PREVALENCE AND ECONOMIC IMPACT OF *FASCIOLA GIGANTICA* AND HYDATID CYSTS IN CATTLE AND SHEEP AT ELDORET SLAUGHTERHOUSE, KENYA

FARDOSA ABASS TAWANE

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DECLARATION

Declaration by the Student

This research thesis is my original work and has not been submitted for any academic award in any institution and shall not be reproduced in part or full, or in any format without prior written permission from the author and/ or University of Eldoret.

FARDOSA ABASS TAWANE

__________________________________ Date___________________________

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Approval by Supervisors

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

__________________________________ Date___________________________

1. **Dr. Joseph Amesa Omega (Ph.D.) Signature**

   Department of Animal Science and Management
   School of Agriculture and Biotechnology
   University of Eldoret, Kenya

__________________________________ Date___________________________

2. **Dr Jackson Kibet Kitilit (Ph.D.)**

   Department of Animal Science and Management
   School of Agriculture and Biotechnology
   University of Eldoret, Kenya

DEDICATION

This work is dedicated to my brothers; Dr. Tawane, Dr. Abdurrahman Abass, Dr Abdiaziz Mumin, Dr Amin Haji, Eng. Abdallah Abass, Idman Tawane and my mother, Mrs. Adey Issack for their continuous support throughout my education.

ABSTRACT

Fasciolosis and hydatidosis significantly affect livestock production globally, with a high prevalence in Sub-Saharan Africa. This study aimed to determine the prevalence of *Fasciola gigantica* and hydatid cysts in cattle and sheep, along with the financial losses associated with organ condemnation and to assess the knowledge of farmers, meat sellers and meat inspectors about fasciola gigantica and hydatid cysts in cattle and sheep, at Eldoret Slaughterhouse. A total of 479 cattle and 313 sheep carcasses were examined and various samples, including bile, faeces, and condemned organs, were analysed at the Veterinary Investigation Laboratory, Eldoret. Data were collected through systematic post-mortem inspection using visual examination, palpation, incision and laboratory analysis. The collected data were analysed using spss. The findings revealed a *Fasciola gigantica* prevalence of 91.77% in cattle and 58.58% in sheep. In cattle, 39.09% had *Fasciola* eggs in bile and 19.41% in faeces. Additionally, 19.83% whole and 13.5% partially trimmed livers of cattle were condemned. In sheep, 24.92% had *Fasciola* eggs in bile and 14.69% in faeces, with 11.82% of livers entirely condemned and 4.15% partially trimmed. Hydatidosis had a prevalence of 13.36% in cattle and 9.9% in sheep. Financial losses due to organ condemnation were substantial: KSh 329,580 from cattle livers and KSh 27,990 due to fasciolosis in cattle, while sheep-related losses amounted to KSh 29,520 for condemned livers and KSh 2,850 for hydatidosis-infected lungs. Awareness among respondents showed that 66% recognized economic losses caused by these parasitic infections, 14% had limited awareness, and 20% highlighted inadequate government support. The study concluded that *Fasciola gigantica* and hydatid cysts were more prevalent in cattle than in sheep. Recommendations conducting regular deworm programme in livestock, Educating the farmers on parasites control and improved animal husbandry i.e. emphasized fencing of wet areas, provision of clean water, regulate stray dogs and avoid feeding them raw infected offal's to break the hydatid life cycles.

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LIST OF ACRONYMS/ABBREVIATIONS

ASAL	-	Arid Semi-Arid Land
EG	-	*Echinococcus granulosus*
FG	-	*Fasciola gigantica*
FL	-	Financial Loss
GI	-	Gastrointestinal
HC	-	Hydatid Cyst
MP	-	Market price
PAIR	-	Percutaneous aspiration injection respirations
SPSS	-	Statistical Package for the Social Science
TEL	-	Total Economic loss
UG	-	Uasin Gishu
UoE	-	University of Eldoret
VIL	-	Veterinary Investigation Laboratory
WHO	-	World Health Organization

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CHAPTER ONE

INTRODUCTION

1.1 Background information

The parasite of genus *Fasciola* has a wide geographical distribution and affects different livestock species including cattle, sheep, goats, pigs, and camels (Weber, 2018). Fasciolosis, commonly referred to as liver fluke disease, is caused by trematodes of the genus, *Fasciola* with *Fasciola gigantica* being the most widespread species worldwide. The prevalence and severity of these infections vary globally, with significant cases reported in North America, Asia, Australia, and Africa. In Sub-Saharan Africa, where livestock farming is crucial for many communities, the presence of *Fasciola gigantica*, among other parasites, exacerbates poverty and food insecurity. In East Africa, economic losses attributed to *Fasciola gigantica* in livestock exceed USD 10 million annually (Fikire *et al*., 2020).

Fasciola gigantica infections result in considerable losses in livestock due to the condemnation of infected organs and milk production, and lower overall production. The financial impact includes veterinary treatment costs and the diminished market value of infected livestock, particularly in regions where livestock farming is vital for income and the loss of the condemned organ show chronic or acute liver inflammation, bile duct damage, sub-mandibular oedema, anaemia, and general intoxication, which can lead to death. The affected livers are condemned during meat inspections (Price *et al*., 1993). Economic losses from *Fasciola gigantica* infections, such as liver condemnation, are substantial (Behm, 1999).

Hydatid cysts, is a fluid-filled sac that develops in the internal organs of human and animals due to the infection by the larval form of *Echinococcus granulosus* (a small tapeworm of dogs), these cysts primarily affect the liver and the lungs, but they can also occur in the spleen, kidney, brain and other tissues. another significant parasitic concern in livestock production and human health. Domestic ruminants like cattle, sheep, goats and buffaloes serve as intermediate hosts and become infested after ingesting eggs from dog faeces. Hydatid cysts are prevalent in animal organs and pose serious public health risks (Redfar *et al*., 2005; Kaniki & Kia, 2006; Paharsefat *et al*., 2007; Rokni, 2008;

Kaniki *et al*., 2010). Studies in parts of Kenya have shown the devastating effects of hydatid cysts in cattle and sheep (Omega & Koskei, 2012).

The Liver, a highly nutritious organ rich in iron and proteins, is often condemned due to parasitic infections due to aesthetic reasons and liver damage. Its price is generally higher than that of regular meat due to its nutritional value (Hosseini *et al*., 2020). In the United States, while *Fasciola* infections in cattle are relatively rare, hydatidosis is occasionally reported in sheep and goats in south-western states (California. Reports by Jones *et al*. (2019) highlighted localized outbreaks of hydatid cysts in sheep and goats in areas where livestock coexists with wildlife like coyotes, which act as definitive hosts for *Echinococcus granulosus.* Pigs in rural farming communities with poor sanitation are also susceptible to hydatid cysts.

In Asia, *Fasciola gigantica* and hydatid cyst infections are prevalent in multiple domestic livestock. In Iran, for instance, cattle and goats are frequently infected with hydatid cysts, and *Fasciola gigantica* infections are widespread among them. A study by Ahmadi *et al*. (2017) revealed significant economic losses due to organ condemnation. In India and Pakistan, buffaloes frequently suffer from *Fasciola* infections, causing substantial losses in the dairy and meat industries. In Southeast Asia, regions where water buffaloes and goats are reared, the conditions provide ideal environment for *Fasciola gigantica*, to significantly affect animal productivity (Thammasirirak *et al*., 2016).

Although Australia has a well-regulated livestock industry with stringent veterinary controls, occasional outbreaks of *Fasciola gigantica* in cattle, sheep, and goats occur, particularly in the tropical northern regions. Hydatid cysts also pose a threat, especially in sheep and goats. Johnson *et al*. (2018) reported that while the prevalence of these infections is lower compared to other regions, the economic impact remains substantial, particularly in southern states where sheep farming is concentrated.

In Africa, *Fasciola gigantica* and hydatidosis are endemic parasites, affecting not only cattle and sheep but other domestic animals also such as goats, pigs and camels. In Central Africa, hydatidosis is common in goats and pigs, leading to significant losses for smallholder farmers. Goats, essential for subsistence farming, suffer from reduced meat and milk production due to this infection. In Cameroon, Kalla *et al*. (2020)

reported a high prevalence of hydatidosis cattle and goats, contributing to economic losses from organ condemnation and decreased productivity.

In East Africa, where pastoralism is prevalent, *Fasciola gigantica* and Echinococcus granulosus infections are widespread across various livestock species. A study by Fikire *et al*. (2020) revealed that Echinococcus granulosus are prevalent in camels, which are critical to pastoral communities in arid regions. In Tanzania, abattoirs report high levels of hydatidosis goats and sheep, resulting in significant economic losses in the meat industry (Matemu *et al*., 2018).

Kenya faces a significant challenge with parasitic infections among livestock, especially in its arid and semi-arid regions, where *Fasciola gigantica* and hydatidosis are common. These infections affect cattle, sheep, goats, camels and pigs. In counties such as Marsabit, Isiolo and Garissa, camels, which are vital to pastoral communities, often suffer from hydatid cysts, leading to reduced milk production and severe economic losses. High prevalence of *Fasciola gigantica* and Echinococcus granulosus in camels has been found in Marsabit County among challenges faced by livestock farmers according to Wanjala *et al*. (2019)

In Baringo and Samburu counties, hydatid cysts are of significant concern in goats, where livestock farming is the primary economic activity. Reports by Ochieng *et al*. (2020) revealed that up to 20% of goats slaughtered in Baringo County were infected with hydatid cysts, leading to the condemnation of liver and lungs which results in substantial financial losses to farmers.

In Uasin Gishu County, *Fasciola gigantica* and hydatidosis are prevalent in cattle and sheep, goats and pigs. The Eldoret Slaughterhouse, one of the largest slaughterhouses, frequently reports organ condemnation due to parasitic infections. These infections have led to significant economic losses due to the condemnation of affected organs and reduced production in meat and milk.

The economic impact of parasitic infections in Uasin Gishu County extends beyond direct losses to farmers. The local economy, heavily reliant on livestock farming, is burdened by the reduced market value of infected animals, the costs of treating parasitic infections, and lost income from condemned organs. The presence of these parasites in multiple domestic animals exacerbates the financial strain on farmers and the broader meat value chain in the region.

1.2 Statement of the problem

Studies on the prevalence of Fasciola gigantica and hydatid cysts have not been carried out in North Rift region. Farmers lose a lot of money through condemnation of organs due to infestation of *Fasciola gigantica* and hydatid cysts. Condemnation of large quantities of liver and other abdominal organs affected due to *Fasciola gigantica and* hydatid cysts at the Eldoret Slaughterhouse presents a significant financial and nutritional challenge. Human act as accidental intermediate host when they ingest parasites eggs from dog feaces. Farmers, traders and consumers incur substantial financial losses as these organs, particularly the liver, are highly valuable both nutritionally and economically. The rejection of these organs reduces income from meat sales and threatens the profitability of cattle and sheep farming. This financial strain is further intensified by the additional costs of veterinary care required to treat infected livestock, making the business of livestock rearing less viable.

Organ condemnations raise serious public health concerns. Communities that depend on meat as a vital source of nutrition loose access to essential nutrients such as protein, iron, and vitamins, which are abundant in animal liver. Given that livers are typically more expensive than other meat cuts due to their high nutrient content, the widespread condemnation of this organ could contribute to nutritional deficiencies, particularly among populations with limited alternative protein and iron sources. This is especially worrying in regions like Uasin Gishu County, where livestock farming is central to both the local economy and food security.

The effects of *Fasciola* and hydatid cyst infections extend beyond individual losses, as the entire livestock industry faces reduced productivity, rising operational costs, and potential trade restrictions. These parasitic infections also pose a broader public health threat, as hydatid cysts can be transmitted to human

1.3 Justification of the Study

The findings of this study will highlight the prevalence of both *Fasciola gigantica* and hydatid cysts in livestock. This information will guide the Veterinary Department in formulating appropriate control measures. By providing information on the prevalence of these parasites, the research will enable farmers, livestock traders, and veterinary professionals to adopt more effective strategies to reduce infection, minimize economic losses and improve health and productivity. The study will also quantify the number of organs condemned and evaluate the economic impact on the livestock industry. By shedding light on the financial losses associated with these parasitic infections, the study will provide crucial insights for industry stakeholders, allowing for more effective management strategies to reduce infection rates and lessen the economic burden. Additionally, understanding the extent of organ condemnation and its economic consequences can help inform public health policies to address potential nutritional deficiencies, particularly in regions where malnutrition is an increasing concern.

This study holds significant value for the livestock industry and public health sectors in Uasin Gishu County and its surroundings. In regions where cattle and sheep farming are crucial to the economy, understanding the economic effects of *Fasciola gigantica* and hydatid cysts is essential. The study addresses how these parasitic infections lead to considerable financial losses through organ condemnation and diminished market value.

From a public health standpoint, this research is crucial as it reveals the impact of parasitic infections in livestock on human nutrition. The condemnation of nutrient-rich organs, as liver, diminishes the availability of affordable and nutritious food, which can contribute to malnutrition, especially in areas where offal is a key dietary component. The study's findings will inform public health strategies aimed at enhancing nutrition and preventing zoonotic diseases, addressing a critical need for better food security.

1.4 Objectives

1.4.1 General objective

To investigate the occurrence and losses caused by parasites in livestock in the North Rift region of Kenya.

1.4.2 Specific objectives

i. To determine the prevalence of *Fasciola gigantica* and *hydatid cysts* in cattle and sheep slaughtered at the Eldoret Slaughterhouse.
ii. To determine the financial losses caused by condemnation of organs infected by *Fasciola gigantica* and hydatid cysts in cattle and sheep slaughtered at Eldoret Slaughterhouse.
iii. To assess the knowledge of farmers, meat sellers and meat inspectors about Fasciola gigantica and hydatid cysts in cattle and sheep at Eldoret slaughterhouse.

1.5 Null Hypothesis

Ho_1: There is no *Fasciola gigantica* and *hydatid cysts* cattle and sheep slaughtered at the Eldoret Slaughterhouse.

Ho_2: There is no economic loss caused by condemnation of organs affected by *Fasciola gigantica* and/or hydatid cysts in cattle and sheep slaughtered at Eldoret Slaughterhouse.

Ho_3: Farmers and meat sellers in Eldoret have no significant knowledge about Fasciola gigantica and hydatid cysts in cattle and sheep slaughtered at Eldoret slaughterhouse.

CHAPTER TWO

LITERATURE REVIEW

2.1 Fasciola gigantica

2.1.1 Fasciola gigantica

Fasciolosis is a food-borne trematode infection with worldwide distribution Fasciolosis which is a neglected zoonotic disease by world health organization (Rondeland *et al* 2020) is caused by the parasite *Fasciola gigantica* whose taxonomic classification is: Phylum*: Platyhelminthes*, Class: *Trematodes,* Subclass: *Digenia*. Family: *Fasciolosis.* And Genus: *Fasciola*. *F. gigantica* is closely related *Fasciola hepatica.* Its length may vary 25-75mm long by 15 mm wide. *(Dennis et al 1985)* Its cephalic cone is proportionally shorter than that of *F. hepatica* and the egg of *Fasciola gigantica* longer in size and measures 200nm X 100 nm (Dunn, 1995).

