# PREVALENCE OF GASTRO INTESTINAL PARASITES OF CATTLE IN MATHIRA CONSTITUENCY, KENYA

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**A THESIS SUBMITTED TO THE SCHOOL OF PURE AND APPLIED SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE CONFERMENT OF THE DEGREE OF MASTER OF SCIENCE IN PARASITOLOGY, KARATINA UNIVERSITY.**

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## DECLARATION

**Declaration by the candidate**

This thesis is my original work and has not been presented for a conferment of a degree in any other University or for other award.

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**Declaration by the supervisors**

We confirm that the work reported in this thesis was carried out by the candidate under our supervision and has been submitted with our approval as university supervisors.

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## DEDICATION

This work is dedicated to my dad, John Nyutu, late mum mama Purity Njeri, my husband Ben, my children Abigail and Joyness, my sisters and brothers and in-laws. Honour and praise to almighty God for his grace and abundant love.

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## LIST OF ABBREVIATION AND ACRONYMS

ASAL – Arid and Semi-Arid Lands

ASF – Animal Sourced Foods

CAHWs - Community Animal Health Workers

COMESA – Common Market Eastern and Southern Africa

EAC – East African Community

FAO - Food and Agricultural Organization

FEC - Faecal egg count

GDP – Gross Domestic Product

GI- Gastro Intestinal

GIT - Gastro-intestinal Tract

GOK - Government of Kenya

KSH - Kenya Shilling

MT – Metric Tonnes

PGE- Parasitic Gastro Enteritis

SPSS - Statistical Package for Social Science

## ABSTRACT

Cattle's farming is a crucial activity for Mathira constituency; since it acts as a source of livelihood to many people. However, gastrointestinal parasitic infection is a limiting factor in cattle management. Understanding the epidemiological characteristics of the infections is necessary to recommend control and preventive measures. There is however inadequate knowledge regarding the prevalence of gastrointestinal tract parasite infection of cattle in the study area. The current study was to assess the prevalence of gastrointestinal parasites of cattle in Mathira constituency. The specific objectives included determination of the association of farmers' knowledge and prevalence of gastrointestinal parasites, the association of farming practice and prevalence of gastrointestinal parasites, the combined association between prevalence of gastrointestinal parasites and farmer's knowledge and farming practice. A total of 387 faecal samples were collected and subjected to parasitological analysis: modified McMaster technique was used to determine the number of Eggs per Gram (EPG); Willis technique to identify any stages for nematodes and cestodes; sedimentation method for trematodes identification and; direct smear to identify any stages for protozoans. Point prevalence was used to determine the prevalence of gastrointestinal parasites among cattle. The association between the prevalence of gastro-intestinal parasite and farming practice or farmers' knowledge was tested statistically using the Chi-square test of independence. Binary logistic regression analysis was used to determine the relationship between dependent and independent variables while data obtained from the farm and laboratory were analysed using SPSS version 21 software. The risk factors (farming practice and farmers' knowledge) associated with the prevalence of intestinal parasite infection were drawn from the analysis of the questionnaires that were administered during faecal collection. The overall prevalence of parasitic infection was 69.4%. The percentage prevalence by gender shows that females (67%) had relatively high percentage prevalence compare to males (64%). Percentage prevalence on breed Ayrshire (70%) had a relatively high percentage prevalence compared to Guernsey (60%). The percentage prevalence by ward was highest in Kirimukuyu (86%) and lowest in Iriaini (44%). Cattle of age 1-2 (69%), had relatively high percentage prevalence compared to age 3-4 years (55%). It was equally observed that the intensity of infection of cattle was generally very low. Most of the cattle (64.3%) had between 0-200 eggs per gram (epg). The gastrointestinal parasites identified in the study were *Schistosoma 12.14%, Strongyloides 4.39%, Fasciola 5.43%, Entomoeba 7.49%, Giardia 2.58%, Nematodirus 5.68%, Trichuris 2.33%, Toxocara 1.55%, Eimeria 9.82%, and Taenia 2.33%*. Risk factors (farmers' knowledge and farming practice) were significantly associated with the prevalence of gastrointestinal parasites. To manage gastrointestinal parasites and improve cattle farming veterinary services such as regular mass deworming, frequent diagnosis for infection and training farmers on control and prevention of infection are recommended.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Helminths (cestode, nematode, and trematode) and protozoan parasites are the major cause of gastrointestinal infection in cattle. Helminth parasites infecting ruminants are classified into two phyla, namely nemathelminths which are nematodes such as *Nematodirus*, and *Chabertia* and Platyhelminths which include cestodes (example *Taenia*), and trematodes such as, *Fasciola* and *Schistosoma* (Urquhart, Armour, Duncan, Dunn & Jenings, 2003). Transmission of GI parasites is mainly through ingestion of parasitic eggs and infective larvae on water, contaminated pasture, soil, transplacental, skin penetration, gastropod intermediate hosts, and arthropod (Greenland *et al.*, 2015). Gastrointestinal parasitism is a parasitic disease caused by different genera such as *Eimeria* and *Fasciola spp* that inhabit the digestive tract of cattle, causing damage to the gastrointestinal tract and tampers with the normal functioning of the infected animal (Cordero & Campillo, 1999). Protozoan such as *Eimeria* spp. that parasitizes ruminants such as cattle and poultry causes diseases such as bovine and ovine coccidiosis (Cordero & Campillo, 1999). Gastroenteritis in cattle is caused by GI parasites such as cestode, nematode, and trematode. The most prevalent genera worldwide is a nematode belonging to the order Strongylida (Charlier, Sanders & Vercruysse, 2009). Trematode such as *Fasciola hepatica* affecting cattle, sheep, and occasionally man, where an intermediate host for their transmission is required. Herbivory is one route through which cattle ingest infectious parasite, hence pasture condition is considered as a risk to parasitic infections. Different genera of gastrointestinal parasites are excreted through faeces to the environment by infected mammals and

transmitted to the animal during grazing (Hutchings, Athanasiadou, Kyriazakis, Gordon & 2003).

Infection by GI parasite can be either clinical or subclinical. A few or all of the following clinical signs may be seen: weight loss, reduced feed intake, diarrhoea, mortality, reduced carcass quality, and reduced wool production/quality. Extreme protein and blood loss in the intestine and abomasums due to injury resulting from blood-sucking parasites causes anaemia. The blood-sucking parasite includes *Haemonchus, Bunostomum* and *Oesophagostom* (Hansen & Perry, 1994). According to a study carried out in Indian, different helminths and protozoan parasites tampers with the health of the farm animals. Heavy infection by GI parasite inhibits digestion resulting in mal-absorption of vital mineral such as calcium and vitamin required for milk production, leading to a reduction in milk production (Murthy & Rao, 2014).

Gastrointestinal parasites infection remains a threat to the dairy industry, particularly in the central Kenya region, where it is of great importance since it acts as a source of livelihood for 1.2 million smallholder households. This is similar to the trend reported in COMESA and EAC countries, where 80% of produced milk comes from small scale farm holdings. Recent estimates demonstrate that the value of dairy products in the region is close to 30 billion and this can easily be doubled if stability in the industry is maintained (GOK, 2012). The Central Kenya region is the leading producer of milk compared to the other regions in Kenya (FAO, 2011). The dairy cattle population in this region estimated at 852,900 kept on smallholder dairy farms with approximately 1– 3 cows (GoK, 2012). The production per cattle among smallholders is estimated to be 1,400 litres per annum which translate to 4 litres per cattle per day (Mbugua, Kjonge, Muchemi, Waiyaki & Ngaruiya, 2012). The people of Mathira depend on agriculture and animal husbandry for their livelihood. Small

scale cattle farming is of great economic importance to the people of the Mathira constituency (www.nyeri.go.ke/livestock). Cattle infected with intestinal parasites could lead to significant economic loss, which could have far-reaching implications on the well-being of the residents. Besides, the consumption of products from infected animals could lead to poor health, reduced growth, the mortality of children and adult (FAO, 2011).

The amalgamation of several factors such as poor nutrition, communal grazing and lack of anthelmintic medication may end up to a serious worm burden in cattle (Pandey, Chitate & Nyanzunda, 1993). Hence grazing system such as rotational grazing of paddocks by calves ahead of heifer and cows could greatly reduce gastrointestinal infection. (Morley & Donald, 1980). Suitable management practices such as upgrade of farm husbandry routine can help decrease exposure to infection by a parasite such as *Eimeria* that tend to have a higher prevalence than the other parasites (Peter *et al.,* 2015). Athanasiadou, Arsenos and Kyriazakis (2001) reported that nutritional supplementation during the dry season in combination with pasture management could be used in controlling helminth infections in grazing production.

**1.2 Problem Statement**

This study tries to find out the prevalence of gastrointestinal parasites of cattle due to lack/limited information on associated risk factors and intensity of GI parasites. It is a matter of concern that studies on GI parasite have only been carried out in neighbouring constituency, without considering that Mathira plays an important role in the dairy industry. Moreover, most of the farmers in the study area depend on animal husbandry for their livelihood. The majority of the farmers are unable to control the occurrence of gastrointestinal tract infection due to low income, limited information on the prevalence and risk factor associated with GI parasites (Peter *et al.,* 2015.

It is of great importance to identify GI parasite infecting cattle in the study area and recommend control measures. Since most GI parasites are communicable from animals to human (zoonotic) under natural conditions. Some of the zoonotic parasites diseases include *trichinellosis, fascioliasis, hydatidosis, settariosis, ascariosis* and *amphistomiasis* (Pandey *et al.*, 1993)

The identified gaps thus need to be explored. The objectives of this study are to estimate the prevalence of GI parasite, the risk factor and intensity associated with GI infection. The research has led to the development of recommendation for the control of GIT parasites infection in cattle in the Mathira constituency.

## 1.3 Objectives

### 1.3.1 General Objective

To determine the prevalence of gastrointestinal parasites of cattle on inherent characteristics in the Mathira constituency.

### 1.3.2 Specific Objectives

The specific objective was:

1. To determine the association of farmers knowledge and prevalence of GI parasite in the Mathira constituency
2. To determine the association of farming practice and prevalence of GI parasite in Mathira constituency
3. To determine the combined association between prevalence of GI parasite and farmers knowledge and farming practice in the Mathira constituency

## 1.4 Hypothesis.

1. There was no significant association between farmers' knowledge and prevalence of the intestinal parasite in the Mathira constituency

2. There was no significant association between farm practice and the prevalence of the intestinal parasite in the Mathira constituency

3. There was no significant association between farmers' knowledge, farm practice and prevalence of the intestinal parasite in the Mathira constituency

**1.5 Justification of the Study**

Cattle's farming is a crucial activity for Mathira constituency; since it acts as a source of livelihood to many households. However, gastrointestinal parasitic infection is a limiting factor in cattle management. A research carried out in Mukurweini constituency reported improved management practice was associated with a lower prevalence of GI infection in Mukurweini, where farmers participate in zero-grazing farming and regularly treat cattle infected with GI parasite. In Mukurweini, the farmers have put in place management activities, such as proper feeding, housing and helminths control (Kabaka, Gitau, Kitala, Maingi & Van Leeuwen, 2013). According to research carried out in Kiambu, infection levels vary from locality to locality, thus extensive epidemiological studies on the intestinal parasites of cattle in the various agro-climatic zones in the country should be undertaken and sound control programmes formulated. Most of the animals examined had low to moderate strongyle type and liver fluke faecal egg counts (Waruiru *et al.,* 2000).

Most of the past research carried out has dealt with a single specific parasite, either a nematode, cestode or protozoan without putting into consideration that polyparasitism infection might have a greater impact on cattle productivity (Peter *et al.,* 2015). Furthermore, the understanding of the prevalence, predisposing risk factors, control and preventive measure of (GI) parasites will dramatically improve cattle herd health and result in reduced severity of gastrointestinal parasites, increased production and profitability of cattle farming

and ensure a supply of safe and nutritious dairy products for consumers throughout Mathira and the county at large.

### 1.6 Limitation of the Study

Like any other research, challenges were inevitable. Lack of previous research studies on the study topic or related topics in the study area hundred-baseline data on the gastrointestinal parasite. There was limited access to climatic data and geographical conditions of the study area.

### 1.7 Assumptions of the Study

The research study was based on the assumption that the respondents were honest in answering the questionnaire, and that data gathered by researchers was valid and reliable for testing the risk factors associated with the GI infection. In addition, the research study is believed to be timely and relevant to the respondent, as it will provide basic knowledge to their questions.

### 1.8 Definition of Key Terms

Infected cattle: Cattle whose stool samples were positive for GI parasite by microscopy

Prevalence: Prevalence is a statistical concept referring to the number of cases of GI infection that is present in a particular population at a given time

Refugia: The proportion of the parasite population that is not exposed to drugs and thus escapes selection for resistance

Anthelminthic resistance: Reduction in the efficacy of a drug against a population of parasites that are susceptible to this anthelminthic

Drug Resistance: It is the reduction in the effectiveness of a medication to cure a disease or condition.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

Gastrointestinal parasite (GI) is known to infect cattle worldwide. The most common GI parasites include trematodes of great economic significance like *Fasciola* spp (*Fasciola hepatica* and *Fasciola gigantica*) and *Paramphistomum* spp (*Paramphistomum cervei*), nematodes like *Strongyloide* spp, *Haemonchus spp, Ostartagia, Trichostrongylus, Cooper*ia and cestodes like *Monezia spp* (*Monezia benideni* and *Monezia expanza*) (Rafiullah, Sajid, Shah, Ahmad & Shahid, 2011). Protozoan parasites that has been identified and described are over 65,000 and are either parasitic or free living (Taylor, 2000). Some of the parasitic forms include *Cryptosporidium, Giardia lamblia, Entamoeba and Eimeria among many* (Taylor, 2000). Herbivory is one route through which cattle ingest infectious parasite, hence pasture condition is considered as a risk to parasitic infections. Besides, different genera of gastrointestinal parasites are excreted through faeces to the environment by infected mammals and transmitted to the animal during grazing (Hutchings *et al.*, 2003). Gastrointestinal disease is a problem that needs to be addressed because it acts as an obstacle to higher productivity as it leads to decreased weight, quality of skin and meat and growth retardation in young animals, and danger of zoonoses (*Thompson* & Smith, 2011; Maharana, Kumar, Sudhakar, Behera & Patbandha, 2016).

There are several control and management measures but none can work alone, integration of more than one measure is the way to go for long term solution to be achieved. Some of the measures to be integrated include good farming practices, best breeding strategies,

appropriate biological control measures, scientific utilization of biotechnological tools and techniques and appropriate chemical control measures is required to attain the sustainable control of the GI *parasites (*Kumar, *Rao,* Varghese & Rathor 2013).

**2.2 Economic Importance of the Dairy Industry**

Global meat and milk consumption are likely to grow significantly by 2050 due to the growing population and income. The demand for meat will more than double from 229 million tonnes in 1999 to 465 million tonnes in 2050 and that of milk will grow from 580 million tonnes to 1043 million tonnes (Steinfeld, 2006). Whereas the overall meat consumption in the developing countries is 326 million metric tonnes annually that also expected to double by the year 2050 (Mwinyihija, 2011). The increase in demand for animal products is driven by population growth, increased purchasing power and changes in dietary preferences favouring more animal source foods (ASFs) notably meat and milk (Delgado, 2003). The contribution made by Kenya's hides, skins and leather industry is estimated to 4% of agricultural gross domestic product (GDP) and 1.5% of total GDP (Mwinyihija, 2011). The dealer of hides, skins, leather and leather goods at the local market earns about KES 1.8 billion annually, while in the export the country earns approximately Ksh. 4 billion (Mwinyihija, 2011).

The beef cattle population in Kenya stands at over 9 million and the beef produced is consumed locally. The potential to export beef produced is limited by market accessibility and diseases. The total meat production is currently estimated at 320,000 MT annually. To improve performance in livestock production the government must promote animal health by reactivating and expanding dipping, breeding and clinical services including monitoring and control of animal diseases (Kiptarus & Director, 2005).

Smallholder dairy farming is the most important livestock enterprise in Nyeri County. The most popular breeds are Friesians, Ayrshires, Guernsey, Jerseys. A total of 172,000,000 litres of milk was produced in 2013 earning farmers Kshs. 4.3 billion. (www.nyeri.go.ke/livestock). The production per cattle among smallholders in the region is estimated to be 1,400 litres per annum which translate to 4 litres per cattle per day (Mbugua *et al.,* 2012). According to Sellen *et al.,* 1990 estimated returns to smallholder dairy farming in the Nyeri district were Ksh.3.1 per litre. A drop-in return was observed from the same district, the estimated profits were Ksh. 2.8 per litre in 1992 (Staal, 1996).

**2.3 Economic Importance of Gastrointestinal Infection**

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**2.3 Economic Importance of Gastrointestinal Infection**

Gastrointestinal parasite infection in cattle can be either subclinical or clinical. Subclinical infections might lead to major economic loss which results in production losses in adults and much higher mortality and morbidity in most young animals. Major economic losses that are caused by GI parasites include decreased work capacity, low fertility, reduce food efficiency, lower weight gain, lower milk production, increased treatment cost and mortality in seriously parasitized animals (Williams & Loyacano, 2001). A gastrointestinal infection has adverse effects on animals; including reduced productivity, mortality and reduced animal performance (Sykes, 1994). The productivity of animals is held back due to gastrointestinal infections that can have a substantial effect, ranging from reduced proficiency utilization of food due to reduced food intake, however in some instance increase in nutrient demand are initialized by damage or host tissue loss (Sykes, 1994).

