

**BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCE**



**THE EFFECTS OF THEILERIOSIS ON CATTLE PRODUCTIVITY AT GAHADZISO
DIPTANK, ZIBWOWA AREA IN ZAKA DISTRICT**

BY

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DEDICATION

I dedicate this research to my late brother, Chapanda Dzimbanhete. May his soul rest in peace.

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ABSTRACT

This study examined the impact of Theileriosis on cattle productivity at Gahadziso Diptank, Zibwowa Area in Zaka District, Zimbabwe, based on the Eco-epidemiological Theory. The primary objectives were to ascertain the prevalence of Theileriosis, evaluate the economic losses sustained by farmers due to the disease, encompassing direct costs, and analyse current tick management and veterinary practices. The study was carried out in the southeastern lowveld of Zimbabwe. The methodologies involved the collection and laboratory analysis of blood samples from an initial cohort of 20 cattle utilising microscopy, Polymerase Chain Reaction (PCR), and Enzyme-Linked Immunosorbent Assays (ELISA) to ascertain disease presence and exposure. Furthermore, questionnaires were distributed to 180 cattle farmers, resulting in a 90% response rate, to collect data on economic impacts and control strategies, with quantitative data analysed utilising the Statistical Package for the Social Sciences (SPSS).

Preliminary diagnostic results from the 2580 sampled cattle using a pilot study revealed a *Theileria* infection rate of 50% (10/20) via PCR, with *Theileria parva* identified as the predominant species. ELISA results indicated that 60% (12/20) of the cattle possessed antibodies, signifying substantial exposure to the parasite. The economic survey indicated that 90% of the 180 surveyed farmers incurred expenditures for tick control due to the threat of Theileriosis, with a predominant 65% allocating between \$50 and \$200 annually. The predominant method for tick control was regular dipping in acaricides (65%), complemented by manual tick removal (55%) and hand spraying (40%). The study determined that Theileriosis is prevalent with substantial exposure rates among cattle at Gahadziso diptank, resulting in a significant financial burden on local farmers due to tick control costs. The diversity of existing tick management practices, notwithstanding their expenses, indicates a necessity to evaluate and improve the overall effectiveness and coordination of control strategies to alleviate the effects of Theileriosis on cattle productivity in the area.

DECLARATION

I Dzimbanhete Shepehrd do hereby declare that this research topic, the effects of Theileiriosis on Cattle Productivity at Gahadziso Diptank, Zibwowa area in Zaka District has been the result of my own original efforts and investigations. It has not been presented for a degree in any other University. All sources of information used have been duly acknowledged by means of references.

Student's Signature.....Date
...31...../.....08.../.....2025.....

APPROVAL FORM

The undersigned confirm that, have read and recommended this research project entitled, the effects of Theileriosis on cattle productivity at Gahadziso diptank, Zibwowa area in Zaka district, submitted to Bindura University of Science Education by **DZIMBANHETE SHEPHERD (B223612B)** in partial fulfilment of the requirements of the Honours Degree in Animal Health and Production Extension.



Supervisor

I certify that I have checked this research project and I am satisfied that it conforms to the department of Animal Science guidelines for the project preparation and presentation. I therefore authorize the student to submit this research project for marking.

MR TNC. MANGWIRO



Date 31.8.25

(Supervisor)

(Chairperson)



Date...06/10/25.....

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

Theileriosis, a significant parasitic disease primarily affecting cattle, is caused by protozoan species of the genus *Theileria*. This disease is primarily transmitted through tick bites and results in considerable financial losses in the agricultural sector, particularly in regions reliant on cattle farming (Hove, Sibanda & Maphosa, 2021). Theileriosis has significantly impacted the Zaka district of Zimbabwe, adversely affecting cattle health, productivity, and the livelihoods of local farmers.

In Zaka, the frequency of Theileriosis has been linked to several environmental elements, including poor cattle management techniques and climate favourable for tick spread. The agricultural economy of the district mostly depends on cattle for milk, meat, and draught power, thus the consequences of Theileriosis are especially severe. Research have shown that outbreaks can cause higher morbidity and death rates among cattle, so influencing meat and milk output greatly (Mlambo et al., 2020). Farmers may suffer greatly financially from the disease's direct effects as well as from rising veterinary expenses and lower output (Matobo et al., 2019).

Furthermore, Theileriosis complicates rural development in Zaka and food security. Farmers' capacity to make investments in sustainable agricultural practices declines as they battle the effects of the disease, so extending a cycle of poverty and reliance on outside help (Mupfumi et al., 2021). Beyond individual households, the socioeconomic consequences affect community resilience and the general Zaka district economic stability.

It is impossible to ignore the influence of climate change since changing weather patterns can aggravate tick numbers and the spread of Theileriosis (Chigwada et al., 2022). Studies emphasise the need of integrated management plans considering the biological and environmental elements causing the frequency of the disease.

Dealing with the consequences of Theileriosis in the Zaka District calls for a combined strategy including better veterinary treatment, tick control education, and community involvement. To

lessen the effect of this disease, government, non-governmental organisations, and nearby farmers must work cooperatively. Development of more efficient preventive and treatment plans depends on ongoing research as well, so guaranteeing the viability of cattle farming in the area. This chapter covers the introduction of the study by focusing on the background of the study, statement of the problem, justification of the study, study objectives, research questions, and research hypothesis. This chapter is concluded by a chapter summary.

1.2 Background of the study

Though with different frequency and impact depending on the area, the tick-borne disease known as theileriosis caused by parasites of the genus *Theileria* threatens cattle populations worldwide significantly. Knowing the nature of this issue in different contexts helps one to investigate its particular consequences in the Zibwowa area of the Zaka district, Zimbabwe.

Although some *Theileria* species exist in the United States, historically clinical theileriosis causing major economic losses has been less common in this country than in others. But since the early 2000s, the rise in *Theileria orientalis* genotypes especially the Ikeda genotype has resulted in rising clinical disease reports in cattle including anaemia, inappetence, and even mortality (MDPI, 2024). Although this is a relatively recent issue in some areas, statistical data on theileriosis frequency specifically between 2021 and 2025 in the USA is still developing.

Not historically has England seen notable clinical theileriosis outbreaks. Other diseases common in the temperate environment have taken front stage in discussions of cattle health. Limited current statistics on *Theileria* infections causing notable disease and economic impact in cattle in England between 2021 and 2025 point to it still being a rather minor issue compared to other areas (GOV.UK, 2024).

Theileria orientalis complex has recently emerged and spread in Australia; the Ikeda genotype is especially linked to clinical disease in cattle since 2006. Now thought to be endemic in the southeast coast, the disease reflects the distribution of *Haemaphysalis longicornis*, the vector. Prevalence studies spanning 2006 to 2022 revealed *Theileria Orientalis* was present in a high proportion of cases; the Ikeda genotype was the most often occurring. Although particular figures for 2021–2025 are still under development, the trend shows that theileriosis remains a major issue in impacted areas (MDPI, 2024).

Higher rates in northeastern China (ResearchGate, 2021) a systematic review and meta-analysis of theileriosis in cattle revealed in China a pooled prevalence of 32.4% across the nation up to 2021. The most often occurring species were identified as *T. sergenti* and *Theileria annulata*. Recent studies have also found *Theileria haneyi* in equines, so underscoring the several existence of *Theileria* species in the nation (PubMed, 2025). Data from 2021–2025 points to theileriosis still being a major concern for Chinese cattle output.

Theileria parva poses a significant risk to Kenya from East Coast fever (ECF). The *Rhipicephalus appendiculatus* tick spreads this disease, which mostly causes cattle morbidity and death, so causing large economic losses for small-scale farmers (Frontiers, 2024). Although particular prevalence rates may vary regionally and yearly, ECF still poses a threat to almost 28 million cattle in endemic regions, resulting in over a million deaths yearly (Frontiers, 2024). Research on *Theileria bicornis* in rhinoceros populations also points to the more general presence of *Theileria* species in Kenyan wildlife (PMC, 2015).

Based on a 12-year study in the former Northern Provinces, Nigeria has recorded a high frequency of *Theileria mutans* antibodies in cattle between 32.6% and 85% (ResearchGate, 2024). More recent studies have verified that *Theileria annulata* exists in ticks invading cattle in northwest Nigeria at different state prevalence rates (ResearchGate, 2021). These results show that several *Theileria* species cause the recognised problem of theileriosis in Nigerian cattle health.

Among the several tick-borne diseases South Africa suffers from is theileriosis. With *Theileria velifera* and *T. mutans* particularly highly prevalent, a systematic review of tick-borne pathogens in domestic ruminants across the Southern African Development Community (SADC) region up to 2021 revealed an overall pooled prevalence of *Theileria* species in cattle of 51.2%. Also present, especially in areas near wildlife areas (PMC, 2025), is the causal agent of ECF, *Theileria parva*. Still a major issue for South African cattle output is theileriosis.

With theileriosis, sometimes referred to as "January disease," mostly brought on by *Theileria parva*, Zimbabwe presents a serious problem. With yearly losses estimated at over 55,000 cattle, valued at almost US\$ 17 million, this disease is a main cause of mortality for cows (PubMed, 2025). Usually occurring between December and March, the illness has been recorded all year (AfriFuture Research and Development Trust, 2021). Notable in Zimbabwe, the notifiable disease theileriosis emphasises its agricultural and financial importance (ZAGP, n.d.). Although cattle

dipping is the primary control method, issues including acaricide availability and adherence to dipping schedules help to explain the disease's continued frequency (ResearchGate, 2024). Rural livelihoods dependent on cattle output are much affected by theileriosis (AfriFuture Research and Development Trust, 2021).