2.1.2 Epidemiology

Fasciolosis are a global emerging infection. Influences from climate change may increase rainfall in some areas and decrease freezing temperature in others creating new habitats where fasciola and its host can emerge. Man-made modification of the environment such as irrigation projects may also increase the availability of sustainable habitats. Migration, globalization and import/export of livestock might introduce the parasite and its vectors to new regions. All this factors together can potentially cause the expansion of pandemic areas and increase the prevalence of *Fasciola gigantica* in humans. (Moazeni et al 2016). Populations in developing countries will likely be the most affected and *Fasciola* controls effort declines.

Fasciolosis predominately affects human population living in poverty (Taghipour etal 2019) where poor sanitation, Limited access to clean water and dependence on livestock increases the risk of infection.

2.1.3 The life cycle of Fasciola species

The life cycle of *Fasciola* species, including *Fasciola gigantica*, is a complex process characteristic of trematode parasites. Adult *Fasciola* flukes inhabit the bile ducts of their definitive hosts, such as cattle or sheep, where they lay eggs. These eggs are then excreted into the duodenum and subsequently pass out with the host's faeces. Initially, the eggs are un-embryonated and take about two weeks to develop fully. Once matured, the eggs release motile larvae known as miracidia (Dunn, 1995).

Miracidia are free-swimming and actively search for an intermediate host, typically a freshwater snail like *Lymnaea natalensis*. Upon locating the snail, the miracidia penetrate its tissues and lose their cilia, transforming into sporocysts. Inside the snail, sporocysts undergo asexual reproduction, producing rediae, which eventually develop into cercariae. This transformation generally occurs over a period of 4 to 7 weeks within the snail (Dennis *et al*., 1985; Spithill *et al*., 1999).

Cercariae are motile larvae characterized by a body length of 0.25-0.35 mm and a long, unbranched tail approximately 0.5 mm long. After exiting the snail, cercariae seek out suitable vegetation, such as watercress, to encyst. Under optimal conditions—moist environments with temperatures between 22-26°C—the cercariae encyst to form metacercariae. These cysts are moderately resistant but cannot survive dry conditions for long; however, they can persist for up to a year in high humidity and cooler temperatures (Roberts *et al*., 1997).

When a definitive host ingests metacercariae along with contaminated vegetation, the cysts are released in the small intestine. The larvae then penetrate the gut wall and migrate to the peritoneal cavity before reaching the liver. In the liver, the juvenile flukes move to the bile ducts, where they mature into adult parasites over approximately three months. Adult flukes feed on blood and tissues, causing significant liver damage and contributing to chronic infection (Nadis, 2019). Mature flukes produce between 20,000 and 50,000 eggs daily, which contaminate pastureland and perpetuate the infection cycle. The high egg production rate significantly impacts the epidemiology of Fasciolosis by increasing pasture contamination and influencing infection rates (Mas-Coma *et al*., 2005).

The main intermediate host for *Fasciola gigantica* is the aquatic snail *Lymnaea natalensis*. This snail thrives in well-oxygenated, unpolluted water bodies and can survive dry periods. Environmental changes, such as climate variability and land use practices, can affect the distribution and abundance of this intermediate host, potentially altering the transmission dynamics of *Fasciola* species. Recent research by Khamis *et al*. (2021) has shown how shifts in climate and irrigation practices can impact snail habitats and influence the prevalence of *Fasciola* infections.

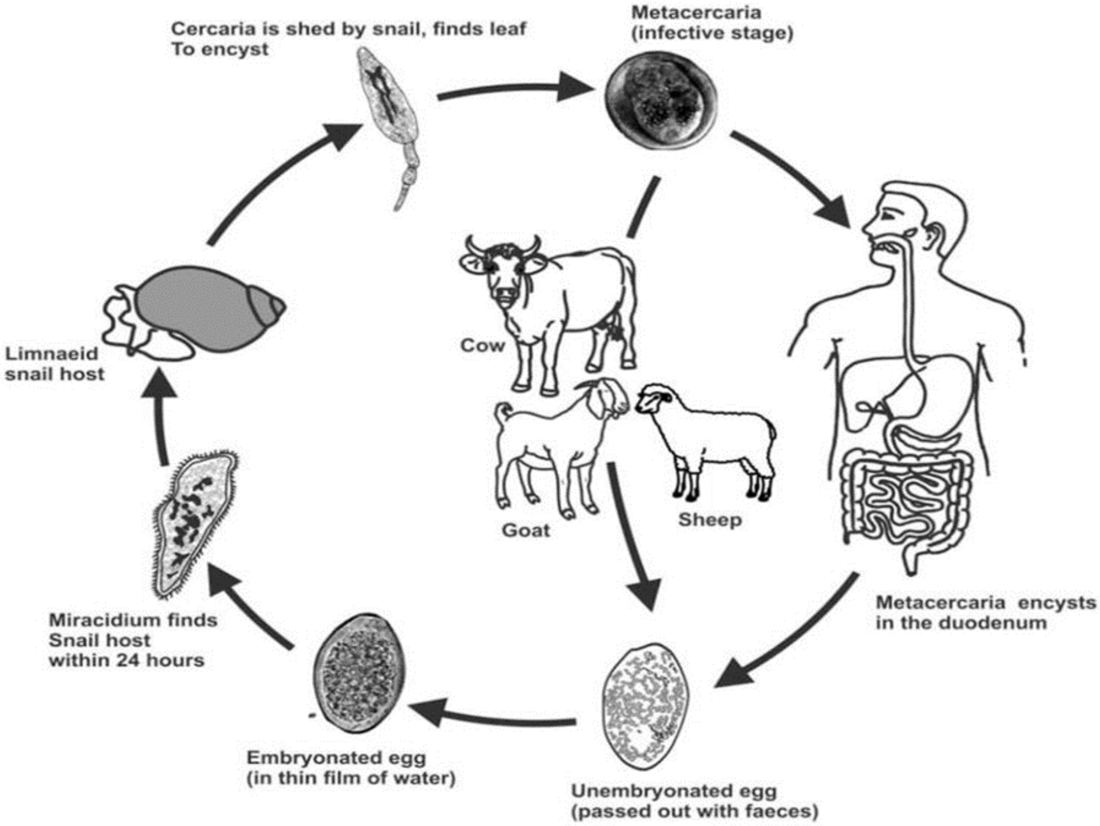

Figure 2.1: Life cycle of *Fasciola gigantica (Kerala et al., 2021)*

2.1.4 Clinical Signs and Diagnosis

Fasciola gigantica infection presents a range of clinical manifestations depending on the stage and severity of the infestation. In acute cases, the migration of juvenile flukes through the liver can lead to sudden death and severe anaemia due to extensive tissue damage and haemorrhage. Sub-acute cases are characterized by rapid loss of body condition, severe anaemia, and elevated fluke egg counts, potentially leading to death more than 20 weeks after initial infection (Taylor and Wall, 2007; Zanzani *et al*., 2015).

The most effective diagnostic method for *Fasciola gigantica* is liver examination at post-mortem. Histological findings include fibrosis resulting from repair to the migratory pathways and cholangitis, with bile ducts showing significant thickening and dilation filled with flukes and eggs. However, faecal egg counts do not always correlate well with the number of flukes in the liver. An animal might have a zero faecal egg count despite being infected with juvenile flukes, while a high faecal egg count might reflect an abundance of eggs being expelled from the gallbladder rather than the true fluke burden (Tesfaw, 2012; Cwiklinski *et al*., 2016).

For accurate diagnosis, sedimentation techniques are commonly used to concentrate and identify parasite eggs, especially those with high specific gravity like trematode eggs. Methods such as faecal sedimentation, flotation, and formalin-ether concentration are employed to enhance detection. Faecal sedimentation is particularly useful for identifying trematode eggs due to their high specific gravity (Yilmaz, 2004; Fairweather, 1999).

Diagnosing fasciolosis by detecting adult parasites in the liver post-mortem has limitations, as it only confirms the disease in animals that have already died. In sheep, significant damage is often caused by juvenile flukes migrating from the intestines to the bile ducts, resulting in severe liver damage before eggs become detectable in the faeces. Research indicates that *Fasciola* eggs may not appear in faecal samples until 13 weeks after infection, although sheep can die as early as 7 weeks due to damage from juvenile parasites (Omega, 1997; Omega *et al*., 1998; El-Badry *et al*., 2020).

Recent advancements in diagnostic methods include serological tests and molecular techniques such as PCR, which can detect *Fasciola* antigens or DNA in the host's blood or faeces even before eggs are visible. For instance, Cwiklinski *et al*. (2018) demonstrated the efficacy of ELISA tests for detecting *Fasciola* antigens in serum, providing an earlier and more accurate diagnosis compared to traditional faecal examination methods.

2.1.5 Prevalence of *Fasciola gigantica*

The parasite *Fasciola gigantica* is a globally distributed trematode that affects livestock across different continents. In Australia, *Fasciola gigantica* is less common than

Fasciola hepatica, but it remains a concern in specific regions. A study identified *Fasciola gigantica* in cattle from northern Queensland, reporting a prevalence rate of around 12% (McCormack *et al*. 2021). The study highlighted how environmental factors, including high rainfall and suitable vegetation, contribute to the parasite's life cycle. According to Collins *et al*. (2020) there is a prevalence of 15% in cattle in the Northern Territory, emphasizing the impact of climatic conditions on parasite distribution.

In China, *Fasciola gigantica* is notably prevalent in regions with extensive irrigation systems that favour the existence of the snail hosts. According to Zhang *et al*. (2022) there was a prevalence of 20% in cattle from Jiangsu Province, attributing this to the area's wetland agriculture. Another study by Li *et al*. (2021) found an 18% prevalence in cattle in Guangxi Zhuang Autonomous Region, underscoring the need for effective control measures due to the economic impact of Fasciolosis on livestock.

In Thailand, *Fasciola gigantica* is frequently encountered in rural and semi-rural areas where water buffaloes and cattle are commonly raised. Chai *et al*. (2020) observed a 25% prevalence in water buffaloes in central Thailand, with seasonal variations affecting prevalence rates, Sangkhathat *et al*. (2023) reported a 22% prevalence in cattle in north-eastern Thailand, highlighting how traditional grazing practices contribute to the spread of the parasite.

In Vietnam, *Fasciola gigantica* is prevalent in areas with extensive rice cultivation. Hoang *et al*. (2021) documented a 30% prevalence in cattle in the Mekong Delta region, driven by irrigation practices. A similar prevalence of 28% was reported by Le *et al*. (2022) in northern Vietnam, emphasizing the need for improved management strategies to address the parasite's impact on livestock.

In Japan, *Fasciola gigantica* is less frequently reported but still present in specific areas, Nakamura *et al*. (2020) found a prevalence of approximately 10% in cattle in Okinawa Prefecture, where environmental conditions support the development of snail hosts. The study highlighted the importance of local climatic conditions in the distribution of the parasite.

In South Korea, *Fasciola gigantica* has been reported in cattle, particularly in regions with suitable conditions for snail hosts. Park *et al*. (2021) found a 12% prevalence in cattle on Jeju Island, noting that local environmental factors and agricultural practices influence the parasite's distribution. The study stressed the need for targeted control measures to manage Fasciolosis effectively.

In Nigeria, *Fasciola gigantica* is a major concern, particularly in areas with suitable conditions for the intermediate host, the snail *Lymnaea natalensis*. A recent study by Biu *et al*. (2020) reported a 34.8% prevalence of *Fasciola* infection in cattle in north-eastern Nigeria. The study highlighted the significant impact of seasonal variations on prevalence, with higher rates observed during the rainy season when environmental conditions favours snail proliferation. Similarly, a study by Omoigberale *et al*. (2022) in south-western Nigeria found a prevalence of 29% in cattle, with the infection being more common in areas with extensive wetland grazing.

In Egypt, *Fasciola gigantica* is a significant problem in rural areas with suitable environmental conditions for the parasite's life cycle. El-Sayed *et al*. (2018) reported a 20% prevalence of *Fasciola* in cattle in the Nile Delta region, with prevalence influenced by the presence of waterlogged areas that support snail populations. A study by Zaki *et al*. (2022) in Upper Egypt found a prevalence of 23% in cattle, emphasizing the need for effective control measures to manage the impact of Fasciolosis in the region. In South Africa, *Fasciola gigantica* is endemic in several regions, particularly where environmental conditions support the survival of snail hosts. A study by Van Wyk *et al*. (2020) reported a prevalence of 26% in cattle from the Limpopo Province, with the research highlighting the impact of seasonal variations and grazing practices on infection rates. Another study by Ezeokoli *et al*. (2023) in the Eastern Cape found a prevalence of 28% in cattle, underscoring the importance of targeted control measures to reduce the prevalence of Fasciolosis.

In Uganda, *Fasciola gigantica* is prevalent in areas with poor livestock management practices. According to Kasozi *et al*. (2021), a 31.2% prevalence of *Fasciola* in cattle from central Uganda, attributing the high infection rates to inadequate control measures and environmental conditions conducive to snail survival. A study by Balirwa *et al*. (2020) in northern Uganda found a similar prevalence of 30% in cattle, with the research highlighting the need for improved management and control strategies to reduce the burden of Fasciolosis.

Kenya is known for high prevalence rates of *Fasciola gigantica*, particularly in regions with abundant water bodies and suitable conditions for the snail hosts. According to the study of Wambura *et al*. (2019) a 28% prevalence of *Fasciola* in cattle from Meru County, noting significant variation across different counties. The study found that grazing in wetland areas contributed to higher infection rates. Another study by Karanja *et al*. (2023) reported a prevalence of 32% in cattle in the Lake Victoria basin, highlighting the influence of environmental factors such as rainfall and temperature on the parasite's distribution.

2.2 Echinococcus granulosus

2.2.1 Overview and Classification

Echinococcus granulosus is a tapeworm parasite and the causative agent of cystic echinococcosis (CE)., It is also known as hydatid disease or hydatidosis. It has a complex life cycle involving two hosts: Definitive hosts: Primarily canines that include dogs, wolves, foxes. Intermediate hosts are sheep, cattle, goats, and humans (accidental hosts) (Wen *et al*., 2021). Key Characteristics Adult worms are 2-7 mm long Possess a scolex with hooks and suckers for attachment Typically have three proglottids (segments) Larvae form fluid-filled cysts (hydatid cysts) in intermediate hosts (Mahmood *et a*l., 2020)

Genetic evaluations have revealed the existence of 10 genotypes of *E. granulosus* (G1-G10), each with varying host preferences and geographic distributions. The G1-G3 genotypes, collectively known as the sheep strain, are the most common in human infections. Other strains include the horse strain (G4), cattle strain (G5), and camel, pig, and cervid strains (G6-G10). Recent reports have provided new insights into the genomic structure of *E. granulosus*, including the discovery of a 4.4 kb tandem repeat region in the mitogenome of the G1 genotype (Kinkar et al., 2021).

Geographically, *E. granulosus* has a worldwide distribution, with higher prevalence in Mediterranean countries, Central Asia, China, South America, and Sub-Saharan Africa. The global distribution of this parasite is influenced by various factors, including livestock husbandry practices, climate conditions, and socioeconomic factors (Vuitton et al., 2020).