Studies have revealed that helminthic parasites are undoubtedly the causes of enormous production losses for most farmed ruminants. On the other hand trematodes parasite are also inarguably the mainspring of severe losses in production for ruminants in the sub-Saharan Africa region (Odoi, Gathuma, Gachuiri & Omore, 2007; Kanyari, Mhoma & Kagira, 2009). In most instances, infections with intestinal nematodes in cattle might not result in disease. Nevertheless, serious infestation aggregate to clinical Parasitic Gastro Enteritis (PGE) and this sub-consequently leads to appetence and changes in protein, water balance, mineral metabolism and energy (Fox, 1993). In Thailand, gastro-intestinal parasite infection is of great significance, particularly liver fluke caused by *Fasciola gigantica.* The parasites directly cause reduced growth, productivity and poor health to traditional domestic animals of Thai farmers (Chompoochan, Nithiuthai & Prasitirat, 1998). Animals in India experience major problem caused by gastrointestinal (GI) parasitism which causes diarrhoea, emaciation, weakness, anaemia, oedema and death (Singh, Das, Roy, Nath, Naresh & Kumar, 2015). According to a study carried out in Indian, different helminths and protozoan parasites harm the health of farm animals. Heavy infection by GI parasite inhibits digestion resulting in mal-absorption of vital mineral such as calcium and vitamin required for milk production, leading to a reduction in milk production (Murthy & Rao, 2014). According to research carried out in Tanzania Ngorongo district it highlighted that Sub-clinical infections are of major economic value as they lead to delayed growth; animals become more vulnerable to other infections and a reduction in productivity (Swai, Mtui, Mbise, Kaaya, Sanka & Loomu, 2006). In semi-arid coastal Kenya, the total loss due to *Fasciola. gigantica* and *Fasciola .hepatica* infested livers was Ksh 4,408,272 (USD 72,272). Fasciolosis contributed Ksh 3505410 (79.5%) and *Fasciola hepatica* infestation Ksh 903,210 (20.5%) to the total losses due to liver condemnations (Mungube, Bauni, Tenhagen,

Wamae, Nginyi & Mugambi, 2006). Approximately US$ 2.5 billion is spent on drugs in the cattle industry for control of parasite (Williams & Loyacano, 2001). Milk production increased from 4-18% in anthelmintic treated cattle (Singh *et al.,* 2015). A higher infection in calves than in adults was recorded and the same infection was associated with a decrease in milk production of 1.4 litres per cow per day less milk which cost Ksh 28/day/cow (Kabaka *et al.,* 2013). Several benefits emerge from effective control of gastrointestinal parasite ranging from increased reproductive performance, weight gain, carcass quality, improved milk production, reduced mortality and morbidity, increased feed conversion and improved immune status (Jittapalapong *et al.*, 2011).

Gastrointestinal parasites infection remains a threat to the dairy industry, particularly in the central Kenya region, where it is of great importance since it acts as a source of livelihood for 1.2 million smallholder households. This is similar to the trend reported in COMESA and EAC countries, where 80% of produced milk comes from small scale farm holdings. Recent estimates demonstrate that the value of dairy products in the region is close to 30 billion and this can easily be doubled if stability in the industry is maintained (GOK, 2012). The people of Mathira depend on agriculture and animal husbandry for their livelihood. Small scale cattle farming is of great economic importance to the people of the Mathira constituency (www.nyeri.go.ke/livestock).

## 2.4 Factors Influencing Gastrointestinal Parasite Infection.

### 2.4.1 Climatic Factors

The season is also a factor to consider since during hot, cold and rainy season the infection rate is high. Parasite such as *Strongyloides Eimeri* and *Cryptosporidia* in calves were prevalent in Mukurweini (Peter *et al.*, 2015). According to Odoi *et al.*, (2007) an upsurge of

faecal egg count (FEC) was approximately two months after the start of the rains, hence season stand to be an important determiner of FEC (Kabaka *et al.,* 2013).

### 2.4.2 Age and Gender Factor

Animals with less than 12 months old had a higher FEC of GI nematode as compared to adults. Therefore, adults are viewed as the source of infection and cause a constant infection for more vulnerable young animals (Pfukenyi & Mukaratirwa, 2013). Younger animals have little or no resistance to GI nematode infections compared to older animals with more resistant. The periparturient egg rise was confirmed by a higher number of egg count of GI nematodes by pregnant and lactating cows as compared to dry cattle, bulls and oxen (Pfukenyi & Mukaratirwa, 2013) Younger cattle tend to be more susceptible to GIT infections in comparison to adults, with the enormous impact caused by superfamily *Trichostrongyloidea*, which result to clinical expression including mucous membranes that are pale because of anaemia, poor body condition (Charlier *et al.,* 2009) and reduced immunity (Urquhart *et al.,* 2003). The probability of infection is highest for young and old animals and lowest in middle-aged animals (Zvinorova, Halimani, Muchadeyi, Matika, Riggio & Dzama, *2*016). In addition, recurrent infection with *Paramphistomum spp* occurred in adults while *Toxocara spp* were common in calves. Local young cattle were frequently infected with *Trichostrongylus spp* whereas infection with *Haemonchus spp* was notable higher in local adult cattle. Most cases of gastrointestinal infection were found in young ruminant in comparison with adult ruminant (Singh *et al.,* 2015. Hence, suitable management practices from the age of 1 month are of great importance in the control of gastrointestinal infections in calves (Peter *et al.,* 2015). According to Mungube *et al.,* 2006 he perceives that there is still more work to be done to ascertain the prevalence of the

infection in animals of various ages group, species, breeds and the economics of disease control at the farm level.

### 2.4.3 Geographical Location.

Intestinal parasite varied with a geographical location in selected areas of Gampaha District, Sri Lanka, hence geographical location influences the infection rate (Gunathilaka, Niroshana, Amarasinghe & Udayanga, 2018). The particulars about the most prevalent GI parasites in varying geographical locations will assist in the invention of preventive and control strategies for parasitic problems. This includes early detection and treatment that results in reduced economic losses to poor farmers who depend on cattle farming for their livelihood (Murthy & Rao, 2014). Subsequently, pastoralist communities inhabiting areas contiguous to wildlife areas are at risk of been infected by zoonotic parasites. The tendency of closely related host species to be infected by a similar parasite was high (Obanda, Maingi, Muchemi, Ng'ang'a, Angelone & Archie, 2019). In places where nutrition is so limited, such as arid and semi land much more decrease in productivity is expected in the presence of parasite infection. A viable control approach should be incorporated to accelerate the productivity of the livestock (Maichomo, Kagira & Walker, 2004).

Farmers in central Kenya have not fully embraced modern agricultural practices. Cattle in this region are fed in an unhygienic and poor environment and therefore a higher chance of infection. Parasite such as *Cooperia*, *Oesophagostomum*, *Haemonchus* and *Trichostrongylus*, were the cause of parasitic gastroenteritis in a study carried out in Kiambu, Kenya (Waruiru *et al.,* 2000).

Currently, there is insufficient information on the prevalence of GIT parasites in cattle in the Mathira constituency. Intestinal parasitic infections caused by helminths and protozoans are

among the most widespread and a major cause of morbidity and mortality in developing countries (Gedle, Kumera, Eshete, Ketema, Adugna & Feyera, 2017). The study investigated the temporal and spatial distribution of gastrointestinal parasites and the associated risk factors in cattle. The results were used to design and recommend appropriate mitigative measures.

### 2.4.4 Epizootiology

Epizootiology of parasitism is crucial for the effective control of the gastrointestinal parasite (Odoi *et al.,* 2007). In developing countries, grazing practice is strongly associated with GI parasites because pasturage is usually not available or provided (Jittapalapong *et al.,* 2011). According to Akand *et al*., (2014), age and season influence gastrointestinal parasitism. The season is one of the determinants of GI parasite survival, some parasite such as *Paramphistomum spp* were common during the rainy season whereas. *Moniezia spp* and *Haemonchus spp* were identified in summer (Singh *et al.,* 2015). There are several other factors that influence FEC include grazing system, age group, manure removal source of forage de-worming during the preceding month and farmers education (Kabaka *et al.*, 2013). Other than poor hygiene there are other numerous correlated risk factors exerting influence on the prevalence and intensity of GI infection. They include management practices, weather condition, age and sex (Khan, Sajid, Khan, Iqbal & Hussain, 2010). Other multiple factors influence the occurrences of GI infections such as breed, nutritional status, environment, ecology and pathogenicity of the parasites (Pfukenyi & Mukaratirwa, 2013).

## 2.5 Global Distribution of Gastrointestinal Parasite

In Tondojam, Pakistan the most common GI parasites were *Taenia, Haemonchus, Trichuris, Trichostrongylus, Liverfluke, Paramphisomum* and *Eimeria* Amongst all gastrointestinal parasites observed in the region, the liver fluke was predominant and appeared to be most prevalent in buffalo, Cow, Goat and Sheep (Khaskheli *et al.,* 2016)

The prevalence of natural fasciolosis in cattle in Central France showed an increased from 1990 to 1993 (25.2% to 13.6%) and decreased thereafter to 1999 (at 12.6%). Natural paramphistomosis displayed a progressive increase between 1990 and 1999 (from 5.2 to 44.7%). The increase of prevalence for paramphistomosis in cattle and snails was explained by a better quality of diagnosis for the detection of *P. daubneyi* eggs in veterinary analysis laboratories, the use of specific molecules in the treatment of cattle fasciolosis since 1993, and the lack of an effective treatment up to now against cattle paramphistomosis (Mage, Bourgne, Toullieu, Rondelaud & Dreyfuss, 2002).

In Swiss, Germany endoparasites such as *E. bovis*, *C. parvum*, *S. papillosus* and *Trichostrogylida* were frequently observed in healthy calves than in diarrheic calves, except for *E. zuernii* (Lentze, Hofer, Gottstein, Gaillard & Busato, 1999). According to research in Sri Lanka by Gunathilaka *et al.,* (2018) the highest infection occurred in Kelaniya, followed by Welisara, where calves and yearlings had the highest rate of GI parasitic infections. Neto and Fonseca (2002) of Rio de Janeiro noted that *Trichostrongylus* tend to have a higher resistance to the environment especially during the harsh seasons, which enable them to both survive and reinfection.

In Taiwan, Eat Asia prevalence of gastrointestinal parasitic infection stands at 86.9%. Protozoan are the most common parasite in the region. The most occurring parasites

include *Buxtonella sulcate, Cryptosporidium spp* and *Eimeria spp* (Huang, Wang, Pan,Yang & Lai, 2014).

### 2.6 Distribution of Gastrointestinal Parasite in Africa

The tropical climate of sub-Sahara Africa tends to favour gastrointestinal helminths since the tropical climate is associated with a wider range of agroecological factors suitable for the survival of diversified hosts and helminth species (Sissay, Asefa, Uggla & Waller, 2006). A research carried out in Ghana pointed out that intestinal parasites are more common in cattle compared to other ruminants. The GI parasites have great economic significance and others are also zoonotic. It is important to improve on the present control method in order to better production (Squire, Amafu-Dey & Beyuo, 2013).

Four groups of parasites which include trematodes, protozoa, cestodes and nematodes were identified in Akure Nigeria. Among the parasites, *Enterobius vermicularis (protozoan)* had the highest prevalence while the least prevalent is *Avitelium spp* (cestode) which was absent in male cattle but present in female cattle (Peter *et al.,* 2015).

According to research carried out in Tanzania animals that excreted amphistome eggs were higher than that of animals excreting *Fasciola* eggs in all study zones, villages, management systems, farms and age groups. The number of animals infected with fluke eggs increased steadily from the early dry season and peaked at the end of the dry season and the early part of the rainy season. (Keyyu, Monrad, Kyvsgaard & Kassuku, 2005)

In Colombian, Northeastern Mountain cattle and sheep were commonly infested with helminths and coccidia. There was moderate infection with GI parasite for both species hence demanding treatment. Some parasite like F. *hepatica* that is zoonotic were present hence posing risk to public health (Murthy & Rao, 2014).

## 2.7 Distribution of Gastrointestinal Parasite in Kenya

In Kirinyaga the most prevalent intestinal parasite in cattle is *Haemonchus, Oesophagostomum, Nematodirus* and *Trichostrongylus* species. Trematodes species of *Fasciola, Shistosoma* and *Paramphistomum* were seen to be common in zebu cattle with *Schistosoma* showing the highest prevalence (Kabaka *et al.,* 2013). Trematode infection was more common in young stock and adults compared to calve. While Strongyles were the most common nematodes among cattle under one year. Most of the cattle had a mix infection of 2 to 3 parasite types while very few had none, single or multiple infections (Kanyari *et al.*, 2009)

The research carried out across Kenya indicate that fasciolosis is most prevalent in cattle in all provinces of Kenya -the highest prevalence of fasciolosis occurring in Western Province. *Fasciolosis* causes great economic losses as a result of the condemnation of infected livers. (Kithuka, Maingi, Njeruh & Ombui, 2002). The overall prevalence of nematodes in the calves found in Magadi, South Western Kenya was 69.2 %, while the prevalence of coccidial oocysts in calves was 30 %. Poor productivity in ASAL areas is expected to be more pronounced due to poor nutrition and parasite infections. Hence sustainable internal parasite control should be put in place.to increase the productivity of the livestock there (Kagira, Walker & Maichomo, 2004)

The most prevalent GI parasite in Kajiado District was Strongylosis (nematode), with 40 per cent of the cattle were infected. Infection rate and age in cattle were correlated with most of the cases occurring in calves. Coccidiosis infection was second after strongylosis in prevalence, which occurred in calves, kids and lambs (Ndarathi, Waghela & Semenye, 1989)

**2.8 Antihelmith Interaction.**

The resistance of antihelminth is outlined as a reduction in the effectiveness of an anthelminth towards a given group of parasites that are normally vulnerable to that drug. This reduction in vulnerability is an effect of an increase in the frequencies of ‘‘resistance’’ gene alleles that come because of selection through repeated use of an anthelmintic (Sangster, 1999)

Resistance developed by nematode and trematode to a variety of anthelminths has posed a serious problem. Over the past decades, relatively few chemically dissimilar groups of anthelmintics have been introduced, resulting in widespread resistance. A higher percentage of antihelminths originate from one of three chemical classes, macrocyclic lactones, benzimidazoles and imidazothiazoles within which all individual compounds act similarly. Hence, resistance to one specific compound may be accompanied by resistance to other members of the group (that is, side-resistance) (Merck, 1991).

Genetic interactions have implications because of the usage of anthelmintic combinations and for drug rotation schemes and emphasize the urgency for a proper understanding of the mechanisms and genetics of anthelmintic resistance to provide accurate advice on a better way to control (Prichard, 2001).

There was a spontaneous increase in a complete malfunction of the modern spectrum antihelminths in the control of nematode in the flock in regions such as subtropical/tropical regions of the world. Blood-sucking parasite such as *Haemonchus contortus* is more pathogenic and has developed resistance and cannot be controlled by chemotherapy, leading higher mortality of flock (Sissay *et al.,* 2006).

An addition of ivermectin to both albendazole and mebendazole lead to an improved therapeutic outcome against *T. trichiura* and may be considered for use in soil-transmitted helminth (Knopp *et al.,* 2010)

Multidrug (benzimidazoles and macrocyclic lactones) resistance in cattle nematodes has been documented on farms in Europe, New Zealand and the Americas, and there is a probability of spreading widely. Several worm species have developed resistance, for instance, *Cooperia* spp and *Ostertagia ostertagi* have developed resistance toward macrocyclic lactone. More research is needed to know the exact extend of antihelminths resistance in cattle nematode (Merck, 1991).

Factors promoting anthelmintic resistance include long term use of the same anthelmintic class, under-dosing, lack of efficacy testing and treatment when environmental refugia are low (Falzon, O'neill, Menzies, Peregrine, Jones-Bitton & Mederos, 2014).

**2.9 Prevention of Resistance to the Gastrointestinal Parasite.**

It is crucial to acknowledge resistance as a genetic characteristic that can only be revealed phenotypically at a point when the allele frequencies of resistance genes come to relatively high levels. The resistance toward Benzimidazole could not be perceived till 25% of the intestinal nematode was resistant (Anderson, 2000). Refugia-based strategies are intended to help slow the development of anthelmintic resistance by providing a population of parasites that are not exposed to the treatment (Greer, Van Wyk, Hamie, Byaruhanga & Kenyon, 2020). The maintenance of a parasite population that is unexposed to a drug (refugia) will maintain the genes for susceptibility within the parasite population. Several management plans employ refugia-based methods include targeted selective treatments (TST), targeted or strategically timed whole flock treatments through which only a

proportion of the flock is treated at any one time, and the dilution of resistant with susceptible parasites (Kenyon *et al.,* 2009).

