County namely; Mandera North, Mandera East, Mandera West, Mandera South, Banissa and Lafey. Purposive sampling was used to select three of the sub counties to collect data from- ie. Mandera West, Mandera South and Banissa. This was due to insecurity in the other sub-counties as well as difficulties in access to camel keepers at the time of study. Random sampling was used to choose target respondents from each of the selected camel households in which a mature and knowledgeable member of the household was taken as a respondent. Each farmer or member had an equal chance of being chosen to take part in the study. Two government officers representing animal production and veterinary care from the three selected sub counties respectively, were taken as respondents on the government side. There were 43,691 camel rearing households in Mandera County (KNBS, 2022). Sampling was done using Yamane (1967) formula. The sample size for the study was determined thus;

$$n = \frac{N}{1 + N(e)^2}$$

Where,

n = Selected Sample Size

N = Total Population

e = Error Value (0.05)

The sample size thus was;

Mandera:

$$n = \frac{43691 \text{ households.}}{1+43691\ (0.05)^2}$$

= **households/respondents = 396 respondents.**

3.5 Data Collection Instruments

A tool used by a researcher to collect data from respondents is a data collecting instrument (Moola & Cilliers, 2020). For this study, structured questionnaires were used to collect data from target respondents who were mainly camel dealers (farmers, traders and those engaged in camel business). The questionnaires contained closed-ended statements mostly on a 5-point Likert scale. For farmers or other stakeholders who were illiterate and could not fill in the questionnaires and whose input into the study was deemed critical, the researcher would arrange for focused group discussions among common interest groups like camel cooperatives in the selected sub counties of Mandera and assist them to respond to the statements on the questionnaire or participate in an open discussion. Although the sample size was 396 for the entire county, three sub-counties could not be accessed due to insecurity and communication challenges. Due to this, a decision was made to increase the number of respondents from each of the selected three counties from 79 (396 divided by 6) to 100 per sub county. Therefore, a total of 300 questionnaires were distributed to randomly selected respondents in the three selected sub counties. Six questionnaires were distributed to the government officers.

3.6 Validity and Reliability of Data collection instruments

These tests ensured that the research instruments were sound and reliable.

3.6.1 Validity

Validity is normally determined through pre-testing the research instruments. Pilot testing was described by Vlasceanu et al. (2018) as a practice run for the primary test. It is impossible to emphasize the importance of a pilot test because it helps identify any vague

or unclear concerns. Pilot studies pretest the research tools, such as the questionnaire. According to Geisen and Murphy (2020), it makes it easier to spot questions that respondents do not understand or interpret incorrectly, locations where they get stuck in the questionnaire, and questions that don't yield accurate or useful information at all. An ideal sample size for high-precision pilot trials is between 1 and 10% (Tseng & Sim, 2021).

The pilot study's sampled participants were not included in the main investigation (Storme et al., 2020). Because a measurement error could be made if questions were misinterpreted, the participants were asked to evaluate the questionnaire item by item. The questionnaire was pre-tested in all regards, including question content, language, sequencing, format, layout, question difficulty, and instructions, before being given to the study participants. Any necessary changes were made based on the input received. Target respondents for piloting were from neighbouring county of Garissa which had comparable conditions of whether and socio-economic lifestyles of the population to that of Mandera county.

According to Story and Tait (2019), the degree to which an instrument actually measures "what it is intended to measure" or "what it potentiates to measure" (s) is a common way to describe the relevance of a tool for tackling a study's purpose(s) and research topic. Instrument validity, as defined by Knekta et al. (2019) is the ability to appropriately assess the variables that a research instrument was created to capture. The researcher tested for content and face validity.

3.6.2 Reliability

By improving openness and lowering the likelihood of bias, reliability provides neutrality and dependability (Mackieson, 2019). Reliability is the constancy of results that the same individual would obtain if they retook the exam (Clark & Watson, 2019). The extent to which the items of the same tool correlate with each other, either in both parts of the test or among itself, if the instrument contains a single subject or substance, is known as internal coherence (Hayes and Coutts, 2020). Reliability is thus estimated rather than

verified. In this study, the researcher depended on Cranbach alpha coefficient to assess the reliabilty of the study instruments. Cranbach alpha coeficient ranges from 0 to 1. A

coefficient of 0.7 and above is considered to represent high validity while coefficients below 0.5 are very low to be considered. The Cranbach alpha coefficient was generated from data analysis during pretesting.

3.7 Data Collection Procedure

The researcher, sometime with the aid of research assistants and through area chiefs or opinion leaders in villages, delivered the 300 questionnaires to target respondents through drop and pick method. Government officers were interviewed through interview schedules/guides (Appendix III). The researcher further organized common interest groups through their leadership and conducted focused group discussions in which illiterate members were assisted to fill the questionnaires and general maters of concern in the camel industry discussed (Appendix IV). The researcher guided and collected all relevant information with aid of his research assistants. The data collected from all these sources and through the above methods was reviewed for completeness and consistency in order to carry out statistical analysis.

3.8 Data Analysis

Data analysis is the process of deliberately identifying patterns and generating concepts that the data has indicated, then attempting to support those themes and concepts with evidence (Wise & Jung, 2019). Data was collated and tabulated in excel spreadsheets and analyzed through SPSS version 26. Both descriptive and inferential statistics were used in the interpretation of the data. While inferential statistics were applied to the quantitative data to make deductions about the findings for generalizability, descriptive statistics (mean, standard deviation, and percentages) described the characteristics of the sample. Frequency tables were used to present the findings. Information was gotten from government officers who dealt with camel producers/dealers particularly the livestock production and veterinary officers in each of the sub-counties through interview schedules which were later analyzed qualitatively to corroborate the quantitative findings

in explaining phenomenon leading to the espoused findings. Qualitative analysis was done through in-depth understanding and contextualizing of the verbal responses from the participants perspectives.

3.9 Multivariate regression analysis

To establish relationships between dependent and the independent variables, singly and collectively, both univariate and multivariate regression analysis were carried out. Multivariate regression was carried out according to the formula below;

$Y = ß_0 + ß_1X_1 + ß_2X_2 + ß_3X_3 + ß_4X_4 + Ɛ$

Where

Y-Camel productivity

$ß_0$ –y-intercept or the constant; $ß_1$– $ß_5$ –regression coefficients

X_1 – Effects of camel breed

X_2–Effects of animal care

X_3- Effects of infrastructure

X_4- Effects of Government support

Ɛ-error term

3.9.1 Diagnostic Tests (Assumptions for Regression Analysis)

Before carrying out multivariate analysis, diagnostic tests were carried out to ensure assumptions that render data to regression analysis were met. Tests for normality, absence of multicollinearity, and autocorrelation were carried out. This is critical because scientific insights yielded by a regression model that has violated these assumptions may be at best, inefficient or at worst, seriously biased or misleading (Oteki, 2019).

Normality Test sought to assess whether the scores for the Independent Variable and Dependent Variable were normally distributed through use of Shapiro-Wilk test. The results showed that for both variables all the p-values had a level of significance greater than 0.05. This indicated that the scores for all the variables were significantly normally distributed for all the constructs (Ghasemi et al., 2019).

Test of Homoscedasticity refers to the assumption that the dependent variable exhibits similar amounts of variance across the range of values for an independent variable (Tharu, 2019). According to Mugenda and Mugenda (2003), multicollinearity exists in multiple regression models in which some of the predictor variables are significantly correlated among themselves. It is a data problem which may cause serious difficulty with the reliability of the estimates of the model parameters (Alin, 2017), whereby the regression model fits the data well, but none of the explanatory variables has a significant influence in forecasting the dependent variable (O'Brien, 2017). The study adopted the use of Variance Inflation Factor (VIF) to detect any problem of collinearity. According to O'Brien (2017), its recommended that independent variables with VIF higher than 5 or a tolerance value less than 0.2 should be removed from the multiple linear regression model this indicates presence of multicollinearity.

Autocorrelation is where error terms in time series transfer from one period to another. Thus, the error for one time period α is correlated with error for subsequent time period β. It refers to deficiency of independence between the residual terms of observations (Field, 2000). For data to have high predictive power, the residual terms between any two observations in different time periods should not be autocorrelated (Maddala, 2001).

3.10 Ethical Issues

Making sure a researcher adheres to the code of conduct established by the relevant authorities can be characterized as an ethical consideration in research (Shiraani et al., 2022). Anonymity and confidentiality of the information provided, analysis and reporting, injury or danger to participants, and any other required professional code of ethics are a few examples of ethical dilemmas that may occur. In order to ensure that the research was carried out ethically and in line with the expectations of all authorities, the researcher first received an introduction letter from the Kenya Methodist University.

The researcher had a moral responsibility to handle the private data with the highest respect. The researcher explained to the participants that the instruments were being used solely for study. The researcher reassured the respondents who were hesitant to share certain details that the material would be treated with strict secrecy.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The empirical findings and outcomes of analysis indicated in chapter three are presented in this chapter. Response rate, reliability analysis, demographic information, descriptive statistics, diagnostic tests results, regression analysis, correlation analysis, and finally the findings of the hypothesis testing are presented.

4.2. Response Rate

Out of 300 questionnaires distributed in each of the three sub counties of Mandera West, Banissa and Mandera South, 223 were returned duly filled in which translated to a response rate of 74.33%. The response rate was considered excellent given the recommendations by Mugenda and Mugenda (2003) that a response rate of 50% is adequate for analysis and reporting while a rate of 60% is generally good and one of above 70% is excellent. This is also the same position taken by Babbie (1990) who adds that a response rate of above 70% is deemed to be very good. Based on these assertions, this implies that the response rate for this study was very good and most appropriate. The results are presented in Table 4.1.

Table 4. 1

Response Rate

S/No	Respondents Category	Sample target	Returned	Percentage (%)
1	Mandera West	100	78	34.9
2	Banissa	100	63	28.3
3	Mandera South	100	82	36.8
TOTAL		300	223	100

4.3 Reliability Results

Table 4.2 shows the results of reliability analysis by Cranbach's alpha coefficient.

Table 4. 2

Summary of Cronbach's alpha Reliability Coefficient

Variables	Number of items	Cronbach's alpha
Camel Breed [CB]	9	0.778
Animal care[AC]	8	0.916
Infrastructure [INFRA]	7	0.723
Government support [GOVT]	11	0.887

According to Table 4.2, all constructs of the independent variables had a cranbach coefficient above 0.7 which was considered of very high reliability. This demonstrates that the items had high level of internal consistency.

4.4.1 Respondents' Gender

In order to determine the gender of the respondents, the findings were as presented in Table 4.3, which showed that 174 (78.2%) of the respondents were male and 49 (21.8%) were female. The findings indicate that the majority of participants in camel production were men.

Table 4. 3

Respondents' Gender

County		**Frequency**	**Percent**
Sampled sub counties	Male	174	78.2
	Female	49	21.8
	Total	**223**	**100**

4.4.2 Respondent Duration in Camel Business

The study sought to establish the respondents' duration in camel business. The results in Table 4.4 show that 41(18.3%) indicated less than five years in camel business while 34(15.3%) indicated 5-10 years, 111(49.7%) were in camel business for 10-20 years and 37(16.7%) were in it for more than 30 years.

Table 4. 4

Duration in Camel Business

County		Frequency	Percent
Mandera	< 5 years	41	18.3
	5-10 years	34	15.3
	10-20 years	111	49.7
	> 30 years	37	16.7
	Total	**223**	**100.0**

4.5 Effects of Camel Breed Preferences on Camel Productivity

The purpose of this objective was to determine how camel breed preferences affected camel productivity in Mandera county. The data from the five-point Likert scale was condensed to three categories by merging those who "strongly disagreed" with those who "disagreed" scale 1 & 2 to mean all "disagreed" and likewise those who "strongly agreed" and those who "agreed" scales 4 & 5 to mean all "agreed" to the statements for ease of interpretation. Those who were undecided remained in the "neutral" category. Therefore, the five-point scale was reduced to three categories and their descriptive statistics in terms of actual number of respondents, percentages, means and standard deviations were as presented in Table 4.5. However, the full results of descriptive statistics were as presented in Appendix V.

