ASSESSMENT OF THE EFFECT OF GRAZING SYSTEMS ON CATTLE PRODUCTIVITY IN KARAMOJA REGION, MOROTO DISTRICT

CASE STUDY OF RUPA SUB-COUNTY

BY

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DECLARATION (DISCLAIMER):

Except where stated and acknowledged, this Dissertation is my sole and unaided work.

SIGNED.....

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SUPERVISOR'S APPROVAL:

This dissertation by Ojwok Noah Ewatu Reg No: **2016-M152-20017** under the study area: Assessment of the effects of grazing systems on cattle productivity in Karamoja, has been prepared under my close supervision and is now ready for submission to the faculty of Agriculture for due approval

SIGN.....

NAME:

DATE.....

DEDICATION

I am so much delighted to dedicate this piece of my work to my family, my Wife Aujo Christine, my daughter Aryekot Shimrath given and my son Edonu Treasure Mishma. To my parents (Joel Raymond Ewatu and Aryekot Joyce), I am so much grateful for all their support physically, spiritually and financially during my study times.

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ABSTRACT

This study was aimed finding out the effect of grazing systems on cattle productivity in Moroto District, Rupa Sub-county.

Generally; more males were interviewed relative to the females since the males are the heads of families and make most of the decisions. Most of the respondents interviewed had no formal education. The main occupation of most of the respondents was livestock rearing and growing of crops. Most of the respondents reared cattle. Grazing distance had varying effects on calf mortality depending on the season.

Results showed that, there was higher calf mortality ($P>0.05$) while grazing in the wet season compared to grazing during the dry season ($P<0.05$). Most respondents noted that calves are mixed with adult animals at ages between 12-24 months.

There was no significant association ($P>0.05$) between grazing hours and age at first calving. Most respondents noted that heifers which were grazed for more than four hours and for at least five hours during the wet season conceived normally relative to those grazed for similar durations during the dry season. Moreover, many respondents also noted that heifers which were grazed for more than six hours during the dry season had delayed age at first calving. Causes of delayed age at first calving included; failure of bulls to mount, heifer malnutrition, poor management and diseases. Different management practices were employed while caring for heifers including; supplementary feeding, mixing heifers with the main herd and grazing around homes.

There was a highly significant association ($P<0.05$) between the effect of dry season grazing reserves and parasite infestation in cattle. Most respondents noted that there was moderate parasite infestation in the dry season grazing reserves. Both endo-parasites and ecto-parasites were noted to be prevalent in the grazing reserves. The endo-parasites which were observed by respondents on the grazing reserves included; liverflukes and roundworms. The ecto-parasites which were observed by respondents included; ticks, lice, biting flies and mites. High parasite infestation on the dry season grazing reserves was attributed to such factors as; high stocking rate, favorable environmental conditions and parasitic lifestyle of endo-parasites and ecto-parsaites.

Table of Contents

LIST OF ABBREVIATIONS

FGD	Focus Group Discussion
KII	Key Informant Interview
NAADS	National Agricultural Advisory Services
OPM	Office of the Prime Minister
NGO	Non -Governmental Organization
CAHWs	Community Animal Health Workers
DVO	District Veterinary Office
UBOS	Uganda Bureau of Statistics
UPDF	Uganda Peoples' Defence Forces
IGAD	Inter-Governmental Authority on Development
ICT	Information and Communications Technology
TLU	Tropical Livestock Units
UNDP	United Nations Development Programme
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
FAO	Food and Agriculture Organization
KDF	Karamoja Development Forum
BCS	Body Condition Score
IPC	Integrated Phase Classification
AFRISA	Africa Institute for Strategic Animal Resource Services and Development
GOU	Government of Uganda
C&D	Corporation and Development
CCPP	Contagious Caprine Pleura-Pneumonia
PPR	Pestes des Petit Ruminants
ECF	East Coast Fever

CBPP	Contagious Bovine Pleura-Pneumonia
GALV med	Global Alliance for Livestock Veterinary Medicines
IICD	Institute for International Corporation and Development
NHPC	National Housing and Population Census
AET	Africa Education Trust
IFAD	International Fund for Agricultural Development
IPC	Integrated Food Security Phase Classification
IRAN	Inter-Agency Regional Analyst's Network
IUCN	International Union for Conservation of Nature
IUPS	International Union of Physiological Sciences
MLA	Meat and Livestock Australia
NGOs	Non-Government Organizations
ODI	Oversees Development Institute
UIA	Uganda Investment Authority

DEFINITION OF KEY WORDS

Grazing systems are controlled grazing management practices that manipulate livestock to systematically control periods of grazing, deferment or rest. An extremely important concept in creating grazing systems is to select the appropriate season of grazing or rest (uidaho.edu/range456. Grazing systems)

Transhumance

A system of animal production characterized by seasonal and cyclical migration of varying degrees between complementary ecological areas and supervised by a few people, with most of the group remaining sedentary".

Agro-Pastoralism

Agro-pastoralists may be described as settled pastoralists who cultivate sufficient areas to feed their families from their own crop production. Agro-pastoralists hold land rights, use their own or hired labour to cultivate land and grow staples. While livestock are still valued property, their herds are on average smaller than other pastoral systems, possibly because they no longer solely rely on livestock and depend on a finite grazing area around their village which can be reached within a day.

Pastoralism

A production system in which 50% or more of household income and subsistence comes from livestock or livestock-related activities; Swift (1988):

Calf Mortality:

Refers to death of calves up to 12 month of age

Early pre-weaning mortality:

Refers to death of young stock within 1–3 months of age

Late Pre-weaning Mortality:

Refers to death of young stock within 3–12 months of age in cattle

Abortion and stillbirth:

Refers to expulsion of dead fetus immediately before parturition or death during parturition

Carrying capacity

Carrying capacity of rangelands refers to the maximum number of livestock units that a given range area can carry when forage is at its lowest (Relma, 1999).

Stocking rate

Refers to the amount of land allocated to an animal unit (cow or cow–calf pair) for a specified time (grazing intensity).

RELATIONSHIP OF THE STUDY TO AGRO-ECOLOGY

One of today's crucial agricultural dilemmas is how to find a balance between a fast growing global demand for food and the need to sustain the natural resource base of land, water, air and bio-diversity (Cheeke, 1993; Steinfeld, et al., 1998). As important component of agriculture, livestock are one of the main users of natural resource and can favorably and unfavorably react with the environment

Haan, et al (1989) and Steinfeld et al (1998) have made a comprehensive review and have critically analyzed livestock-environment interaction impacts across the livestock production systems. In the Ethiopian Highlands for example, negative livestock-environment interaction impacts are associated with overgrazing and land degradation. (Haan, et al., 1998; Steinfeld et al., 1998) further states that, the major threat to grassland ecosystems today is their potential for conversion to farmlands, which has often been favoured by development programs and policies (Cheeke, 1993). Across the world the most productive pasture lands are being turned into crop lands as demands for arable lands continues to increase with the rapid increase of human population, with livestock being marginalized into limited and increasingly poorer and fragile grazing areas

Therefore, livestock associated environmental damages have a lot to do but with the ever increasing and conflicting interests that people carry for both livestock and the environment. More often ignorance about ecosystems and their links with livestock leads to wrong policy and development decisions. The challenge is to critically identify and enhance positive contributions of livestock in agricultural development that will satisfy current and future human needs, while preserving the natural resource base. With government support and willingness and commitment by all stakeholders, there are sufficient mechanisms to keep adverse effects of livestock production within acceptable limits. Thereby enhance the net contribution of livestock to sustainable agriculture; such a move contributes significantly towards the efforts to ensure food security and food self-sufficiency.

CHAPTER ONE: GENERAL INTRODUCTION

1.1. Background to the study

The rangeland of Karamoja supports about 6 million head of cattle, representing 19.8 percent of the national cattle numbers (UBOS, 2008, MAAIF 2011). This cattle population is of great importance to the country's economic development. The production system in the region is majorly transhumance involving human and cattle population migration during the dry season, in this system grazing is mainly curtailed because most of the grazing areas are dry and wiped clear of nutritious and tender pasture, once the water points have dried up, the respective grazing areas are usually abandoned completely, as a consequence, pastoralists and livestock are compelled to move further, crossing over to neighboring Districts and regions. Grazing areas that hold on to a bit of moisture in the dry season are left to shoulder all the remaining livestock, which in turn often leads to degradation, high carrying capacity, overgrazing and conflicts over limited resources (KDF, 2017). Lack of feed supplementation during the dry season is frequent. The limited availability and access to pasture and water exacerbates cattle mortalities in case of disease outbreak, reduction in milk yields and emaciation of cattle thus decreasing their value in the market (KDF, 2017)

The grazing pattern further involves moving cattle to the dry season grazing reserves, these grazing reserves are not close to the homesteads and the cattle herds have to walk long distances to access pasture and water, in addition, the movements are associated with poor husbandry practices such as herd mixing, inter-herd contact, overcrowding of livestock around the drinking points, mixing of calves with the main herds, communal grazing practices and high disease and parasite incidence (Rufael et al, 2008; Schoonman and Senyael Swai, 2010). Leisige and Schmitt (1995) also revealed that, trekking long distances to reach grazing and watering points causes death of livestock, and the commonly affected are calves because they cannot withstand long distance trek under conditions of forage scarcity resulting from low dry season rainfall.

On the other hand, findings by Hunting (1994) contradicts and shows that, cattle productivity parameters such as age at first calving, rates of calving were higher in migratory systems as compared to sedentarized systems. This is because; the former allows cattle to have access to their favoured pastures and consequently demonstrates higher growth and productivity. Nalule Sarah (2010) also revealed that, mixing livestock species ensures maximization of range utilization, labour and also lessened risk of livestock losses since chances are that if one livestock species succumbed to environmental stress others would survive and also reduced susceptibility of herds to diseases.

Traditionally, the cattle keepers in the region mainly keep the indigenous short horned east African zebu cattle (Bos Indicus) breed in their herds, the zebu cattle have the ability to cope well with the harsh climate and disease and parasites that are common in the region (Kisamba - Mugerwa, 1992). However, in Karamoja, the productivity of this breed of cattle has remained low in terms growth, age at first conception, milk yield and meat quality compared to its genetic potential, the low productivity is attributed to mainly feed shortage and disease incidences (Waiswa 2016), for example milk yield of these breeds is in average of 1-2.5 litres/ cow per day and a mature bull may weigh up to 150 - 180 Kgs much less than the average recommended slaughter weight of a cow (DVOs reports, 2017).the situation is further worsened during the dry season when pasture and water shortage increases leading to the problem of seasonal weight loss of approximately 20 -40 % of the body weight at the onset of the dry season (preston and Leng 1987; Cleiget et al, 1998) with lactating cows exhibiting reduced average Body Condition Score of 2.2 much lower than the recommended BCS of 5 scores (FAO, 2014). The current District Veterinary Officers' (DVOs') livestock estimates of 600, 000 heads of cattle, 650,000 goats and about 600,000 sheep (FAO, 2014,) are significantly lower than the 2008 UBOS estimates. Although these numbers are a current subject of debate, any decrease in the number of livestock has been mainly attributed to shortage of feed and water and pests and diseases which lead to loss of animals and negatively impacts on the livelihood of pastoralists

Therefore, although the current grazing systems of the Karimojong is the core for their survival, its status and contribution to lifting the socio-economic wellbeing of the local communities and to the national economy (in terms of improving cattle productivity) has not yet been exploited and is yet to be well recognized. The frequent movement of pastoralists and their animals as they look for water and pasture is viewed by development actors as unproductive, backward and unsustainable while other studies (Nalule Sarah et al (2010, IUCN et al (2012) view it as a sustainable livestock productivity system for most of the fragile arid regions of East Africa. this has led to an unanswered question of whether pastoralism in Karamoja is regarded as *'a way of life' or 'a recognized system of animal husbandry'? In addition production policies in Uganda center on an* agricultural model that puts little emphasis on the Karimojong production systems, although it is supposed to employ strategies intended to address the challenges of harsh and uncertain conditions. The need to maintain and exploit the livestock potential in Karamoja is high and it is urgent to efficiently utilize or implement policies that enable the Karimojong take advantage of the available livestock markets (Waiswa, 2016)

Therefore this study attempted to find out whether the low productivity of cattle is attributed to the current Karimojong grazing systems.

1.2. Problem statement

The ideal situation for the Agro-pastoral (transhumance) grazing system that can enhance cattle productivity, should aim at improving feed quality and quantity while maintaining pasture species composition through; optimum carrying capacity and stocking rate, reduced over-grazing and burning of pasture, providing adequate rest for pasture by planned rotation , establishing nutritious pasture species and reducing seasonal movement of cattle by; fodder preservation and reduced distance to water points and disease and parasite control.

Cattle productivity in Karamoja is generally low, with high disease and parasite prevalence, lower calf growth, high calf mortality, late first heat in heifers, low milk yield in lactating cows, poor feed conversion, poor weight gain and lower carcass weight among others.

In Karamoja, cattle herds walk for long distances in search of water and pasture, communal grazing, herd mixing and high stocking rate around water points is practiced, cattle feed on low nutrient pasture and during water scarcity calves are taken for watering along with older herds, supplementary feeding for milking cows and weaned calves is not included in the grazing cycle. This study will therefore attempt to assess whether, these grazing gaps are partly responsible for the current low productivity of cattle in Karamoja.

1.3. The aim of the study was

To assess the effect of grazing systems on cattle productivity in Karamoja

1.4. Specific objectives of the study:

1. determine the influence of grazing distance on calf mortality
2. Find out the influence of dry season grazing on age at first conception in heifers
3. Evaluate the effect of dry season grazing reserves on parasite infestation in cattle

a. Research Hypothesis

The hypotheses were tested in the study as follows.

i. Distance to grazing areas influences calf mortality
ii. Dry season grazing influence age at first conception in heifers

iii. Dry Seasonal grazing reserves influence parasite incidence in cattle

b. Significance of the study

The results of this study was to inform pastoral rangeland management policy decisions, contribute to the understanding of the effects of pastoralists grazing systems on the major pastoral livelihoods (livestock) as well as inform efforts of government, local, national and international organizations focusing on improving livestock production in Karamoja on the measures that can be adopted to improve grazing systems in the region. The anticipated outputs will include the determination and documentation of the relationship between the grazing systems and how they influence cattle productivity in Karamoja. The study will also be of importance to students in higher learning institutions who will be conducting studies in livestock related fields, finally; this study will be submitted as a dissertation for the award of Master of Science degree in Agro- Ecology of Uganda Martyrs University.

c. Scope of study

The study targeted the pastoralists living in the cattle-sorghum zone of Moroto District (Rupa Sub-county). This zone is ecologically set in such a way that, long dry spells normally result in severe pasture and water shortages that directly influence dry season movements of the pastoralists with their cattle to long distances in search of pasture and water for livestock (Karamoja IPC, 2017).

d. Justification for the study

***Figure 1: Photo Courtesy: Ewatu Noah*: Calves join main herd during the long distance migration to Kobebe dry season grazing/ watering area in Rupa Sub-county**

The frequent mobility of pastoralists and their animals as they search for water and pasture is viewed as unproductive, backward and unsustainable and has led to an unanswered question of whether pastoralism in Karamoja is regarded as *'a way of life' or 'a recognized system of*

animal husbandry'? In addition production policies in Uganda center on agricultural model that puts little emphasis on pastoralism, although it is supposed to employ strategies intended to address the challenges of harsh and uncertain conditions. The need to maintain and exploit the livestock potential in Karamoja is high and it is urgent to efficiently utilize or implement policies that enable the Karimojong take advantage of the available livestock markets (Waiswa, 2016). Recent studies have criticized the pastoral grazing systems as being unproductive and primitive, other studies (Waiswa, 2016) have concluded that, improving cattle productivity in Karamoja will require introducing improved cattle breeds in the region; however, this initiative will require improving feed availability in terms of nutritious fodder production and feed preservation for dry season feeding. This therefore calls for development of interventions that will promote improved grazing systems to enhance livestock production and productivity in Karamoja. Therefore, to inform the policy development, sufficient information regarding the pastoral livestock systems needs to be available thus making this research necessary and timely

e. Conceptual framework:

The study was focus on the following inter-linking concepts as a measure to understand the relationship between grazing systems and its effects on cattle productivity in Rupa sub-county.

