PREVALENCE OF GASTROINTESTINAL PARASITES AND ASSOCIATED FACTORS IN ZEBU CALVES AMONG PASTORALISTS IN ISIOLO COUNTY KENYA

MOSES IRUNGU GAKURU BVM (University of Nairobi)

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DECLARATION

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

Moses Irungu Gakuru

J56/34663/2019

Signature……………………………………………Date…4/7/2022…………

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

Prof. George Karuoya Gitau (BVM, MSc, PhD)

Department of Clinical Studies

University of Nairobi

Signature…………………… Date…4-7-2022…………

Dr. John Kaunga Muthee (BVM, MSc, PhD

Department of Clinical Studies

University of Nairobi

Signature… Date…4-7 -2022

DECLARATION OF ORIGINALITY

NAME OF STUDENT: MOSES IRUNGU GAKURU

REGISTRATION NUMBER: J56/34663/2019

COLLEGE: COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES

FACULTY/SCHOOL/INSTITUTE: VETERINARY MEDICINE

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LIST OF ABBREVIATION

BCS	-	Body condition score
CFR	-	Case fatality rate
CI	-	Confidence interval
DNA	-	Deoxyribonucleic acid
ECF	-	East coast fever
EPG	-	Eggs per gram of fecal sample
FMD	-	Foot and mouth disease
FT	-	Feet
GIP	-	Gastrointestinal parasites
GIT	-	Gastrointestinal
KG	-	Kilogram
MM	-	Milliliter
OPG	-	Oocysts per gram of fecal sample
OR	-	Odds ratio
PCR	-	Polymerase chain reaction
SD	-	Standard deviation
USD	-	United states dollar

ABSTRACT

Helminthosis is a gastrointestinal infection caused by nematodes, cestodes and trematodes, which causes sub-optimal production, reproduction, early culling, work capacity, extra cost of treatment, reduced market values of the affected animals and death.

The aim of our study was to investigate the prevalence of gastrointestinal parasitic infections by screening for helminth eggs and coccidian oocysts using MacMaster technique and the associated factors among zebu beef calves in Isiolo County Kenya. A cross-sectional study was conducted in 2020 between November and December in Isiolo North and Isiolo South sub-counties. Garbatulla and Burat wards in Isiolo North and Kinna in Isiolo South were purposively selected due to high number of large herds compared to other areas. A total of 411 calves from 34 herds aged between 3 weeks and 12 months were randomly selected. Calf level and management and environmental data were collected through semi-structured questionnaires, observations and by taking measurements. Faecal samples were obtained from the rectum or immediately after defaecation for laboratory analysis. In the laboratory, faecal egg counts were estimated using the McMaster faecal floatation technique. Descriptive and logistic regression data analyses was done using STATA version 13. In logistic regression, factors with a p-value ≤ 0.05 in the final models were considered significant, hence retained.

The overall prevalence of GIP infection was estimated at 66.9% (275/411). Concurrent helminthosis and coccidiosis prevalence was slightly low, estimated at 16.5% (68/411). Coccidia was the most prevalent type of infection estimated at 45.7% (188/411) while the prevalence of helminths was 38.4% (158/411). Strongyle infection was predominant among other helminths detected with a prevalence 29.4% (121/411) followed by *Strongyloides* 6.5% (27/411), *Monezia* 2.7% (4/411), *Toxocara* 1% (4/411) and *Trichuris* 0.2% (1/411).

The factors associated with GIP infections in the final multivariate logistic regression analysis for coccidia were: Location, with Isiolo North recording a higher prevalence than Isiolo South (OR=4.906, p-value=0.000, CI=2.033-11.84), availability of drinking water was associated with lower prevalence compared to calves not provided with drinking water (OR=0.282, p-value=0.000, 0.168-0.472), calves in areas covered with lush pastures recording a higher prevalence than in areas covered with dry pastures (OR=2.604, p-value=0.009, CI=1.273-5.328), calves raised in dry floor having lesser risk of infection compared with calves raised in wet floor condition (OR=0.208, p-value=0.000, CI=0.094-0.462), calves in farms receiving extension services from animal health providers recorded a lower prevalence of coccidiosis than calves in farms without extension services (OR=0.208, p-value=0.023, CI=0.239-0.896). Calves in larger herd sizes of 20 cattle and above were at a higher risk of coccidiosis than calves raised in smaller herd sizes of less than 20 cattle (OR=1.004, p-value=0.022, CI=1.001-1.008).

For strongyle infection, the factors associated in the final model were: co-infestation with other gastrointestinal helminths and coccidiosis, with coinfected calves having a higher risk of strongyle infection than non-coinfected calves (OR=27.23, p-value=0.000, CI=12.76-60.62). Calves aged between 9 to 12 months were at the higher risk of strongyle infection compared to calves aged between 3 weeks to 4 months (OR=26.7, p-value=0.000, CI=10.32-68.78), also calves aged between 4 to less than 9 months, were at a higher risk of strongyle infection than younger calves aged between 3 weeks to less than 4 months (OR=19.7, p-value=19.7, p-value=7.69-50.59), calves raised in larger herd sizes were associated with a lower risk of strongyle infection compared with calves raised in smaller herd sizes (OR=0.99, p-value=0.000, CI=0.98-1.0). Calves raised in farms with extension services available recorded a higher prevalence of strongyle infection compared to calves raised in farms where extension services were unavailable (OR=3.74, p-value=0.005, CI=1.499-9.333).

The results of this study indicated that prevalence of gastrointestinal parasitic infections in calves is high, dominated by strongyles and coccidian infections and management/environmental factors and animal factors were associated with the infections. Robust integrated control program is therefore important to curb the infections which should include proper clinical and laboratory diagnosis, deworming with anthelmintics especially during rainy seasons, and treatment of calves with anti-coccidial drugs, grazing management and isolation of infected animals.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Approximately 80% of Kenyan land is categorized as arid and semi-arid lands (ASAL). Pastoralism is the main source of income to large number of people inhabiting these areas (Amwata *et al.*, 2016). At least 75% of cattle herds in Kenya are under nomadic pastoralism who supply the bulk of meat consumed in country (ILRI, 2013). In Africa, pastoralism contributes 10% to 44 % of the gross domestic product that supports 1.3 billion people (Karaimu, 2013). Helminthosis is a gastrointestinal infection caused by nematodes, cestodes and trematodes, which usually cause sub-optimal production, reproduction, early culling, poor work capacity, extra cost of treatment, reduced market values of the affected animals and death (Rafiullah *et al.*, 2011; Regassa *et al.*, 2006). Helminthosis is among the most prevalent infections globally in freely grazing animals (Fitzpatrick 2013; Charlier *et al.*, 2017). Gastrointestinal parasitism mainly causes chronic and subclinical infections leading to low growth rate, poor production and infertility (Morgan *et al.*, 2013). In Kenya, helminthosis in cattle, is the second highest cause of death in zebu calves up to 12 months old, estimated at 12% mortality rate, ranked after east coast fever with a mortality rate estimated at 50% (Thumbi *et al.*, 2013). Mortality rate in indigenous calves raised in traditional manner is very high and can reach 33%, with East Coast Fever (ECF) accounting for about 21% of the fatalities and this is higher among farmers with poor tick control strategies. Approximately, 28% of the calf experience high fecal egg counts of more than a thousand eggs per gram of feces, at 4 weeks of age (Latiff *et al.*,1995). The effect of helminthosis depends on parasite involved, the level of infection, animal factors like age and species and weather conditions (Singla *et al.*, 2014). In Kenya, a study that was designed to estimate the prevalence of gastrointestinal parasitic infection prevalence in wet and dry seasons the prevalence of helminths and coccidia infections were estimated at 85.5% during wet season in dairy calves aged between 6-12 months (Waruiru *et al.*, 2000).