Preventive and control of parasite should not depend on the sole use of anthelmintics, but engage other more complex and sustainable methods, including pasture management, parasite resistant breeds, nutrition, nematode-trapping fungi, botanical dewormers and antiparasitic vaccines (Shalaby, 2013)

**2.10 Findings on Research done on the Revalence of GI Tract Infection**

Among all nematode species, the most predominant ones include, *Cooperia, Oesophagostomum*, *Haemonchus* and *Trichostrongylus*. Several factors such a season, farm and age of the animals had a noticeable influence on the intensity of infection with strongyles, liver flukes and coccidia, whereas the gender of the animals had no significant impact on the prevalence or intensity of infections (Waruiru *et al.,* 2000).

According to Swai *et al.,* (2006) the majority of the animals examined had minimal to a moderate count of *coccidia* oocyst and *strongyle* eggs and the infections were mainly sub-clinical. Sub-clinical infections may lead to delayed growth, decrease production and animals became more vulnerable to other different infections. To optimize the production and control of GI parasite a good, cost-effective control plan should be put in place. A proper gastrointestinal tract (GIT) parasite control plan is required to not only optimise production but also to reduce the number of infected cattle which will continuously contaminate pastures (Swai *et al.,* 2006).

## 2.11 The Life Cycles of the Different Gastrointestinal Parasite.

### 2.11.1 Life cycle of *Nematodirus* worms by Junquera, 2014

Nematodirus have a direct life cycle, therefore they lack an intermediate host. The adult female lay their eggs in the small intestine, which are in turn shed in the faeces by the host. Once the eggs are shed the larvae remain inside the egg to complete development to infective larvae. Therefore, they can withstand very cold winters because of their resistance to cold and dryness.

Figure 2.1: Nematodirus egg under light microscope (adapted from Junquera, 2014

**(www.vetbook.org)**

It can take 2 to4 weeks for the larvae that are infective to complete their development. Several factors such as environmental conditions and species determine how quick the infective larvae will hatch. For some species such as *Nematodirus filicollis and Nematodirus battus* to hatch, they have to be exposed to long cold periods. Larval development can also

be completed indoors and infective larvae can survive inside animal facilities for months. Livestock can only be infected if it consumes pasture contaminated with larvae that are infective, outside or inside the egg, depending on the time of the year and species. Immediately the ingested larvae reach the small intestine complete development of adult occur and laying of eggs follows. The period between infection and when the first eggs are shed (**prepatent period**) is 2 to 4 weeks (without dormancy).

#### 2.11.1.1 Impact Caused by *Nematodirus* Worms, Symptoms and Diagnosis

Among gastrointestinal roundworm, *Nematodirus spp* are not the most harmful to livestock. Some species such as *Nematodirus battus* are infectious to lambs leading to serious illness even before the larvae complete development to adult that is before egg production start. Larvae are the most destructive stage. Instances of heavy infection damage can be witnessed because they eat the tissue of the gut's wall. Clinical signs include strong diarrhoea that is dark, green or yellow leading to dehydration; reduce weight gains and loss of appetite in chronic infections. Diagnosis is grounded on **t**he clinical signs and confirmed by detection of characteristic eggs in the faeces.

#### 2.11.1.2 Prevention and Control of *Nematodirus* Infections

Farming practice such as regular and thorough removal of all manure, keeping the animal facilities dry, proper hygienic and pasture rotation will reduce the *Nematodirus* and other GI parasite infection in livestock. Many broad-spectrum anthelmintics are effective against adult worms and larvae for example benzimidazoles and several macrocyclic lactones.

### 2.11.2 Life Cycle of *Strongyloides* Worms by Junquera, 2014

*Strongyloides* has a special and complex life cycle. It can complete both asexually and bisexually development. Parthenogenic reproduction occurs once the worm is inside the final host following a cycle called homogenetic**.** This implies that an adult female reproduces asexually produces approximately 2000 eggs per day (which are viable), which is not fertilized by males but can develop into an adult worm. When the egg is been deposited it already contains well-developed larva 1 (L1) larva.

These asexually produced eggs are egested from the host with faeces**.** Once in the environment **s**ome of these eggs hatch and develop directly to infective larva 3 (L3) larvae in 2 to 3 days. When outside the host they can remain infective for up to 4 months by suitable conditions, but they don't resist cold and dryness. The larvae infect a host again via the skin or are ingested with contaminated pasture, food or water. After ingestion, they undertake a migration through blood vessels, lungs, trachea, mouth and small intestine. Some larvae develop indirectly, that is a heterogenic cycle (bisexual route) and in the environment, they complete development to either male or female adult, which is not common behaviour to parasitic helminths. After mating and fertilization, the adult female produces eggs within 7 to 10 days, which develop to infective L3 larvae. These larvae that are bisexually produced and free-living can either complete development to adult males and females in the environment or infect a host through the skin or orally. Complete development to adult occurs in the host gut where only female are produced, which start producing eggs pathogenetically.

Some of the migrating larvae might change the route from the usual route to the lung and move to other organs, such as the udder, the placenta and the milk. Suckling young one can

be infected directly (galactogenic transmission). While the unborn can be infected with transplacental/perinatal).

The mechanisms that trigger one or the other development paths are not completely elucidated. It is observed that the type of host, its health and especially its immune system play a role in the future development of the larvae.

#### 2.11.2.1 Prevention and Control of *Strongyloides* Infections

These worms are commonly found in large numbers in warm regions and particularly harmful to young stock. Therefore, preventative measures should concentrate on protecting young stock, which involves protecting pregnant and lactating stock as well, since it can directly infect its offspring.

Stringent hygiene and removal of manure (in pens, stables and boxes.) are mandatory, and the facilities should be kept as dry as possible, which diminishes the risk of infection through the skin since larvae need humidity to survive and reach their hosts. Grazing on dry pastures reduces the survival of infective larvae and hinders infection through the skin.

Progressively livestock exposed to these worms develops natural resistance. In such a case resistant animals do not fall ill if infected, hence progressively shedding eggs that contaminate the environment.

Dewormers containing benzimidazoles, levamisole and tetrahydropyrimidines kill the worms a short period after treatment. Consequence, treated animals are cured of worms but are not protected against new infections. The animal must be dewormed regularly for them to remain worm-free, considering the ecological, local epidemiological and climatic conditions.

### 2.11.2.2 Resistance of *Strongyloides spp* to Anthelmintics

Nonetheless, at the moment resistance of Strongyloides *spp* tend to be less widespread as compared to the resistance of other gastrointestinal roundworms such as *Ostertagia* spp, *Cooperia spp*, *Haemonchus spp* among others. Consequently, if an anthelmintic fails to accomplish the anticipated efficacy against *Strongyloides* worms, there is a definite risk that it is due to resistance to anthelmintics, specifically in goat and cattle. However, most instances of product failure are certainly because of inaccurate use of a product, or to the use of the inappropriate product, not to resistance.

### 2.11.3 Life cycle of *Toxocara vitulorum* by Junquera, 2014

There is no intermediate host for the direct life cycle of *Toxocara vitulorum*s. Eggs that are laid by the mature adult female in the small intestine of the host are shed together with the faeces. This species is one of the most productive worms: bearing approximately 8 million eggs that can be shed daily. The larva 2(L2) develop inside the egg: at the right temperate of 27°C to 30°C in 7 to 15 days. Below 12°C development is inhibited and can only continue when temperatures rise. These eggs containing the L2 larvae are quite contagious and contaminate the pastures. They are very sensitive to sunlight but can live for months or even years.

Ingestion of embryonated egg leads to the infection to adult livestock. Immediately it reaches the gut the larvae that come out of the embryonated egg, penetrate the walls of the gut and move via the bloodstream to the liver, lungs, trachea, mouth, oesophagus and then back to the small intestine where they finish their development to adult worms and start producing eggs; or they might migrate to other tissues, such as the mammary glands and the

placenta of pregnant cows from where they can be passed on to the calves or unborn embryos, respectively. For up to 5 months the larvae can survive on the tissues.

Larvae that happen to reach the mammary glands remain dormant until about 3 weeks before birth when they are revitalized and passed to the sucklings with the milk during the first 3 weeks after birth (lactogenic transmission). Transmissions via the milk tend to be the most frequent way of infection in calves. Subsequently, those calves that get infected the larvae that precede to the intestine cannot migrate further but instead develop directly to adult worms in approximately three weeks after birth or after suckling. Infected calves shed eggs for 3 months maximum then ends quickly after.

The period between infection and first eggs shed is approximately 3 to 4 weeks in calves. The time is taken by the larvae to migrate and for the embryonated egg to break dormancy in adult cows might take a longer time. Nevertheless, it's like most larvae do not complete development and only lay eggs in adult cows but are perinatally transmitted to the offspring.

### 2.11.4 Life Cycle and Biology of *Fasciola gigantica* by Junquera, 2014

*Fasciola gigantica* has an indirect life cycle with freshwater snails as the intermediate hosts**,** examples the genus *Lymnaea, Physopis, Radix*. Eggs are produced by adult flukes in the biliary duct of the host. Once these eggs reach the gall bladder they are moved to the host's gut when the gall bladder is emptied. They are passively moved to the anus and are shed with faeces. A single fluke can lay up to 25000 eggs a day.

Immediately after it reaches outside the host, it takes 7 to 15 days for the larvae miracidia to hatch out of the eggs. For as long as there is abundant humidity the larvae can remain alive for several weeks. In a dry environment, they die quickly. Miracidia are capable of swimming and creep into the snails where they remain for 4 to 8 weeks and develop

successively to sporocysts**,** rediae and cercariae**,** the usual larval stages of most fluke species. A single miracidium can asexually produce up to 600 cercariae.

Mature cercariae leave the snail, attach to the vegetation, lose their tail and produce **cysts** of about 0.2 mm, the so-called metacercariae, which are infective for the final host. Such cysts can survive for months in the vegetation, both underwater and under dry conditions. Livestock becomes infected by feeding on contaminated pastures or hay that is animals kept inside can also become infected if they are fed on contaminated hay. Once the immature fluke is inside the final host it hatches out of the cysts and within a short time, they migrate from the intestinal wall and get into the abdominal cavity where they move towards the liver. For the fluke to reach the biliary ducts they must cross the hepatic tissue, a specifically harmful process for the host that lasts approximately 6 to 8 weeks. When they reach the biliary ducts they complete their development to adult flukes and start producing eggs. The prepatent period of *Fasciola gigantica* is about 9 to 12weeks**,** subject to the host and other factors.

Livestock grazing in swampy, marshy or flooded regions or close to water places are at high risk of becoming infected with the tropical liver fluke. Evidence shows that consumption of contaminated raw liver with juvenile flukes can be infectious for human.

**The harm caused by *Fasciolagigantic***

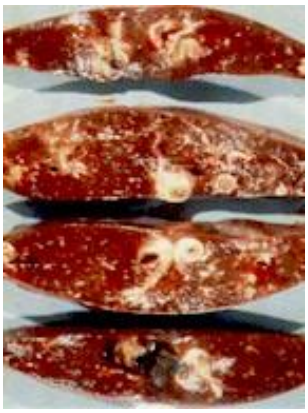

Figure 2.2: Bile duct damaged by Fasciola spp (Kaufmann, 1996).

The Young immature flukes moving through the liver tissues and crossing the wall of the bile ducts resulting in major damage. This activity damages the tissues and causes bleeding. The spines on the surface of the flukes irritate the tissues that end up been inflamed. All this ends up in cell death and fibrosis**,** which is the formation of excessive connective tissue that replaces the dead liver cells, which damage the normal functioning of the liver. The infected liver becomes fragile and big. Some flukes can become enclosed in the liver tissues and build cysts as large as walnuts. The bile ducts are also damaged: they become thickened and can be calcified and even obstructed. General weakness of the host weakens its immune system, lead to infection with secondary bacteria. Furthermore, the normal functioning of the liver is tampered with by toxin produced by the fluke.

In summary, the many vital physiological processes that run the liver are affected. The affected animal end up sick to an extent that it depends on the number of flukes that infect them. The major economic damage is a reduction **of** weight gains of up to 30% less, even after slight infections in young calves and the **condemnation of livers** at slaughter.

### 2.11.4.1 Symptoms and Diagnosis of *Fasciola gigantica* Infections

There are no typical and easily recognizable symptoms of a liver fluke infection in livestock or other animals. The major symptoms are related to the inflammation of the liver **(**hepatitis**)** and of the bile ducts **(**cholangitis**)** that can be also due to other disorders. Other vital organs are usually not affected.

The most common form of infection in sheep, goat and cattle is chronic fasciolosis. It develops along with the gradual establishment of adult flukes in the bile ducts. It is identified by the development of such symptoms as anaemia (reduced number of red blood cells), oedema (local swellings due to excess fluid) often as "bottle jaw**",** digestive disturbances **(**diarrhoea, constipation etc.), and cachexia (wasting, i.e. weight loss, fatigue, weakness, loss of appetite, etc). Acute fasciolosis is rare in cattle but can occur in sheep. It occurs as a result of the sudden movement of many immature flukes through the liver, which ends up in complete organ failure. It can develop in healthy animals that may be killed in a few days.

The diagnosis is through the detection of eggs in the faeces. There can be a false positive since the eggs are passed to the intestine when the gall bladder is emptied, hence a negative faecal egg count is not conclusive.

### 2.11.4.2 Prevention and Non-chemical Control of *Fasciola gigantica* Infections

*Fasciola gigantica* can infect almost all mammal species, wild and domestic animal. Consequently, it is almost impossible to eradicate it from a given property in endemic regions with favourable conditions. Therefore, where it is known to occur, mitigating

methods are required to reduce the snail population, infection of pastures with an infective stage.

Snail vector lives in water (like watering holes, ponds, ditches, streams, lakes, pools, swamps, marshes, irrigation channels waterlogging, among others.). The typical habitat in many regions is rice fields. These snails are enormously prolific: a single snail can produce more than 100000 snails within one year.

Whichever, methods that aid in keeping the pastures dry or shorten the survival of encysted metacercariae or reduce the snail population have to be promoted. The methods include; making sure that there is good drainage, building watering points on solid ground, make unavoidable ditches or channels less attractive to the snails by making the borders steeper and/or cover them with concrete, eliminate the surrounding vegetation, avoid waterlogging as extremely small water places support the snails, fencing of environments that are permanently humid will prevent livestock from grazing there, rotational grazing will lessen fluke infestations and grazing of sheep and cattle in the same piece of land is not advisable.

Infected livestock with liver fluke can develop a certain level of natural immunity and become resistant particularly cattle. Animals with chronic fasciolosis may recover spontaneously. However, slight damage to the liver function due to hepatic fibrosis which is associated with natural resistance results in reduced productivity. Healthy and well-fed livestock reduces the harm caused by liver flukes and aid in the development of natural immunity.

#### 2.11.4.3 Chemical control of *Fasciola gigantica* infections

Active elements with efficacy against flukes such as flukicides or fasciolicides should be recommended in the treatment of cattle infected with *Fasciola spp*. Preventive measures

mentioned early and the use of flukicides is recommended in an endemic region. Treatment that is administered on the onset of the first symptoms often too late, since much harm has been already done and pastures might already be contaminated with fluke eggs. The best application time of such preventative treatment strongly relies on ecological conditions and local climatic that drive the snail population.

The use of chemicals such as molluscicides (that is snail killers) such as copper sulphate**,** sodium pentachlorophenate, niclosamide, to control snail can be logic if placed where livestock congregates e.g water holes, salt licks shade trees etc to keep them free of snails. However, trying to get rid of snails from a property might be hard.

### 2.11.4.3 Resistance of *Fasciola gigantic*

*Fasciola hepatica* is known to have developed resistance to several flukicides in various regions. To prevent or at least delay the development of resistance it is highly recommended to periodically change the chemical class of the product used, before resistance is suspected, example every one or two years. This is usually called **rotation**.

### 2.11.5 Life cycle and Biology of *Schistosoma* spp

Blood flukes have an indirect life cycle with freshwater snails as the intermediate hosts**,** mainly of the genus *Bulinus*. The eggs are laid by an adult female in the capillaries of the intestinal wall. Abscesses are formed by egg masses that later burst and release the eggs into the gut, where they are transported outside together with the host faeces. The abscesses usually heal spontaneously.

Immediately the eggs are outside and in contact with water, small swimming larvae are released by the eggs, the miracidia, identify a suitable snail and penetrate its body. While

inside the snail miracidia develop further during 1 to 4 months through two generations of **s**porocysts to asexually produce dozens of cercariae**.** Mature infective cercariae exit the snail via its respiratory hole. A single snail can release up to 3000 cercariae.

Figure 2.3: *Schistosoma spp* egg (adapted from Kaufmann, 1996).

The cercaria is a free-swimming search for a final host actively. Their survival in the environment is limited to a few days. These infective cercariae get into the host through the skin or are ingested with contaminated water when grazing in swamps or humid vegetation. Immediately they are ingested the cercariae penetrate the rumen. Once they are inside the host's body move to the blood vessel and begin a species-specific migration. They are passively transported with the blood to various organs until they come to their preferred location in the body they complete development to adult flukes, mate and start producing eggs. They feed on red blood cell as they migrate to the host body.