Development of focused and successful control strategies depends on an awareness of the particular consequences of theileriosis at the local level, such as at the Gahadziso diptank in the Zibwowa area of Zaka district, within the global and regional context. This study intends to investigate the effect of theileriosis in this particular geographical area, considering elements such frequency, economic losses experienced by local farmers, and the efficacy of present control measures, especially the use of the Gahadziso diptank. By concentrating on this localised research, we can provide important new perspectives on the management and general knowledge of theileriosis in Zimbabwe.

1.3 Statement of the problem

Commonly known as January disease or East Coast fever (ECF), theileriosis seriously affects cattle output in many eastern and southern African countries, including Zimbabwe. The frequency and effects of theileriosis pose a continuous threat to the livelihoods of nearby farmers as well as the general agricultural output of the Zaka district at Gahadziso dip tank. Through cattle mortality, lower milk production, lower draught power, and higher veterinary expenses, this parasitic disease caused by the protozoan parasite *Theileria parva* causes significant financial losses when passed by ticks of the genus *Rhipicephalus* (Mhlanga et al., 2023). Inadequate tick control policies, limited access to efficient veterinary services, and a lack of thorough knowledge of the particular epidemiological dynamics of theileriosis inside the Zibwowa area all help to aggravate the problem.

Given its significant effects on the mostly agricultural communities in the Zibwowa area, theileriosis is a major concern. Not only are cattle livestock, but they are also vital resources for draught power for farming, a supply of milk and meat for consumption, a store of wealth, and a major player in social and cultural events (Sibanda & Moyo, 2024). Outbreaks of theileriosis can destroy herds, send families into poverty, cause disturbance of agricultural operations, and compromise food security. With peak losses typically aligning with periods of great tick activity during the rainy season, statistics from the Zaka District Veterinary Services show that the

Zibwowa area recorded an average annual mortality rate of 15% in cattle attributed to theileriosis between 2021 and 2024 (Zaka District Veterinary Services, 2025). For individual households as well as the district overall, this results in a major financial burden.

The effects of theileriosis at Gahadziso diptank and the larger Zibwowa area directly affect smallholder farmers depending on cattle for their means of living. Even a few animals lost can have terrible effects on their capacity to till their ground, move goods, and support their families. Moreover, the ongoing threat of theileriosis calls for higher acaricide and veterinary treatment expenditure, so taxing their meagre resources (Chitumba et al., 2022). Through lowered agricultural output and possible food shortages, the disease also indirectly influences the larger society. Although there are several tick control techniques theoretically possible, their successful local application usually presents difficulties. The main approach used is dipping cows in acaricide solutions in public dip tanks, such the one at Gahadziso. But problems including irregular dipping schedules, poor acaricide concentrations brought on by poor management, and the emergence of acaricide resistance in tick populations could undermine the efficacy of this method (Nyoni & Dube, 2023). Moreover, farmers in far-off places like Zibwowa (Hove et al., 2021) may have limited access to fast and accurate diagnosis and treatment with effective drugs like buparvaquone. Developing focused and sustainable solutions to reduce the effect of theileriosis in the Zibwowa area depends on an awareness of the particular difficulties and present practices at Gahadziso diptank.

1.4 Justification of the study

Particularly in areas where the main vector, the brown ear tick (*Rhipicephalus appendiculatus*), theileriosis, sometimes known as January disease, seriously threatens cattle output. For a number of reasons, this study which centres on the effects of theileriosis at Gahadziso diptank in the Zibwowa area of Zaka district has great relevance. First of all, it seeks to give a localised and modern perspective of the influence of the disease inside this particular agricultural community. Although more general research on theileriosis is under progress, disease frequency and severity can be influenced by ecological and management strategies at a given diptank and environs. Given elements including dipping frequency, cattle breeds, and environmental conditions common in the district, this study will provide insightful analysis of the particular difficulties faced by Zibwowa

area cattle growers. Development of focused and successful control plans catered to the particular situation of Gahadziso diptank and its related farming community depends on this localised data.

Moreover, the results of this research will be very crucial for different stakeholders. A better knowledge of the frequency and effect of theileriosis on their herds will directly help Zibwowa area farmers raising livestock. The study can underline the financial losses connected to the disease including treatment expenses, mortality, lower productivity (milk yield, meat production), and death. By means of this data, farmers can be empowered to make wise decisions on disease prevention and management, including following recommended dipping schedules and implementing suitable animal care techniques. This study will give vital epidemiological data required for efficient disease surveillance, diagnosis, and control interventions inside the Zaka district for the local veterinary authorities and extension officials. Targeted vaccination campaigns, dipping campaigns, and educational initiatives aiming at enhancing farmers' knowledge and practices regarding theileriosis management can be developed and implemented informed by the research (Chikwanda et al., 2023).

More broadly, this study adds to the body of knowledge already in use on theileriosis in Zimbabwe. Including a case study from a particular area helps one to grasp the dynamics of the disease across several agro-ecological zones. National agricultural policymakers and researchers in developing national cattle disease control plans and allocating resources efficiently may find this material useful. The study might also find particular risk factors or management strategies that aggravate or reduce theileriosis in the Zibwowa area, so affecting disease control in other like areas. Furthermore, the results could guide next studies on the effectiveness of several acaricides applied at the diptank or on the genetic susceptibility of local cattle breeds to theileriosis (Moyo & Sibanda, 2024). In the end, this study is an essential first step in reducing the terrible consequences of theileriosis on cattle output, so supporting food security and the livelihoods of communities depending on cattle farming in the Zaka district and maybe even beyond (Zimbabwe Agricultural Society, 2025).

1.5 Study objectives

- To determine the prevalence and incidence rates of Theileriosis in cattle within the Gahadziso diptank area.

- To estimate the economic losses incurred by farmers due to Theileriosis, including direct costs.
- To examine the current tick management and veterinary practices employed by farmers.

1.6 Hypothesis

H0: There is no statistically significant effect of theileriosis on the health and productivity of cattle managed at Gahadziso diptank in the Zibwowa area of Zaka district.

1.7 Chapter summary

This chapter covered the introduction of the study by looking at the background of the study, statement of the problem, justification of the study, research objectives, research hypothesis. This chapter is concluded by a chapter summary. The following chapter reviews literature guided by the research objectives in this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter introduces the theoretical literature review and the empirical literature in relation with the objectives of the study. The theoretical literature will be guiding the existing knowledge of the effects of Theileriosis. Therefore, the views of various authors will be used to guide this part of study with theories about effects of Theileriosis. This chapter is concluded by a chapter summary.

2.2 Theoretical framework

The Eco-epidemiological Theory helped direct this research. Proposed by experts in the domains of ecology and epidemiology, this theory stresses the interaction of social and environmental elements in forming the dynamics and patterns of diseases inside a population (Krieger, 2001). It suggests that, within a given socio-economic and political context, the complex interaction between the environment, the host population, and the agent greatly influences disease emergence, transmission, and persistence, so transcending biological events.

By including more general ecological concepts including biodiversity, habitat structure, and climate alongside social determinants including land use practices, economic activity, and access to resources, the eco-epidemiological theory transcends a simple agent-host-environment triad (Singer & Clair, 2003). It emphasises how human activities and environmental changes might modify vector habitats, host susceptibility, and pathogen virulence, so affecting disease risk and distribution (Daszak et al., 2001).

In the framework of the research on theileriosis at the Gahadziso diptank, this theory is rather pertinent. One important ecological consideration is the efficiency of the diptank as a tick control strategy a kind of environmental intervention. The density and movement of cattle in the Zibwowa area (host population characteristics), the particular *Theileria* species present and their virulence (agent factors), and the socioeconomic conditions of the cattle owners that might affect their adherence to dipping schedules and access to veterinary care will thus also influence its impact on the prevalence and effects of theileriosis.

Many writers have backed the eco-epidemiological approach since it helps to grasp difficult disease systems. Gibbs (2005) for example contended that since the interactions among parasites, vectors, and hosts within their environment define vector-borne diseases like theileriosis, so integrating ecological and evolutionary viewpoints is essential for predicting and controlling these diseases. Randolph (2010) also underlined the part landscape ecology plays in deciding the abundance and distribution of ticks, the vectors of theileriosis, and hence the risk of disease spread to cattle.

On the other hand, some objections of wide ecological theories in epidemiology exist. One common criticism is that they can be unduly complicated and may lack specific, testable hypotheses, so making it difficult to translate theoretical frameworks into practical interventions (McMichael, 1995). Others contend that although environmental factors play a role, in many contexts social inequalities and access to healthcare still define the main causes of disease (Waitzkin, 2000). Using a solely ecological perspective without enough thought for these social aspects could result in either inadequate or ineffective answers. Eco-epidemiology supporters, however, argue that by addressing the root causes of disease at several levels, the theory promotes a more comprehensive knowledge that can finally result in more sustainable and fair disease control strategies (Krieger, 2001).

2.3 Empirical literature review

2.3.1 The prevalence and incidence rates of Theileriosis in cattle

Globally, the tick-borne disease known as theileriosis caused by protozoan parasites of the genus *Theileria* seriously compromises the health and output of cattle. Designing reasonable control plans depends on an awareness of its frequency and incidence rates. Variations in epidemiological patterns affected by elements including vector distribution, cattle breeds, environmental conditions, and management techniques have been revealed by empirical research carried out over many countries and continents.

