A STUDY TO DETERMINE FACTORS AFFECTING HEALTH AND PRODUCTIVITY OF CAMEL CALVES IN MARSABIT DISTRICT OF KENYA

GILBERT KIRUI

BVM (University of Nairobi)

A thesis submitted in partial fulfilment of the requirements for

Master of Science in Clinical Studies

University of Nairobi.

Faculty of Veterinary Medicine,

Department of Clinical Studies,

©June 2012
DECLARATION

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

Dr. G. Kirui, B.V.M.

This thesis is submitted for examination with our approval as the university supervisors

Prof. G. K. Gitau, B.V.M., M.Sc., Ph.D.

Dr. A. G. Thalyah, B.V.M., M.Sc., Ph.D.

Prof. C. M. Mulei, B.V.M., Ph.D.
DEDICATION

This thesis is dedicated to the Glory and Honour of God Almighty.

It is a testimony that God does great things.
ACKNOWLEDGEMENT

I am grateful to the University of Nairobi (UoN), the Ministry of Livestock Development (MoLD) and Africa Development Bank (ADB) ALLPRO project for the award of the scholarship that enabled me to undertake this project.

Many thanks to my supervisors, Professor G.K. Gitau, Professor C. M. Mulei, Dr. A.G. Thaiyah, Professor J.K. Wabacha, Professor M. S. Badamana and the late Professor J.M. Maribe who offered their technical advice, support, patience, friendship and many encouragements. Your input has been great throughout the journey.

I extend many thanks to the staff at Veterinary and Livestock production departments of Ministry of Livestock Development (MoLD), Marsabit District office, who gave tremendous support throughout the course of the study. I also wish to acknowledge the centre director and staff at Kenya Agricultural Research Institute (KARI)-Marsabit for accepting part of the study to be undertaken in the institute. My appreciation also go to the local communities in Marsabit for they welcomed me in their homesteads, allowed me to interact with their animals and spared their time for the project even in times of scarcity due to drought. The same indebtedness go to Dr. W. Ogara for going out of his way to assist me with logistics and Dr. F. Mutua for assistance in statistical data analysis.

My deepest gratitude goes to my family: my late father William, my mother Joyce, wife Cameline, my son Jeremy and my brothers and sisters for their
patience and understanding. I also wish to thank friends, relatives and colleagues who offered moral support and friendship.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>II</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>III</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>IV</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>VI</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>XI</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>XIII</td>
</tr>
<tr>
<td>ACRONYMS AND ABBREVIATIONS</td>
<td>XV</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>XVI</td>
</tr>
<tr>
<td>CHAPTER ONE</td>
<td>1</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1. Background information</td>
<td>1</td>
</tr>
<tr>
<td>1.2. Objectives of the study</td>
<td>5</td>
</tr>
<tr>
<td>1.2.1. General objective</td>
<td>5</td>
</tr>
<tr>
<td>1.2.2. Specific objectives</td>
<td>5</td>
</tr>
<tr>
<td>1.3. Justification</td>
<td>6</td>
</tr>
</tbody>
</table>

VI
CHAPTER TWO

2. LITERATURE REVIEW

2.1. Breeds of camels in Kenya

2.2. Economic importance of the Camel

2.3. Camel neonate and calf

2.4. Camel calf health and production

2.5. Factors influencing camel calf health and productivity

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the study area

3.2. Selection of study ranches and herds

3.3. Data collection

3.3.1. Pretesting of questionnaires

3.3.2. Recruitment and Training of field assistants

3.3.1. Herd level factors influencing health and productivity of camel calves

3.3.2. Field observations and calf mortality data collection
3.4. Data handling and storage ..................................................................................20

3.5. Data analysis .....................................................................................................21

CHAPTER FOUR ......................................................................................................22

4. RESULTS ...........................................................................................................22

4.1. Herd characteristics and camel keepers perception of camel calf health and production constraints ..................................................................................................22

4.1.1. Questionnaire Response rate ...............................................................................22

4.1.2. Herd demographics ..............................................................................................22

4.1.2.1. Production systems ..............................................................................................22

4.1.2.2. Categories of animals kept by pastoralists .........................................................23

4.1.2.3. Camel herd sizes ..................................................................................................25

4.1.2.4. Reason for keeping camels ...................................................................................27

4.1.3. Ranking of camel calf production constraints ..................................................27

4.1.4. Ranking of camel calf health constraints .............................................................28

4.2. Camel calf management, and health parameters ................................................29

4.2.1. Calf birth management .......................................................................................29
4.2.2. Feeding of calves and milking management .....................................................29

4.2.3. Protection of camel calves at night...............................................................35

4.2.4. Ectoparasite control in camel calves.............................................................36

4.2.5. Helminth control in camel calves .................................................................39

4.2.6. Provision of water to camel calves ...............................................................40

4.2.7. Vaccination of camel calves ........................................................................44

4.3. Common diseases and conditions affecting preweaned camel calves and
their management by pastoralists........................................................................46

4.4. Crude calf mortality .........................................................................................48

4.5. Unconditional herd factors associated with calf crude mortality .................49

4.5.1. Helminth control in camel calves .................................................................49

4.5.2. Tick control in camel calves ........................................................................51

4.5.3. Confinement of camel calves at night ..........................................................53

4.5.4. Watering of camel calves separate from adult herds during dry
periods ..................................................................................................................55

CHAPTER FIVE ....................................................................................................57
5. DISCUSSION ........................................................................................................57

CHAPTER SIX ........................................................................................................65

6. CONCLUSIONS AND RECOMMENDATIONS .............................................65

6.1. Conclusions........................................................................................................65

6.2 Recommendations.............................................................................................66

REFERENCES ........................................................................................................68
LIST OF TABLES

Table 4.1: Summary statistics for types of livestock kept by camel keepers in Marsabit District.................................................................................................................24

Table 4.2: Summary statistics for distribution of camels per herds in selected divisions in Marsabit District.................................................................................................25

Table 4.3: Camel herds characteristics in selected divisions in Marsabit District.................................................................................................................................26

Table 4.4: Ranking of constraints encountered in camel calf production in pastoral and ranch camel herds in Marsabit District.................................................................27

Table 4.5: Ranking of common health constraints in camel calves by herders/ranchers in pastoral and ranch camel herds in Marsabit District................................................................28

Table 4.6: Calf birth observation and feeding management of camel herds in Marsabit District..................................................................................................................30

Table 4.7: Orphan calf management and weaning of camel calves in Marsabit District............................................................................................................................33

Table 4.8: Common parasite control practices carried out for camel calves in Marsabit District....................................................................................................................36

Table 4.9: Age at which ectoparasite control in camel calves is started in Marsabit District...........................................................................................................................37

Table 4.10: Age at which deworming of camel calves was started in Marsabit District.................................................................................................................................39
Table 4.11: Water provisions management for camel calves in Marsabit District............................................................................................................41

Table 4.12: Reasons given by camel keepers for not vaccinating camel calves in Marsabit District ...................................................................................45

Table 4.13: Management/treatment practices carried out by camel keepers against common conditions in camel calves in Marsabit District.........................47

Table 4.14: Crude mortality per division and sex of camel calves in Marsabit District............................................................................................................48

Table 4.15: Interrelationship between deworming and crude mortality of calves in camel herds in Marsabit District...............................................................50

Table 4.16: Interrelationship between tick control and crude mortality of calves in camel herds in Marsabit District.................................................................52

Table 4.17: Interrelationship between confinement of calves in a boma at night and crude mortality of calves in camel herds in Marsabit District.......................54

Table 4.18: Interrelationship between watering of calves separate from adult herds during dry periods and crude mortality of camel calves in Marsabit District.................................................................56
LIST OF FIGURES

Figure 3.1: A map of Kenya showing Marsabit District.................................16

Figure 3.2: Questionnaire administration to respondents at North Horr, Marsabit
District..........................................................................................................18

Figure 4.1: Two-teat milking of camel dam where the calf is allowed to suckle one-
half of the udder (Arrow) during milking process in Gudas, Marsabit........31

Figure 4.2: Four-teat milking of a camel dam with the calf only being allowed to
suckle before onset of milking so as to aid in milk let down and after
milking is complete in Gudas, Marsabit District..........................................31

Figure 4.3: A camel calf suckling after milking in Gudas, Marsabit District......32

Figure 4.4: Camel dam suckling its calf and a foster calf in Gudas, Marsabit
District............................................................................................................34

Figure 4.5: Temporary night sleeping boma (Forra) for calves at Gudas, Marsabit
District............................................................................................................35

Figure 4.6: Camel flies on pre-scapular area in a nine months old camel calf in
Laisamis, Marsabit District...........................................................................38

Figure 4.7: A dam filled by surface runoff water. This water serves camel herds
during dry spells in Gudas, Marsabit District..............................................42

Figure 4.8: A three-day-old calf tied on its hind leg (arrow) to restrain it from
following the dam to grazing fields in Gudas, Marsabit
District............................................................................................................42
Figure 4.9: Young Camels scrambling for water from a dug watering canal in North Horr Division, Marsabit District after travelling over 30 kilometres to this oasis..........................43

Figure 4.10: Carcass of a dam and its calf with the calf suspected to have died of starvation as it tried to suckle the dam (arrow) at North Horr Marsabit District.................................................................43
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADB</td>
<td>Africa Development Bank</td>
</tr>
<tr>
<td>AHW</td>
<td>Animal Health Worker</td>
</tr>
<tr>
<td>ALLPRO</td>
<td>ASAL Based Livestock &amp; Rural Livelihoods Support Project</td>
</tr>
<tr>
<td>ASALs</td>
<td>Arid and Semi-arid Lands</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>GOK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>IgG&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Immunoglobulin G 1</td>
</tr>
<tr>
<td>KNBS</td>
<td>Kenya National Bureau of Statistics</td>
</tr>
<tr>
<td>KARI</td>
<td>Kenya Agricultural Research Institute</td>
</tr>
<tr>
<td>MOLD</td>
<td>Ministry of Livestock Development</td>
</tr>
<tr>
<td>NGO(s)</td>
<td>Non-Governmental Organizations</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>SE</td>
<td>Standard Error</td>
</tr>
<tr>
<td>SNLP</td>
<td>Sedentary Nomadic Livestock Production</td>
</tr>
<tr>
<td>UN-OCHA</td>
<td>United Nations office of coordination of humanitarian affairs</td>
</tr>
<tr>
<td>UO.N.</td>
<td>University of Nairobi</td>
</tr>
<tr>
<td>°C</td>
<td>Degrees Centigrade</td>
</tr>
</tbody>
</table>
ABSTRACT