### 2.11.6 Life cycle and Biology of *Taenia* spp by Junquera, 2014 and CDC, 2010

Most *Taenia* species have an indirect life cycle with cats, human and dog (or other carnivores) as their **last hosts**, and other domestic or wild animals (often livestock) as intermediate hosts**.**

In the final host (dogs, cats, humans) the eggs are shed with the faeces, often still inside gravid segments that have detached from the worm's body. Sometimes a chain of gravid segments is shed and can be seen by the naked eye in the faeces of the host or on the skin around the anus.

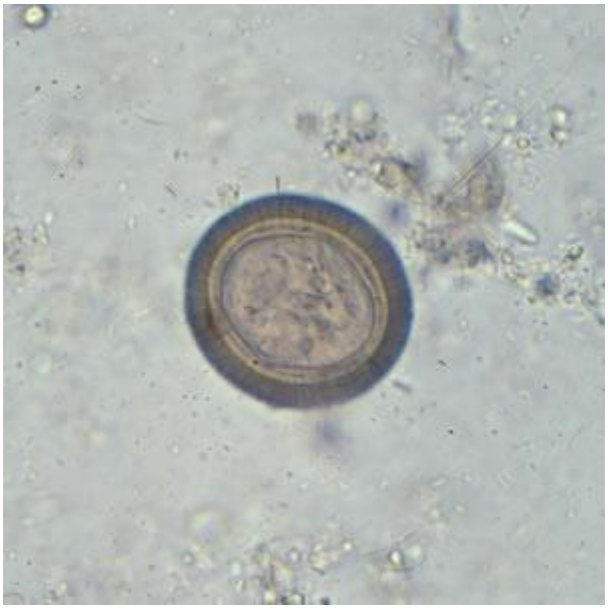

Figure 2.4: *Taenia spp* egg (CDC, 2010)

The eggs are directly infective for the intermediate hosts and can remain infective for months in a moist and cool environment, but die quickly under dry and hot conditions. Eggs in hay may remain infective for several weeks. The intermediate host (e.g. cattle, sheep, pigs, etc.) ingests the eggs with contaminated food or drinking water. In the host's gut the young larvae hatch out of the eggs, go through the gut's wall and reach the bloodstream. They are then

passively transported throughout the body. After being stopped in a capillary they develop cysticercoids or bladder worms**.** They will not complete development to adult worms but remain there until a final host eats the intermediate host (or its offal).

The final host becomes infected when it feeds on offal contaminated with cysticercoids. In its gut, the cysticercoids release the young worms (called *protoscolices*), which attach to the gut's wall and start producing segments (*proglottids*). The period between the first infection and shedding of the first egg is 5 to 12 weeks and is species-specific. Inside the last host, adult worms can survive for years.

Diagnosis of *Taenia* tapeworm infections is through stool examination of stool samples; identification of tapeworm segment in the stool. Stool specimens should be collected on three different days and examined in the lab for *Taenia* eggs using a microscope. Tapeworm eggs can be seen in the stool 2 to 3 months after the tapeworm infection is established.

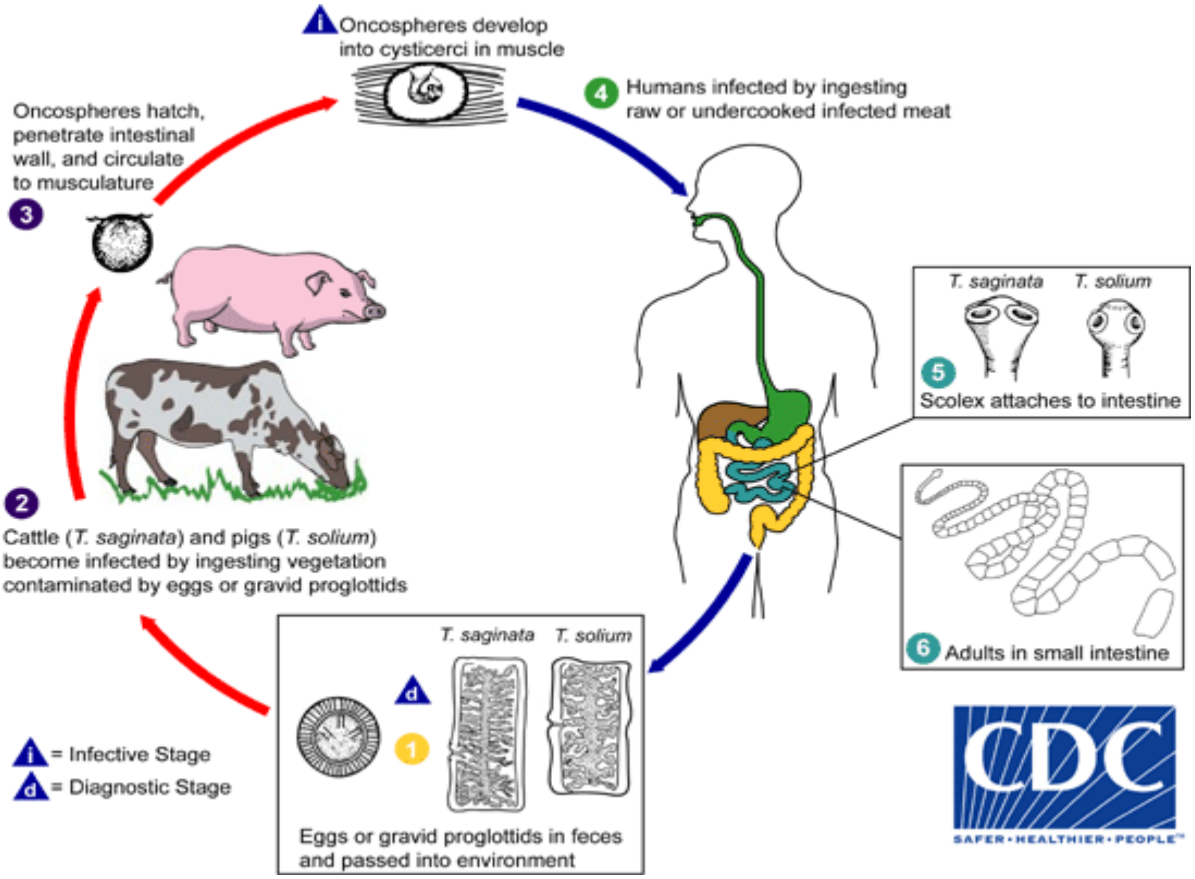


**Figure 2.5: Life cycle and biology of *Taenia* spp (adapted from CDC, 2010).**

### 2.12 Conceptual Framework

The conceptual framework was developed drawing on a range of different parameters such as farming practice (farming method, watering-place, cleaning cattle house, house type) and farmers' knowledge (education level, deworming, and check for infection). This framework was used to determine the prevalence of GI parasite and identify farmer's knowledge and farming practice associated with GI parasite infections.

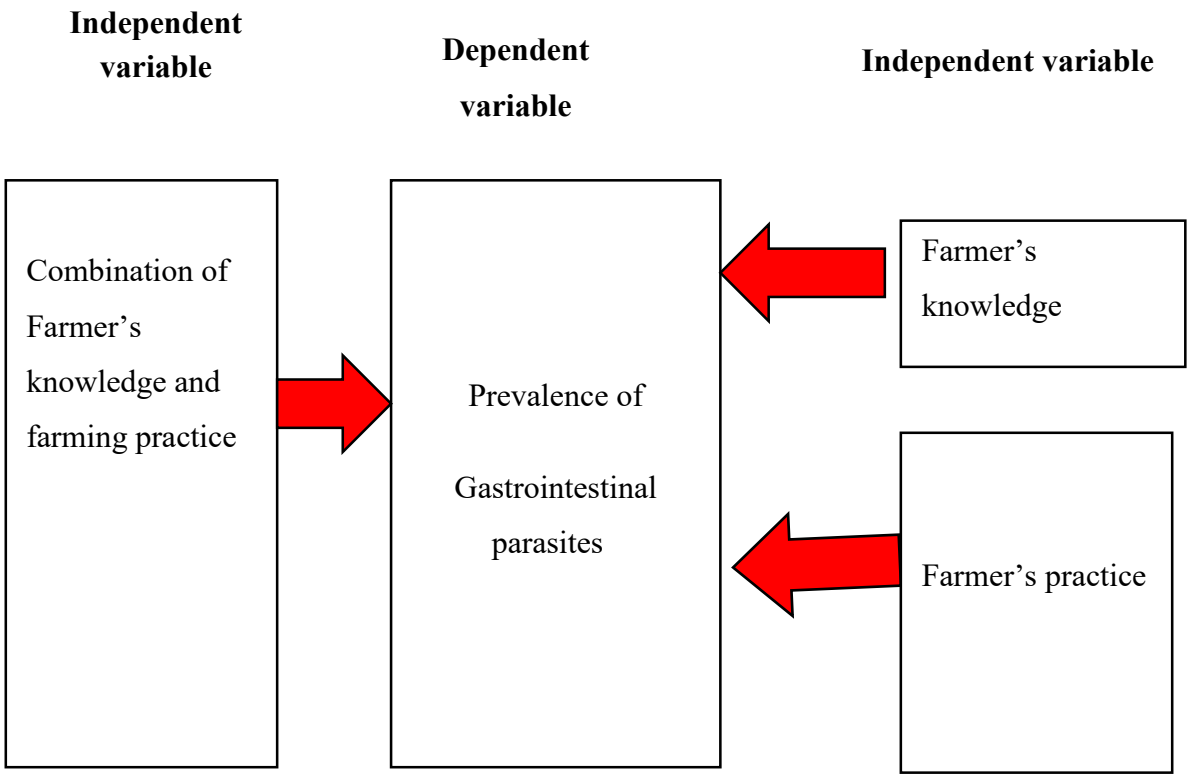


Figure 2.6: Conceptual framework of risk factors associated with GI parasite infection in Mathira, Kenya 2019.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter gives detailed information on the process and the method used to carry out the study. The chapter includes research design, study area, target population, sampling, data collection instrument and procedure and data analysis and presentation.

## 3.2 Research Design

The study designed was cross-sectional and analytical. The farms to be sampled in a cross-sectional study were selected based on the inclusion and exclusion criteria. The faecal samples of cattle from selected farms were examined individually for GI parasite in the laboratory. A questionnaire (appendix 1) was administered to the farmer whose cattle were sampled to obtain information on farming practice and farmers knowledge (risk factors). The data obtained from the farm and laboratories were statistically analysed to determine the prevalence of GI parasite, the association of risk factor on the prevalence of GI parasites infection and intensity of infection in the study area.

## 3.3 Variables

### 3.3.1 Dependent Variables

The dependent variable was the prevalence of the GI parasite. Willis technique, sedimentation and direct smear were used to record the prevalence of the infection based on whether the cattle sampled tested positive or negative for GI infection.

### 3.3.2 Independent Variable

The following factors were considered as independent variables; farming practice (farming method, watering place, cleaning of cattle house, house type) and farmer's knowledge (education level, deworming, and check for infection) which were obtained from the analysis of the questionnaires.

## 3.4 Study Area

The study was carried out in Mathira constituency of Nyeri county, central Kenya. Nyeri County is located between longitude 36° and 38° east and between the equator and latitude 1° south. Mount Kenya is located to the east of Nyeri County at an altitude of 5199 m, and the Aberdare Range is to the west at 3999m. The average rainfall ranges from 500 mm to 1500 mm during both short and long rains periods making it conducive for its diverse agricultural activity. Nyeri county has some of the lowest temperatures in Kenya which range between 12°C in the cold months (June and July) and 27°C in the hot months (January-March and September-October). Besides, the study area receives adequate equatorial rainfall, making it suitable for coffee, tea and dairy farming. Dairy farming is mainly done on smallholder farms on which zero-grazing is also practised (Kenya Information Guide., 2018).

Nyeri County is divided into six constituencies Othaya, Mukurwe-ini, Mathira, Kieni, Nyeri town and Tetu. Subsequently, the Mathira constituency is divided into Mathira east (Magutu, Iriaini, Konyu, and Karatina town wards) and Mathira West sub-county (Ruguru and Kirimukuyu ward (IEBC, 2017). The area in the Square kilometre is approximate 296.60 with a population of 148,847.

### 3.5 The Status of the Cattle Population

Dairy cattle breeds commonly found in the study area are the Friesians, Ayrshires, Guernsey and Jerseys. The breeding systems practised in the study area are artificial insemination (AI) and natural mating. The majority of the farmers use AI (94.5%), 3.5% applied natural mating with only 2% using both (Ajak, Gachuiri & Wanyoike, 2020)

Milk production in Mathira constituency has fivefold from 4000 to approximately 20000 litres between 2002 and 2005, owing to this to the installation of a cooling facility, with over ten thousand members, and a gross income of 12 million Kenyan shillings An increase in the number of dairy product operators is a clear indication of a faster-growing dairy industry compared to the time before the crash of the coffee industry. In 2008, 90% of the farmers in the region had an average of one cow which produced milk for domestic use and sale. During that time milk was meant for domestic consumption while coffee was the main source of income. Many families started relying on milk for extra income after the fall of the coffee price. Consequently, pastures and fodder production reduced as a result of land that shrunk over several years. Many families opted for zero grazing. However, dairy farming was ranked second after coffee as a source of income. (Nyambari, 2008).

### 3.6 Target Population

The sample was drawn from six wards (Ruguru, Magutu, Iriaini, Konyu, Kirimukuyu and Karatina town) in the Mathira constituency. The sampling frame for the study came from dairy cattle on smallholder farms segregated by; Breed (Friesians, Ayrshires, Guernsey, Jerseys), age (Group 1 (1-2yrs), Group 2 (3-4yrs) and Group 3 (>5 yrs.) and both genders and from questionnaires.

### 3.7 Sample Selection

Samples were collected between February and March 2019. The cattle sampled were from small farm holders rearing a minimum of 9-10 cattle of all age, breeds and gender. Trained Community Animal Health Workers (CAHWs) from their respective ward assisted in herd selection to be used for the study. Several criteria and factors were considered for a farm or an animal to be selected for investigation as discussed in the subsequent subheadings.

#### 3.7.1 Inclusion Criteria

The following criteria were considered for a farm to be included for investigation; farms must have more than one pure breed were sampled, farm owners with a minimum of 9 cattle of different age group and gender and the cattle not dewormed three months before the study.

#### 3.7.2 Exclusion Criteria

The following criteria were considered for a farm to be excluded for investigation; farmer owning less than 9 cattle were excluded. Farmer rearing only one breed of the same age and gender were excluded and cattle dewormed three months before the study.

#### 3.7.3 Breed Selection

Faecal samples were obtained from four breeds that are commonly reared in the Mathira constituency. The breeds include Friesians, Ayrshires, Guernsey and Jersey. Most farmers in the Mathira constituency keep Friesians in large number compared to the other three breeds due to their high economic returns. The breed was determined by well-trained Community Animal Health Workers (CAHWs) who are trained to carry out veterinary services in respective wards. Crossbreeds occurred in small numbers hence never considered in the study.

### 3.7.4 Age Selection

The cattle sampled were categorised into three groups to represent all age groups. Group 1 (1-2yrs), Group 2 (3-4yrs) and Group 3 (>5 yrs.) .Cattle age were derived from records and dentition. Table 3.1 gives a brief illustration of typical cattle age when permanent teeth erupt, develop and wear.

| | Cattle age at occurrence | | |
|---|---|---|---|
| **Teeth** | **Eruption** | **Full development** | **Wear** |
| ***Incisors*** | | | |
| Pinchers | 18 to 24 months | 24 months | Leveled at 5 to 6 years, noticeable wear at 7 to 8 years |
| 1st intermediate pair | 24 to 30 months | 36 months | Leveled at 6 to 7 years, noticeable wear at 8 to 9 years |
| 2nd intermediate pair | 36 months | 48 months | Leveled at 7 to 8 years, noticeable wear at 9 to 10 years |
| Corners | 42 to 48 months | 60 months | Leveled at 9 years, noticeable wear at 10 years |
| ***Premolars*** | | | |
| 1st cheek tooth pair | 24 to 30 months | | |
| 2nd cheek tooth pair | 18 to 30 months | | |
| 3rd cheek tooth pair | 30 to 36 months | | |
| ***Molars*** | | | |
| 4th cheek tooth pair | 5 to 6 months | | |
| 5th cheek tooth pair | 12 to 18 months | | |
| 6th cheek tooth pair | 24 to 30 months | | |

Table 3.1: Typical cattle ages when permanent teeth erupt, develop and wear (adapted from Parish & Karisch, 2013).

### 3.7.5 Sex Selection

Visual observation of the external genitalia was used to differentiate between a male and a female. Both genders were put into consideration. The female occurred in a large number than male due to their great economic importance in milk production.

### 3.8 Sample Size Determination

Sample size was derived from the equation $n = 1.962pq/L2$ (Thrusfield, 2007), where $p$ = expected prevalence, $n$ = sample size, $q = 1 - p$ and $L$ = limits of error on the prevalence (absolute precision at 95% confidence interval) 0.05.