1.2 Problem statement

The gastrointestinal parasitic infection has a high prevalence in Kenya and globally, with freely grazing animals being highly exposed than zero-grazed animals. Studies on helminthosis and coccidiosis and the predisposing factors are mainly focused on dairy cattle with little epidemiological information available in indigenous and traditionally raised cattle. Research on gastrointestinal parasitism in cattle under nomadic pastoralism system is scanty in Kenya, and targeted research in these areas will help add the knowledge on epidemiology of helminths and coccidia infections.

1.3 Justification

There is an ever increasing human population globally which translates to high demand for protein including animal sourced proteins. Control of diseases of animals particularly GIP infections help in improving livestock production to meet the demand of animal proteins and to fit the reduced natural resources for production and meet global requirement for greenhouse gas emission (Charlier et al., 2017). Understanding the epidemiology of gastrointestinal parasites help in determination of control measures to be applied (Ento, 2005).

1.4 Objectives

1.4.1 General objective

To determine the prevalence of the gastrointestinal parasites infection and associated factors in zebu calves in Isiolo County Kenya.

1.4.2 Specific objectives

1. To determine the prevalence of nematodes, cestodes and coccidia infections in zebu calves under pastoralism grazing system in Isiolo County of Kenya.
2. To determine the factors associated with nematodes, cestodes and coccidia infections in zebu calves under pastoralism grazing system in Isiolo County of Kenya.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Helminthosis is a gastrointestinal infection caused by nematodes, cestodes and trematodes, which causes sub-optimal production, reproduction, early culling, work capacity, extra cost of treatment, reduced market values of the affected animals and death. (Rafiullah *et al*., 2011; Regassa *et al*., 2006)**.** Bovine coccidiosis is a protozoan gastrointestinal infection caused by the *Eimeria* species and affect calves of all ages worldwide resulting in negative economic impact both in beef and dairy sectors (Daugschies and Najdrowski, 2005). Coccidiosis causes diarrhea in the first few months of life causing watery and in some cases, hemorrhagic diarrhea (Kimeli *et al*., 2020).

2.2 Prevalence of gastrointestinal parasitic infections

In India, coccidiosis prevalence of 33.2% in dairy calves has been reported (Das *et al*., 2015). In Sweden, a prevalence of 32% has been reported in calves, both in dairy and beef calves with *Eimeria bovis* being the most dominant species (Forslid *et al*., 2015). In Japan, prevalence of 69.1% in calves that suffered hemorrhagic diarrhea, with 83.6% of the cases caused by *Eimeria zurnii* has been estimated (Kirino *et al*., 2015).

The animals that are under pastoralism system have a higher risk of suffering from helminth infection (Keyyu *et al*., 2006) and in animals getting fodder from distant lands through cut and carry in stall-feeding system (Kabaka *et al*., 2012).

In African countries, coccidia infection prevalence of 24% in calves has been reported in Egypt, which is highly associated with large herd sizes above 10 animals, poor hygiene and body condition, and the infection with coccidian was highly associated with calves with diarrheic feces with of such cases testing positive (Zerihun *et al*.,2018; Kimeli *et al*.,2020).

Haemonchus, *Cooperia*, *Oesophagostomum*, *Trichostrongylus*, *Nematodirus* and *Trichuris*, are the commonly reported nematodes in Kenya, with higher prevalence during wet season (Waruiru *et al*., 2000; Thumbi *et al*., 2013). Point prevalence of nematode and coccidia indigenous cattle calves in Magadi south-western Kenya is estimated at 69.2% and 30% respectively (Maichomo *et al*., 2004).

Infection with coccidia has also been reported to be a problem affecting dairy calves under zero-grazing system with estimated prevalence in Kenya as high as 71% in wet season in calves between one and a half months and 3 months of age with risk of infection diminishing with age (Waruiru *et al*.,2000). In Kenya, four species of Eimeria have being reported with *Eimeria zuernii* and *Eimeria bovis* leading in prevalence with 29% and 43% respectively in calves about 3 months old. *Eimeria ellipsoidalis* and *Eimeria cylindrical* having less than 10% prevalence (Kimeli *et al*., 2020).

2.3 Clinical manifestation of gastrointestinal parasites in cattle

In general, GIP infection cause loss in body condition, digestive problems, infertility, emaciation and anemia (Keyyu *et al*., 2005). Clinical Signs are experienced within a short time post-exposure which include; listlessness, lethargy and unthriftiness, rough hair coat, dullness, dejection, development of pot-belly and diarrhoea (Smith and Archibald, 1968).

Bovine coccidiosis is associated with hemorrhagic diarrhoea, dehydration, loss of weight, anorexia, depression and death in severely affected (Squire *et al*., 2013). The most common clinical manifestations include anorexia, weakness and loss of weight, diarrhoea, depression and anaemia (Alula *et al*., 2013).

2.4 Predisposing factors of gastrointestinal parasites in cattle

Risk factors include animal factors, environmental factors. Host factors like immunity, age and breed, presence of intermediate hosts and vectors, level of grazing fields' contamination are important determinants of GIP infection (Kagira *et al*., 2012). Environmental temperatures, level of humidity, type of the pasture/fodder and management factors are highly associated with coccidiosis (Debela, 2002). Clinical coccidiosis depends on level of exposure, species of parasite involved, age of the animal, concomitant infections and management factors. Conditions like poor hygiene, poor nutrition and heavy stocking are associated with low animal resistance that enhance coccidia infections (Oluwadare *et al*., 2010).

2.5 Zoonotic aspect of the gastrointestinal parasitic infection

Parasites infecting animals like Cryptosporidium and Giardia cause severe infection in dairy cattle and humans with a high transmission rates (Olson *et al*., 2004). Cryptosporidiosis is prevalent in humans and calves and other domestic and wildlife animals (Fayer, 2004). Human infection by the trematodes for example *Fasciola hepatica* in endemic areas worldwide have been reported (Mas-Coma *et al*., 2009).

2.6 Life cycle of helminths in cattle

The life cycles of most nematodes are direct which include *Cooperia*, *Nematodirus*, and *Haemonchus*. Adult worms reside in the gastrointestinal tract, where they lay eggs which are extruded into the environment together with the faeces that hatch into first stage larvae which develops into the infective larvae stage 3. Time taken in the development of infective stage depends on temperature and humidity. Hatching is stimulated by presence of moderate humidity and warmth. Animals are infected by consuming the third-stage larvae during feeding which develop to maturity in the gastrointestinal tract. The larvae-stage 3 of *Bunostomum* infect ruminants when they are ingested or penetrate the host's skin. The infective larval stage of *Trichuris* is contained within the egg (Hansen and Perry, 1994). Ascarids are common in calves (*Toxocara vitulorum*), which has a direct life cycle whereby the excreted eggs develop into first and second infective stage larvae in one week under favorable conditions (Roberts, 1993). The eggs with second larvae when swallowed by the host animal, they hatch within 6 hours and the larvae penetrate the intestinal wall with majority migrating through the portal vein into the liver and a few move into the mesenteric lymph nodes and the lungs (Roberts, 1990). After tissue migration the larvae undergo hypobiosis in different organs and the cycle is initiated in pregnant animals (Murray *et al.*, 2012). One week to parturition, they begin migrating into the udder, but the trigger to this activity is still unknown (Roberts, 1993). The larvae are excreted in milk within 11 days with highest number detected in day 2 and 3 post-calving (Roberts 1990). The dormant larvae may persist in the dam tissues for long infecting the calves for one to two consecutive parturitions, through lactogenic route (Rast *et al*., 2013). The larvae develop to mature stage in the duodenum of the calf with the eggs detected when the calf is about 6-7 weeks old Roberts 1990; Roberts 1993).