Table 4. 5

Effect of Camel Breed on Camel Productivity in Mandera County

Statements	**Disagree**	**Neutral**	**Agree**	**Mean**	**STD. DEV**
I prefer the breed for its high productivity of	78(35.1%)	52(23.4)	93(41.5%)	3.1	0.87
The breed of camel is adapted to the environment	30(13.4%)	21(9.3%)	172(77.3%)	4.1	1.02
I keep mixed breeds of camels	31(13.9%)	23(10.3%)	169(75.8%)	4.1	1.17
Camel breeding is mainly through bulls	25(11.3%)	22(10.0%)	176(78.7%)	4.1	0.81
other breeds of camels tried have failed	12(5.5%)	36(16.1%)	174(78.4%)	4.1	1.21
Other breeds of camels not accessible	33(14.6%)	40(18.1%)	150(67.3%)	3.9	1.91
A I is not advisable	29(13.2%)	57(25.4%)	137(61.4%)	3.6	1.14
Farmers can access the better breeds through cooperatives	37(16.7%)	33(14.7%)	153(68.6%)	3.8	1.14
There is a shortage of male camels	22(9.9%)	42(18.7%)	159(71.4%)	3.9	0.11
Meand and Standard Deviation				**3.7**	**1.1**

N = 223

According to the study findings on whether respondents chose a breed because of its high milk, meat, and hide productivity in Mandera county, only 93(41.5%) agreed with the statement, 78(35.1%) disagreed while 52(23.4%) neither agreed nor disagreed with a mean of 3.1 and a standard deviation of 0.89. On the reasons for the breed of camels kept, the majority of respondents at 172(77.3%) agreed that the breed kept in Mandera was for resilience and production with a mean of 4.1 and a standard deviation of 1.02. This breed was kept because it had been tried and tested and had characteristics of resilience, productivity, and trade hence preferred. According to Wernery (2006), good camel 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, 2008; Farah et al., 2007). 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., 2007). Ramet (2001) had also reported that under more intensive systems, camels could yield between 12 to 20 litres a day. In Kenya, different daily milk yield figures have been reported for camels under traditional pastoral management systems.

On keeping mixed breeds to compare productivity, 169(75.8%) of the respondents agreed with the statement with only 31(13.9%) disagreeing with a mean of 4.1, and a standard deviation was 1.17. It was realized that the majority of respondents in Mandera at 176(78.7%) agreed with the statement that camel breeding was primarily through bulls (camel males), making the only breed(s) available with a mean of 4.1 and a standard deviation of 0.81.

On whether they had tried other breeds of camels in Mandera area but failed, the majority of respondents at 175(78.4%) confirmed by agreement with a mean score of 4.1 and a standard deviation of 1.21. Further, results showed that the majority of respondents 150(67.3%) agreed with the statement that farmers in the study area could not access any other breed of camels with a mean score of 3.9 and a standard deviation of 1.91. Other indicators on breeds in Mandera County are as shown in Table 4.5.

The overall mean and standard deviation of 3.7 and 1.1 respectively showed that most of the respondents were around the mean but gravitating towards "agreeing" with the statements. The low deviation of 1.1 indicated that there was minimal variability in responses as a variability of below 2 is considered normal.

These findings were corroborated by the government extension officers from the sub counties under study in the interviews. One animal production officer opined

> *"It is very difficult to get good production and productivity from camels in this area due to continued overuse of the same breeds all the time. When a few able people bring breeding bulls from outside, they become very competitive in terms of the huge number of female camels among the farmers that would need the bulls at the same time hence do not serve the purpose. We really need to address the acute shortage of camel breeding bulls if we have to improve the quality of our camels in terms of body size, milk, meat and hides*" he ended. From the neighbouring sub county, the veterinary officer had this to say *"I think the camel farmers are really disadvantaged in terms of variety of breeds available in the area and have very limited choices. It is a sad situation."*

4.6 Effect of Animal Care on Camel Productivity in Mandera County

The purpose of the objective was to determine how animal care especially on provision of supplementary feeds and veterinary services affected camel productivity in Mandera county. The results are shown in Table 4.6.

According to the study findings on whether there was insufficient veterinary care for animals in Mandera county, the majority at 188(84.3%) of respondents agreed with the statement, 20(10.6.1%) disagreed while another 15(6.5%) did not give any opinion. This was a very strong statement on the severe lack or insufficiency of veterinary services which is a very critical component of animal health with a high mean of 4.0 and a standard deviation of 0.75 indicating low variation in responses since the standard deviation was below 2. Regarding availability of government veterinary services, the majority of respondents at 194(86.9%) agreed that government veterinary services and other technical advisory services on animal care were no longer available in areas where

they were required by camel farmers in Mandera county with a mean of 4.1 which is also over 80% and a standard deviation of 0.67. The results agree with Tafesse (2001) who established that in Isiolo, Government veterinary officers were few in number and could not cover such a vast area to adequately address the veterinary needs of livestock keepers. Besides, government staff need adequate mobile facilities for which the government did not have the capacity to provide.

Table 4. 6

Effect of Animal Care on Camel Productivity in Mandera County

	Disagree	**Neutral**	**Agree**	**Mean**	**Std. dev**
There is insufficient veterinary care for animals in this area.	20(10.6 %)	15(6.5%)	188(84.3 %)	4.0	0.75
No Government veterinary services and other technical advisory services	8(3.5%)	21(9.4%)	194(86.9 %)	4.1	0.67
Poor animal husbandry practises.	22(9.8%)	36(16.1 %)	165(73.9 %)	4.0	0.95
Expensive animal care	25(11.2 %)	44(19.7 %)	154(69.1 %)	4.1	0.86
Camel drug are not available	31(13.9 %)	53(23.7 %)	139(62.3 %)	3.8	1.16
Limited cooperatives.	43(19.2 %)	56(25.1 %)	124(55.6 %)	3.9	1.25
Government support needed.	27(12.3 %)	35(15.6 %)	161(72.1 %)	4.1	1.09
Milk and meat productivity	22(9.8%)	49(22.1 %)	152(68.1 %)	4.0	1.11
Average mean and standard deviation				**4.0**	**0.97**

N = 223

One veterinary assistant said *"it is very difficult to serve both cattle, goats and sheep farmers leave alone camel herders given the few facilities like veterinary medicine or equipment the government provides. Camel herders are not able or willing to pay for veterinary services"* he further opined.

On effects of quality of breeds, production practices and animal care on camel productivity, 165(73.9%) of the respondents agreed that the poor breeds, poor production practices, and poor animal care were due to lack of knowledge and support on these issues with a mean as 4.0, and standard deviation of 0.97.

Regarding animal care cost, 154(69.1%) of the respondents agreed that animal care was critical but also expensive for an ordinary camel farmer hence sometimes they ended up losing animals to preventable diseases, 25(11.2%) disagreed while 44(19.7%) were neutral and the statement's mean was 4.1, while its standard deviation was 0.86. This means that even if there were drugs and veterinary services in Mandera, they were not affordable by ordinary camel farmers as depicted by the high rate of respondents at almost 70%.

This was further corroborated by the veterinary officer in Banissa who confirmed that the government did not have adequate capacity to serve farmers in terms of providing veterinary care. Specifically, he said;

> "*Sometimes we feel sorry for the camel farmers because camels are least considered although they are among the most important life supporting animals in the area. Where facilities are available like vaccines, drugs and other requirements including time, the other livestock like cattle and goats may get preference over camels. It will take time for camels to get the required high-level consideration in this county*" "*Supplementary feeding of camels and provision of mineral salts is almost unheard of in this county unless by individual farmer efforts*" He continued.

According to Wilson (1984), salt (Nacl) requirement for camel body maintenance is six to eight times that of other livestock. Additionally, the author observed that camels can tolerate extremely high salt concentrations in their food and water (physiological

adaptation to arid environments). The recommended daily allowance ranges from 120 to 140 grams. Garden (1971) believes a lower intake of 57 to 112 grammes per day is adequate. Camel intakes between 30 and 60 $gday^{-1}$ are associated with arthritis-associated deficiency syndrome (Wilson, 1984). This author observed an immediate improvement in the camel condition after administering 140 $gday^{-1}$. According to Kuria (2004), camel breeders in Rendille were aware of the importance of minerals and referred their animals to natural sources or mineral supplements. Alhadrami and Faye (2022) observed that the exact mineral requirements of camels were unknown. However, it had been demonstrated that camel needs varied based on breed, location, age, sex, nutrition, and health status but also known to affect bioavailability and, consequently, the dietary mineral requirements of animals, including camels, were mineral interactions.

The findings agree with those of Ibrahim (2021) that camel health care and improved health management was one of the major constraints of camel development in Isiolo, which caused poor performance across the production system. Many of the problems result from the interaction among the technical and nontechnical constraints themselves. For instance, poorly fed Camels have low disease resistance and fertility problems partly because the Camel health care relies heavily on availability of veterinary 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.

On existence of private veterinary and agro-chemical shops, 139(62.3%) of the respondents agreed that private veterinary and agro-chemical shops existed in Mandera but drugs and chemicals for camels were out of reach of most farmers. However, 31(13.9%) disagreed while 53(23.7%) were undecided with the statement with a mean of 3.8, and a standard deviation was 1.16.

Concerning cooperatives, 124(55.6%) of the respondents agreed that they were not very well established to deal with camels and the few available ones were weak and limited in their services. However, 56(25.1%) disagreed while 43(19.2%) were neutral, with a mean of 3.9 and a standard deviation of 1.25. This was corroborated by the animal production

officer in Mandera West who opined "the *cooperatives concerning camel keepers are still weak and limited in a number of ways. Although they provide some limited services, they are not as strong and effective as expected*"

On milk and meat productivity, 161(72.1%) of the respondents in Mandera agreed that milk and meat productivity (liters of milk/camel/day and carcass cold dressed weight (Kg)/slaughtered camel were low when animal health was not properly maintained, while 27(12.3%) disagreed and 35(15.6%) were neutral with a mean of 4.1 which corresponds to "agree" on a Likert scale and a standard deviation being 1.09.The overall mean and standard deviation of 4.0 and 0.97 respectively showed that most of the respondents were agreeing with the statements on the 5 point Likert scale. The findings were in line with Ibrahim (2021) observations that camel health care and improved health management was one of the major constraints of camel development in Isiolo, which caused poor performance across the production system.

4.7 Effect of Infrastructure on Camel Productivity in Mandera County

Infrastructure determines ease of availability of factors of production like feeds, drugs and veterinary services. Although camels are known to move around on their own, providers of services require elaborate infrastructure like all-weather roads to reach destinations in time. To test the effect of this in Mandera county, respondents' opinion was sought based on select statements as shown in Tables 4.7.

According to the study findings on effects of the road network in Mandera, 123(55.1%) of the respondents agreed that the road network in the County was very poor for transportation of goods and services which negatively impacted on all aspects of camel production and trade, 37(16.5%) disagreed while 63(28.3%) were neutral. Here again, it was a matter of perception as the many who were neutral could fall on either side of agreeing or disagreeing meaning, only 37(16.5) percent felt truly that the roads were okay in Mandera, maybe with regards to camel movements which is not really very much dependent on roads. It would also depend on the level of exposure of the respondents. The statement's mean was 3.6 and its standard deviation was 0.53. The results agreed with Noor et al.'s (2013) findings that farmers in pastoral production systems cited poor

road conditions and long distances to the market places as some of the reasons they were not able to sell their milk. During transportation, the milk was exposed to high temperatures for a long time before reaching the market and then pooled without carrying out tests which led to milk spoilage (Machan, 2020).

Table 4. 7

Effects of Infrastructure on Camel Productivity in Mandera County

	Disagree	**Neutral**	**Agree**	**Mean**	**Std dev**
Poor road network	37(16.5%)	63(28.3%)	123(55.1%)	3.4	0.43
Livestock productsare impacted by poor poor state of roads in the county.	58(26.1%)	72(32.2%)	93(41.7%)	3.3	0.24
High Spoilage of milk during the rainy season	32(14.3%)	40(17.9%)	151(67.7%)	3.8	0.09
Meat transportation affected by roads	32(14.3%)	71(31.8%)	120(53.9%)	3.6	1.04
There are no refrigeration services	40(17.9%)	47(21.1%)	136(60.9%)	3.4	1.04
Lack of refrigerated trucks	24(10.7%)	75(33.6%)	124(55.6%)	3.2	1.02
Long distances to markets and poor roads militate affects the productity	45(20.1%)	35(15.6%)	143(64.1%)	3.7	1.15
Average mean and Standard deviation				**3.5**	**0.72**

N = 223

On effect of infrastructure on transportation of livestock products, veterinary care products and services, 93(41.7%) of the respondents agreed while 72(32.2%) were neutral and 58(26.1%) disagreed that livestock products, veterinary care products and services were all negatively impacted by poor state of roads in the county as shown by a mean of 3.3 and Standard Deviation (SD) of 0.23 indicating low variation in responses. The reasons for about one third of the respondents' opinion that the infrastructure like road network was not hindering availability of goods and services for camel productivity was interesting but still held valid since it was their opinion. It is however apparent that infrastructure affects most other sectors of the economy. The reason for so many undecided or neutral responses could be attributed to interpretation of the questions and understanding of the constructs especially for respondents who filled the questionnaires on their own. Thise could be due to their low or average level of education and interpretation of the constructs.