The conceptual framework has been represented graphically as follows:

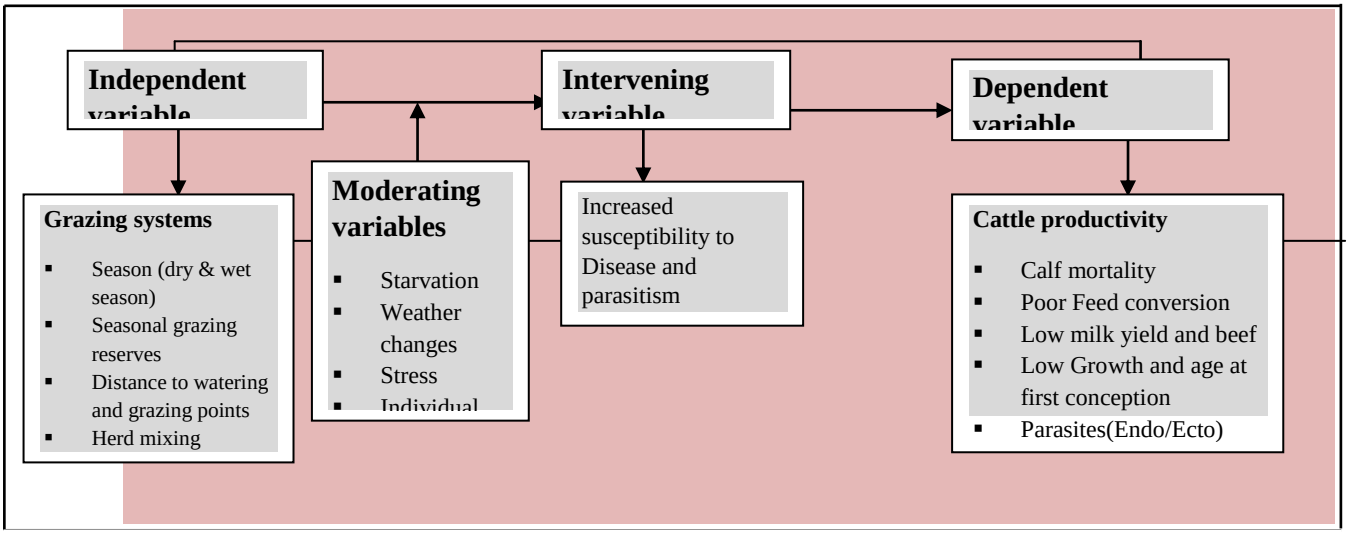

Figure 2: conceptual framework

Grazing patterns determine mobility of cattle herds in Karamoja search that, during the rainy season, movements are limited and animals are grazed within a short distance from homesteads during the day and returned in the evening to the Kraal. However changes occur during the dry season and so feeding animals becomes very hard. As a response to this problem, the pastoralists have to move to other places in search for pastures and water. This

type of movements is not limited to the grazing areas within the communities, but even across neighboring communities or districts AFRISA (2014)

According to FAO (2014) studies, tick infestation in Moroto was more in the dry season grazing areas around Kobebe grazing and watering zone. It is also reported that, the rainy season of 2013 exacerbated the disease condition especially endemic diseases such as CBPP, CCPP, tick-borne diseases (Anaplasmosis and Babesiosis), East Coast fever, and goat plague (PPR), foot rot, Endo-parasites and Ecto-parasites. [1]

[1] Inter-herd contact- cattle from different herds mixed in the same grazing point

Herd-mixing or combination stocking (mixtures of numbers of cattle, sheep and goats)

CHAPTER TWO

LITERATURE REVIEW

General overview:

2.1. Karamoja grazing systems

Grazing systems are controlled grazing management practices that manipulate livestock to systematically control periods of grazing, deferment or rest. An extremely important concept in creating grazing systems is to select the appropriate season of grazing or rest (uidaho.edu/range456. Grazing systems)

2.2. Factors that influence grazing patterns

According to ACTED (2016) the grazing pattern that, with specific differences, can be attributed to all the pastoral communities in the Karimojong cluster is the organization of livestock migration across the three ideal ecological zones with increasing quality of pasture: a home area, a grazing area and a grazing reserve. The grazing area are the locations used for feeding animals during migration, while the grazing reserve is near to the home area, and used for feeding cattle when the home area is depleted. Travel between these production zones is organized through a transhumance system based on weather, animal health, pasture quality, and a multitude of other external factors.

Seasonal movement of herds to distant grazing sites is dependable on the harshness of the dry season, involving moving livestock to distant grazing and watering sites and establishing temporary camps near to grazing sites (Lind Jeremy, Sabales Rachel, Cerevani, Kohnstamm Sarah, 2016). Livestock grazing is geographically distributed in terms of the mountain grazing lands allocated to the dry season and the plains grazed during the wet season. The geographical distribution of grazing landscape is identified using place names. The places are endowed with diverse grazing landscapes that vary from marshes to dry valleys and uplands. The grazing landscapes are categorized according to the conditions of the soil and vegetation indicators. During the wet season, grazing distribution is likely to cover large geographical areas due to high spatial distribution of grazing and water sources, while during the dry season, the scope of coverage is limited. The type of resources in the dry season will be rested during the growing season (Oba, 2009)

The herders are aware that some landscapes can only be grazed for brief periods. Such landscapes have patchy vegetation. Conversely, other landscapes with high grazing potential will resist degradation even when overstocked for extended periods. Such landscapes have

[2]the capacity to recover rapidly compared to those that disclosed less grazing potential. For example, the Karimojong perceived that the *eketela* (sandy landscapes) are more vulnerable to heavy grazing than the *arro* (black soil) landscapes. The latter landscapes have greater potential for resisting heavy livestock grazing and recovering rapidly after grazing and therefore they can withstand a higher carrying capacity. These types of landscapes are grazed during the dry season or drought year, while *eketela,* which is sensitive to heavy stocking, is grazed mostly during the wet season. Continuous grazing of *eketela* will result in severe degradation that will take longer periods to recover. The Karimojong will in relation to the status of grazing pressure rate conditions of grazing that might vary from poor to excellent based on presence of the relative levels of indicators. In reconstructing landscape change, therefore, the herders consider, trends based on historical knowledge of grazing compared to the present. Adverse land use changes alter plant species composition, while the landscapes that disclose no changes compared to historical knowledge show stability (Oba, 2009).

2.3. Transhumance system

Grazing is mainly extensive on much of the communal land in Karamoja and without any supplementary feeding. Due to cycles of drought, transhumance system of livestock management is practiced. In the wet season, enclosures ("kraals") are closer to the permanent settlement areas, taking advantage of the temporal pools for watering. In the dry season, pastoralists move their animals to neighbouring districts and sometimes countries in search of pasture and water (Anderson and Robinson, 2009).

FAO (2014) studies show that the larger population (up to 97%) of domestic livestock in Karamoja is located in the two livestock systems which are the agro- pastoralist/pastoralist systems. The pastoralist component is based on a transhumant livestock rearing system which involves movement of the majority herds and flocks throughout the year in search of water and grass. The pastoralist system is the smallest in terms of people involved, and pastoralists own bigger herds and flocks and cover longer distances during seasonal movements (up to 80 km) FAO/GIEWS, 2014 and Aklilu, Y. 2016). Movement of animals is based on drinking water availability and where the pastoralists know they are able to defend themselves and their assets, pasture management is a secondary consideration (Waiswa, 2016). pasture management practices by Karimojong people include: i) movements from kraal to kraal as areas become grazed to a point when further use becomes destructive; ii) daily travel of up to 12-14 km per day from the kraal to grazing areas for the more able/older or more

[2] *Eketela*- (sandy landscapes) , *Aro* -(Black soil Landscapes)

conscientious herder, with earlier morning departures and later evening returns than the less able/often very young or less conscientious herder; iii) combination stocking (mixtures of numbers of cattle, sheep and goats) adjusted to match browse and grass type availability at the preferred sites; iv) changing watering regimes adjusted to account for water availability and the water content of grasses eaten at different times of the year; and the physiological state and associated requirements of the animals in the herd/flock; v) controlled and timely burning of pasture (only if it is expected that the burner will profit from the highly digestible re-growth and expected control of vectors and parasites); vi) shaking high protein pods and leaves/lopping branches/pollarding browse trees for feeding in situ or dragging back to the kraal and vi) regular visits to mineral rich areas included in the round (Waiswa Charles, 2016, FAO, 2014, et al)

2.4. Determine the influence of grazing distance on calf mortality

In Karamoja, the grazing pattern is mainly determined by the availability of pasture and water. As the dry season reaches its peak, herds are moved to the mobile kraals (grazing areas). Young stock, milking cows and older herds remain at the homesteads and are grazed on the preserved pasture during the rainy season called *Apero* (Feinstein international, 2016). However, during the dry season, even the animals that remain at home have to walk for long distances to access water, thus subjecting calves to stress, starvation, susceptibility to diseases and thirst as a result of movement in collective herds (Leisige and Schmitt, 1995). Survival of calves during the dry season highly depends on the distance to grazing and watering points. If calves are tethered within homestead, it entails fetching water that is enough for household use and watering of young stock. Households that are away from watering source hardly fetches enough water to meet both the domestic use and take care of the young stock daily requirement and in such circumstances calves often die with time.

In case there is no access to grazing and watering point within reasonable distance, calves are taken for grazing and watering with the mature herds and have high chances of dying due to long distance they have to trek. Death of calves is further increased because lactating cows have low milk yield (off take) therefore unable to suckle the calves (Grandin et al, 1991). With more communities travelling further distances to reach the grazing and watering points, this has also resulted in overcrowding of livestock around the rivers and borehole grazing areas leading to delays in pastoralists access to water and also increase in water borne diseases spread between livestock with calves being more susceptible to infections. Pastoralists also report experiencing significant problems with ticks during migration

(ACTED, 2016), long distance walk also weakens cattle with calves adversely affected (Oba 2001; Angassa and Oba 2007).

Studies in Ethiopia by USAID/ Feed the Future (2016) revealed that Health- and management-related causes of morbidity and mortality of cattle are malnutrition or starvation and dehydration due to drought. Mortality in newborn animals increases with age; significantly higher mortality is normally reported in early life up to one month of age and decreases with increased age of calves. The mortality rate in the first one month of age is 40.5% in cattle. Mortality rate from birth-to-weaning in general increases with age in calves. However, high calf mortality is also reported in the late pre-weaning stage that can be related to recurrent feed shortages and susceptibility to many of the endemic diseases prevalent in the area.

Grandin et al (1991) reveals that; pastoralist grazing regime should aim at four things:

1) Minimizing the distance between homesteads and water sources
2) Avoiding predators and other losses for small stock
3) Ensuring that livestock arrive at the watering point at the right time
4) Providing the best possible grazing for each stock class

(USAID/Mercycorps, 2013), have also concluded that one of the major constrain to livestock production in Karamoja is the high calf/kid mortality associated with poor management from kraal centre during the dry season grazing. Therefore, the Neo-natal mortality rates have been reported to be high at 20 percent for cattle (GOU and C&D, 2010).

2.5. Find out the influence of dry season grazing on age at first conception in heifers

Availability of dry season watering and grazing areas is proportional to the calving rates. Calf management especially with regards to watering also tends to be influenced by availability of water points during dry seasons. Grandin (1991) concluded that the Maasai do not control breeding of their cattle and hence reproduction is primarily influenced by bi-modal rainfall. In his research carried out in Kajiado District (Kenya), he, found out that there are two major peaks in conception that coincide with the two rainy seasons. This conception pattern results in a calving peak from the end of the dry season: Over 80% of calves are born during the 8 months when rainfall probability is high. The bimodal nature of calving rates also indicates

that nutrition has a role to play in calving rates. Poor nutrition is, in part, responsible for low average number of calves born to cows in a herd. Improved fodder and water availability or better utilization of existing production would do much to reduce the nutritional stress, particularly in dry seasons, and thus improve the reproductive rate (Wilson, 1986).

Calving rate is also affected by amount of rainfall and prevailing drought conditions. During drought, conception rates are low caused by either low nutrition or inadequate drinking water, which reduces feed intake. High calving rates occur after drought as many of the surviving cows are often open and likely to conceive once forage conditions improve. Therefore, it becomes clear that two factors, which may influence calving rates, are availability of pasture and water because these determine nutrition level that livestock can acquire. Hence, presence of dry season watering points and pasture (fodder, hay, silage etc) may influence calving rates Oduor (2001).

Presence of grazing and watering areas at reasonable distance may contribute significantly to livestock production because of increasing calving rates. Oduor (2001) concludes that, in areas that are semi arid, conception rate of heifers reduces during the dry season because, bulls that walk long distances in search of drinking water and pasture are likely to be tired. They may not be able to service cows that are on heat effectively while those walking short distances to the watering/grazing point during the wet season may be very active and be able to service many cows effectively. This is attributable to the fact that bulls that walk long distances will spend much of their time resting instead of servicing cows. Cows that walk long distances to the watering point also are bound not to be on heat as regularly as they should. Heifers kept under good husbandry practices, will reach conception age at the recommended time, walking long distances and mixing of herds subjects heifer to disease susceptibility and reduced feed intake, also feed conversion to enhance growth reduces as much of the energy is spent on trekking long distances thus reduced growth, heat onset, conception and increased susceptibility to diseases (AFRISA, 2014)

2.6. Evaluate the effect of grazing seasonality on parasite incidence in cattle

Disease and parasites are among the most severe factors that impact livestock production and productivity. Animal diseases and parasites have great impact on food supplies, trade and commerce and human health globally (pearson 2006; Thornton 2010, E. Lamy et al 2012)

In Karamoja, helminthiasis and tick borne diseases (Anaplasmosis, East coast fever, Babesiosis and heart water are ranked among the most common endemic diseases affecting cattle productivity (Waiswa Charles, 2016)

Bohm et al 2009) has concluded that in systems where communal and transhumance grazing practices are common, there is a high rate of inter-herd contact and disease and helminthes transmission than under other management practices. Studies in south Sudan (Alif Elamin Abdelgadin et al 2012) have shown that, helminth infestation increases during migration in the mobile kraals because veterinary services are far and cannot be accessed in these remote areas. Moreover, in the dry season pasture is poor and water is scarce so pastoralists are forced to migrate with their livestock for long distances or crowd and over graze certain places which lead to rapid spread of internal parasites.

Among the pastoralists of West Africa, (Hanse and Perry 2009) reported that, the severity of Gastro Intestinal (GI) infections increase during the dry season fodder shortage which place many animals under nutritional stress thus making them more susceptible. They (Hanse and Perry 2009) also showed that the prevalence of certain Gastro Intestinal parasites like flukes (Fasciola, Paramphistome and schistosoma) increase during the wet season in areas with abundant water points in which the intermediate host (snail) is found. And it is a similar phenomenon with coccidia. In most cases these parasites are confined to specific areas with favourable conditions and will create hazard if the infected animals move and contact other susceptible herds which is a common practice in the communal grazing systems where animals congregate in specific grazing areas for a long time.

In Moroto District for example worm infestation mainly occurs during the wet season and tick burden in cattle increase during the dry season mainly in the dry season grazing areas where grazing is not controlled which exacerbates high rate of inter-herd contact and herd mixing. FAO (2014) have also revealed that, major disease outbreak is associated with changes in the seasonal grazing pattern and related to livestock trekking long distances to search for water and pasture. That, trekking long distance to search for water and pasture exposes livestock to disease outbreaks through herd-mixing, overcrowding along the drinking points and stress from long distance treks. This normally results in delays for the pastoralists to access the water and also increase the speed at which water borne diseases spread between livestock (ACTED 2016).

In addition, estimates by GALVmed indicated that 60% of Karimojong pastoralists' calves die of ECF (Byaruhang. C, Oosthuizen M.C. Collins N.E., Knobel D., 2015, GALVmed, 2014). other reports from Karamoja revealed that, on average 100 cattle (out of about 3000) die per month in communal camps, mostly due to disease (equating to 40% annual mortality; (Anderson and Robinson, 2009), and the average herd sizes have markedly reduced in the last

decade (IICD, 2010) from around 100 to around 40 (field veterinarians, personal communication)

Studies by (Waiswa Charles, 2016) clearly show that, attempts to introduce other breeds of cattle in the region have faced big challenges related to disease/parasites and feeding.

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1. The research design

The study used a descriptive and explanatory research design because of the nature of the variables that were at hand, to produce data, required for quantitative and qualitative analysis and to allow simultaneous description of views, perceptions and beliefs at any single point in time (White, 2000). The explanatory research design in addition allowed test of relationships. It enabled the study to formally seek answers to problems by answering the question ―why‖ as opposed to questions such as ―what‖, ―where‖, ―when‖ which are answered by a descriptive approach. Finally, this combination of designs enabled the study to describe relationship(s) among variables (Singleton and Strants, 2005; Babbie, 2010). Further, the study will incorporate both quantitative and qualitative research by collecting data for both.

3.2. Area of the study

The study was conducted in Rupa Sub-county of Moroto District. The District has 6 sub-counties 4 rural and two urban sub-counties and they include Katikekile, Tapac, Nadunget, Rupa, South and North Divisions respectively. The vegetation of the area is savannah woodland towards the south east and west with shrubs in the north. (IPC Report 2015) .It is located within the Karamoja Region and is divided into two livelihood zones; Central Sorghum and Livestock Zone and Mountain slopes Maize and Cattle Zone. The District has a total human population of 104,539 people (UNHPC, UBOS 2014) and Livestock population of 1,040,067 (FAO, 2014).

The District is part of the pastoral and Agro-pastoral zones; the rainy season in Moroto District is from March to September and is less reliable than in western parts of Karamoja region with an annual average of 500-800 mm. rain fed crop production is practiced throughout the zone, although the environment and climate are more conducive for livestock rearing than crop production. This is a food deficit livelihood zone, in two out of every three years on average. The majority of the households depend on food purchase from the markets supplemented by food from their own crop production, milk, meat and sometimes blood from their own livestock (IPC for Karamoja, 2011).