Life cycle of coccidiosis, is utilized for designing treatment and control protocols for coccidiosis. The life cycle takes 2 to 4 weeks to be completed (Soulsby, 1987). Unsporulated oocysts are passed in feces before sporulating to become infective. When the oocysts in the intestinal cells mature, cytolysis of enterocytes subsequently occur (Chartier and Paraud 2012).

2.7 Economic importance of gastrointestinal parasites in cattle

Pathology caused by gastrointestinal parasites in infected livestock, is associated with lower daily weight gain, deterioration of the carcass, suboptimal milk production, infertility, and death

(Woodgate *et al*., 2017). These parasites adversely affect the health of animals and cause losses to the livestock sector (Rafiullah *et al*., 2011; Singla *et al*., 2014). In Kenya the total economic loss as a result of condemnation of liver due to fascioliasis is estimated at USD 2.6 million (Njeruh *et al*., 2004).

Globally bovine coccidiosis is known to cause an estimated annual loss of above 100 million USD annually with more losses experienced during cold weather (Niranjan and Samanta, 2015). Losses are experienced mainly through loss of draught power, high treatment cost, early culling, low milk production and death of infected animals in severe cases of helminthosis (Lebbie *et al*., 1994). Strongylosis with an estimated 1000 worms and above, has been shown to reduce the growth rate by 3.3% in calves of 1 to 12 months with increased mortality rate by 1.5 times (Thumbi *et al*., 2013). Gastrointestinal helminths in animals are ranked as the most important among poor farmers in developing countries based on the negative economic impact (Perry *et al*., 2002). Livestock keepers in sub-Saharan countries are the most affected (Grace *et al*., 2017).

2.8 Diagnosis of gastrointestinal parasites in cattle

Diagnosis of nematodes parasites is directed to analysis of faeces with identification of eggs and larvae being most routine way of confirmatory diagnosis through faecal floatation and culturing (Hedrix 1998). The modified McMaster technique is commonly used floatation method (Gordon and Whitlock, 1939). As a quantitative technique, the amount of faeces and volume of solution used for floatation determines the sensitivity of the test (Zajac and Conboy, 2012).

A modification of the traditional McMaster method is the high sensitivity McMaster, which uses a three-chamber with a higher sensitivity (Paras *et al*., 2018). The use of floatation technique helps to float the parasite eggs and oocysts except trematode eggs by using a floatation solution with a high specific gravity of 1.2 mainly sodium chloride and magnesium sulphate (Taylor, 2007).

Mini-FLOTAC technique is a recently developed dilution method that is easy to use, and offers a high detection sensitivity (Barda *et al*., 2013). The Mini-FLOTAC apparatus consists of two devices, the Fill-FLOTAC, which is a self-enclosed system that allows homogenization of the faecal sample and then direct filling of the counting chamber.

The coproculture method is used for genus or species-level identification of third-stage larvae based on larval gross appearance, since the eggs of Strongyles/Trichostrongyles are almost morphologically similar. Coprocultures are done by pooling of samples, with approximately the same amount of faecal sample from each animal (Van Wyk and Mayhew 2013).

Baermanns method is used to recover third-stage larvae after coproculture or directly from the faeces and from the respiratory tracts of the animals. The collected larvae are immobilized using Lugol's iodine for identification of features like length, shape, tail characteristics, cuticle and cephalic extremity (Zajac and Conboy, 2012).

Molecular methods like PCR are used for identifying gastrointestinal nematodes to species-level using their eggs and larvae. Sequence variations in the coding and noncoding regions of the nuclear DNA are utilized genetic markers for nematode species identification. Internal transcribed ribosomal DNA provides reliable interspecies variation for species identification (Stevenson *et al*., 1995; Zarlenga *et al*., 1998).

2.9 Control of helminths and coccidiosis in animals

2.9.1 Use of anthelmintics

The control of helminthosis in cattle rely mostly on use of chemical anthelmintics which has led to development of resistance by the helminths. Benzimidazoles were the first to be discovered which include albendazole and oxfendazole (Campbell, 1990). Macrocyclic lactones were discovered in 1980s which include ivermectin. Levamisole and pyrantel belonging to nicotinic agonist group are widely used as broad-spectrum (Martin 1997). Farmers were quick to adopt anthelmintics for control of parasites due to their broad spectrum aspect, low toxicity, high efficacy and can be used in different production systems with maintenance of husbandry practices (Nansen, 1993).

2.9.2 Anthelmintic resistance

Some helminths have been able to tolerate recommended doses of several drugs that initially killed the particular species, transmitting the resistant gene to the future generations (Prichard *et al*., 1980). Development of resistance depends on genetic diversity of the parasite, selection pressure caused by exposure to a particular drug and time (Prichard, 2001). Farmers over rely on anthelmintic treatment as a way of controlling gastrointestinal helminthes leading to development of resistance.

2.9.3 Control of bovine coccidiosis

Management strategies like hygiene, proper stocking rate, help to reduce the incidence of coccidiosis (Catchpole, 1989). Proper feeding of the dam and the calves enhances the immunity and single housing also help in reducing the incidence of coccidiosis (Pavlasek *et al*., 1984).

Chemotherapy composed of amprolium, toltrazuril, lasalocid sodium and Sulfaquinoxaline give 100% efficacy post-treatment (Sultana *et al*., 2017). Sulponamides inhibit dihydropteroate synthase and are effective against gram-positive and gram-negative bacteria and *Eimeria* species. (McCullough and Maren 1974). Toltrazuril interferes with respiratory system in the mitochondria cells causing death of the organisms (Harder and Haberkorn, 1989).

Ionophores like monensin are preferred due to their ability to allow animals mount an immune response after initial infection (Chapman et al., 2010). Ionophores are effective against all stages of parasite development, by inhibiting the transmembrane movement of the ions (Augustine *et al*., 1992). Control of bovine coccidiosis should be directed at improving the immune status of the animals by; good hygiene, proper stocking, isolation and treatment of the affected, early and sufficient colostrum consumption (Worku *et al*., 2019).

2.9.4 Vaccine for helminths in animals

Few vaccines against nematodes like *Dictyocaulus viviparus* vaccine (Bovilis®) have been used to stimulate the immunity of the animals (Jarrett *et al*., 1958). In sheep, vaccine for *Haemonchus contortus* have been used and commercialized and is currently registered and used in Australia (Barbervax ®) and in South Africa (Wormvax ®) (Le Jambre *et al*., 2008). Vaccines against other species of helminths like *Cooperia oncophora*, *Ostertagia ostertagi* in cattle, *Teladorsagia circumcincta* in sheep are in the process of development (Matthews *et al.,* 2016).

2.9.5 Biological control of helminths

Recently, biological control of helminths based on the use of certain soil saprophytic fungi have been reported to reduce environmental worm burden. *Duddingtonia flagrans,* is mostly studied fungi which traps and consume the larvae in the environment (Araújo *et al*., 2004). Some fungi like *Pochonia chlamydosporia* possess chemicals that interferes with hatching of the helminth eggs (Cazapal-Monteiro *et al*., 2015).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area

The study was carried out in Isiolo County in Kenya. Isiolo County is located 285km north of Nairobi at Latitude: 0° 52' 60.00" N Longitude: 38° 40' 0.12" East. The average altitude is 770m above sea level. The County is categorized as semi-arid and arid land receiving rainfall of between 400mm and 650mm annually. The weather is hot and dry and has two rainy season, with long rain experienced from March to May with peaking in April and short rain occurring from October to December. The mean annual temperature is 29 degrees centigrade. Areas close to Mount Kenya receive on average 550mm of rainfall annually. Northeastern areas are drier parts receiving less than 300mm. (Republic of Kenya. 2017).