On effects of roads on sale of camel milk, 151(67.7%) agreed that sale of camel milk was mostly affected by poor road network especially during the rainy season since the same could not reach the market in time and mostly got bad or was wasted while on transit. However, 32(14.3%) disagreed and 40(17.9) were undecided meaning poor road network did not affect them that much – in their own opinion. The mean and SD are as shown for the statement in Table 4.7. A veterinary officer from Mandera south expressed strong sentiments on the poor road network in the county thus;

> "*The road network in the entire county is pathetic in that we have no tarmac roads and the roads available are not all-weather roads. During the rainy season, transport comes to a standstill. If you do not have supplies before, you may be stuck without them for a long time. When we run of drugs and vaccines in such times, even the few farmers we serve get very disadvantaged*"

Concerning meat products transportation, 120(53.9%) agreed that meat products from slaughtered camels sometimes failed to reach towns due to poor road networks hence fetched poor prices in the localities which sometimes were not even paid. However, 32(14.3%) disagreed as 71(31.8%) were undecided and the mean and SD are as shown in Table 4.7. The huge number of those undecided could be attributed to interpretation of

the constructs in the questionnaire. However, those who disagreed could be informed by other factors like failure to experience any transportation of camel meat if they only knew of camels slaughtered and consumed in the locality.

Regarding availability of refrigeration services, 136(60.9%) agreed that there were no refrigeration services like cold rooms for storing milk or meat products hence these products got spoilt and sometimes wasted before they could reach the market which negatively impacted trade as 47(21.1%) were indifferent while 40(17.9%) disagreed with a mean of 3.4 and SD of 1.04. The issue of refrigerated trucks mirrored that of cold storage for as shown in Table 4.7. This could be a new phenomenon to the respondents in the study area as most may not be aware of refrigerated trucks transporting camel meat or milk. Djenane et al. (2020) recommends that treatment of camel meat with plant leaves such as wild olive oil tree leaves that had been ground into powder could be used for inhibition of microbial growth and therefore prolong the shelf life of meat. Addition of specific oils to minced camel meat can also be used to extend its shelf life (Shahbazi et al., 2018). Baba et al. (2021) discussed a number of methods that could be used to preserve and also improve the quality of camel meat among them low temperature storage and aging. The quality of the meat is achieved through colour retention, reducing microbial load, and peroxidation of lipids among other ways. Use of garlic has also been reported to decrease lipid oxidation for a period of 14 days by Shahryari et al. (2019). On long distances to markets along poor roads, 143(64.1%) of the respondents agreed that this militated progressive and profitable camel production with a mean of 3.7and SD of 1.15. The veterinary officer from Mandera South had this to say on refrigeration services;

> "*The few refrigeration services we have are only for vaccines during mass vaccinations campaigns against notifiable diseases. We have no luxury of any refrigeration. For camel farmers to access refrigerated trucks, it is normally very difficult and requires huge resources. Therefore, a lot of milk and meat go bad on transit to market or when not bought in time leading to huge losses that could be easily avoided*"

The overall mean and standard deviation of 3.5 and 0.72. respectively showed that most of the respondents were around the mean corresponding to neither agreeing nor

disagreeing but gravitating towards “agreeing” on the 5-point Likert Scale. The low deviation of 0.72. indicated that there was minimal variability in responses as a variability of below 2 is considered normal.

4.8 Effects of Government support on Camel Productivity in Mandera County

Government support services in terms of advisory (extension service) or direct support in inputs is critical to development of agricultural productivity. To extract meaning from the results, the statements of the respondents were sought according to their means and standard deviations and responses on the 5-point Likert scale as shown in Table 4.8

According to the study findings on government intervention in camel breeds in Mandera County, 158(70.7%) agreed that there was limited or no government intervention in camel breeds and breeding which negatively impacted camel production, productivity, and trade with 49(21.9%) being neutral while 17(7.4%) disagreed with a mean of 3.7 and SD of 0.34. Regarding government intervention in veterinary care, 139(62.2%) agreed that there was little or no government intervention in veterinary care which negatively impacted camel production, productivity, and trade while 56(25.1%) disagreed and 28(12.7%) were neutral with a mean of 3.5 and SD of 0.61. On government support to road development and maintenance, 164(73.4%) agreed that little or no government intervention in road development and maintenance was experienced which negatively impacted camel production, productivity, and trade while 25(11.3%) disagreed with the assertion and 34(15.3%) were neutral. The mean and SD were 3.8 and 0.78 respectively.

On government formulated policies to help camel farmers and traders, 107(48.2%) respondents agreed with the statements while 87(37.9%) were neutral and 29(12.9%) disagreed that County Governments of Mandera had formulated policies that were geared towards improving the welfare of camel producers with a mean of 3.3 and SD of 1.22. Further, 145(65%) of the respondents disagreed that the Mandera County and National Governments had provided additional funds to improve farming and trade in camels with only 29(12.9%) agreeing showing the miserably low level of opinion on government intervention. The mean was 2.3 and SD was 0.69.

Table 4. 8

Effect of Government support on Camel Productivity in Mandera County

Statements	**Disagree**	**Neutral**	**Agree**	**Mean**	**Std dev**
There is limited or no government intervention	17(7.4%)	49(21.9%)	158(70.7%)	3.7	0.34
Little or no government intervention in veterinary care	56(25.1%)	28(12.7%)	139(62.2%)	3.5	0.61
Lack of government extension services	35(15.8%)	52(23.2%)	136(61.0%)	3.4	0.45
Little or no government intervention	25(11.3%)	34(15.3%)	164(73.4%)	3.8	1.03
Lack of refrigeration services from the government	16(7.3%)	65(29.2%)	142(63.5%)	3.8	0.78
County Governments has formulated policies	29(12.9%)	87(38.9%)	107(48.2%)	3.3	1.22
Provision and additional funds	145(65.0%)	50(22.3%)	29(12.9%)	2.3	0.69
Support by the government is only limited to mass vaccinations	17(7.4%)	46(20.6%)	160(71.7%)	3.6	1.11
Average mean and standard deviation				**3.6**	**0.80**

Lastly, on whether the support by the government was only limited to mass vaccinations against quarantine disease outbreaks hence had very little impact on camel production, the majority of the respondents at 160(71.7%) agreed while 17(7.6%) disagreed and 46(20.6%) were undecided giving a mean of 3.6 and a standard deviation of 1.11. Government support is not very clear to most respondents especially with the collapse or near collapse of the extension service. This explains why about 28 percent were either neutral disagreed with the statements. Government officers interviewed confirmed the low level of government intervention in terms of provision of extension services, thus;

> "*The extension service is literary dead. We hardly get any support on that vote anymore and we have no vehicles, no facilities to assist farmers besides being very few. The most extension or advisory services nowadays are offered by private vendors who market their own products but unfortunately, these are biased and end up confusing the farmers. Camel farmers are particularly disadvantaged when it comes to advisory services because even those of us who are in the extension service have very limited knowledge and experience with camels- maybe just what we have learnt while here. At least, we can talk of some expertise on other livestock but not camels"*

The overall mean and standard deviation of 3.6 and 0.80. respectively showed that most of the respondents were around the mean but gravitating towards agreeing with the statements. The low deviation of 0.80. indicated that there was minimal variability in responses as a variability of below 2 is considered normal.

4.9 Camel Productivity– Aspects of the dependent variable

The study found it necessary to collect information directly from camel producers and dealers on the factors that affected camel productivity. Table 4.9 has the details.

According to the study findings, 207(93.0%) agreed that they kept camels for their high-quality milk as shown by a mean of 4.6 and a standard deviation of 0.83. Also regarding whether camels provided enough milk for their families and for sale to generate income, 63(28.1%) disagreed, 37(16.7%) were neutral while 123(55.2%) agreed as shown in Table 4.9. Camel milk is limited in quantities and amounts needed in the family which

could explain the high number of those who disagreed at 28.1% and those that were neutral at 16.7%. On milk increase, 129(57.8%) agreed that the yield of milk/camel/day had been increasing with 28(12.5%) being undecided while 66(29.7%) disagreed resulting in a mean of 3.6 and a standard deviation of 0.87. The many who disagreed at about one third of the respondents confirmed that camel milk was subdued from the expected potential production and productivity due to the underlying factors of poor breeds and poor animal husbandry.

Regarding the quality of meat sold, most of the respondents at 123(55.2%) agreed that they kept camels for high quality meat which they sold in the local butcheries/abattoirs for income, with 52(23.4%) disagreeing while 48(21.4%) were undecided resulting in a mean of 3.6 and a standard deviation of 1.2.

Table 4. 9

Camel Productivity response from Mandera County

	Disagree	**Neutral**	**Agree**	**Mean**	**Std dev**
I keep camels for their high-quality milk	0(0.0%)	16(7.0%)	207(93.0%)	4.6	0.83
Camels provide enough milk for my family and for sale to generate income	63(28.1%)	37(16.7%)	123(55.2%)	3.5	1.12
The yield of milk/camel/day has been increasing over the years	66(29.7%)	28(12.5%)	129(57.8%)	3.6	0.87
I keep camels for high quality meat	52(23.4%)	48(21.4%)	123(55.2%)	3.5	1.38
The meat production per unit	40(18.0%)	72(32.3%)	111(49.7%)	3.7	1.19
I sell high quality hides from camels	32(14.3%)	74(33.0%)	118(52.7%)	3.6	1.2
I keep camels for other by-products like manure	45(20.2%)	49(21.8%)	129(58.0%)	3.4	1.32
The quality of hides	37(16.7%)	41(18.2%)	145(65.1%)	3.5	0.79
My camels provide other sources of food and blood.	5(2.3%)	20(9.0%)	198(88.7%)	4.1	0.82
Camel trade generates enough	32(14.5%)	16(7.2%)	175(78.3%)	3.6	1.17
I am able to educate my children	35(15.5%)	51(22.8%)	138(61.7%)	3.6	1.25
Supplementary feeding increase productivity	58(26.1%)	41(18.2%)	126(56.6%)	3.4	1.23
Camel business gives my family income	45(20.2%)	30(13.5%)	148(66.3%)	3.6	0.94
Average Mean and Standard Deviation				**3.8**	**1.08**

N = 223

Regarding quality of hides, 118(52.7%) of the respondents agreed that the quality of hides (price/hide/camel) was high and increasing, while 74(33.0%) were undecided and 32(14.3%) were neutral resulting in a mean of 3.5 and a standard deviation of 0.79. Not many of the respondents could be expected to be experts on quality of hides which explains the variability in responses with many gravitating to undecided or disagreeing. Most respondents may not have experienced what high quality hides would look like or be like.

Furthermore, 138(61.7%) agreed they were able to educate their children with income from camel production and trade as shown by a mean of 3.6 and a standard deviation of 1.25. This meant that camel business, though still of low productivity, was still a sustainable venture. Lastly, on increased family income, 148(66.3%) agreed that camel business gave their families income to carry out other financial transactions to improve their lives resulting in a mean of 3.6 and a standard deviation of 0.94. Other indicators of the dependent variable which was improvement of camel productivity and trade are as shown in Table 4.9 from respondents in Mandera County.

The overall mean and standard deviation of 3.8 and 1.08. respectively showed that most of the respondents were around the mean but gravitating towards "agreeing" with the statements. The low deviation of 1.08. indicated that there was minimal variability among responses. It was not lost on a veterinary officer from Banissa sub-county on the need for improvement of camel productivity. He had this to say;

> "*I wish someone could see the huge potential that camels have towards food security, socio-economic and livelihood support and even cultural activities and invest in improvement of this highly resilient animal. The future of arid lands lies in the improvement of the camel*"

4.10 Analytical Model Diagnostic Tests

Diagnostic tests for suitability of the data for multivariate analysis were caried out first. These were: multicollinearity test, normality test, and auto-correlation tests.

4.10.1. Multi-Collinearity Test

Multicollinearity is a problem that arises when two or more predictor (independent) variables in a multiple regression are tightly related, according to Hair et al. (2018). Prior to carrying out multivariate analysis (VIF), multicollinearity was tested using tolerance values and variance inflation factors (VIF). Hair et al. (2018) asserts that the threshold of VIF is 10. If VIF is greater than 5, and tolerance values less than 0.2, then the independent variable should be dropped from the model since the two indicators portend presence of multicollinearity.

The findings of variance inflation factors (VIFs) and the degree of tolerance values are summarized in Table 4.10. The data shows that the explanatory factors' VIFs ranged from 1.531 to 3.765. According to the results, the tolerance scores ranged from 0.121 to 0.173. As a result, neither the tolerance values nor the VIFs point to the presence of multicollinearity meaning there was absence of multicollinearity in the data and so it was amenable to multiple regression analysis.