Pastoralism is practiced on communally-owned land, which has been the traditional Karimojong mode of life, however this lifestyle has undergone changes due to on-going changes in the land tenure systems including gazzeting wildlife and mining areas and increasing crop production.

The location has been chosen due to its livestock population, pastoralism and agro-pastoralism, climate changes and livestock disease outbreaks. Pastoralists from the location migrate frequently in search of water and pastures occasioned by climatic variations in terms of rainfall and droughts. The area also has one of the largest dry season grazing point (Kobebe) with the second largest dam (Kobebe dam) in the region which serves the larger cattle population in the dry season and therefore livestock from different parts of the region including from neighboring countries (Kenya and South Sudan) converge in this area during the dry season

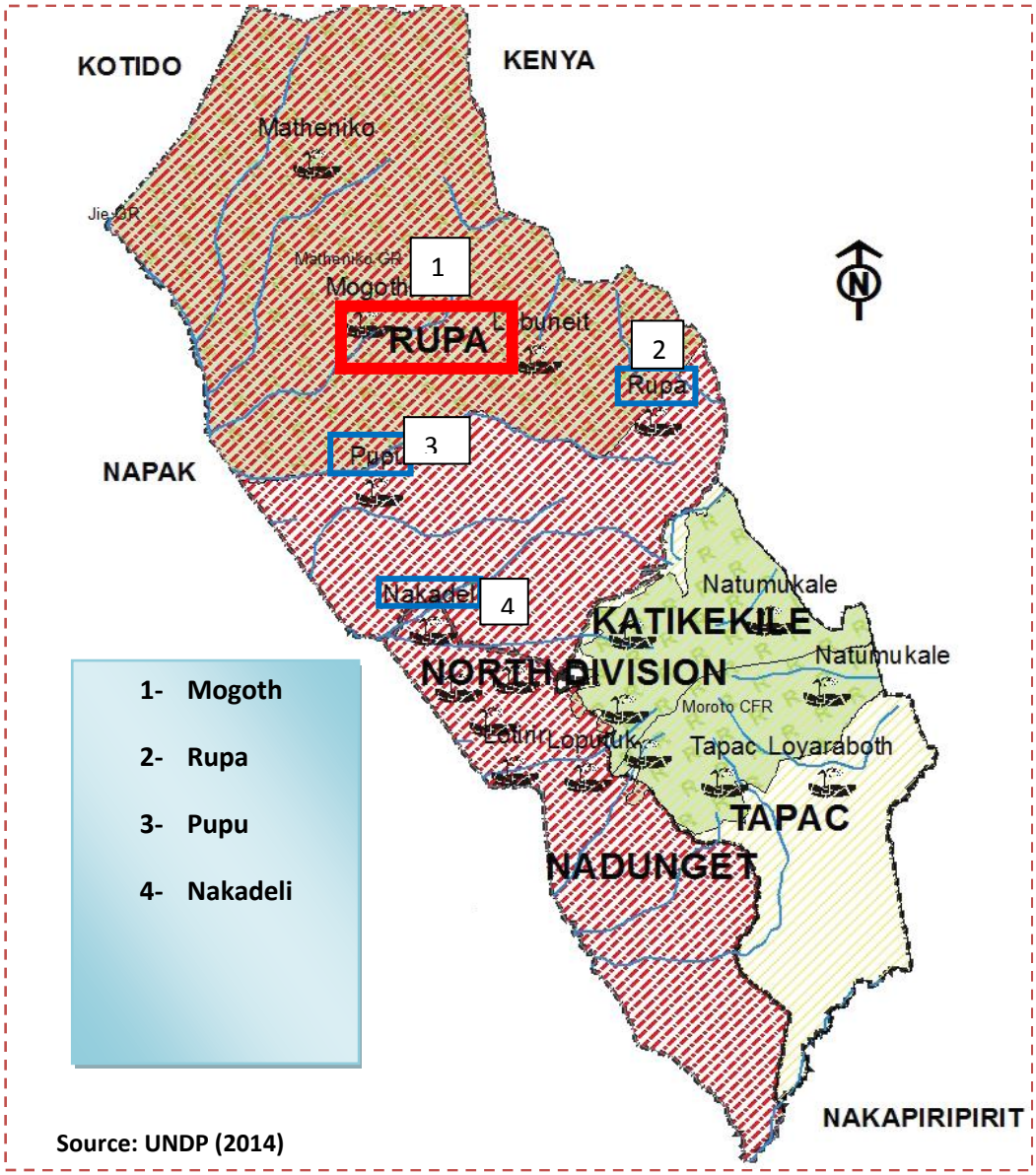

Figure 3: Map of Moroto Showing the study area and study sites

3.3. Population and sampling

3.3.1. Population

Rupa sub-county comprises five parishes and 21 villages with an estimated population of 25,786 people and 5018 households (UBOS 2016). The respondents will include livestock owners, herdsmen, UPDF persons, veterinary officers, community animal health workers (CAHWs), cattle traders, village local councils, sub-county administrators and clan leaders.
5018

3.3.2. Sampling

Five parishes participated in the study; two villages were selected at random per parish. The sample size was selected at random from the study population. The sample took 5% of the population households in the study area i.e. up to 124 households participated in the study.
The sample size was estimated using the following formula:

$$n = \frac{(Z)^2 pq}{e^2}$$

Where n =sample size, 8Z = Z value 1.97 at 95% confidence level, e = desired level of precision (5%), p = estimated pro-portion of an attribute that is present in the population (Angwech*et al.,* 2015)andq =100− p.five parishes participated in the study; three villages were selected at random per parish. The sample size was selected by use of simple random selection from the study population. The sample was taken 5% of the population households in the study area. Up to 124 households' participated in the study.

Sampling frame of the respondents for the research:

3.3.3. Sampling technique

List of study area households was compiled with the help of parish chiefs (stratified into sub-locations and *manyattas*) using a Uganda Bureau of statistics (UBOS) pre-census survey. A total of 450 households will be listed. A household was considered the unit of study. However, in the Karimojong cultural set up, people live in groups called *manyattas* that consists of 6-10 households of close relatives.

A systematic random sampling was used to select the households to be included in the survey. The first household was selected randomly between the first and third listed names and thereafter every third household was subsequently selected. A total of 125 households were selected for the study. During the community meeting, the area residents were informed of the planned survey and a guide selected. A maximum of

three households per *manyatta* were selected. Semi-structured interviews were conducted on the selected households. In case the selected household members were not available due to migration or any other reason, then alternative nearby household would be select for the interview.

3.4. Data collection

3.4.1. Instruments

Data collection instruments that were used included; structured questionnaires which was administered to respondents to capture cattle and grazing information, factors influencing grazing systems etc; of the different stakeholders in the households. For data that was not easily captured at household level, focus group discussions were held with small groups of village members to mostly discuss the different variables with regards to grazing systems and cattle productivity variables, questionnaires for key informant interviews were administered to (opinion leaders, relevant local government officials and kraal leaders), secondary data was collected from existing literature on related studies.

3.4.2. Research procedure

Community mobilization

A multidisciplinary Stakeholders meeting was held at Rupa Sub-county headquarters to explain the aim and objectives of the study while at the same time incorporating suggested improvements. The stakeholders included Community based organizations (CBOs), Non-governmental organizations (NGOs), sub-county administrators, local leaders, churches, Ministries of Livestock Development, Water Development, Agriculture, farmers/pastoralists. Permission was sought from local leaders to conduct the research in the area.

Mobilization of the pastoralists to participate in the activities, the data collection was undertaken by the parish chiefs in collaboration and the LC I chairpersons of Rupa Sub-county. Another community meeting was held to introduce the research team to the community leaders in the location. The researcher explained to the community the purpose of the study and outlined the specific objectives that would be pursued. Community cooperation was requested for, during interviews and the administration of questionnaires.

Primary data

Data was collected through questionnaire that was administered to the heads of selected households, and interview guides were administered in Focus Group Discussions (FGD). This took place between the months of April- May 2018. The timing was to ensure that most pastoralists would have returned from dry season grazing camps.

Questionnaire survey

A questionnaire was developed and administered to capture information on seasonal grazing trends, grazing distance, watering distance, grazing frequency, watering frequency, calf mortalities, helminthes prevalence etc. The questionnaire consisted of both closed and open ended questions. A pretest of the questionnaire was done in a neighboring location with similar set up called ***loputuk***. This enabled test the weaknesses of the questionnaire before being administered. Final modifications were then made and the questionnaire administered to the pastoralists via personal interviews with the assistance of enumerators who will have been trained on aspects of data collection. The data collected included household structure, problems associated with grazing systems, grazing seasonality (wet and dry season), animal movements, animal diseases and management practices, calf mortalities in relation to grazing Distance and availability of pasture and water, water sources, coping mechanisms and environmental conservation strategies including pasture improvement among others.

Secondary Data

An in-depth search and review of information and literature was conducted on grazing systems/livestock production parameters (calve mortalities, conception in heifers, milk yields etc), livestock diseases/ parasites outbreak trends, livestock movement trends, demographic figures, water sources etc. information on cattle population was acquired from the DVOs office at Moroto District, Reports and survey data from various line agencies was cited to compare findings during the study.

3.5. Quality control

First, before data collection, the researcher defined and enforced standards that were used during the study, this included designing effective data storage, minimizing errors during data entry, using consistent terminologies, adequate training of enumerators to minimize erroneous data collection from the field

Formats that were used for the data tables or data entry forms and Codes were considered. Measurement units for data were specified and relevant metadata was identified before collection.

3.6. Data analysis

Data was entered in excel and exported to SPSS

The results were presented in tables, charts and bar graphs

Chi-square test was run to test the associations between the variables using $P<0.05$ level of significance.

3.7. Ethical considerations

- The researcher treated the information got from the respondents with privacy and high degree of confidentiality
- There was maximum respect and seeking permission before the scheduled meeting with the respondent
- The information collected was strictly used for study purpose only
- The appointed meeting time with respondent was highly observed without fail.

3.8. Limitation of the study

- The major constraint during the study was the time factor especially during the data collection since the study area and the study population was fairly large.
- Seasonal dynamics in grazing systems partly affected collection of observable data especially in the dry season camping kraals as livestock owners who had retreated to their homesteads

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

Upon completion of this study, there were different findings obtained on calf mortality, age at first conception of heifers and prevalence of parasites in the dry season grazing reserves. Grazing distance had varying effects on calf mortality with higher calf mortality observed during wet season grazing relative to dry season grazing. There was no significant association ($P>0.05$) between grazing hours and age at first calving. Most respondents noted that age at first calving for heifers was 3.5years. There was a highly significant association ($P<0.05$) between the effect of dry season grazing reserves and parasite infestation. There was moderate parasite infestation in the dry season grazing reserves according to the respondents.

4.2 Socio-demographic characteristics

Information on socio-demographic characteristics was collected from 123 respondents. The socio-demographic characteristics included; sex, educational level and main occupation. Generally, more men were interviewed compared to women. Many respondents had no formal education and many were peasants mainly rearing animals and growing crops for a living.

4.2.1 Sex of the respondents

During data collection, information was obtained from a total of 123 respondents. Generally, more males, 58% (n=123) were interviewed relative to females, 42% (n=123) (Figure 1). Sustainable dry land development calls for an understanding of the gender-based roles, relations and obstacles that rural men and women face in dry lands globally (FAO, 2003; Karmeback *et al*., 2015). Overall, both men and women play pivotal roles in the dry land development. It is in this regard that acknowledging and supporting these roles is crucial to sustainable management and development of resources (IFAD, 2006; Karmeback *et al*., 2015). Though women are increasingly taking on more tasks and responsibilities in dry lands due to dry land degradation and land restoration efforts (Awumbila and Momsen, 1995; Karmeback *et al*., 2015), they tend to be excluded from most decision-making processes at both household and community levels (Nedessa *et al*., 2005; Karmeback *et al*., 2015).

Women in pastoral societies are generally responsible for small stock such as; sheep and goats as well as processing and marketing of milk and milk products. Generally, women, men, boys and girls provide for different livestock related tasks. Gender roles, however are not static and change for different social, economic, environmental and health related reasons (World Bank, FAO and IFAD, 2009; Hill, 2018).While men and boys are away tending the herd, pastoralist women are responsible for collecting fodder to supplement the feed of these livestock kept close to the homestead. They look after pregnant stock and their calves, kids and lambs and take care of sick animals that cannot keep up with the main herd (Rota and Sperandini, 2010; IFAD, 2018). They milk lactating animals and make sour milk and butter, which are important parts of the diet of many pastoralist families. They also sell these products at the markets (Rota *et al*., 2012; IFAD, 2018).

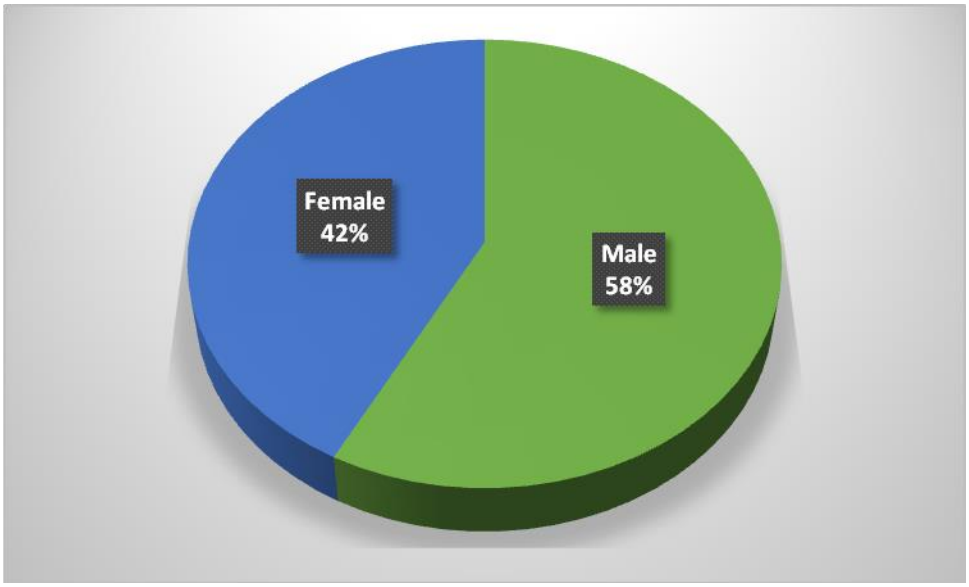

Figure 4: Sex of respondents, N=123

4.2.2 Highest education level attained by the respondents

Generally, most respondents, 66.68% (n=123) had no formal education. On the contrary, only 0.81% (n=123) of the respondents had attained tertiary education (Table 1).Delivery of social services to pastoralists is widely acknowledged to be one of the most evident processes of marginalization and exclusion by policy makers. Mobility and difficult physical environment

have been generally used as the explanation for under development in pastoral areas or for the poor use of social services (Schelling *et al*., 2008).There have been a number of attempts to provide access to children and young people from pastoralist and nomadic families in East Africa and the Horn Region. Mobile schools have been experimented with but a research paper prepared for the Aga Khan Foundation (Aga Khan Foundation, 2004; AET, 2008) reported 'they have performed far below expectations' (AET, 2008).

In the contemporary world, modern technology, formal education, cultural integration, concern for quality life is gradually changing people's perspectives on their traditional beliefs and practices. However, this has not been so with pastoralists who keep on moving with their livestock in search of water and pasture for their livestock. There have been many attempts to establish education services to meet the learning needs of the nomadic pastoralists. On the whole, they have failed for some reason, this is because pastoralists are unable to develop beyond traditional economic practices and cling stubbornly to outdated cultural practices (Hussein, 2016).

Pastoralist community views towards education are paradoxical from place to place. Some include; education is the role of government and NGOs in other words education must be entirely free. Schools are where people pray, prepare people for baptism; therefore, non-believing families don't send their children to school and that education destroys tradition. Education changes children's habits, language and dressing code which is culturally unacceptable and it is meant for people living in towns, parents fear that girls will get pregnant while at school. The communities do not take ownership of school facilities and destroy them. All first born children are not sent to school; they have to look after cattle (AVSI, 2020).

Table 1: Highest education level attained by the respondents, N=123

Education level	Percentage
No formal education	66.68
Primary	14.63
Secondary	17.89
Tertiary	0.81
Total	100

4.2.3 Main occupation of the respondents

In Moroto district, most of the respondents who were interviewed were peasants, 92.68% (n=123). Most of the peasants were involved in agricultural activities notably; livestock rearing and crop production. For livestock rearing, most peasants had cattle (Figure 2).Pastoralists in Uganda and East Africa are a heterogeneous group characterized by varying aspects of ethnicity and socio-cultural set ups, production forms and strategies (ODI, 2010; Davies *et al*., 2016; Waiswa *et al*., 2019). Pastoralism combines dependence on livestock with social structures and traditional practices, specific beliefs and institutions and sets of laws and customs (Davies *et al*., 2016; Waiswa *et al*., 2019). Like in many parts of Africa, pastoralists in Uganda share many common features including; their reliance on livestock and livestock products, a cultural identity associated with livestock and expertise in livestock rearing and arid rangelands (Davies *et al*., 2016; Waiswa *et al*., 2019).