Figure 3.1: Map of Isiolo County showing the study sub-counties.

3.2 Study design

A cross-sectional study was carried on cattle calves aged between 3 weeks to 12 months recruited from households in Kinna and Isiolo Central Sub-Counties. Garbatulla and Ngaremara wards in Isiolo Sub-County in Isiolo North and Kinna ward in Garbatulla Sub-County in Isiolo south areas were selected purposively, due to availability of large number of cattle herds. A total of 34 herds were selected, in Isiolo North, 16 herds were selected while in Isiolo South, a total of 18 herds which were conveniently considering accessibility of various locations, security and willingness of the pastoralists to participate because of homogeneity of production system, with each herd contributing 3 to 20 calves.

Selection of the animal for the study was done by simple random selection. Animals were given a random numbers using animal markers, with calves bearing even numbers were selected in ascending order.

3.3 Sample size calculation

The sample size was calculated using 50% as the expected prevalence due to lack of previous studies in the selected study sites (Thrusfield, 2007), Confidence interval of 95% and a 5% precision.

$$N = \frac{z^2 \times pexp\,(1-pexp)}{d^2} = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384 \text{ cattle calves.}$$

The figure was rounded off to 400 calves.

Where:

N = required sample size

z=is the statistic corresponding to level of confidence

pexp=expected prevalence,

d = desired absolute precision.

3.4 Data collection

Data were obtained from the principal farmer or a relative/person with full knowledge of the household and animals. The data were collected using semi-structured questionnaires and this included information on demographics, constraints affecting pastoralists, land ownership for grazing, control of gastrointestinal parasites. Details of individual calves and management factors were collected and this included weight and height at withers, using a measuring weighing band, age, and provision of concentrates and mineral salts. Other data collected were; sex, breed, body condition score, hair coat appearance, faecal consistency, color of oral mucous membranes and size of the abdomen hygiene of the floor, stocking rate, type of the pasture and status (dry or lush), and animal grouping (based on age).

3.5 Faecal sample collection

Fresh faecal samples were obtained from rectum or immediately post defaecation using gloved hand and transported to the laboratory at 4°C in cool boxes and refrigerated prior to processing within 12 hours post collection. While collecting faecal samples, details including the name of the owner, date of sampling, sex, age, breed, body condition score, housing, hygienic status of the floor and prophylactic treatment, feeding were recorded.

3.6 Laboratory analysis of faecal samples

McMaster technique was used to identify and quantify helminth (nematodes and cestodes) eggs and coccidia oocysts and counted as helminths/coccidian oocysts/eggs per one gram of the faecal sample (Zajac and Conboy, 2012). The two McMaster slide chambers were filled with a processed faecal sample using sodium chloride solution with 1.2 specific gravity with two grams of the faecal sample mixed with 28mls of sodium chloride solution. The light microscope was used (magnification of x10) and all eggs and oocysts in the marked areas of the chambers were identified and estimated. They were calculated as the number of eggs within the grid of each chamber multiplied by a factor of 50 (Soulsby, 1982).

The level of infection was grouped as light between 0 to 200, moderate infection with 200 to 800 eggs/oocysts per gram and a heavy infection when above 800, for cattle (Hansen and Perry, 1994). The estimated egg/oocyst counts were thereafter used to determine the prevalence of the parasites of interest.

3.7 Data analysis

Data collected were entered and stored in Microsoft Excel spread sheet version 10, and then coded for analysis where applicable. Descriptive analysis on management and calf factors was done first using proportions and frequencies. Statistical analysis was done using STATA version 13 statistical software.

The prevalence was calculated as the number of infected calves (for either helminths or coccidia) divided by the total number of calves selected and then changed into percentage. Logistic regression was used to determine the association between gastrointestinal infection and management and calf variables. All calves with a positive epg/opg were regarded as positive and coded 1 while those that were negative were coded as 0. Univariate analysis was done first and factors with p-value ≤ 0.25 were eligible for inclusion in the final multivariable logistic regression model. In the final multivariable logistic regression analyses, factors were considered significant if they had a $P \leq 0.05$. The analysis was carried out using forward inclusion procedure and variables with a p-value ≤ 0.05 were retained in the final model. The multivariable logistic model fitness was checked using Hosmer-Lemeshower chi^2 test p-value and Pearson test.

CHAPTER FOUR

4.0 RESULTS

4.1. Household and Farm demographics

The household and farm demographic data are summarized in Table 4.1. The principal farmers were mainly male, comprising of 88% (30/34) and 12% females (4/34). A slight majority of principal farmers (53%) were aged between 25 and 55 years with 47% of the farmers aged above 55 years. The level of education of the principal farmer was as follows: 24% having no formal education, 38% with primary level, while 32% with secondary level and only 6% had tertiary level of education. The size of the families of the respondents were as follows: 38% with between 4-6 family members and 62% having between 7-11 family members. Mixed livestock rearing was common with 72% of the cattle herds mixed with other species and only 38% of the households rearing cattle only. The average number of cattle was 37 in the selected herds. Goats were the most common among animals co-reared with cattle at 62% with a mean of 35 goats. Only 18% of the participants had camels with an average of 3, making camels most unpopular in the selected herds. Sheep were reared by 59% of the selected herds, having an average of number of 22 sheep. All participants relied on community land for grazing with only 21% of them having private land used mainly as a back-up for grazing during dry seasons and human settlement.

Table 4.1 Descriptive statistics for demographic variables on 34 herds under pastoralism in Isiolo County between November and December 2020.

Categorical variables

Variable	Category	Frequency	Percentage
Gender of principal	Male	30	88
farmer	Female	4	12
Age (years)	25 to 55	18	53
	Above 55	16	47
Level of education	None	8	24
	Primary	13	38
	Secondary	11	32
	Tertiary	2	6
Size of the family	4 to 6	13	38
	7 to 11	21	62
Livestock species reared	Beef cattle only	13	38
	Goats	21	62
	Sheep	19	59
	Camels	6	18
Land for grazing	Private and community	7	21
	Community land only	21	79

Continuous Variables

Variable	Mean	Median	Range
Private land (acres)	3.5	8	2-200
Distance covered during dry Seasons in such of water/pastures (km)	93.3	80	20-500
Cattle	37	118	10-200
Goats	35	80	20-320
Sheep	22	58	12-175
Camels	3	37	9-60

4.2. Distribution of calf management factors in 34 herds selected in Isiolo County between November and December 2020

The calf management factors are summarized in Table 4.2. All calves were kept in temporary circular enclosures made of thorny tree branches, with majority (64.7%), being located under a tree shade, while 35.3% were left in open field. The floor was natural dirt ground with no modification or beddings provided. In these calf enclosures, 52.9% of the dirt floors were wet at the time of the study while 47.1% were dry. Only 14.7% of the participants reported having extension services available to them and most farmers, 52.9% solely treated their animals without consulting animal health service providers. Most farmers, 94.2% reported to strategically deworming their animals during the rainy season and only 5.8% of the participants reporting to regularly deworming their animals at an interval of 3 months. Control of ticks was reported to be by the use of acaricides which were administered through hand spraying with 55.8% of the farmers doing control at weekly interval while 44.2% did it beyond one-week interval. Vaccination in cattle was done in 64.7% of the herds mainly funded by the government and non-governments organizations and was reported to be carried out during research projects as incentives. Some of the constraints that were reported to negatively impact cattle production were drought, animal diseases, cattle rustling, tribal conflicts and community grazing land grabbing in the descending order (Table 4.2).