Camel rearing is faced with challenges ranging from low growth rates and high mortality in camel calves within the Arid and Semi-Arid Lands (ASALs) Livestock Production systems in Kenya. A study was conducted on the major factors associated with health and production of camel calves in Marsabit district of Kenya. The main objective of the study was to identify important health and production constraints in camel calf production in Marsabit District, which forms part of the ASAL areas in Kenya. The study was conducted for a period of twenty-four months from 2005 to 2006. The study was conducted in seven (7) study sites in three divisions (Laisamis, North Horr and Loyangalani) which were conveniently selected in Marsabit District. Study locations were selected based on accessibility and existence of manyattas for ease of administration of questionnaires and accessibility of camel herds. One on one interviews were conducted for 74 camel keepers with semi structured questionnaires being administered to collect information on camel production system, herd characteristics, ranking of production and disease constraints in camel keeping, preventative and management practices and views of the community on importance of the camel. Camel keepers ranked high calf mortality, inadequate feed resources, low birth rates and water scarcity as some of the most important constraints in calf production. Camel calf health constraints ranked highest in importance. Others included ectoparasite infestation (ticks/fleas), trypanosomosis, diarrhoea, helminthiasis and mange. Ninety seven percent of camel keepers' supervised camel calving process with 84.9% of these monitoring the process until XVI
the calf was suckled. Milking was carried out mainly through a combination of 2 teat milking with the calf suckling the other half during milking process in the wet season. In the dry season all the teats were milked and the calf allowed to suckle after milking. When a dam of a calf died during lactation, 85.3% of camel keepers preferred to adopt the calf to another milking camel. Eighty six percent of the camel calves were kept in a night enclosure made of acacia twigs and branches to fend off wild animals. Ectoparasite control in camel calves was carried out for 89.1% of the calves. The most (93.96%) preferred method of applying acaricides was through hand dressing. Tick control was carried out every one to three months for 77.47% of camel calves with the other 22.5% only receiving tick control when heavy tick load was noticed. The mean age of starting helminth control for camel calves was 3.4 months. Helminth control was carried out for slightly over half (50.72%) of the calves. Commercial anthelmintic preparations were preferred by 73.61% of camel keepers over ethno veterinary/herbal preparations. Herbal anthelmintics were reported to contain mainly plant extracts of *Acacia anthelmintica*. The mean age of beginning endoparasite control was 3 months. The prevalences were estimated for both morbidity and mortality events recorded for 558 camel calves studied. Of these 61.11% were females and the rest (38.89%) males. Crude mortality of preweaned camel calves was estimated at 18.6%. There was slightly higher crude mortality rate for female camel calves (20.06%) than that of male camel calves (16.67%). Herd level factors were investigated for association with crude mortality. The results showed that crude mortality was significantly (P<0.01) lower in dewormed calves (13.07%) than in those calves, which were not, dewormed (24.36%). Mortality was significantly (P<0.01) lower
for calves receiving ectoparasite control (15.69%) than that in calves with no ectoparasite control (42.62%). Confinement of calves at night in the boma was associated with significantly (P<0.01) lower (14.32%) mortality than those left in the open (46.05%). Watering of calves separate from adult herds was associated with significantly (P<0.01) lower mortality (6.96%) than for calves watered together with adults (40%) during the dry season. The study has demonstrated that carrying out of routine practices in management of calves such as helminth control, tick control, and adequate water and milk provision contributed to reduction in overall mortality of preweaned camel calves.
CHAPTER ONE

1. INTRODUCTION

1.1. Background information

Pastoral and agro-pastoral communities cover about 466,000 km² or 88% of Kenya, pre-dominantly occupying the Arid and Semi-Arid Lands (ASALs) of the country. Provisional results of the 2009 census, places the Kenya's population at 38 million people (KNBS, 2009). Annual rainfall varies between 125 to 500 mm in arid districts and between 400 to 1250 mm in semi-arid districts. The economic mainstay is Sedentary Nomadic Livestock Production (SNLP).

The ASALs account for 50% of the livestock, 3% of agricultural output, and 7% of commercial output for Kenya. The camel represents approximately 6% of the domestic herbivore biomass in Kenya (Chabeda, 2002). The camel is a unique resource, adapted and able to utilize the Arid and Semi-Arid environments of Kenya and may be one of the key solutions to the rampant and recurring food crisis in these areas in future as well as improving the economic position of the pastoralist.

There are two genera within the Camelidae family, *Camelus* and *Lama*. Both genera belong to the sub-family Camelinae of the family Camelidae. The genus *Camelus* consists of *Camelus dromedarius*, dromedary camel (one hump) and *Camelus bactrianus*, Bactrian camel (two humps). Both species are also referred to as Old World camelids. The camel originated in North America, subsequently
migrating to Asia and eventually Africa (Epstein, 1971). In Kenya, it was first kept by the Somali community but has since found great importance in the drier parts of the country. The camel populations or 'breeds' present in Kenya are; Somali, Rendille, Gabra and Turkana camel breeds. World camel population (both Bactrian and Dromedary) stood at over 24 million in 2007 (FAO GLiPHA, 2011). There are over 3,000,000 camels found mainly in Kenya's ASAL (KNBS, 2009). The Kenyan camel population represented approximately six (6) percent of the African camel population in 2003 which stands at about 15 million (GOK, 2003). The importance of this species is great and its contribution to the pastoral communities paramount.

The camel ranks third in importance among the animal species kept by the poor; under 'livestock only, rangeland-based arid/semi-arid pastoral production system' in East and Central African regions (Perry et al., 2002). Overall, North-Eastern Province is the most important camel producing area in the country keeping 54% of the national herd. Eastern Province comprising Marsabit, Moyale and Isiolo districts support a further 29% of the herd, Rift Valley 13% and Coast Province 4%. Camels are a cornerstone of the mobile animal-based production systems of Turkana, Gabra, Rendille and Somali pastoral communities in northern Kenya. The camel provides financial (sales of milk, meat and hides), social (dowry payment, social status indicator and presents), physical (drought power for transport), natural (manure for maintaining soil fertility) as well as provision of milk, blood and meat for household consumption. However, in all the four communities, camels are highly valued mainly as milk producers (Hülsebusch and
Kaufmann, 2002). Their value is seen in their productivity and in ensuring a balanced ecosystem of the rangelands in the long term; this includes an ability to produce five to ten times as much milk as a cow kept under the same climatic conditions (Chabeda, 2002). The future role of camels in animal production can be understood by considering these advantages over other types of livestock and breeds.

Camel production is poorly understood and its value is highly underestimated by animal health service providers leading to high mortalities due to inadequate health support structures. Chabeda (2002), also sites lack of long-term research on camel production and inadequate camel husbandry management practices as some of the constraints. Camel calves serve as replacers in camel calf production and therefore should be managed well in order to sustain herd size growth.

Camel calf diseases and calf losses can have devastating effects on economic success of camel production, as these will affect the amount of milk produced, the number of calves weaned and availability of adult camels for sale in later years. A study in Marsabit district (Njanja, 2007) found a mean mortality rate of 22.9% for pre-weaned camel calves. Other studies in the same area have indicated much higher mortality rates, estimated at over 50% (Schwartz and Dioli, 1992; Wilson, 1988).

Despite the importance of camel calves, there still exist many gaps on information regarding production and disease management under pastoral system due to low
emphasis given to camel research. There is therefore need to study this if camel keeping is to be sustained in future.

This study was therefore conducted to provide data on the common diseases and/or conditions affecting camel calves and to document the common herd level management factors influencing health and productivity of camel calves in Marsabit District in Kenya.
1.2. Objectives of the study

1.2.1. General objective

The overall objective of the study was to identify important health and production constraints in camel calf production in Marsabit District of Kenya.

1.2.2. Specific objectives

In order to achieve the overall objective, the following specific objectives were developed;

I. To assess the camel keeper’s perception of preweaned camel calf health and production constraints.

II. To determine baseline preweaned camel calf health and production parameters including camel calf mortality.

III. To determine herd level factors associated with preweaned camel calf health and production.
1.3. Justification

The camel provides an obvious solution to improving human nutrition in the Arid and Semi-Arid zones, where hunger is endemic and affects millions of people every year. There is therefore need to help the local populations become independent of foreign aid and capable of providing their own food sources in times of drought (Gitu, 2004).

Despite the great potential that camel rearing has to alleviating problems in ASALs, it is faced with poor growth and high mortality rates in calves. As communities respond to the challenges in camel calf production, they use non-effective and sometimes hazardous interventions. Such interventions are based on long held myths or ‘trial and error’ home remedies, which may further complicate the health and growth of affected calves.

Earlier studies have shown that preweaned camel calves suffer high mortality rates: 22.9% (Njanja, 2007) and over 50% (Schwartz and Dioli, 1992). The factors contributing to this high mortality rates have not been clearly elaborated.

This study was designed with the aim of determining health and production parameters of camel calves in ASALs. The study sought to identify the management and other factors influencing health and productivity of these calves. The findings of this study will contribute towards an increased understanding of challenges and opportunities for improving camel calf health and production.
CHAPTER TWO

2. LITERATURE REVIEW

2.1. Breeds of camels in Kenya

The classification of different camel breeds in Kenya is based on the pastoralist tribe: Common camel breeds in Kenya are: Somali, Rendille/Gabra, Turkana, Pokot and Samburu (Hülsebusch and Kaufmann, 2002; Farah and Fischer, 2004; Ilona, 2007; Njanja, 2007). This classification is based mainly on the tribe that keeps the camels but crosses between these breeds exist within each tribe. A few imported camels from Pakistan and their crossbreeds with the above-mentioned Kenyan camel breeds are also found on ranches (Ilona, 2007). The most commonly kept breeds in Marsabit district is Rendille/Gabra breed and a few crosses with Turkana and Somali breeds.

2.2. Economic importance of the Camel

Since domestication, the camel has been used by man to traverse arid lands and deserts due to its unique survival ability in hot arid environments (Field, 1979). The camel can also produce milk, blood, meat and hides as well as provide transport in arid environments (Wilson, 1988, Schwartz and Dioli, 1992). There are over 3,000,000 camels found mainly in Kenya’s ASALs (KNBS, 2009). Almost all of these camels are kept by nomadic pastoralists in Northern Kenya, and are essential to the subsistence economy of these people. Field and Simpkin (1985), have shown that the camels meet 50% of the protein requirements and
20% of energy requirements of the average Rendille family during drought without serious damage to the environment due to its extended range of habitat and mode of forage utilization. Castrates within the camel herds are also used for water transport.

The camel can also be used more widely as a pack and riding animal (Field, 1979). Most of the nutritional needs of families living in ASAL areas are met through milk consumption. Due to the subsistent nature of camel production, its' contribution to the national economy has not been properly documented, and is therefore most often ignored. With the stated wish of the government to intensify utilization of the ASAL due to the expanding population and the need for food sustainability, the camel is likely to gain its rightful place in the economy (GOK, 2010). Camel herds have been established on some commercial ranches in Kenya, and are used for transport within ranches, milk production for local consumption and sale of camels for slaughter to the Middle East (Schwartz and Dioli, 1992).

The camel population in Kenya is estimated to be expanding at the rate of about 1.5% to 2% per annum. This expansion is within the traditional keeping areas as well as in the Southern ASAL like Kajiado, Narok, Mwingi, Kilifi, Machakos and Makueni (GOK, 2003). To keep pace with human population growth and be able to utilize the ASAL areas in a profitable and sustainable manner without jeopardizing its future productivity, efforts need to be made to raise camel productivity and to improve production of replacement calves.
2.3. The camel neonate and calf

The newborn camel calf goes through dramatic changes in its physiology during the first few hours after parturition. Camelids have an extra membrane of foetal epidermal origin called "the epidermal membrane". This membrane covers the neonate and is attached at muco-cutaneous junctions but does not cover the nostrils or mouth reducing the danger of suffocation. The membrane is also very friable and can be easily removed with only the slightest friction. The process of foetal maturation or readiness for birth, involves all the organs and especially the respiratory and cardiovascular systems. Therefore, any complication during the last phases of pregnancy or during parturition can compromise the ability of the new-born to survive (Tibary and Anouassi 2001).

All camelidae are born in a relatively advanced stage of development and are capable of standing, nursing and walking unaided within a few minutes to one hour after birth. The most important parameters in the evaluation of the new-born are birth weight, heart rate, type and rhythm of respiration and body temperature. The average normal birth weight ranges from 28 to 42 kg in the dromedary (Njanja, 2007) while the heart rate is usually very high at birth (80 to 120 beats per minute), but respiration should be regular (20 to 30 breaths per minute). Normal body temperature varies from 37.5°C to 39.0°C but the newborn may show shivering during the first few hours after birth, which is quite normal as the calf attempts to maintain body temperature. Camelidae are born agammaglobulinemic because of the lack of placental transfer of immunoglobulins (Tibary and Anouassi
Camel calves therefore, rely exclusively on passive immunity from antibodies absorbed from maternal colostrum for their protection against infection during the first few weeks of their life. This makes colostrum intake is very essential for the survival of camel calves. Some camel keepers strip colostrum to the ground to reduce chances of diarrhoea in calves due to high milk intake; this predisposes calves to diseases due to inadequate colostral antibody intake (Farah, 2007).