Table 4. 10

Collinearity Statistics

Variables	Tolerance values	VIF
Camel Breed Preferences [CB]	0.139	2.143
Animal care [AC]	0.121	1.531
Infrastructure [INFRA]	0.130	3.679
Government support [GOVT]	0.173	3.765

4.10.2 Test for Normality

To expand the scope of a study beyond the sample size, the fundamental premise of linear regression is the normality of the residuals in the outcome variable. The Kolmogorov-

Smirnov test and graphical techniques were used to assess for normality of the variables to see if Camel productivity data was normally distributed.

The alternative and null hypotheses were as follows: While H_1 implied that the data was not regularly distributed; H_o showed that the data was. Given that $\alpha = 0.05$, the p value rule states that H_1 is accepted if it is greater than 0.05; otherwise, H_o is rejected and H_1 is accepted. The data in Table 4.11 yield a Kolmogorov-Smirnov Z statistic of 0.091 (p = 0.001). Since the p value was less than 0.05, the alternative hypothesis was deemed plausible and the null hypothesis was rejected. It was concluded that the research data had a normal distribution and appropriate for linear regression analysis (Table 4.11).

Table 4. 11

Kolmogorov-Smirnov Test

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
Camel productivity	.091	366	.082

a. Lilliefors Significance Correction

4.10.3 Auto-correlation Test

The Durbin-Watson statistic was used to examine auto-correlation. The Durbin-Watson statistic's fundamental criterion is that values between 1.5 and 2.5 imply that the data are not auto-correlated. The Durbin-Watson statistic for this research was 1.513. The fact that the value was in the range of 1.5 to 2.5 shows that the data did not automatically correlate. Therefore, there was no serial autocorrelation in the data. The results are shown in Table 4.12.

Table 4.12

Autocorrelation Test

Model	Durbin Watson
1	1.513

4.11 Inferential Analysis

Inferential statistics extrapolate population data from the sample. Based on the features of the sample, they calculate the likelihood of the population's characteristics. The strength of the association between the independent and dependent variables can be evaluated with the aid of inferential statistics.

4.11.1 Correlation Analysis

The Pearson's correlation coefficients range from -1 to +1, with -1 indicating a perfect negative correlation, +1 indicating a perfect positive correlation, and 0 indicating no correlation at all. Table 4.13 shows the results.

Table 4. 13

Correlations of the Study Variables with dependent variable

		GOVT	AC	INFRA	CB	CP
GOVT	r	1				
	Sig. (2-tailed)					
	N	223				
AC	r	. .437**	1			
	Sig. (2-tailed)	.000				
	N	223	223			
INFRA	r	.579**	.445**	1		
	Sig. (2-tailed)	.000	.000			
	N	223	223	223		
CB	r	.227*	0.014	.214*	1	
	Sig. (2-tailed)	.000	.000	.000		
	N	223	223	223	223	
CP	r	.397**	.303**	.737**	.733**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	223	223	223	223	223

**. Correlation is significant at the 0.01 level (2-tailed).

KEY: CB = Camel Breed, **AC** = Animal Care, **INFRA** = Infrastructure, **GOVT** = Government support and **CPT** = Camel productivity

Table 4.13 indicates that camel breed had a significant and positive relationship with camel productivity as shown by the Pearsons correlation coefficient (r=0.733) and p-value of 0.000. The results further showed presence of a positive and significant strong relationship between Government support and camel productivity as indicated (r= 0.397, p=0.000). The results also showed presence of a positive and significant strong

relationship between Government support and camel productivity as indicated by the p-value and the correlation coefficient (r= 0.397, p=0.000). The correlation matrix in Table 4.13 shows presence of strong and significant positive relationship between infrastructure and camel productivity (r= 0.737, p=0.000).

In order to determine the model's significance, analysis of variance (ANOVA) was performed. The F-ratio (F= 76.312, p=.000) in the ANOVA Table 4.14 indicates that the models was statistically significant for Mandera county.

Table 4. 14

ANOVA for Mandera County

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	8234.138	3	2744.713	76.312	.000[b]
	Residual	7876.765	219	35.967		
	Total	**16110.903**	**222**			

a. Dependent Variable: Camel productivity

b. Predictors: (Constant), Camel breed, Animal Care, Infrastructure, and Government support

4.11.2. Regression model for Mandera County

According to Table 4.15 coefficient results, infrastructure had a positive and significant effect on camel productivity and trade in Mandera County (ß= 0.305, p-value = 0.0000) while government intervention had a positive and significant effect on camel productivity

at (ß= 0.413, p-value = 0.002) and animal care had a positive and significant effect on camel productivity (ß= 0.370, p-value = 0.000). Additionally, camel breed had a positive and significant effect on camel productivity at (ß= 0.201, p-value = 0.032).

Table 4. 15

Model Summary

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.808	.394		2.049	.044
	Infrastructure	.305	.083	.334	3.694	.000
	Government support	.413	.107	.443	3.842	.000
	Animal Care	.370	.127	.344	2.918	.005
	Camel breed	.201	.092	.233	2.183	.032

a. Dependent Variable: Camel productivity

4.11.3. Hypotheses Testing

H_{01}: Camel breeds have no significant effect on camel productivity in Mandera County

The effects of camel breed on productivity in Mandera County was the first objective of the study. The results are shown in Table 4.15. According to Table 4.15, camel breed had a statistically significant positive impact on camel productivity (β= 0.201, p=0.032). Therefore, at a 5% level of significance, the null hypotheses was rejected.

H_{02}: Animal care has no significant effect on camel productivity in Mandera County

The second null hypothesis was that there was no statistically significant effect of animal care on camel productivity in Mandera County. The results are shown in Table 4.15. According to the Table, animal care had a statistically significant positive effect on camel productivity (β= 0.370, p=0.005). At a 5% level of significance, the null hypothesis was rejected meaning animal care had an effect on camel productivity in Mandera.

The results are in line with Bediye et al. (2018) observation that the production and trading of camels on a global scale can be significantly impacted by the standard of animal care. Well-cared-for camels are typically healthier, more productive, and more valuable, which can enhance the effectiveness and profitability of the sector. The findings are also in line with Ibrahim (2021) observations that camel health care and improved health management is one of the major constraints of camel development in Isiolo, which causes poor performance across the production system. 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.

H_{03}: Infrastructure has no significant effect on camel productivity in Mandera County.

The third null hypothesis as stated above was tested. The results are shown in Table 4.15. Accordingly, infrastructure had a statistically significant positive effect on camel productivity and trade in Mandera County (β= 0.305, p=0.000). At a 5% level of significance, the null hypotheses were therefore rejected.

Although it is not easy to accurately measure effect of infrastructural development, the implication is that it would have positive effect on camel productivity and trade and more so if it were to be developed. The results are in line with Noor et al. (2013) that infrastructure is crucial to the production and commerce of camels. By easing the transportation, storage, and processing of camels and their products, it may have an impact on the effectiveness and profitability of the sector. For instance, having access to roads, airports, and ports can make it simpler for farmers and traders to move camels and their products to market, increasing their access to a wider clientele and boosting their profitability.

The results agreed with Machan (2020) findings that farmers in pastoral production systems cited poor road conditions and long distances to the market places as some of the reasons they were not able to sell their milk. During transportation, the milk is exposed to high temperatures for a long time before reaching the market and then pooled without carrying out tests which leads to milk spoilage.

H_{04}: Government support have no significant effect on camel productivity in Mandera

The fourth null hypothesis as stated above was tested. The results are shown in Table 4.15. Government support had a statistically significant positive effect on camel productivity in Mandera County (β= 0.413, p=0.000). At a 5% level of significance, the null hypotheses were therefore rejected. The results agree with Muloi et al. (2018) who established that to promote the camel industry in Kenya, the Kenyan government must make sure that the right policy environment is created and that funding is provided. This must take into account the knowledge of the camel sector's existing and prospective future economic contributions to the national economy.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study set to find out the perceived effects of some selected indicators on camel productivity in Mandera County. The specific indicators of productivity examined were camel breeds, camel care in terms of feeding and veterinary services, effects of road infrastructure and cold storage for camel products specifically milk and meat and effects of government support in terms of extension services provision. The study was guided by the following theories: Basic needs theory, resilience and food production theory and livelihood diversification theory. This study adopted descriptive survey research design. The population of the study was all the 43,691 camel keeping households in Mandera County, from which a sample size of 396 was obtained. The study distributed 300 questionnaires in 3 sub counties. Both descriptive and inferential statistics were generated from the findings and discussed in chapter four. This chapter summarizes the findings, makes conclusion on each of the independent variables and makes recommendations for policy direction and future research.

5.2 Summary of Findings and conclusions

This section presents the study findings

5.2.1 Effect of Camel Breeds on Camel productivity in Mandera County

Descriptive statistics was used to present findings of this research objective and other subsequent results. The results showed the aggregate means were 3.7 and 1.1 for effects of camel breeds on productivity in Mandera County. This meant that most of the respondents were in agreement with statements related to camel breed on the Likert scale approaching 4 meaning “agree” After carrying out correlation analysis, the study results indicated that camel breed was positively and highly significantly correlated with Camel productivity at r=0.733**. The study further confirmed that camel breed had a statistically significant positive impact on camel productivity in Mandera County (β=

0.201, p=0.032). The null hypothesis of non-significant relationship was therefore rejected. The study concluded that breeds of camels determined how much milk, meat and other products the farmers got from camel business. It was concluded that a lot was needed to improve on camel breeds if productivity was to be increased to make camel business more rewarding to farmers and even traders. Camel bulls were singled out as the most problematic issue in terms of breeding due to shortage, overuse and genetic weaknesses. Therefore, the study concludes that in order to improve camel productivity, the government must assist camel herders with high quality young bulls of good pedigree.

5.2.2 Effect of Animal Care on Camel productivity of camels in Mandera County

The results showed an aggregate mean of 4.0 and standard deviation of 0.97 on the statements for effects of animal care on camel productivity depending on responses on the Likert scale. This meant that most of the respondents were in agreement with statements related to animal care. Correlation analysis revealed that animal care was positively and highly correlated with Camel productivity by r=0.303** which was significant. The regression analysis confirmed that animal care had a statistically significant positive effect on camel productivity (β= 0.370, p=0.005). The null hypothesis of non-significant relationship was thus rejected. Animal care in terms of feeding especially with adequate forage, supplementary feeds and minerals as well as provision of adequate water are known to contribute highly to the milk, meat and other products from camels and must be enhanced if the productivity of the animals has to be improved. The study concluded that animal care was fairly low and almost abandoned in the County. There was a great need to invest in productivity enhancing animal care commodities like supplementary camel feeds, fodder in terms of hay, camel drugs and vaccines among others. Provision of timely animal care like treatment against some disease would also save a lot of camels and increase their productivity. It is imperative that the government invests in camel care to enable farmer realize the innate potential in this amazing dryland animal.

5.2.3 Effect of Infrastructure on Camel productivity of camels in Mandera County

The results showed the aggregate mean and standard deviation was 3.0 and 0.72 meaning that most of the responses fell at the middle of the Likert scale indicating indecision. It implies that most of the respondents were not very clear on the effect of infrastructure on camel productivity probably due to a missing link in the whole equation of what infrastructure like roads meant for camels which were used for transportation in places that had no roads in the first place. However, lack of infrastructure has been known to impair ease of transport for goods and services like veterinary drugs, feeds, camel products like milk and meat and indeed even services of veterinary officers. Without roads in the county, it is very difficult to access the rural areas to avail the requisite goods and services.

Correlation analysis revealed a significantly positive relationship between infrastructure and camel productivity at 0.737**. Further, regression analysis indicated that infrastructure had a statistically significant positive effect on camel productivity at (β= 0.305, p=0.000). The null hypothesis of no statistical significance was consequently rejected. It was concluded that infrastructure, though not directly related to camel productivity, was critical to the latter in ensuring provision of other services and goods required by the camel producers and other stakeholders. Road transport should be improved to all weather conditions to ensure timely delivery of good (camel feeds and veterinary products) from Nairobi and other sources as well as improvement of other facilities like cold storage for camel milk and meat. Accessibility through a good road network would also improve mobility of service providers like veterinary officers.