When conducting the first-ever prevalence study for a particular condition in a given population, but there is no previous study to help estimate P. It is recommended that n may be calculated using P=0.5 (Lwanga, Lemeshow & WHO, 1991). The overall prevalence rate of the GIT parasite in the Mathira constituency is not known, p was taken to be 50%. A total of 387 cattle were sampled. Where each cattle gave 1 faecal sample

A total of 9 faecal samples were collected from each farm. The target of 9 samples which were inclusive of four breeds (Friesians, Ayrshires, Guernsey, Jerseys), three age groups-(group 1 (1-2yrs), group 2 (3-4yrs), group 3(>5 yrs) and both genders was partially achieved. Since cattle of the Friesian breed, age group 1 (1-2yrs) and females occurred in large numbers due to their economic importance in milk production. The sample size of 387 was divided by the 9 faecal samples from each farm to get the number of farms to be investigated. The total numbers of farms investigated were 43. The number of farms per ward to be investigated was based onward area in Square Kilometers (Ruguru-13 farms, Magutu-5 farms, Iriaini-7 farms, Konyu-4 farms, Kirimukuyu-7 farms and Karatina town-7 farms).

Community Animal Health Workers (CAHWs) in respective wards assisted in the random selection of farm and cattle by use of inclusion and exclusion criteria. Each (CAHWs) had information of farmers in the respective ward where they offer veterinary services.

### 3.9 Data Collection Instruments

The primary data was obtained by observation and questionnaire:

**Questionnaires**: They were administered on a single day farm visit and used to collect information related to the farming practice (farming method, watering-place, cleaning cattle house, house type) and farmers knowledge (education level, deworming, check for infection. The risk factors associated with the prevalence of intestinal parasite was drawn from the analysis of the questionnaires.

**Observations**: The 387 faecal samples collected were subjected to microscopic examination to identify the various gastrointestinal parasite. Laboratory form for parasitology data was used in duplicate (A and B) to record parasitology results from two slides per study subjects. The laboratory form also carried information on inherent characteristics (age, breed and gender), farm number and ward of the cattle sampled.

#### 3.9.1 Pre-Testing

The questionnaire was pre-tested before use to check on ambiguity on questions. The questionnaire was pretested by first administering it to thirty farmers. The pilot study was to ensure the reliability and validity of the questionnaire. There were corrections made to ensure clarity to answer the research hypothesis and achieve study objectives.

#### 3.9.2 Validity

The study achieved the validity of study the instrument through pre-testing the questionnaire which was constructed based on the research objectives and research hypothesis. Each laboratory analysis was duplicated to give greater validity to the findings and research instrument.

### 3.9 3 Reliability

This was achieved by the construction of the questionnaire based on study objectives and research hypothesis.

### 3.10 Sample Collection Procedure

#### 3.10.1 Precautions and Preservation

To ensure a better condition during the sample collection, the following measures were undertaken.

1. Only fresh stool was collected directly from the cattle rectum samples from the ground were avoided
2. The samples were collected in an airtight container to prevent desiccation.

##### 3.10.1.1 Faecal Collection

Faecal samples for parasitological examination were collected from the rectum of the cattle as described by Gibbons, Jacobs, Fox and Hansen (2014). Appropriate disposable gloves were worn. Small calves of less than 1 year old were restrained manually. Gloved, lubricated fingers were gently passed through the anus and the rectal wall massaged to stimulate rectal evacuation. Larger cattle were restrained in a race, crush or bail. A gently pass of gloved, lubricated hand was passed through the anus and withdraw of approximately 20 grams of faecal material. One sample per cattle was collected. Firm gentle restraint was applied to reduce the chance of traumatic injury. The cattle age and breed derived from cattle record, dentition and sex determined by visual observation of external genitalia was recorded during sample collection. Faecal samples obtained directly from the rectum of the cattle were placed in plastic bags, labelled, packed and transported in a cool box to the laboratory where samples were stored at 4°C until examined. Faecal samples were examined individually for

GI nematodes, cestodes and trematodes eggs, as well as for protozoan cysts, trophozoites and oocysts.

### 3.10.2 Faecal examination

Due to the morphological difference occurring in the different parasite, several suitable techniques for identification of specific GI parasite was employed. The techniques were classified as quantitative and qualitative. The 20grams faecal that was evacuated from each cattle was thoroughly mixed then subjected to both quantitative and qualitative technique.

**Qualitative techniques**

The techniques employed here were used to detect whether a sample was positive or negative for GI parasites. The detected parasites were classified at phylum and genus level. Results from these techniques were used to determine the prevalence of the GI parasite. The qualitative technique included the Willis technique, sedimentation and direct smear. Each cattle sample was subjected to one of the three qualitative technique and those that tested positive were further subjected to the quantitative technique.

**Quantitative techniques**

Here the modified Mc master technique was used as a quantitative technique to determine the number of eggs for trematode, cestode, nematode and protozoan: oocyts, cysts and trophozoites in faecal samples that tested positive for qualitative technique. The result from the quantitative technique was used to determine the intensity of GI parasites by the use of the number of egg per gram (EPG).

#### 3.10.2.1 The Willis Technique

This technique was used to detect nematodes and cestode eggs since the eggs are lighter and small, thus they can float in flotation liquid (Willis, 1921).

**Description**

One to two grams of faeces was transferred to a mortar and mixed with 50 ml normal saline. The mixture was stirred then poured through a tea strainer into a container and a gentle pressing to remove excess fluid from the debris remaining in the strainer. Sodium Chloride was mixed with the filtrate then immediately poured into a round bottom flask until it produced a convex meniscus. A clean glass slide was placed over the top of the flask and left for 10 minutes after which the slide was removed quickly. A coverslip was applied on the slide then examined microscopically for nematode and cestodes eggs. The eggs were observed under 40X and 100X magnification.

**3.10.2.2 The Modified McMaster Technique as described by Soulsby (1986) and Tibor, (1999)**

The technique was used to determine the intensity of infection using egg per gram. The number of eggs of each parasite was recorded and converted into the number of eggs per gram of faeces (EPG). This EPG was calculated by multiplying the egg count by a coefficient factor that is 50. The mean intensity of EPG was classified as very low, low, moderate and high (WHO, 2002)

**Description**

Four grams of faeces was weighed and mixed with 2ml of tap water in a mortar and rubbed using a pestle. Fifty-four millimetres of saturated sodium chloride solution was added to the mixture and thoroughly stirred. Using a tea strainer the mixture was sieved into another container. Pasteur pipette was filled with the faeces and salt suspension. The small sample was rapidly run into a McMaster double-counting slide of (2*0.15ml). The slide was left for 5 minutes to allow all eggs and oocysts to float before microscopic examination. Counting

and recording of all the eggs and oocysts under the microscope within the drawn squares on each chamber of the slide was done. The examination was done under 10X magnification. The sum of both chambers was multiplied by a coefficient of 50 to give the number of eggs per gram.

How to calculate the coefficient;

$$\text{Coefficient} = \frac{Volume\ (water + Faecal\ sample\ ) + Flotation\ solution}{Volume\ of\ faecal \times\ measurement\ volume\ of\ slide}$$

$$\text{Coefficient} = \frac{(2+4)+54}{4 \times 0.3} = 50$$

### 3.10.2.3 Sedimentation as described by Gibbons *et al*., 2014

This technique was used for detecting trematodes eggs as they are heavier than the other eggs. The eggs get deposited at the bottom of the test tube after sedimentation.

**Description**

Four to five grams of faeces was mixed with fifty ml of water. After thorough disintegration, the suspension was passed through a tea strainer into a beaker and then into a conical flask. To the filtrate, more water was added until it filled the flask. The suspension was allowed to sediment and clarifies the faecal mass. The supernatant was carefully decanted and the flask containing the sediment refilled with water. The process was repeated several times until the supernatant became clear. Using a pipette, few drops of the sediment were transferred to a glass slide and a drop of methylene blue was added for staining. Then it was covered with a coverslip before microscopical examination of nematode eggs. The examination was done under 40X magnification.

### 3.10.2.5 Direct Smear Technique as Described by Michael, Dryden, Patricia and Payne, 2010.

This method was to specifically detect protozoan trophozoites. It is a rapid screening method with the ability to observe trophozoites that may be distorted and killed in hypertonic flotation solutions.

**Description**

A small amount of normal saline was mixed with 2mg of faecal sample in a mortar. Using a pipette a drop of the saline mixture was placed on a clean glass slide and a drop of iodine was added for staining. The smear was observed under a microscope. The examination was done under 40X magnification.

### 3.11 Distinguishing Characteristics used to Identify Parasites

*Schistosoma spp* -The eggs are oval-shaped, measuring 115-175 µm long and 45-47 µm wide, and ~150 µm diameter on average. They have pointed spines towards the broader base on one side,that is lateral spines.

*Strongyloides spp*-They are 3.5–6 mm long and are small, embryonated eggs

*Nematodirus spp*-eggs are larger than the typical egg the eggs contain larvae that remain inside the eggs where they complete development to infective larvae.

*Trichuris spp*-eggs have thick, lemon-shaped, light yellow shells. Opposite ends of the shells are plugs that protect the eggs.

*Toxocara spp* -eggs, 75 to 95 × 60 to 75 µm, are dark, subglobular, and single-celled with a thick-pitted shell

*Fasciola spp*- eggs are broadly ellipsoidal, operculated, and measure 75 mm by 15 mm.

*Entamoeba spp*-trophozoitesrange from 10 to 35 microns in diameter; cysts range from 10 to 30 microns in diameter and contain 8 to 16 nuclei when mature; the nucleus exhibits an eccentric karyosome with irregular, coarse chromatin.

*Giardia* - Cyst measures9 x 12 micrometres and contain 2 to 4 nuclei. Trophozoite - Four pairs of flagella - one pair located anterior, two pair located ventral, and one pair located posteriorly.

**3.12 Identification Key**

Bench aids for the diagnosis of intestinal parasites by the World Health Organization, 1994.

Parija (1990). Helminthic infections: trematode, cestode and nematode.Review of Parasitic Zoonoses; 1: 41-393

Soulsby, (1986). Eggs of worm parasites. Helminths, Arthropods and Protozoa of Domesticated Animals; 7th edition, 1: 24-338

Gibbons *et al.,* (2014).The RVC/FAO guide to veterinary diagnostic parasitology.

All gastrointestinal tract parasites observed were identified to the genus level

**3.13 Data Analysis and Presentation**

Data obtained from the farm and laboratory was cleaned, coded and analysed using SPSS software version 23.

Point prevalence was to determine the prevalence of gastrointestinal parasites in cattle in the study area using the result from faecal samples as described by Hansen and Perry (1994). The prevalence was calculated as a percentage of d/n

That is,

Prevalence $= \frac{Numbers\ of\ Infected\ Cattle}{Numbers\ of\ Cattle\ Examined} * 100 = \frac{d}{n}$ ……**Equation 1**

Where; *d* is the number of cattle infected at a specified time and *n* is the total number of animals examined. The computed percentage, which was continuous numerical data, was converted into a categorical qualitative variable by recoding into different codes using SPSS as 1= high prevalence and 0 =low prevalence.

The Pearson Chi-square test was used to test independence between risk factors (farmers' knowledge and farming practice) and the prevalence of intestinal parasite. The direction of this association was further established by running Goodman and Kruskal's gamma test. Wald test was used to test significant between prevalence and risk factors (farmers' knowledge and farming practice).

To determine the relationship between risk factors (farmers' knowledge and farming practice) and prevalence of GI parasites, binary logistic regression analysis was preferred for this model, since the response variable that is the prevalence of gastrointestinal parasites was converted to the categorical qualitative variable. The models are as follows:

To determine the relationship between farmers' knowledge and prevalence of GI parasites the following model was used;

$$\boldsymbol{log\left\{\frac{\pi(x)}{1-\pi(x)}\right\} = 5.674 - 2.460X_1} \quad \textbf{……equation 2}$$

Where: $\boldsymbol{X_1}$is farmers' knowledge while dependent variable is prevalence of intestinal parasite

To determine the relationship between farming practice and prevalence of GI parasites the following model was applied:

$$\boldsymbol{log\left\{\frac{\pi(x)}{1-\pi(x)}\right\} = 5.170 - 2.169X_2}$$

**……equation 3**

Where $\boldsymbol{X_2}$is farm practice while dependent variable is prevalence of intestinal parasite

To determine the combined relationship between farmers' knowledge and farming practice) and prevalence of GI parasites the following model was used:

$$\boldsymbol{log\left\{\frac{\pi(x)}{1-\pi(x)}\right\} = 11.894 - 2.730X_2 - 2.436}$$ **…….equation 4**

Where: $\boldsymbol{X_1}$farmers' knowledge

$\boldsymbol{X_2}$is farming practice

The intensity of infection was determined by arithmetic mean where egg intensity for each parasite was calculated by using the formula (Montresor, Crompton, Gyorkos, Savioli, 2002).

$$\text{Arithmetic mean} = \Sigma\frac{\text{epg}}{\text{n}}$$

Where epg equals the sum of each epg per sample per slide while n is the number of subjects investigated.

The mean intensity of EPG was classified as very low, low, moderate and high (WHO, 1994). All tests were considered significant at $P < 0.05$. Simple random sampling without replacement was a suitable method for sample selection.

### 3.14 Ethical clearance

A research permit was obtained from the National Commission for Science, Technology and Innovation. Authorization from the county commissioner and the county director of education (appendix II), Nyeri County was obtained before embarking on the research project

Informed verbal consent was obtained from the study participants before the interview. At the end of the research project information about parasites, their mode of transmission, methods of prevention and control was explained to the study participant.

# CHAPTER FOUR

# DATA ANALYSIS, PRESENTATION AND INTERPRETATION

## 4.1 Inherent Characteristics of the Cattle and Parasites

The study sought to examine how the inherent characteristics in terms of cattle's breed, gender and age and the parasites (genus level) affected the intensity and percentage prevalence of GIT parasites in Mathira Constituency.

### 4.1.1 Cross-tabulation of the Cattle Breed by Gender by Wards

The dominant cattle breed in Mathira constituency was Friesian (55.0% of the 387 individuals sampled**)** while Jersey was the least reared breed in the region (10.6% of the 387 individuals sampled) (Table 4.1). 70.54 % of the sampled cattle were female while 29.45% were males (Table 4.1). The wards Kirimukuyu, Karatina town, and Iriani had the same number of cattle sampled with the highest sample taken from Ruguru which can fairly be stated that there are more cattle in Ruguru ward than any other ward in Mathira Constituency (Table 4.1).

**Table 4.1: Distribution of the sampled cattle by breed, gender and ward.**

| Mathira Sub-county wards | Description | Cattle breed by Gender | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Friesian** | | **Arshire** | | **Guernsey** | | **Jersey** | | **Sub-Total** | | |
| | | **Male** | **Fem.** | **Male** | **Fem.** | **Male** | **Fem.** | **Male** | **Fem.** | **Male** | **Fem.** | |
| Kirimukuyu | Count | 8 | 31 | 3 | 3 | 0 | 6 | 0 | 12 | 11 | 52 | **63** |
| | % within cattle breed | 12.70% | 20.70% | 10.70% | 5.30% | 0.00% | 18.20% | 0.00% | 36.40% | 9.60% | 19.00% | **16.28%** |
| Konyu | Count | 8 | 16 | 2 | 5 | 2 | 2 | 1 | 0 | 13 | 23 | **36** |
| | % within cattle breed | 12.70% | 10.70% | 7.10% | 8.80% | 13.30% | 6.10% | 12.50% | 0.00% | 11.40% | 8.40% | **9.30%** |
| Karatina town | Count | 14 | 23 | 6 | 10 | 0 | 6 | 0 | 4 | 20 | 43 | **63** |
| | % within cattle breed | 22.20% | 15.30% | 21.40% | 17.50% | 0.00% | 18.20% | 0.00% | 12.10% | 17.50% | 15.80% | **16.28%** |
| Iriaini | Count | 12 | 23 | 5 | 7 | 4 | 9 | 0 | 3 | 21 | 42 | **63** |
| | % within cattle breed | 19.00% | 15.30% | 17.90% | 12.30% | 26.70% | 27.30% | 0.00% | 9.10% | 18.40% | 15.40% | **16.28%** |
| Magutu | Count | 11 | 17 | 0 | 4 | 5 | 4 | 3 | 1 | 19 | 26 | **45** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % within cattle breed | 17.50% | 11.30% | 0.00% | 7.00% | 33.30% | 12.10% | 37.50% | 3.00% | 16.70% | 9.50% | **11.63** |
| Ruguru | Count | 10 | 40 | 12 | 28 | 4 | 6 | 4 | 13 | 30 | 87 | **117** |
| | % within cattle breed | 15.90% | 26.70% | 42.90% | 49.10% | 26.70% | 18.20% | 50.00% | 39.40% | 26.30% | 31.90% | **30.23** |
| Sub-Total | | 63 | 150 | 28 | 57 | 15 | 33 | 8 | 33 | 114 | 273 | **387** |
| Total | | **213** | | 85 | | **48** | | **41** | | **387** | | **100 %** |
| | | | | 55.00% | | | | **10.60%** | | **100%** | | |

Table 4.2: Parasite at Genus Level by Cattle Breed by Gender of Cattle Cross Tabulation (in Appendix)

It was observed that *Schistosoma* spp was the dominant parasite at genus level (Table 4.2). The study revealed that male Friesian breed was likely to host parasites (0.9%) as compared to the female Friesian breed (0.7%); however, generally the parasites are more likely to be hosted in the female cattle breed (1.8%) than it was in the male breeds (0.9%). It was established that a fair percentage (34.4%) of the cattle did not host any parasite but the percentage was still low.