It is important to assess regularly the growth rate of the calf mainly through weighing (every day for the first 2 weeks and every other week thereafter) in order to determine the adequacy of milk intake (Tibary and Anouassi, 2001).

**2.4. Camel calf health and production**

Camel calves serve as replacement stock, gifts for friends and for meat production (Wilson, 1988). A study in Marsabit district found a mean daily weight gain up to 540 days of age to be 0.28 kg d\(^{-1}\) and 0.39 kg d\(^{-1}\) for Rendille and Rendille Somali cross camel calves, respectively (Njanja, 2007).

The minimum amount of colostrum needed within the first 12 to 24 hours after birth by camelids is not known and recommendations are made based on research done in calves, which require 100 grams of Immunoglobulin G\(_1\) (IgG\(_1\)) (Kamber et al., 2001; Tibary and Anouassi, 2001). Newborn camel calves should receive 10% of their body weight in colostrum, preferably within the first 12 hours after birth, with half of this amount given in the first 6 hours after birth.
All new-born calves should be examined soon after birth focusing on its maturity and for any signs of congenital abnormalities including abnormal limb development, atresia ani, cleft palate, abnormal reflexes and blindness (Tibary and Anouassi, 2001). The importance of evaluation and primary care for the new-born is essential for the reduction of neonatal mortality, the major cause of production loss in camelidae (Tibary and Anouassi, 2001).

The umbilicus should be examined regularly few hours after birth for abnormalities (hemiation or haemorrhage). It should be cleaned with chlorhexidine solution and dipped in regular strength tincture of iodine to protect against umbilical infections (Tibary and Anouassi, 2001). Adult calves should receive preventive management including ectoparasite control, endoparasite control and guarding against predators. Measures of health include birth weight, vigour at birth, health status including respiratory rate, pulse and rectal temperature.

Measures of production in the camel calf include management practices such as supervision of calving process, colostrum provision and watering management. If the dam does not have enough colostrum, and no other camel colostrum is available, then cow or goat colostrum may be used as a substitute (Tibary and Anouassi, 2001). Average daily weight gain is another good indicator of calf productivity (Ihuthia et al., 2010; Njanja, 2007).
A major problem in camel productivity is the high mortality rate of camel calves in the first 3 months. The causes for such a high mortality are mainly poor management practice and infectious diseases (Kamber et al., 2001). Some of the causes leading to early calf losses include low colostrum intake during the first 24 hours of life, tick infestation, camel pox, diarrhoea and navel-ill (Gitao, 1994a; Gitao, 1997; Kamber et al., 2001; Njanja, 2007).

In his study, Njanja (2007), found a mean morbidity prevalence of 38.3% and mean morbidity incidence of 79.7%. Diseases/conditions found affecting calves under one year included mange, coccidiosis, trypanosomiasis and helminthiasis.

The high pre-weaning mortality ranging between 22.9% to 50% or more (Njanja 2007; Schwartz and Dioli, 1992; Wilson, 1988) also mitigates against rapid expansion of camel populations. The high calf mortality has been said to be related to factors of poor management especially malnutrition and starvation, making calves more prone to diseases and parasitism which cause death (Schwartz and Dioli, 1992; Gitao et al., 1998). Other factors identified include heavy tick loads, helminthiasis and contagious diseases such as diarrhoea, camel pox, contagious ecthyma and mange. Tibary and Anouassi (2001), also recommend vaccination of all dams against tetanus and Clostridium perfringens (type C and D) during the last month of pregnancy to ensure adequate amount of colostral antibodies that will protect the calf.
Helminthiasis in the camel calf is of great importance worldwide as it is associated with acute diarrhoea especially during rainy season when there is an upsurge in parasite burden. Some of the types of helminth/protozoan parasites eggs/oocyst encountered in the camel calf include *Strongylus spp.*, *Trichostrongylus spp.*, coccidia, *Strongyloides spp.*, *Anaplocephala spp.*, *Oxyuris spp.*, *Dictyocaulus spp.*, *Gastrodiscus spp.*, *Parascaris spp.*, *Trichonema spp.* and *Triodontophorus spp.* (Abdul-Salam and Farah, 1988; Fadlet *et al.*, 1992; Mukani and Kimani 1999; Rewatkare *et al.*, 2009; Khanet *et al.*, 2010; Swaier *et al.*, 2011). In acute cases of diarrhoea, there is severe loss of body fluid and minerals resulting into rapid loss of body weight and even death. Deworming of calves was associated with lower crude mortality in calves. Protozoan infections in camel calves has been associated with high morbidity and mortality in young camels (Chineme, 1980; Boidet *et al.*, 1986; Kinne and Wernery, 1997).

Heavy tick infestation leads to blood loss, anaemia and tick paralysis contributing to heavy losses in production of camels (Dolan *et al.*, 1983; Straten and Jongejan, 1993; Gebreer *et al.*, 2004). Camel calves aged 2 to 3 weeks have been observed to die due to thousands of larval and nymphal tick attachments. Tick control therefore reduces challenges and diseases associated with tick infestation in calves and lead to reduced calf mortality as was found in this study. Though, heavy tick burden has been associated with rainy season in studies in Eastern Ethiopia (Zeleke and Bekele, 2004) and in Saudi Arabia (Al-Khalifaer *et al.*, 2007) it is not always true as indicated in a study Southern Sudan by Elghali and Hassan (2009), who found no seasonal effect on tick loads on camels. Tick control programmes are faced with
challenges including availability of acaricides, cost of the acaricides and inability of some acaricides including macrolytic lactones to clear tick loads (Straten and Jongejan, 1993).

Other reasons for the high mortality rate among camel calves including diarrhoea, predation and other diseases have been identified (Kegode, 1990; Schwartz and Dioli, 1992; Gitao, 1994; Kaufmann, 1998; Agab and Abbas, 1999; Diaet al., 2000; Zeleke and Bekele, 2000; Abbas and Omer, 2005; Farah et al., 2007). Trypanosomosis plays a less important role in the camel calf. Its main effect is in reducing ability of the dam to raise calves effectively (Nyang’ao, 1993).
CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the study area

The study was carried out in Marsabit District between January 2005 and December 2006.

Marsabit District occupies an area of approximately 66,000 Km\(^2\) which includes 4,956 Km\(^2\) covered by Lake Turkana (Figure 3.1). It borders the Republic of Ethiopia to the North, Moyale to the North-East, Turkana to the West, Samburu to the South and Isiolo and Wajir to the East. Lying between latitude 01° 15' North and 04° 27' North and longitude 36° 03' East and 38° 59' East (GOK, 2007). The larger district has a population of 291,166 people (KNBS, 2009), giving a population density of about two persons per square kilometre. Marsabit District is divided into six divisions. Pastoralism is the main preoccupation of 84% of the people. Climatically, Marsabit is one of the driest districts in Kenya with a typical arid climate. The mean annual rainfall ranges between 150mm in the low-lying areas to 800mm in the highlands (GOK, 2003). The rainfall periods are short (lasting 3-4 days a times) with a highly variable distribution. Heavy rains result in devastating floods that last for a few days. The area has two rainy seasons: late March through May and again from late October through to early December. Temperatures range from 22°C to 42°C (GOK, 2007).
Figure 3.1: A map of Kenya showing Marsabit District
3.2. Selection of study ranches and herds

Seven (7) study sites in three divisions were conveniently selected in Marsabit District in Eastern Province. Study locations were selected in consultation with Ministry of Livestock Development (MOLD) personnel, the Kenya Camel Association (KCA), Non-Governmental Organizations (NGOs) working in the area and the provincial administration. The study locations were selected based on accessibility and existence of *manyattas* for ease of administration of questionnaires, confidence building and collection of reliable data. *Manyattas* are settlement or compounds, often temporary, group of huts forming a unit within a common fence established by a family or clan.

In Marsabit District, three divisions (Laisamis, North Horr and Loyangalani) were selected for the study. In Laisamis division, Sanchir and Kobola manyattas, and Kari-Gudas ranch all in Gudas sub-locations were selected. In North Horr division Dukana manyatta in Dukana sub-location was selected. The selected sites in Loyangalani included Rongumo, Gooborre and Urawen manyattas all in Kargi sub-location.

3.3. Data collection

Data were collected through interviews by administration of semi-structured questionnaires (Figure 3.2) to 74 selected camel keepers (73 pastoralists and 1 ranch/herd manager)
Figure 3.2: Questionnaire administration to respondents at North Horr, Marsabit District
The questionnaires (Appendix I) were designed to collect data on production system, herd/ranch characteristics, ranking of production and disease constraints in camel keeping, preventative and management practices and views of the community on importance of the camel. Biophysical parameters captured included location, seasons and land use systems.

The data collected included objectives of camel production, ranking of production and health constraints, identification of preventive and management practices carried out by camel owners and the common treatment regimes/intervention for specific diseases and/or conditions affecting camel calves.

3.3.1. Pretesting of questionnaires

The questionnaire was administered to fifteen camel keepers in Marsabit District during the pretesting phase. The questionnaire was revised based on feedback from camel keepers and on the experience of the persons administering the questionnaire.

3.3.2. Recruitment and Training of field assistants

Ten (10) field assistants with good command of English, Kiswahili and Rendille languages were recruited. They were trained and appraised on interviewing skills and techniques, and data collection procedures.

The field assistants visited camel herds in Manyattas together with the principle investigator to collect data. The field assistants also aided in interpreting information given by pastoralists and relaying information from principle investigator to the pastoralists.
3.3.1. **Herd level factors influencing health and productivity of camel calves**

Herd level factors influencing health and productivity of camel calves investigated were; disease management practices including deworming and tick infestation control as well as husbandry practices including herd size, provision of feed supplements to calves and confinement of calf in night boma (Appendix I).

3.3.2. **Field observations and calf mortality data collection**

Data on calf births and mortality was collected during monthly field visits. During field visits, observations on calf management practices mentioned by the 74 camel keepers were made and photos taken whenever possible and when permission was granted.

For calf mortality data collection, calves belonging to the 74 camel keepers were recruited to the study at birth. A total of 558 calves were born between January 2005 and December 2005. These calves were followed up until one year of age (Average age of weaning by pastoralists) then dropped from the study.

3.4. **Data handling and storage**

Data collected were cross-checked and information in field record sheets validated. Where clarification was required, the questions were rephrased to capture clearly information provided by pastoralists. Data record sheets were transported to the office where the data were entered into the computer using MS-Excel® 2007 (Microsoft 20...
Corporation, USA), coded and reorganized where applicable. The computer data files were screened for any errors that might have occurred during data entry and errors were corrected by rechecking against the original data forms.

3.5. Data analysis

The outcome measure of interest was crude mortality rates for preweaned camel calves less than one year old. Crude mortality was calculated as the number of calves that died from any cause during one preweaned calf year (numerator) divided by total number of calves (denominator). The data were exported to Instat® 3.36 2006 (University of Reading, UK) statistical package for analysis.

Descriptive statistics including, frequencies, means, range, standard deviation were computed. These were used to generate descriptive tables. The prevalences were estimated for both morbidity and mortality events. Herd level factors (Appendix II) were investigated for association with crude mortality. Additional analysis included cross tabulations, and Chi-square tests. Differences were considered significant at $p<0.05$. Chi Square results from tables with predictive values of 5 and above in each cell were considered significant.
CHAPTER FOUR

4. RESULTS

4.1. Herd characteristics and camel keepers’ perception of camel calf health and production constraints

4.1.1. Questionnaire Response rate

All the selected pastoralists (71 owners and 2 sons), and one ranch manager were interviewed during the study. This accounted for 100% response rate. The good response rate was achieved through involvement of local communities and local administration in planning and carrying out of the study. Of the respondents, 20 (27.03%) were from Laisamis Division, 44 (59.46%) from Loyangalani Division and 10 (13.51%) from Dukana Division.

4.1.2. Herd demographics

4.1.2.1. Production systems

All (73) camel owners under pastoral system in Marsabit district practised communal mixed production of camels where there was no restriction on herd sizes. Camels were herded next to other animals including cattle, sheep and goats.