The public health significance of *E. granulosus* is substantial. It not only causes significant economic losses in the livestock industry but also poses a serious threat to human health. Human infections can lead to severe complications, including organ dysfunction and death if left untreated. Control measures for echinococcosis include regular deworming of dogs, proper disposal of infected offal, and improved hygiene practices. Recent studies have further elucidated the burden of this zoonotic disease in various regions, emphasizing the need for continued research and control efforts (Sudhakar et al., 2023; Counotte et al., 2021).

2.2.2 Life cycle of *Echinococcus granulosus*

The life cycle of *Echinococcus granulosus* involves both definitive and intermediate hosts, reflecting a complex parasitic relationship that supports its reproduction and spread. Understanding this cycle is essential for comprehending the transmission dynamics and implications for human and animal health are typically canines, such as dogs and wolves, which shed the parasite's eggs in their faeces. These eggs are then ingested by intermediate hosts, which are usually herbivores like sheep, cattle, or pigs. Humans can be infected dogs or consume food or water contaminated with the parasite's eggs (Khanfar *et al*., 2004) Upon ingestion by an intermediate host, the intestinal wall and enter the mesenteric vessels, from which they travel to various organs. The liver is the primary site of infection, with approximately 70% of echinococcal lesions occurring there. The remaining larvae are often carried to the lungs, where 15-30% of lesions are found (Craig *et al*., 2007; Brunetti *et al*., 2010).

In the liver or lungs, the larvae develop into hydatid cysts, which are surrounded by a fibrous capsule. The cysts have an outer chitinous layer and an inner germinal layer. The germinal layer can produce internal protrusions and daughter cysts, leading to the cyst's growth. Hydatid cysts grow at a rate of 1-3 cm per year and can remain asymptomatic for years. Due to their slow growth and lack of immediate symptoms, these cysts can reach significant sizes before they are detected (Giraudoux *et al*., 2006; Deplazes *et al*., 2015).

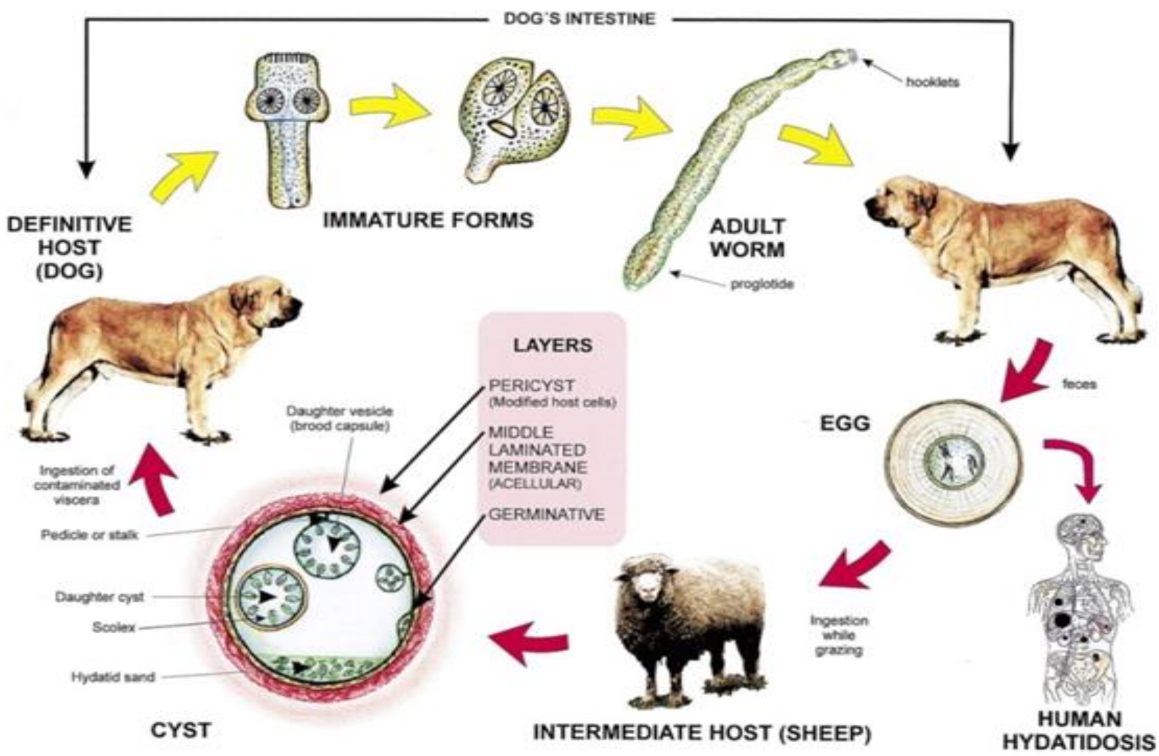

Figure 2.2: Life cycle of Echinococcus granulosus (Afera, 2014)

2.2.3 Clinical Manifestations of *Echinococcus granulosus*

Liver hydatidosis can lead to severe complications such as anaphylaxis if cysts rupture into the peritoneum or biliary tract. It may also cause liver abscesses and other issues such as cholestasis and portal hypertension (Schantz *et al*., 2009). Symptoms and complications depend on cyst size and location.

Recent advances in treatment have been reviewed by Al-Majali *et al*. (2023), who evaluated various management approaches. They found that while surgery remains the primary treatment, percutaneous techniques like PAIR (Percutaneous Aspiration-Injection-Respiration) offer effective alternatives with fewer recurrence rates.

2.2.4 Management and treatment of hydatid cysts

The treatment of hydatid cysts, caused by the parasitic worm *Echinococcus granulosus,* encompasses a range of strategies including surgical procedures, percutaneous methods, and medical therapies. The selection of an appropriate treatment approach depends on factors such as the cyst's characteristics, the patient's health, call veterinary resources.

Surgery remains a widely used method for managing hydatid cysts. Conventional open surgery provides direct access to the cysts, allowing for comprehensive removal and decontamination. Despite its effectiveness, open surgery is invasive and involves longer recovery periods. Alternatively, laparoscopic surgery offers benefits such as reduced postoperative pain and quicker recovery. However, it is associated with a higher rate of disease recurrence compared to open surgery (Schantz *et al*., 2009). Advances in laparoscopic techniques and post-operative care aim to address these recurrence issues, but the choice of surgical method often depends on factors like cyst size, location, and the surgeon's expertise.

Percutaneous Aspiration-Injection-Respiration (PAIR) has become an attractive alternative to conventional surgery, particularly for patients who may not be suited for invasive procedures. PAIR involves aspirating the cyst contents percutaneously, injecting a scolicidal agent, and then performing cyst respiration. This less invasive method generally leads to fewer complications and lower recurrence rates compared to laparoscopic surgery (Tanyuksel *et al*., 2022). PAIR is effective in managing hydatid cysts and offers a less disruptive recovery process.

Medical treatment also plays a crucial role in the management of hydatid disease. Antiparasitic medications such as albendazole and mebendazole are used to reduce cyst viability and prevent further growth. These drugs are often used in conjunction with surgical or percutaneous treatments to address any remaining cysts or to treat patients who are not candidates for surgery (Khanfar *et al*., 2004).

For symptomatic cysts or those with a high risk of complications, treatment is considered essential. Viable cysts also require intervention due to the potential for severe complications if left untreated (Schantz *et al*., 2009). The choice of treatment should be individualized, considering factors such as the cyst's location, the patient's overall health, and the available medical resources.

2.2.5 Prevalence of hydatid cysts

Hydatid cysts, caused by the larval stage of the tapeworm *Echinococcus granulosus,* represent a significant zoonotic health issue across various regions worldwide. The prevalence of these cysts differs greatly depending on geographic location, livestock management practices, and the effectiveness of public health measures.

In South America, hydatid cysts pose a considerable public health problem, while in Chile, Muñoz *et al*. (2020) found that hydatid cysts are endemic in rural regions, with infection rates in livestock reaching up to 25%. This situation underscores the need for improved veterinary practices and public health strategies. A prevalence rates of 15% to 30% in sheep and cattle, largely due to extensive grazing systems and the presence of stray dogs has been reported in Argentina (García *et al*. 2021).

Asia shows significant variation in hydatid cyst prevalence while Turkey, Aydin *et al*. (2018) found infection rates of 18% in sheep and 22% in cattle, highlighting the impact of traditional agricultural practices and insufficient control measures. Similarly, Sharif *et al*. (2022) observed an approximate prevalence of 20% in Iranian livestock, with regional differences indicating the need for targeted control programs.

In Europe, although the prevalence of hydatid cysts is generally lower, cases of infection still occur in certain areas. In Spain, Morchón *et al*. (2017) reported a prevalence of 10% in sheep and 8% in cattle, with the findings linked to the presence of stray dogs and close contact with dogs People or livestock living near infected dogs are at high risk of exposure to eggs shed in dogs and faeces. In France, Giraud *et al*. (2021) found a lower prevalence rate of around 5% in sheep, attributed to effective control measures and public health interventions. In Africa, hydatid disease is a major concern, especially in areas with extensive livestock farming. Research by Kabede et al. (2021) highlighted a high prevalence of hydatid cysts in Ethiopian cattle, with infection rates ranging from 30% to 40%. This elevated prevalence is attributed to traditional farming practices and frequent interactions between livestock and dogs. Similarly, a study by Wamae *et al*. (2019) reported a prevalence of about 28% in Kenyan cattle and 15% in sheep, emphasizing the ongoing challenge posed by inadequate control measures and traditional farming methods.

Overall, the prevalence of hydatid cysts varies widely across different regions, reflecting differences in agricultural practices, public health initiatives, and environmental conditions. Ongoing efforts in monitoring, control, and public education are crucial for managing and reducing the incidence of this zoonotic disease.

2.3 Economic impact of Fasciolosis and hydatidosis

Fasciolosis and hydatidosis exert significant economic burden on livestock industries and public health systems, particularly in areas where these diseases are endemic.

2.3.1 Direct economic losses

Recent studies have continued to highlight the significant economic burden of Fasciolosis and hydatidosis on livestock production and public health globally (Abebe et al.2022) Fasciolosis, caused by *Fasciola hepatica* and *F. gigantica*, remains a major concern for the livestock industry, particularly in endemic regions. Findings in Ethiopia estimated the annual economic loss due to bovine Fasciolosis at US$4.2 million, with the majority of losses attributed to liver condemnation and carcass weight reduction (Mekonnen et al., 2020). In Europe, a comprehensive analysis of the economic impact of Fasciolosis on dairy farms in Belgium revealed annual losses of €8.2 million, or €30 per adult dairy cow, due to reduced milk yield and increased treatment costs (Charlier et al., 2020).

Hydatidosis, caused by *Echinococcus granulosus*, continues to pose significant economic challenges in both developed and developing countries. A 2021 study in Iran estimated the annual economic losses due to hydatidosis in livestock at approximately US$114 million, with sheep and cattle being the most affected species (Khalkhali et al., 2021). In Australia, where The global economic impact of these parasitic diseases remain a challenge. A systematic review and meta-analysis estimated that Fasciolosis causes annual production losses of US$3.51 billion worldwide, with the highest impact observed in Africa and Asia (Abebe et al., 2022). For hydatidosis, a study estimated the global economic burden, including both human and animal losses, to be approximately US$3 billion annually (Budkes et al., 2020).

These updated figures underscore the significance of these parasitic diseases and emphasize the need for continued research and implementation of effective control strategies to mitigate their economic impact on livestock production and public health.

2.3.2 Indirect economic losses

The authors estimated annual losses of up to $25 million in highly endemic regions due to these factors alone.

Hydatidosis similarly results in major indirect economic burdens. A comprehensive analysis by Budke et al. (2021) revealed that human cases of hydatidosis led to production losses from missed work days, reduced earning capacity, and premature mortality. They calculated the global burden of cystic echinococcosis to be 871,000 disability-adjusted life years (DALYs) annually. This translates to billions in economic losses when considering the value of a statistical life year.

In the livestock sector, both et al. (2022) demonstrated that hydatidosis causes reduced meat, milk, and wool production in infected animals. Their economic model estimated that these productivity losses amount to $2-3 billion annually worldwide. Additionally, trade restrictions on livestock and animal products from endemic areas further compound the indirect economic impact.

Studies explored the broader societal costs of these parasitic diseases and found that endemic regions often face reduced tourism revenue due to concerns about food safety and disease transmission (Torgerson et al. 2023). The study also noted increased public health expenditures for disease surveillance and control programs, which divert resources from other economic development initiatives.

2.3.3 Impact of parasites on human health and economic performance

Both Fasciolosis and hydatidosis can cause severe ill health such as abdominal pain, jaundice, and respiratory problems, impairing individuals' ability to work and engage in economic activities (WHO, 2021). The associated healthcare costs for treating these diseases and managing their complications contribute significantly to the economic burden. Chronic infections can lead to long-term health complications, including liver damage and respiratory complications, which can severely affect quality of life and productivity (Khanfar *et al*., 2004).

In addition to the health impacts, communities heavily affected by these diseases often face socio-economic consequences such as stigma and social marginalization.

Misconceptions about these diseases and fear of contagion can lead to social isolation and reduced economic opportunities for affected individuals (Kabede *et al*., 2019). This stigma further intensifies the economic impact by hindering access to economic opportunities and social services.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

The study was carried out at the Eldoret Slaughterhouse, located in the City of Eldoret, Uasin Gishu County, Kenya. The City of Eldoret is the headquarters of Uasin Gishu County and has a human population of four hundred and sixty-four thousand, five hundred and seventy (460,570). All the members of the community contribute to the demand of meat and other animal-based products. The city is a major livestock-trading hub in the North Rift region of the Country. Eldoret Slaughterhouse is situated just outside the City centre at Latitude 0°31'47.24"N and Longitude 35°16'28.92"E off the Eldoret-Iten Road as shown in Figure 3.1. The slaughterhouse handles 15-25 heads of cattle and 12- 30 sheep per day sourced from various farms and markets within the North Rift region, an area covering Uasin Gishu, Elgeyo Marakwet, Turkana, West Pokot, and Trans Nzoia Counties. The region has a transition climate, with some parts being semi-arid, others high potential and waterlogged, making it suitable for inhabitation of *Fasciola gigantica* and hydatid cysts parasitic infections in livestock.