Table 4.2: Descriptive statistics of distribution of management on 34 herds in Isiolo County in Isiolo County between November and December 2020

Factors	Categories	Number of farms	Percentage
Calf accommodation	Under tree shade	22	64.7
	Open field	12	35.3
Floor condition	Dry floor	18	52.9
	Wet	16	47.1
Grazing land	Private and community	7	20.5
	Community land only	27	79.5
Livestock species	Cattle only	13	38.2
	Mixed species	21	61.8
Extension services	Available	5	14.7
	Unavailable	29	84.3
Vet services	Animal health assistant	5	14.7
	Owner/herdsman	18	52.9
	Animal health assistant/owner	11	32.3
Deworming strategy	Regular, 3month interval	2	5.8
	Strategic, during wet season	32	94.2
Use of acaricides	Weekly	19	55.8
	Beyond 1 week	15	44.2
Vaccinations	Available	22	64.7
	Unavailable	12	35.3
Major constraints	Drought	34	100
	Diseases	31	91.2
	Cattle rustling	24	70.6
	Tribal conflicts	5	14.7
	Land grabbing	1	2.9

4.3 Morbidity, mortality and case fatality rates in 1,074 beef calves in 34 selected herds of various diseases in calves over a period of one year, 2020.

The results of morbidity, mortality and case fatality rates are obtained through semi-structured questionnaire and clinical examination, summarized in table 4.3. Foot and mouth disease had the highest morbidity rate estimated at 30.1% (323/1074) followed by diarrhoea, 24.3% (261/1074), East Coast fever, 7.9% (85/1074), trypanosomiasis, 1.4% (15/1074), lumpy skin disease, 1.3% (14/1074), anaplasmosis 1.1% (12/1074). Pneumonia, papillomatosis, emphemeral fever, wounds, eye infections, actinomycosis, bloat, and black quarter had a prevalence estimated below 1%.

The overall mortality rate was estimated at 12.9% (139/1074), with 37.4% (52/139) accounted by diarrhoea which was the highest cause of death, followed by ECF32.4% (45/139), foot and mouth disease 15.8% (22/139), trypanosomiasis, 2.9% (4/139), pneumonia, 1.4% (2/139).

The case fatality rate was highest in ECF, estimated at 52.9% (45/85), followed by anaplasmosis 41.7% (5/12), pneumonia 26.7% (4/15), trypanosomiasis 22.2% (2/9), diarrhoea, 19.9% (52/261), FMD 6.8% (22/323). There were two cases reported for bloating and black quarter leading to death of both calves.

Table 4.3: Morbidity, mortality and case fatality rates in 1,074 beef calves in 34 selected herds of various diseases in calves over a period of one year from November to December 2020.

Disease/Condition	Morbidity rate (%)	Mortality rate (%)	Case fatality rate (%)
Foot and mouth disease	30.1 (323/1074)	2 (22/1074)	6.8 (22/323)
Diarrhoea	24.3 (261/1074)	4.8 (52/1074)	19.9 (52/261)
East coast Fever	7.9 (85/1074)	4.2 (45/1074)	52.9 (45/85)
Trypanosomiasis	1.4 (15/1074)	0.3 (4/1074)	26.7 (4/15)
Lumpy skin disease	1.3 (14/1074)	0.2 (2/1074)	14.3 (2/14)
Anaplasmosis	1.1 (12/1074)	0.5 (5/1074)	41.5 (5/12)
Pneumonia	0.8 (12/1074)	0.2 (2/1074)	16.6 (2/12)
Eye infections	0.5 (5/1074)	-	-
Skin wounds	0.5 (5/1074)	-	-
Actinomycosis	0.09 (1/1074)	-	-
Black-quarter	0.09 (1/1074)	0.09 (1/1074)	100 (1/1)
Papillomatosis	0.8 (9/1074)	-	-

4.4 Description of individual animal characteristics

Description of individual animal characteristics, are summarized in Table 4.4. A total 411 calves were sampled from 34 herds. Majority, 86.8%, (357/411) were of boran breed, 5.8% sahiwal and 7.2% were boran and sahiwal crosses. The average age was 5.5 months while the range was 3 weeks and 12 months, with majority, 48% aged between 3 weeks and less than 4 months, 26% aged >4 and 9 months and 25.5% were between 9 to 12 months old. The number of male calves was higher at 54% compared to female calves (46%). The average BCS was 2.7 and most calves, 55% were in poor body condition between 2 to 2.5 while 45% were in between 3 to 3.5, on a scale of 1 to 5. The average estimated weight was 84kg, with the lightest calf weighing about 36kg while the heaviest weighing about 166kg.

Table 4.4: Descriptive statistics for 411 beef calf samples from 34 herds under pastoralism in Isiolo County, between November and December 2020

Categorical variables

Variable	Levels	Total	Percentage
Breed	Boran	357	86.8
	Sahiwal	24	5.8
	Boran and Sahiwal cross	30	7.2
Age-class	Immature (<4 months)	199	48.4
	Young (4 to<9 months)	107	26
	Young Adults (9 to 12 months)	105	25.5
Sex	Male	222	54
	Female	189	46
Body condition	2 to 2.5	227	55.2
	3 to 3.5	184	44.8

Continuous variables

Variable	Mean	Median	Range	SD
Age (months)	5.5	4	0.75-12	3.7
Body condition	2.7	2.5	2-3.5	0.4
Weight (kg)	84	83	36-166	28.9
Height (cm)	79	78	47-155	11.4

4.5 Prevalence and intensity on helminth eggs and coccidian oocysts from Isiolo County between November and December 2020

The laboratory results from the GIT egg and oocyst counts, and the prevalence and the level of infection by various parasites is summarized in Table 4.5 below. The coccidia mean oocysts per gram of faecal sample was highest at 689, with highest value being 36,000 oocysts per gram of faecal sample. The helminths epg counts were mainly strongyle with a mean egg count of 80 followed by *Strongyloides* with a mean of 14. *Monezia*, *Toxocara* and *Trichuris* species egg counts means for each parasite, were below 5.

The overall prevalence of gastrointestinal parasitic infection was 66.5%, with coccidia being highest at 45.7% and helminths estimated at 38.4%. Prevalence of strongyles was 29.4% and highest among helminthes, followed by *Strongyloides* with a prevalence of 6.5%. *Monezia*, *Toxocara*, and *Trichuris*, recorded a prevalence of less than 5%. Prevalence of coccidia and helminth coinfection was 16.5%. Light to moderate helminth infection was dominant affecting 96.8% of the infected calves and only 3.2% suffering from heavy helminthosis. Light and moderate coccidia infection affected 78% while 22% of the affected animals had heavy coccidia infection.

Table 4.5: Prevalence and intensity on helminth eggs and coccidian oocysts from Isiolo County between November and December 2020

Variable	Total	Prevalence (%)
Coccidia	188	45.7
Helminths	158	38.4
Nematodes	153	37.2
Strongyles	121	29.4
Strongyloides	27	6.5
Monezia	11	2.7
Toxocara	4	1
Trichuris	1	0.2
Helminths and coccidia concurrently	68	16.5
Helminthiasis or coccidiosis	275	66.9
Light helminthosis	71	44.9
Moderate helminthosis	82	51.9
Heavy helminthosis	5	3.1
Light coccidiosis	57	30.3
Moderate coccidiosis	91	48.4
Heavy coccidiosis	40	21.3

Eggs/oocysts per gram of faecal sample

Parasite group	Mean	Median	Range	SD
Coccidia (OPG)	689	0	0-36000	2860
Strongyle (EPG)	80	0	0-2500	217
Strongyloides (EPG)	14	0	0-1100	75
Monezia (EPG)	3	0	0-200	18
Toxocara (EPG)	2	0	0-300	20
Trichuris (EPG)	0.2	0	0-100	5

OPG- Oocysts per gram of faecal sample.
EPG- Eggs per gram of faecal sample.