The K.A.R.I. ranch in Marsabit District herded its camels together with local communities but had a central night boma where camels returned in the evening. The ranch practiced herd size control in order to limit competition for resources with local community. None of the pastoralists kept written records for their livestock, instead
they only relied on memory for herd management. Adequate records were kept in KARI ranch including allocation of unique identification numbers for each animal. Calves in KARI ranch were provided with mineral supplements in the evening a practice that was not common with the other pastoralists.

4.1.2.2. Categories of animals kept by pastoralists

Species of animals kept by camel keepers are as summarised in Table 4.1. The population of camels were ranked third among animals kept by the pastoralists in terms of numbers. Goats were ranked second and sheep ranked first. The mean number of camels kept in a herd was 33.5 with a minimum of 4 and a maximum of 83 and a median of 39 as shown in Table 4.1 below.

All camel keepers also kept other livestock species mainly cattle, sheep and goats. Other animals kept in some homesteads included donkeys 55% (41/74) and dogs kept by 58% (43/74) of camel keepers. The donkey and the dog were mainly kept around the manyattas. Donkeys were used to transport water for domestic use while dogs were used for security purposes.
Table 4.1: Summary statistics for types of livestock kept by camel keepers in Marsabit District

<table>
<thead>
<tr>
<th>Animal Species Kept</th>
<th>No. of respondents</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Coefficient of Variations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camels</td>
<td>74</td>
<td>33.5</td>
<td>39</td>
<td>4</td>
<td>83</td>
<td>55.2%</td>
</tr>
<tr>
<td>Goats</td>
<td>74</td>
<td>86.4</td>
<td>71</td>
<td>4</td>
<td>300</td>
<td>75.3%</td>
</tr>
<tr>
<td>Sheep</td>
<td>74</td>
<td>147.4</td>
<td>96</td>
<td>3</td>
<td>426</td>
<td>95.3%</td>
</tr>
<tr>
<td>Cattle</td>
<td>74</td>
<td>21.9</td>
<td>13</td>
<td>1</td>
<td>73</td>
<td>109.1%</td>
</tr>
<tr>
<td>Donkeys</td>
<td>74</td>
<td>2.8</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>62.1%</td>
</tr>
<tr>
<td>Dogs</td>
<td>74</td>
<td>0.54</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>141.0%</td>
</tr>
</tbody>
</table>
Most camel owners kept about 5 to 55 camels in a herd with a mean of 33 camels (Table 4.2; Table 4.3). There was no statistically significant difference (p>0.05) in the mean herd sizes between the divisions as shown (Table 4.2).

Five hundred and fifty eight (558) camel calves were included in the study. Of these, 61.11% (341/558) were females and the rest (38.89%; 217/558) males. The calves included 155 from Laisamis Division, 349 from Loyangalani division and 54 from North Horr Division (Table 4.3).

Table 4.2: Summary statistics for distribution of camels per herds in selected divisions in Marsabit District

<table>
<thead>
<tr>
<th>Division</th>
<th>No of herds</th>
<th>Mean</th>
<th>LQU 25%</th>
<th>UQU 75%</th>
<th>Coefficient of Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laisamis</td>
<td>20</td>
<td>36.0</td>
<td>18.5</td>
<td>45.8</td>
<td>584.2</td>
</tr>
<tr>
<td>Loyangalani</td>
<td>44</td>
<td>33.1</td>
<td>12.0</td>
<td>41.0</td>
<td>287.7</td>
</tr>
<tr>
<td>North Horr</td>
<td>10</td>
<td>30.6</td>
<td>15.0</td>
<td>41.0</td>
<td>160.9</td>
</tr>
<tr>
<td>All</td>
<td>74</td>
<td>33.5</td>
<td>12.0</td>
<td>41.3</td>
<td>342.7</td>
</tr>
</tbody>
</table>

LQU: Lower quartile unit
UQU: Upper quartile unit
Table 4.3: Camel herds characteristics in selected divisions in Marsabit District

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>No.</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel Herd Size range per households</td>
<td>&lt;5</td>
<td>22</td>
<td>29.73</td>
</tr>
<tr>
<td></td>
<td>15_35</td>
<td>28</td>
<td>37.84</td>
</tr>
<tr>
<td></td>
<td>36_55</td>
<td>21</td>
<td>28.38</td>
</tr>
<tr>
<td></td>
<td>&gt;55</td>
<td>3</td>
<td>4.05</td>
</tr>
<tr>
<td>Camel calves selected for the study by sex</td>
<td>Males</td>
<td>341</td>
<td>61.11</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>217</td>
<td>38.89</td>
</tr>
<tr>
<td>Camel calves distribution by division</td>
<td>Laisamis</td>
<td>155</td>
<td>27.78</td>
</tr>
<tr>
<td></td>
<td>Loyangalani</td>
<td>349</td>
<td>62.54</td>
</tr>
<tr>
<td></td>
<td>North Horr</td>
<td>54</td>
<td>9.68</td>
</tr>
</tbody>
</table>
4.1.2.4. Reason for keeping camels

Most (81.08%, 60/74) camel keepers did so for both commercial and subsistence purposes. The other 19.02% kept camels purely for subsistence purposes only. All respondents aimed to increase their herd sizes and calf survival rates.

4.1.3. Ranking of camel calf production constraints

The production constraints as perceived by the camel owners in order of importance were the high mortality of calves, inadequate feed resources, low birth rates, water scarcity, lack of market for camels, inadequate work force and lack of capital (Table 4.4).

Table 4.4: Ranking of constraints encountered in camel calf production in pastoral and ranch camel herds in Marsabit District

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Y.</th>
<th>Rank1</th>
<th>Rank2</th>
<th>Rank3</th>
<th>Rank4</th>
<th>Rank5</th>
<th>Rank6</th>
<th>Rank7</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Mortality</td>
<td>74</td>
<td>54</td>
<td>15</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>493</td>
</tr>
<tr>
<td>Inadequate feed</td>
<td>74</td>
<td>0</td>
<td>43</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>19</td>
<td>0</td>
<td>339</td>
</tr>
<tr>
<td>Low birth rate</td>
<td>74</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>2</td>
<td>19</td>
<td>16</td>
<td>1</td>
<td>318</td>
</tr>
<tr>
<td>Water scarcity</td>
<td>74</td>
<td>0</td>
<td>0</td>
<td>40</td>
<td>12</td>
<td>12</td>
<td>7</td>
<td>0</td>
<td>301</td>
</tr>
<tr>
<td>No Market</td>
<td>74</td>
<td>5</td>
<td>3</td>
<td>11</td>
<td>26</td>
<td>2</td>
<td>26</td>
<td>1</td>
<td>271</td>
</tr>
<tr>
<td>No Manpower</td>
<td>74</td>
<td>2</td>
<td>3</td>
<td>36</td>
<td>3</td>
<td>1</td>
<td>30</td>
<td>2</td>
<td>289</td>
</tr>
<tr>
<td>Lack of capital</td>
<td>74</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>20</td>
<td>17</td>
<td>20</td>
<td>194</td>
</tr>
</tbody>
</table>

Key:

Y = Number of respondents
X = Total weighted score calculated by multiplying weight of rank with the number of respondents for that rank (rank 1 has the highest weight of 7 while rank 7 has the lowest weight of 1)

Total weighted calculation example: High mortality calculation = 54x7 (Rank 1) + 15x6 (Rank 2) + 3x5 (Rank 3) + 1x4 (Rank 4) + 1x3 (Rank 5) + 1x2 (Rank 6) + 1x1 (Rank 7) = 493

27
4.1.4. Ranking of camel calf health constraints

Camel calf health constraints were ranked in order of importance with ectoparasite infestation (ticks/fleas) and trypanosomosis ranking the highest. The other production constraints were diarrhoea, helminthiasis, mange, abscesses and camel pox (Table 4.5). Other constraints of importance mentioned but not ranked included lymph node swellings and predators as indicated in Table 4.5.

Table 4.5: Ranking of common health constraints in camel calves by herders/ranchers in pastoral and ranch camel herds in Marsabit District

<table>
<thead>
<tr>
<th>Constraint</th>
<th>No. of respondents</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
<th>Rank 4</th>
<th>Rank 5</th>
<th>Rank 6</th>
<th>Rank 7</th>
<th>Total Score*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ectoparasites</td>
<td>74</td>
<td>22</td>
<td>9</td>
<td>29</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>409</td>
</tr>
<tr>
<td>Trypanosomosis</td>
<td>74</td>
<td>24</td>
<td>24</td>
<td>4</td>
<td>14</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>407</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>74</td>
<td>14</td>
<td>11</td>
<td>10</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>24</td>
<td>287</td>
</tr>
<tr>
<td>Helminthiasis</td>
<td>74</td>
<td>1</td>
<td>2</td>
<td>18</td>
<td>9</td>
<td>22</td>
<td>20</td>
<td>3</td>
<td>254</td>
</tr>
<tr>
<td>Mange</td>
<td>74</td>
<td>2</td>
<td>16</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>16</td>
<td>24</td>
<td>235</td>
</tr>
<tr>
<td>Abscesses</td>
<td>74</td>
<td>10</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>13</td>
<td>26</td>
<td>17</td>
<td>221</td>
</tr>
<tr>
<td>Camel Pox</td>
<td>74</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>16</td>
<td>21</td>
<td>15</td>
<td>18</td>
<td>204</td>
</tr>
<tr>
<td>Lymph node swellings+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predators +</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KEY:
* = Total weighted score arrived at by multiplying weight of rank with the number of respondents for that rank (rank 1 has the highest weight of 7 while rank 7 has the lowest weight of 1)
+ = Constraints mentioned by few camel keepers (not ranked)
4.2. Camel calf management, and health parameters

4.2.1. Calf birth management

Most (98.65%, 73/74) camel owners observed calving process in their camels. Of the camel owners who observed camel calving, 15.1% (11/73) waited until the calf was born. The other 84.9% (62/73) waited until the calf was suckled (Table 4.6).

4.2.2. Feeding of calves and milking management

All (73) pastoral camel keepers fed calves solely on milk and allowed pasture browsing at will until they were one year old. Camel calves kept under ranching system (39/558, 6.99%) received salt supplements in addition to milk and pasture. During the dry season, camel keepers also got pods and fodder from forest and riverbeds for calves over three months old at manyattas.

All calves (558) had their dams milked. Most (97.13%, 542/558) camel calves had their dams milked both in the morning and in the evening during the wet season. The other 6.87% had their dams milked occasionally when demand for milk was high and they were only milked in the morning or in the evening. Milking was carried out mainly (57.18%, 319/558) through a combination of 2 teat milking (Figure 4.1), with the calf suckling the other half during milking process in the wet season (Table 4.6).

During the dry season, the percentage of calves that had their dams milked reduced to 85.13% (475/558). During dry season, 54.34% camel keepers employed mainly the 4 teat milking technique with the calf being allowed to suckle after milking in order to extract adequate amount of milk (Figure 4.2; Figure 4.3). Seventy eight percent
(58/74) of owners reported that they encountered some difficulties during milking of camel dams. Most challenges encountered during milking were difficulty in restraint of dams (41.38%; 24/58), difficulty in milking due to small teats (31.03%; 18/58) and difficulty in restraining calves (27.59%, 16/58) as shown in Table 4.6.

If a dam refuses to suckle the calf, 98.64% (73/74) camel keepers indicated that they would restrain the dam to enable suckling by the calf with the other 1.16%, (1/74) providing milk to the calf using either a jug or a cup.