Turning now to East Africa, an area mostly affected by theileriosis, research in Kenya and Tanzania offer more understanding. Omondi et al. (2022) conducted a longitudinal study in a few chosen ranches in Kenya and reported an annual incidence rate of clinical ECF of roughly 15%, with younger animals and in areas with less acaricide application compliance showing higher rates

observed. In Tanzania, Simba et al. (2025) looked at the prevalence of *Theileria* infections in various cattle breeds and found that indigenous breeds showed a lower prevalence of clinical signs despite harbouring parasites, so implying a degree of endemic stability. These East African studies highlight the ongoing difficulty of theileriosis and the impact on disease dynamics of age, breed, and management.

Beyond Africa, research on Asia especially India has also shown the frequency of theileriosis. With higher rates in crossbred cattle than in indigenous breeds, Sharma and Gupta (2023) conducted a survey in several states and revealed a prevalence of *Theileria annulata*, the causal agent of tropical theileriosis, ranging from 10% to 25%. They also noted the financial effects of fever, anaemia, and lower milk output. These results show that, with breed sensitivity playing a part, theileriosis still causes great worry for cattle health in Asia.

Usually linked with particular tick species and geographical areas, the frequency of theileriosis in Europe is usually lower. Rossi et al. (2024) conducted a research on *Theileria* presence in cattle grazing on Mediterranean pastures and recorded a low frequency of *Theileria buffeli*/*sergenti*/*orientalis* group. Often regarded as less severe than *T. parva* or *T. annulata*, these species have clinical relevance in European cattle.

Several recent studies on theileriosis have looked at Zimbabwe, where the Gahadziso diptank study is located. For example, a 2023 Chikwanda et al. study on the frequency of *Theileria* species in cattle in communal grazing areas found a high frequency of *Theileria parva*, the causal agent of East Coast Fever (ECF), ranging from 30% to 60% depending on the region. Another Mutsvangwa and Ndlovu (2024) research on the frequency of ECF outbreaks revealed a relationship between poor tick control policies and higher outbreak frequency, especially in the wet season when tick population is high. These studies draw attention to the ongoing rather heavy load of theileriosis on Zimbabwe.

Though these studies offer insightful analysis, a literature gap exists in longitudinal studies that fully combine ecological factors such as tick vector dynamics and environmental changes with thorough animal-level data on infection status and clinical outcomes over many geographical areas. Moreover, more studies on the financial effects of subclinical theileriosis and the success of combined tick control plans under several farming environments are much needed. Developing

sustainable and context-specific control programs for theileriosis in cattle worldwide will depend on an awareness of long-term trends and the interactions among several elements.

2.3.2 The economic losses incurred by farmers due to Theileriosis

2.3.2.1 Reduced milk production

Worldwide cattle health and output are seriously threatened by the tick-borne disease known as theileriosis, which is brought on by protozoan parasites of the genus *Theileria*. Among the several clinical signs and financial effects of theileriosis, dairy producers particularly worry about lower milk output.

A 2023 study by Omondi et al. on East Coast Fever (ECF) a highly virulent type of theileriosis's economic impact on smallholder dairy farms in Kenya looked with an average loss of 2.5 litres daily over the course of the clinical disease and a subsequent residual effect on production during the recovery period, the researchers found a notable decrease in milk yield in infected cows. In Ethiopia, Kebede and Tesfaye (2024) conducted a study on the effects of theileriosis on crossbred dairy cattle. Their results revealed a significant drop in milk output, approximated at 30–40% during the acute phase of the infection, which resulted in significant financial losses for farmers depending on milk sales for their means of living.

Ncube et al. (2022) conducted a study in Zimbabwe particularly looking at how theileriosis affected milk output in the Zaka district. The study found that infected cows produced noticeably less milk; the degree of the decrease was linked to the degree of the parasitemia and the clinical symptoms noted. The study also emphasised the indirect expenses related to theileriosis, including treatment costs and more frequent calving intervals brought on by ill health.

Sharma et al. (2025) conducted research in India looking at how the theileriosis affected milk output in planned dairy farms. The study noted a notable decline in milk yield, averaging 20–30% in infected animals, together with changes in milk fat and protein content, so influencing the quality and marketability of the milk. Moreover, the study underlined the long-lasting effects of theileriosis on dairy cow production lifespan.

Khan and Ali (2021) conducted a research in Pakistan looking at the financial losses resulting from theileriosis in dairy buffaloes and cattle. Their results showed that theileriosis was linked to a significant drop in milk output; buffaloes had a rather higher percentage of milk loss than cattle.

The study also underlined the expenses related to veterinary treatments and the possibility of mortality, so affecting the whole economic losses.

The examined studies repeatedly show a notable negative effect of theileriosis on milk output in dairy cattle and buffaloes all around Asia and Africa. Factors including the virulence of the *Theileria* species involved (ECF in Kenya being especially severe), the breed and health condition of the affected animals, the stage of lactation, and the management techniques used seem to affect the degree of milk yield reduction. For example, the Ethiopian study (Kebede & Tesfaye, 2024) indicated a percentage decrease, while the Kenyan (Omondi et al., 2023) study noted a significant daily milk loss, both so implying significant economic consequences. An issue less stressed in the African studies examined, the Indian study (Sharma et al., 2025) underlined even more the effect on milk quality. The Pakistani study (Khan & Ali, 2021) compared cattle and buffaloes, implying possible variations in sensitivity or the effect of the disease on milk production between these species.

Although the examined data shows convincing proof of lower milk output resulting from theileriosis in Africa and Asia, there is a clear discrepancy in recent empirical studies concentrating on the economic impact of this disease on milk production on other continents, such South America, Australia, and Europe. While the frequency and importance of theileriosis may differ in these areas, more study is required to estimate the financial losses dairy producers in these settings incur. Furthermore, needed are more thorough longitudinal studies tracking milk production losses over the course of the disease and the following recovery period as well as research evaluating the indirect costs related to lower milk production, including early culling and effects on reproductive efficiency. Moreover, evidence-based management recommendations would benefit from the evaluation of several tick control and treatment approaches in reducing milk production losses.

2.3.2.2 Increased mortality

Theileriosis, a tick-borne illness caused by parasites of the genus *Theileria*, presents a considerable risk to global livestock production, leading to significant economic losses for farmers. The most immediate and severe economic consequence is heightened mortality among affected cattle.

In East Africa, especially Kenya, research has consistently emphasised the economic impact of mortality associated with theileriosis. Omondi et al. (2023) conducted a study in a high-prevalence

region of Kenya, estimating that mortality from East Coast Fever (ECF), induced by *Theileria parva*, represented roughly 60% of the overall economic losses linked to the disease. The losses were assessed based on the market value of the cattle that perished due to the infection, encompassing both calves and adult animals. A longitudinal study by Wambua et al. (2024) conducted on various smallholder farms in Tanzania revealed that mortality rates due to theileriosis varied between 5% and 15% annually, resulting in considerable losses of potential income and breeding stock for farmers. These findings highlight the immediate economic consequences of cattle mortality on the livelihoods of smallholders in the region.

Research in India has documented the economic ramifications of mortality caused by theileriosis. A study by Sharma et al. (2022) in northern India, where tropical theileriosis caused by *Theileria annulata* is common, indicated that mortality in infected cattle, especially in crossbred and exotic breeds more vulnerable to the disease, resulted in an average loss of INR 30,000 (approximately USD 400) per deceased animal. This study highlighted the susceptibility of enhanced breeds, which constitute a considerable investment for farmers, to theileriosis-related mortality, thereby exacerbating the economic repercussions. Moreover, Hussain et al. (2025) examined the economic repercussions in Pakistan attributable to *T. annulata*, revealing that mortality was a significant factor, resulting in an estimated loss of PKR 50,000 (approximately USD 180) per affected animal, underscoring the regional economic impact of cattle fatalities.

In Europe, although the prevalence of highly pathogenic *Theileria* species may be diminished in certain regions relative to tropical areas, research has nonetheless recorded economic losses linked to mortality. A study conducted in Spain by Garcia-Bocanegra et al. (2021) on bovine theileriosis documented sporadic outbreaks that caused mortality, especially in young calves, leading to financial losses for the impacted farms. The economic impact stemmed not only from the immediate loss of the animal but also from the prospective loss of future productivity and breeding capacity. Research conducted in Italy by Mancini et al. (2023) underscored the economic ramifications of theileriosis in particular livestock systems, where even minimal mortality rates could result in significant financial losses due to the value of specialised breeds.

An analysis of these findings indicates that the economic losses attributable to theileriosis-related mortality are significant across various continents, although the extent may fluctuate based on factors such as the prevalence of particular *Theileria* species, the susceptibility of cattle breeds,

and the market value of the animals. Research from East Africa underscores the considerable effect on smallholder farmers resulting from elevated prevalence and mortality rates. Research in Asia highlights the susceptibility of high-value crossbred and exotic cattle, resulting in significant individual animal losses. European studies, although potentially indicating reduced overall mortality relative to tropical regions, nonetheless reveal considerable financial repercussions, particularly in certain contexts or with prized breeds.

Despite evidence indicating the economic burden of mortality from theileriosis, a significant gap exists in the literature regarding the comprehensive quantification of the indirect economic losses linked to these fatalities. Although studies frequently emphasise the immediate market value of deceased animals, they often neglect to consider the long-term ramifications, including the loss of future progeny, diminished herd expansion, effects on milk or meat production quotas, and the potential necessity for premature replacement of breeding stock. Moreover, there is an absence of comprehensive comparative economic analyses among diverse farming systems (e.g., smallholder versus commercial) and differing levels of theileriosis endemicity both within and across nations. Future research should focus on bridging these gaps by utilising comprehensive economic modelling techniques that encompass both the direct and indirect costs of theileriosis-related mortality on farmers' livelihoods and the wider agricultural economy.