5.2.4 Effect of Government support on Camel productivity in Mandera.

The results showed the aggregate means at 3.6 with a standard deviation of 0.80 meaning that most of the respondents were gravitating towards “agreement” with constructs determining this independent variable. This meant that Government support were conceived to be critical to camel productivity in terms of provision of technical advisory

services regarding feeding, veterinary care, marketing of products, value addition and even the right breeds of camels to keep. Correlation analysis revealed a positive and significant relationship between Government support with camel productivity at r=0.397**. Regression analysis indicated that Government support had a statistically significant positive effect on camel productivity as depicted by the results (β= 0.413, p=0.000). This implied that the null hypothesis of non-significant relationship was rejected. Government interventions are critical in advancing the course of camel productivity in that some public goods are only provided by a responsible and caring government. The County Government of Mandera needed to provide the requisite interventions like technical advisory services (extension) to camel farmers to improve their knowledge base and consequently, productivity. It is concluded that government support was minimal and limited to very few activities that had no major impact on camel herders/farmers. The government must do more in terms of offering technical advisory services in animal production to improve feeding and care of camels as well as in veterinary care to reduce incidences of pests and diseases that impact negatively on productivity of milk, meat and hides. The County Government can set more resources to employ more extension staff and train farmers on good camel husbandry if productivity of this great livelihood animal is to be improved.

5.3 Recommendations

It was clearly evident from the study findings that camel breeds, animal care, infrastructure and Government support influenced overall camel productivity in Mandera County. Based on the above conclusions, the following recommendations were made:

5.3.1 Recommendations on camel breeds

The county government of Mandera needs to invest in more productive breeds and avail adequate bulls for production to farmers in order to maximize on the breeding period of female camels which is normally wasted due to inadequate bulls. Further, the bulls should be from pedigrees of high producers to improve on milk, meat and hides productivity.

5.3.2. Recommendations on animal care for camels.

The national government and the county governments of Mandera needs to provide an enabling environment for provision of animal care in terms of veterinary drugs, vaccines, supplementary feeds and minerals. Given these are private sector business services, the government can improve on an enabling environment to ensure private investors are attracted to the business in terms of motorable roads, cold storage and veterinary services among others. Deliberate investments on these fronts is critical to success of the productivity of camels.

5.3.3 Recommendations on infrastructural services

Infrastructure was also found to play a key role in promoting camel productivity. The study recommended improvement in road network, cold storage and other public goods to enable investors in camel production and create an effective demand pull by traders on sustainable business who would even venture into exports of camels and camel products. This would in turn improve the welfare of camel farmers to encourage them to produce more and translate to more revenue for government.

5.3.4 Recommendation on Government support

The government plays a critical role on provision of public goods that are not possible with individual producers. The study recommended a redoubling of government efforts in terms of proactively setting aside finances to provide support to camel producers and monitoring the progress of farmers in this critical socio-economic and livelihood support animal.

5.4 Implications for policy and Recommendation for Further Studies

The findings and conclusions from the study point to the urgent and serious need for the government to invest in camel productivity enhancing factors among those studied but not confined to them only as well as other enablers to productivity. Both the County and National Government have a role to play with the former required to invest in support to farmers through an enlightened and elaborate extension service providers while the latter provides trunk roads from the City of Nairobi to Mandera Town and other highways

which is a public good. In the meantime, farmers need to be assisted with feeding, veterinary care and cold storage for their camel products.

Future research should consider other aspects of camel productivity and even promotion of trade which was only implied in this study. Furthermore, it would be useful to carry out the same type of research in other counties to compare results. Instead of gathering perceptions from respondents, future study can go a step further and gather actual productivity data from some baseline on some critical performance determining camel productivity factors like change of breeding from bulls to AI (assuming it is available in the area), Change from browsing to feedlots and their effects of productivity and a variation of such factors on measurement basis.

REFERENCES

Abrhaley, A., & Leta, S. (2018). Medicinal value of camel milk and meat. *Journal of Applied Animal Research*, *46*(1), 552-558. https://www.tandfonline.com/doi/full/10.1080/09712119.2017.1357562

Akweya, B. A., Gitao, C. G., & Okoth, M. W. (2012). The acceptability of camel milk and milk products from north eastern province in some urban areas of Kenya. *African Journal of Food Science*, *6*(19), 465-473. https://academicjournals.org/journal/AJFS/article-full-text-pdf/18EBF9512084

Alhadrami, G., & Faye, B. (2022). *Camel In: Encyclopedia of dairy sciences.* Academic Press.

Alin, A., & Agostinelli, C. (2017). Robust iteratively reweighted SIMPLS. *Journal of Chemometrics*, *31*(3), e2881. https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/full/10.1002/cem.2881

Almutairi, S. E., Boujenane, I., Musaad, A., & Awad-Acharari, F. (2010). Genetic and nongenetic effects for milk yield and growth traits in Saudi camels. *Tropical Animal Health and Production*, *42*, 1845-1853. https://link.springer.com/article/10.1007/s11250-010-9647-6

Aloo, P. A., Charo-Karisa, H., Munguti, J., & Nyonje, B. (2017). A review on the potential of aquaculture development in Kenya for poverty alleviation and food security. *African Journal of Food, Agriculture, Nutrition and Development*, *17*(1), 11832-11847. https://www.ajol.info/index.php/ajfand/article/view/153816

Baars, R. M. T. (2000). Costs and returns of camels, cattle and small ruminants in pastoral herds in eastern Ethiopia. *Tropical Animal Health and Production*, *32*, 113-126. https://link.springer.com/article/10.1023/A:1005282719931

Baba, W. N., Rasool, N., Selvamuthukumara, M., & Maqsood, S. (2021). A review on nutritional composition, health benefits, and technological interventions for improving consumer acceptability of camel meat: an ethnic food of Middle East. *Journal of Ethnic Foods*, *8*(1), 1-13. https://journalofethnicfoods.biomedcentral.com/articles/10.1186/s42779-021-00089-1

Babbie, E. (1990). The essential wisdom of sociology. *Teaching Sociology*, *18*(4), 526-530. https://www.jstor.org/stable/pdf/1317643.pdf

Babiker, W. I., & El-Zubeir, I. E. (2014). Impact of husbandry, stages of lactation and parity number on milk yield and chemical composition of dromedary camel milk. *Emirates Journal of Food and Agriculture*, 333-341. https://www.ejfa.me/index.php/journal/article/view/402

Bediye, S., Tilahun, S., & Kirub, A. (2018).Engaging opportunities for camel production.Ethiopian Somali Region Pastoral and Agro-pastoral Research Institute (EsoRPARI), Jigjiga, 1-105. https://camed.cirad.fr/fr/content/download/4359/32112/version/1/file/Bediye+al+2018+Engaging+Opportunities+for+Camel+Production.pdf

Bekele, S. T. (2008). Gross and microscopic pulmonary lesions of camels from Eastern Ethiopia. *Tropical Animal Health and Production*, *40*, 25-28. https://link.springer.com/article/10.1007/s11250-007-9046-9

Berhe, T., Seifu, E., Ipsen, R., Kurtu, M. Y., & Hansen, E. B. (2017). Processing challenges and opportunities of camel dairy products. *International journal of food science*, *2017*, 1-8. https://www.hindawi.com/journals/ijfs/2017/9061757/

Catley, A., & Aklilu, Y. (2013). *Moving Up or Moving Out? Commercialization, growth and destitution in pastoralist areas. In Pastoralism and Development in Africa* (pp. 85-97). Routledge.https://www.taylorfrancis.com/chapters/oa-edit/10.4324/9780203105979-9/moving-moving-andy-catley-yacob-aklilu

Chema, S., & Gathuma, J. M. (2004). Kenya: the development of private services and the role of the Kenya Veterinary Association. *Revue Scientifique et Technique (International Office of Epizootics)*, *23*(1), 331-40. https://europepmc.org/article/med/15200107

Chuluunbat, B., Charruau, P., Silbermayr, K., Khorloojav, T., & Burger, P. A. (2014). Genetic diversity and population structure of M ongolian domestic B actrian camels (Camelusbactrianus). *Animal genetics*, *45*(4), 550-558. https://doi.org/10.1111/age.12158

Clark, L. A., & Watson, D. (2019). Constructing validity: New developments in creating objective measuring instruments. *Psychological assessment*, *31*(12), 1412. https://doi.org/10.1037/pas0000626

Costagli, R., Mugunieri, L. G., & Wanyoike, F. N. (2017). A rapid appraisal of the Yemeni end-market for Somali livestock exporters. *ILRI Discussion Paper*. https://cgspace.cgiar.org/bitstream/handle/10568/80374/dp34.pdf

Debowicz, D., Dorosh, P., Haider, H., & Robinson, S. (2012). A 2007-08 social accounting matrix for Pakistan. *Pakistan Strategy Support Program (PSSP) Working Paper*, (001). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2161402

Djenane, D., Aboudaou, M., Djenane, F., García-Gonzalo, D., & Pagán, R. (2020). Improvement of the shelf-life status of modified atmosphere packaged camel meat using nisin and Olea europaea subsp. laperrinei leaf extract. *Foods*, *9*(9), 1336. https://onlinelibrary.wiley.com/doi/full/10.1002/fsn3.1650

Dokata, M. D. (2014). *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 [Master's Thesis, University of Nairobi]. Kenya. http://erepository.uonbi.ac.ke/handle/11295/74148

Dong, W., Liao, S., & Zhang, Z. (2018). Leveraging financial social media data for corporate fraud detection. *Journal of Management Information Systems, 35*(2), 461-487. https://www.tandfonline.com/doi/full/10.1080/07421222.2018.1451954

Dowelmadina, I. M. M., Zubeir, I. E. M. E. I., Arabi, O. H. M. H., &Abaker, A. D. (2015). Performance of she camels under traditional nomadic and semi-intensive management in Sudan. *Livestock Research for Rural Development*, *27*(6), 798-1012 https://www.researchgate.net/profile/Adam-Abakar/publication/330848734_

Elhadi, Y. A., Nyariki, D. M., & Wasonga, O. V. (2015). Role of camel milk in pastoral livelihoods in Kenya: contribution to household diet and income. *Pastoralism, 5*(1), 1-8. https://doi.org/10.1186/s13570-015-0028-7

Etikan, I., & Babtope, O. (2019). A basic approach in sampling methodology and sample size calculation. *Med Life Clin*, *1*(2), 1006. http://www.medtextpublications.com/open-access/a-basic-approach-in-sampling-methodology-and-sample-size-calculation-249.pdf

Evans, G. I. (2012). *Welsh writing in English: Case studies in cultural interaction*. Swansea University

Farag, E., Sikkema, R. S., Mohamedani, A. A., De Bruin, E., Munnink, B. B. O., Chandler, F., & AbdElrahman, S. H. (2019). MERS-CoV in camels but not camel handlers, Sudan, 2015 and 2017. *Emerging infectious diseases*, *25*(12), 2333-2410. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6874263/

Farah, Z., Mollet, M., Younan, M., & Dahir, R. (2007). Camel dairy in Somalia: Limiting factors and development potential. *Livestock Science*, *110*(1-2), 187-191. https://doi.org/10.1016/j.livsci.2006.12.010

Faraz, A., Mustafa, M. I., Lateef, M., Yaqoob, M., & Younas, M. (2013). Production potential of camel and its prospects in Pakistan. Punjab University Journal of Zoology, 28(2), 89-95. https://www.researchgate.net/profile/Asim-Faraz/publication/327620631

Faraz, A., Waheed, A., Mirza, R. H., & Ishaq, H. M. (2019). The camel–a short communication on classification and attributes. *Journal of Fisheries and Livestock Production*, *7*(1), 289-291. https://www.researchgate.net/profile/Asim-Faraz/publication/332058242_

Field, J. (2000). *Lifelong learning and the new educational order*. Trentham Books, Ltd., https://eric.ed.gov/?id=ED462589

Food and Agriculture Organization (2019)**.** *Crops and livestock products* http://www.fao.org/faostat/en/#data/QA

Freitas, L. E., da Silva Neves, S. M. A., Nunes, M. C. M., Serafim, M. E., & de PAULA, D. G. (2017). Agricultural aptitude of lands and conflicting uses in permanent preservation areas of Ribeirão Jacobina Basin in Cáceres/Mato Grosso State, Brazil. *Geografia*, *42*(3), 41-56. https://www.periodicos.rc.biblioteca.unesp.br/index.php/ageteo/article/view/13088

Geisen, E., & Murphy, J. (2020). A compendium of web and mobile survey pretesting methods. *Advances in questionnaire design, development, evaluation and testing*, 287-314. https://doi.org/10.1002/9781119263685.ch12

Ghasemi, J., Saaidpour, S., & Brown, S. D. (2007). QSPR study for estimation of acidity constants of some aromatic acids derivatives using multiple linear regression (MLR) analysis. *Journal of Molecular Structure: THEOCHEM*, *805*(1-3), 27-32. https://www.sciencedirect.com/science/article/abs/pii/S0166128006006531

Green, M. A. (2019). Photovoltaic technology and visions for the future. *Progress in Energy*, *1*(1), 013001. https://iopscience.iop.org/article/10.1088/2516-1083/ab0fa8/meta