### Table 4.6: Calf birth observation and feeding management of camel herds in Marsabit District

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Number*</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of observation of calving process</td>
<td>Until calf is born</td>
<td>11</td>
<td>15.07</td>
</tr>
<tr>
<td></td>
<td>Until placenta the calf sucked</td>
<td>62</td>
<td>84.93</td>
</tr>
<tr>
<td>Calf Suckling method</td>
<td>2 teats while milking</td>
<td>319</td>
<td>57.17</td>
</tr>
<tr>
<td>wet season</td>
<td>4 teats after milking</td>
<td>223</td>
<td>39.96</td>
</tr>
<tr>
<td></td>
<td>Occasional milking</td>
<td>16</td>
<td>2.87</td>
</tr>
<tr>
<td>Calf Suckling method</td>
<td>2 teats while milking</td>
<td>172</td>
<td>30.82</td>
</tr>
<tr>
<td>dry season</td>
<td>4 teats after milking</td>
<td>303</td>
<td>54.31</td>
</tr>
<tr>
<td></td>
<td>Dam not milked/ only suckled</td>
<td>83</td>
<td>14.87</td>
</tr>
<tr>
<td>Difficulties encountered during milking</td>
<td>Restraint of the dam</td>
<td>24</td>
<td>41.38</td>
</tr>
<tr>
<td></td>
<td>Small teats</td>
<td>18</td>
<td>31.03</td>
</tr>
<tr>
<td></td>
<td>Restraint of the calf</td>
<td>16</td>
<td>27.59</td>
</tr>
</tbody>
</table>

* Totals based on number of respondents and number of calves experiencing an event.
Figure 4.1: Two-teat milking of camel dam where the calf is allowed to suckle one-half of the udder (Arrow) during milking process in Gudas, Marsabit.

Figure 4.2: Four-teat milking of a camel dam with the calf only being allowed to suckle before onset of milking so as to aid in milk let down and after milking is complete in Gudas, Marsabit District
Figure 4.3: A camel calf suckling after milking in Gudas, Marsabit District
It was observed that if the dam of a calf died, 85.3% (64/73) of camel keepers adopted the calf to another milking camel as shown in Figure 4.4 while 14.7% (11/73) gave cow milk to the calf (Table 4.7). The surrogate dam had to provide milk for two or more calves and was under a lot of strain to maintain a good body condition (Figure 4.4).

Calves were separated from the dam once they were over one year of age. This was aimed at stopping it from suckling after it was weaned. However, some calves continued to suckle their dams. If a calf continued to suckle after weaning, 41.9% (31/74) of pastoralists transferred the calf to another camel herd far away; 41.9% (31/74) pierced the nostrils/muzzle to make suckling process painful while 14.9% (11/74) put on a maze which acted as a deterrent for calves who try to suckle, and 1.3%, (1/74) pastoralist indicated that he would pierce the tongue to stop the calf from suckling (Table 4.7).

Table 4.7: Orphan calf management and weaning of camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Handling of orphaned calves</th>
<th>Adopted to another dam</th>
<th>64</th>
<th>85.33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fed cow milk</td>
<td>11</td>
<td>14.67</td>
</tr>
<tr>
<td>Handling of calves that refuse to be weaned</td>
<td>Taken to another herd</td>
<td>31</td>
<td>41.89</td>
</tr>
<tr>
<td></td>
<td>Maze put on</td>
<td>11</td>
<td>14.87</td>
</tr>
<tr>
<td></td>
<td>Nostrils slit/pierced</td>
<td>31</td>
<td>41.89</td>
</tr>
<tr>
<td></td>
<td>Tongue pierced</td>
<td>1</td>
<td>1.35</td>
</tr>
</tbody>
</table>
Figure 4.4: Camel dam suckling its calf and a foster calf in Gudas, Marsabit District
4.2.3. Protection of camel calves at night

Most (86.40%, 482/558) of the camel calves were kept in a night enclosure made of acacia twigs and branches as shown in Figure 4.5. The rest of the calves (13.60%, 76/558) were mostly left to sleep in open fields.

Figure 4.5: Temporary night sleeping boma (Forra) for calves at Gudas, Marsabit District
4.2.4. Ectoparasite control in camel calves

Ectoparasite control for camel calves was carried out in most of the calves (89.07%, 497/558). This practice was carried out by 67/74 (90.54%) of camel keepers. Hand dressing was practiced by 94% of camel keepers (Table 4.8). Tick control was carried out every one to three months for 77.47% (385/497) of camel calves with the other 22.53% only receiving tick control when heavy tick load was noticed (Table 4.8).

The mean age at which ectoparasite control was started was 4 months (Coefficient of Variation 51.8%). The differences within the divisions in age of beginning tick control for calves are as shown in Table 4.9. Other ectoparasites that were observed in the camel calves included camel flies (Figure 4.6), biting flies, lice and fleas.

Table 4.8: Common parasite control practices carried out for camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>No. of calves tested</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of ectoparasite control</td>
<td>Hand dressing of acaricide</td>
<td>467</td>
<td>93.96</td>
</tr>
<tr>
<td></td>
<td>Hand picking of ticks</td>
<td>22</td>
<td>4.43</td>
</tr>
<tr>
<td></td>
<td>Using pour on acaricide</td>
<td>8</td>
<td>1.61</td>
</tr>
<tr>
<td>When is tick control considered</td>
<td>Only if tick load is heavy</td>
<td>112</td>
<td>22.53</td>
</tr>
<tr>
<td></td>
<td>Once every 1-3 months</td>
<td>385</td>
<td>77.47</td>
</tr>
</tbody>
</table>
Figure 4.6: Camel flies on pre-scapular area in a nine months old camel calf in Laisamis, Marsabit District
4.2.5. Helminth control in camel calves

Helminth control was carried out on 50.72% (283/558) of the calves. The deworming of calves was carried out by 51.35% (38/74) of camel keepers. Of those deworming calves, 73.61% (28/38) used commercial anthelmintics and 26.32% (10/38) used herbal medicines, mainly *Albizia anhelmintica* plant extracts.

The mean age of the first helminth control was 3 months (Coefficient of Variation 73.6%). The differences within the divisions in age of beginning deworming for calves are as shown in Table 4.10 and a box plot in Appendix III.

Table 4.10: Age at which deworming of camel calves was started in Marsabit District

<table>
<thead>
<tr>
<th>Division</th>
<th>% of camel calves dewormed</th>
<th>Between 2 to 6 Months</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Laisamis</td>
<td>147/155</td>
<td>94.84</td>
<td>5/147</td>
</tr>
<tr>
<td>Loyangalani</td>
<td>122/349</td>
<td>34.96</td>
<td>20/122</td>
</tr>
<tr>
<td>North Horr</td>
<td>14/54</td>
<td>25.93</td>
<td>1/14</td>
</tr>
<tr>
<td>Total</td>
<td>283/558</td>
<td>50.72</td>
<td>26/283</td>
</tr>
</tbody>
</table>
4.2.6. Provision of water to camel calves

All camel keepers provided water for camel calves during the dry periods. However, during the wet periods 70/74 (94.59%) camel keepers provided water for camel calves. The main sources of water for camels during the wet season included streams/runoff water (48%, 268/558) water dams (Table 4.11; Figure 4.7) and local boreholes (49.03%, 273/558). Camel keepers reported delaying watering of camel calves until they are over six months old for fear of causing diarrhoea. In order to achieve this, they used techniques including tying of the hind leg so that the calf would not accompany the dam to grazing during the day (Figure 4.8).

During the dry periods, 75.27% (420/558) camel calves were watered separately from the adult herd. This reduced the risk of trampling of young camel calves by adults and ensured that the camel calves got adequate drinking water, as the levels are low in water troughs and trenches (Figure 4.9). The main sources of water for camels during the dry period included oasis (57.35%, 320/558) and large communal boreholes (32.07%, 179/558) as shown in Table 4.11.

One common was to find carcasses of dead camel dams lying close to water sources with carcasses of their calves whose heads were close to the udder interpreted to mean that the calf died trying to suckle an already dead dam (Figure 4.10). It was also observed that some herders returned from watering camels carrying on their back young camel calves completely exhausted after trekking long distances.
Table 4.1: Water provisions management for camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>No. of calves</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calf separation during watering</td>
<td>Calves watered separately</td>
<td>420</td>
<td>75.27</td>
</tr>
<tr>
<td></td>
<td>Calves watered with adults</td>
<td>138</td>
<td>24.63</td>
</tr>
<tr>
<td>Source of water during the wet season</td>
<td>Streams/runoff water</td>
<td>268</td>
<td>48.03</td>
</tr>
<tr>
<td></td>
<td>Dams and local boreholes</td>
<td>273</td>
<td>48.92</td>
</tr>
<tr>
<td></td>
<td>Oasis/Large communal boreholes</td>
<td>17</td>
<td>3.05</td>
</tr>
<tr>
<td>Source of water during the dry season</td>
<td>Large communal boreholes/big dams</td>
<td>179</td>
<td>32.07</td>
</tr>
<tr>
<td></td>
<td>Oasis</td>
<td>320</td>
<td>57.35</td>
</tr>
<tr>
<td></td>
<td>Rivers</td>
<td>59</td>
<td>10.56</td>
</tr>
</tbody>
</table>
Figure 4.7: A dam filled by surface runoff water. This water serves camel herds during dry spells in Gudas, Marsabit District

Figure 4.8: A three-day-old calf tied on its hind leg (arrow) to restrain it from following the dam to the grazing fields in Gudas, Marsabit District
Figure 4.9: Young Camels scrambling for water from a dug watering canal in North Horr Division, Marsabit District after travelling over 30 kilometres to this oasis.

Figure 4.10: Carcass of a dam and its calf with the calf suspected to have died of starvation as it tried to suckle the dam (arrow) at North Horr Marsabit District.
4.2.7. Vaccination of camel calves

No vaccination was reported to be carried out for camel calves under pastoral system. However, vaccination against anthrax was carried out in KARI Gudas Ranch in Laisamis for 7% (558) of camel calves. Sixty two percent (46/74) of camel owners cited unavailability of vaccines as the main reason as to why they did not carry out any vaccinations. On the other hand 20.27% (15/74) of the respondents cited long distance to vaccination centres as the reason for not taking camel calves for vaccination. There was 5.41% (4/74) of owners who felt that vaccination of camel dams would cause abortion and were of the opinion that such vaccines are also harmful to the young camel calf (Table 4.12).
Table 4.12: Reasons given by camel keepers for not vaccinating camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Division</th>
<th>Causes abortion</th>
<th>High cost of vaccines</th>
<th>Long distance to vaccination centre</th>
<th>Unavailability of Vaccines</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Laisamis</td>
<td>0/19</td>
<td>0.00</td>
<td>6/19</td>
<td>31.58</td>
<td>0/19</td>
</tr>
<tr>
<td>Loyangalani</td>
<td>4/44</td>
<td>9.09</td>
<td>2/44</td>
<td>4.55</td>
<td>12/44</td>
</tr>
<tr>
<td>North Horr</td>
<td>0/11</td>
<td>0.00</td>
<td>1/11</td>
<td>9.09</td>
<td>3/11</td>
</tr>
<tr>
<td>Grand Total</td>
<td>4/74</td>
<td>5.41</td>
<td>9/74</td>
<td>12.16</td>
<td>15/74</td>
</tr>
</tbody>
</table>
4.3. Common diseases and conditions affecting preweaned camel calves and their management by pastoralists

Mange, diarrhoea, camel pox/orf, dermatophytosis, navel ill and joint ill were some of the common conditions reported by camel keepers. Of the camel owners, 56.95% (41/72) did not treat their own calves for mange but called a community Animal Health Worker (CAHW) to treat the affected calves. Other herders (20.83%, 15/72) washed calves with Amitraz/Organophosphates (OP) until the signs disappeared. All the above treatment choices reportedly gave favourable success rates of between 80% and 100%. Eight percent (6/72) of camel owners rotated sleeping area and applied motor vehicle grease with lower success rate of 20% (Table 4.13).

Over forty percent (27/62) of camel herders whose calves had diarrhoea, either reduced milk intake or stopped water intake for calves with diarrhoea. Camel keepers found it difficult to differentiate camel pox and orf but when any of these conditions occurred, 65% (24/37) applied used motor vehicle oil on the muzzle and other affected areas. Most (94.12%, 32/34) owners whose calves had navel ill, treated the infection by placing hot iron rod on the navel with mixed success (Table 4.13). Calves born prematurely were hand fed milk mixed with herb by 35% (12/34) of owners with reported 90% success rates. Eighteen percent (6/34) handled milk and injected the calves with tetracycline with a reported 70% success rate.