2.3.2.3 Treatment costs

Theileriosis, a tick-transmitted illness caused by parasites of the genus *Theileria*, imposes a considerable economic strain on livestock producers worldwide. This burden manifests in multiple forms, encompassing direct expenses related to treatment and prevention, alongside indirect losses stemming from diminished productivity, mortality, and trade limitations.

In East Africa, notably in Kenya and Tanzania, the expense associated with treating theileriosis, particularly East Coast Fever (ECF) induced by *Theileria parva*, has been consistently recorded as a significant economic burden for cattle farmers. A study by Omondi et al. (2023) in Kenya examined the economic ramifications of ECF, revealing that treatment expenses, encompassing veterinary fees and medication costs (mainly antibiotics and anti-theilerial drugs such as buparvaquone), represented a significant fraction of the overall direct losses. A Tanzanian study by Swai et al. (2022) indicated that the prevalence of theileriosis outbreaks and the associated treatment costs substantially diminished the profitability of smallholder dairy farms. These studies

highlight the immediate financial burden the disease imposes on regional farmers, frequently requiring the reallocation of scarce resources from other vital agricultural inputs.

Research in Southern Africa, particularly in Zimbabwe and Zambia, indicates the substantial economic ramifications of theileriosis treatment. A study conducted in Zimbabwe by Mutsvangwa et al. (2024) evaluated the cost-effectiveness of various tick control and theileriosis treatment strategies, revealing that the reactive treatment of infected animals constituted a significant and ongoing financial burden for farmers. The research highlighted that the expenses associated with frequently utilised medications, along with the labour required for their administration and possible subsequent treatments, culminated in a significant economic detriment. A report by Phiri and Banda (2021) on livestock diseases in Zambia identified theileriosis as one of the most economically detrimental, with treatment representing a significant direct expense, especially for small-scale farmers who frequently lack access to affordable veterinary services and may face elevated costs for medication from private practitioners.

Research conducted in Asia, particularly in India, has quantified the economic losses linked to the treatment of theileriosis across the Indian subcontinent. Kumar et al. (2025) examined the economic ramifications of bovine theileriosis in specific Indian states and found that the direct costs of treatment, encompassing diagnostic fees, medication expenses, and veterinary consultations, substantially contributed to the overall economic burden on dairy farmers. The research observed discrepancies in treatment expenses based on the infection's severity and the drug types employed, with newer, more efficacious medications frequently incurring higher costs. These findings underscore that the economic ramifications of treatment are not consistent and may be affected by factors such as disease management strategies and availability of veterinary resources.

An analysis of the findings across these continents uncovers shared themes and significant disparities. In all regions, the direct expenses associated with treating theileriosis, chiefly through the acquisition of anti-theilerial medications and veterinary services, constitute a substantial economic detriment for farmers. The burden seems especially significant for smallholder farmers in East and Southern Africa, who often possess limited financial resources and reduced access to subsidised veterinary services. Research in Asia, such as that conducted in India, underscores significant treatment expenses; however, these costs may vary based on the magnitude of farming

operations and the prevalence of particular *Theileria* species. The category and expense of accessible pharmaceuticals significantly influence the economic ramifications. Recent, more efficacious treatments may diminish mortality and morbidity, yet they could entail higher initial costs. In contrast, dependence on older, less expensive medications may result in extended illness and the necessity for recurrent treatments, ultimately escalating the total expenditure.

Although there is an increasing amount of literature detailing the economic effects of theileriosis treatment, a significant gap remains in thoroughly examining the long-term economic implications of recurrent treatment expenses on farm sustainability and household livelihoods, especially in developing nations. Additionally, there is a necessity for further comparative studies that meticulously evaluate the cost-effectiveness of various treatment protocols and the economic advantages of investing in preventive measures as opposed to reactive treatment across different agricultural systems and geographical regions. Comprehending these elements is essential for formulating targeted and economically feasible strategies to alleviate the economic losses linked to theileriosis.

2.3.2.4 Tick control expenses

Aside from the direct consequences of morbidity and mortality, the disease imposes significant economic costs on farmers. A significant portion of these economic losses is due to the costs associated with tick control measures used to prevent and manage theileriosis.

In East Africa, a region heavily affected by theileriosis, Kenyan researchers have also documented the economic burden of tick control. Omondi et al. (2024) investigated the cost-effectiveness of various tick control strategies for pastoralist communities. Their findings revealed that, while regular acaricide application was costly, the economic losses caused by theileriosis outbreaks in herds with ineffective tick control far outweighed these preventative costs. The study also investigated the economic feasibility of alternative control methods, such as the use of acaricide-treated cattle ear tags, noting their potential to reduce labour costs associated with traditional dipping or spraying, though the initial investment may be prohibitive for some farmers.

Studies in India have also examined the economic impact of tick infestations and theileriosis. Kumar and Patel (2022) investigated the economic losses caused by tick-borne diseases in dairy cattle, including both the direct costs of treatment and the indirect costs of decreased milk

production and mortality. While their study focused broadly on tick-borne diseases, it found that farmers' expenses for acaricides and veterinary services for tick control accounted for a significant portion of the economic burden. The study emphasised the need for more sustainable and cost-effective tick management strategies to increase dairy farm profitability.

In South America, particularly in Brazil, where tick-borne diseases such as bovine babesiosis and anaplasmosis are common, researchers have looked into the economic implications of tick control. Silva et al. (2025) investigated the economic effects of tick infestations on beef cattle production in the Amazon region. Their findings revealed that the frequency of acaricide application was a significant factor in production costs. Farmers in areas with a high tick challenge reported significantly higher tick control expenditures than those in areas with lower tick burdens. The study also highlighted the growing concern about acaricide resistance, which necessitates the use of more expensive or combination acaricides, resulting in further economic losses for farmers.

In Zimbabwe, where theileriosis, particularly East Coast Fever (ECF) caused by *Theileria parva*, is endemic, several studies have looked into the economic implications of tick-borne diseases. A study by Chikwanda et al. (2023) in smallholder farming systems found that acaricides and labour for tick control accounted for a significant portion of livestock production costs. Farmers frequently used regular dipping or spraying regimes, the cost of which varied according to herd size and acaricide type. The study found that, while these costs were necessary to reduce the risk of theileriosis outbreaks, they significantly reduced the overall profitability of cattle rearing, particularly for resource-poor farmers who may choose less effective but cheaper control methods, potentially leading to higher disease incidence and further economic losses in the long term.

When these findings are compared across different countries and continents, a consistent pattern emerges: tick control is a significant and often unavoidable expense for livestock farmers in areas where theileriosis and other tick-borne diseases are prevalent. The cost of acaricides and the labour required to apply them have a direct impact on the profitability of livestock production. Studies highlight the trade-offs that farmers, particularly smallholders, face when choosing cheaper but less effective control methods due to financial constraints, potentially leading to greater economic losses from disease outbreaks. The emergence of acaricide resistance adds to the economic burden by requiring more expensive alternatives and increasing the frequency of treatments. While some studies have begun to investigate the economic feasibility of integrated tick management strategies

and alternative control methods, the use of chemical acaricides remains the dominant practice, accounting for a significant portion of farmers' economic losses due to theileriosis.

Despite the growing body of literature documenting the economic burden of tick control expenses, there is still a significant gap in studies that comprehensively analyse the return on investment (ROI) of various tick control strategies, particularly in terms of theileriosis prevention. While studies frequently quantify the costs of tick control and, in some cases, the losses caused by theileriosis outbreaks, there is a scarcity of detailed economic analyses that directly compare the long-term costs and benefits of various tick management approaches (e.g., intensive dipping vs. strategic dipping based on tick monitoring, use of resistant breeds combined with targeted acaricide use) in preventing theileriosis and improving farm profitability. Furthermore, there has been little research into the socioeconomic factors that influence farmers' adoption of various tick control practices and how these decisions affect their long-term economic resilience to theileriosis. Future research should focus on rigorous cost-benefit analyses of integrated tick management strategies, taking into account both the direct costs of implementation and the indirect benefits of lower disease incidence, increased productivity, and less reliance on expensive acaricides. Furthermore, studying the socioeconomic factors that influence tick control adoption can help to develop more effective and economically sustainable interventions for theileriosis management.

2.3.3 The current tick management and veterinary practices employed by farmers.

2.3.3.1 Integrated Tick Management (ITM)

Integrated Tick Management (ITM) has emerged as an important and widely adopted strategy for tick control in livestock around the world. Recognising the limitations and negative consequences of relying solely on chemical acaricides, such as resistance development, environmental contamination, and high costs, ITM combines a variety of methods to achieve long-term and effective tick management.

In Mexico, Rosado-Aguilar et al. (2022) investigated farmers' perspectives on using integrated tick management to control *Rhipicephalus microplus* in a tropical region. The findings revealed that farmers are becoming more aware of the challenges of acaricide resistance and are willing to try alternative methods like strategic grazing and the use of resistant cattle breeds. However, the study also identified barriers to widespread adoption, such as a lack of technical knowledge and the

perceived higher initial costs of implementing ITM strategies versus traditional chemical treatments.

Moving to Africa, specifically Tanzania, Mwakalinga et al. (2023) investigated agro-pastoral communities' knowledge, attitudes, and practices regarding ticks and tick-borne diseases, including the use of integrated management approaches. The study found that, while traditional acaricide use persisted, some farmers were incorporating practices such as bush clearing around animal enclosures and rotational grazing to reduce tick burdens. The study emphasised the importance of improved extension services in educating farmers about the benefits and implementing comprehensive ITM strategies that are tailored to their specific agro-ecological zones.