Guliye, A. Y., Noor, I. M., Tariq, M., & Bebe, B. O. (2021). Assessment of camel and camel milk marketing practices in an emerging peri-urban production system in Isiolo County, Kenya. *Pastoralism: Research, Policy and Practice*, *3*(1), 1-8. https://link.springer.com/article/10.1186/2041-7136-3-28

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*, *31*(1), 2-24. https://www.emerald.com/insight/content/doi/10.1108/EBR-11-2018-0203/full/pdf?title=when-to-use-and-how-to-report-the-results-of-pls-sem

Hart, K. (1973). Informal income opportunities and urban employment in Ghana. *The journal of modern African studies*, *11*(1), 61-89. https://www.cambridge.org/core/journals/journal-of-modern-african-studies/article/abs/informal-income-opportunities-and-urban-employment-in-ghana/F440D34392BBF69D76543EB717A9FBB7

Hayes, A. F., & Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. But…. *Communication Methods and Measures*, *14*(1), 1-24. https://doi.org/10.1080/19312458.2020.1718629

Herren, U. J. (1992). Cash from camel milk: the impact of commercial camel milk sales on Garre and Gaaljacel camel pastoralism in Southern Somalia. *Nomadic Peoples*, *30* (1992), 97-113. https://www.jstor.org/stable/43123360

Ibrahim, I. M. (2021). Task scheduling algorithms in cloud computing: A review. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(4), 1041-1053. https://turcomat.org/index.php/turkbilmat/article/view/612

Isako, T. (2023). *Performance of Camel Calves in Kenya Fed on Milk Substitute Formulated from Locally Available Feed Ingredients.* [Doctoral Thesis, Egerton

University]. Kenya. http://ir-library.egerton.ac.ke/jspui/bitstream/123456789/4526/1/Performance%20of%20Camel%20Calves%20In%20Kenya%20Fed%20On%20Milk%20Substitute%20Formulated%20From%20Locally%20Available%20Feed%20Ingredients%20%282%29.pdf

Isako, T., & Kimindu, V. (2019). Camel milk value chain in Kenya: a review. *J Marketing Consumer Res*, *58*, 51-64. https://d1wqtxts1xzle7.cloudfront.net/86324397/234694582-libre.pdf?1653286415=&response-content-disposition=inline%3B+filename%3D

Jores, J. (2015). Middle East respiratory syndrome-coronavirus in camels: an overview for Sub-Saharan and North Africa. *Evidence on Demand*, *4*, 21. https://assets.publishing.service.gov.uk/media/57a08969e5274a27b2000085/EoD_Consultancy_Jul15_MERS_Study.pdf

Kagunyu, A. W., & Wanjohi, J. (2014). Camel rearing replacing cattle production among the Borana community in Isiolo County of Northern Kenya, as climate variability bites. *Pastoralism*, *4*(1), 1-5. https://pastoralismjournal.springeropen.com/articles/10.1186/s13570-014-0013-6

Kemboi, F., Ondiek, J. O., & Onjoro, P. A. (2017). Evaluation of nutritive value and in-vitro degradation of selected indigenous browses from Semi-Arid areas of Kenya. *Livestock Research for Rural Development. 29* (5). https://www.lrrd.cipav.org.co/lrrd29/5/kemb29092.html

Kenya National Bureau of Statistics (2019). *Kenya Population and Housing Census Volume IV: Distribution of Population by Socio-Economic Characteristics—Kenya National Bureau of Statistics. 2019*. https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-iv-distribution-of-population-by-socio-economic-characteristics

Khan, B. B., Arshad, I., & Riaz, M. (2003). *Production and management of camels*. University of Agriculture, Faisalabad, Department of Livestock Management. https://d1wqtxts1xzle7.cloudfront.net/40518061/production_and_management_of_camels_www.freebookbank.net-with-cover-page-

Knekta, E., Runyon, C., & Eddy, S. (2019). One size doesn't fit all: Using factor analysis to gather validity evidence when using surveys in your research. *CBE—Life Sciences Education*, *18*(1), rm1. https://doi.org/10.1187/cbe.18-04-0064

Kuria, S. G., Wahome, R. G., Gachuiri, C. K., & Wanyoike, M. M. (2004). Evaluation of forages as mineral sources for camels in western Marsabit, Kenya. *South African Journal of Animal Science*, *34*(3).https://web.p.ebscohost.com/ehost/detail/detail?vid=0&sid=bdf073bd-7ef6-4c76-b538-19e8c83558ff%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=15933782&db=a9h

Kyule, G., & Nguli, J. (2020). *Exploring Kenya Dairy Industry for Job Creation for the Youth*. Kenya Institute for Public Policy Research and Analysis.

Lamuka, P. O., Njeruh, F. M., Gitao, G. C., & Abey, K. A. (2017). Camel health management and pastoralists' knowledge and information on zoonoses and food safety risks in Isiolo County, Kenya. *Pastoralism*, *7*, 1-10. https://link.springer.com/article/10.1186/s13570-017-0095-z

Machan, C. W. (2020). Advances in the molecular catalysis of dioxygen reduction. *ACS Catalysis*, *10*(4), 2640-2655. https://pubs.acs.org/doi/abs/10.1021/acscatal.9b04477

Mackieson, P., Shlonsky, A., & Connolly, M. (2019). Increasing rigor and reducing bias in qualitative research: A document analysis of parliamentary debates using applied thematic analysis. *Qualitative Social Work*, *18*(6), 965-980. https://doi.org/10.1177/1473325018786996

Maddala, G., & Flores-Lagunes, A. (2001). *A companion to theoretical econometrics*. Blackwell Publishing Ltd

Matofari, J. W., Nanua, J., Younan, M., & Adongo, A. O. (2013). *Analysis of microbial quality and safety of camel (Camelus dromedarius) milk chain and implications in Kenya.* http://ir-library.egerton.ac.ke/jspui/bitstream/123456789/2634/1/Analysis%20of%20microbial%20quality%20and%20safety%20of%20camel%20%28Camelus%20dromedarius%29%20milk%20chain%20and%20implications%20in%20Kenya.pdf

Mehmood, M. A., Ye, G., Luo, H., Liu, C., Malik, S., Afzal, I., & Ahmad, M. S. (2017). Pyrolysis and kinetic analyses of Camel grass (Cymbopogonschoenanthus) for bioenergy. *Bioresource technology*, *228*, 18-24. https://doi.org/10.1016/j.biortech.2016.12.096

Mohamed, H., Nagy, P., Agbaba, J., & Kamal-Eldin, A. (2021). Use of near and mid infra-red spectroscopy for analysis of protein, fat, lactose and total solids in raw cow and camel milk. *Food Chemistry*, *334*, 127436. https://doi.org/10.1016/j.foodchem.2020.127436

Moola, S., & Cilliers, C. P. (2020). *Gender and Aging Research Methods. In Handbook of Research Methods in Health Psychology.* Routledge.

Mugenda, O. M., & Mugenda, A. G. (2003). *Research methods: Quantitative & qualitative approaches*. Acts press.

Muloi, D., Alarcon, P., Ombui, J., Ngeiywa, K. J., Abdullahi, B., Muinde, P., & Fèvre, E. M. (2018). Value chain analysis and sanitary risks of the camel milk system supplying Nairobi city, Kenya. *Preventive Veterinary Medicine*, *159*, 203-210. https://doi.org/10.1016/j.prevetmed.2018.09.010

Musaad, A., Faye, B., &Nikhela, A. A. (2013). Lactation curves of dairy camels in an intensive system. *Tropical Animal Health and Production*, *45*(4), 1039-1046. https://link.springer.com/article/10.1007/s11250-012-0331-x

Mutambara, J., Dube, I., Matangi, E., & Majeke, F. (2013). Factors influencing the demand of the service of community based animal health care in Zimbabwe. *Preventive Veterinary Medicine*, *112*(3-4), 174-182. https://www.sciencedirect.com/science/article/abs/pii/S016758771300233X

Njoroge, J. (2022). *Determinants of Profit Efficiency of Camel Milk Traders in Five Counties in Northern Kenya* [Master's Thesis, University of Nairobi). Kenya. http://erepository.uonbi.ac.ke/bitstream/handle/11295/163475/Njoroge_Determinants%20of%20Profit%20Efficiency%20of%20Camel%20Milk%20Traders%20in%20Five%20Counties%20in%20Northern%20Kenya.pdf?sequence=1&isAllowed=y

Noor, I. M., Guliye, A. Y., Tariq, M., & Bebe, B. O. (2013). Assessment of camel and camel milk marketing practices in an emerging peri-urban production system in Isiolo County, Kenya. *Pastoralism: Research, Policy and Practice*, *3*, 1-8. https://link.springer.com/article/10.1186/2041-7136-3-28

O'Brien, R. M. (2017). Dropping highly collinear variables from a model: why it typically is not a good idea. *Social Science Quarterly*, *98*(1), 360-375. https://onlinelibrary.wiley.com/doi/full/10.1111/ssqu.12273

Oselu, S., Ebere, R., & Arimi, J. M. (2022). Camels, camel milk, and camel milk product situation in Kenya in relation to the world. *International Journal of Food Science*, *2022*. https://doi.org/10.1155/2022/1237423

Oteki, E. B. (2019). *Influence of Electronic Procurement Practices on Supply Chain Performance of Sugar Processing Firms in Kenya* [Doctoral Thesis, Jomo Kenyatta University of Agriculture and Technology]. Kenya. http://ir.jkuat.ac.ke/bitstream/handle/123456789/4903/Oteki%2c%20Evans%20Biraori%2c%20PhD%20SCM%2c%202018.pdf?sequence=1&isAllowed=y

Qi, M., Li, J., Zhao, A., Cui, Z., Wei, Z., Jing, B., & Zhang, L. (2018). Host specificity of Enterocytozoon bieneusi genotypes in Bactrian camels (Camelus bactrianus) in China. *Parasites & vectors*, *11*(1), 1-6. https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-018-2793-9

Ramet, J. P. (2001). *The technology of making cheese from camel milk (Camelus dromedarius)*. Food & Agriculture Org.

Raziq, A., Younas, M., & Kakar, M. A. (2008). Camel a potential dairy animal in difficult environments. *Pak. J. Agri. Sci*, *45*(2), 263-267. https://d1wqtxts1xzle7.cloudfront.net/65968834/camel_a_potential_milk_animal2

Redding, L. E., Barg, F. K., Smith, G., Galligan, D. T., Levy, M. Z., & Hennessy, S. (2013). The role of veterinarians and feed-store vendors in the prescription and

use of antibiotics on small dairy farms in rural Peru. *Journal of dairy science*, *96*(11), 7349-7354. https://www.sciencedirect.com/science/article/pii/S002203021300653X

Salim, B., Bakheit, M. A., Kamau, J., Nakamura, I., & Sugimoto, C. (2011). Molecular epidemiology of camel trypanosomiasis based on ITS1 rDNA and RoTat 1.2 VSG gene in the Sudan. *Parasites & Vectors*, *4*(1), 1-5. https://parasitesandvectors.biomedcentral.com/articles/10.1186/1756-3305-4-31

Schwartz, H. J., Dolan, R., & Wilson, A. J. (1983).Camel production in Kenya and its constraints. I. Productivity. *Tropical animal health and production*, *15*(3), 169-178. https://europepmc.org/article/med/6623648

Shahbazi, Y., Karami, N., & Shavisi, N. (2018). Effect of Mentha spicata essential oil on chemical, microbial, and sensory properties of minced camel meat during refrigerated storage. *Journal of Food Safety*, *38*(1), e12375. https://onlinelibrary.wiley.com/doi/full/10.1111/jfs.12375

Shahryari, Z., Gheisari, K., & Motamedi, H. (2019). Corrosion behavior of API X70 microalloyed pipeline steel in a simulated soil solution in the absence and presence of aerobic Pseudomonas species. *Materials Research Express*, *6*(6), 065409. https://iopscience.iop.org/article/10.1088/2053-1591/ab0f67/meta

Shaito, A., Posadino, A. M., Younes, N., Hasan, H., Halabi, S., Alhababi, D., & Pintus, G. (2020). Potential adverse effects of resveratrol: A literature review. *International journal of molecular sciences*, *21*(6), 2084. https://www.mdpi.com/1422-0067/21/6/2084

Shiraani, F., Shaheer, I., & Carr, N. (2022). *Procedural Ethics vs Being Ethical: A Critical Appraisal. In Contemporary research methods in hospitality and tourism* (pp. 21-37). Emerald Publishing Limited. . https://doi.org/10.1108/978-1-80117-546-320221003

Simpkin, D. J. (1995). Transmission data for shielding diagnostic x-ray facilities. *Health Physics*, *68*(5), 704-709. https://journals.lww.com/health-physics/Abstract/1995/05000/Transmission_Data_for_Shielding_Diagnostic_X_Ray.11.aspx

Sisay, F., & Awoke, K. (2015). Review on production, quality and use of camel milk in Ethiopia. *J Fisheries Livest Prod*, *3*(145), 2. http://dx.doi.org/10.4172/2332-2608.1000145

Sovacool, B. K., Axsen, J., & Sorrell, S. (2018). Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design. *Energy research & social science*, *45*, 12-42. https://www.sciencedirect.com/science/article/pii/S2214629618307230

Stiles, F. G. (1995). Behavioral, ecological and morphological correlates of foraging for arthropods by the hummingbirds of a tropical wet forest. *The Condor*, *97*(4), 853-878. https://academic.oup.com/condor/article-abstract/97/4/853/5126159

Storme, T., De Vos, J., De Paepe, L., & Witlox, F. (2020). Limitations to the car-substitution effect of MaaS. Findings from a Belgian pilot study. *Transportation Research Part A: Policy and Practice*, *131*, 196-205. https://doi.org/10.1016/j.tra.2019.09.032

Story, D. A., & Tait, A. R. (2019). Survey research. *Anesthesiology*, *130*(2), 192-202. https://doi.org/10.1097/ALN.0000000000002436

Tafesse, T. (2001). The hydropolitical assessment of the Nile question: an Ethiopian perspective. *Water international*, *26*(4), 1-11. https://www.tandfonline.com/doi/abs/10.1080/02508060108686945

Tharu, S., & Niranjana, T. (2019). *In Dalit Feminist Theory*. Routledge.