4.6 Factors associated with coccidia infection from the univariate logistic regression

The results of univariable logistic regression are summarized in Table 4.6. Variables that had a p-value of ≤0.20, were retained for preliminary multivariable logistic regression. Age categories, sex, weaning status, availability of drinking water, floor condition, color of faeces, location (Sub-Counties), availability of drinking water, herd size, type of the pasture and floor wetness, were significant.

Table 4.6: Univariate factors associated with coccidia infection in 411 calves from Isiolo between November and December 2020

Explanatory variables	Levels	Total	Infected (%)	χ^2	p-value
Age-class	<4months	199	27	8.6	0.0000
	4 to <9 months	107	44		
	9 to 12 months	105	57		
Sub-County	Isiolo-North	200	68	10.7	0.002
	Isiolo-South	211	25		
Sex	Male	222	41	4.4	0.036
	Female	189	51		
Weaning status	Weaned	167	36.5	9.6	0.002
	Unweaned	244	52.1		
Extension service	Available	43	26.7	11.4	0.001
	Unavailable	368	73.4		
Drinking water	Available	200	34.5	22.0	0.000
	Unavailable	211	56.4		
Floor wetness	Dry	246	63	9.8	0.003
	Wet	165	33		
Pasture type	Lush	218	74	12.7	0.000
	Dry	193	41		
Herd size	Above 20	318	57	6.2	0.01
	Below 20	93	36		
Faecal color	Green	378	43.9	6.3	0.012
	Yellow	33	66.7		

4.7 Multivariable factors associated with coccidia infection in 411 in calves in Isiolo County between November and December 2020

The multivariable factors associated with coccidia infection are summarized in table 4.7.

In Isiolo North, calves were 4.9 times more likely to contract coccidiosis, compared to calves in Isiolo South. Calves having access to drinking water at least once per day were 0.28 times less likely to get coccidiosis compared to calves not having access to drinking water. Calves in areas covered with lush pastures were 2.6 times more likely to get coccidiosis than calves covered with dry pastures. Animals confined in dry floors were 0.21 less likely to be coccidiosis positive compared to calves in raised on wet floors. Large herd sizes of above 20 cattle were 1.004 times more likely to get coccidia infection compared to calves in herd sizes less than 20. Calves in herds with access to professional extension services were 0.463 times less likely to contract coccidiosis.

Table 4.7: Multivariate factors associated with coccidia infection in 411 sampled calves, with 188 testing positive in beef calves in Isiolo County between November and December 2020

Variables	Levels	OR	p-value	95% CI
Sub-County	Isiolo-North	4.906	0.000	2.033-11.84
	Isiolo-South	Baseline		
Drinking water	Available	0.282	0.000	0.168-0.472
	Unavailable	Baseline		
Type of pasture	Lush	2.604	0.009	1.273-5.328
	Dry	Baseline		
Floor condition	Dry	0.208	0.000	0.094-0.462
	Wet	Baseline		
Extension service	Available	0.463	0.023	0.239-0.896
	Unavailable	Baseline		
Herd size	Above 20	1.004	0.022	1.001-1.008
	Below 20	Baseline		

OR= Odds ratio, CI= Confidence interval

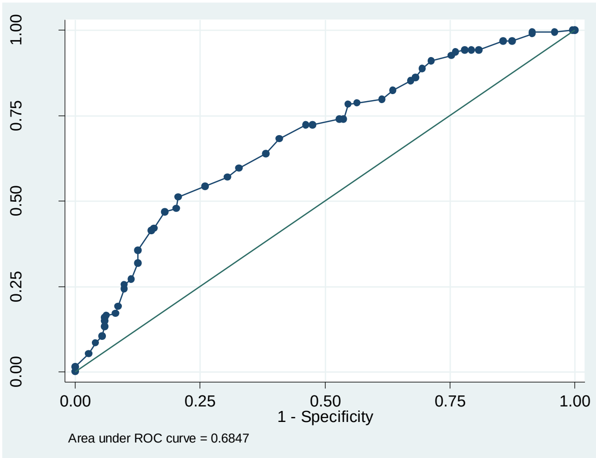

Figure 4.1: Area under the curve showing goodness of fit of the final model in a study on factors associated with coccidiosis in 411 calves on 34 cattle herds in Isiolo County Kenya in 2020.

4.8 Factors associated with strongyles in 129 calves in the univariable analysis in a study conducted in Isiolo County between November and December 2020

The univariable logistic regression analyses of variables association with strongyles are summarized in table 4.8. Variables with a chi-square value of 3.84 and above and a p-value ≤0.20 and below were retained for preliminary multivariate logistic regression. Location, color of faeces, co-infestation with condition of the abdomen, weaning status, drinking water availability, floor wetness, type of pasture, herd size, age of the calf, and extension services were significant.

Table 4.8: Factors associated with strongyles from univariate analysis from 411 calves in beef calves in Isiolo County between November and December 2020

Explanatory variables	Levels	Total	Infected (%)	Chi-square	p-value
Sub-County	Isiolo North	196	19.9	16.42	0.000
	Isiolo South	215	38.1		
Faecal color	Green	378	31.8	12.1	0.000
	Yellow	33	3.03		
Abdomen condition	Normal	387	27.7	10.2	0.001
	Pot-belly	24	58.3		
Weaning status	Weaned	167	48.5	49.2	0.000
	Unweaned	244	16.4		
Drinking water	Available	200	46.5	54.6	0.000
	Unavailable	211	13.3		
Floor wetness	Dry	216	22.2	11.4	0.001
	Wet	105	37.4		
Type of pasture	Lush natural grass	306	36.9	32.3	0.000
	Dry natural grass	105	7.6		
Co-infestation	Coinfested	113	72	18.6	0.004
	Non-coinfested	298	39		
Herd size	Above 20	318	42	5.8	0.006
	Below 20	93	53		
Extension services	Available	43	42.4	16.8	0.000
	Unavailable	368	27.4		

4.9 Factors associated with strongyles from the multivariable logistic regression

Significant variables in the final multivariate logistic analyses are summarized in table 4.9. Calves infected by one or more different type of parasites other than strongyles, were 23.23 more likely be test positive for strongyles than calves infected with a single type of gastrointestinal parasitic infection. The odds of calves aged between 4 months to <9 months were 19.7 times more likely to be infected with strongyles which was lower than calves aged between 9 to 12 months which were 26.7 more likely to be positive for strongyles, both categories compared to calves aged between 3 weeks to less than 4 months as the reference group. Calves in large herd sizes above 20 cattle were 0.99 less likely to be infected with strongyles. Calves in herds where extension services were available, were 3.74 times more likely to be positive to for strongyle infection compared to the rest.