Eighty percent (12/15) of calves with joint ill were treated by way of massaging herbs to joints with 90% of camel keepers reporting good recovery rates (Table 4.13).
Table 4.13: Management/treatment practices carried out by camel keepers against common conditions in camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Disease/condition</th>
<th>Common choice of treatments given for affected calves</th>
<th>No. using treatment choices</th>
<th>Experience of herdsmen on recovery of cases based on treatment given (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
<td>Most recover</td>
</tr>
<tr>
<td>Prematurely born calf</td>
<td>Hand fed milk only</td>
<td>16</td>
<td>47.06</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Hand fed milk with Herbs <em>(Salvadoraperissica)</em></td>
<td>12</td>
<td>35.29</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Hand fed milk and injected tetracycline</td>
<td>6</td>
<td>17.65</td>
<td>70</td>
</tr>
<tr>
<td>Mange</td>
<td>Didn't treat-Called CAHW</td>
<td>41</td>
<td>56.95</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Injected ivermectin only</td>
<td>9</td>
<td>12.50</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Rotated sleeping area and applied grease</td>
<td>6</td>
<td>8.33</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Sprayed Doom insecticide</td>
<td>1</td>
<td>1.39</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Washed with Amitraz/OP</td>
<td>15</td>
<td>20.83</td>
<td>80*</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>Didn't treat-Called CAHW</td>
<td>12</td>
<td>19.35</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Dewormed</td>
<td>6</td>
<td>9.68</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Herbs and tetracycline</td>
<td>4</td>
<td>6.45</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Sugar, salt and porridge orally</td>
<td>13</td>
<td>20.97</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Reduced milk suckled</td>
<td>20</td>
<td>32.25</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Stopped water intake</td>
<td>7</td>
<td>11.29</td>
<td>5</td>
</tr>
<tr>
<td>Camel pox/Orf</td>
<td>Applied motor vehicle oil</td>
<td>24</td>
<td>64.86</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Injected Tetracycline</td>
<td>13</td>
<td>35.14</td>
<td>0</td>
</tr>
<tr>
<td>Dermatophytosis (Ringworm)</td>
<td>Washed with Amitraz/OP</td>
<td>15</td>
<td>26.32</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Applied animal fat on lesions</td>
<td>25</td>
<td>43.86</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Hot iron on lesions</td>
<td>15</td>
<td>26.31</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Salty water + ointment</td>
<td>2</td>
<td>3.51</td>
<td>100*</td>
</tr>
<tr>
<td>Navel ill</td>
<td>Hot iron on navel</td>
<td>32</td>
<td>94.12</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Injected Tetracycline</td>
<td>2</td>
<td>5.88</td>
<td>100</td>
</tr>
<tr>
<td>Joint ill</td>
<td>Herbs Massage on joints</td>
<td>12</td>
<td>80.00</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Injected Tetracycline</td>
<td>2</td>
<td>13.33</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>No treatment</td>
<td>1</td>
<td>6.67</td>
<td>0</td>
</tr>
</tbody>
</table>

* Cases took long to recover.
** Cases recurred
4.4. Crude calf mortality

The crude mortality rate for camel calves was 18.64% (104/558). This means that in any 1000 camel calves, 186 had a risk of death. There was no significant (p>0.05) difference in crude mortality of camel calves in the three divisions of Marsabit District; Laisamis (15.48%, 24/155), Loyangalani (19.77%, 69/349) and North Horr divisions (20.37%, 11/54) as shown in Table 4.14. Though the crude mortality rate for females (16.67%; 39/234) was slightly lower than of males (20.06%), this difference was not statistically significant (p>0.05).

Table 4.14: Crude mortality per division and sex of camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>n</th>
<th>Number died</th>
<th>Crude Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division</td>
<td>Laisamis</td>
<td>155</td>
<td>24</td>
<td>15.48</td>
</tr>
<tr>
<td></td>
<td>Loyangalani</td>
<td>349</td>
<td>69</td>
<td>19.77</td>
</tr>
<tr>
<td></td>
<td>North Horr</td>
<td>54</td>
<td>11</td>
<td>20.37</td>
</tr>
<tr>
<td>Sex</td>
<td>Males</td>
<td>234</td>
<td>39</td>
<td>16.67</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>324</td>
<td>65</td>
<td>20.06</td>
</tr>
</tbody>
</table>
4.5. Unconditional herd factors associated with calf crude mortality

4.5.1. Helminth control in camel calves

The effect of helminth control on calf mortality was determined by dividing 558 calves into two groups; those that were dewormed and those that were not dewormed in Marsabit District. Deworming of calves was associated with lower crude mortality \((X^2=11.7, P<0.01)\) in calves (Table 4.15). The crude mortality rate in dewormed calves was 13.07\% (37/283) whereas that of non-dewormed calves stood at 24.36\% (67/275).

Within Laisamis Division, deworming of camel calves was highly associated with lower crude mortality \((X^2=15.6, P<0.01)\) in the calves (Table 4.15). The crude mortality rate in dewormed calves was 19.81\% (21/106) whereas that of non-dewormed calves was 51.02\% (25/49).

Deworming of calves was also associated with lower mortality in North Horr Division \((X^2=12.6, P<0.05)\). The crude mortality rate in the dewormed calves was 13.79\% (4/29) whereas that of non-dewormed calves was 60.0\% (15/25).

In Loyangalani, crude mortality in dewormed camel calves was lower 8\% (12/148) than that in the non-dewormed calves 13.4\% (27/201), but this difference was not statistically significant (Table 4.15).
Table 4.15. Interrelationship between deworming and crude mortality of calves in camel herds in Marsabit District

<table>
<thead>
<tr>
<th>Variable (Region)</th>
<th>Category</th>
<th>Calf Died</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsabit District</td>
<td>Dewormed.</td>
<td>37</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td>Not dewormed</td>
<td>67</td>
<td>208</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>104</strong></td>
<td><strong>454</strong></td>
</tr>
<tr>
<td>Loyangalani Division</td>
<td>Dewormed.</td>
<td>12</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>Not dewormed</td>
<td>27</td>
<td>174</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>39</strong></td>
<td><strong>310</strong></td>
</tr>
<tr>
<td>Laisamis Division</td>
<td>Dewormed.</td>
<td>21</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Not dewormed</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>46</strong></td>
<td><strong>109</strong></td>
</tr>
<tr>
<td>North Horr Division</td>
<td>Dewormed.</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Not dewormed</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>
4.5.2. Tick control in camel calves

The effect of tick control on calf mortality was determined by dividing 558 calves into two groups; those that received tick control and those that did not receive tick control. Tick control in calves was associated with significantly lower crude mortality ($X^2=26.0$, $P<0.01$) in calves (Table 4.16). The crude mortality rate in calves with ticks controlled was 15.69% (78/497) whereas that of calves with no tick control was 42.62% (26/61).

In Loyangalani Division, tick control in calves was associated with significantly lower ($X^2=4.7$, $P<0.05$) crude mortality (Table 4.16). Crude mortality rate in calves with ticks controlled was 18.3% (58/317) whereas that of calves with no tick control was 34.38% (11/32).

In Laisamis Division, tick control in calves was associated with significantly lower ($X^2=16.0$, $P<0.01$) crude mortality (Table 4.16). The crude mortality rate in calves with ticks controlled was 11.97% (17/142) whereas that of calves with no tick control was 53.85% (7/13).

In North Horr Division, tick control in calves was associated with significantly lower ($X^2=7.7$, $P<0.01$) crude mortality (Table 4.16). The crude mortality rate in calves with ticks controlled was 10.53% (4/38) whereas that of calves with no tick control was 43.75% (7/16).
Table 4.16: Interrelationship between tick control and crude mortality of calves in camel herds in Marsabit District

<table>
<thead>
<tr>
<th>Variable (Region)</th>
<th>Category</th>
<th>Calf Died</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Marsabit District</td>
<td>Ticks controlled.</td>
<td>78</td>
<td>419</td>
</tr>
<tr>
<td></td>
<td>No tick control</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>104</strong></td>
<td>354</td>
</tr>
<tr>
<td>Loyangalani Division</td>
<td>Ticks controlled.</td>
<td>58</td>
<td>259</td>
</tr>
<tr>
<td></td>
<td>No tick control</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>69</strong></td>
<td><strong>280</strong></td>
</tr>
<tr>
<td>Laisamis Division</td>
<td>Ticks controlled.</td>
<td>17</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>No tick control</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
<td><strong>131</strong></td>
</tr>
<tr>
<td>North Horr Division</td>
<td>Ticks controlled.</td>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>No tick control</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>
The effect of confinement of camel calves at night on calf mortality was determined by dividing 558 calves into two groups; those that were kept in a night boma/enclosure and those that were left in the open at night (Table 4.17). The confinement of calves at night in the boma was associated with significantly lower mortality ($\chi^2 = 43.6, P < 0.01$) in the calves. The crude mortality prevalence in calves confined at night in a boma was 14.32% (69/482) whereas that of calves not confined was 46.05% (35/76).

In Laisamis Division, confinement of calves at night in the boma was associated with significantly lower mortality ($\chi^2 = 83.5, P < 0.01$) in calves. The crude mortality rate in calves confined at night in a boma was 6.47% (9/139) whereas that of calves not confined at night was 93.75% (15/16).

Within Loyangalani Division, confinement of calves at night in the boma was associated with significantly lower mortality but the difference was not statistically significant ($P > 0.05$), (Table 4.17). The crude mortality prevalence in calves confined at night in a boma was 18.94% (54/296) whereas that of calves not confined at night was 28.30% (15/53).

In North Horr division, confinement of calves at night was associated with lower mortality in calves but the difference was not statistically significant as some 2x2-table cells had expected values less than 5 in chi-square test. Crude mortality prevalence in calves confined at night in a boma was 12.77% (6/47) whereas that of calves not confined at night was 71.43% (5/7).
Table 4.17: Interrelationship between confinement of calves in a boma at night and crude mortality of calves in camel herds in Marsabit District

<table>
<thead>
<tr>
<th>Variable (Region)</th>
<th>Category</th>
<th>Calf Died</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Marsabit District</td>
<td>69</td>
<td>413</td>
<td>482</td>
</tr>
<tr>
<td>Confined at night.</td>
<td>35</td>
<td>41</td>
<td>76</td>
</tr>
<tr>
<td>Not confined at night</td>
<td>104</td>
<td>454</td>
<td>558</td>
</tr>
<tr>
<td>Loyangalani Division</td>
<td>54</td>
<td>242</td>
<td>296</td>
</tr>
<tr>
<td>Confined at night.</td>
<td>15</td>
<td>38</td>
<td>53</td>
</tr>
<tr>
<td>Not confined at night</td>
<td>69</td>
<td>280</td>
<td>349</td>
</tr>
<tr>
<td>Laisamis Division</td>
<td>9</td>
<td>130</td>
<td>139</td>
</tr>
<tr>
<td>Confined at night.</td>
<td>15</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Not confined at night</td>
<td>24</td>
<td>131</td>
<td>155</td>
</tr>
<tr>
<td>North Horr Division</td>
<td>6</td>
<td>41</td>
<td>47</td>
</tr>
<tr>
<td>Confined at night.</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Not confined at night</td>
<td>11</td>
<td>43</td>
<td>54</td>
</tr>
</tbody>
</table>
4.5.4. Watering of camel calves separate from adult herds during dry periods

The effect of water provision to camel calves separately from adult herds during dry periods on calf mortality was determined by dividing 558 calves into two groups; those were watered separately from adult herds during dry season and those which were given water together with adult herds. Provision of water during dry periods to calves separately from adult herds was associated with significantly lower mortality ($\chi^2=28.7$, $P<0.01$) in calves (Table 4.18). The crude mortality rate in calves given water separately from adults during dry period was 13.57% (57/420) whereas that of calves given water together with adults was 34.00% (47/138).