Karamoja is more than 1,000 masl and four main mountains overlook the region's savannah, highlands and river valleys. Mount Morungole in the north, Mount Moroto in the east, Mount Napak in the west and Mount Kadem in the south. In many areas, rains do not often exceed 800mm per year sometimes hovering around a mere 500mm. The precipitation that does fall usually comes sporadically between June and October with desert winds and the hot dry season taking over the land from November to March (UIA, 2016). The sub-region is vulnerable to both drought and flooding and has traditionally supported pastoral groups who have best adopted themselves to the erratic weather through semi-nomadic transhumance (Jordan, 2015; IRAN, 2017).

Karamoja is an agro-pastoralist area; the economy is based on cattle herding; this is considered by the Karamojong to be the most sustainable type of livelihood in the harsh environment in which they live. Most of its land is communal and customarily held under traditional authority (UIA, 2016).The people of Karamoja are traditionally cattle keepers, relient on the open savannah and free movement between the region's dry belt and the area known as the 'greener belt', a rainier zone running through Napak, Kotido and Kaabong district that has been undergoing increasing settlement for agricultural settlement (Jordan, 2015; IRAN, 2017).Farming and pastoralism will continue to play a predominant role in Karamoja's livelihoods portifolio for the fore-seeable future. Agriculture is not a livelihood that will change quickly or dramatically (IRAN, 2017).

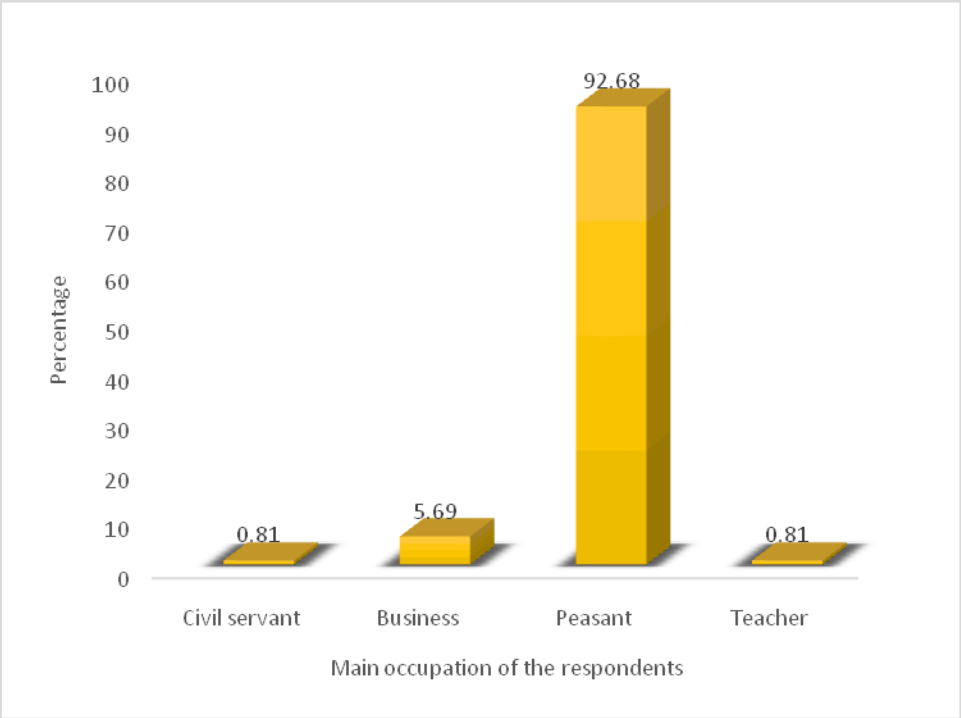

Figure 5: Main occupation of the respondents, N=123

4.3 Determination of the influence of grazing distance on calf mortality

4.3.1 Determination of the influence of grazing distance in the wet season on calf mortality

Generally, there was higher calf mortality while grazing during the wet season (Table 2). There was a non-significant relationship (P>0.05) between grazing distance to the nearest grazing area and calf mortality during the wet season. The highest calf mortality rate of 100% (n=123) was recorded for calves which were moved to the grazing area for a whole day. Furthermore, very highly calf mortality rate of 76.2% (n=123) was recorded for calves which were moved to the grazing area for less than one hour (Table 2).

Homeo-thermic animals keep their body temperature almost constant. They generate metabolic heat and continuously exchange heat with the environment. The rate of heat exchange depends on the climatic environment and the thermo-regulation mechanisms of an animal. Thermo-

regulation involves physiological, morphological and behavioral mechanisms (Khalifa, 2003; Ivanon, 2006; Da Silva, 2012). The heat balance of an animal is composed of the heat produced by metabolic and muscular activity as well as heat exchanges with the environment (IUPS, 2001; Roland *et al*., 2016).

Calves are born with functional thermo-regulatory mechanisms (Gluchman *et al*., 1999; Schaffer and von Borrell, 2008; Roland *et al*., 2016). Approximately 2% of their body weight is composed of brown adipose tissue, which is involved in non-shivering thermogenesis (Vermorel *et al*., 1989b; Roland *et al*., 2016). New calves however, are prone to heat loss under cold conditions because of their low surface/mass ratio and poor insulation (their skin and subcutaneous fat) (Gonzalez-Jimenez and Blaxter, 1962; Berman, 2003; Van Iaer *et al*., 2014).Either extremes of the season's wet or dry are equally not good for grazing animals as nutrient intake is low. Early in the rains, grasses have a lot of water, thus the bulk of feed consumed consists of a greater proportion of indigestible material (Kratli, 2015; Waiswa *et al*., 2019).

Calf health and animal welfare are of interest to producers, consumers and policy makers (Amon *et al*., 2014; Tautenhahn *et al*., 2020). High rates of morbidity and mortality lead to huge economic losses, are at odds with animal welfare and with food safety (Bostelmann, 2000; Bockel, 2008; Tautenhahn *et al*., 2020). Calf mortality is considered as one of the major constraints to herd expansion in the dairy sector. The calf morbidity and mortality studies in Africa indicate high calf loss both in subsistence and market oriented dairy production systems. Studies of calf mortality on small holder farms indicate pre-weaning and early post-weaning mortality rates in the range of 15-25% (Chenyambuga and Mseleko, 2009; Changa *et al*., 2010; Fentie *et al*., 2020). Neonatal calf mortality is the most important constraint in young stock and accounts for 8.7-84% of total calf mortality (Inamdar, 2012).

Different management and environmental factors such as; colostral feeding, housing, calving assistance, production system, herd size, season and hygiene of micro-environment are reported to affect significantly calf morbidity and mortality (Shiferaw *et al*., 2002; Fentie *et al*., 2020). Both infectious and non-infectious causes contribute to the morbidity and mortality of calves. Calf diseases that cause morbidity and mortality are the results of the complex interactions of the management practices; the environment, infectious agents and the animal itself. Mortality of

neonates is attributed to conditions such as; diarrhea and pneumonia, associated with poor housing, hygiene and nutrition (Lema *et al*., 2001; Fentie *et al*., 2020).

Table 2: Percentage of the influence of grazing distance in wet season on calf mortality, N=123

Variables	Confirmation of calf mortality		Overall χ^2 value; ρ value	
	Yes	No		
Less than one hour	76.2	23.8		
1-3 hours	71.4	28.6		
4-6 hours	75.0	25.0	$\chi^2 = 3.977$	$\rho = 0.553$
1 day	100	0.0		
Don't know	87.5	12.5		

4.3.2 Determination of the influence of grazing distance in the dry season on calf mortality

Generally, there was lower calf mortality while grazing during the dry season in relation to wet season grazing (Table 3). There was a significant relationship (P>0.05) between grazing distance and calf mortality during the dry season. The highest calf mortality rate of 100% (n=123) was recorded for calves which were moved to the grazing area for a whole day. Furthermore, very high calf mortality rate of 100% (n=123) was recorded for calves which were moved to the grazing area for less than one hour (Table 3).

The productivity of cattle depends largely on the reproductive performance and the survival of calves. Calf morbidity and mortality are the major problems in all countries where cattle are raised, and the problem is more acute in developing countries (Amuamuta *et al*., 2006; Gessesse *et al*., 2021). According to reports, calf mortality rates in the first year can be as high as 50% in the tropics due to bad management, poor adaptation of exotic breeds to the prevailing tropical environment and endemic diseases (Kim *et al*., 2013). A high mortality rate causes great economic losses to the dairy industry around the world, and the survival of dairy calves and replacement heifers is paramount in modern dairy breeding (Hailiang *et al*., 2019). Calf death represents a cost to the dairy farm due to the loss of the present value of the calf and the loss of genetic potential for herd improvement (Nigussie, 2019).

Thermo-regulation is the ability of homeo-thermic animals to keep their body temperature within a certain range despite being exposed to different ambient temperatures (Bligh, 1998; Roland *et al*., 2016). A physiological core temperature is maintained by generating metabolic heat with the environment (Da Silva, 2012). Animals are able to adjust to adverse climate by means of acclimatization and adaptation (Roy and Collier, 2012). Extreme climatic conditions that cannot be compensated by thermo-regulatory mechanisms result in thermic stress. Thermic stress in calves has a negative effect on animal welfare (Silanikowe, 2000; Roland *et al*., 2016) and causes direct economic losses in the form of mortality and morbidity and indirect costs caused reduce weight gain, performance and long term survival (Virtala *et al*., 1996; Snowden *et al*., 2006; Roland *et al*., 2016). Because some sub-species and breeds are better adapted to a hot climate (Cartwright, 1955; Silva *et al*., 2013), efforts have been made to create heat resistant and high performing cross breeds, but with varying results (Mc Dowell, 1985; Eberhardt *et al*., 2009; Roland *et al*., 2016).

There is a seasonal variation in availability of natural pastures. Pastures tend to become more succulent, highly nutritious and more abundant in the rainy season as opposed to the dry season. However, they become fibrous, scarce and devoid of most essential nutrients such as; proteins, energy, minerals and vitamins which are required for increased ruminant fermentation that results into production of volatile fatty acids and consequently performance of the host animal in the area of maintenance, production and reproduction (Sowande, 2004; Lamidi, 2009; Lamidi and Ologbose, 2014).During the dry season, many grasses have either completed their life-cycle (such as; annuals) or are dormant (such as; perennials). They have very little water content and are low in digestibility (Kratli, 2015; Waiswa *et al*., 2019).

Low nutritional content of grass species during the dry season means that trees and shrubs are important for livestock diets during the dry season. However, such trees are usually found in inaccessible areas such as; hill tops or conservation areas (Kratli, 2015; Waiswa *et al*., 2019).During this dry period, the performance of ruminant animals which are dependent on the native pastures have limited intake, digestibility and utilization (Olafadehan *et al*., 2009; Lamidi *et al*., 2014). Post weaning losses may also occur as a result of unavailability of succulent and highly nutritious forage since the nutrients in the dry fibrous forages cannot meet the nutrient requirement of the newly weaned ruminants (McDonald *et al*., 1998; Lamidi *et al*., 2014).

Table 3: Percentage of the influence of grazing distance in dry season on calf mortality, N=123

Variables	Confirmation of calf mortality		Overall χ^2 value; ρ value	
	Yes	No		
Less than one hour	100	0.0		
1-3 hours	68.4	31.6		
4-6 hours	62.5	37.5	$\chi^2 = 11.061$	$\rho = 0.011$
1 day	100	0.0		
Don't know	86.9	13.1		

4.3.3 Livestock ownership by the respondents

Generally, most of the respondents, 97% (n=123) owned livestock. The respondents owned both ruminant and non-ruminant livestock. The livestock owned include; camels, goats, rabbits, cattle, donkeys and sheep (Figure 3).Pastoralism is a subsistence livelihood with nomadic societies grazing herbivorous livestock on poor rangelands. Pastoralists predominantly live in arid and semi-arid rangelands typically in tropical and sub-tropical regions (Colin, 2018).

Pastoralism is a fundamental subsistence pattern that dates back over 10,000 years to the global warming that ended the Pleistocene epoch. Excluding dogs, the earliest domesticated animals were; goats, sheep and cattle (Little, 2015).Several hundred millions of pastoralists manage rangelands covering one third of the terrestrial land surface. They live in the world's harshest environments and produce food where no rain fed crops can grow (FAO, 2021).Among indigenous livestock species, cattle provide draught power, income to farming communities, means of investment and an important source of foreign exchange to a nation. Moreover, they provide milk, meat, manure and serve as a hedge against risks (Gessesse *et al*., 2021).

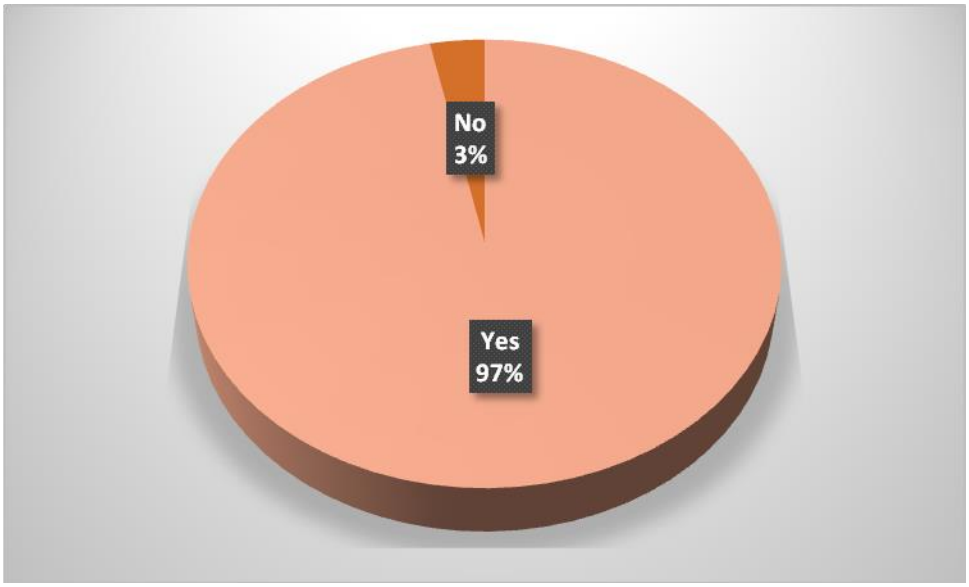

Figure 6: Livestock ownership by the respondents, N=123

4.3.4 Types of livestock owned by the respondents

The respondents reared different types of livestock including; camels, goats, rabbits, cattle, donkeys and sheep. Most respondents, 88.7% (n=123) owned cattle. Furthermore, a high percentage of respondents, 61.3% (n=123) owned goats. On the contrary, few respondents, 0.8% (n=123) owned rabbits while 4% (n=123) owned camels (Figure 4).Pastoralists are typically involved in herding livestock including; cattle; goats, sheep, camels, yaks, ilamas, buffalos, horses, donkeys and reindeers (FAO, 2021). In Uganda, the diversity of livestock species kept include; camels, donkeys, cattle, sheep, pigs, poultry and goats (Rugadya, 2006).They produce meat, milk, eggs, and non-food products such as; hides, fibre and wool (FAO, 2021).

Cattle fulfil multiple roles in agro-pastoralist communities, providing meat, milk and draught power while sales of stock generate income and provide insurance against disasters. They also play a key role in status and prestige such as; kinship and marriage. For pastoralists, cattle represent the major household assets (Ducrotoy *et al*., 2016).Cattle together with sheep and goats are the most important sources of live animals and skins for export markets (Belete *et al*., 2011; Gessesse *et al*., 2021). Organic sheep and goat production based on grazing (Rahmann, 2002; Rahmann, 2014; Ansari-Renari, 2016) could be a valid alternative to animals kept in intensive/pastorals systems (Ansari-Renari, 2016). Nomads play an important role in sheep and goat production (FAO, 2014).Growing demand for organic sheep and goat products will continue

to be the main driver of nomadic livestock systems for domestic and export markets (Ansari-Renari, 2016).