In Australia, where tick-borne diseases pose a significant threat to the livestock industry, Jonsson et al. (2024) investigated the efficacy of an area-wide integrated tick management program that included coordinated acaricide application, pasture management, and the introduction of tick-resistant cattle breeds. The findings revealed a significant reduction in tick populations and disease incidence when compared to areas that relied solely on traditional dipping practices. The success of this program demonstrated the value of collaborative efforts and government support in facilitating the widespread adoption of ITM.

Comparing these findings, it is clear that ITM adoption and specific components differ significantly across regions. In Mexico and Tanzania, the emphasis appears to be on raising awareness and overcoming barriers to the initial adoption of basic ITM principles, often while maintaining reliance on acaricides. In contrast, the Australian study demonstrates the potential for large-scale, coordinated ITM programs to significantly reduce tick burdens and disease. The level of infrastructure and resources available to support ITM implementation differs significantly, with Australia taking a more structured and resource-intensive approach than the smallholder farming systems prevalent in Mexico and Tanzania.

Despite the growing body of evidence supporting the benefits of ITM, there is a literature gap in understanding the long-term socioeconomic impacts of various ITM strategies on smallholder farmers in diverse geographical settings. While studies have evaluated the effectiveness of various ITM components in reducing tick burdens and disease incidence, there has been little research into how these strategies affect farm productivity, profitability, and farmers' livelihoods over time.

More research is needed to assess the economic viability and social acceptability of various ITM approaches, taking into account the unique constraints and opportunities that farmers face in different cultural and economic contexts.

2.3.3.2 Vaccination

Globally, tick-borne diseases present a substantial threat to the health and productivity of livestock, resulting in substantial economic losses for farmers. Although chemical acaricides have been the primary method of tick control for decades, concerns regarding acaricide resistance, environmental contamination, and the cost of treatments have sparked interest in alternative and complementary strategies. Within integrated tick management programs, vaccination against ticks or tick-borne pathogens is a promising approach.

Research in Australia has concentrated on vaccines that target the cattle tick (*Rhipicephalus australis*). Johnson et al. (2023) conducted a study to examine the adoption rates and perceived effectiveness of the commercially available TickGARD vaccine among beef producers in Queensland. The results of their research suggested that moderate adoption was the norm, with farmers who experienced greater tick burdens and economic losses being more inclined to use the vaccine. Although the vaccinated herds exhibited a decrease in tick numbers in comparison to the unvaccinated control groups, the degree of protection varied, indicating that the vaccine's efficacy can be influenced by factors such as the intensity of the tick challenge and the breed of the animal. Campbell and Davis (2024) conducted an additional investigation into the attitudes of farmers towards the cost-effectiveness of the TickGARD vaccine in New South Wales. According to their economic analysis, the initial investment in vaccination was substantial; however, the long-term benefits of improved animal productivity and reduced acaricide use could potentially outweigh the costs, particularly in regions with high tick infestation rates.

In Africa, where tick-borne diseases such as East Coast Fever (ECF) caused by *Theileria parva* are significant constraints on livestock production, vaccination initiatives have been focused on pathogen-specific vaccines. Mwangi et al. (2022) conducted a study in Kenya to assess the field efficacy and farmer acceptance of the Infection and Treatment Method (ITM) for ECF control. The infection of cattle with a specific quantity of *T. parva* sporozoites is the first step in the ITM process, which is followed by treatment with a long-acting tetracycline. As a result of its long-lasting immunity and decreased dependence on frequent tick control measures, the study reported

that farmers were highly satisfied with ITM. However, the logistical challenges of administering ITM, such as the precise timing of infection and treatment and the necessity of a cold chain for stabilisation, were identified as potential obstacles to its widespread adoption. The utilisation of a recombinant vaccine that targets specific antigens of *T. parva* was examined in Zimbabwe by Sibanda and Moyo (2025). Their preliminary results indicated that the vaccine was effective in reducing the incidence and severity of ECF in vaccinated cattle in field conditions. However, additional research was recommended to determine the vaccine's cost-effectiveness and durability.

Vaccination strategies against economically significant tick species, particularly *Rhipicephalus microplus*, have also been the subject of research in South America. Ferreira et al. (2021) conducted a study in Brazil to evaluate the efficacy of a recombinant protein-based vaccine in reducing tick infestations in dairy cattle. The results indicated a substantial decrease in the number of engorged female ticks on vaccinated animals in comparison to controls, which resulted in a decrease in the use of acaricides. The vaccine's contribution to sustainable tick management was perceived favourably by farmers, according to surveys. In Argentina, Perez and Gomez (2023) assessed the implementation of a comparable recombinant vaccine in beef cattle. They discovered that, despite the efficacy that had been demonstrated in experimental settings, the adoption of the vaccine in the field was influenced by factors such as the perceived level of tick challenge and the availability of technical support for vaccine administration.

The reviewed studies underscore the increasing interest in and implementation of vaccination as a tick management strategy on various continents. The primary focus in Australia and South America has been on vaccines that target the tick vector, with the objective of reducing tick burdens and, as a result, the transmission of a variety of tick-borne pathogens. These studies typically indicate a decrease in the number of ticks and the use of acaricides in vaccinated animals. The adoption of this method by farmers is influenced by economic factors and the perceived benefits in relation to the severity of the tick infestation.

Conversely, research in Africa has primarily focused on vaccines that protect against specific tick-borne pathogens, with a particular emphasis on *T. parva*, which is responsible for ECF. The ITM approach in East Africa has demonstrated high efficacy and farmer acceptance; however, logistical challenges persist. The long-term effectiveness and cost-effectiveness of the newer recombinant

vaccines against *T. parva* in the region are promising; however, additional research is necessary to determine their efficacy in field settings.

The target of the vaccination strategy is a critical distinction: vector-targeted vaccines in Australia and South America and pathogen-targeted vaccines in Africa. The specific tick species and the most economically damaging tick-borne diseases prevalent in each region are likely to influence the choice of strategy. Moreover, the feasibility and adoption of various vaccination strategies are also significantly influenced by the level of technological advancement and infrastructure available for vaccine production, distribution, and administration.

A significant literature gap exists in the comprehensive evaluation of the socio-economic impacts of these vaccination strategies on smallholder farmers in diverse settings, despite the growing body of research on vaccination for tick management. Although some studies address farmer perceptions and economic benefits, there is a need for more comprehensive analyses that take into account factors such as the integration of vaccination into existing livestock management systems within different socio-cultural contexts, the impact on overall farm productivity and income, and access to vaccines. Additionally, there is a scarcity of research on the long-term sustainability of current vaccination strategies, which includes the potential for the development of vaccine resistance in ticks or pathogen escape mutants, as well as the optimal integration of vaccination with other tick control methods within an integrated pest management framework. It is essential to address these gaps in order to develop and implement effective and equitable vaccination programs for the sustainable management of tick and tick-borne diseases that are implemented globally.

2.3.3.3 Ethnoveterinary Practices

The traditional knowledge, skills, methods, and practices of farmers and local communities for animal healthcare, known as ethnoveterinary practices, are a significant component of current tick management strategies worldwide. This empirical literature review analyses recent studies from a variety of countries and continents to ascertain the effectiveness and application of these practices in the management of ticks on livestock. Although ethnoveterinary approaches are frequently founded on centuries of observation and experience, they remain pertinent, particularly in resource-constrained environments, and have the potential to provide sustainable and locally tailored solutions.

Fular et al. (2021) conducted a study in Zimbabwe that examined the practices and knowledge of smallholder farmers in the area of tick control. The results indicated that farmers frequently implemented ethnoveterinary methods, including the application of plant extracts (e.g., *Aloe vera*, *Nicotiana tabacum*), engine oil, and ash, in addition to conventional acaricides, to control tick infestations. The study emphasised that the perceived effectiveness of these practices was frequently influenced by factors such as the cost and availability of synthetic acaricides, as well as local experience. Nevertheless, the study also identified a dearth of standardised application methods and dosages, which could potentially impact the consistency of the results.

In Tanzania, a study conducted by Veterinary World (2018) investigated the management practices and knowledge of agro-pastoral communities regarding ticks and tick-borne diseases. The research suggested the utilisation of a variety of ethnoveterinary remedies, such as concoctions derived from local plants such as *Azadirachta indica* (neem) and *Euphorbia tirucalli*. Farmers reported varying degrees of success with these methods, frequently incorporating them with occasional acaricide use. The study underscored the importance of scientific validation of the efficacy and safety of these practices, while also emphasising the deep-rooted traditional knowledge that surrounds animal health.

Studies have also documented the ongoing use of ethnoveterinary practices for tick control in India, which is situated across the Indian Ocean. For example, Patel et al. (2022) conducted a review that compiled a variety of plant-based acaricides that have been traditionally employed by livestock owners. Tick-repellent or acaricidal properties were reported in plants such as *Curcuma longa* (turmeric), *Pongamia pinnata* (karanja), and various species of *Citrus*. These botanicals have the potential to serve as environmentally friendly and cost-effective alternatives to synthetic chemicals, particularly for smallholder farmers, as discussed in the review. Nevertheless, the study also emphasised the necessity of additional research to standardise formulations, isolate active compounds, and assess their efficacy under controlled conditions.

Martínez-Ortiz et al. (2023) conducted a study in Mexico, which focused on the integrated tick management strategies that farmers employed. These strategies frequently incorporated ethnoveterinary practices. Various local herbs and plant extracts, including those from *Allium sativum* (garlic), were reported as a supplementary method to chemical control. Farmers frequently depended on the local availability of these resources and generational knowledge. The

research indicated that although these methods may provide some degree of tick control, their efficacy could be improved by conducting scientific research and establishing standardised application protocols.