Table 4.9: Multivariable factors associated with strongyle infection in 121 calves in Isiolo from November to December 2020

Variables	**Categories**	**Odds ratio**	**P-value**	**95% CI**	
Co-infestation	Non-coinfested	Baseline	_		
	Coinfested	27.23	0.000	12.76	60.62
Age	3 weeks to <4 months	Baseline	_		
	4 to <9 months	19.7	0.000	7.69	50.59
	9 to 12 months	26.7	0.000	10.32	68.78
Herd-size	Above 20	0.99	0.000	0.98	1.0
	Below 20	Baseline			
Extension services	Unavailable	Baseline	_		
	Available	3.74	0.005	1.499	9.333

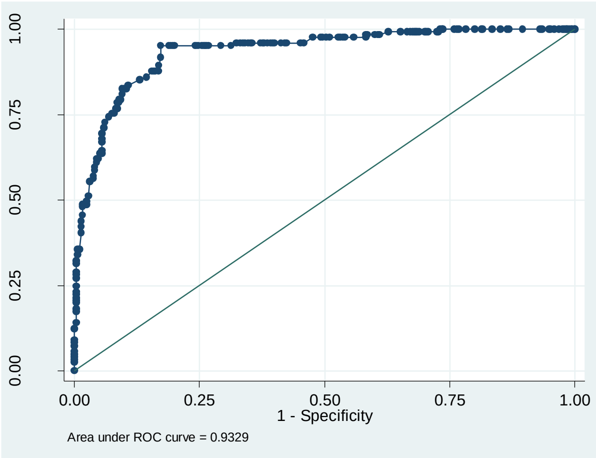

Figure 4.2: Area under the curve showing goodness of fit of the final model in a study on factors associated with strongylosis in 411 calves on 34 beef herds in Isiolo County Kenya in 2020.

CHAPTER FIVE

5.1 DISCUSSION

Majority of herds were headed by males and most of the principal farmers had low level of formal education. Community land formed was relied on for grazing with cattle being the most popular type of livestock reared in the herds selected. Management practices of the calves and selected herds revealed that calves were kept on earthen floor, confined in circular portions using thorny branches with virtually half of the herds raised in wet floors and in crowded conditions. Most farmers practiced mixed livestock rearing which involved cattle, goats, sheep and camels, with similar observation made in Kenya, making mixed livestock rearing a common practice among pastoralists (Ilatsia, 2012). Veterinary and extension services were unavailable to majority of the farms, leading to farmers and herdsmen treating sick animals. The poor delivery of veterinary and extension services among pastoralists is complicated by constant migration by the herders looking for water and pastures and security (Bett *et al.*, 2009). To control helminthosis, almost all farmers used dewormer during the wet seasons with a few following regular deworming protocol. Tick control was directed mainly at reducing the prevalence of ECF which was done by hand-spraying the animals using acaricides. More than a half the selected herds, the owners and their representatives reported that their animals were being irregularly vaccinated against diseases like foot and mouth disease by the County government and researchers as a part of incentive for their cooperation to participate. The main challenges that were reported by the pastoralist included; drought, animal diseases, cattle rustling, tribal conflicts and land grabbing. In another study in Kenya, climate change was also indicated as the main challenge by the pastoralists leading to shortage of water and pastures (Bobadoye *et al.*, 2016).

For the diseases affecting cattle calves from the past for a period of one year, foot and mouth disease diarrhoea and East Coast fever were the most significant diseases in terms of morbidity and mortality rates. The general mortality rate in calves was 12.4% which was mainly associated with diarrhea, East Coast Fever and foot and mouth diseases, which was in concurrence with other studies carried out in Kenya involving mainly freely grazing zebu calves and their crosses in Murang'a county (Gitau *et al*.,1999) and in Busia involving 548 East African shorthorn zebu calves (Thumbi *et al*., 2013). The case fatality rate for the East Coast fever was the highest estimated at 52.9%, followed by diarrhoea estimated at 19.9%.

All the calves selected in this study were indigenous, dominated by borana breeds, a few sahiwal and their crosses. Pastoralist mainly keep indigenous livestock (Kagira and Kanyari 2010) probably due to their adaptation to harsh environmental condition and diseases compared to exotic breeds like Friesian and Ayrshire breeds. About a half of the calves selected were males. The calves were between 3 weeks to 12 months and majority were in body condition below the standard average of 2.7 on a scale of 1 to 5.

The mean coccidian oocyst epg was the highest estimated at 689, followed by the mean of egg per gram of faecal sample of strongyle eggs and *Strongyloides* estimated at 80 and 14 respectively. The mean of eggs for *Monezia*, *Toxocara* and *Trichuris* species epg were below 5 and a similar observation was made in a study of dairy calves in Kiambu County in Kenya (Kimeli *et al.,* 2020). The overall prevalence of 66.9% was lower than a similar study conducted in Ghana, which was estimated at 95.5%. The higher prevalence in Ghana could have been attributed to age of the animals sampled with 78.3% of these cattle being adults. In addition, sedimentation technique test that was included to detect *Fasciola* species and *Paraphistomes* species eggs in this study (Squire *et al*., 2013). The prevalence of nematodes estimated in this study, at 37.2% was lower than other studies carried out in Kenya and worldwide. A cross-sectional study involving 109 zebu calves conducted in Kenya, estimated a higher prevalence of nematodes at 69.2% but a lower prevalence of coccidia than our study recorded a 30% and a higher prevalence of *Strongyloides* estimated at 27.4% (Maichomo *et al*., 2004). The difference in these two studies, could probably be explained by difference in material and methods and weather conditions and time difference. The study by Maichomo and others, involved a smaller sample size of 109 calves and data collection was conducted from January to June. The results in this study agreed with a study carried out in diarrheic calves in Iraq with prevalence of coccidia estimated at 46.7%, with calves aged between 3 to 6 months old showing the highest risk (Malek and Kuraa, 2018). The recorded prevalence of coccidiosis involving dairy calves in Kenya was lower than the prevalence estimated in the current study (Peter *et al.*, 2015; Waruiru *et al*., 2000), which could be attributed to high level of exposure in indigenous cattle raised traditionally (Kanyari et al.,2010; Thumbi *et al*., 2013). The estimated prevalence of *Monezia* was similar to a study conducted in Ghana (Squire *et al*., 2013).

In our study, the prevalence of strongyles (29.4%) was below several studies in Kenya and worldwide, 51% (Kanyari *et al*.,2010), in Ethiopia, 37.9% (Kemal *et al*., 2013), in Nigeria 85% (Sanda *et al*., 2019). The variance was mainly attributed to difference in age of the animals in the mentioned studies involving yearlings and adult cattle that are more predisposed due to full reliance on grazing/fodder (Waruiru *et al*., 2000; Kimeli *et al* 2020).

The final model results for coccidiosis revealed significant factors which included location difference with Isiolo North Sub-County having higher odds of infection than Isiolo South which was unexplained our study. Drinking water availability was associated with lower prevalence of coccidiosis which can be explained by dehydration stress relief by providing drinking water to calves, hence improving resistance to coccidiosis. Calves raised in environments covered with lush pastures which was used as an indicator of recent rainfall, had higher odds of having coccidiosis, compared to calves in raised in dry pastures indicating dry season (Rodriguez *et al*., 1996; Waruiru *et al*., 2000). Calves raised in confinement with dry floor had lesser odds of coccidiosis compared to calves raised on dry floor which could result from increased stress level to the calves raised in wet floors and favorable moist condition of sporulation of oocysts. Calves in large herd size above 20 were 1.004 times more likely to test positive for coccidia than calves in herds with less than 20 cattle, similar observations made in Ethiopia and Mexico (Rodriguez *et al*., 1996; Kemal *et al*.,2013) which is expected due to high level of pasture contamination of the pastures and high stocking density in large herds compared to small herds (Vorster and Mapham 2012).