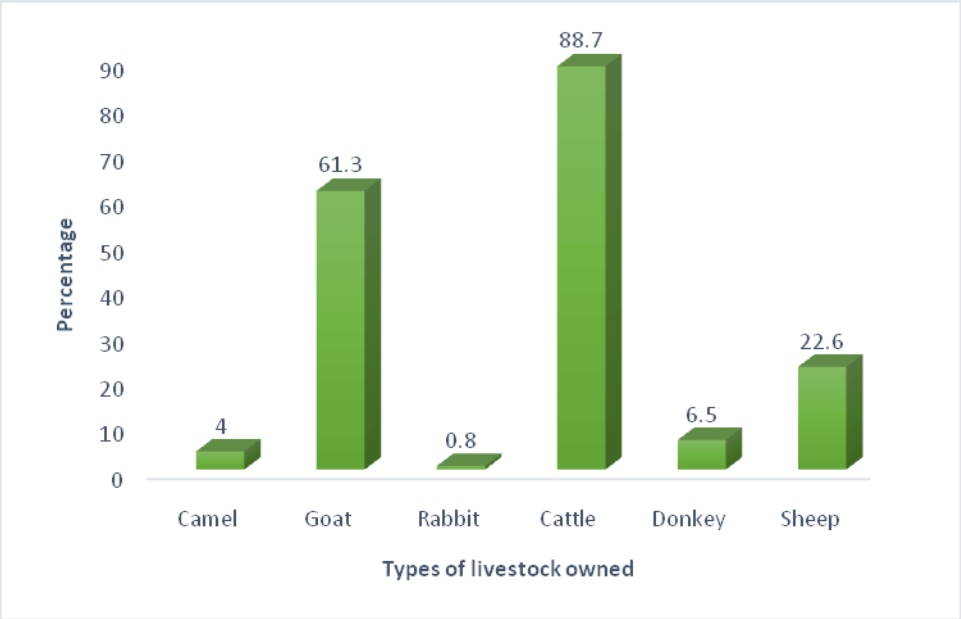

Figure 7: Types of livestock owned by the respondents, N=123

4.3.4 Age at which calves are mixed with adult animals

A high number of respondents, 30.08% (n=123) affirmed that they mix their calves with the adult animals between 12-24 months. A relatively high number of respondents, 10.57% (n=123) also affirmed that they mix calves with adult animals between 8-12 months. On the contrary, the highest number of respondents, 55.28% (n=123) did not have the knowledge when calves are mixed with adults (Table 4).The first important social partner for the calf is his or her mother. In the first 2 weeks of life, dairy calves housed indoors increase in their social behavior towards their mothers, a shift that may indicate that calves become the initiator of contact (Jensen, 2011; Whalin *et al*., 2021).

During the milk feeding period, the calf relies on social cues from the dam and other conspecifics that influence behavioral development (Hotzel *et al*., 2014).When reared extensively with maternal contact, a calf's activity may be directed by his or her mother. For example, when housed with daytime pasture access, 4 week older zebu calves had similar walking durations as their mothers (both cows and calves spend approximately 2hours per day walking during the calf's first 6 months of age) (Hutchinson *et al*., 1962; Whalin *et al*.,

2021).Social cohesion between calf and mother may be initially driven by the calf's need for milk, but there may also be calf factors. A calf mimics his or her mother's daily activities (Dwyer, 1961; Hutchinson *et al*., 1962; Whalin *et al*., 2021). For example, reindeer calves grazed close to their mothers learn which plants to consume (Espmark, 1971; Whalin *et al*., 2021).

Calves in close contact with the mothers are also afforded protection (Dwyer, 1961; Whalin *et al*., 2021).Allo-grooming appears to maintain the bond between the cow and calf (Johnson *et al*., 2015). Cows are able to lick and groom areas that acalf is unable to reach such as; the head, ears and neck (Reinhardt *et al*., 1978; Vitale *et al*., 1986; Whalin *et al*., 2021), which may improve the coat hygiene of calves (Whalin *et al*., 2021). Calves also interact with other adults in the herd when provided the opportunity (Tulloch, 1976; Whalin *et al*., 2021).

Under natural or semi-natural conditions, grazing ruminants select their diets from a wide variety of plants differing in nutritional composition and availability (Provenza and Balph, 1987; Baumont, 2000; Costa *et al*., 2016). Calves that are reared with their dam and other conspecifics start grazing and ruminating at approximately 3 weeks of age and graze regularly with the herd at 3 to 6 months of age (Reinhardt and Reinhardt, 1981; Vitale *et al*., 1986; Costa *et al*., 2016). The social interactions of young angulates are associated with learning to recognize suitable diet and habitat, where selection happens through mimicking or imitation of social companions (Key and MacIver, 1980; Mirza and Provenza, 1994; Costa *et al*., 2016).

Table 4: Age at which the calves are mixed with adult animals, N=123

Age (months)	Percentage
Less than 6 months	0.81
6-8	3.25
8-12	10.57
12-24	30.08
Don't know	55.28
Total	100

4.3.5 Management practices of calves in both wet and dry seasons

Generally, different management practices were employed both during the dry and wet season for calf management (Table 5). In the wet season, most pastoralists tethered their animals, 23.4% (n=123)at their homes while during the dry season, most pastoralists, 19.4% (n=123) preferred to graze the calves separately from the adult animals (Table 5).Most dairy production systems remove newborn calves from their mothers within 12-24 hours of birth (Hotzel *et al*., 2014).Newborn calves and replacement heifers are often housed separately from lactating cows (Dinsmore, 2021).Social isolation during infancy has been associated with negative effects including abnormal behavior and developmental problems in a range of species (Costa *et al*., 2016). The detrimental effects of maternal separation and social isolation during infancy have been studied in a range of social species (Troller-Renfree *et al*., 2015). Negative effects of social deprivation in early life have been shown in adulthood, which include; impaired maternal care (Lovic *et al*., 2011; Costa *et al*., 2016), increased aggression (Toth *et al*., 2011; Costa *et al*., 2016) and impaired social recognition (Lukas *et al*., 2011; Costa *et al*., 2016).

Tethering means tying an animal with a rope, line or chain to a stationary object (Wisch, 2021). Tethering is one method of cattle management that has been widely adopted since it offers so many management benefits; ease of management and prevention of antagonistic behavior and feed competition among calves (Nakayama and Ninomiya, 2017). Tethering also reduces exposure of animals to predators, toxic plants and extreme weather conditions (Schutz *et al*., 2010; Mandel *et al*., 2016). This practice also enables the provision of a nutritionally balanced diet throughout the year (Algers *et al*., 2009; Mandel *et al*., 2016). Keeping the animals in an environment that meets their proximal needs (‘here and now’, Dawkins, 1983 such as; feeding, drinking and sleeping) allows them to engage in low resilience behaviors (also referred to as ‘luxury activities’); that is; behaviors that typically decrease when energy resources are limited or when the cost involved in the activity increases; (McFarland, 1999; Mandel *et al*., 2016), which are associated with improved welfare and long term fitness (Held and Spinka, 2011).

Table 5: Care of calves during movement in the wet and dry seasons respectively, N=123

Management practice	Wet season (%)	Dry season (%)
Zero grazing calves	13.7	4.80
Tethering calves around home	23.4	6.50
Mixing calves with adult herds	16.9	16.9
Grazing calves separately	22.6	19.4
Resting calves	4.80	8.10
Weaning calves	0.80	16.9
Leaving lactating cows and calves at home	22.6	6.50

4.3.6 Management risks associated with caring for calves during movements to the grazing areas

There were many management risks associated with caring for calves during movement to the grazing areas (Figure 5). The management risks included; starvation, diseases, parasites, predators and fatigue. The most encountered challenge by pastoralists was calf starvation, 85.5% (n=123) and calf disease/parasites, 78.20% (n=123) (Figure 5). Droughts have increased severity and frequency over the years leading to chronic food insecurity and widespread economic hardships in the Karamoja region. This has led to the drying of crops and grasses for animals that form the basis for the community's livelihood (Musinguzi, 2013).

Karamoja continues to have the highest food insecurity and malnutrition levels in Uganda due to factors related to inadequate food, poor dietary diversity, structural poverty, limited livelihood options, poor hygiene, sanitation and diseases. The region also faces a predisposition to recurrent climate related shocks such as; long mid-season dry spells/drought, erratic rainfall that often causes floods/water logging. There is pronounced vulnerability to other shocks such as; food price increase, declines in livestock or crop production and market disruptions (IPC, 2021).

There are so many causes of calf mortality and they can be classified as maternal factors (body condition score at pregnancy diagnosis, cow age, mustered around calving, bottle teats and udder abnormalities), heat stress, phosphorus deficiency, diseases, mis-mothering, calf factors (calf birth weight), viruses (corona and rota viruses, navel ill and septicemia and respiratory diseases), clostridial diseases, vitamin A deficiency, genetic defects and ticks (Tautenhahn *et al*., 2020).Multifactorial diseases such as; neonatal calf diarrhea and bovine respiratory disease form

the main threats to calf health and welfare (Reinhardt *et al*., 2009; Hoedemaker, 2018; Urie *et al*., 2018). The latter diseases arise as a result of interactions between husbandry conditions, host factors and pathogens (Mayr, 2002; Tautenhahn *et al*., 2020).

Diarrhea and respiratory diseases, the two most common health problems when raising calves are typically caused by multiple factors with climate and housing system playing an important role in the etiology (Roy, 1980; Garden and Plummer, 2010; Walker *et al*., 2012). The incidence of respiratory diseases tends to be higher in calves reared in mechanically ventilated barns than in calves housed with natural ventilation or in outdoor enclosures (Okamoto *et al*., 1993; Wojcik *et al*., 2012; Roland *et al*., 2016).

Calf morbidity is due to calf diarrhea, pneumonia, septicemia, dehydration and navel illness (Mohammed *et al*., 2020). Calves diseases include; joint problems, umbilical diseases, trauma, congenital abnormalities, nutritional deficiencies, dystocia and other infections (Svensson *et al*., 2003; Singla *et al*., 2013; Hadgu *et al*., 2021) associated with poor housing, hygiene and nutrition (Lema *et al*., 2001; Hadgu *et al*., 2021), bovine viral diarrhea in pastoral, peri-urban and mixed areas (Yitagesu *et al*., 2021).

Growth rates reflect appropriate nutrition and proper feeding strategies of calves on the one hand, but on the other hand, growth rates can be hampered when calves are sick or stressed (Donovan *et al*., 1998; Roland *et al*., 2016; Shivley *et al*., 2018). Furthermore, poor nutrition can cause immune suppression, which can result in disease or even death (Nonnecke *et al*., 2003; Fox *et al*., 2005; Tautenhahn *et al*., 2020). Due to heavy dependence on livestock rearing for agricultural production, livestock predation by wild predators could form a significant economic setback for rural communities (Sangay and Vernes, 2014; Rajaratnam *et al*., 2015; Tshering and Thinley, 2017).

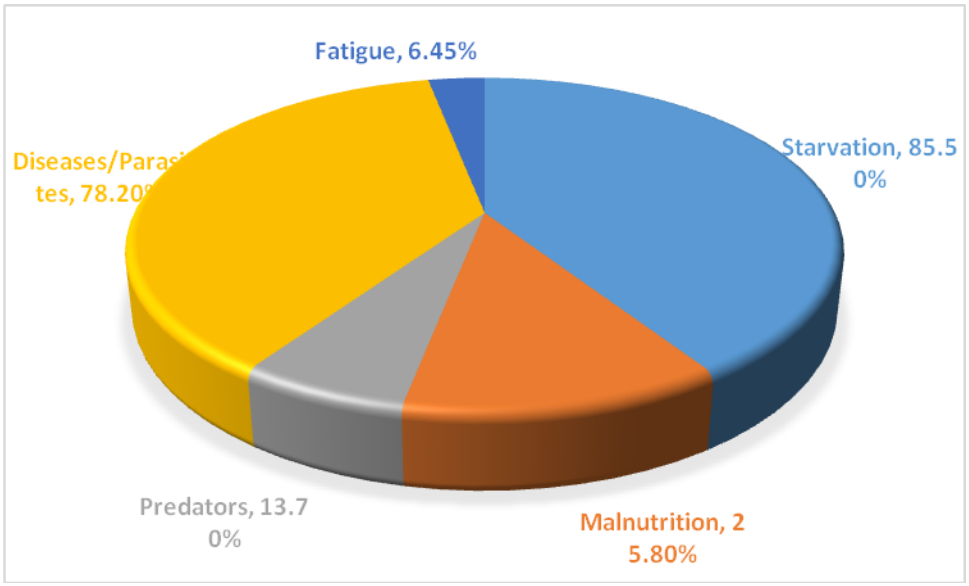

Figure 8: Management risks associated with caring of calves, N=123

4.4 Assessment of the influence of grazing time on age at first calving in heifers

4.4.1 Age at first calving

Most of the respondents, 86.99% (n=123) were not aware about the age at first calving of their heifers (Table 6). However, of the respondents who were aware about the age at first calving, most of them, 8.94% (n=123) confirmed that it was at 3.5 years for their heifers (Table 6).Age at first service is the age at which heifers attain body condition and sexual maturity for accepting service for the first time (Tesfa *et al*., 2016; Tadesse and Tegegne, 2018).Many studies suggest that the optimal age at first calving is ≤24 months (Mourits *et al*., 1999; Stevenson, 2008; Krpalkova *et al*., 2014).The average age at first calving for local heifers is 42-48 months (Bimerew, 2008; Tadesse and Tegegne, 2018). The desirable age at first calving in local breeds is three years, even if the recommended heifers calve between 23-25 months of age which is considered optimum that increases profitability of the dairy business (Mekuria, 2016).

First calving marks the beginning of a cow's productive life and influences both productive and reproductive life of the female, directly through its effect on her lifetime, calf crop and milk production and indirectly through its influence on the cost invested for up-bringing (Bimerew, 2008; Tadesse and Tegegne, 2018).A primary determinant of pregnancy success in the first breeding season of a heifer is the time at which puberty occurs relative to the start of her first

breeding season. Subsequently, this affects her ability to rebreed in subsequent years and remain in the herd as well as her lifetime productivity (Davey, 2013). The age at which a heifer calves for the first time is key indicator of the quality of youngstock management (MacDonald, 2005; Bond, 2015; Steele, 2021).

Reproductive performance is the most essential trait in livestock enterprise, if there is no calf, there is no economic return. Best cows in the herd are those with low age at first calving. These are therefore the most important measures of reproductive performance in the females (Swiger *et al*., 1961; Bergland, 2008; Alphonsus *et al*., 2015).The age at first calving is the most important single variable for predicting differences in efficiency of production (Abanikannda and Olutogun, 2019).Heifers and cows should maintain body condition before calving, but over conditioning causes excess fat deposition in the pelvis and may result in dystocia. Good body condition aids in calving ease, early return to cycling in beef cows and also milk production. There is a balance to achieve between avoiding excessive conditions which leads to dystocia and insufficient condition which leads to post calving sub-estrus/anestrus (Statham, 2016).

Age at first calving, the period that a female calf needs to reach puberty and to reproduce for the first time is an important factor in the cost of rearing replacements in dairy herds (Tozer and Heinrichs, 2001; Boulton *et al*.,2015; Atashi *et al*., 2021). The length of period has a direct effect on the total cost of heifer rearing Heinrichs, 1993; Gabler *et al*., 2000; Boulton *et al*., 2017).In order to optimize dairy farm profitability, it is therefore advisable to aim for early calving (Hultgren *et al*., 2011; Froidmont *et al*., 2013) while ensuring that the animals are sufficiently developed (Froidmont *et al*., 2013). In order to reduce rearing costs, heifers can calve at between 22 and 24 months of age without negative effects on milk yield and animal health during their lifetime (Hoffman, 1997; Nilforooshan and Edriss, 2004; Froidmont *et al*., 2013), even where later calving is sometimes proposed for specific breeds or management systems (Le Cozler *et al*., 2009; Froidmont *et al*., 2013).

Age at first calving is affected by different factors such as; breed, nutritional status and management differences of cows (Mekuria, 2016). In general, earlier calving increases lifetime productivity of the cow (Tadesse and Tegegne, 2018).The critical nature of this physiological endpoint is influenced by factors related to management of the annual cycle of beef production as well as the physiology and genetics of the female (Davey, 2013). Calf health management and

nutrition can affect production and age at first calving in a herd (Britney *et al*., 1984; Warmick *et al*., 1995; Heinrichs and Heinrichs, 2010).

Table 6: Age at first calving, N=123

Age (years)	Percentage
2.5	0.00
3.0	4.06
3.5	8.94
Don't know	86.99
Total	100

4.4.2 Effect of grazing hours on age at first calving of heifers during the wet season

Generally, there was no significant association (P>0.05) between grazing hours and age at first calving. Most respondents,100% (n=123) affirmed that the heifers which were grazed for more than four hours and for atleast five hours during the wet season conceived normally relative to those grazed for similar durations during the dry season (Table 7).Reproductive performance and milk production are important factors that affect the profitability of a dairy farm (De Vries, 2006a; Galvao *et al*., 2013; Gobikrushanth *et al*., 2014). Reproductive success in a dairy farm is typically measured by reproductive indices such as; days open, calving interval, service rate, pregnancies per artificial insemination and pregnancy rate (Van Ambingh *et al*., 1997; Tenhagen *et al*., 2003; Gobikrushanth *et al*., 2014).

In cattle, a successful hormonal control of estrus requires healthy females of adequate age, weight and nutrition status (Romano, 2021).The environment of dairy cattle can have considerable influence on health and productivity (Dinsmore, 2021).Environmental factors such as; temperature and light exert dramatic effects on the production, health and well-being of animals (Tao and Dahl, 2013). Heifer reproductive success in the first calving season is highly linked with lifetime reproductive efficiency (Cushman *et al*., 2013; Sarah and Biase, 2020). Heifers calving within the first 21 days of their first calving season remain in the productive herd longer and wean more total pounds of calves than their later calving counterparts (Cushman *et al*., 2013; Sarah and Biase, 2020).