In Loyangalani division, provision of water to calves separately from adults during dry season was associated with low mortality ($\chi^2=16.8$, $P<0.01$) (Table 4.18). The crude mortality rate in calves given water separately from adults during dry period was 15.99% (47/294) whereas that of calves given water together with adults was 40.00% (22/55).

In Laisamis divisions, provision of water to calves separately during dry season was associated with low mortality ($\chi^2=24.8$, $P<0.01$). The crude mortality rate in calves given water separately from adults during dry period was 6.96% (8/115) whereas that of calves given water together with adults was 40.00% (16/40).

In North Horr division, provision of water to calves separately from adults was associated with lower mortality but this was not statistically significant as some 2x2-table cells had expected values less than 5 in chi-square test. The crude mortality
Prevalence in calves given water separately from adults during dry period was 18.18% \((2/11)\) where as that of calves given water together with adults was 20.93% \((9/43)\).

Table 4.18: Interrelationship between watering of calves separate from adult herds during dry periods and crude mortality of camel calves in Marsabit District

<table>
<thead>
<tr>
<th>Variable (Region)</th>
<th>Category</th>
<th>Calf Died</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Marsabit District</td>
<td>Calves given water separately from adults</td>
<td>57</td>
<td>363</td>
</tr>
<tr>
<td></td>
<td>Calves given water together with adults</td>
<td>47</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>104</strong></td>
<td><strong>454</strong></td>
</tr>
<tr>
<td>Loyangalani Division</td>
<td>Calves given water separately from adults</td>
<td>47</td>
<td>247</td>
</tr>
<tr>
<td></td>
<td>Calves given water together with adults</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>69</strong></td>
<td><strong>280</strong></td>
</tr>
<tr>
<td>Laisamis Division</td>
<td>Calves given water separately from adults</td>
<td>8</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Calves given water together with adults</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
<td><strong>131</strong></td>
</tr>
<tr>
<td>North Horr Division</td>
<td>Calves given water separately from adults</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Calves given water together with adults</td>
<td>9</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>
CHAPTER FIVE

5. DISCUSSION

The results of this study showed that there was a very high voluntary participation rate by camel keepers. This was achieved through involvement of local elders, right from the initial stages in development of the study and may have been contributed by the fact that the study was carried out during the drought when most camel keepers identified with problems facing pastoral camel keeping. It is therefore paramount to involve the community in any study in order to achieve success.

This study found that the pastoralist is increasingly incorporating business aspects to camel production. This agrees with observations in a study described by Njanja (2007). Eighty percent of the respondents kept camels for both subsistence and commercial purposes with increase of herd sizes and calf survival rates as the main aim towards improving production. There was no restriction on the number of camels kept by each household based on the results of this study, and if unchecked, it could present a potential risk of straining the fragile pastoral ecosystem in the future. The increase in camel populations was evident from the livestock census conducted in 2009 (KNBS, 2009).

The choice of any interventions in animal production and health has been shown to be greatly influenced by perceptions of animal owners in the past (Chilonda and Ven-Huylenbroeck, 2001). This study identified key production constraints to camel calf production, which included high calf mortality and inadequate feed resources.
especially during the dry season as perceived by camel keepers. This agrees with other studies (Njanja et al., 2003; Njanja, 2007; Bekele, 2010). This study also found that low birth rate was another key concern for camel herders and this was a hindrance to their main aim of increasing herd sizes.

Although trypanosomosis has been reported in some literature as endemic diseases in camel calves, it has not however been reported as major health concern (Elamin et al., 1998; Ngaira et al., 2002; Delafosse and Doutoum, 2004; Njanja, 2007). The findings in this study indicated that in spite of the low prevalence of clinical trypanosomosis in camel calves, camel herders still rank the disease as the second most important disease affecting calf health. When camel keepers were further probed, it was noted that trypanosomosis received such a high ranking due to its negative effect on the ability of the dam to support the suckling calf rather than its direct impact on the calf.

In raising calves, attention should be directed to prenatal, postnatal and the period up to weaning (Tibary and Anouassi, 2001). The calves should be managed very closely immediately after birth to ensure that both the neonate and dam are healthy as this is a very critical period for their survival. The camel neonate should be assisted to suckle colostrum in order to receive immunoglobulins that are not passed transplacentaly (Kamber et al., 2001; Tibary and Anouassi, 2001). Though most herders have been reported to value the need for a calf to get colostrum, most do so only for cultural reasons (Njanja, 2007). The results from this study showed that there was little emphasis placed on either the volume of colostrum consumed or the time limit by which a calf should have consumed colostrum after birth. Birth process in the camel can take 5-10 hours (Khanvilkar et al., 2009) and requires close observation. The
findings in this study also showed that most herders observed calving process until the placenta was dropped and assisted the calves to suckle as was reported in a study by Njanja (2007).

Due to the very nature that camels are kept mainly for milk production (Simpkin, 1996; Njanja, 2007; Ihuthia et al., 2010) most camel calves in this study had their dams milked. The main milking method employed during the wet season was '2 teat milking' where only half of the quarters were milked while the calf was left to suckle the rest. The latter method was attributed to the low demand for milk during the wet season. Some herders were found to strip milk on the ground so as to reduce chances of diarrhoea in calves due to consumption of excess milk. This practice was observed in Laisamis and Loyangalani areas as has been documented in other studies (Njanja, 2007; Kuria et al., 2010). However, due to high demand for milk during drought; more camel herders milked all the four quarters creating competition with the calves especially for herds near homesteads.

The camel herders considered providing water to as a key management activity as reported in the past (Njanja, 2007). The findings in this study however showed that management of the water provision process with an aim of ensuring that individual camel calves were able to drink adequate water was not emphasised. During drought, access to water was reported to be limited and herders were only allowed short periods to water their animals at animal watering points. The results of this study agree with previous observations that water provision for camel calves begins after the adults have drunk to their fill especially during the dry periods (Njanja, 2007; Kuria et al., 2010). During this study, it was further observed that the practice of tying
camel calves on their hind limbs so as not to follow their dams to grazing fields was common. The latter practice had the risk of exposing camel calves to excessive dehydration and exhaustion thus can affect their welfare.

The benefits of providing mineral salt supplements to the camel calf for growth have been documented by Kuria et al. (2004). This study found that a low percentage of camel herders considered supplementing camel calves with mineral salts. Those herders, who supplemented their calves, got their salts mainly from local sources during the dry periods including Chalbi desert, where adult calves are taken to get salt licks. Other feed supplements (acacia pods, climbing plants and household remnants) for preweaned calves identified in this study agree with those found by Njanja (2007). It was also noted that children were mainly given the role of searching for such supplements (pods and climbing plants) from the wild during drought as the parents went to queue for relief food or herd camels in fora.

Crude mortality of 18.6% for preweaned camel calves found in this study was close to that documented by Njanja (2007) who got 22.9% and Kaufmann (1998), who got between 22% and 31% under pastoral system. It was also close to 20.4% reported by Zeleke and Bekele (2000) in Ethiopia, 20.2% by Bengoumi et al. (2000), in Morocco and 22.4% reported by Kegode (1990), under ranching system in Kenya. The slightly higher crude mortality rate for female camel calves (20.06%) than that of male camel calves (16.67%) further agrees with the findings of Njanja (2007). Causes of mortalities in camel calves under sedentary nomadic pastoral system have been documented (Field, 1979; Rutagwenda, 1985; Simpkin, 1996; Kaufmann, 1998; Njanja, 2007). Camel calf diarrhoea has been reported to be of importance in
Marsabit (Kaufmann, 1998) and even greater importance under Somali ecosystem as a cause of preweaning calf mortality where it accounts to between 20% and 73% of all deaths in calves (Iłona, 2007; Farah et al., 2007). Other causes suggested by Farah et al. (2007), include low immunity in the calf due to reduced intake of colostrum.

There are many diseases affecting camel calves including camel pox, contagious ecthyma, tetanus, rabies, anthrax and clostridial enterotoxaemia, which are preventable through vaccination. The results in this study showed that only 7% of calves were vaccinated against anthrax, which was in a ranch in Gudas. This study identified challenges facing camel herders, which included unavailability of the vaccines (especially camel pox vaccine) and long distance to vaccination centres especially during drought when vaccinations are carried out in anticipation of animal herd migration and mixing. Camels have largely been left out of most vaccination programmes (Bekele, 2010), this shortcoming is increasingly being tackled by Ministry of Livestock Development and partner Non-Governmental organizations working in ASALs but more should be put in place. There have been efforts to improve availability (Gitao, 1994c) of vaccine access to these vaccines by pastoral communities through improved production and distribution channels. Tibary and Anouassi (2001), recommend vaccination of dams against Clostridium perfringens (type C and D). This study found that some herders fear giving any vaccine to the camel dam for fear that it will cause abortion. This concern needs to be addressed through education and field demonstrations if such vaccination is considered for camel calves in Marsabit.
Loss of camel calves due to predation and theft was reported in this study and may have been underestimated. Predation has been identified as a major cause of mortality in camel calves in the past (Njanja, 2007). During this study, it was observed that due to insecurity, camel owners kept camels in one place for long where such places were perceived to be safe. The practice of keeping camels for long periods in one place was likely to encourage build-up of parasites and diseases. It was also observed that due to constant security threats and wildlife conflicts that have been documented in most of the study areas (UN-OCHA, 2011) pastoralists have been forced to build the night boma/enclosure. The camel calves were placed in the middle, surrounded by stronger camels that can wade off any wild animals that try to attack calves over the fence.

This study found that only 50% of preweaned camel calves were routinely dewormed. This moderate level of deworming may have been due to the low ranking of helminthiasis in calves by camel herders. Previous studies have also indicated that helminthiasis is not a serious problem in camel calves (Wilson et al., 1981; Jacquiet et al., 1997; Njanja, 2007). This study found out that over 20% of camel herders dewormed camel calves using herbal medicines, mainly Albizia antihelmintica. The mean age at which routine deworming was reported to be initiated in this study was three months.

Tick infestation was ranked as the most important condition affecting health of preweaned camel calves from this study. This may be because it was easily identifiable. Controlling of ticks was identified from this study as one of the most commonly (89%) carried out management practice for camel calves under Sedentary
Nomadic Pastoral Livestock Production system (SNPLP). This practice may have reduced the prevalence of tick infestation in pre-weaned camels as reported by Njanja (2007). In a study in Ethiopia, all animals had ticks; the only difference was tick load, supporting the believe that only high tick load levels cause concern to camel keepers (Bekele, 2010). This study showed that controlling of ticks was associated with lower prevalence of crude mortality. Mortality was significantly lower for calves receiving ectoparasite control (15.69%) than in calves with no ectoparasite control (42.62%). The mean age at which ectoparasite control was started in the camel calves was about four months. The late start of ectoparasite control and the low frequency (1-3 months) of tick control found in this study did not appear to support effective control of ticks.

Mange has been documented as the most common skin condition of camel calves (Bekele, 2010; Njanja, 2007; Abbas and Omer, 2005; Higgins, 1985). Some of the commonly used products in treating mange found in this study included Amitraz, organophosphate and non-conventional ones such as application of 'used motor vehicle oil' concurs with findings of other studies in the Borana lowlands of Ethiopia (Bekele, 2010).

Navel ill, which is a common complication of umbilicus, was ranked by pastoralists amongst the important diseases constraining camel calf production. This disease has also been documented to be an important disease for camel calves leading to calf mortality (Njanja et al., 2003). Navel ill disease was considered as a curse, and information on the disease was provided only after careful probing. This finding concurs with those of Njanja (2007). In this study, burning of the infected navel with
hot iron rod was the preferred treatment method. This could contribute to low recovery rates of this disease as expressed by camel keepers who felt that in only 43% of the times do most affected calves recover.