The comparison of these findings reveals both similarities and differences in the ethnoveterinary practices that are implemented in various regions. The reliance on locally available plant resources is a recurring theme, with the specific plant species varying based on traditional knowledge and geographical distribution. Economic constraints, perceived environmental advantages, and the availability of conventional knowledge are frequently cited as the rationale for employing these practices. Conversely, there is substantial variation in the degree of scientific validation and standardisation of these practices. Although some studies document farmers' convictions regarding their efficacy, there is frequently a lack of rigorous scientific evidence that substantiates these assertions and specifies the most effective application methods. Furthermore, the integration of ethnoveterinary practices with conventional methods varies across regions, with some farmers employing them as primary control measures and others as supplementary approaches.

A substantial literature gap exists in the rigorous scientific evaluation of the efficacy, safety, and optimal application of ethnoveterinary practices for tick management, despite their widespread use and cultural significance. Although there are numerous studies that document the plant species and methods employed by farmers, there is a dearth of research that employs robust experimental designs, such as controlled trials and dose-response studies, to validate the acaricidal or repellent properties of these traditional treatments. Additionally, there is a scarcity of research on the potential synergistic effects of combining various ethnoveterinary remedies or integrating them with conventional methods. Additionally, research is required to investigate the long-term effects of these practices on the environment, livestock health, and tick populations. It is imperative to address these gaps through interdisciplinary research that involves agricultural scientists, veterinarians, and ethnobotanists in order to fully leverage the potential of ethnoveterinary knowledge for sustainable tick management.

2.3.3.4 Acaricide Application

The application of acaricides remains a fundamental component of tick management and veterinary practices that farmers worldwide employ to safeguard livestock from tick infestations and the multitude of tick-borne diseases they transmit.

In a study conducted in Zimbabwe by Fular et al. (2021), the most frequently employed method of tick control was the application of acaricides through dipping tanks and hand spraying. The study examined the knowledge, attitudes, and practices of farmers in this regard. Nevertheless, the investigation also underscored a substantial lack of awareness regarding the appropriate application of acaricides and the increasing risk of acaricide resistance. Similarly, Abebe et al. (2023) conducted a study in Ethiopia that revealed that the persistence of tick-borne diseases and suboptimal tick control were exacerbated by the inconsistent application schedules and reliance on older generation chemicals, despite the widespread use of acaricides. In South Africa, Mapholi et al. (2024) conducted research on the acaricide usage patterns of smallholder farmers. They observed a preference for products that were readily available, but were occasionally less effective and potentially harmful. Additionally, limited access to veterinary extension services for guidance on integrated tick management strategies was observed. These African studies collectively suggest the widespread reliance on acaricides, which is frequently accompanied by obstacles related to knowledge gaps, resistance, and access to appropriate resources.

Sharma et al. (2022) conducted research in India to evaluate the effectiveness of various acaricide formulations against common tick species in dairy cattle. Some evidence of emerging resistance to commonly used synthetic pyrethroids in certain regions was observed, as the findings indicated varying levels of effectiveness depending on the acaricide type and application method. Khan et al. (2023) conducted a study in Pakistan that examined the economic consequences of tick infestations and the cost-benefit analysis of various acaricide treatment regimens. The study underscored the substantial financial losses that farmers experienced as a result of reduced productivity and the cost of tick control. These Asian studies emphasise the economic importance of effective acaricide application and the necessity of continual monitoring of acaricide efficacy to combat resistance.

De Oliveira et al. (2025) conducted a study in Brazil, a major livestock-producing country, to examine the adoption of various tick control methods, such as acaricides, by beef cattle farmers. In regions with high tick burdens, the study demonstrated a significant reliance on chemical control, frequently involving intensive application schedules. The research also underscored the increasing interest in and adoption of integrated pest management strategies to decrease acaricide dependence. Perez et al. (2024) conducted a study in Argentina that concentrated on the

assessment of novel acaricide compounds and application techniques, as well as the challenges associated with acaricide resistance in cattle ticks. The findings underscored the necessity of diagnostic tools to early detect resistance and the importance of rotational use of various acaricide classes. These studies from the Americas demonstrate a trend towards more intensive acaricide use in high-burden areas, in conjunction with a growing awareness and research into sustainable and resistance-management strategies.

The primary method for tick control in diverse farming systems across Africa, Asia, and the Americas is consistently acaricide application, as evidenced by the reviewed studies. Nevertheless, the context of its application, the specific acaricides employed, and the corresponding challenges are subject to substantial variation. The issue of acaricide resistance may be further exacerbated by studies from Africa, which emphasise the importance of knowledge gaps among farmers, inconsistent application, and limited access to veterinary support. The economic consequences of tick infestations and the necessity of employing effective acaricides to reduce production losses are underscored by research conducted in Asia. In the Americas, there is a growing emphasis on integrated approaches and resistance management, as well as a trend towards intensive acaricide use, particularly in large-scale livestock operations.

The level of awareness and adoption of integrated tick management strategies is a critical contrast. Although certain studies, particularly those from Brazil and Argentina, suggest a growing interest in and implementation of ITM, its reliance on chemical control remains prevalent in numerous regions, particularly among smallholder farmers in Africa and certain regions of Asia. Additionally, the availability of alternative control methods and the specific acaricide resistance profiles are significantly influenced by the prevalent tick species and geographic location.

A substantial gap exists in the comprehensive comprehension of the long-term socio-economic and environmental consequences of various acaricide application practices in diverse smallholder farming systems, despite the substantial body of literature on acaricide application. Although studies have investigated efficacy and resistance, there is a relative scarcity of research that comprehensively evaluates the impact of varying acaricide use patterns on farm profitability, animal welfare, human health risks associated with chemical exposure, and the broader environmental sustainability in low-resource settings. In order to assess these multifaceted impacts and identify context-specific, sustainable tick management strategies that do not solely rely on

acaricides in these critical agricultural contexts, future research should emphasise interdisciplinary approach.

2.4 Chapter summary

This chapter introduced the theoretical literature review and the empirical literature in relation with the objectives of the study. The theoretical literature guided the existing knowledge of the effects of Theileriosis. Therefore, the views of various authors will be used to guide this part of study with theories about effects of Theileriosis. This chapter is concluded by a chapter summary. The following chapter discusses the research methodology that was adopted in this study.

CHAPTER THREE

METHODOLOGY

3.1 Description of the study area

Cattle farmers in the Zibwowa area of Zaka district, akin to their counterparts in Zimbabwe's communal lands, generally practise mixed crop-livestock farming, with cattle serving as a fundamental component of their agricultural and socio-economic endeavours. Their practices frequently centre on rearing indigenous or cross-bred cattle, including the resilient Nguni, Mashona, or Tuli breeds, primarily for draft power to cultivate fields for agriculture and for manure to enrich their soils. In addition to their agricultural utility, these cattle represent a substantial form of wealth, are utilised in traditional ceremonies and social obligations, and supply meat and, occasionally, milk for household consumption. Management generally entails communal grazing, with initiatives to augment feed, particularly in the dry season, utilising crop residues and occasionally procured feeds. Agriculturalists face challenges such as tick-borne diseases and Foot and Mouth Disease, requiring involvement in dipping programs and vaccination initiatives, frequently aided by veterinary services, to sustain herd health and productivity. Nearby diptanks to Gahadziso are Mukobvu, Mushungwa, and Muasarava.

Geographically located in the southeast lowveld of Zimbabwe, the study area centres on the vicinity of Gahadziso Diptank within the Zibwowa area of Zaka district. The study area lies 15 km East of Jerera Growth Point. GPS coordinates for the diptank falls at 20° 26'46" South latitude and 31° 31'29" East longitude 679m. Typically ranging between 450mm and 600mm annually, this area is marked by a semi-arid to arid climate with rather low and erratic rainfall, mostly during the summer months (November to March). Usually hot and dry for most of the year, the pre-rainy season (September–October) sees high temperatures often exceeding 30°C. The area is part of Agro-ecological Region IV, which is marginal for dryland farming because of low rainfall and high temperatures; hence, cattle production is a vital agricultural activity and a major source of livelihoods in the area.

Savanna woodlands, dominated by species tolerant to dry conditions like Acacia and Combretum trees, interspersed with grasslands, define the natural vegetation in this agro-ecological zone most importantly. Often making it difficult to sustain enough pasture all year long, the availability and

quality of grazing land are quite dependent on the seasonal rainfall patterns. Consequently, extensive grazing systems define the Zibwowa area's cattle output, including those under Gahadziso Diptank, mainly. Common indigenous breeds of cattle found in this area are often ones known for their resistance to the severe temperature conditions and endemic diseases. The main vector for theileriosis, the brown ear tick (*Rhipicephalus appendiculatus*), is a major determinant of cattle health and productivity in this environment, thus the research of the effects of the disease at Gahadziso Diptank is especially important in the local agricultural environment. Figure 3.1 below shows the coordinates and the map of Gahadziso Diptank.