Table 7: Percentage of the effect of grazing hours on age at first calving of heifers during the wet season, N= 123

Variables	Confirmation of age at first calving		Overall χ^2 value; ρ value	
	Yes	No		
Less than 4 hours	100	0.0		
5 hours	100	0.0		
6 hours	78.6	21.4	$\chi^2 = 3.842$	$\rho = 0.428$
More than 6 hours	84.6	15.4		
Don't know	92.9	7.1		

4.4.3 Effect of grazing hours on age at first calving of heifers during the dry season

Generally, there was no significant association (P>0.05) between grazing hours and age at first calving during the dry season. Most respondents, 100% (n=123) affirmed that grazing livestock for more than six hours during the dry season delayed the age at first calving of the replacement heifers (Table 8). In cattle, female reproductive failure is assumed when animals do not become pregnant within the breeding season or do not maintain pregnancy to calving (Lamb, 2013; Sarah and Biase, 2020).Late breeding heifers contribute to a less efficient cow-calf production system due to reduced days postpartum to resume estrus cycling, reduced pregnancy rates in the subsequent calving season and reductions in calf age and weaning weight (Cushman *et al*., 2013; Damiran *et al*., 2018). The cost of development and reduced lifetime potential profitability, however, lead to a negative economic impact for cattle producers (Hughes, 2013; Sarah and Biase, 2020).

Major related causes of reproductive failure include; improper health, reproductive and nutritional management or reproductive disorders and genetics (Houghton *et al*., 1990; Bolormaa *et al*., 2015). Environmental and management factors such as; season, oestrus detection and artificial insemination influence conception rates in heifers (Badinga., 1985; Rensis and Scaramuzzi, 2003; Madeleina *et al*., 2019). The performance, health and wellbeing of livestock are strongly affected by climate. Reproductive functions of livestock are particularly vulnerable to climate change; it has been established that large ruminants are more prone to heat stress compared to small ruminants (Singh *et al*., 2011; Krishnan *et al*., 2017).High ambient temperatures, high direct and indirect solar radiation and humidity are environmental stressing

factors that impose strain on animals. Among the environmental variables affecting livestock, heat stress seems to be one of the most intriguing factors hampering animal production in many regions in the world. Thermal stress effects on livestock are of multifactorial nature. (Singh *et al*., 2011; Krishnan *et al*., 2017).

Heat stress affects the fertility and reproductive livestock performance by compromising the physiology of the reproductive tract through hormonal imbalance, decreased oocyte quality and poor semen quality and decreased embryo development and survival. Oocytes exposed to thermal stress lose their competence for fertilization and development into the blastocyst stage, which results in decreased fertility. In general, the percentage of conception rate was found to be reduced by 4.6% for each unit increase in temperature humidity index (Krishnan *et al*., 2017).Most studies indicate that heat stress depresses luteinizing hormone secretion and compromises its function. For instance, follicle tissues obtained from heat stressed cows under gonadotropin stimulation were shown to secrete lower levels of steroids during hot seasons (Bridges *et al*., 2005; Wolfenson and Roth, 2019).

Reduced luteinizing hormone surge and/or alteration in the sensitivity of follicular cells to luteinizing hormone might, in turn impair the cascade of events leading to ovulation and formation of functional *corpus luteum*. Moreover, reduced estradiol concentrations under heat stress in cows close to ovulation may disrupt pre-ovulatory luteinizing hormone surge (Wolfenson *et al*., 1995; Wolfenson and Roth, 2019). Low luteinizing hormone surge may cause the development of suboptimal *corpus luteum* secreting low levels of progesterone. Together, altered gonadotropin secretion can depress cow fertility during the hot season (Kaim *et al*., 2003; Wolfenson and Roth, 2019).

Table 8: Percentage of the effect of grazing hours on age at first calving of heifers during the dry season, N=123

Variables	Confirmation of age at first calving		Overall χ^2 value; ρ value	
	Yes	No		
Less than 4 hours	81.8	18.2		
5 hours	75.0	25.0		
6 hours	83.3	16.7	$\chi^2 = 6.065$	$\rho = 0.194$
More than 6 hours	100	0.0		

Don’t know	94.4	5.6

4.4.4 Normal age at first calving vs Delayed age at first calving

Generally, most respondents were not aware about normal and delayed age at first calving (Figure 6). For the respondents who were aware, most of them, 13% (n=123) confirmed that most heifers have normal age at first calving during the wet season. However, many respondents, 14.63% (n=123) also confirmed that age at first calving is delayed during the dry season (Figure 6).The age at first calving can be affected by many factors including; nutrition quality and availability, disease risk (including parasitism), breed and insemination practices being only some of the influencing factors (MacDonald, 2005; Bond, 2015; Steele, 2021). Heifers that conceive earlier and give birth at a younger age are also more fertile in later stages and may have shorter calving intervals (Eastham *et al*., 2018).

Decreasing age at first calving is also associated with a shorter generation interval and subsequently higher genetic progress (Pirlo *et al*., 2000; Atashi *et al*., 2021); however, calving too early may be associated with an increased risk of dystocia, reduction in milk yield components and reproductive performance (Hoffman, 1997; Eastham *et al*., 2018). In addition, it has been shown that heifers calving at older age usually have a lower lifetime productive and reproductive performance and survive shorter than those calving at younger ages (Nilforooshan and Edriss, 2004; Adamicyz *et al*., 2017; Atashi *et al*., 2021).

Productive and reproductive traits are crucial factors determining the profitability of cattle production (Lobago *et a*l., 2007; Tadesse and Tegegne, 2018). The most common reproductive performance is age at first service, age at first calving, days open, calving interval and number of services per conception (Wondatin, 2010; Mekuria, 2016). Reproductive performance is one of the most important concerns of the modern dairy industry worldwide. It is a characteristic of outstanding importance in dairy cattle business and often a major determinant of biological and economic efficiency of livestock production in the tropics. The reproductive performance of the breeding female is probably the single most important factor that is a pre-requisite for sustainable dairy production system and influencing their productivity (Chagas *et al*., 2007; Kumar *et al*., 2014; Tadesse and Tegegne, 2018).

Heat stress is the major cause for infertility and reproductive efficiency in livestock (Wofenson *et al*., 2000; Gendelman and Roth, 2012; Krishnan *et al*., 2017).Heat stress during summer disrupts several reproductive processes resulting in a pronounced depression of conception rate is dairy cows. The rise of body temperature during summer is responsible for the impaired reproduction (Wolfenson and Roth, 2019). Hotter seasons result in reduced conception rates (Badinga *et al*., 1985; Rensis and Scaramuzzi, 2003; Madeleina *et al*., 2019). Summer heat stress is a major cause of low fertility in cattle. Consequently, cows are unable to conceive (Wofenson *et al*., 2000; Gendelman and Roth, 2019).

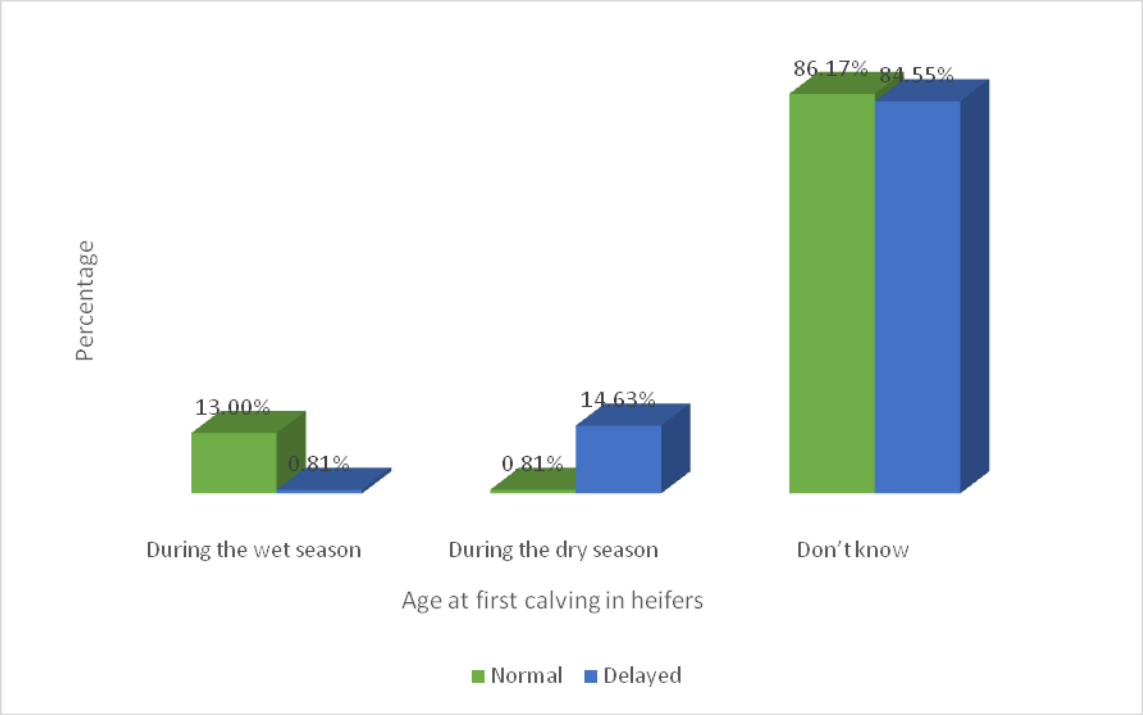

Figure 9: Normal age at first calving vs Delayed age at first calving, N=123

4.4.5 Causes of delayed age at first calving

The respondents cited many causes of delayed age at first calving which included; failure of bulls to mount, heifer malnutrition, poor management and diseases (Figure 7). Most respondents cited malnutrition 66.10% (n=123) and diseases 65.30% (n=123) as the lead causes of delayed

age at first calving (Figure 7).A substantial delay in the attainment of sexual maturity may lead to serious economic loss, due to additional, on-lactating, unproductive period of the cow over several months (Bimerew, 2008; Tadesse and Tegegne, 2018). Factors affecting reproductive performance are either associated to the management factors (methods of husbandry, feeding, estrus detection, semen handling and transition cow management) or to the cow factors (such as; age, body condition score, post-parturient problem, disease events, milk yield and genetics). The performance of animals depends not only on their genetic merits but also on other factors such as; nutrition, management, health and environment. Genetic factors are likely to explain only a small proportion of variation in fertility within a population of cows and suggest the strong influence of environmental factors such as; management decisions on the reproductive efficiency of cows (Mekonnen *et al*., 2010; Tadesse and Tegegne, 2018).

Nutrition has a major limiting impact on productive and reproductive performance in all animals. It also plays a major role in enhancing reproductive efficiency of cows. Energy and proteins are the major nutrients required in greatest amounts and should be in the topmost priority to optimize reproduction in cattle, but also, minerals and vitamins cannot be neglected and must be optimum in the diet (Bindari-Raj *et al*., 2013; Tadesse and Tegegne, 2018).Changes in feeding systems from year to year as well differences between years in the quantity and quality of forage availability have a significant effect in year of calving or birth on reproductive performance of cows (Tadesse and Tegegne, 2018).

Reducing feeding levels, however, can actually reduce cow weight gain, decrease milk production, increases the incidence of scours and most importantly decrease pregnancy rate (Stewart *et al*., 2017). Developing heifers on a low nutrient diet has clearly demonstrated an increase in dystocia. This primarily due to poor skeletal growth, and therefore, smaller pelvic areas (Deutscher, 1990; Stewart *et al*., 2017). Delaying the time of first calving until 3 years of age decreases but does not eliminate dystocia (Stewart *et al*., 2017).Many viral diseases are endemic in cattle populations worldwide. The ability of many viruses to cross the placenta and cause abortions and foetal malformations is well understood. Acute infection with non-cytopathic bovine viral diarrhea virus in mid-gestation increases abortion rates or causes the birth of persistently infected calves (Wathes *et al*., 2020).

The effect of age on first calving on reproductive performance of cows could be attributed to change in climatic conditions during different seasons (Bindari-Raj *et al*., 2013; Tadesse and Tegegne, 2018).Severe hyperthermia results from high metabolic heat production and low rate of evaporative heat loss. Multiple reproductive processes are impaired including; oocyte competence, embryonic growth, gonadotropin secretion, ovarian follicular growth steroidogenesis and uterine endometrial responses (Wolfenson and Roth, 2019). Heat stress reduces the libido, fertility and embryonic survival in livestock and favors the occurrence of diseases in neonates with reduced immunity (Wofenson *et al*., 2000; Gendelman and Roth, 2012; Krishnan *et al*., 2017).

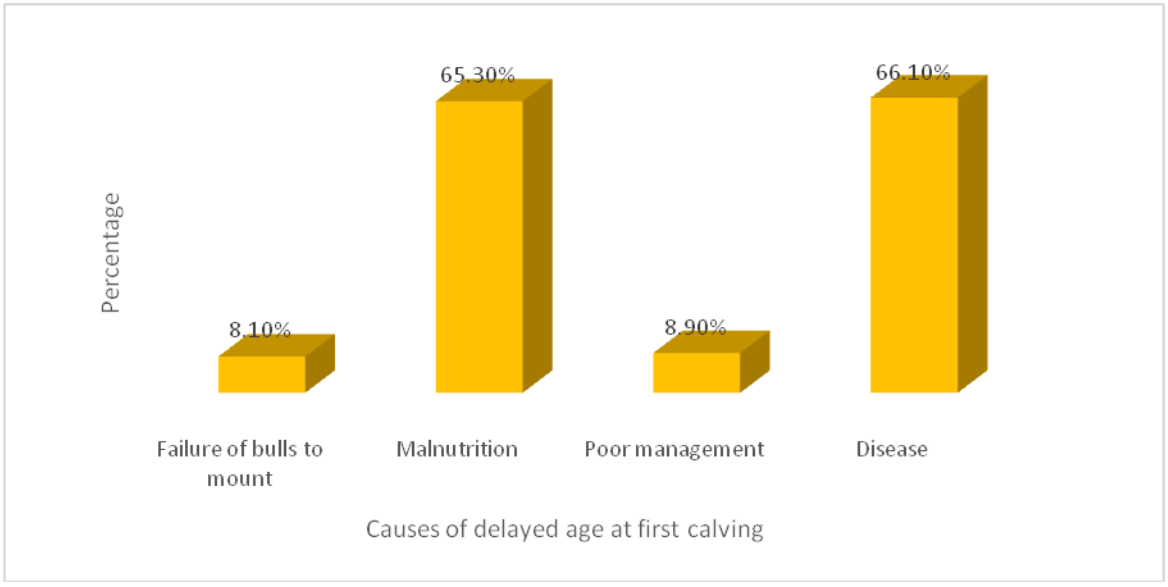

Figure 10: Causes of delayed age at first conception in heifers, N=123

4.4.6Heifer ownership

Many respondents, 82% (n=123) who were interviewed owned heifers. On the contrary, very few respondents, 18% (n=123) owned heifers (Figure 8). In pastoralist and agro-pastoralist areas, wealth and poverty are closely aligned to levels of livestock ownership and social inclusion (Catley and Ayele, 2021). The Karamoja region of Uganda comprising of the districts; Kaabong, Kotido, Abim, Moroto, Nakapiripirit, Amudat and Napak is part of the pastoral corridor; an area

inhabited by semi-nomadic cattle keeping groups. The livestock in the area consist of; cattle, goats, sheep, donkeys, camels, pigs, chicken and turkeys (Loupa, 2019). In general, literature on pastoralists' own perception of poverty, vulnerability, well-being and identity consistently highlights the importance of livestockownership, social connectedness and a position in society that enables the sharing or receipt of livestock (Haaland and Kedderman, 1984; Talle, 1999; Catley and Ayele, 2021); poverty is closely related to social exclusion, and livestock isthe main financial and social asset (Catley and Ayele, 2021).