### 4.1.3 Distribution of Parasite

At the level of phylum, Protozoan infections was highest (19.64%) while cestode infections were the least (2.07%) (Table 4.3). A total of 65.38% of the samples had parasite identified at genus level. 53.75% percent of the sampled cattle had a single infection. While 34.63 % did not have any infection GI parasite (Table 4.4). Mixed infection was 11.63% of the cattle sampled, a combination of at least two parasite at genus level. *Schistosoma spp* caused most infections in cattle (12.14%) compared to *Toxocara spp* 1.55% (Table 4.4)

Table 4.3: Parasitic distribution at phylum level

| Parasite at phylum level | Frequency of infection | Percentage infections |
|---|---|---|
| Protozoa | 76 | 19.64 |
| Cestode | 8 | 2.07 |
| Trematode | 71 | 18.35 |
| Nematode | 52 | 13.44 |
| Mixed Infection | 46 | 11.89 |
| Negative infection | 134 | 34.63 |
| Total | 387 | 100 |

Table 4.4: Parasitic distribution at genus level

| **Parasites at Genus level** | **Frequency of infection** | **Percentage infections** |
|---|---|---|
| *Schistosoma* spp | 47 | 12.14 |
| mixed infection | 45 | 11.63 |
| Negative infection | 134 | 34.63 |
| *Strongyloides* spp | 17 | 4.39 |
| *Fasciola*spp | 21 | 5.43 |
| *Entomoeba*spp | 29 | 7.49 |
| *Giardia* spp | 10 | 2.58 |
| *Eimeria* spp | 38 | 9.82 |
| *Taenia* spp | 9 | 2.33 |
| *Nematodirus* spp | 22 | 5.68 |
| *Trichuris* spp | 9 | 2.33 |
| *Toxocara* spp | 6 | 1.55 |
| **Total** | **387** | **100** |
| Samples with single infection | 208 | 53.75 |
| Samples with both single and mixed infection | 253 | 65.37 |

### 4.1.4 Prevalence of Parasites by Gender, Breed and Age

The percentage prevalence of GI parasites by gender shows that female (67%) had relative high percentage prevalence compare to male (64%). Ayrshire (70%) had are a relatively high percentage prevalence compared to Guernsey (60%). Cattle of age 1-2 (69%) had relatively high percentage prevalence compared to age 3-4 years (55%) as indicated in Table 4.5.

Table 4.5: Percentage prevalence of GI parasite by gender, breed and age

| | | Infection | | | |
|---|---|---|---|---|---|
| **Variables** | | **Positive** | **Negative** | **Total** | **% Prevalence of infection** |
| Gender | Male | 72 | 42 | 113 | 64 |
| | Female | 182 | 91 | 271 | 67 |
| | Total | 251 | 133 | 387 | |
| Breed | Friesian | 140 | 73 | 213 | 66 |
| | Ayrshire | 59 | 26 | 84 | 70 |
| | Guernsey | 29 | 19 | 48 | 60 |
| | Jersey | 26 | 15 | 39 | 67 |
| | Total | 251 | 133 | 387 | |
| Age group | Group 1 (1-2 yrs.) | 128 | 59 | 186 | 69 |
| | Group 2 (3-4yrs) | 40 | 30 | 68 | 59 |
| | Group3(>5yrs) | 86 | 44 | 130 | 66 |
| | Total | 251 | 133 | 387 | |

The study also revealed that Kirimukuyu ward had the highest percentage prevalence (86%) while Iriaini had the least percentage prevalence (44%) as shown in Table 4.6.

Table 4.6: Percentage prevalence of GI parasite by ward

| Wards in Mathira contituency | Infection by GI parasites | | Total | Percentage |
|---|---|---|---|---|
| | Positive | Negative | | prevalence % |
| Kirimukuyu | 54 | 9 | 63 | 86 |
| Konyu | 23 | 13 | 36 | 64 |
| Karatina town | 38 | 25 | 63 | 60 |
| Iriaini | 28 | 35 | 63 | 44 |
| Magutu | 31 | 14 | 45 | 69 |
| Ruguru | 77 | 37 | 114 | 68 |
| **Total** | **251** | **133** | **384** | |

### 4.1.5 Intensity of Infection by Eggs per Gram (EPG)

A frequency distribution table was developed from the continuous variable of the number of eggs by recoding using a class width of 200. Each class represented the intensity level of number of eggs per gram in a sample (very low, low, moderate and high.

The study sought to find out the mean intensity of the parasites using the following formula: $\text{Arithmetic mean} = \Sigma\frac{\text{epg}}{\text{n}}$. (73800/387).

The intensity of the parasites was first measured by establishing the number of eggs per gram in every sample taken. It was revealed that the overall mean intensity of EPG was 191 which was fairly positively skewed as indicated in Table 4.7. Overall mean intensity of 191 EPG was classified as very low. Some of the sample had zero parasites per gram meaning that some of the cattle were not infected.

**Table 4.7: Descriptive Statistics of the Number of Eggs per Gram**

| | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Statistic | Std. Error | Statistic | Std. Error |
| Total no. of eggs per sample | 387 | 0 | 800 | 190.70 | 195.589 | .868 | .124 | .090 | .247 |

It was further observed that 64.3% of cattle had EPG between the modal class of 0-200 very low level of epg.

Table 4.8: Intensity of Parasites using Frequency of EPG

| Intensity of parasites (eggs per gram) | Frequency | Percentage |
|---|---|---|
| <200(very low) | 249 | 64.3 |
| 200-400(low) | 106 | 27.4 |
| 400-600(moderate) | 18 | 4.7 |
| >600(high) | 14 | 3.6 |
| Total | 387 | 100.0 |

### 4.1.6 Intensity of Infection by Gender

The mean intensity of infection by gender was male 185 and female 193, which was classified as very low. Most male had a very low intensity (19.1%) while most female (45.2%) had very low intensity of infection (Table 4.9).

Table 4.9: Intensity of infection by gender of cattle

| **Intensity of parasites** | **Gender of Cattle** | | | | | |
|---|---|---|---|---|---|---|
| | **Male** | | **Female** | | **Total** | |
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| < 200 (very low) | 74 | 19.1% | 175 | 45.2% | 249 | 64.3% |
| 200-400 (low) | 31 | 8.0% | 75 | 19.4% | 106 | 27.4% |
| 400-600 (moderate) | 6 | 1.6% | 12 | 3.1% | 18 | 4.7% |
| > 600 (high) | 3 | 0.8% | 11 | 2.8% | 14 | 3.6% |
| **Total** | **114** | **29.5%** | **273** | **70.5%** | **387** | **100.0%** |

## 4.2 The Association between Farmers' Knowledge and Intestinal Parasite Prevalence

The study sort to establish the relationship between farmers' knowledge and prevalence of intestinal parasites.

### 4.2.1 Overall Prevalence of Intestinal Parasite

Prevalence of intestinal parasite = $\frac{Number\ of\ positive\ infections}{Total\ examined\ in\ the\ sample} \times 100$ ……. $\boldsymbol{EQ.1}$

The computed percentage which was continuous numerical data was converted into categorical qualitative variable by recoding into different codes using SPSS as 1-high

prevalent and 0-low prevalence. The output showed that the prevalence of GI parasites was 69.4%, which the study considered to be on a high scale of 0 to 1.

Table 4.10: The Prevalence of Intestinal Parasites in Mathira Sub County

| **Prevalence of intestinal parasites** | **Frequency** | **Percentage** |
|---|---|---|
| Low prevalence | 14 | 32.6 |
| High Prevalence | 29 | 67.4 |
| **Total** | **43** | **100.0** |

### 4.2.2 Farmers' Knowledge of Gastro Intestinal Parasites

Farmers' knowledge was measured in terms level of education (none, primary, secondary and tertiary level), frequency on deworming (regular, irregular and not at all) and checking for infection (check and do not check for infection). In Table 4.11 the study established that 79.1 % of the sampled farmers do not check for infections.

Table 4. 11: Farmers' Knowledge of Gastro Intestinal Parasites

| **Farmers knowledge** | | **Frequency** | **Percentage** |
|---|---|---|---|
| Do they check for infection | Do not check for infection | 34 | 79.1 |
| | Check for infection | 9 | 20.9 |
| | **Total** | **43** | **100** |
| Farmers level of education | None | 2 | 4.7 |
| | Primary Education | 9 | 20.9 |
| | Secondary Education | 19 | 44.2 |
| | Tertiary Education | 13 | 30.2 |
| | **Total** | **43** | **100** |
| frequency of deworming | Irregularly | 24 | 55.8 |
| | Regularly | 19 | 44.2 |
| | Not at all | 0 | 0 |
| | **Total** | **43** | **100** |

The study established that 44.2%, 20.9% and 4.7% of the famers have secondary level education, primary education and no education respectively. With 30.2% having post-secondary education. It was also established that 55.8% of the farmers carry irregular deworming which indicates lack of knowledge of doing it irrespective of whether the farmer has knowledge of deworming but is reluctant to do so.

When measures of each item of farmers knowledge was recoded into a dichotomous scale of 1 (having knowledge) and 0 (lacking knowledge), it was established that while majority of the farmers have post-secondary education they lack knowledge on deworming and checking for infection as indicated in Table 4.12.

Table 4.12: Farmers Knowledge Items After Recoding

| **Farmers knowledge items** | **Farmers' knowledge** | | | |
|---|---|---|---|---|
| | **Lack knowledge** | | **Have knowledge** | |
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| Education level | 11 | 25.6 | 32 | 74.4 |
| Deworming | 24 | 55.6 | 19 | 44.2 |
| Check infections | 34 | 79.1 | 9 | 20.9 |

The study having established the sub variables of famers knowledge (educational level, deworming and checking for infections) whose scores in a dichotomous scale, the scores were then summed up to a composite scale whose maximum score was three. The maximum score of the items was three because the highest in each of the three items was one whose summation led to three. The composite score was rescaled into categorical variable where 0 to 1 being low level of knowledge, 2 - medium level of knowledge and 3 - high level of knowledge. This established farmers' knowledge as an independent variable whose output showed that just 20.9% of the sampled farmers had high knowledge on deworming and checking for infection as indicated in Table 4.13

Table 4.13: General Level of Knowledge of the Farmers

| Farmers knowledge | Frequency | Percentage |
|---|---|---|
| Low | 16 | 37.2 |
| Medium | 18 | 41.9 |
| High | 9 | 20.9 |
| Total | 43 | 100.0 |

### 4.2.3 The Relationship between Famers' Knowledge and Prevalence of Intestinal Parasite

Cross tabulation of prevalence of intestinal parasites by farmers' knowledge was conducted and the output showed a 32.6% low prevalence and 67.4% high prevalence that reduced with farmers' knowledge as shown in Table 4.14

Table 4.14: Cross Tabulation of Prevalence of Intestinal Parasites by Farmers' Knowledge

| Farmers knowledge | Prevalence of intestinal parasites | | | | | |
|---|---|---|---|---|---|---|
| | Low prevalence | | High Prevalence | | Total | |
| | Frequency | Percentage | Frequency | Percentage | Freq. | % |
| Low | 0 | 0.0 | 16 | 37.2 | 16 | 37.2 |
| Medium | 7 | 16.3 | 11 | 25.6 | 18 | 41.9 |
| High | 7 | 16.3 | 2 | 4.7 | 9 | 20.9 |
| Total | 14 | 32.6 | 29 | 67.4 | 43 | 100.0 |

The association between farmers' knowledge and the prevalence of intestinal parasite was tested on a hypothesis that there was no significant association between farmers' knowledge and prevalence of the intestinal parasite in the Mathira constituency. The null hypothesis was stated as:

$\boldsymbol{Ho_1}$: There was no significant association between farmers' knowledge and prevalence of the intestinal parasite in Mathira constituency.

The Chi-square test of independence was run to examine the association between farmers' knowledge and prevalence of intestinal parasite. The Chi-square test of independence revealed that there was a significant association between farmers' knowledge and prevalence of intestinal parasite as revealed by Pearson chi-square as $(\chi^2{}_{(2)} = 16.434, p = 0.001)$. The findings were also confirmed by Likehood Ratio value in which $\left(\chi^2{}_{(2)} = 20.675, p = 0.001\right)$. the output also revealed that linear by linear association between the variables was significant$(\chi^2{}_{(1)} = 16.052, p = 0.001)$. The results are presented in Table 4.15.

Table 4.15: The Association between Farmers' Knowledge and Prevalence of Intestinal Parasite

| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
|---|---|---|---|
| Pearson Chi-Square | 16.434[a] | 2 | <0.001 |
| Likelihood Ratio | 20.675 | 2 | <0.001 |
| Linear-by-Linear Association | 16.052 | 1 | <0.001 |
| N of Valid Cases | 43 | | |

The output revealed that there is a statistically significant association between farmers' knowledge and prevalence of intestinal parasite. The direction of this association was further established by running Goodman and Kruskal's gamma whose value was -0.911 while the "Approx. Sig**.**" column shows that the statistical significance value (i.e., *p*-value) is **0.**001.Therefore, the association between farmers' knowledge and prevalence of intestinal parasite is statistically significant as indicated in Table 4.16. The negative value indicates an opposite relationship between farmers' knowledge and prevalence of intestinal parasite.

Table 4.16: The Direction of the Association between Farmers' Knowledge and Prevalence

| | | **Value** | **Asymp. Std. Error[a]** | **Approx. T[b]** | **Approx. Sig.** |
|---|---|---|---|---|---|
| Ordinal by Ordinal | Gamma | -.911 | .069 | -5.644 | .000 |
| N of Valid Cases | | 43 | | | |

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The study hence established that higher knowledge of the farmer in terms of a high level of education, higher knowledge in deworming and checking for infection significantly reduces the prevalence of intestinal parasites in cattle. The model of the relationship between farmers' knowledge and prevalence of intestinal parasite was established by running a simple binary logistic regression, which indicated a significant association between farmers' knowledge and prevalence of intestinal parasite$\left(Wald's\ test: \chi^2{}_{(1)} =\right.$

$10.328, p = 0.001$) at a five percent level of significance as indicated in Table 4.17. The Exp (B) value shows that farmers knowledge (high level of education, knowledge on deworming and checking for infections) was 5.085 times more likely to reduce the prevalence of intestinal parasites.

Table 4.17: Odds Ratio for Logistic Regression of Intestinal Parasite Prevalence on Farmers' Knowledge

| | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Exp(B)** |
|---|---|---|---|---|---|---|
| Farmers Knowledge | -2.460 | .766 | 10.328 | 1 | 0.001 | 5.085 |
| Constant | 5.674 | 1.663 | 11.648 | 1 | 0.001 | 291.203 |

The output in Table 4.17 leads to the model in Equation 1

$$\boldsymbol{log\left\{\frac{\pi(x)}{1-\pi(x)}\right\} = 5.674 - 2.460X_1} \qquad \textbf{……. Eq.2}$$

Where: $\boldsymbol{X_1}$is farmers' knowledge while dependent variable is prevalence of intestinal parasite.

### 4.3 The Association between Farming Practice and Intestinal Parasite Prevalence

The farming practice was considered as the independent variable while intestinal parasite prevalence was the independent variable. The measurements of the prevalence of intestinal parasites had already been established in sub-section 4.2. The measurement of farming practice will therefore be explored in this section and its relationship compared to that of intestinal parasite prevalence and a model of the association shall be established.

### 4.3.1 Farming Practice

The farming practice was measured using five items namely: housing (provides or do not provide), type of shed floor (concrete or earth floor), frequency of cleaning the shed (not at all, once a year, monthly, weekly), watering animals (designated place at home, non-designated place at home, at the river, at the dam or a stagnant pool of water).

First, the study established farming practice in terms of the provision of housing to the cattle. It was established that the 69.8% of the farmers provide housing for their cattle which the study interpreted to mean that there is an improved farming practice in the provision of cattle housing as indicated in Table 4.18.

Table 4.18: Farm Practice and Intestinal Parasites Prevalence

| **Farm practice** | | **Frequency** | **Percentage** |
|---|---|---|---|
| Provision of housing | Provide housing | 30 | 69.8 |
| | Do not provide housing | 13 | 30.2 |
| | ***Total*** | ***43*** | ***100*** |
| Watering place | Designated at home | 19 | 44.2 |
| | Non-designated at home | 10 | 23.2 |
| | At the river | 3 | 7 |
| | At the dam | 4 | 9.3 |
| | stagnant waters | 7 | 16.3 |
| | ***Total*** | ***43*** | ***100*** |
| Method of farming | Zero grazing | 15 | 34.9 |
| | Paddocking | 5 | 11.6 |
| | Tethering | 5 | 11.6 |
| | Free range | 18 | 41.9 |
| | ***Total*** | ***43*** | ***100*** |
| Floor type | Earth floor | 23 | 53.5 |
| | Concrete floor | 20 | 46.5 |
| | ***Total*** | ***43*** | ***100*** |
| Number of times the cattle house is cleaned | Not at all | 4 | 9.3 |
| | Yearly | 0 | 0 |

| | | | |
|---|---|---|---|
| | Monthly | 11 | 25.6 |
| | Weekly | 28 | 65.1 |
| | ***Total*** | ***43*** | ***100*** |

Even though it was established that 19% and 10% of the animals are watered at home at a designated and undesignated place respectively confirms the provision of housing indicated in Table 4.18 the majority of the farmers sampled, water their animals in undesignated places (44.2%) which will, later on, be treated to include rivers, dams and stagnant waters. The later would later treat designated watering places at home as a superior otherwise inferior hence poor farming practice.