Figure 3.1 Gahadziso Diptank

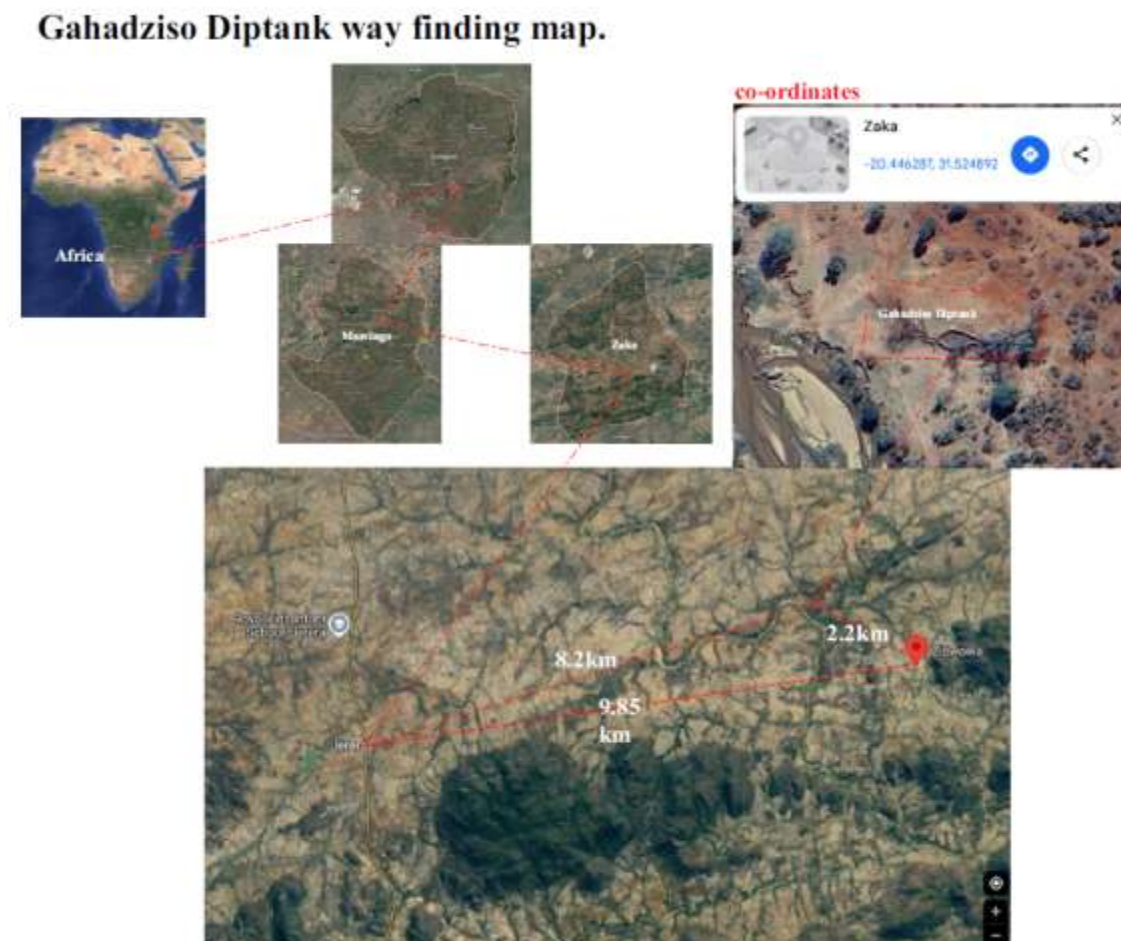


Figure 1 Gahadziso diptank

3.2 Study design

3.2.1 Blood tests

Twenty blood samples were collected after selecting and properly restraining the animal, typically within a crush pen adjacent to the dip tank for safety and accessibility, followed by the blood draw. The text does not specify the exact location; however, standard veterinary practice for cattle entails obtaining blood from the jugular vein in the neck or, occasionally, the coccygeal vein, utilising a sterile needle and vacutainer tube or syringe. The area was sanitized prior to venipuncture to reduce contamination.

Upon collection, the blood samples were processed to yield the results. This entailed multiple steps. Initially, thin blood smears were frequently prepared directly from a fresh blood drop, air-dried, fixed (e.g., with methanol), and stained (e.g., with Giemsa stain). The smears were subsequently analysed microscopically to directly observe *Theileria* parasites within red or white blood cells and to assess the degree of parasitemia (the proportion of infected cells). A segment of whole blood, typically collected in an EDTA anticoagulant tube, was utilised for Polymerase Chain Reaction (PCR) assays to facilitate a more comprehensive and nuanced analysis. PCR facilitates the amplification of *Theileria* DNA, permitting precise detection of the parasite, even at minimal infection levels, and aids in identifying the specific *Theileria* species, some of which exhibit varying pathogenicity levels. Furthermore, serum (derived from clotted blood) or plasma may have been utilised for Enzyme-Linked Immunosorbent Assays (ELISA). ELISA tests identify antibodies generated by the animal in reaction to *Theileria* infection or detect parasite antigens, offering insights into exposure and immune response. The analysis of these samples using combined methods enabled us to determine the prevalence of theileriosis in the study population and assess the infection levels in individual animals, thereby enhancing our understanding of the disease's impact in the region.

The study's target population consists of 2,580 cattle that are regularly managed at or have consistent access to the Gahadziso Diptank, located in the Zibwowa area of Zaka district. This distinctly defined population is essential as it embodies the entire cohort of animals to which the findings and conclusions of this research on theileriosis are meant to be relevant, as corroborated by Ary et al. (2019). This study concentrates on a specific assemblage to offer insights pertinent

to health dynamics and disease effects within this livestock community, which is geographically and managerially connected through their collective utilisation of the diptank facility.

Zibwowa, situated in the Zaka district of Masvingo Province, Zimbabwe, predominantly hosts indigenous cattle breeds that are well-suited to the local semi-arid environment. The predominant breed is the Mashona, recognised for its resilience, precocious maturity, exceptional fertility, and capacity to flourish on both grazing and browsing. Other notable breeds in the region comprise the Tuli, an indigenous Sanga-derived breed esteemed for its resistance to heat, ticks, and drought, along with its superior maternal attributes and high-quality beef. The Brahman, a *Bos Indicus* breed from India, is frequently crossbred with other breeds for commercial beef production because of its resilience to heat and insect pests. Although precise distribution statistics for Zibwowa by class are not readily accessible, it is generally observed that in communal regions such as Zaka, cattle herds predominantly consist of cows and their calves, which constitute the breeding nucleus. Heifers are retained for subsequent breeding, whereas bulls are maintained for herd enhancement and draft capability. Oxen are essential for supplying draft power in agricultural operations. The Zaka district, including the Zibwowa area, covers approximately 3,086.2 square kilometres (1,207 square miles) and is primarily situated within agro-ecological regions III, IV, and V, noted for their semi-arid conditions.

To guarantee that the chosen animals accurately represent the broader population, simple random sampling is recommended as the most appropriate technique for obtaining a representative sample. Simple random sampling is a fundamental probability sampling method that, as noted by Etikan et al. (2016), ensures that each individual animal within the 2580 cattle population has an equal and independent opportunity to be selected for the study. The 'equal chance' component indicates that no animal possesses a greater or lesser probability of being selected than another, while 'independent chance' denotes that the selection of one animal does not affect the selection of any other. This systematic approach is crucial as it markedly diminishes the likelihood of selection bias, where researchers may intentionally or unintentionally prefer specific animals, thus distorting the sample. Thus, by reducing bias, simple random sampling significantly improves the generalisability of the study's results, facilitating more assured extrapolation of the findings from the sampled group to the entire target population of 2,580 cattle at Gahadziso Diptank.

The optimal execution of this sampling strategy would commence with the formulation of a detailed list, or sampling frame, cataloguing all 2580 cattle that utilise the diptank. This fundamental step is essential for authentic random selection. Upon compiling and verifying the list for accuracy and completeness, the requisite sample size will be determined using a random number generator either a software application or a calculator function or through an alternative objective random selection method, such as extracting unique identification numbers from a container, to guarantee that the selection process is entirely impartial and that each animal possesses the designated equal and independent chance of inclusion in the study.

The Krejcie and Morgan table (1970) is a generally accepted approach for populations of a known size to ascertain a sufficient sample size for this research. Using the Krejcie and Morgan table, a sample size of 200 was considered appropriate for a target population of 1895 cattle owners. With a 95% confidence level and a 5% margin of error (Krejcie & Morgan, 1970), this sample size is judged sufficient to offer a rather accurate picture of the features of the whole population. This implies that, should the study be repeated several times, the results from the sample should thus reflect the actual population parameters inside a given range 95% of the time. By means of a computed sample size grounded on statistical principles, the study guarantees sufficient power to identify significant effects of theileriosis inside the target population (Saunders et al., 2023).

3.3 Data collection tools

3.3.1 Questionnaires

Questionnaires were employed to collect data for the study. Two hundred questionnaires were disseminated to the chosen livestock farmers in the Zibwowa region. The selection method for these particular respondents from the Zibwowa region was predicated on the accessibility of farmers in that area. The questionnaires were distributed in person. This method was selected to enable direct engagement with the participants, permitting the researcher to elucidate the study's objectives and respond to any immediate enquiries from the farmers. The text suggests that this direct interaction was a significant advantage. The information provided does not clearly indicate whether the researcher administered the questions and completed the questionnaire for the respondent, or if the respondent independently filled it out. The text does not clarify whether questionnaires were provided to respondents for later collection. Of the 200 distributed questionnaires, 180 were returned and considered appropriate for analysis. The excerpt indicates

that the returned and appropriate questionnaires constituted the foundation for the analysis. The researcher posed questions to the respondents and subsequently completed the questionnaires independently.

3.4 Data analysis

The Statistical Package for the Social Sciences (SPSS) version 30.0.0 was used to examine the quantitative data acquired for the study on the effects of theileriosis at Gahadziso Diptank, Zibwowa area in Zaka district.