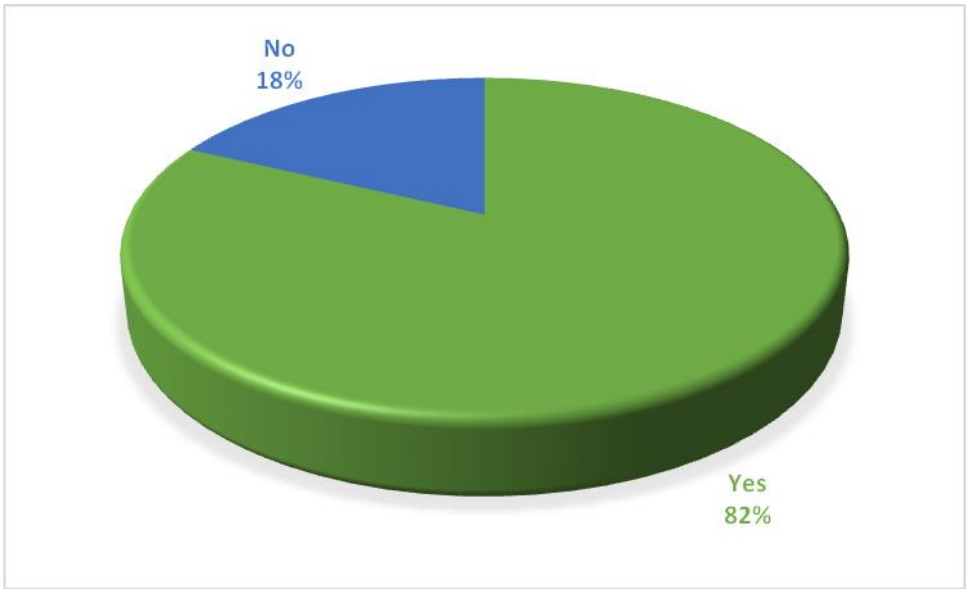

Figure 11: Respondents who owned heifers, N=123

4.4.7Care of heifers during movements to the grazing areas during the wet and dry seasons

The respondents mentioned different practices which were employed while caring for heifers during grazing in both the wet and dry seasons (Figure 9). These different practices included; supplementary feeding, mixing the heifers with the main herd and grazing heifers around the homes. Generally, most respondents, 76.6% (n=123) mixed their heifers with the main herd during the dry season compared to the wet season, 41.1% (n=123) (Figure, 9).Social learning especially through modelling or learning by observing another individual allows heifers to avoid dangerous mistakes (Das *et al*., 2000; Whalin *et al*., 2021).Herbivores that feed in large mixed-generation groups like cattle, are able to use social learning to transmit information about suitable food items from experienced to inexperienced foragers (Boyd and Richarson, 1996; Costa *et al*., 2016).

Food neophobia is well known in ruminants (Chapple and Lynch, 1986; Costa *et al*., 2016) and is defined as avoidance and reluctance to taste unfamiliar foods (Cooke *et al*., 2006; Costa *et al*., 2016). Food neophobia is known to decrease in the presence of companions in lambs (Nolte *et al*., 1990; Costa *et al*., 2016) and when dairy heifers are raised in complex social groups (Costa *et al*., 2014). Young ruminants naturally form social relationships starting with the dam and then with other individuals, even in the first weeks of life (Hotzel *et al*., 2014). In nature and in extensive beef systems, the young heifer lives in a complex social environment (Costa *et al*., 2016).Mixing heifers with the main herd has been shown to decrease aggression (Nilesen *et al*., 2009; Boyle *et al*., 2012).

Supplementary feeding is the additional supply of feed containing energy, proteins, vitamins and minerals to grazing livestock that may be lacking in the pasture. It is important to ensure that the whole diet of the animal; including supplements and pasture is balanced (Princess, 2018). Native pastures generally have adequate nitrogen levels during the growing season. During this time, phosphorus is the most limiting nutrient. As the grass matures and sets seeds, the nitrogen content of the pasture decreases. This can lead to protein and energy deficiencies which results in decreased animal production. Feeding urea during the dry season can increase digestion, resulting in improved animal performance (Butcher, 2017).Concentrates contain moderate to high concentrations of phosphorus. Protein supplements such as; cotton seed meal and soybean meal contain moderate concentrations, whereas many byproduct feeds such as; distiller's grains have high phosphorus concentrations (Stewart, 2017).Animals are fed crop residues, cut-and-carry roadside grasses and maize flour (Agyemang and Nkhanjera, 1990; Munthali *et al*., 1993; Watnabe *et al*., 2017).

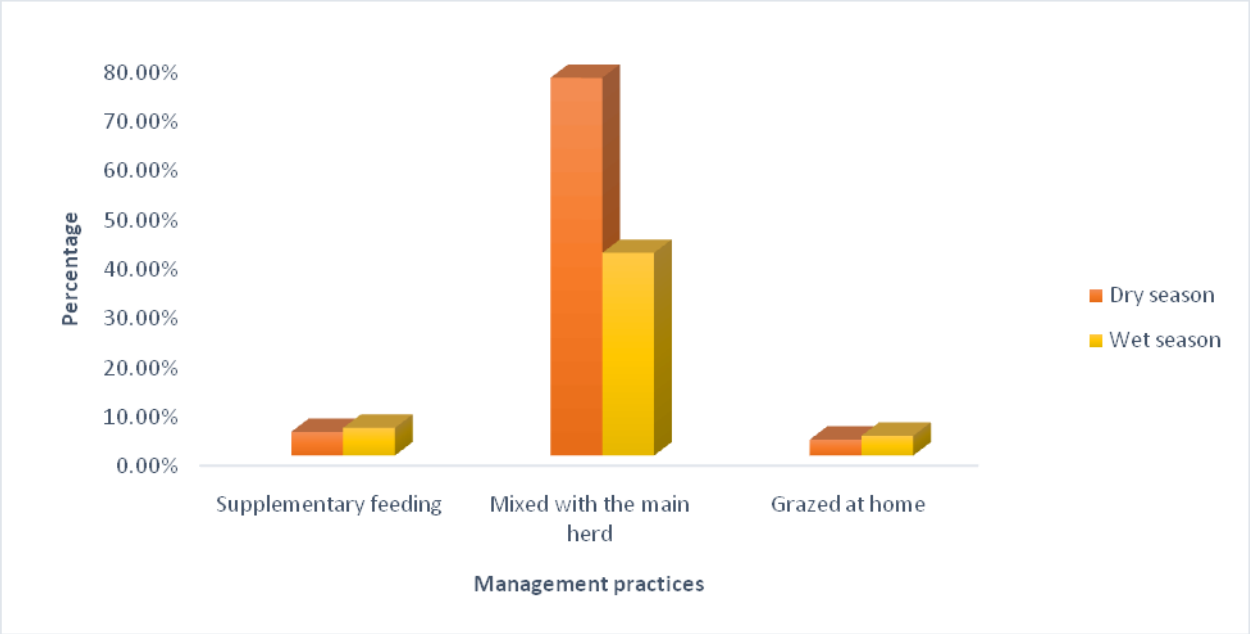

Figure 12: Care of heifers during movements to the grazing area during movements to the grazing areas during the wet and dry seasons, N=123

4.5 Evaluation of the effect of dry season grazing reserves on parasite infestation in cattle

4.5.1 Effect of dry grazing reserves on parasite infestation in cattle

There was a highly significant ($P<0.05$) association between the effect of dry season grazing reserves and parasite infestation in cattle (Table 9). The respondents had varying responses on the effect of dry season grazing reserves on parasite infestation. Most respondents, 100% (n=123) agreed that there was moderate, high and very high parasite infestation on the dry season grazing reserves (Table 9). Gastro-intestinal parasites have been documented in countries with tropical and temperate climatic conditions with a prevalence rate ranging from 20-96% (Gebeyehu *et al*., 2013; Sharma and Busang, 2014; Gunathilaka *et al*., 2018). Some studies have recorded concurrent helminthic and coccidial infections at a rate of 78% among the cattle (Faizal and Rajapakse, 2001; Gunathilaka *et al*., 2018).

Table 9: Percentage of effect of dry season grazing reserves on parasite infestation in cattle, N=123

Variables	Rate of parasite infestation		Overall χ^2 value; ρ value
	Yes	No	
Moderate	100	0.0	
High	100	0.0	$\chi^2 = 64.611$ $\rho = 0.000$
Very high	100	0.0	
Don't know	33.3	66.7	

4.5.2 The challenge of parasite infestation on dry season grazing reserves

Parasites were said to be a huge threat on the dry season grazing reserves. Most respondents, 91% (n=123) confirmed that parasite infestation was a very big challenge on the dry season grazing reserves (Figure 10). Parasitic infections are one of the major constraints to the production of ruminants in tropical and sub-tropical countries (Aunpromma and Papirom, 2006; Tharasuawan *et al*., 2021).Parasites commonly refer to helminth (endo-parasites) and arthropods (ecto-parasites) (Mayer and Donnelly, 2013). A parasite is an organism that lives in another organism called the host, and often harms its host. Without a host, a parasite cannot live, grow and multiply. For this reason, it rarely kills the host, but it can spread diseases and some of these can be fatal (Brazier and Biggers, 2018).

Parasites unlike predators are usually much smaller than their hosts and reproduce at a faster rate (Brazier and Biggers, 2018). Parasite transmission falls into three general categories; transmission of propagules, transmission by living vectors and transmission by intermediate hosts. Some parasites have direct life-cycles; these parasites produce propagules that colonise new hosts and produce yet more propagules. Other parasites use vectors- commonly hematophagous insects- to transmit infective stages to new hosts (Moore, 2010). There are two main types of parasites that cause diseases in cattle; internal parasites that live inside animals and external parasites that live on the outside of the animal (Zoetis, 2018).

Internal parasites such as; roundworms and coccidian live inside the gastro-intestinal tract whereas external parasites such as; lice and flies live on or around the animal (Gilleard,

2019).Some parasites can affect different host species (Ramos *et al*., 2016). The effects of both internal and external parasites can add up to a significant impact on cattle health, welfare and productivity (Zoetis, 2018). Parasites can cause malnutrition and reproductive disorders for their hosts (Seva *et al*., 2018). Endo-parasites such as; worms and protozoans have great impacts on public, animal health and wildlife conservation around the world mainly in developing countries (Ramos *et al*., 2016).

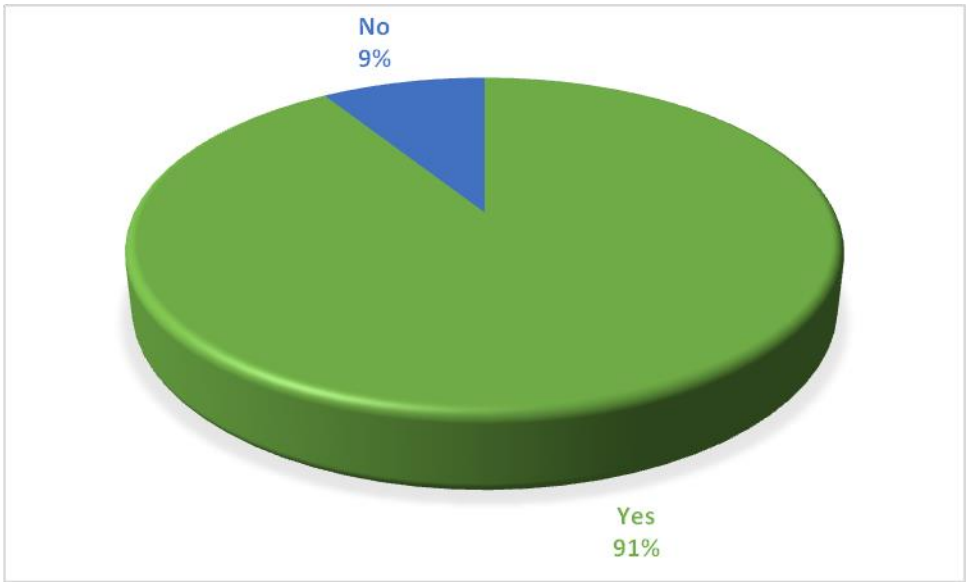

Figure 13: The challenge of parasite infestation on the dry season grazing reserves, N=123

4.5.3 Rating of parasite infestation on the dry season grazing reserves

There were varying scores given by respondents on parasite infestation in the dry season grazing reserves. Most respondents, 57% (n=123) asserted that there was moderate parasite infestation on the dry season grazing reserves (Figure 11).The grazing areas are always exposed to parasites and thus are constantly being re-infected in chain reactions mode (Kumar *et al*., 2012). Various risk factors play an important role in the onset of gastro-intestinal infections due to the host and the environment (Ratanapob *et al*., 2012; Zvinorova *et al*., 2016).

Environmental factors include; agro-ecological conditions, animal husbandry practices such as; housing system, deworming interval and pasture management (Ratanapob *et al*., 2012; Zvinorova *et al*., 2016); these largely determine the type, incidence and severity of various parasitic diseases (Bardan *et al*., 2012; Zvinorova *et al*., 2016). Other risk factors such as; the

host species, sex of the animal, age, body condition and breed/genotype (Badaso and Addis, 2015), parasite species and intensity of the worm population, have an effect on the development of gastro-intestinal parasitic infections (Tariq *et al*., 2010; Zvinorova *et al*., 2016).

Normally, gastro-intestinal parasitism in ruminants is present throughout the year, with a higher prevalence rate during the rainy season. Climatic conditions such as; temperature and humidity are primary factors related to the growth, development and survival of various parasites including; eggs, larvae, cysts and oocysts or their intermediate hosts (Jittapalapong *et al*., 2011; Tharasuwan *et al*., 2021). The prevalence of parasites is increasingly attributed to environmental changes, emerging anthelmintic resistance and herd management practices that favor parasite development (Martinez *et al*., 2015; Namutosi *et al*., 2015). The emerging climate change characterized by alternating rainfall patterns, floods and prolonged droughts resulting from global warming have contributed to spatial and temporal distribution and abundance of pests and diseases that impact on animal health (Martinez *et al*., 2015; Namutosi *et al*., 2019).

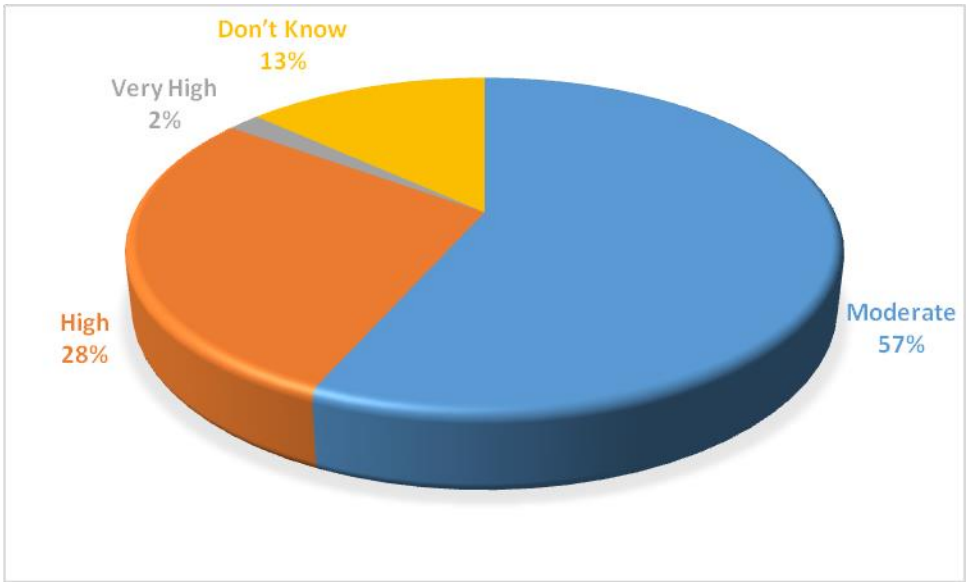

Figure 14: Rating of parasite infestation on the dry season grazing reserves, N= 123

4.5.4 Endo-parasites on the dry season grazing reserves

Endo-parasites were cited as a challenge on the dry season grazing reserves. The endo-parasites which were listed included; liverflukes and round worms. Liverflukes were cited as the most prevalent endo-parasites, 48.40% (n=123) on the dry season grazing reserves (Figure 12). Endo-parasites live inside the host (Brazier and Biggers, 2018). Endo-parasites of cattle include a large group of worms/helminthes such as; trematodes (flukes), cestodes (tapeworms) and nematodes (roundworms) and protozoal species (for example; *Cryptosporidium parvum*, *Eimeria species*, *Neospora caminum* and *Trichomonas species* (Elsheikha, 2017).

Endo-parasite hosts are both habitat and nutritional resources. Because the host is also ephemeral, transmission between hosts is essential for parasite survival and reproduction (Moore, 2010). Endo-parasites are transmitted by the fecal-oral route, typically via contaminated food or water (Mayer and Donnelly, 2013). Endo-parasites rely on a third organism known as a vector or carrier. The vector transmits the endo-parasite to the host. Epi-parasites feed on other parasites in a relationship known as hyper-parasitism. A flea lives on a dog; but the flea may have a protozoan in its digestive tract. The protozoa are the hyper-parasites (Brazier and Biggers, 2018).

Parasitic diseases caused by intestinal parasites constitute a major impediment to livestock production (Hoste *et al*., 2006; Gunathilaka *et al*., 2018). All ages of cattle are affected by a diverse set of intestinal parasites. These infections are rarely associated with high mortality of cattle. However, their effects are usually characterized by lower outputs of animal products, by products, manure and traction, thereby affecting the contribution of cattle in ensuring food security especially in developing countries (Hoste *et al*., 2006; Rajakaruna *et al*., 2011; Gunathilaka *et al*., 2018).The effects of internal parasites on cattle will vary with the severity of infection as well as age and stress level of the animal (Gadberry *et al*., 2019).

In general, younger animals under stress are most likely to shown signs of parasitism. Mature cows acquire a degree of immunity to parasites that reside in the lower gastro-intestinal tract. In addition, parasite burdens are most detrimental in mature cows near parturition because immunity is suppressed (Gadberry *et al*., 2019). There are many types of parasites, andsymptoms can vary widely. Sometimes these may resemble the symptoms of other conditions such as; hormone deficiency, pneumonia or food poisoning. Symptoms that might occur include; skin

bumps or rashes, weight loss, increased appetite, abdominal pain, diarrhea, vomiting, sleeping problems, anemia, aches and pains, allergies, weakness etc (Brazier and Biggers, 2018).