Thompson, K. (2014). *Where Do Camels Belong? The story and science of invasive species*. Profile Books. https://webmail.psych.purdue.edu/bckmstcydx90/10-dr-richmond-howell-phd/w-9781781251751-where-do-camels-belong-the-story-and-science-of-.pdf

Tseng, C. H., & Sim, D. (2021). Sample size planning for pilot studies. *arXiv preprint arXiv:2105.05483*. https://doi.org/10.48550/arXiv.2105.05483

Vlasceanu, M., Morais, M. J., & Coman, A. (2021). The effect of prediction error on belief update across the political spectrum. *Psychological Science*, *32*(6), 916-933. https://journals.sagepub.com/doi/abs/10.1177/0956797621995208

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and society*, *9*(2), 1-9.; https://www.jstor.org/stable/26267673?typeAccessWorkflow=login

Walsh, N. E., & Schwartz, R. (1992). Prevention of Back Injury in the Work Place. *Physical Medicine and Rehabilitation Clinics of North America*, *3*(3), 553-561. https://www.sciencedirect.com/science/article/abs/pii/S1047965118306314

Wang, C., Xu, J., Yang, L., Xu, Y., Zhang, X., Bai, C., & China Pulmonary Health Study Group. (2018). Prevalence and risk factors of chronic obstructive pulmonary disease in China (the China Pulmonary Health [CPH] study): a national cross-sectional study. *The Lancet*, *391*(10131), 1706-1717. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)30841-9/fulltext

Wernery, U. (2006). Camel milk, the white gold of the desert. *Journal of Camel Practice and Research*, *13*(1), 15-26. http://camelmilkforhealth.com/publications/White%20Gold%20of%20Dessert001.pdf

Wilson, R. T. (1984). *The camel*. Longman.

Wise, A. F., & Jung, Y. (2019). Teaching with analytics: Towards a situated model of instructional decision-making. *Journal of Learning Analytics*, *6*(2), 53-69. https://doi.org/10.18608/jla.2019.62.4

Woodford, D. J., Ivey, P., Novoa, A., Shackleton, R., Richardson, D., Weyl, O., & Zengeya, T. (2017). Managing conflict-generating invasive species in South Africa: Challenges and trade-offs. *Bothalia-African Biodiversity & Conservation*, *47*(2), 1-11. https://journals.co.za/doi/abs/10.4102/abc.v47i2.2160

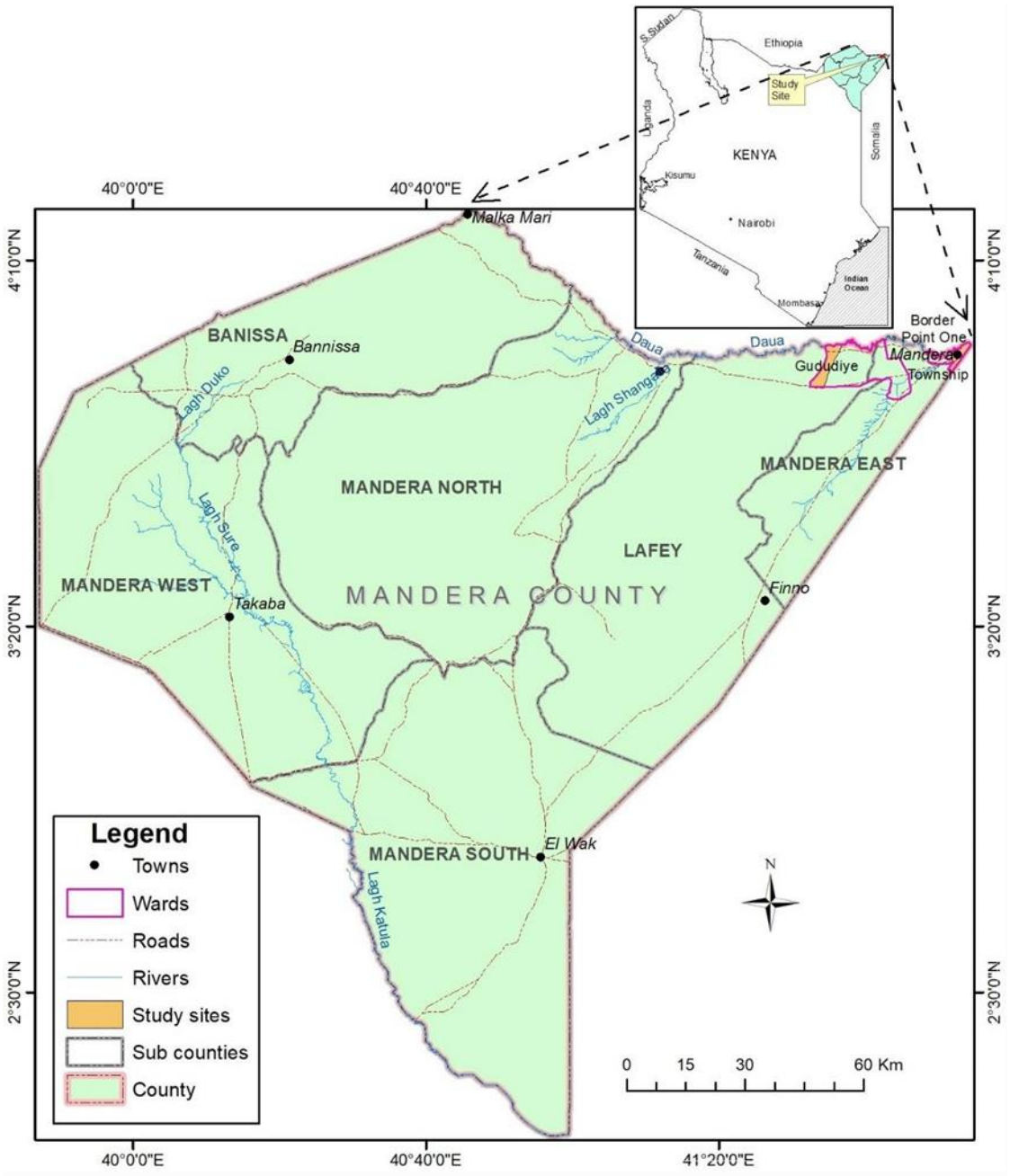
Yamane, I., & Sato, K. (1967). Effect of temperature on the decomposition of organic substances in flooded soil. *Soil Science and Plant Nutrition*, *13*(4), 94-100. https://www.tandfonline.com/doi/pdf/10.1080/00380768.1967.10431981

Yu, H., Shi, R., Zhao, Y., Bian, T., Zhao, Y., Zhou, C., & Zhang, T. (2017). Alkali-assisted synthesis of nitrogen deficient graphitic carbon nitride with tunable band structures for efficient visible-light-driven hydrogen evolution. *Advanced Materials*, *29*(16), 1605148. https://onlinelibrary.wiley.com/doi/epdf/10.1002/adma.201605148

Zulu, R., Gichohi-Wainaina, W., Fungo, R., Birachi, E. A., Nchanji, E. B., Munthali, J., & Okori, P. (2020). *Nutrition, Markets and Gender Analysis: An integrated approach towards alleviating malnutrition among vulnerable populations in Malawi.* https://cgspace.cgiar.org/bitstream/handle/10568/108909/Malawi%20Seed%20Industry%20Development%20Project%20Phase%20II%20(MSIDP%20II)%20-%20Executive%20Summary.pdf?sequence=1

APPENDICES

Appendix I. Map of Mandera County



Appendix II: Study Questionnaire for camel producers

i. General Information

Age: a)18-25 ____b) 25-35 ____c) 35-45 ____d) 45-55 ____ e) 55 -65 ____

f) 65-75 ___g) >75 __

Gender Male ____ Female ____

Occupation: a) Camel farmer (Producer) b) Camel Trader (Live camels, Camel Milk, Camel Meat, Camel Hides, c) Other _____ specify)

County: Mandera _____ Wajir _____

Duration in Camel Business: a) < 5 years ____, b) 5-10 years ____, c) 10 -20 ____years, d) >30 years ____.

ii. Specific information

a. Breed preferences and factors affecting productivity

The following statements relate to issues of production of camels in your area. On a scale of 1 – 5 (with 1-Strongly Disagree 2- Disagree 3 – Neither agree nor disagree, 4-Agree, 5- Strongly agree), please indicate your opinion with reference to breeds of camels in terms of production.

Type of breed(s) kept. _____ _____

S/NO	Statement	1	2	3	4	5
1	I prefer the breed for its high productivity of milk, meat and hides					
2	The breed of camels kept in this area is only one due to its tried and tested qualities of					

	resilience, productivity and trade					
3	I keep mixed breeds of camels to compare their productivity					
4	Camel breeding is mainly through bulls (camel males) hence the only breed(s) available					
5	I have tried other breeds of camels in this area but they have failed					
6	Farmers in this area cannot access any other breed of camels					
7	Technology for artificial insemination is not available hence farmers use male camels for breeding hence low-quality breeds.					
8	Farmers can access better genetic potential of breeds through cooperatives and other pooled resources.					
9	There is shortage of male camels which negatively affects productivity due to loss of mating time and genetic vigour					

b. Purpose of keeping camels

The following statements relate to issues of production of camels in your area. On a scale of 1 – 5 (with 1-Strongly Disagree 2- Disagree 3 – Neither agree nor disagree, 4-Agree, 5- Strongly agree), please indicate your opinion on the state of camel production.

S/NO	Statement	1	2	3	4	5
1	I keep camels for family sustenance in terms of milk and meat for food.					
2	I keep camel(s) only for prestige and as a show of wealth					
3	I keep camel(s) for both milk, meat and hides trade (commercial purposes only)					
4	I keep camels since they are the most resistant to climatic conditions in this area					
5	I keep camels after all other livestock keeping became difficult due to adverse weather					
6	I keep camels for social cultural purposes like marriages and other traditional rites.					
7	Due to cattle rustling and other raids (insecurity) which affect cattle, sheep and goats, I chose to keep camels as a less risky venture					

d. Effects of animal care on camel productivity

The following statements relate to issues of animal care for camels in your area. On a scale of 1 – 5 (with 1-Strongly Disagree 2- Disagree 3 – Neither agree nor disagree, 4- Agree, 5- Strongly agree), please indicate your opinion with reference to availability, quality and efficiency of animal care for camels in your area.

S/NO	Statement	1	2	3	4	5
1	There is insufficient veterinary care for animals in this area.					
2	Government veterinary services and other technical advisory services on animal care are no longer available in this area.					
3	The poor breeds, poor production practices and poor animal care are due to lack of knowledge and support on these issues.					
4	Animal care is critical but also expensive for an ordinary camel farmer hence sometimes we end up losing animals to preventable diseases.					
5	Private veterinary and agro-chemical shops exist in the area but drugs and chemicals for camels are out of reach of most farmers.					
6	Cooperatives are not very well established to deal with camels and the few available ones are weak and limited in their services.					
7	Camel keeping can be a lucrative venture if government or other agencies improved on					

	animal care.					
8	Milk and meat productivity (litres of milk/camel/day and carcass cold dressed weight (Kg)/slaughtered camel are low when animal health is not properly maintained.					

e. Economic benefits of camel productivity (Dependent Variable)

S/NO	**Statement**	**1**	**2**	**3**	**4**	**5**
1	I keep camels for their high-quality milk					
2	Camels provide enough milk for my family and for sale to generate income					
3	The yield of milk/camel/day has been increasing over the years					
4	I keep camels for high quality meat which I sell in the local butcheries/abattoirs for income.					
5	The meat production per unit (carcass cold dressed weight (Kg)/slaughtered camel) are high and have continued to increase					
6	I keep camels for other by-products like manure which I use in crop production or sell.					
7	I sell high quality hides from camels when I slaughter them and get income.					