Multiple logistic regression for strongylosis revealed several factors that were associated with the infection statistically significant. Co-infected calves by different groups of parasites in the current study, had higher odds of having strongyles, than calves with single type of gastrointestinal parasite a finding which was in concurrence in a similar study in Kisumu Kenya (Kanyari *et al*., 2010). Calves in large herd sizes of more than 20 cattle were 0.9896 less likely to be positive for strongyle, probably because large herds were economically more viable and control of diseases like strongylosis by deworming were more efficient than in smaller herds. Calves that were in farms with extension services available had higher odds of having strongylosis than in calves in herds without extension services an indication that extension services providers and pastoralists did not apply control measures appropriately. Older calves between 9 to 12 months had highest odds of strongylosis, with similar observation made by others (Waruiru *et al*.,2000; Kanyari *et al*., 2010). The higher prevalence in older calves could be attributed grazing post-weaning leading to higher exposure to infective larvae, compared to unweaned younger calves with lower prevalence. Calves passing green feces which was an indication that the calf was feeding on pastures, were more likely to have strongylosis that calves passing yellow feces indicating that the calves were still suckling milk.

CHAPTER SIX

6.1 CONCLUSION AND RECOMMENDATIONS

6.1.1 CONCLUSIONS

- The prevalence of GIP mainly strongyles and coccidia was significantly high in our study
- Management, calf and environmental factors were associated with GIP infections.
- Majority of infected calves with helminths had epg less than 800 and above epg of fecal sample, which is an indication that helminthosis is mainly sub-clinical.
- A large number of infected calves with coccidia had heavy infection with 800 and above opg per gram of fecal sample, making coccidia a significant disease in calves.
- The prevalence of GIP mainly strongyles and coccidia was significantly high in our study.

6.2 RECOMMENDATIONS

- Occasional random sampling of fecal samples to screen for coccidiosis and other gastrointestinal parasites is therefore recommended for informed treatment and control measures.
- Deworming of calves is recommended about 3 to 4 weeks after commencement of grazing which is associated with increased exposure to helminths infective stages.
- Robust deworming strategy is recommended, and organized extension services are important with emphasis to gastrointestinal parasitic infection.

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APPENDICES

Appendix 1: Household-questionnaire-MSc field work in Isiolo county

Questionnaire number………………….

This study is designed to gather information on challenges affecting animals under pastoralism system of different species with attention focused on various diseases and condition. As a community member, you are humbly requested to participate in this study by answering questions in various sections of this questionnaire. You are guaranteed that the information gathered will be treated with the highest degree of confidentiality.

Signed consent.

Signature…………………………

Date……/……/……………….

Name of interviewer…………………………………………………………………………….

Principal Farmer personal details:

1. Name………………………………………………………
2. Telephone number …………………………………
3. Gender of principal:

   Male……………….

   Female…………….
4. Age in years…………….
5. Place of residence:

   Ward………………………Location………………………. Sub-location…………

6. **Level of education:**

None………………………. Primary…………………Secondary……………….

Tertiary…………………

7. **Occupation:**

Unemployed……Employed…………Self-Employed………Others (specify)…………………

Household demographic information:

8. Size of the family……………………

9. Position of principal in the family:

Husband……………………Wife…………………Child………………Employee ………………Other (specify)……………………………………………………

10. Land ownership:

Private…………………Community land………………………..Others (specify)………………………….

11. If private, how many acres owned? ....
12. What is the size of land used for cattle rearing……….
13. What size of the land used for crop production if any………
14. What type main type of pasture species used……………
15. Estimated distance covered by cattle in search of pasture and water……
16. What is the breeding method utilized?
    a. Natural mating……... If yes, is there inbreeding practiced? ....

b. Artificial insemination……..

17. Major constraints to livestock farming experienced (Rank – 1, 2, 3, 4,)

a. Water
b. Pastures
c. Diseases
d. Predation
e. Rustling
f. Others …………………

18. Farm animals owned and their purpose.

Type of the animal.	**Breed.**	**Total.**	**Number of young animals.**	**Number of adults.**	**Number of males.**	**Number of females.**	**Production system.**	**Main purpose.**
Cattle								
Goats								
Sheep								
Camels								
Donkeys								

19. Diseases encountered the last 1 year

a) Anaplasmosis………….
b) Trypanosomiasis………..
c) Blackquater………….
d) East coast fever……..
e) Foot and mouth disease……..

f) Lumpy skin disease…….

g) Malnutrition…………

h) Mange………..

i) Helminths…………

j) Mastitis………..

k) Pneumonia…………

l) Pink eye………..

m) Cow pox…………

n) Milk fever............

o) Leeche………….

p) Allergic dermatitis……………

q) Fascioliasis………..

r) Diarrhea………..

s) Others specify………………

20. Who attends to sick animals?

a. Animal health assistant………

b. Veterinary surgeon……………

c. Principal farmer……………….

d. Herds man………….

e. Other (specify)…………..

21. Morbidity and mortality of livestock in general in the last one year:

Type of the animal	Common diseases experienced	Major signs experiences	No. that died	Diagnosis suspected or made
Adult cattle				
Calves (cattle)				
Camels				
Lambs				
Sheep				
Kids				
Goats				
Donkeys				

Appendix 2: Questionnaire for calves (Isiolo county)

Questionnaire number……………………

Date……/………./…………

Identity of the interviewer…………..

Calf details:

1. Household identity…………………
2. Identity of the calf……………………………
3. Sex: male………..Female………….
4. Breed……….
5. Age……
6. Body condition score……..
7. Estimated body weight……….
8. Height in CM from withers to hoof……………
9. Hair coat condition: Rough………….. Smooth………………
10. Condition of the abdomen: Normal……….. Pot-belly…………
11. Colour of mucous membrane: Pink…….. Pale…………
12. Condition of inter-mandibular space: Normal……….. Swollen (bottle jaw) ……..
13. Fecal consistency: Soft…. Hard…..Watery……
14. Colour of feces: (red) bloody……………….Greenish ……….….yellowish…………..
15. What is the method used to feed the calves with milk?
    a. Suckling from the dam…………..
    b. Milking and hand feeding………..
16. If bucket fed what amount of milk provided per day?................

17. At what age the calf is weaned…………

18. At what age is the calf released to graze with the herd……….

19. At what age solid feeds are introduced?...................

20. Which source of water for drinking by the animals

    a. River…….

    b. Dams……..

    c. Swamps……

    d. Harvested rain water……

21. What type of fodder is fed to the calf?

    Grass…………. Vineyard…………Others (specify)………..

22. What are concentrates fed to the calves if any?

    a. Energy rich concentrates.... Protein rich……. Fiber rich……A mixture of the above………Others specify…………………

23. Is the calve provided with mineral supplementation…………….

24. How are the calves housed?

    Indoors…………………… Outside……………………

25. What is the production system adopted?

    Zero-grazing………Pastoralism………Semi-zero-grazing…………Others (specify)………………................

26. At what age are the calves introduced to the rest of the herd?.............

27. At what age is the first deworming done?..................

28. What is the frequency of deworming?..................

29. When is the last date that his was the calf dewormed………………?

30. Which type of dewormer was used and dosage? ....

31. What type of the pasture availed? Lush…..Dry……….

32. Hygiene of the floor………

33. Which diseases/conditions are common in the farm affecting calves

a) Anaplasmosis………….
b) Trypanosomiasis…………
c) Blackquarter………….
d) East coast fever………
e) Foot and mouth disease………
f) Lumpy skin disease…….
g) Malnutrition…………
h) Mange…………
i) Helminths…………
j) Pneumonia…………
k) Pink eye…………
l) Cow pox…………
m) Milk fever.............
n) Leeche………….
o) Allergic dermatitis……………
p) Fascioliasis…………
q) Diarrhoea…………
r) Others specify………………

34. Which disease control measures are utilized:

Vaccination……… Vector control……. Good hygiene...... Proper nutrition…… Regular deworming…………

35. Do you receive extension services on livestock rearing?...........

36. Calf morbidity and mortality.

No of calves in the farm 1-12 months old in the last one year	No of calves that got sick	Common signs exhibited and diagnoses made.	No. that died