Liverflukes (*Fasciola hepatica*) are large flat worms that can invade the liver of cattle (Larson, 2021). Liverflukes (trematodes, flatworms) can be sub-divided into several species such as; *Dicrocoelium spp*., *Eurytrema pancreaticum*, *Fasciola gigantica*, *Fascioloides magna*, *Paramphotomun spp*. and *Schistoma spp*. (Junquera, 2021).The life-cycle of these trematodes involves mollusc as an intermediate host (Soulsby, 1982; Shingyu *et al*., 2019) and the tropical environment in association with the relative abundance of a snail intermediate host that propagates the sproocyst, redia and cercarial stages of the parasites (Peter, 1997; Shingyu *et al*., 2019). Cattle usually get infected after ingesting the meta-cereamial stage while grazing or in drinking water for *Fasciola* and following ingestion of infected and for *Dicrocoelium* (Soulsby, 1982; Shingyu *et al*., 2019).

Liver flukes (*Fasciola hepatica*) are widespread parasites of ruminants which can have significant economic impact on cattle production (Bryne *et al.*, 2016). Liverflukes cause economic loss through liver condemnation at slaughter as well as decreased growth and reproductive efficiency (Larson, 2021).*Fasciola*, *Fascioloides* and *Dicrocoelium* cause liver fluke diseases in ruminants and are zoonotic and economically importance (Shingyu *et al*., 2019). Liver fluke infections of cattle are caused by digenean trematodes of the genera *Fasciola* and *Dicrocoelium* widely referred to as common liver fluke and lancet fluke of ruminants respectively (Radistita *et al*., 2000; Shingyu *et al*., 2019).

Diseases caused by two genera are *fasciolosis* and *dicrocoeliosis* with etiologic agents in tropical Africa as *Fasciola gigantica* and *Dicrocoelium hospes* respectively (Radistita *et al*., 2000; Shingyu *et al*., 2019).The disease usually results in decreased production of meat, milk and wool, secondary bacterial infections, fertility problems, loss of weight, poor carcass quality (Alcairo, 1990; Ozang *et al*., 2011; Shingyu *et al*., 2019). In addition to their veterinary importance, these flukes are also known to be zoonotic affecting a number of human population (Esteban *et al*., 2003; Mas-loma *et al*., 2005; Shingyu *et al*., 2019).

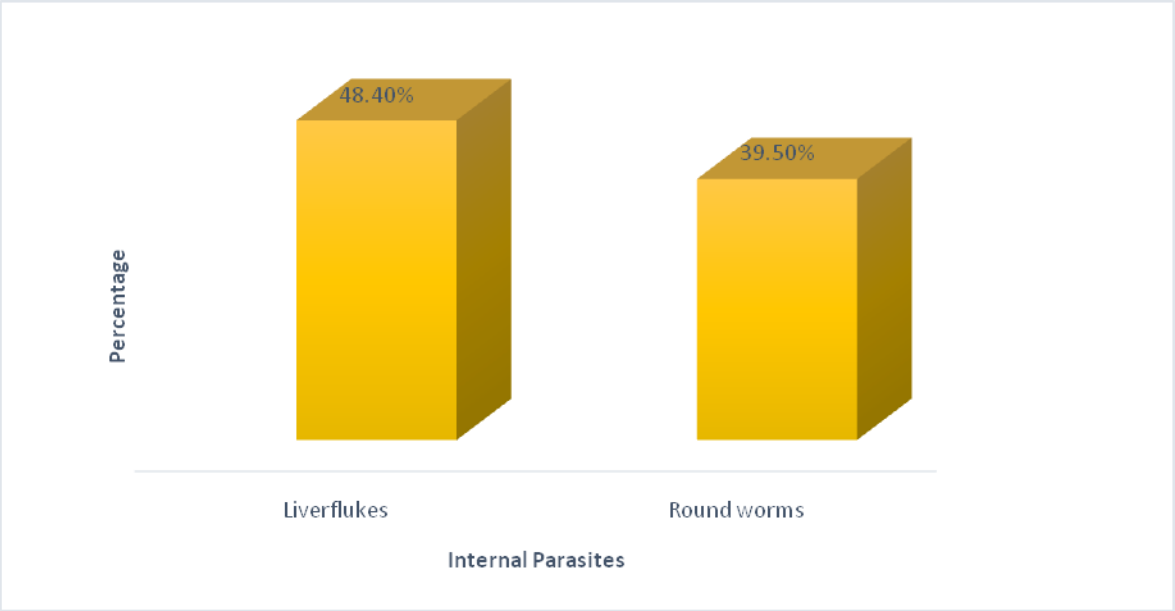

Figure 15: Internal parasites on the dry season grazing reserves, N= 123

4.5.5 Ecto-parasites on the dry season grazing reserves

Ecto-parasites were also mentioned as a major challenge on the dry season grazing reserves. The different types of ecto-parasites listed included; ticks, lice, biting flies and mites. The most prevalent ecto-parasites according to respondents were ticks, 83.10% and biting flies, 61.30% (n=123) (Figure 13).Arthropods mainly insects, mites and ticks, represent the most economically important group of cattle ecto-parasites (Wall and Shearer, 2001; Adalberto *et al*., 2020). Multiple species of arthropod ecto-parasites are also vectors of pathogens causing bovine diseases some of which are zoonotic (Garros *et al*., 2018). Moreover, several diseases caused directly by ecto-parasites or the pathogens they transmit to cattle are listed as notifiable by the World Organization for animal health (World Animal Health Organization, 2019).

Common cattle ecto-parasites include; ecto-parasitic flies (Mullen and Darden, 2019) such as; horn and buffalo flies (Schreiber *et al*., 1987; Adalberto *et al*., 2020), stable flies (Campbell and Berry, 1989; Adalberto *et al*., 2020), face flies (Fowler *et al*., 2015), mosquitoes in the family *culicidae* (Steelman *et al*., 1972; Adalberto *et al*., 2020), black flies (Adler *et al*., 2016), tabanids (Baldacchino *et al*., 2014), biting midges (Harrup *et al*., 2016), sand flies (Faiman *et al*., 2011; Adalberto *et al*., 2020), tsetseflies, myiasis causing flies (Hennessey *et al*., 2019).These flies

persistently suck blood from animals, irritate animals, aremechanical vectors of bacteria which cause diseases thereby causing losses (Adalberto *et al*., 2020).

Ticks are obligate hematophagous arthropod ecto-parasites distributed worldwide (de la Funete and Centreras, 2015); and belong to two economically important families; *ixodidae* (hard bodied ticks) and *argasidae* (soft bodied ticks). Ticks affect 80% of the world's cattle population and are associated with numerous health and economic effects (Hurtado and Giraldo-Rios, 2019). Depending on the number of hosts required to complete their life-cycle from larvae to adults, the *Ixodidae* can be one-, two- or three- host ticks (Minjauw and Mcleod, 2003; Kasaija and la Fuente, 2021).

Ticks are leading vectors of economically important pathogens and are widespread in Uganda due to suitable climatic conditions (Kasaija and la Funete, 2021).Ticks are well adapted for long periods of starvation, maintaining their water balance by absorbing atmospheric moisture (Jongejan and Uilenberg, 1994; Kasaija and la Fuente, 2021).Besides the physical injury inflicted on the animal host, ticks transmit a number of pathogens that can cause morbidity and mortality if left untreated. East Coast Fever caused by a protozoan haemo-parasite, *Theileria parva*, is the most prevalent and economically important tick borne disease. Other prevalent tick borne diseases include; anaplasmosis, babesiosis and heartwater (Kasaija and la Funete, 2021).

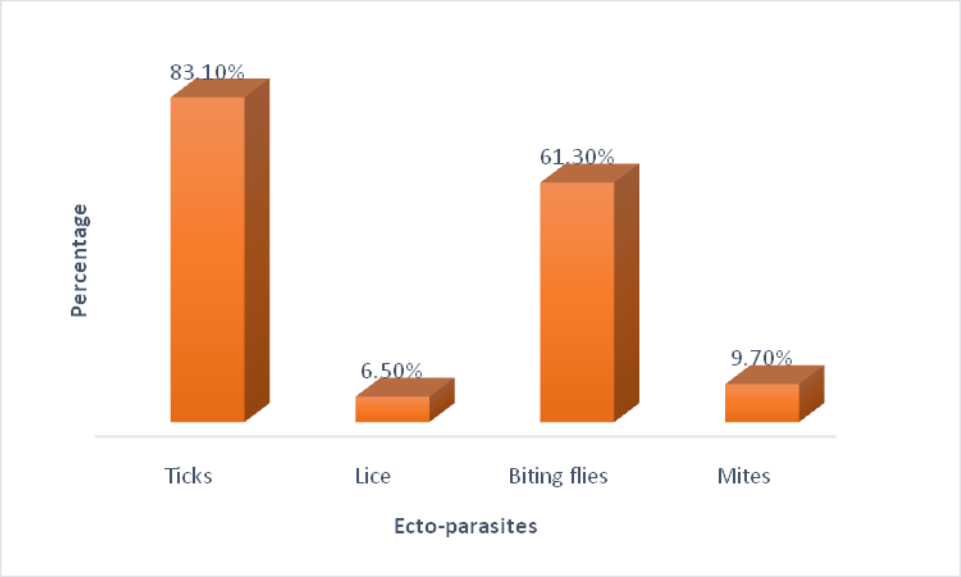

Figure 16: External parasites on the dry season grazing reserves, N= 123

4.5.6 Factors favoring prevalence of ecto-and endo-parasites on the dry season grazing reserves

The respondents cited different factors which favor the prevalence of endo- and ecto-parasites on the dry season grazing reserves. The different factors included; favorable weather, high stocking rate, parasitic lifestyle and vegetation. Most respondents cited high stocking rate, 67.70% (n=123) and parasitic lifestyle, 51.60% (n=123) as the major factors favoring prevalence of endo- and ecto-parasites on the dry season grazing reserves (Figure 14). Stocking rate is defined as the number of animals on a given amount of land over a certain period of time. Stocking rate is generally expressed as animal units per unit of land area (Redfearn and Bidwell, 2017).The basic principle of pasture management is limiting the intake of infective stages of pasture borne parasitic infection (Barger, 1996; Waller, 2006; Thamsborg *et al*, 2010).

Pasture management encompasses practices related to grazing; time of turn-out, length of grazing period, age composition of flocks, co-grazing with other species and frequency of pasture changes, although other factors such as; type of herbage and productivity, stocking rates and parasite contamination, levels at turn out also are very important (Barger, 1996; Waller, 2006; Thamsborg *et al*., 2010). Several studies have indicated an exacerbating effect of high stocking rates such as; gastro-intestinal nematode infection levels in both cattle and sheep (Thamsborg *et al*., 1998; Thamsborg *et al*., 2010). Pastures that are heavily stocked generally have a higher parasite burden than lightly stocked ones (Gadberry *et al*., 2019). Heavily stocked pastures lead to increased pasture contamination with infective parasite larvae. Overgrazing increases the number of parasite larvae ingested since cattle graze closer to fecal pats and closer to the ground where the numbers of parasite larvae are highest (Gilleard, 2019).

Parasites grow and reproduce in certain environments (Villarroel, 2013). In Uganda, the favorable equatorial climatic conditions suitable for livestock production also supports large tick populations, which enhances transmission of tickborne diseases (Ocaido *et al*., 2009a; Kasaija and la Fuente, 2021). Some tick species reproduce and survive best in warm and humid climatic conditions (Kohli *et al*., 2014; Kasaija and la Funete, 2021). Particularly, the genus*rhipicephalus* has been introduced to diverse geographical regions around the world, being aided by its great adaptive and propagative capability (Hurtado and Giraldo-Rios, 2019).

The cattle tick for example; is known to cause the greatest economic impact worldwide because of its broad distribution, vector capacity, blood sucking habits and the proportion of cattle it

affects (Dominguez *et al*., 2016; Lagumes *et al*., 2016; Kasaija and la Fuente, 2021). The direct economic effects on products results from damage caused by tick bites in heavily infested animals (Rodriguez-Vivas, 2017), blood loss in cases of heavy parasite loads, anemia, severe allergic reactions due to toxins in tick saliva, chronic stress and irritation which not only alters the behavior and welfare of the animals, but also leads to immuno-depression and loss of energy directed to the constant movement that occurs in response to infestation (De Castro, 1997; Abbas *et al*., 2014; Kasaija and la Funete, 2021).

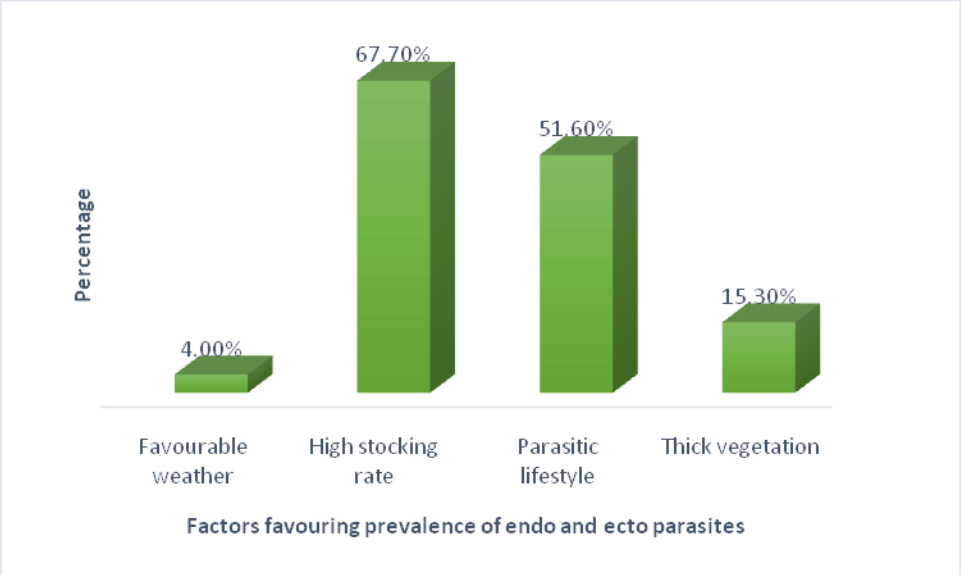

Figure 17: Factors favoring prevalence of ecto and endo parasites in dry season grazing reserves, N=123

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Generally, more males were interviewed relative to the females since the males are the heads of families and make most of the decisions. Most of the respondents interviewed had no formal education notably due to the nomadic lifestyle which involves movement from place to place in search of water and pasture for grazing animals. The main occupation of most of the respondents was livestock rearing and growing of crops. Most of the respondents reared cattle. Grazing distance had varying effects on calf mortality depending on the season. Generally, there was higher calf mortality ($P>0.05$) while grazing in the wet season compared to grazing during the dry season ($P<0.05$). Most respondents noted that calves are mixed with adult animals at ages between 12-24 months. The management risks associated with caring of calves during grazing included; starvation, diseases, parasites, predators and fatigue. Furthermore, different management practices were employed while rearing calves including; zero grazing, tethering around home, mixing calves with adult herds and weaning calves.

Most respondents noted that the age at first calving was 3.5 years. There was no significant association ($P>0.05$) between grazing hours and age at first calving. Most respondents noted that heifers which were grazed for more than four hours and for at least five hours during the wet season conceived normally relative to those grazed for similar durations during the dry season. Moreover, many respondents also noted that heifers which were grazed for more than six hours during the dry season had delayed age at first calving. Causes of delayed age at first calving included; failure of bulls to mount, heifer malnutrition, poor management and diseases. Different management practices were employed while caring for heifers including; supplementary feeding, mixing heifers with the main herd and grazing around homes.

There was a highly significant association ($P<0.05$) between the effect of dry season grazing reserves and parasite infestation in cattle. Most respondents noted that there was moderate parasite infestation in the dry season grazing reserves. Both endo-parasites and ecto-parasites were noted to be prevalent in the grazing reserves. The endo-parasites which were observed by respondents on the grazing reserves included; liverflukes and roundworms. The ecto-parasites which were observed by respondents included; ticks, lice, biting flies and mites. High parasite infestation on the dry season grazing reserves was attributed to such factors as; high stocking

rate, favorable environmental conditions and parasitic lifestyle of endo-parasites and ecto-parsaites.

5.2 Conclusion

In conclusion, there was generally high calf mortality in both the wet and dry seasons. The high calf mortality was attributed to diseases, parasites, starvation due to lack of nutritive pasture as a result of drought. Most of the heifers had delayed age at first calving which is due to high temperatures experienced in Karamoja which destabilizes the reproductive and physiological performance of heifers. Moreover, there was a high parasite infestation rate in the dry season grazing reserves due to overstocking of animals in the reserves.

5.3 Recommendations

A study should be carried out to ascertain the effect of supplementary feeding of cows and heifers on reproductive performance. Studies should be conducted to assess the effect of different strategies that can be used to lower parasite infestation in the dry season grazing reserves. Finally, research should be conducted to examine the effect of mixing different animal age on the social behavior of livestock.

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