The study further revealed that 41.9% of the farmers practiced a free range of farming and not zero grazing, which the study used as a reference item in terms of farming methods as indicated in Table 4.18.

The highest percentage of the farmers had earth floor cattle housing (23%) as indicated in Table 4.18. The study treated concrete floor to be superior thus its presence meant the farmers practised improved farming otherwise it was poor farming practice if the housing has an earth floor. The majority of the farmers 65.1% sampled cleaned cattle houses every week. Weekly clean-up was treated as regular cleaning otherwise the cattle house was irregularly cleaned. These results guide the preceding sections when computing for the composite scale.

The measures of each of the five items of farming practice (floor type, frequency of cleaning, provision of housing, watering of animals and farming method) were recoded

into a dichotomous scale of 1 – improved farming practice and 0 – poor farming practice. It was established that only two items are majorly practiced, that is, cattle house was provided and cleaned regularly otherwise the majority of the farmers sampled do not water animals at designated places at home nor they practice zero grazing including most of the housing floor being earth floor type.

Table 4.19: Relationship between Farm Practices

| **Farming practice items** | **Farming item practiced** | | | |
|---|---|---|---|---|
| | **Improved farming Practice** | | **Poor farming practice** | |
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| Cattle house: provided | 30 | 69.8 | 13 | 30.2 |
| Watering at designated place at home | 19 | 44.2 | 24 | 55.8 |
| Cattle farming method: zero grazing | 15 | 34.9 | 28 | 65.1 |
| Housing floor type: concrete floor | 20 | 46.5 | 23 | 53.5 |
| Cleaning the cattle house: regularly | 28 | 65.1 | 15 | 34.9 |

The study then established, on average, the level of farming practice on the five items. This was achieved by summing up all the recoded scores to a composite scale whose maximum score was five since the dichotomous scale was either 1 or 0. The composite score was rescaled into 0 to 2 being a low level of practice, 3 - medium level of practice and 3 - high level of practice. This rescaling formed farming practice as the second independent variable, which the study revealed that the majority of the sampled farmers are at low levels

of expected farming practice as shown in the output, in Table 4.20 and; therefore, predisposed the cattle to gastrointestinal infection.

Table 4.20: Level of Farm Practice

| Farm practice | Frequency | Percentage |
|---|---|---|
| Low | 23 | 53.5 |
| Medium | 6 | 14.0 |
| High | 14 | 32.6 |
| Total | 43 | 100.0 |

### 4.3.2 The Relationship between Farming Practice and Prevalence of Intestinal Parasite

Cross-tabulation of the prevalence of intestinal parasites by farming practice was conducted and the output showed 32.6% had low prevalence while 67.4% high prevalence that reduced with farmers' knowledge as shown in Table 4.21. The study established that intestinal parasites are not prevalent at high levels of farming practice but are prevalent at low levels of farming practice as indicated in Table 4.20.

Table 4.21: Cross Tabulation of Prevalence of Intestinal Parasites by Farmers' Knowledge

| **Level of farming practice** | **Prevalence of intestinal parasites** | | | | **Total** | |
|---|---|---|---|---|---|---|
| | **Low prevalence** | | **High Prevalence** | | | |
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** | **Freq.** | **%** |
| Low | 0 | 0.0 | 23 | 53.5 | 23 | 53.3 |
| Medium | 4 | 9.3 | 2 | 4.7 | 6 | 14.0 |
| High | 10 | 23.3 | 4 | 9.3 | 14 | 32.6 |
| Total | 14 | 32.6 | 29 | 67.4 | 43 | 100 |

The study established that a high level of expected farming practice suppressed the prevalence of the intestinal parasite, which would otherwise remain very high at low levels of the expected farm practice. Further, the intestinal parasite prevalence remains very high.

The association between farming practice and the prevalence of intestinal parasite was tested on a hypothesis that there was no significant association between farming practice and prevalence of the intestinal parasite in the Mathira constituency. The null hypothesis was stated as:

$Ho_2$: There was no significant association between farm practice and prevalence of the intestinal parasite in Mathira constituency

The Chi-square test of independence was run to examine the association between farming practice and the prevalence of intestinal parasite. The Chi-square test of independence revealed that there was a significant association between farming practice and prevalence

of intestinal parasite as revealed by the Pearson chi-square as$(\chi^2_{(2)} = 23.916, p = 0.001)$. The findings were also confirmed by the Likelihood Ratio value in which $\left(\chi^2_{(2)} = 29.877, p = 0.001\right)$. The output also revealed that linear by the linear association between the variables was significant $(\chi^2_{(1)} = 21.179, p = 0.001)$.. The results are presented in Table 4.22.

Table 4.22: The Association between Farming Practice and Prevalence of Intestinal Parasite

| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
|---|---|---|---|
| Pearson Chi-Square | 23.916[a] | 2 | .000 |
| Likelihood Ratio | 29.877 | 2 | .000 |
| Linear-by-Linear Association | 21.179 | 1 | .000 |
| N of Valid Cases | 43 | | |

The output revealed that there is a statistically significant association between farming practice and the prevalence of intestinal parasite. The direction of this association was further established by running Goodman and Kruskal's gamma whose value was -0.911 while the "Approx. Sig." column shows that the statistical significance value (i.e., *p*-value) is .001, which means $p < .05$. Therefore, the association between farming practice and the prevalence of intestinal parasite is confirmed to be statistically significant as indicated in Table 4.23. The negative value indicates an opposite relationship between farming practice and the prevalence of intestinal parasite.

Table 4.23: Direction of Association between Farming Practice and Prevalence of Intestinal Parasite

| | | Value | Asymp. Std. Error[a] | Approx. T[b] | Approx. Sig. |
|---|---|---|---|---|---|
| Ordinal by Ordinal | **Gamma** | -.911 | .059 | -6.418 | .000 |
| N of Valid Cases | | 43 | | | |

The study hence established that a higher level of the expected farming practice will lower the prevalence of intestinal parasites in cattle. The model of the relationship between farming practice and prevalence of intestinal parasite was established by running a simple binary logistic regression which indicated a significant association between farm practice and prevalence of intestinal parasite $\left(Wald's\ test: \chi^2{}_{(1)} = 14.097, p < 0.001\right)$at five per cent level of significance as indicated in Table 4.24. The Exp(B) value shows that farming practice (provision of housing, type of housing floor, cleaning of the house, place of watering the cattle, and the farming method was 8.114 times more likely to reduce the prevalence of intestinal parasites.

Table 4.24: Odds Ratio for Logistic Regression of Intestinal Parasite Prevalence on Farming Practice

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Farm Practice | -2.169 | .578 | 14.097 | 1 | <0.001 | 8.114 |
| Constant | 5.170 | 1.394 | 13.748 | 1 | <0.001 | 175.935 |

The output in Table 4.X4 lead to the model in Equation 1

$$log\left\{\frac{\pi(x)}{1-\pi(x)}\right\} = 5.170 - 2.169X_2 \quad \text{..... Eq.3}$$

Where $X_2$ is farming practice

### 4.4 The Combined Relationship between Farming Practice, Farmers' Knowledge and Prevalence of Intestinal Parasite

The study established the combined relationship between farming practice and farmers' knowledge and prevalence of intestinal parasite. The study tested the null hypothesis that there is no significant relationship between farming practice and farmers' knowledge and prevalence of intestinal parasite.

There was no significant association between farmers' knowledge, farming practice and prevalence of the intestinal parasite in Mathira constituency

The hypothesis was tested using binary logistic regression whose output indicated that there is a negative association between the explanatory variables (farming practice and farmers' knowledge) and output variable (prevalence of intestinal parasites) as shown in Table 4.25. If farm practice and farmers knowledge are added by one unit then the

prevalence of intestinal parasite is more likely to reduce 6.088 times and 8.065 times respectively.

Table 4.25: The Combined Relationship between Farming Practice, Farmers' Knowledge, and Prevalence of Intestinal Parasite

| **Explanatory variables** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Exp(B)** |
|---|---|---|---|---|---|---|
| Farmers' Knowledge | -2.730 | 1.227 | 4.948 | 1 | .026 | 8.065 |
| Farm Practice | -2.436 | .970 | 6.303 | 1 | .012 | 6.088 |
| Constant | 11.894 | 4.612 | 6.651 | 1 | .010 | 146357.235 |

The output in Table 4.25 lead to the model in Equation 1

$$\boldsymbol{log\left\{\frac{\pi(x)}{1-\pi(x)}\right\} = 11.894 - 2.730X_2 - 2.436X_2} \quad \textbf{.....Eq.4}$$

Where: $\boldsymbol{X_1}$ farmers' knowledge

$\boldsymbol{X_2}$ is farming practice

# CHAPTER FIVE

# DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

## 5.1 Discussion

### 5.1.1 Prevalence of GI parasites

The prevalence of GI parasites in the Mathira constituency was 69.4%, which the study considered to be high. This indicates that 69.4% of the cattle examined were infected by GI parasites. This could be because the majority of the sampled farmers do not check for infections 79.1% , deworm irregularly, carry out free-range farming and have secondary education and below with just a few having post-secondary education.

### 5.1.2 Percentage Prevalence of GI Infection by Gender, Breed, Age and Ward

The percentage prevalence by cattle gender shows that females (67%) had relatively high percentage prevalence compare to males (64%). In Table 4.1 the dominance of the female breeds can be interpreted that the Mathira constituency is a milk-producing region but on small scale. This is in line with a study carried out by Gunathilaka *et al.*, (2018) where the prevalence of GI parasites in males was high compared to females, but the difference was not significant (Gunathilaka *et al.,* 2018). Female were more susceptible to diseases (54.32%) than male cattle (45.68%). Gastrointestinal parasite prevalence in males was higher when compared to that of females, but the difference was non-significant ($p > 0.05$) Cattle of age 1-2 years had a relatively high percentage prevalence (69%) compared to age 3-4 years (55%). The result is similar to the findings of the study carried out in the Kiambu District which established that cattle between weaning and one year of age are more susceptible to gastrointestinal parasite infection compared to other groups (Waruiru *et al.,*

2000). Older animals are more resistant since their adaptive and innate immune system is more developed to counteract gastrointestinal infection (Singh *et al.,* 2015).

The percentage prevalence on breed revealed that Ayrshire (70%) had a relatively high percentage prevalence compared to Gernsey (60%). This agrees with a study carried out in Kenya that shows *Bos taurus* which displays a higher percentage of prevalence. From the same study, Boran cattle (*Bos indicus*) have lower prevalence rates and fluke burdens than *Bos Taurus.*

The percentage prevalence by ward indicates that Kirimukuyu ward had the highest percentage prevalence (86%) while Iriaini had the least percentage prevalence (44%). From the result of percentage prevalence on the regions (wards), it is clear that cattle from Ruguru, Konyu, Kirimukuyu, Karatina town and Magutu ward are more infected compared to cattle from Iriaini ward which were least affected.

Intestinal parasite varied with geographical location as recorded in selected areas of Gampaha District, Sri Lanka, hence geographical location influences the infection rate (Gunathilaka *et al.,* 2018). The presence of a regional veterinary laboratory centre near Iriaini gives the farmers from Iriaini an upper hand in terms of veterinary services compared to those in the neighbouring wards. The farmers in Iriaini are well informed about how to treat, control and prevent the spread of GI infections. Farmers from Ruguru and Magutu wards graze their animals in the Mount Kenya forest where the cattle are more prone to infection compare to those under zero grazing or paddocking. Subsequently, pastoralist communities inhabiting areas contiguous to wildlife areas are at risk of been infected by zoonotic parasites. The tendency of closely related host species to be infected by a similar parasite was high (Obanda *et al.,* 2019).

### 5.1.3 Intensity of GI parasite

Most of the cattle (64.3%) had between 0-200 eggs per gram which is a very low intensity of infection. Overall mean intensity of 191 EPG was also recorded and classified as very low intensity. Compared to the highest intensity of infection (>600 EPG) which accounted for 3.6% of the cattle.

The mean intensity of infection by gender was also very low whereby for male was 185 and female 193. A lower intensity of infection could be associated with improved farming practices such as providing a house with a concrete floor for the cattle, cleaning cattle house on weekly bases, and farming methods such as zero-grazing and watering animal at home. This inconsistent with research carried out in Ghana where the intensity was low (Squire *et al.,* 2013)

### 5.1.4 Farming practice and farmers knowledge conditions

Currently, most farmers use anthelmintic drugs as a way to control or prevent GI infections and to increase production. But it is not adequate to control infections without other complementary intervention (Vande Velde, Charlier & Claerebout, 2018). According to Gunathilaka *et al.,* 2018, animals not dewormed had the highest parasitic infection compared to the treated animals. Several other factors influence a higher prevalence of GI parasite infection. It was established that intestinal parasites are more prevalent in situations when farmers lack knowledge of deworming and checking for infection, which arises due to their low education level. The farmers' knowledge measured using farmers' level of education, which the study established that the majority of the farmers have secondary education and below with just a few having post-secondary education where knowledge on agricultural practices specialized is taught. Most of the farmers lack

knowledge on how to control GI infection, as most of them has primary or no education at all. A research carried out in Greek indicated that the educational level of the farmer was an important risk factor of GI helminth infections (Kantzoura, Kouam, Theodoropoulou, Feidas & Theodoropoulos, 2012). This finding is in agreement with reports from other investigators in Kenya (Gathuma et al., 2007).

The variation in livestock production was caused by quality stock people teams which equal the farmers' knowledge in the current study (English *et al.*, 1999). The low education level of farmers may be associated with a low degree of stock-manship which might lead to risky activities such as the careless manipulation of offal, carcass, faeces, water or feed in the farm, which increases the rate of infection of GI parasites (English *et al.*, 1999). However, where the farmers have high knowledge of deworming (regular) and checking of infections, there is a low prevalence of GI parasite.

The prevalence of GI parasites in the Mathira constituency was 69.4%, which the study considered to be high. Which indicate that 69.4% of the cattle examined were infected by GI parasites. This could be because the majority of the sampled farmers do not check for infections, do irregularly deworm, carry out free-range farming and have secondary education and below with just a few having post-secondary education, which could have led to a higher prevalence of GI parasite. These findings are in agreement with reports from other authors, that time from last deworming is an important factor, with infection prevalence been high among dairy cattle that were dewormed in the last 5 to 6 month compared with animals dewormed within the previous months (Kabaka *et al.*, 2013). Farmers practising a deworming frequency of fewer than 3 months had an overall low prevalence of nematode infection (Kabaka *et al.*, 2013). Animals with high FEC before

deworming presented lower IG on the days following deworming (Seó, *et al.*, 2015). Most of the farmers were unable to check for infection (79.1%) which might be due to limited veterinary services.

High level of expected farm practice such as provide cattle house, watering at the designated place at home, a farming method such as zero-grazing, housing floor type: concrete floor and cleaning the cattle house regularly suppressed the prevalence of the intestinal parasite, which would otherwise remain very high at low levels of the expected farm practice. Instead, intestinal parasite prevalence remains very high by 67.4%. It could be associated with the fact that most housing floor type (53.5%) for cattle is the earth which is hard to maintain hygiene and most GI parasite thrive well in the soil. To control or manage various parasitic infections like winter coccidiosis bedding material should be allowed to decompose along with manure. It is, therefore, necessary to ensure that we provide a house for the cattle that are well ventilated, lit, clean and dry floor to reduce parasite infection.

Most farmers in the region use the free-range farming method (41.9%), since there is no restriction to areas prone to infections it might have led to a higher prevalence of GI parasite. Hence, farming methods such as zero grazings, paddocking and tethering decrease the rate of infection compared to free-range farming according to Sissay *et al.,* (2006). The free-range grazing method will always lead to recurrent infection and reinfection from pastures that are soo much contaminated. It is much easier to control helminth infection in a zero-grazing farming system because the risk of exposure to infective larvae is low (Odoi *et al.,* 2007). Most farmers provided a house for their cattle (69.8%). The animals living in a good build house can resist or tolerate better against internal parasites compared

than animals kept under poor housing conditions. To maintain the required humidity and air circulation in the animal shed ventilation and lighting should be a priority (Madke, Lathwal, Yajuvendra, Anil & Vinay, 2010). Hence providing a house reduces the prevalence of infection.