8	The quality of hides (price/hide/camel) is high and increasing					
9	My camels provide other sources of food like milk by-products (cream) and blood.					
10	Camels are the lifelines of people in this area since they provide all our food and other social needs like payment of dowry.					
11	Camel trade generates enough profits to keep my business running and surplus for investments.					
12	I am able to educate my children with income from camel productivity and trade.					
13	I could get more in terms of milk and meat from camels if I got productivity enhancing inputs like supplementary feeds.					
14	Camel business gives my family income to carry out other financial transactions to improve our lives.					

Thank you for participating in this interview. The findings will be used for academic purposes only.

Appendix III: Interview Schedule for the County Extension Officers

(Animal production and veterinary officers)

1. What is your view on the existing camel breeds in Mandera County?
2. How productive are the breeds in terms of camel milk, meat and hides?
3. What are the major breeding methods available among farmers? Camel bulls, Artificial insemination, etc- please explain.
4. Are the breeding bulls of high genetic vigour? Are they adequate for the right breeding ration of bulls: female camels?
5. What, in your view, is the main purpose of farmers/dealers keeping camels in Mandera county? Give a few reasons.
6. Is camel keeping an adequate and lucrative socio-economic and livelihood sustaining venture? Explain.
7. How has camel husbandry and business impacted on the ordinary farmers or camel dealers in Mandera County?
8. What do you think can be done to improve or enhance this socio-economic impact?
9. Do camel farmers have access to free Government Veterinary Services?
10. Are there private Veterinary Service providers in the County?
11. How expensive is veterinary care from private care givers, if any?
12. Do you think the available veterinary care givers are adequate to serve camel farmers?
13. How accessible are veterinary drugs and vaccines by camel farmers in the county?
14. How critical is infrastructure in terms of facilitating camel farmers or dealers in this county.
15. What do you think should be done to improve on the infrastructure in the county to serve camel
16. How has the government extension or technical advisory service assisted camel farmers in Mandera county?
17. Are adequate government specialists or extension agents to reach out and teach camel farmers on good camel husbandry (feeding) and veterinary care?

18. What challenges face government extension services in terms of serving camel farmers and other dealers in camel business?
19. Are there camel cooperatives in Mandera? If so, how robust are they? What services do they provide to their members?
20. In your view, is camel business in Mandera county a lucrative venture? If yes, why? If no, why not?
21. What do you think the Government of Mandera County and the national government can do to improve on camel production for the welfare of camel keepers in Mandera? Please elaborate.

Thank you for participating in the interview. The findings will be for academic purposes only.

Appendix IV: Focus Group Discussion Guide for camel farmers

(For Common Interest Groups)

Focus Group Discussion Guide

County: _____

Name of group: _____

Type of group eg producer, traders, processors, etc: _____

Registration date and number: _____

Group type e.g. Self-help, Community service or cooperative (specify)

_____

Directions:

Any member in the group with knowledge and right answers can volunteer information in a ground table discussion. All suggestions or contributions or opinions are valid and should be respected by members unless they are contrary to the group norms which should be aptly corrected. No member should vilify another over their contributions.

Guiding questions?

1. What does the group exist to do?
2. How is the group leadership arrived at?

3. What are the major benefits of being in this group?
4. What are the major challenges of being in the group?
    a. How does the group lobby and advocate for interventions by relevant bodies e.g. government on its challenges?
5. How effective is the lobby?
6. What tangible benefits has the group gotten from any stakeholder (government or NGO) over the previous three years?
7. What is the future focus of the group in terms of Camel production and productivity?
8. What suggestions do member have on improving their group welfare and indeed commercializing camel production?
9. What would the group want to be highlighted from this study?
10. What plans does the group have to expand its business of Camel production?
11. Any other suggestions?

Appendix V: Descriptive Statistics Results

Appendix V.1. Effect of Camel Breed Preferences on Camel Productivity in Mandera county

		SD	D	N	A	SA	Mean	Std deviation
I prefer the breed for its high productivity of milk, meat, and hides	n	12	51	52	41	52	3.1	0.87
	%	12.0	22.9	23.4	18.3	23.3		
The breed of camels kept in this area is only one due to its tried and tested qualities of resilience, productivity, and trade	n	7	23	21	87	85	4.1	1.02
	%	3.1	10.3	9.3	39.0	38.0		
I keep mixed breeds of camels to compare their productivity	n	18	13	23	77	92	4.1	0.17
	%	8.0	5.8	10.3	34.5	41.2		
Camel breeding is mainly through bulls (camel males) hence the only breed(s) available	n	11	14	22	79	97	4.1	0.81
	%	4.9	6.3	10.0	35.4	43.5		
I have tried other breeds of camels in this area but they have failed	n	5	7	36	85	89	4.1	1.21
	%	2.2	3.1	16.1	38.1	39.9		
Farmers in this area cannot access any other breed of camel	n	16	17	40	60	90	3.6	1.14
	%	7.2	7.6	18.1	26.9	40.2		
Technology for artificial insemination is not available hence farmers use male camels for breeding low-quality breeds.	n	11	18	57	55	82	3.9	1.91
	%	4.9	8.1	25.4	24.6	36.8		

Farmers can access the better genetic potential of breeds through cooperatives and other pooled resources.	n	16	21	33	88	65	3.8	1.14
	%	7.2	9.4	14.7	39.5	29.1		
There is a shortage of male camels which negatively affects productivity due to loss of mating time and genetic vigor.	n	6	16	42	84	75	3.9	0.11
	%	2.6	7.2	18.7	37.7	33.6		
Mean and Standard Deviation							**3.7**	**1.1**

Appendix V.2: Effect of Animal Care on Camel Productivity in Mandera County

		SD	**D**	**N**	**A**	**SA**	**Mean**	**Std deviation**
There is insufficient veterinary care for animals in this area.	n	2	18	15	92	96	4.0	0.75
	%	0.01	0.08	6.5	41.3	43		
Government veterinary services and other technical advisory services on animal care are no longer available in this area.	n	1	7	21	94	100	4.1	0.67
	%	0.0	0.03	9.4	42.2	44.8		
The poor breeds, poor production practices, and poor animal care are due to a lack of knowledge and support on these issues	n	0	6	23	134	60	4.0	0.95
	%	0.0	2.7	10.3	60.1	26.9		
Animal care is critical but also expensive for an ordinary camel farmer hence sometimes we end up losing animals to preventable diseases	n	3	12	26	117	65	4.1	0.86
	%	1.3	5.4	11.7	52.5	29.1		

Private veterinary and agro-chemical shops exist in the area but drugs and chemicals for camels are out of reach of most farmers.	n	3	13	39	108	60	3.8	1.16
	%	1.3	5.8	17.5	48.4	26.9		
Cooperatives are not very well established to deal with camels and the few available ones are weak and limited in their services.	n	3	23	24	109	64	3.9	1.25
	%	1.3	10.3	10.8	48.9	28.7		
Camel keeping can be a lucrative venture if the government or other agencies improved animal care.	n	0	14	37	102	70	4.1	1.09
	%	0.0	6.3	16.6	45.7	31.4		
Milk and meat productivity (liters of milk/camel/day and carcass cold dressed weight (Kg)/slaughtered camel are low when animal health is not properly maintained.	n	8	28	47	63	77	4.0	1.11
	%	3.6	12.6	21.1	28.3	34.5		
Mean and Standard Deviation							**4.0**	**0.97**

Appendix V.3: Effects Infrastructure on Camel Productivity in Mandera County

		SD	D	N	A	SA	Mean	Std deviation
The road network in the County is very poor for transportation of goods and services which negatively impacts on all aspects of camel production	n	10	27	63	57	66	3.4	0.43
	%	4.4	12.1	28.3	25.5	29.6		
Livestock products, veterinary care products and services are all negatively impacted by poor state of roads in the county.	n	16	42	72	56	37	3.3	0.24
	%	7.2	18.8	32.2	25.1	16.6		
Sale of camel milk is mostly affected by poor road network especially during the rainy season since the same cannot reach the market in time and mostly gets bad or is wasted	n	18	14	40	75	65	3.8	0.09
	%	8.1	6.3	17.9	33.6	29.2		
Meat products from slaughtered camels sometimes fail to reach towns due to poor road networks hence fetch little prices in the localities which sometimes are not paid	n	21	11	71	57	63	3.4	1.04
	%	9.4	4.9	31.8	25.6	28.3		
There are no refrigeration services like cold rooms for storing milk or meat products hence these get spoilt and waste before they reach	n	31	9	47	60	76	3.4	1.04
	%	13.9	4.0	21.1	26.9	34.1		

the market which negatively impacts trade.								
There are no refrigerated trucks for long distance transport of milk, meat or other camel products hence wastage and poor prices	n	12	12	75	58	66	3.2	1.02
	%	5.3	5.3	33.6	26	29.6		
Long distances to markets and poor roads militate progressive and profitable camel production	n	22	23	35	71	72	3.7	1.15
	%	9.9	10.3	15.6	31.8	32.2		
Mean and Standard Deviation							**3.5**	**0.72**

N = 223

Appendix V.4: Effect of Government Interventions on Camel Productivity in Mandera County

		SD	**D**	**N**	**A**	**SA**	**Mean**	**Std deviation**
There is limited or no government intervention in camel breeds and breeding which negatively impacts camel production, productivity, and trade.	n	3	14	49	59	99	3.7	0.34
	%	1.3	6.3	21.9	26.5	44.4		
Little or no government intervention in veterinary care negatively impacts camel production, productivity, and trade	n	17	39	28	73	66	3.5	0.65
	%	7.6	17.5	12.7	32.7	29.6		
Lack of government intervention in knowledge provision	n	20	15	52	65	71	3.4	0.45

(extension service) negatively impacts camel production, productivity, and trade	%	8.9	6.7	23.2	29.1	31.8		
Little or no government intervention in road development and maintenance negatively impacts camel production and trade	n	10	15	34	58	106	3.8	1.03
	%	4.5	6.7	15.3	26.0	47.5		
Failure of the government the provision of refrigeration facilities negatively impacts camel production and trade	n	3	13	65	62	80	3.8	0.78
	%	1.3	5.8	29.2	27.8	35.9		
County Governments has formulated policies that are geared towards improving the welfare of camel producers and traders	n	17	12	87	54	53	3.3	1.22
	%	7.6	5.4	38.9	24.2	23.7		
The County and national governments have provided additional funds to improve farming and trade in camels.	n	79	66	50	13	16	2.3	0.69
	%	35.4	29.6	22.3	5.6	7.2		
Support by the government is only limited to mass vaccinations against quarantine disease outbreaks and hence has very little impact on camel production and trade	n	10	7	46	59	101	3.6	1.11
	%	4.5	3.1	20.6	26.5	45.3		
Mean and Standard Deviation							**3.6**	**0.80**

N = 22

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **476766**

Date of Issue: **05/April/2023**

RESEARCH LICENSE

This is to Certify that Mr.. ISSADIN MAALIM ALI of Kenya Methodist University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Mandera, Wajir on the topic: FACTORS AFFECTING CAMEL PRODUCTIVITY AND TRADE IN MANDERA AND WAJIR COUNTIES for the period ending : 05/April/2024.

License No: **NACOSTI/P/23/24941**

476766

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY &
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DIRECTORATE OF POSTGRADUATE STUDIES

March 27, 2023

Commission Secretary,
National Commission for Science, Technology and Innovations,
P.O. Box 30623-00100
NAIROBI.

Dear Sir/Madam,

RE: ISSADIN MAALIM ALI – (REG. NO. AGR-3-0032-1/2021)

This is to confirm that the above named person is a bona fide student of Kenya Methodist University, in the School of Science and Technology, Department of Agriculture undertaking a Master's Degree in Agriculture and Rural Development. He is conducting research on; **"Factors Affecting Camel Productivity and Trade in Mandera and Wajir Counties".**

We confirm that his research proposal has been presented and approved by the University.

In this regard, we are requesting your office to issue a research license to enable him collect data.

Any assistance accorded to him will be highly appreciated.

Yours sincerely,