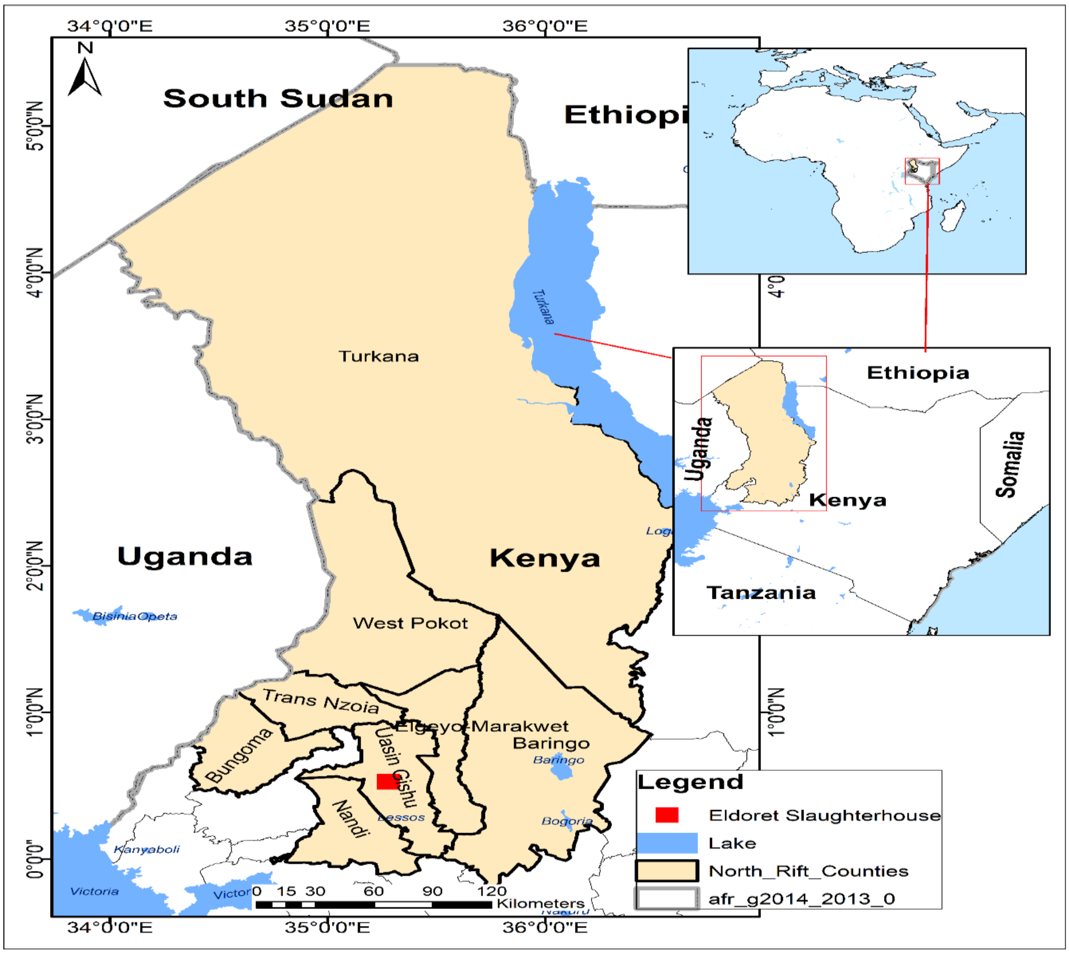

Figure 3.1: The study area showing location of North Rift counties and Eldoret slaughterhouse.

3.2 Study design

The study was conducted from May to June 2024 to determine the prevalence of *Fasciola gigantica* and hydatid cysts in cattle and sheep presented at the Eldoret Slaughterhouse. Data was collected from all cattle and sheep that were offered for slaughter within the study period ensuring their assessment for infestation by the two parasitic species. Determination of the financial losses due to organ condemnation at the Eldoret Slaughterhouse was also carried out.

3.3 Sample size determinations

All 479 cattle and 313 sheep slaughtered at the Eldoret Slaughterhouse between 4th May and 4th June 2024 were examined irrespective of their sexes, ages and the area they originated from.

3.4 Data Collection

3.4.1 Animal slaughter and inspection process

The slaughter process at the Slaughterhouse followed established protocols to ensure humane handling and minimized suffering of the animals. The cattle were stunned using the captive bolt, whereas sheep were slaughtered using the Halal method, where a swift, deep incisionsss was made to the throat with a sharp knife, severing the jugular veins, carotid arteries, and trachea in a single motion.

3.4.2 Inspection of carcass and organs.

All the animals that were brought for slaughter were inspected by qualified personnel for purposes of human consumption. Organs that were infested with *Fasciola gigantica* and/or hydatid cyst, among others, were condemned, trimmed off from the rest of the animal carcass or organs and discarded for disposal. These discarded tissues or organs were visually examined for signs of infestation or affection by *Fasciola gigantica* and/or hydatid cysts. Presence of liver fluke was ascertained by either looking for the parasites or noting other post-mortem signs and lesions such as thickening and hardening of the bile ducts, distension of gall bladders with bile, jaundice or haemorrhage which are characteristic of *Fasciola gigantica* infestation. The lungs, livers and other organs that were condemned due to hydatid cysts affection were examined visually. Hydatid cysts, were recognised as fluid-filled sacs either attached to or embedded in or on organs. Livers were gently palpated to detect the presence of parasites which may not have been visible externally and were suspected to be present. Incisions were made to expose the parasites. By this procedure, small or hidden parasites were exposed. A total of one hundred and thirty-two (27.55%) livers were condemned due to fasciolosis, while ninety-five (19.83%)were rejected due to hydatidosis, as recommended by Bashiri, *et al*. (2021). The weights (kg) of the condemned organs were taken using a spring balance.

3.4.3. Laboratory examination of *Fasciola gigantica*

3.4.3.1 Examination of *Fasciola* parasites

All livers from both cattle and sheep that were condemned were, after examination and confirmation of the parasites, weighed in kilograms and recorded.

3.4.3.2 Examination of *Fasciola* eggs in bile and faeces.

From each of the animals slaughtered, 10ml of bile was collected from gall bladders into labelled Universal bottles and at least 3 gm of fecal material was collected directly from the animals' recti into labelled fecal pots. All the bile and fecal samples were taken to the Regional Veterinary Investigation Laboratory (RVIL) Eldoret for examination for *Fasciola* eggs.

The samples were processed by Sedimentation Technique (Parfitt and Banks, 1970; Omega, 1997). Briefly, 3gm of each faecal sample was placed into a 50ml-Falcon tube to which clean water was added to attain about 45mls. It was mixed thoroughly and then strained through an ordinary sieve to remove all the coarse particles. The supernatant was discarded but the filtrate containing the *Fasciola* eggs was allowed to settle for 15 minutes before being poured out to leave the sediment in 5ml. The tube containing the sediment was filled up with water up to 50mls. Separately, 5 ml of each of the bile samples was poured on a petri dish. To both the processed faecal sediment and the bile, 1ml of Methylene Blue dye solution was added, mixed gently but thoroughly and poured onto a calibrated petri dish before being examined under a stereo microscope (Olympus SZ51) at magnification x40. All the Fasciola eggs in the petri dish were counted and data recorded as egg count per 3gm of faeces or per 5 ml of bile.

3.4.4. Examination of hydatid cysts

All condemned organs from cattle and sheep examined and suspected to have hydatid cysts were taken to the RVIL Eldoret for cyst examination and viability assessment. (Appendix X).

Viability of hydatid cysts was determined as described by Macpherson, (1985). Cysts were carefully collected from the infected organs, ensuring minimum damage to the cyst wall (Alvarez Rojas *et al*., 2022). They were examined with measurements taken of the cyst's size, weight, and any abnormalities (Wen *et al*., 2021). Cyst fluid was then aspirated using a sterile syringe and transferred to a sterile container for viability testing (Manzano-Román *et al.*, 2023). Microscopic examination of the fluid was carried out to identify protocolises, hooklets, and calcareous corpuscles (Hidalgo *et al.*, 2022). The cyst wall was incised and examined for brood capsules and the germinal layer (Basika *et al.*, 2021). Viability assessment of protocolises was conducted using eosin staining, with viable protocolises remaining unstained and non-viable ones staining red (Deplazes *et al.*, 2020). The germinal layer was scraped and examined microscopically for cellular details (Monteiro *et al.*, 2022). All observations were carefully documented. Being a zoonotic parasite, strict safety measures were taken, including handling all samples as potentially infectious, using a biosafety cabinet when possible, and disposing of materials according to biohazard protocols of the Laboratory.

3.4.5 Financial Loss Data

Data on financial losses due to the condemnation of organs was collected by recording the weight and market value of liver and lungs affected by *Fasciola gigantica* and/or hydatid cysts. The total financial loss from organ condemnation was estimated based on the current market prices for these organs in the City of Eldoret.

Financial losses were calculated as:

Financial Loss= (Weight (Kg) of condemned organ) × (Market price in KSh.)

3.4.6 Interviews with stakeholders in the value chain

In addition to physical interviews, questionnaires were administered to various stakeholders in the value chain from the farmers to the consumers (Appendices I to IX). The aim of the interviews was to obtain information on all aspects of farm-to-fork food chain with special attention to cattle and sheep and in relation to fasciolosis and hydatidosis. Information about knowledge attitudes and perceptions regarding parasites and parasitic infections and the economic impact of organ condemnations was captured in the questionnaires. Slaughterhouse workers involved in the slaughter and inspection processes were also among those interviewed. These included veterinarians, meat inspectors, and slaughterhouse attendants who handled cattle and sheep on a daily basis.

3.5 Data Analysis

3.5.1 Prevalence estimation

Data was analysed in Statistical Package for Social Sciences (SPSS version 21). The prevalence of *Fasciola gigantica* and hydatid cysts was calculated as the proportion of cattle or sheep that had the parasite against the number of respective animals slaughtered expressed as a percentage. Prevalence was calculated separately for *Fasciola gigantica* and hydatid cysts, as well as for each species (cattle and sheep). The formula for prevalence was:

$$\text{Prevalence} = \frac{\text{Number of infected animals}}{\text{Total number of animals slaughtered}} \times 100$$

3.5.2 Analysis of data from questionnaires

Descriptive statistics was used to describe the data from the interviews and questionnaires in form of tables, graphs, pie-charts etc. as appropriate.

3.5.3 Financial Loss Analysis

The total financial losses caused by condemned and trimmed organs were calculated using the following methods and formulas:

1. For each type of organ affected by *Fasciola gigantica* or hydatid cysts, the weight of condemned or trimmed portions was recorded.
2. The current market price per kilogram for each organ type was obtained from the traders.
3. The financial loss for each organ was worked out.

This method provided an assessment of the financial loss by *Fasciola gigantica* and hydatid cysts infestations in the livestock sector of Usain Gishu County and the neighbouring counties by accounting for variations in both the weight of affected tissues and the market value of different organ types.

3.6 Ethical Considerations

Permission was sought from the Eldoret Slaughterhouse management to conduct post-mortem examinations on the livestock. Ethical clearance was obtained from County Director of Veterinary Services, Uasin Gishu County ensuring that animal welfare standards were maintained throughout the study.

CHAPTER FOUR

RESULTS

4.1 Prevalence of *Fasciola gigantica* in cattle and sheep at the Eldoret Slaughterhouse

4.1.1 Prevalence of *Fasciola gigantica*

4.1.1.1 Cattle

All four hundred and seventy-nine slaughtered had their livers examined 95(19.83%) of the livers were condemned, and 65(13.5%) were partially trimmed due to *Fasciola gigantica infestation*.

4.1.1.2 Sheep

From the three hundred and thirteen sheep livers examined, 37 (11.82%) were condemned while 13 (4.15%) were trimmed due to presence of *Fasciola gigantica* (Figure 4.1 and 4.2).

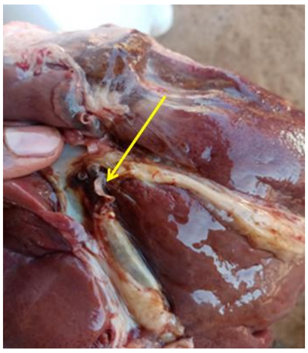

Plate 1: *Fasciola gigantica* (see arrow) in the liver of sheep.

4.1.2 Prevalence of *Fasciola gigantica* by eggs in faeces

After carrying out the Sedimentation Technique on the faecal samples, the eggs were identified as shown in Figure 4.2. The Fasciola eggs were identified as yellowish-brown, oval eggs with thin shells. Each egg contained one cell stage embryo surrounded by a group of oval body yolk cells, with a distinct, inner concaved operculum and an umbilicus-like invagination at the posterior end of the shell (Soulsby 1968).

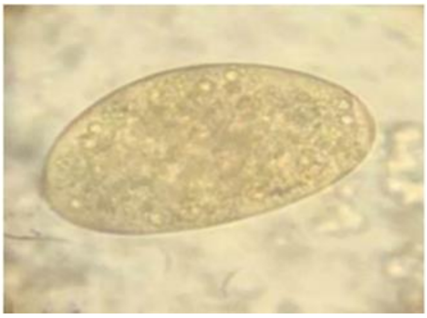

Plate 2: *Fasciola gigantica* egg as seen under X100 magnification

4.1.2.1 Cattle

After examining all the faecal matter from the cattle that were slaughtered 19.41% had fasciola eggs in their faecal materials.

4.1.2.2 Sheep

After examining all the sheep slaughtered 14.69% had *Fasciola* eggs in their faeces.

4.1.3 Prevalence of *Fasciola gigantica* by eggs in gall bladder

4.1.3.1 Cattle

All the animals their bile samples were collected and examined at the Eldoret veterinary investigation laboratory showed that 39.03%had bile eggs

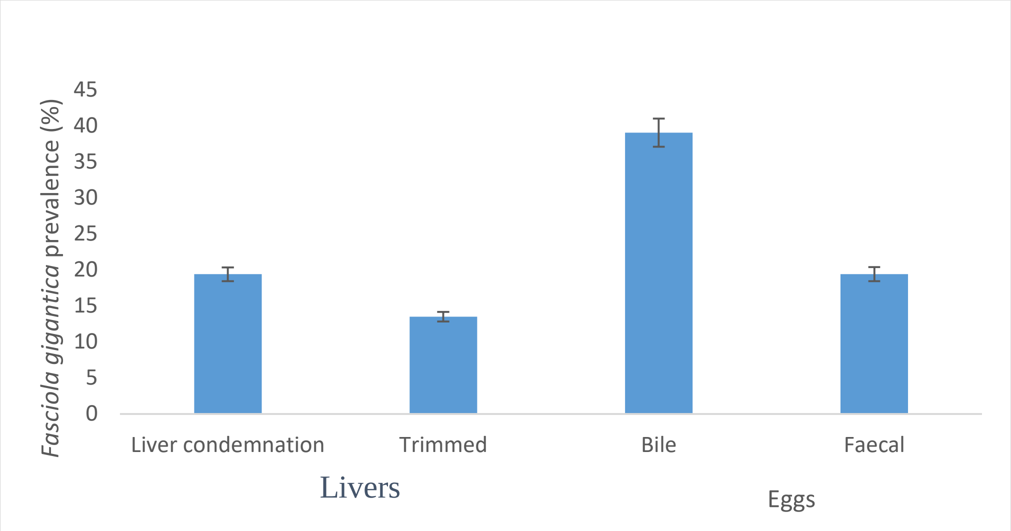

Figure 4.3:prevalence of *fasciola gigantica* in cattle at the Eldoret slaughterhouse

4.1.3.2 Sheep

Fasciola eggs were found in the bile of 24.92% of the slaughtered sheep. The average *Fasciola gigantica* egg counts per 5ml of bile in cattle was 207.13±39.7 while the average egg count per 3 grams of faeces was 61.67±8.48. Out of 479 cattle slaughtered, 39.03% had *Fasciola gigantica* eggs in the bile, 19.41% had *Fasciola gigantica* eggs in,19.83% had their livers condemned and 13.5% had their livers partially trimmed due to *Fasciola gigantica* infestation (Figure 4.4).