### 5.1.5 Association between Farmer's Knowledge and Prevalence of GI Parasite

The association between the prevalence of intestinal parasite and farmers' knowledge in terms of the level of education (none, primary, secondary and tertiary), knowledge on deworming (regular, irregular and not at all) and checking for infection (check and do not check for infection) was tested. It indicated that there was a significant association between farmers' knowledge and prevalence of intestinal parasite as revealed by Pearson chi-square. The result agrees with the findings of a study carried out in Nakuru and Mukurweni on the risk factors associated with the gastrointestinal nematode, factors such as deworming management was significantly associated with the prevalence of gastrointestinal infection in dairy cattle (Kabaka *et al.,* 2013). A study carried out in central Kenya highlands (Odoi *et al.,* 2007) on smallholder mixed farming system indicated that grazing system, deworming status and education of the farmer is the major predictor of gastrointestinal infection. Effects of treatment status were significantly associated with the prevalence of GI parasite. Non treated animals accounted for 46.67% of parasitic infections while for partially treated 15.15% (Gunathilaka *et al.,* 2018). According to research carried out in Ethiopia deworming of cattle had a significant association with the occurrence of nematodes. Dewormed animals had a lower nematode infection rate (46.1%) as compared to non-dewormed cattle (64.5 % (Kemal Muktar & Hiko, 2017).

### 5.1.6 Association between Farmers Practice and Prevalence of GI Parasite

The decreased risk of infection by *C.parvum* in ruminants was associated with low numbers of ruminants in the farm and cleaning of the ruminant house (Ratanapob, Arunvipas, Kasemsuwan, Phimpraphai & Panneum, 2012). The study assessed the association between farming practice and the prevalence of GI parasites. It was established that there was a significant association between farm practice and prevalence of intestinal parasite as revealed by Pearson chi-square. Farm practice such as the provision of housing, type of housing floor, cleaning of the house, place of watering the cattle, and the farming method was 8.114 times more likely to reduce the prevalence of intestinal parasites. The prevalence of GI helminths was significantly higher in grazing animals when compared with stall-fed animals. From this study, the free-range farming method was common compared to other farming methods, so it might be significantly associated with a higher prevalence of infection. Farmers in the study area watered their cattle in a designated place at home this might lack significant association with the prevalence of GI parasites in the study area. Considering that the prevalence of helminths was significantly influenced by consuming water from ponds and rivers or canals (Khan *et al.,* 2010)

The floor type statistical revealed that infection by *Eimeria was* easier to happen in concrete floors, depending on animal age (Tomczuk *et al.,* 2015). Our results contradict those reported by Tomczuk *et al., (*2015) where the earthen floor was commonly used which might be associated with a higher GI infection. Providing a house for an individual animal may reduce the risk for coccidiosis, and on the contrary risk of infection increases with the size of the herd (Tomczuk *et al.,* 2015). Most of the farmers provided a house for their cattle hence it might not be a factor influencing the higher prevalence

Several factors such as deworming intervals, housing system, pasture management and agro-ecological conditions influence the incidence, type and damage of various parasitic diseases (Ratanapob *et al.,* 2012).

### 5.1.7 The Combined Relationship between Farm Practice and Farmers' Knowledge and Prevalence of Intestinal Parasite.

The current study established the combined relationship between farm practice and farmers' knowledge and prevalence of intestinal parasite. The output indicated that there was a negative association between the explanatory variables (farm practice and farmers' knowledge) and the output variable (prevalence of intestinal parasites). If farm practice and farmers knowledge are added by one unit then the prevalence of intestinal parasite is more likely to reduce 6.088 times and 8.065 times respectively. The farming method (tethering) and frequency of deworming were associated with a high prevalence of *Trichostrongylus* spp. This is consistent with the findings, Nsereko, Emudong, Mulindwa and Okwee-Acai, 2015) and Beveridge, Pullman, Martin and Barelds (1989). The prevalence of gastrointestinal infection in cattle was associated with other combine factors such as age, location, farmer's education, deworming and grazing system management. (Odoi *et al.,* 2007). There are many other associated risk factors influencing the prevalence and severity of GI helminths. These include age, sex, and weather condition and husbandry or management practices (Ijaz, Khan, Avais, Ashraf, Ali and Khan, 2009). The result of this study indicates that age, breed, deworming, watering-place of cattle and farming method were significantly associated with the prevalence of GIT parasite infection. The result agrees with the findings of the study carried out in Nakuru and Mukurweni on the

risk factors associated with the gastrointestinal nematode, which identified that animal age and deworming management significantly associate with the prevalence of gastrointestinal infection in dairy cattle (Kabaka *et al.,* 2013). A study carried out in central Kenya highlands (Odoi *et al.,* 2007) on smallholder mixed farming system indicated that grazing system, deworming status and education of the farmer is the major predictor of gastrointestinal infection.

## 5.2 Conclusion

Based on the study findings, it can be concluded that:

1. The highest percentage prevalence occurred in female cattle (67%), Ayrshire breed (75%), and cattle aged 1-2 years old (69%).
2. The overall prevalence of GI stands at 69.4%.
3. The mean intensity of infection of cattle was generally very low. Most of the cattle (64.3%) had between 0-200 Egg Per Gram (EPG)
4. Protozoan parasite infection is more common in the study area as compared to other parasites.
5. Cattle in Kirimukuyu ward were the most infected by 19.64% as compared to Ruguru, Karatina town, Magutu, Iriaini, and Konyu.
6. Farmers' knowledge was significantly associated with the prevalence of GI parasite infections.
7. The farming practice was significantly associated with the prevalence of GI parasite infections.
8. Farmers' knowledge and farming practice combined were significantly associated with the prevalence of GI parasite infections.

### 5.3 Recommendations

1. There is a need to create awareness among the farmers on the risk factors such as irregularly deworming, free-range farming, watering the animals on stagnant water as the major cause of GI parasitic infection of cattle in the Mathira constituency.

2. Farmers should be provided with refresher training to increase their awareness that young and old cattle are more vulnerable to infection due to their poor immune response to infection. Young cattle should be regularly checked for infection, reared in an environment that is free from GI parasites, and treat when infected. The older cattle that are not economically important should be discarded to stop them from being a source of infection. From the analysis, the Friesian breed was more vulnerable compared to the other three breeds reared in the Mathira constituency.

3. Farmers should be advised to rear breeds such a Guernsey that are more resistant to GI parasite infection.

4. Veterinary services should be made readily accessible to the farmers, which will facilitate quick access to information and veterinary services.

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# APPENDICES

## APPENDIX I: SAMPLE OF A QUESTIONNAIRE.

### INTRODUCTION

Dear Respondent,

I am a student at Karatina University carrying out a research on the prevalence of gastro-intestinal tract infection in cattle within Nyeri County. The information collected in this questionnaire is for research purposes and will explicitly be used towards gaining statistics and views of farmers on the prevalence of gastro-intestinal parasite in cattle in Mathira sub-county. Thank you in advance.

Instructions

Tick as appropriate by putting an (X) or a tick (√) inside the box provided or answer where required.

### QUESTIONNAIRE

1. Farmers practices regarding gastro-intestinal parasite.

[a] Do you provide a house for your cattle?

Provide housing for cattle ☐

Do not provide housing for cattle ☐

[b]Which are the watering place for you cattle?

At home (in a designated place) ☐

At home (in non-designated place) ☐

At the river ☐

Dam ☐

On stagnant water by the road side ☐

[c]Which is your method of farming?

Paddocking ☐

Tethering ☐

Zero grazing ☐

Free range ☐

[d]What is your cattle housing type?

Concrete floor type ☐

Earth floor type ☐

[e]Number of times you clean the cattle house?

Clean the house monthly ☐

Clean the house twice a year ☐

Clean the house once a year ☐

Other ☐

[f]What is your cattle housing type?

Concrete floor type ☐

Earth floor type ☐

2 . Farmer's knowledge regarding gastro-intestinal parasite.

[a] What is your education level?

Primary level ☐

Secondary school level ☐

Tertiary education ☐

Other ☐

[b] Do you check gastro-intestinal parasite infection?

Check ☐

Do not check ☐

[c] Do you deworm you cattle regularly?

Regularly ☐

Irregularly ☐

Not at all ☐

## APPENDIX II: RESEARCH PERMIT

**NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION**

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref No. **NACOSTI/P/19/19390/27628**

Date: **24th January, 2019**

Caroline Wambui Nyutu
Karatina University
P.O. Box 1957-10101
**KARATINA.**

**RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on ***"Prevalence of gastro-intestinal tract parasite infection of cattle within Mathira Sub-County"*** I am pleased to inform you that you have been authorized to undertake research in **Nyeri County** for the period ending **23rd January, 2020.**

You are advised to report to **the County Commissioner and the County Director of Education, Nyeri County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

**GODFREY P. KALERWA MSc., MBA, MKIM**
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner
Nyeri County.

The County Director of Education
Nyeri County.

THE PRESIDENCY
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT

E-mail: nyericountycommissioner@yahoo.com
Telephone: 061 2030619/20
Fax: 061 2032089
When replying please quote

NYERI COUNTY COMMISSIONER
P.O. BOX 33-10100
NYERI

Ref. No. NYC/ADM 1/57.VOL.VI/153

28th February, 2019

Caroline Wambui Nyutu
Karatina University
P O BOX 1957 – 10101
**KARATINA**

**RE: RESEARCH AUTHORIZATION**

Reference is made to your letter dated 28th February, 2019 on the above subject.

Approval is hereby granted to carry out research on "***Prevalence of gastro-intestinal tract parasite infection of cattle within Mathira Sub-County in Nyeri County***"

The period of study ends 23rd January, 2020.

M. KIAMA
FOR: COUNTY COMMISSIONER
**NYERI COUNTY**

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## APPENDIX III: RESEARCH SHEDULE

| **Time**<br><br>**Activity** | March – May 2017 | Feb<br><br>2019 | Feb-March 2019 | June-July 2019 | August-June 2020 |
|---|---|---|---|---|---|
| Proposal writing | | | | | |
| Issuing of questionnaires | | | | | |
| Sample collection and preparation | | | | | |
| Laboratory analysis | | | | | |
| Data analysis | | | | | |
| Thesis writing and submission | | | | | |

## APPENDIX IV: RESEARCH BUDGET

| ITEMS | NUMBER OF ITEMS | COST PER UNITS (Units) | TOTAL COST (Units) |
|---|---|---|---|
| Slides | 3 packets | 350 per packet | 1050 |
| Coverslips | 5 packets | 100 per packet | 500 |
| pipettes | 200 | 90 per piece | 1800 |
| Applicator stick | 5 packets | 360 per packet | 1800 |
| Universal bottles | 300 pieces | 50 per piece | 15000 |
| Printing Papers | 1 Realm | 1000 | 1000 |
| Cost of Printing | 300 copies | 3000 | 3000 |
| Transport Cost | 80 Days | 1000 Per Day | 80000 |
| Ice Box | 1 small size | 450 | 450 |
| Plastic Bags | 400 Pieces | 15per piece | 6000 |
| Normal saline | 2 litres | 300 | 300 |
| Gloves | 50 packet | 500 per piece | 25000 |
| Giemsa stain | 1 kilogram | 800 per 25g | 24000 |
| Adhesive labels | 400 pieces | 250 per 60 pieces | 15000 |
| Research assistance | 2 people | 1000 per day per person | 160000 |
| Filter papers/sieves | 10 packets | 750 per packet | 7500 |
| Cotton wool | 1 roll | 200 | 200 |
| | | | |
| Sodium chloride | 2kg | 1000 per kg | 2000 |
| Mc Master slides | 4 slides | 25000 per slide | 100000 |
| Contigencies | | 7% of total budget.7/100*409250 | 28647 |
| Grand total | | | 437897 |

## APPENDIX V: LABORATORY REPORTING FORM

| LABORATORY REPORTING FORM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DATE: | | | SLIDES( CIRCLE): **A / B** | | | | | |
| COUNTY: | SUB COUNTY: | | WARD: | | | | | |
| | READER NAME: | | | RESULT | | | | |
| NO | SAMPLE ID | BREED | GENDER | AGE GROUP | PROTOZOAN | CESTODE | TREMATODE | NEMATODE |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 1 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 2 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 3 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 4 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 5 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 6 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 7 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 8 | | | | Name of parasite | | | | |
| | | | | Positive | | | | |
| | | | | Negative | | | | |
| | | | | No.Egg | | | | |
| 9 | | | | Name of parasite | | | | |
| | | | | | | | | |
| | Age group:Group 1(< 1-2) Group 2 (2-3) Group 3(≥4) | | | | | | | |
| | Breed:F(Friesian)A(Ayrshire)G(Guernsey)J(Jersey) | | | | | | | |
| | Gender:F(Female)M(Male) | | | | | | | |
| | Wards:KONY(Konyu),KART(Karatina town),MAGU(Magutu)IRIA(Iriaini),KIRI(Kirimuyu)RUGU(Ruguru) | | | | | | | |

## APPENDIX VI: TABLE 4.2

Table 4.1: Parasite at genus level by cattle breed by gender of cattle Cross tabulation

| **Parasite at Genus Level** | **Description** | **Cattle breed by Gender** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Friesian** | | **Ayshire** | | **Guernsey** | | **Jersey** | | **Sub-Total** | | |
| | | **Male** | **Fem.** | **Male** | **Fem.** | **Male** | **Fem.** | **Male** | **Fem.** | **Male** | **Fem.** | **Total** |
| Schistosoma spp | Count | 7 | 18 | 4 | 7 | 2 | 3 | 0 | 6 | 13 | 34 | **48** |
| | % of Total Gender | 6.10 % | 7.00 % | 3.50 % | 2.60 % | 1.80 % | 1.10 % | 0.00 % | 2.20 % | 11.40 % | 12.50 % | **12.60 %** |
| Strongyloides | Count | 7 | 4 | 0 | 4 | 1 | 0 | 0 | 1 | 8 | 9 | **17** |
| | % of Total Gender | 6.10 % | 1.50 % | 0.00 % | 1.50 % | 0.90 % | 0.00 % | 0.00 % | 0.40 % | 7.00 % | 3.30 % | **4.40 %** |
| Fasciola spp | Count | 2 | 3 | 2 | 5 | 2 | 5 | 0 | 2 | 6 | 15 | **21** |
| | % of Total Gender | 1.80 % | 1.10 % | 1.80 % | 1.80 % | 1.80 % | 1.80 % | 0.00 % | 0.70 % | 5.30 % | 5.50 % | **5.40 %** |
| Entomoeba spp | Count | 3 | 13 | 3 | 3 | 1 | 2 | 0 | 4 | 7 | 22 | **29** |
| | % within cattle breed | 2.60 % | 4.80 % | 2.60 % | 1.10 % | 0.90 % | 0.70 % | 0.00 % | 1.50 % | 6.10 % | 8.10 % | **7.50 %** |
| Giardia | Count | 1 | 2 | 0 | 1 | 2 | 3 | 0 | 1 | 3 | 7 | **10** |
| | % of Total Gender | 0.90 % | 0.70 % | 0.00 % | 0.40 % | 1.80 % | 1.10 % | 0.00 % | 0.40 % | 2.60 % | 2.60 % | **2.60 %** |
| Eimeria | Count | 6 | 20 | 4 | 4 | 0 | 1 | 1 | 2 | 11 | 27 | **38** |
| | % of Total Gender | 5.30 % | 7.30 % | 3.50 % | 1.50 % | 0.00 % | 0.40 % | 0.90 % | 0.70 % | 9.60 % | 9.90 % | **9.80 %** |
| Taenia spp | Count | 0 | 5 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 8 | **9** |
| | % of Total Gender | 0.00 % | 1.80 % | 0.90 % | 1.10 % | 0.00 % | 0.00 % | 0.00 % | 0.00 % | 0.90 % | 2.90 % | **2.30 %** |
| Nematodirus | Count | 2 | 11 | 4 | 2 | 0 | 1 | 1 | 1 | 7 | 15 | **22** |
| | % of Total Gender | 1.80 % | 4.00 % | 3.50 % | 0.70 % | 0.00 % | 0.40 % | 0.90 % | 0.40 % | 6.10 % | 5.50 % | **5.70 %** |
| Trichuris | Count | 2 | 4 | 0 | 0 | 1 | 0 | 1 | 1 | 4 | 5 | **9** |
| | % of Total Gender | 1.80 % | 1.50 % | 0.00 % | 0.00 % | 0.90 % | 0.00 % | 0.90 % | 0.40 % | 3.50 % | 1.80 % | **2.30 %** |
| Toxocara | Count | 1 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 5 | **6** |
| | % of Total Gender | 0.90 % | 0.70 % | 0.00 % | 0.70 % | 0.00 % | 0.00 % | 0.00 % | 0.40 % | 0.90 % | 1.80 % | **1.60 %** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative infection | Count | 24 | 50 | 7 | 18 | 6 | 12 | 5 | 11 | 42 | 91 | **133** |
| | % of Total Gender | 21.10 % | 18.30 % | 6.10 % | 6.60 % | 5.30 % | 4.40 % | 4.40 % | 4.00 % | 36.80 % | 33.30 % | **34.40 %** |
| Mix infection | Count | 8 | 17 | 3 | 8 | 0 | 6 | 0 | 3 | 11 | 34 | **45** |
| | % of Total Gender | 7.00 % | 6.20 % | 2.60 % | 2.90 % | 0.00 % | 2.20 % | 0.00 % | 1.10 % | 9.60 % | 12.50 % | **11.60 %** |
| Sub-Total | | 63 | 150 | 28 | 57 | 15 | 33 | 8 | 33 | 114 | 273 | **387** |
| **Total** | | **213** | | **85** | | **48** | | **41** | | **387** | | **100%** |
| | | **55.00%** | | **22.00%** | | **12.40%** | | **10.60%** | | **100%** | | |