As the calf approached weaning age, getting them to stop suckling became the major challenge to camel keepers. In this study, most herders moved calves to far away herds if a calf refused to stop suckling its dam. It was also observed that some camel keepers preferred to slit the nostrils or even pierce the tongue in an effort to forcefully stop calves from suckling. The pierced nostrils posed a challenge in that calves would not freely forage as they were in pain during this period of high-energy demand.
CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

Based on the results of this study, the following conclusions are outlined;

1. Production and health challenges perceived by camel keepers in raising camel calves included high calf mortality, ectoparasite infestation, inadequate pasture and water scarcity.

2. Herd level factors contributing to lowered overall mortality of preweaned camel calves included carrying out of routine management of calves such as deworming and tick control, and ensuring that camel calves received adequate water and milk.

3. Routine disease control and management practices such as deworming and ectoparasite control in camel calves was started after three months and once started was not carried out at appropriate intervals.

4. There were painful and inhumane treatment practices being carried out in calf disease management and weaning process. These included the use of hot iron rod for navel ill and use of used motor oil to treat mange.

5. There existed information and practices utilizing locally available resources including ethno-veterinary drugs that aid in management and control of camel...
calf diseases including diarrhoea and bronchitis are seen in warmer drier system of Masaai Mara.

6.2 Recommendations

This study recognized that the main place in alleviating measures in improvement of calf health and production would be needed if improvements are to be made. This work is on this basis that the following recommendations are in advance of disease improving management of calf health in view to better calf welfare and improvements of calf calf production according to the following:

1. Local communities should be involved in decision making processes and investments for improved pasture and water resources and conservation of water and pasture for use during drought that affects most areas to the stakeholders and tailor made to suit individual needs and prevailing conditions in order to ease for all needs.

2. Local animal health and protection service systems should be strengthened to better control diseases and to ensure animal intervention in case of disease outbreaks. This effort should increase 50% animal patterns and designed to suit individual needs and prevailing conditions to reach all needy animals.

3. Camel keepers should be supported in demonstrating and applying disease control and management practices including diagnosis and treatment so as to
calf management. Such practices should be carried out at appropriate intervals for success to be achieved.

4. There is need for education and information dissemination to camel keepers, animal health providers and extension service providers to increase the level of awareness and adoption of locally available resources and skills so as to reduce calf mortality and improve overall camel calf productivity. Education should also be targeted at breaking myths and replacing inhumane treatment of preweaned camel calves with appropriate disease control strategies amongst camel keepers.
REFERENCES


calf diseases including diarrhoea and helminthiasis and navel ill within SNLP system of Marsabit District.

6.2 Recommendations

This study recognised that the roles played by different stakeholders in improvement of camel calf health and production required involvement of all stakeholders. It is on this basis that the following recommendations aimed at prevention of diseases, improving management of such diseases in order to reduce calf mortality and improvements of camel calf production are suggested;

1. Local communities should be facilitated to develop clear guidelines and increased investment for improved pasture and water availability, and conservation of water and pasture for use during drought. Such efforts should involve all key stakeholders and tailor made to suit individual local needs and prevailing conditions in order to cater for all needy camels.

2. Local animal health and production service delivery systems should be strengthened to better control diseases and to provide adequate intervention in case of disease outbreaks. Such efforts should incorporate SNLP sedentary patterns and designed to suit individual local needs and prevailing conditions to reach all needy animals.

3. Camel keepers should be supported to incorporate appropriate disease control and management practices including deworming and acaricide application early in


APPENDIX 1: HERD QUESTIONNAIRE

Date (d/m/y): ___________________________ HQ number: _______________________

Enumerator's name: ___________________ Owners name: _______________________

Name and function of the person interviewed (if not owner): __________________________

PART 1: BACKGROUND INFORMATION.

BIOPHYSICAL PARAMETERS

1) Location of the land

Province __________________________ District ___________________________

Division __________________________ Location ___________________________

Sub-location ______________________ Village ___________________________

Manyatta __________________________ Tribe ___________________________

Clan/sub clan _______________________

2) Land tenure system

Individual________ size of land________ (acres preferred)

Group_________________________

Commercial ________________

Government ________________

a) If group how the grazing is arranged

Group herding ____________________

78
Individual herding

Other

b) Are there any limits per household? Yes ________ No _________
c) If individual what is the size of your land ______________________ (acres)

3) What type of animals do you keep?
a) Wildlife _______ type and what number __________________________
b) Livestock

Cattle __________________________ number _________________________

Goats __________________________ number _________________________

Sheep __________________________ number _________________________

Others __________________________

4) Other than keeping animals do you do any other farming activities?
a) Grow crops Yes ______ No ______

If yes which type and acreage __________________________

b) Others __________________________

GENERAL HUSBANDRY PRACTICES.

5) What is your main production objective (e.g. increasing herd size, milk......)

6) Do you categorize your camels into groups? Yes _____ No ______

If yes which categories are these, and why?

a) __________________________

b) __________________________

c) __________________________

7) Where do your camels stay at night?

In the open ______________ Night boma __________________________
8) Which products do you get from your camels?

Milk
Meat
Blood
Hides and skin
Sale

9) Do you wean camel calves/stop suckling Yes ______ No ______
   a) If yes at what age do you wean camel calves ____________
   b) Which method do you use to stop them from suckling ____________
   c) what do you do with calves that continue suckling ____________

FEEDS AND WATER

10) What is the grazing arrangement?

   No programme ____________________________________________
   Rotational ______________________________________________
   Other __________________________________________________

11) What are the grazing patterns/times in each in your animal’s categories?
   a) During rainy season (indicate category and pattern).

   b) During dry season (indicate category and pattern).

12) Do you provide any special feed supplementation to your animals?

   Yes __ No__
   a) If yes which one and to which group of animals

   i) All animals ____________________________________________
   ii) Gestating animals ______________________________________
iii) Lactating animals

iv) Calf

v) Male castrates

PREVENTATIVE MEDICINE

13) Do you vaccinate your animals? Yes_______ No_______
   a) If yes, against which disease and when do you vaccinate?
      i) Tetanus__________________________ time(s)________
      ii) Anthrax________________________ time(s)________
      iii) Camel Pox_______________________ time(s)________
      iv) Other (Indicate)_____________________ time(s)______
   b) If no, why not vaccinate ?.
      i) No need__________________________
      ii) Expensive________________________
      iii) Not available____________________
      iv) Long distance to vaccination centre____________
      v) Other________________________________

14) Do you deworm your animals Yes_______ No_______
   a) If yes, which group of animals
      i) All age groups___________
      ii) The young_____________
      iii) The sick ______________
      iv) The old _______________
v) The pregnant ____________

vi) Recently calved ____________
   b) which dewormers do you use
      
      Commercial_________________Herbal__________________________
   
   c) Brand name/formulation or type of herb(s)_____________________

   d) who does the deworming
      i) Veterinarian________________________
      
      ii) Animal health assistant_______________
      
      iii) Community health animal workers_____
      
      iv) Yourself__________________________

15) Do you control ticks in your animals?Yes_____________No_____________
   a) If yes which method do you use and how often.
      
      i) Dipping ___________________ how often __________________
      
      ii) Hand spraying_______________ how often _________________
      
      iii) Hand dressing_____________ how often _________________
      
      iv) Pour on_____________________ how often _________________
      
      v) Other_________________________

   b) Which chemical do you use?Commercial__________Herbal___________
   c) Brand name/formulation or type of herb(s)_____________________
   d) Who does the spraying/dressing
      i) Your self/owner __________________________
      
      ii) Family member__________________________
      
      iii) Hired/Casual labourer_______________
16) Do you observe camels at calving time? Yes___________ No_________

a) If yes, for how long do you observe?

i) Until the calf is born____________________

ii) Until the placenta is expelled_____________

iii) Until calf suckles_______________________

OTHERS

17) On which special events in your life does a camel play an important role (e.g. as gift at boy’s birth and initiation, wedding.) ________________________________

PRODUCTION TRAITS

Milking traits

18) Do you get milk from your camels whole year round? Yes_____ No_____ 

19) How do you milk the camels?

i) 2 teat method (calf suckling before you milk) _______________________

ii) 2 teat method (calf suckling as you milk) _________________________

iii) 2 teat method (calf suckling after you milk) _______________________

iv) 4 teat method (calf suckling before you milk) _____________________

v) 4 teat method (calf suckling as you milk) _________________________

vi) 4 teat method (calf suckling after you milk) _______________________

vii) Other_______________________________________________________

20) Do you clean teats before milking Yes_________________________ No_____ 

If yes, what do you use _________________________________________

21) How much is the average milk yield ____________________________

22) Which quality in the milk do you like most? ______________________
23) What Milking problems do you encounter? 

SPECIFIC CONDITIONS OF THE CALF.

24) Have you ever had a case of premature calf births? 
   a) How many in the past 5 years? 
   b) What treatment did you give? 
   c) What was the outcome? 

25) Have you ever had a calf that is born dead? 
   a) What was the diagnosis? 
   b) How many in the past 5 years? 
   c) What did you do with the dam? 

26) Have you ever had a calf who died immediately after birth? 
   a) What was the diagnosis? 
   b) How many in the past 5 years? 
   c) What treatment did you give? 
   d) What was the outcome? 

27) Have you ever had a calf with deformities? 
   a) How many in the past 5 years (specify deformity)? 
   b) What treatment did you give? 
   c) What was the outcome?
28) Have you ever had a calf with mange?
   a) How many in the past 5 years
   b) What treatment did you give
   c) What was the outcome? Recovery
   d) Complications (Specify)

29) Have you ever had a calf with diarrhoea?
   a) How many in the past 5 years
   b) What treatment did you give
   c) What was the outcome?

30) Have you ever had a calf with navel infection?
   a) How many in the past 5 years
   b) What treatment did you give
   c) What was the outcome?

31) Have you ever had a calf with joint ill disease?
   a) How many in the past 5 years
   b) What treatment did you give
   c) What was the outcome?

32) Have you ever had a calf with camel pox?
   a) How many in the past 5 years
b) What treatment did you give __________________

c) What was the outcome? ____________________

33) Have you ever had a calf with diarrhoea? _______________

   a) What was the common diagnosis? _______________

   b) How many in the past 5 years _______________

   c) What treatment did you give __________________

   d) What was the outcome? ____________________

34) Have you ever had a calf with ring worm? _______________

   a) How many in the past 5 years _______________

   b) What treatment did you give __________________

   c) What was the outcome? ____________________
**APPENDIX II: HERD/RANCH-LEVEL FACTORS INVESTIGATED FOR ASSOCIATION WITH CAMEL CALF HEALTH AND PRODUCTIVITY**

**HERD/RANCH-LEVEL FACTORS INVESTIGATED FOR ASSOCIATION WITH CAMEL CALF HEALTH AND PRODUCTIVITY IN PASTORAL AND RANCH CAMEL HERDS IN MARSABIT DISTRICT (JANUARY 2005-DECEMBER 2006)**

<table>
<thead>
<tr>
<th>Variable</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disease Management Practice</strong></td>
<td></td>
</tr>
<tr>
<td>Ticks controlled (No/Yes)</td>
<td></td>
</tr>
<tr>
<td>Helminth controlled (No/Yes)</td>
<td></td>
</tr>
<tr>
<td>Clean teats before milking (No/Yes)</td>
<td></td>
</tr>
<tr>
<td><strong>Husbandry Practice</strong></td>
<td></td>
</tr>
<tr>
<td>Herd Size (total number of camels – young and old)</td>
<td></td>
</tr>
<tr>
<td>Provision of feed supplements (No/Yes)</td>
<td></td>
</tr>
<tr>
<td>Observation of calving time (No/Yes)</td>
<td></td>
</tr>
<tr>
<td>Confinement of calves at night (Open/Night boma)</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX III: BOX PLOT PRESENTATION OF AGE OF BEGINNING DEWORMING FOR CAMEL CALVES

Age of Starting Deworming of Camel Calves in Marsabit District

Key

- Mean

----- Median

Age in Months

Laisamis  Loyangalani  North Horr

Divisions