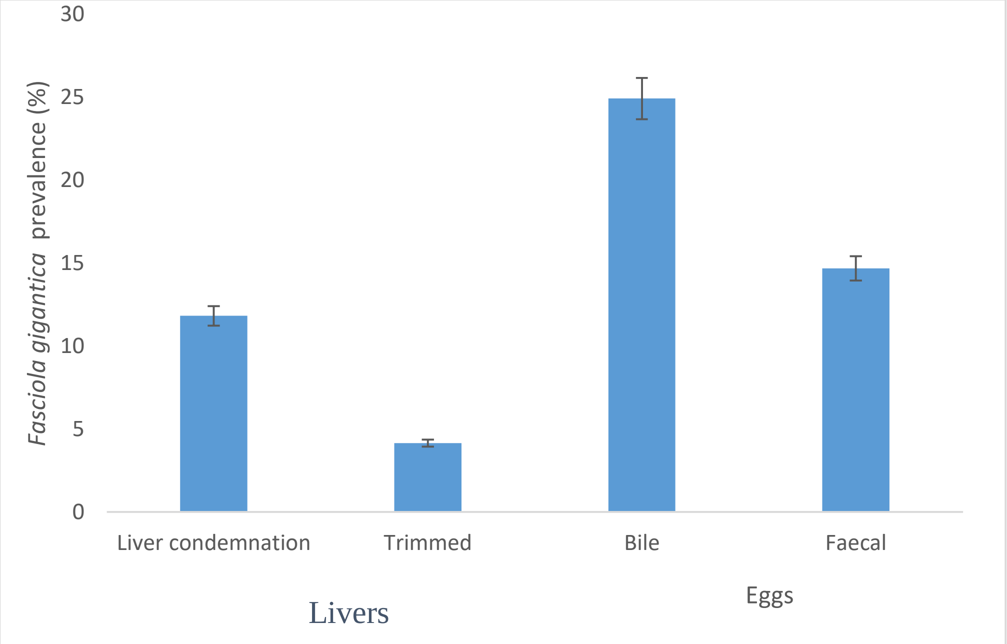

Figure 4.4: Prevalence of *Fasciola gigantica* in sheep slaughtered at the Eldoret Slaughterhouse

There was no correlation between the presence of *Fasciola gigantica* eggs in the bile (-0.321), (faecal samples of cattle. However, a correlation was observed between the numbers of affected livers and the presence of eggs in the bile. This can be attributed to certain factors, such as the parasites hermaphroditic nature, which enables them to produce eggs individually.

The average *Fasciola* egg count in in sheep slaughtered was 31.2332 per 5mls of bile while the average egg count was 7.8722 per 3gms of faeces. 24.92% of the sheep slaughtered had *Fasciola* eggs in the bile while 14.69% had them in faeces. 11.82% of the sheep had their livers condemned and 4.15% had theirs partially trimmed due to *Fasciola gigantica* as illustrated in Figure 4.4. There was no significant ($P \geq 0.05$) difference in prevalence levels recorded between eggs in bile and faeces.

The Spearman rank correlation analysis between *Fasciola* ***gigantica*** egg counts in sheep bile and faeces slaughtered at the Eldoret Slaughterhouse revealed a moderate inverse relationship with a correlation coefficient of −0.3201 ($P \leq 0.0012$) indicating that as the number of eggs in bile increased, the number of eggs in faecal samples tended to decrease and vice versa. This gave a low coefficient of determination of 0.104, which implied that the correlation cannot be relied upon for any prediction.

4.2 Prevalence of hydatid cysts in cattle and sheep slaughtered at the Eldoret Slaughterhouse

4.2.1 Prevalence of hydatid cysts in cattle slaughtered at the Eldoret Slaughterhouse.

The overall prevalence of *hydatid cysts* in the lungs and the livers of the cattle was 13.36% categorised into three groups: viable cysts 4.17%, unviable (sterile) cysts 0.62% and 3.34% calcified cysts (Figure 4.5).

Plate 3: Lungs with hydatid cysts (arrows)

There was no significant (P≥0.05) difference in prevalence levels of *hydatids cysts* caused by viable cysts, unviable cysts and calcified cyst. Seventeen (17) livers from cattle had calcified *hydatids* cyst, translating to a prevalence rate of 3.55% as shown in Figure 4.5. There was no significant (P≥0.05) difference in prevalence levels caused by either viable cyst 0.84%, for unviable cyst 0.84% and calcified cyst 3.55% in the liver. The overall prevalence of *hydatids cysts* in cattle was 13.36%.

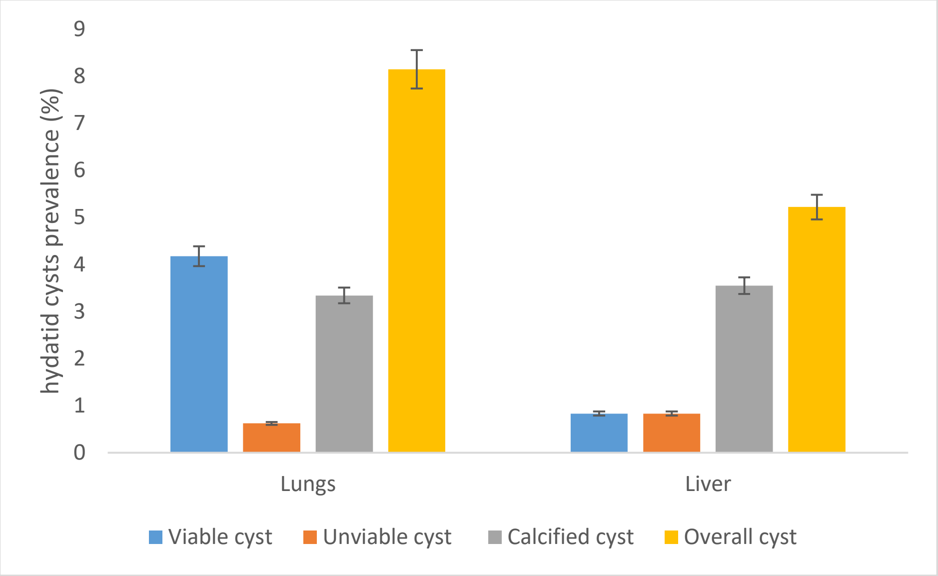

Figure 4.6: Prevalence of *hydatids cysts* in cattle slaughtered at the Eldoret Slaughterhouse

The correlation analysis between lung and liver hydatids cysts in cattle at the Eldoret Slaughterhouse indicated a weak positive relationship (r=0.2923). The correlation analysis between viable, unviable, and calcified cysts showed perfect negative and positive relationships. Specifically, the viable cysts had a perfect negative correlation ($r=-1.0000$, $p<0.05$) with both unviable and calcified cysts, meaning that as the number of viable cysts increased, the number of unviable and calcified cysts decreased, and the vice versa. Conversely, unviable cysts had a perfect positive correlation with calcified cysts, indicating that as the number of unviable cysts increased, the number of calcified cysts also increased as illustrated in Table 4.1.

Table 4.1: Correlation results between viable, unviable, and calcified cysts in cattle organ samples

	Viable cyst	Unviable cyst	Calcified cyst
Viable cyst			
Unviable cyst	-1.0000		
Calcified cyst	-1.0000	1.0000	

Figures in parenthesis are the p values

4.2.2 Prevalence of hydatid cysts in Sheep

All three hundred and thirteen (313) sheep were examined for the presence or absence of hydatid cysts in their organs. In the lungs, 2.24% of the cysts were viable, while 0.63%were unviable and 1.59% appeared as calcified cysts. In the liver, the presence of viable cysts 0.96%, unviable cysts 0.96% while calcified cysts accounted for 3.51%. The overall presence of hydatid cysts in sheep was 9.9%. There was no significant ($P \geq 0.05$) difference in prevalence levels caused by either viable cyst, unviable cyst and calcified cyst in the lungs of sheep. as illustrated in Figure 4.5. There was no significant ($P \geq 0.05$) difference between viable, unviable and calcified cysts in sheep.

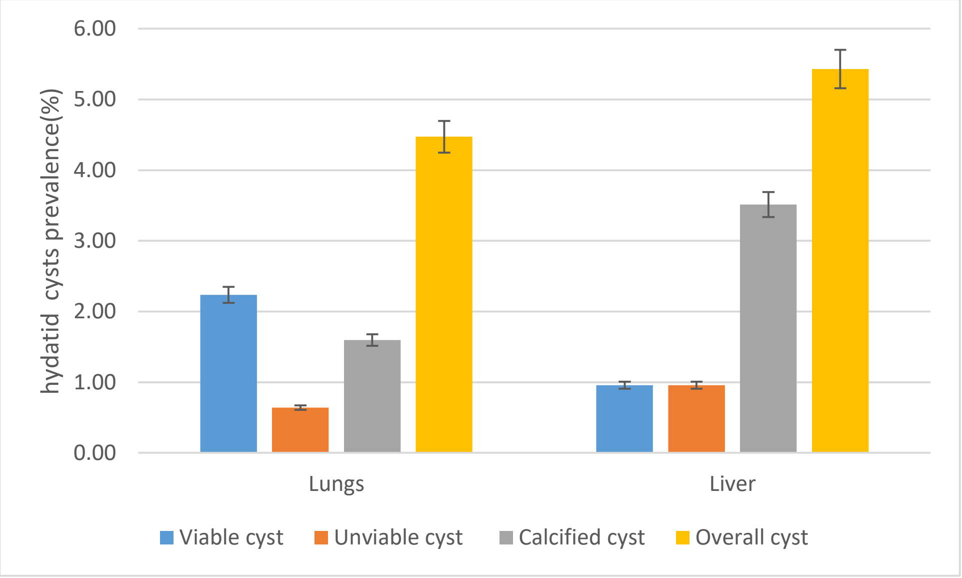

Figure 4.7: Prevalence of hydatids cysts in sheep slaughtered at the Eldoret Slaughterhouse

The correlation analysis among viable cysts, unviable cysts and calcified cysts demonstrated relationship between them. The correlation coefficient between viable cysts and unviable cysts indicated a perfect negative correlation ($r=-1.0000$, $p<0.0001$), and the same coefficient was found between viable cysts and calcified cysts ($r=-1.0000$, $p<0.0001$). Conversely, the correlation coefficient between unviable cysts and calcified cysts indicated a perfect positive correlation ($r=1.0000$, $p<0.0001$), meaning they increase and decrease together as illustrated in Table 4.2.

Table 4.2: Correlation analysis between viable, unviable and calcified cysts in sheep organ samples

	Viable cyst	Unviable cyst	Calcified cyst
Viable cyst			
Unviable cyst	-1.0000 ($p<0.0001$)		
Calcified cyst	-1.0000 ($p<0.0001$)	1.0000 ($p<0.0001$)	

Figures in parenthesis are the p values

4.3. Other pathological findings

Other pathological findings observed included infectious necrotic hepatitis, abscesses, tumours, fibrosis, oedema and hematoma in the examined. Out of four hundred and seventy-nine (479 herds of cattle, 15 (3.14%) were found to have other pathological conditions. The Infectious necrotic hepatitis had affected 0.63% of the cattle, with 1.25% having abscesses, 0.42% having fibrosis in their sampled livers while 0.42% and 0.21% had lungs and hearts with abscesses as illustrated in Table 4.3. Of the 313 examined, six (6) (1.92%) were diagnosed with Infectious necrotic hepatitis and Abscesses in their livers. Oedema and Fibrosis was recorded in the lungs of the 0.32% of the sheep examined while a similar proportion was recorded in the hearts with abscesses as summarised in Table 4.3.

Table 4.3: Other pathological finds

Cattle	Liver	Infectious necrotic hepatitis	3	0.63
		Abscesses	6	1.25
		Tumour	2	0.42
		Fibrosis	1	0.21
	Lung	Abscesses	2	0.42
	Heart	Abscesses	1	0.21
			15	3.14
Sheep	Liver	Infectious necrotic hepatitis	1	0.32
Ungulate	Organ affected	Pathology	Number of affected organs	Proportion of animals affected (%)
		Abscesses	1	0.32
	Lung	Oedema	1	0.32
		Fibrosis	1	0.32
	Heart	Abscesses	1	0.32
	Kidney	Hematoma	1	0.32
			6	1.92

4.4. Losses due to condemnation of organs

4.4.1 Losses caused by condemnation of organs affected by *Fasciola gigantica* in cattle and sheep

The results showed significant financial losses due to fasciolosis, with cattle giving higher losses than sheep. The price per kilogram of cattle liver was KSh. 600.00 at the abattoir. A total of 95 cattle livers were condemned, and 65 were partially trimmed, in which gave a total of 471.1 kg of liver being condemned and 78.2 kg being trimmed. This led to a financial loss of KSh 282,660.00 due to whole-liver condemnation and KSh 46,920.00 due to trimmed liver, bringing the total loss from cattle alone to KSh

329,580.00 and the average loss per cattle is 688KSh during the period of the current study.

In sheep, the price per kilogram of liver was higher at KSh 800 at the abattoir. However, lower sheep livers quantities were condemned (37) and trimmed (13), with 32.3 kg of liver being condemned and 4.6 kg being trimmed. The financial loss from condemning the two species, cattle and sheep, was significantly higher in cattle, both in terms of the numbers of livers affected and the overall financial impact. The total for cattle, at KSh 329,580.00, was more than ten times the KSh 29,520.00 loss from sheep. The total average loss per animal was KSh 94. 3. loss as illustrated in Table 4.4.

Table 4.4: Losses caused by condemnation of organs affected by *Fasciola gigantica* in cattle and sheep

Attributes relating to liver	Cattle liver infected by *Fasciola gigantica*	Sheep liver infected by *Fasciola gigantica*
Price in KSh. per kg of liver	600.00	800.00
Total Number of Liver Condemned	95	37
Total Number of Liver Trimmed	65	13
total number of Kg Condemned	471.1	32.3
total number of Kg Trimmed	78.2	4.6
Total loss in KSh. due to Condemned	282,660.00	25,840.00
Total loss in KSh. due to Trimmed	46,920.00	3,680.00
Total Loss in KSh. Incurred	**329,580.00**	**29,520.00**

4.4.2 Losses caused by condemnation of organs affected by hydatid cysts in cattle and sheep slaughtered

In cattle, the lungs were significantly affected by condemnation and trimming, resulting in substantial financial losses. Priced at KSh. 200.00 per kilogram, 32 cattle lungs were condemned, totalling to 87 kg, while 7 lungs were trimmed, amounting to 6.3 kg loss.

This led to a financial loss of KSh. 26,100.00 from condemned lungs and an additional KSh. 1,890.00 from trimming, bringing the total loss for cattle lungs to KSh. 27,990.00.

The financial losses were even more severe with cattle livers. Priced at KSh. 600.00 per kilogram, 25 livers were condemned, resulting in a loss of 95.6 kg Unlike the lungs, no liver trimming was recorded. The financial loss due to the condemnation of livers alone was KSh. 57,360.00, making it the most significant loss among the cattle organs and making the total loss from cattle to 85,350 and 178 is the average loss per cattle. evaluated as illustrated in Table 4.4.

In sheep, both lungs and livers were also affected by hydatid cysts, though the financial impact was less severe than cattle. Sheep lungs, priced at KSh. 100.00 per kilogram, had 14 lungs condemned, that gave a total weight of 13.9 kg, and 2 lungs trimmed, amounting to 0.7 kg. This resulted in a financial loss of KSh. 1,390.00 from condemned lungs and KSh. 1,460 from trimmed lungs, giving a total loss of KSh. 2,850 for sheep lungs. Sheep livers, priced at KSh. 800.00 per kilogram, had fewer condemned organs but were more valuable per unit. A total of 17 livers were condemned, leading to the loss of 17 kg. No trimming was recorded for the liver, resulting in a total financial loss of KSh. 13,600.00. The total financial loss for sheep is 16,450 and 53 is the average per sheep.

When comparing cattle and sheep, cattle experienced much higher overall financial losses. The most significant loss occurred in cattle livers, where condemnation led to a financial impact of KSh. 57,360.00, far exceeding the losses observed in sheep. In addition, the total loss for cattle lungs due to hydatid cysts (KSh. 27,990.00) was higher than the combined loss for sheep lungs and livers (KSh. 16,450.00) as illustrated in Table 4.5.

Table 4.5: Losses caused by condemnation of organs affected by hydatid cysts in cattle and sheep

	Cattle		Sheep	
Organ	Lungs	Liver	Lungs	Liver
Price per kg at the abattoir	200.00	600.00	100.00	800.00
Total number of Condemned	32	25	14	17
Total number of Trimmed	7	0	2	0
Total number of Kg Condemned	87	95.6	13.9	17
Total number of Kg Trimmed	6.3	0.0	0.7	0.0
Total loss in KSh. due to Condemned	26,100.00	57,360.00	1,390.00	13,600.00
Total loss in KSh. due to trimming	1,890.00	0.00	1,460.00	0.00
Total Loss in KSh. Incurred	**27,990.00**	**57,360.00**	**2,850.00**	**13600.00**

4.5. Respondents' responses on the losses caused by condemnation of organs affected by hydatid cysts in cattle and sheep

Questionnaires were administered to 4 cattle or sheep owners, 6 animal traders, 2 meat inspectors, 1 County Director of Veterinary Services 1 Livestock Production Officer of Uasin Gishu County, 2 meat transporters, 4 butchers and 3 meat consumers and 1 veterinary practitioner to obtain information on economic losses incurred due to condemnation of organs affected by fasciolosis and hydatidosis.

4.5.1 Cattle/sheep owners

The owners stated that condemnation of infected organs (liver, lungs) decreases overall profitability. 44% highlighted lack of awareness and preventive measures, leading to recurring losses and improved deworming programs to control hydatid diseases.

4.5.2 Animal trader

Sixty-six percent reported economic setback as condemned organs lower the resale value of the animals and also highlighted difficulties in identifying infected animal before purchase. They suggested routine veterinary checks before trading.

4.5.3 Meat inspectors

Emphasized the public health risk of consuming infected meat and reported frequent condemnation of affected organs which leads to waste.

4.5.4 County Director of Veterinary Services

He acknowledged economic losses at various levels of meat value chain, stressed the needs for community's awareness on hydatid disease control and recommended government intervention through subsidized deworming programs.

4.5.5 Livestock Production Officer of Uasin Gishu County

Advocated for better disease surveillance and reporting mechanism, there were supposed to recognized financial losses incurred by farmers and traders and suggested training programs for farmers on parasite control.

4.5.6 Meat transporters,

Three transporters confirmed that meat condemnation leads to financial losses for multiple stakeholders, including transporters, butchers and farmers. suggestion for reducing losses i.e. better animal health management, compensation mechanism for affected transporters and farmers and enhanced disposal system to prevent illegal sales of condemned meat.

4.5.7 Butchers

Four butchers reported financial losses due to the organs condemnation and these reduces meat quality, expressed over customer's distrust when they witness condemned organs and called for better disease control measures to ensures consistent meat supply.

4.5.8 Meat consumers

Three meat consumers reported changing their meat purchase habits due to fear of infections and expressed concerns about food safety and health risk to human since these diseases are zoonotic.

4.5.9 Veterinary practitioner

The meat inspector reported encountering hydatid cysts quite frequently, particularly in older animals, with about 10-15% of the animals they slaughter showing signs of infection. They indicated that this leads to significant losses, with approximately 20-30% of the liver and lungs being trimmed and, in some cases, entire organs requiring to be discarded. They highlighted the financial losses and organ condemnation caused by decreased meat quality and the need to discard affected parts., Processing these animals requires more time and labour, which adds another cost per animal to their costs. The presence of cysts was also noted to impact market value, reducing it by 20-30% as consumers are hesitant to purchase such meat.

Meat inspectors reported that hydatid cysts were a common finding, with approximately 1 in every 10 animals inspected showing signs of infection, particularly in animals sourced from Turkana and Uasin Gishu Counties. This resulted in the condemnation of about 5% of the organs inspected, leading to direct financial losses for butchers and farmers. However, the results recorded at Eldoret slaughterhouse give higher figures. The financial impact was described as significant as condemned organs mean less meat available for sale. To ensure public safety, inspectors indicated the need to implement extra measures, such as additional inspections and public awareness campaigns, which increase operational costs. Moreover, documenting each case of hydatid cysts was reported to add to their workload, especially in animals sourced from high disease prevalence areas, leading to higher administrative expenses.

Traders reported that the presence of hydatid cysts in meat products had a noticeable impact on consumer demand. They noted that even a suspicion of infection significantly reduces demand, often forcing them to lower prices by 20-30% to ensure the product sells. This price reduction was said to result in considerable losses. In addition, traders occasionally face returns or complaints from customers, which further reduce their profits.

44% of farmers reported that managing hydatid cysts in livestock was a significant challenge. They stated that regular monitoring of their animals' health was a cost they incurred regularly through veterinary services. Despite these efforts, farmers noted that hydatid cysts led to decreased weight gain and overall poor health in livestock, resulting in lower market prices. Annual expenditures on treatments and preventive measures were estimated at about KSh. 3000 per household, but these measures were not always effective in controlling the parasites. 4 farmers also reported experiencing livestock deaths, which they attributed to hydatid cysts, with each loss costing around KSh 70,000.00 in cattle and approximately KSh. 6,000 in sheep. The marketability of livestock was reported to be affected, as buyers tend to be cautious and often offer lower prices. Overall, farmers estimated that their income has dropped by about 10-15% due to the presence of cysts in their animals.

In general, respondents reported that awareness and education about hydatid cysts are limited among many stakeholders. While some have knowledge of the issue, they are not always certain how to effectively prevent it, leading to financial losses. It was reported that most stakeholders do not have insurance that covers losses due to hydatid cysts, so any costs come directly out of their pockets. Additionally, there was little or no government support available to help mitigate these losses, leaving stakeholders to manage the problem on their own. Overall losses due to hydatid cysts were estimated to be quite high. Even though some have tried implementing best practices, such as regular deworming of animals, these measures were reported to be expensive and not completely effective, resulting in substantial financial impact.

CHAPTER FIVE

DISCUSSION

5.1 Prevalence of *Fasciola gigantica*

5.1.1 Cattle

The prevalence of fasciolosis at the Eldoret slaughterhouse revealed a significant infection rate, with 39.03% of cattle livers being condemned and 19.41% partially trimmed. This high prevalence may be linked to the presence local swamps and wetlands that host intermediate hosts, snails, and support the life cycle of the trematodes in Uasin Gishu and the surrounding Counties. This prevalence rate was, however, lower than that obtained by Mungube *et al.* (2019), who observed *Fasciola gigantica* infection rates ranged between 45% and 60% in areas where cattle grazed in wetlands. The prevalence of Fas*ciola gigantica* in cattle at the Eldoret Slaughterhouse indicated a high parasitic burden, with notably higher prevalence detected in bile compared to faeces. The bile was found to have more *Fasciola* eggs than the faeces due to several factors related to the lifecycle of *Fasciola.* Bile contains all waste material produced by the liver that goes into the gall bladder before being discharged periodically to the intestines via the hepatic duct and eventually out with the faeces. Since *Fasciola* parasites reside in the bile ducts, the eggs they release mix up with the bile and flow into the gall bladder. The fact that the discharge of bile into the intestine is periodical, makes it imperative that the prevalence of *Fasciola* eggs in bile (39.03%) is higher than that of eggs in faeces (19.41%).

5.1.2 Sheep

11.82% of sheep livers were condemned and 4.15% were partially trimmed. In a similar study carried out in Dash Room County, Iran, the prevalence of *F. gigantica* infections in sheep was 17.71% (Moshfe et al.,2016). The high prevalence in sheep can be attributed to their feeding habit as compared to that of cattle. The findings of Mungube et al. (2019), who observed *Fasciola gigantica* infection rates ranging between 45% and 60% in areas where cattle grazed in wetlands.

5.1.3 Comparison between fasciolosis in cattle and sheep

Fasciolosis is an important parasitic disease affecting both cattle and sheep, but the disease manifests differently in the two species. Cattles are generally more resistant to the effect of fasciola infection. Cattles therefore act as reservoir host, maintaining the parasite cycle in endemic areas and contributing to continuous transmission. Sheep are highly susceptible to fasciola infection, especially when exposed to large numbers of immature flukes causing necrosis, hemorrhage, acute inflammation, and then as adult reside in bile duct, cholangitis bile duct obstruction, fibrosis (Stuen and Ersdal (2022) This can lead to sudden death, particularly in young animals

The environmental factors noted in both our study and Mungube et al (2019) reinforced the notion that grazing in wetland creates a higher risk for cattle to contract fasciolosis due to the thriving populations of intermediate hosts like *Lymnaea* snails. Prevalence is generally higher in cattle. This difference can be attributed to several factors. Firstly, cattle are more likely to graze in swampy or marshy areas where the intermediate host, freshwater snails, thrives, while sheep tend to graze in drier areas, reducing their exposure to the parasite (Amare., T., and Alemayen, E 2012) Secondly, cattle, being larger animals, consume more forage and water, increasing their chances of ingesting infective metacercariae compared to sheep. Thirdly, management practices often differ, with cattle frequently kept in less controlled environments than sheep, leading to higher exposure rates. Lastly, sheep may exhibit a slightly more effective immune response to *Fasciola* infections, which could contribute to the lower prevalence observed in this species.

5.2 Prevalence of hydatids cysts

5.2.1 Cattle

At the Eldoret Slaughterhouse, the overall prevalence of hydatid cysts in cattle was 13.36%. in the lungs, viable cysts accounted for 4.17% unviable cyst for 0.62% and calcified cysts for 3.34%. in the livers, viable cysts were 0.84%, unviable cysts were 0.84% and calcified cysts were 3.55%. revealed a higher proportion of calcified cysts compared to viable cysts, indicative of chronic infections. This could be attributed to the fact that most animals that are brought for slaughter are those that are being culled due to old age or poor production. Since hydatid cysts accumulate in animals over time, it is plausible to suggest that the infertile and calcified cysts increase with age. The immune systems of the older animals also have more time to interact with the cysts, thereby resulting in calcification.

Comparative studies from various regions provide robust support for the observed trends in infection rates linked. For instance, Mendez *et al*. (2021) in Argentina found a high prevalence of chronic infections in cattle from areas with extensive grazing practices, with a prevalence of 37% for calcified cysts. Similarly, Garcia *et al*. (2022) in Spain observed higher rates of hydatid cysts in cattle from regions with extensive pastureland, with a prevalence of 42%. In India, Sharma *et al*. (2023) found that cattle from regions with high moisture levels and traditional grazing systems had a higher prevalence of calcified cysts at 34%, mirroring the findings from Eldoret. This reinforces the idea that environmental factors, such as moisture and pasture practices, play a significant role in infection rates.

Reports from Uganda gave a prevalence of 46% for calcified cysts in cattle from areas with wetland grazing, further emphasizing the role of local environmental conditions (Nakayima *et al.* 2023). These studies align with the high prevalence observed in Eldoret, where swampy areas and local water bodies provided ideal conditions for the intermediate snail hosts that contribute to the parasite's lifecycle.

5.2.2 Sheep

The prevalence of calcified hydatid cysts in the liver, particularly in sheep from Uasin Gishu County, reflects chronic infections caused by prolonged exposure to wetland grazing conditions. Reports in Chile confirmed these findings, showing a prevalence of 29% for calcified cysts in sheep from areas with wetland grazing (Martinez et al. 2023). It has also been found that higher prevalence rates of calcified cysts in sheep occur in regions with prevalence of 32% and 35%, respectively (Lopez et al. (2022) Yildirim et al. 2023). Similar trends have been reported in Ethiopia with a prevalence of 31% in sheep from regions with extensive wetland grazing (Tesfaye et al. 2023). These consistent findings from different regions highlight the significant impact of environmental and grazing conditions on the prevalence of parasitic infections like hydatid disease and *Fasciola gigantica*, affecting both cattle and sheep. In contrast, research by Ali *et al*. (2022) in Pakistan indicated that while sheep also suffer from fasciolosis, the economic impact is less severe compared to cattle. Their study noted that sheep often have a lower prevalence of severe liver damage, leading to lower financial losses from liver condemnation and trimming. This agrees with the findings from this study, where sheep experienced significantly lower economic losses.

5.2.3 Comparison between hydatidosis in cattle and sheep

Hydatidosis, caused by the larval stage of *Echinococcus granulosus*, affects both cattle and sheep, but its prevalence and characteristics differ between the two species. Studies have shown that cattle tend to have a higher prevalence of hydatid cysts compared to sheep. This difference can be attributed to factors such as grazing habits, body size, and immune response (Feyera et al, 2020). Cattle, being larger animals, consume more forage and water, increasing their exposure to infective eggs of *Echinococcus granulosus*. Additionally, cattle often graze in areas where dogs, the definitive hosts of the parasite, are present, leading to higher infection rates. Sheep, while also susceptible, may have a slightly more effective immune response, which could contribute to the lower prevalence observed.

The distribution of hydatid cysts within the organs also varies. In cattle, the lungs are more frequently affected, followed by the liver, while in sheep, the liver tends to be the primary site of infection. This organ preference may be influenced by physiological differences between the species (Zalalem et al., 2020). Furthermore, the fertility rate of hydatid cysts is generally higher in sheep than in cattle, which has implications for the transmission dynamics of the parasite.

5.3 Other causes of condemnation of organs

Abscesses and fibrosis in the livers of cattle suggest both acute and chronic health issues. Abscesses, typically caused by bacterial infections, can arise from localized infections or systemic health problems. Fibrosis, indicating chronic liver damage, often results from long-term infections or exposure to toxins. These findings are consistent with literature that reports liver abscesses and fibrosis as common in cattle, often linked to specific management practices or environmental factors.

The presence of abscesses in the lungs and hearts of a few cattle points to possible systemic infections or severe localized infections that have spread. The relatively low prevalence suggests these are not widespread issues but still highlight the need for careful monitoring to manage and mitigate potential health risks.

In sheep, the observed pathological conditions include infectious necrotic hepatitis, abscesses, oedema, and fibrosis. The prevalence of these conditions in sheep mirrors that of cattle in some respects, indicating shared health challenges between these species. The occurrence of these conditions in sheep emphasizes the need for proper health management practices and highlights potential environmental or management factors influencing animal health.

Studies by Li *et al*. (2023) in China reported similar pathological conditions in cattle, with liver abscesses and fibrosis being reported as common issues. This study underscores the significance of routine health inspections to manage these conditions effectively, aligning with findings from the Eldoret Slaughterhouse.

A range of pathological conditions in cattle, including abscesses and necrotic hepatitis, emphasizing the impact of environmental and management practices have been reported at Pakistan (Nasir *et al*. (2022). These findings support the notion that such conditions are influenced by both infection and management factors, consistent with the Eldoret findings.

In sheep, Al-Mamun *et al*. (2022), in Bangladesh reported similar health issues, noting that infectious necrotic hepatitis and abscesses are significant concerns. Their findings highlighted the role of husbandry practices and environmental conditions in the infection of sheep, showing similar patterns observed in Eldoret. Reports from Australia confirmed these observations, showing that localized infections can lead to widespread health problems if not properly managed (Zhao *et al*. 2023).

5.4 Losses due to condemnation of organs of animals slaughtered at the Eldoret Slaughterhouse.

5.4.1 Losses due to fasciolosis

Fasciolosis caused substantial economic losses among livestock owners, as observed in the present study. In cattle, numerous livers were either condemned or partially trimmed, resulting in total losses of KSh. 329,580, equivalent to approximately KSh. 688 per animal. In sheep, liver condemnations led to losses amounting to KSh. 29,520, an average of KSh. 94.30 per sheep. imposed a significant economic burden, on cattle, whose owners suffered higher losses due to a high number of livers condemned or trimmed. This highlights the severe impact of the disease on the livestock sector, driven by high prevalence and the associated costs. According to our data, animal fasciolosis had a high economic significance in Burkina Faso. In fact, estimates of losses related to seizures of liver due to fasciolosis are estimated at XOF 142,068,284 (USD 258,423.44). Earlier work has estimated the annual losses associated with this animal disease in many parts of Africa and the world. These losses are estimated at 18,000 USD in Tanzania (Mwabonimana et al., 2009) and 13,367.72 USD in central Ethiopia (Regassa et al., 2012). The variations in losses obtained could be due to the differences in the local economic realities, the durations of study and the number of animals concerned by these different studies. Despite the variability of these results, noteworthy that fasciolosis causes significant losses in animal production around the world. Despite the significantly high losses in animal production losses associated with fasciolosis, it does not represent the actual losses due to fasciolosis in Burkina Faso. Indeed, the minor zoonotic nature of this parasitic pathology gives it an impact much heavier. Human fasciolosis is classified as one of the most neglected tropical zoonosis (Welburn et al., 2015). Thus, the actual economic losses of this disease are magnified by its burden on public health although it is often overlooked. The morbidities associated with human fasciolosis significantly contribute to poor quality of life, reduced life expectancy and production, since the adult worm can live for more than 10 years in a suitable host such as man (Fentie et al., 2013). As for the losses due to animal cysticercoids, the present study has shown that these losses are estimated at XOF 2,398,500 ($4,362) for and XOF 3,887,500 ($7,071) for bovine cysticercoids. Work in some African countries has estimated losses from condemnation due to porcine cysticercoids at XOF 25,715,448 in the abattoir of Bobo-Dioulasso ($41,565.9) in Burkina Faso (Dahourou et al., 2016) and $29,035 at the Kumasi abattoir in Ghana (Atawalna et al., 2015). However, these economic losses of animal production represent almost nothing compared with the losses related to the reduction of the cost of infested animals and the indirect losses (costs of treatments, diagnosis, social stigmatization, impaired quality of life) associated with human neurocysticercosis often implicated in the occurrence of epilepsy in humans (Winkler et al., 2009). The zoonotic appearance of cysticercoids gives it more important impact than the simple direct losses related to animal productions. Indeed, cysticercoids has so far been considered a neglected tropical zoonosis (Murrell et al., 2005). In a developing country like Burkina Faso where factors promoting the development of human cysticercoids do exist, the socio-economic impact of this pathology is considerable.

Recent reports support the observation that cattle are more severely affected by fasciolosis than sheep. According to Kamau *et al*. (2022) the cattle farmers and traders will experience higher economic losses from fasciolosis compared to small ruminants due to the greater extent of liver damage and condemnation. Also, the size of the liver of an adult cow is 5-10 times larger than that of a sheep. Cattle can therefore harbour large numbers of the parasite than sheep. Fasciolosis is more damaging to sheep while the parasites are in the juvenile stages and eating their way towards the bile ducts, because it leads to internal bleeding and the sheep can die before they are old enough to be taken for slaughter (Omega, 1997). Similarly, a study by Huang *et al*. (2023) in China found that fasciolosis caused substantial economic losses in cattle, with significant costs associated with liver condemnation and trimming. This study emphasized the impact of fasciolosis on the beef industry, aligning with the financial losses observed in the present study.

5.4.2 Losses due to hydatidosis

The financial losses due to hydatidosis between cattle and sheep at the Eldoret Slaughterhouse were 85,350KSh for the cattle and 16,450 for the sheep. The significantly higher losses in cattle, particularly from liver condemnation, may be attributed to the higher prevalence and severity of hydatid cysts infection in these animals. Cattle livers are more frequently affected by hydatid cysts than sheep. Sheep are known to have a better immune response that can limit cyst development. Both cattle and sheep serve as intermediate host but cattle tend to develop more cysts because they are often more exposed to contaminated environments where dogs (definitive hosts) defecate, spreading eggs and condemned due to the and critical function of the liver in hydatid cysts' life cycle, which leads to substantial economic losses. The absence of trimming for cattle livers, contrasted with the trimming of lungs, further amplifies the financial impact. The high cost per kilogram of liver also contributes to the significant losses, highlighting the economic strain placed on the livestock industry by this parasitic disease.

In sheep lower financial losses are incurred despite having a higher liver price per kilogram. This discrepancy is likely due to the lower prevalence of hydatid cysts in sheep compared to cattle. The fewer affected organs and lower overall incidence contribute to the relatively lower financial loss. The reduced loss from sheep organs reflects both the lower prevalence of cysts and possibly different management practices that mitigate the impact of hydatid cysts in sheep. Alhassan *et al*. (2021) in Nigeria found that cattle experienced more severe financial losses due to hydatid cysts compared to small ruminants. Their research highlighted that liver condemnation in cattle led to significant economic losses, aligning with the results observed in the present study. In Nairobi abattoirs Mwangi *et al*. (2022) investigated the economic impact of hydatidosis on livestock and found that cattle faced higher financial losses from organ condemnation than sheep. Their study emphasized that cattle livers, being the primary site for hydatid cysts, contributed significantly to the economic loss, similar to the results observed at the Eldoret Slaughterhouse. Tadesse *et al*. (2023) in Ethiopia and Hossain et al. (2021) in Bangladesh corroborates these findings, reporting that cattle are more severely affected by hydatid cysts than sheep. Their findings also highlight the substantial financial losses associated with condemned cattle livers, reinforcing the economic implications of hydatidosis in large ruminants.

This study has shown that hydatid cysts in cattle and sheep cause significant financial losses for all stakeholders, including butchers, meat inspectors, traders, and farmers. Frequent condemnation and trimming of infected organs, especially livers and lungs, reduced meat marketability. Butchers loose between KSh 1,000 and 3,000 for every animal whose organs are condemned because of hydatidosis, while farmers face reduced livestock health and income, with little support from insurance or government programs. The economic strain highlights the need for better disease control and public awareness efforts.

Recent studies state that there is a widespread economic impact of hydatid cysts in livestock production and the associated industries. A study by Erbeto *et al*. (2020) in Ethiopia found that the presence of hydatid cysts in livestock led to substantial economic losses, particularly among meat traders and farmers, who bear the direct costs of organ condemnation and reduced meat quality. According to Romig *et al*. (2022) hydatid cysts significantly reduced the market value of livestock and lead to financial losses for farmers and traders. This study also pointed out the high costs of preventive measures, such as deworming, which are often not entirely effective, echoing the concerns of stakeholders in the current study. This study also highlighted the increased workload and operational costs for meat inspectors, consistent with the findings at Eldoret Slaughterhouse. According to Khan *et al*. (2023) a substantial financial loss across the livestock value chain, particularly affecting farmers who reported decreased productivity and increased veterinary costs is real. The lack of government support and insurance coverage, as reported by stakeholders in Eldoret, was also a significant issue in this study, underscoring the need for comprehensive strategies to address the economic impact of hydatidosis. In Kenya, a study by Njoroge *et al*. (2021) similarly reported significant economic losses due to hydatidosis, with butchers and traders facing reduced profits from lowered consumer demand and the need to sell meat at discounted prices, which aligns with the concerns raised by respondents in the Eldoret Slaughterhouse.

5.5 Interviews and questionnaires

Hydatidosis, caused by the larval stage of *Echinococcus granulosus,* is a significant parasitic disease affecting livestock, particularly cattle and sheep. There was consensus amongst all the stakeholders interviewed either verbally or through questionnaires, including cattle and sheep owners, animal traders, meat inspectors, county directors of veterinary services, livestock production officers, butchers, meat transporters meat consumers and veterinary officers that hydatidosis leads to economic losses due to the condemnation of infected organs, reduced carcass quality and potential zoonotic risk. Farmers and traders suffer financial losses due to the reduced market value of infected livestock. Organs with visible signs of infection, particularly those with hydatid cysts in the liver and lung are condemned. According to (Abunna et al. (2012), livestock producers in endemic areas report decreased profitability due to high rate of organs condemnation in slaughterhouses. Meat inspectors and veterinary officers play acritical role in ensuring public health by identifying and removing infected organs from the food supply. Studies shows that the most frequently affected organs are the livers and lungs, with condemnation rate ranging from 5%to 40% in endemic areas (Torgerson et al.,2018). The removal of these organs contributes to significant economic losses at the slaughterhouse levels these by-Products re essential for local market. Veterinary officers also emphasize the need for improved disease control strategies, regular deworming of livestock and public education on proper animal husbandry practices. Public health and economic implication for County director veterinary services and livestock production officers. Hydatidosis poses a significant zoonotic risk, as humans can become infected through the consumption of contaminated food or direct contact with infected animals. The condemnation of affected organs reflects efforts to prevent the spread of the disease to humans. However, this process results in economic losses for the livestock sector. A study by Roming et al. (2017) highlights that in developing countries in northern Australia and potential interaction between and wild dogs and these behavioral aspect, particularly the implication for disease transmission and these leads to losses due to hydatidosis. County veterinary officials advocate for stricter control measures, such as improved slaughterhouse hygiene, vaccination programmed for dogs (definitive hosts), and better waste disposal practices to prevent the spread of *Echinococcus granulosus*. Meat transporters and butchers face disruption in the supply chain due to the high rejection of infected organs.in areas where hydatid disease is prevalent, butchers may experience increased operational costs, as they are required to dispose of condemned organs safety. additionally, unscrupulous individuals may attempt to sell condemned organs in unregulated markets, posing health risk to consumers. As noted by Craig et al. (2019), proper enforcement of meat inspection regulations is essential to preventing the illegal sale of infected meat and protecting public health. Consumers Fear of are becoming increasingly aware of the risks associated with consuming meat infected with hydatid cysts. Fear of zoonotic transmission may influence purchasing decisions, leading to a preference for certified inspected meat. According to a study by Eckert and Deplazes (2020),Public awareness campaigns emphasizing the risk of consuming infected meat inspection can help mitigate health risks and build consumers' confidence in the meat industries.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Prevalence of *Fasciola gigantica* and Hydatid cysts in Cattle and Sheep.

6.1.1.1.

The prevalence varied between two species, with cattle generally showing a higher rate of infection compared to sheep. This indicates that these parasitic infections remain a significant animal health problem in the area, contributing to organ condemnation and potential economic losses.

6.1.1.2. Losses due to condemnation in cattle and sheep.

Both *Fasciola gigantica* and hydatid cysts caused significant condemnation livers and lungs leading to notable financial losses to farmers, traders and the meat industry.

6.1.1.3. To assess the knowledge of farmers, meat sellers and meat inspectors about fasciola gigantica and hydatid cysts in cattle and sheep.

The assessment revealed that farmers, meat sellers, and meat inspectors had varying levels of knowledge about fasciola gigantica and hydatid cysts in cattle and sheep. While meat inspectors generally demonstrated adequate awareness due to their training, most farmers and meat sellers showed limited knowledge regarding the parasites 'life cycle, modes of transmission, economic impact and public health significant.

6.1.1.4. Other causes of condemnation.

Other causes of condemnation of organs at the Eldoret Slaughterhouse included infectious necrotic hepatitis, abscesses, tumors, fibrosis, Oedema and hematoma.

6.2 Recommendations

6.2.1

Prevalence of fasciolosis and hydatidosis based on condemned organs at the Eldoret Slaughterhouse is high and can be minimised through proper farm management, better extension services and observance of practises that discourage completion of the life cycles of the respective parasites.

6.2.2

Economic losses due to fasciolosis and hydatidosis are high and this can be reduced to acceptable levels through strict observance of control and prevention measures of the causative parasites.

6.2.3

Dog population control: Regulate stray dogs and discourage feeding raw infected offal to dogs to break the hydatid cysts cycle.

6.2.4

Farmer education programs: Organize regular training workshops and extension services to improve farmers understanding of parasite prevention and control.

6.2.3 Recommendations for future research

6.2.3.1

Investigate the spatial and temporal distribution of fasciolosis and hydatidosis in the region to identify high-risk areas and seasons.

6.2.3.2

Policy makers should institute regulations that guide effective management of fasciolosis and hydatidosis in the areas affected in order to minimise losses caused by condemnation of organs or animals.

6..2.3.3

County veterinary officials advocate for stricter control measures, such as improved slaughterhouse hygiene, vaccination programmed for dogs (definitive hosts), and better waste disposal practices to prevent the spread of *Echinococcus granulosus*.

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APPENDIX

APPENDIX 1 :Permission from Uasin Gishu County Government to carry out research at the Eldoret Slaughterhouse

REPUBLIC OF KENYA

THE CHAMPIONS

COUNTY GOVERNMENT OF UASIN GISHU
(Directorate of Veterinary Services)

Email: uasingishucdvs1@gmail.com
Tel. Eldoret (053) 2063861
When replying please quote:

County Director Veterinary Services
Uasin Gishu County
P. O. Box 2779 - 30100
ELDORET.

REF: CDVS/UG/RESEARCH /VOL.1/12

2nd May 2024

To Fardosa Abass

RE: PERMISSION TO USE EDORET MAIN SLAUGHTER HOUSE FOR SAMPLE COLLECTION FOR YOUR RESEARCH WORK.

Reference is made to your letter dated 30th April 2024.on above mentioned subject, Helminthiasis being among major diseases of economic important disease in the county, through the department of veterinary service will encourage such research as it will give the baseline data hence proper mitigation measure based on your research title: Prevalence and economic impact of Fasciola Gigantica and Hydatid cyst in cattle and sheep slaughtered at Eldoret slaughter house.

Your request to carry out your sample collection and interviews as from 4th May to 4th June, 2024 is granted.

However, Slaughter house being quarantined area, you need to adhere to all regulations as per Meat control act and public health regulation.

COUNTY DIRECTOR OF VETERINARY SERVICES
UASIN GISHU COUNTY
02 MAY 2024
P.O. Box 2779-30100.
ELDORET

Dr Philip K Biamah.
County Director of Veterinary Services
Uasin Gishu County.
Cc
-Sub county Veterinary Officer -Soy
-Officer in charge Eldoret Main Slaughter House

Appendix 2: Questionnaire for cattle/sheep owners who bring their animals directly to the slaughterhouse.

1. What is your name?..
2. Where is your farm located?..
3. What is the size & type of your farm?...
4. How many animals do you bring to the slaughterhouse?...........
5. Which breeds of cattle……………………………………………….
   & sheep……………………………………………… do you keep?
6. What is the purpose of raising animals? A. Meat production B. Breeding. C. Other……………………………….
7. Do you vaccinate your animals? No { } or { } Yes
8. What animal health issues or concerns do you have?..
9. What mode of transportation do you use?......................................
10. How long is the distance?...
11. Are you satisfied with the facility & services provided by the slaughterhouse? A. Yes B. No
12. What challenges do you encounter in the slaughterhouse?..
13. What animal welfare concerns do you have?..

Appendix 3: Questionnaire for cattle/sheep trader who brings animals to the slaughterhouse.

1. What is the name of the trader?..
2. Do you have any contact details? phone number or email……………….…………….....
3. What is your business name?..
4. What types of livestock traded? Cattle sheep goat?..
5. How many animals are transported per trip? …………………………………………....
6. Where is the scarce of animals? Farm {} auction or { } other traders { }
7. What types of transportation is used?...
8. How are the animals handled during transportations?...
9. What measures are taken to ensure the health & well being of the animals during transportation?...
10. How often are veterinary checks conducted?...
11. How do you ensure a smooth process when delivering animals to the slaughterhouse?...
12. Are there specific requirements you follow?...
13. How do you handle necessary documentation for transporting livestock?...
14. Are there specific regulations you adhere to?...

15. How do you establish?...

Appendix 4: questionnaire for meat inspectors at the slaughterhouse

1. What is the name of the meat inspector?...
2. How long have you been in this profession?..
3. Have you received any training?...
4. What is the role in the daily operations of the slaughterhouse?.......................................
5. How do you ensure compliance with safety and hygiene standard?.............................
6. Can you ensure compliance with safety and hygiene standards?....................................
7. Can you describe the procedure you follow during meat inspectors?............................
8. How often are inspections conducted?...
9. What criteria do you use to assess the quality of meat?...
10. How do you handle meat that doesn't meet the quality standards?...............................
11. How do you ensure sanitation and hygiene in the slaughterhouse?...............................
12. What measures are taken to prevent contaminations?..
13. How do you assess and ensure the humane treatment of animals before and during slaughter?...
14. What actions are taken if any welfare concerns are identified?.......................................
15. How do you stay informed about and ensure compliance with relevant regulations?...

16. How do you collaborate with external health and safety authorities?...

Appendix 5: Questionnaire for the County directors of veterinary services, Uasin Gishu County.

1. How many years of experience do you have in veterinary services?...
2. What is your educational background in veterinary medicine?...
3. Can you describe your current responsibilities as the County directors of veterinary services?...
4. What are the major challenges do you face in your current role?...
5. How do you prioritize and address public health concerns related to animals' diseases?...
6. What strategies do you implement for disease surveillance and control?...
7. How do you handle cases of animal abuse or neglect? ....
8. What I your County's preparedness for responding to veterinary emergencies or diseases outbreaks?..

Appendix 6: Questionnaire for the County livestock production officers, Uasin Gishu County.

1. How many years of experience do you have in livestock production and management?...
2. What is your educational background in the field of livestock agriculture? ……………………………………………………………………………………
3. How to assess and monitor the prevalence of Fasciola in the livestock population of the County?...
4. What control measures or strategies have you implemented to minimize the impacts of Fasciola and livestock health? ……………………………………………………..
5. What measures are in place to prevent and control the occupancy of hydatid cysts in livestock within the County?...
6. How do you collaborate with veterinary health professionals to address hydatid cyst livestock?...
7. How do you ensure timely & accurate diagnosis to prevent the spread of these parasites?...
8. How do you educate livestock farmers about the risk and prevent fasciola and hydatid cysts?...
9. What treatment protocols do you recommend for livestock infected with Fasciola and hydatids?...
10. How do you ensure the proper administration of treatment to affected animals?...

11. How do you collaborate with health and authority to address in aspect of fasciola and hydatid cysts?...

12. Are your joint initiatives to protect both animals and human health in this regard?...

Appendix 7: Questionnaire for the veterinary officers, Uasin Gishu County.

1. Have you heard of Fasciola before? Yes ☐ No ☐
2. Have you heard of hydatids cysts before? Yes ☐ No ☐
3. How would you rate your knowledge about these health concerns? Yes ☐ No
4. Do you know the common symptoms associated with fasciola and hydatids cysts in animals?..
5. Are you ☐aware of how hydatids and fasciola are transmitted?...
6. What preventive measures do you take to avoid these health concerns? ………………………………………………………………………………………
7. Have you received any information about prevention of this disease?...
8. Are health care services accessible in your area for diagnosis and treatment of fasciola and hydatids system?...
9. Are you involved in livestock activities?...
10. Has anyone in your community experienced symptoms related to fasciola or hydatids cysts? ………………………………………………………………………………………...
11. Are there economic challenges faced by individual as the community due to these health concerns?...
12. Are there any government initiatives addressing fasciola and hydatids cysts in your area?...

13. What do you think could be done to improve awareness and prevention of fasciola and hydatids cysts in your community?
14. Are there any specific resources or support you believe would be beneficial in addressing these health concerns?...

Appendix 8: Questionnaire for meat transporters from slaughterhouse to butcheries

1. What is the name and location of the slaughterhouse you source meat from?...
2. How do you receive meat from slaughterhouse?..
3. Can you comment on the condition of vehicles used to transport meat to your establishment?...
4. Are there temperature control measures in place during transportation to ensures qualities and safety of the meat?..
5. What kind of the documentation do you receive with each meat shipment?...
6. How important do you consider accurate documentation for traceability and compliance?..
7. How do you communicate with the slaughter regards your meat order and specifications?...
8. Is there a system in place for immediate communication in case of any issues with the meat?..
9. How do you ensure that the meat received adheres to safety standards? ………………………………………………………………………………………
10. Are there staff trained in proper meat handling upon receiving shipment?...
11. How do you ensure that your team is aware of and follows best practices in meat handling and storage? ………………………………………………………………...

12. Are there any specific improvements you would like to see in the meat transport process?..
....

Appendix 9: Questionnaire for the butcher men who sell meat to consumers

1. How long have you been working as a butcher in the slaughterhouse?
2. What motivated you to become a butcher, and how did you enter this profession?
3. How do you ensure the quality and freshness of the meat you sell to consumers?
4. Can you describe the sourcing process for the meat products you offer? (e.g., local farms, specific practices)
5. What steps do you take to maintain cleanliness and hygiene in your workspace?
6. How do you address consumer concerns about the ethical treatment of animals in the meat industry?
7. Are there specific certifications or standards you adhere to in your butchering practices?
8. How do you stay informed about industry trends and changes in consumer preferences?
9. Do you offer information to consumers regarding the types of cuts, meat grades, or cooking recommendations?

In your experience, what challenges or opportunities do you see in the meat industry from a butcher's perspectiAppendix IX: Questionnaire for meat consumers.

1. How often do you purchase meat products from a slaughterhouse?
2. What factors influence your choice of a slaughterhouse for purchasing meat?
3. Are you concerned about the ethical treatment of animals in the meat industry?
4. How important is the quality of meat to you when choosing a slaughterhouse?
5. Are you aware of the environmental impact associated with meat production?

6. Are you aware of the environmental impact associated with meat production?
7. What information do you look for regarding the sourcing of meat products (e.g., farm practices, animal welfare standards)?
8. How satisfied are you with the cleanliness and hygiene standards observed in the slaughterhouse?
9. Do you prefer to buy locally sourced meat from the slaughterhouse?
10. Are you open to trying alternative protein sources, such as plant-based or lab-grown meat?
11. How important is price in your decision to purchase meat from a slaughterhouse?

Appendix 10: Data sheet

S/No.	Animal or sample ID	Number of parasite	parasite identification	
			Bile	Faecal
1.				
2.				
3.				

Appendix 11: Prevalence of *Fasciola gigantica* in cattle slaughtered at the Eldoret Slaughterhouse

Summary Statistics for BILE EGG

Count	479
Average	100.744
Standard deviation	433.556
Coeff. of variation	430.354 %
Minimum	0
Maximum	8000.0
Range	8000.0
Stnd. skewness	122.396
Stnd. kurtosis	1052.36

The Stat Advisor

This table shows summary statistics for BILE EGG. It includes measures of central tendency, measures of variability, and measures of shape. Of particular interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution. Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate any statistical test regarding the standard deviation. In this case, the standardized skewness value is not within the range expected for data from a normal distribution. The standardized kurtosis value is not within the range expected for data from a normal distribution.

Summary Statistics for FEACAL EGG

Count	479
Average	12.0252
Standard deviation	43.4523

Coeff. of variation	361.345 %
Minimum	0
Maximum	576.0
Range	576.0
Stnd. skewness	64.3103
Stnd. kurtosis	318.97

The StatAdvisor

This table shows summary statistics for FEACAL EGG. It includes measures of central tendency, measures of variability, and measures of shape. Of particular interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution. Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate any statistical test regarding the standard deviation. In this case, the standardized skewness value is not within the range expected for data from a normal distribution. The standardized kurtosis value is not within the range expected for data from a normal distribution

Correlations

	BILE EGG	FEACAL EGG
BILE EGG		-0.0018
		(479)
		0.9788
FEACAL EGG	-0.0018	
	(479)	
	0.9788	

Correlation

(Sample Size)

P-Value

The Stat Advisor

This table shows Pearson product moment correlations between each pair of variables. These correlation coefficients range between -1 and +1 and measure the strength of the linear relationship between the variables. Also shown in parentheses is the number of pairs of data values used to compute each coefficient. The third number in each location of the table is a P-value which tests the statistical significance of the estimated correlations. P-values below 0.05 indicate statistically significant non-zero correlations at the 95.0% confidence level. The following pairs of variables have P-values below 0.05:

Appendix 13: Prevalence of *Fasciola gigantica* in sheep slaughtered at the Eldoret Slaughterhouse

Summary Statistics for BILE

Count	313
Average	31.2332
Standard deviation	110.593
Coeff. of variation	354.087 %
Minimum	0
Maximum	1120.0
Range	1120.0
Stnd. skewness	42.5731
Stnd. kurtosis	154.171

The Stat Advisor

This table shows summary statistics for BILE. It includes measures of central tendency, measures of variability, and measures of shape. Of particular interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution. Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate any statistical test regarding the standard deviation. In this case, the standardized skewness value is not within the range expected for data from a normal distribution. The standardized kurtosis value is not within the range expected for data from a normal distribution.

Summary Statistics for FEACAL

Count	288
Average	7.8722
Standard deviation	30.4258
Coeff. of variation	386.496 %
Minimum	0
Maximum	288.0
Range	288.0
Stnd. skewness	47.2016
Stnd. kurtosis	182.881

The StatAdvisor

This table shows summary statistics for FEACAL. It includes measures of central tendency, measures of variability, and measures of shape. Of particular interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution. Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate any statistical test regarding the standard deviation. In this case, the standardized skewness value is not within the range expected for data from a normal distribution. The standardized kurtosis value is not within the range expected for data from a normal distribution.

Correlations

	BILE	FEACAL
BILE		−0.3201
		(313)
		0.0012
FEACAL	−0.3201	

	(313)	
	0.001 2	

Correlation

(Sample Size)

P-Value

The Stat Advisor

This table shows Pearson product moment correlations between each pair of variables. These correlation coefficients range between -1 and +1 and measure the strength of the linear relationship between the variables. Also shown in parentheses is the number of pairs of data values used to compute each coefficient. The third number in each location of the table is a P-value which tests the statistical significance of the estimated correlations. P-values below 0.05 indicate statistically significant non-zero correlations at the 95.0% confidence level. The following pairs of variables have P-values below 0.05:

Appendix 13: Prevalence of *hydatids cysts* in cattle slaughtered at the Eldoret Slaughterhouse

Data for prevalences

S/NO	SPECIES	ORGAN	STATE OF CYST	NUMBER
1	BOVINE	LUNG	VIABLE CYST	20
2	BOVINE	LUNG	UNVIABLE CYST	3
3	BOVINE	LUNG	CALCIFIED CYST	16
4	BOVINE	LIVER	VIABLE CYST	4
5	BOVINE	LIVER	UNVIABLE CYST	4
6	BOVINE	LIVER	CALCIFIED CYST	17
7	OVINE	LUNG	VIABLE CYST	7
8	OVINE	LUNG	UNVIABLE CYST	2
9	OVINE	LUNG	CALCIFIED CYST	5
10	OVINE	LIVER	VIABLE CYST	3
11	OVINE	LIVER	UNVIABLE CYST	3
12	OVINE	LIVER	CALCIFIED CYST	11

Prevalence of *hydatids cysts* in cattle slaughtered at the Eldoret Slaughterhouse

	Lungs	Liver	Lungs and livers combined
Viable cyst	2.24	0.96	
Unviable cyst	0.64	0.96	
Calcified cyst	1.60	3.51	
Overall cyst	4.47	5.43	4.95

Prevalence of *hydatids cysts* in sheep slaughtered at the Eldoret Slaughterhouse

	Lungs	Liver	Lungs and livers combined
Viable cyst	4.175365	0.83507307	
Unviable cyst	0.626305	0.83507307	
Calcified cyst	3.340292	3.54906054	
Overall cyst	8.141962	5.21920668	6.68058455

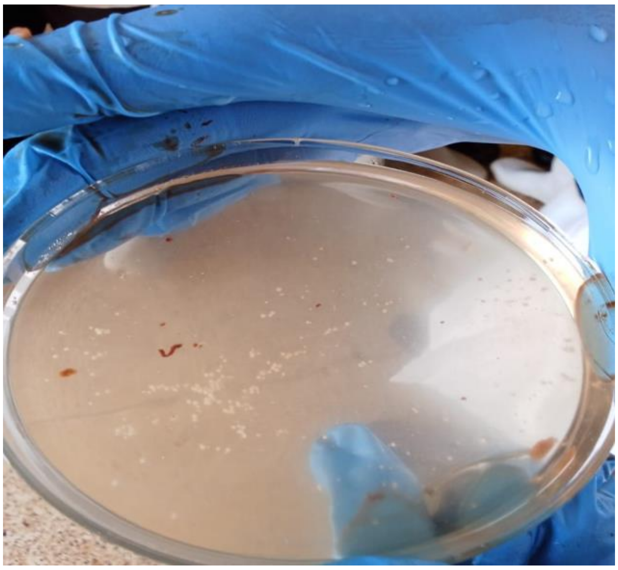
Correlation analysis between viable, unviable and calcified cysts in sheep organ samples

	Viable cyst	Unviable cyst	Calcified cyst
Viable cyst			
Unviable cyst	-1.0000 (p<0.0001)		
Calcified cyst	-1.0000 (p<0.0001)	1.0000 (p<0.0001)	

Figures in parenthesis are the p values

Liver with Fasciola gigantica

Lungs with hydatid cyst



Lungs with calcified cyst

Liver with calcified cyst

Other pathological findings

Kidney with hematoma

Liver with absses

Liver with necrotizing hepatitis

Laboratory analysis


DISSECTING
MICROSCOPE


DISSECTING

Sample collection

Questionnaires