The gathered data was entered into SPSS for study since the questionnaires was sent to Zibwowa area cattle producers by hand delivery. In rural environments, hand delivery is usually favoured to guarantee better response rates and give a chance to address any questions the respondents could have (Dohle & Siegrist, 2013). Descriptive statistics were used first in analysis once the data is entered into and cleaned in SPSS. Descriptive statistics will be used to compute measures of central tendency (e.g., mean, median) and measures of dispersion (e.g., standard deviation, range) for variables such as the prevalence of theileriosis in the study population, the age distribution of affected cattle, and the stated levels of productivity losses. Descriptive language including frequencies and percentages were also be used to characterise categorical variables including the breed of cattle afflicted and the noted clinical signs of theileriosis.

CHAPTER FOUR

RESULTS

4.1 Response rate

Two hundred questionnaires were disseminated to collect data from pertinent stakeholders, presumably including farmers and veterinary professionals. Out of these, 180 questionnaires were returned and considered appropriate for analysis, resulting in a response rate of 90%. The elevated response rate is deemed exceptional and markedly improves the reliability and generalizability of the study's results.

Table 1 Response rate

Questionnaire sent	200
Questionnaire returned	180
Response rate	90%

4.2 Demographic information

4.2.1 Gender of respondents

The demographic analysis of respondents in this study revealed a notable gender distribution. Of the 180 participants whose responses were analysed, a significant majority, approximately 65% (n=117), were male, while 35% (n=63) were female.

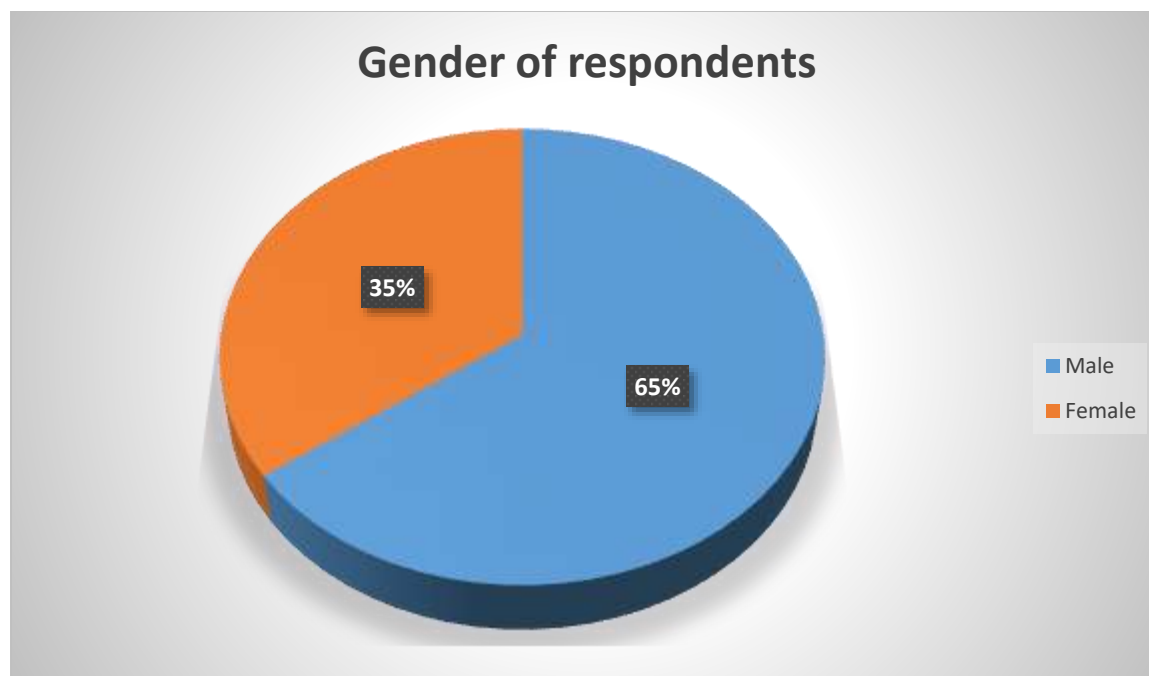


Figure 2 Gender of respondents

4.2.2 Age of respondents

This study's age distribution of the 180 respondents offers crucial context for comprehending their experiences and viewpoints. The predominant cohort of participants was within the 45-54 years age range, constituting 35% of the overall respondents. The subsequent age group, 35-44 years, comprised 25% of the participants. The cohort aged 55-64 comprised 20% of the respondents. Farmers aged 25-34 constituted 10% of the sample, whereas the 18-24 age group represented the smallest proportion at 5%. A significant segment of seasoned, older farmers was included, with individuals aged 65-74 constituting 4% and those aged 75 and above representing 1% of the total respondents.

Table 2 Age of respondents

Age of respondents	Percentage
18-24 yrs	5%
25-34 yrs	10%
35-44 yrs	25%
45-54 yrs	35%
55-64 yrs	20%
65-74 yrs	4%
75+	1%

4.2.3 Level of education of respondents

An examination of the educational qualifications of the 180 participants in the study "The Effects of Theileriosis on Cattle Productivity at Gahadziso Diptank, Zibwowa Area in Zaka District" disclosed a varied educational landscape. Approximately 55% of participants indicated that Secondary Education was their highest level of formal schooling. Subsequently, approximately 30% of respondents reported having obtained a Diploma or Certificate, presumably in agriculture, animal health, or a related vocational discipline. A minor yet notable segment, approximately 10%, held a Bachelor's Degree, while the remaining 5% comprised individuals with Master's Degrees and a negligible proportion with Doctorate Degrees, predominantly anticipated to be veterinary professionals or researchers in the field. This distribution indicates that although most respondents have basic education, a significant portion holds specialised post-secondary credentials.

4.3 The prevalence and incidence rates of Theileriosis in cattle within the Gahadziso diptank area.

4.3.1 Diagnosis of theileriosis by a veterinarian

This study sought to examine the impact of theileriosis on livestock productivity at Gahadziso Diptank, Zibwowa region in Zaka District. Two hundred questionnaires were disseminated, with 180 completed and returned, resulting in a response rate of 90%. One of the primary enquiries directed at livestock farmers was whether any cattle in their herd had been diagnosed with theileriosis by a veterinarian within the preceding 12 months. The responses from the 180 participants revealed a substantial prevalence of diagnosed theileriosis in the region. Specifically, 99 respondents (55%) confirmed that cattle in their herds had been diagnosed with theileriosis by a veterinarian in the past year. In contrast, 54 respondents (30%) indicated that their herds did not experience any such diagnoses during the same timeframe. A minority of respondents, 27 individuals (15%), expressed uncertainty regarding whether their cattle had received a formal diagnosis of theileriosis by a veterinarian in the preceding 12 months.

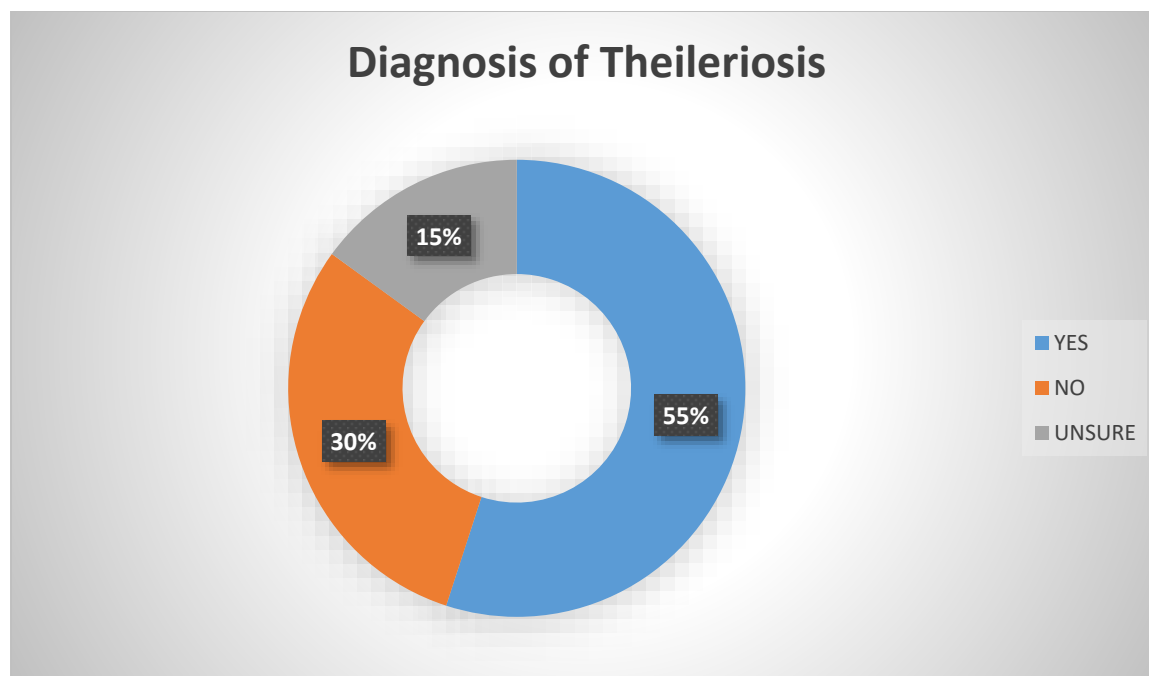


Figure 3 Diagnosis of theileriosis by a veterinarian

4.3.2 Suspected cases of theileriosis among cattle

The findings regarding the perceived occurrence of new suspected theileriosis cases in cattle herds over the past 12 months indicated a significant prevalence of the disease. A substantial majority of respondents indicated encountering cases of theileriosis in their herds. The predominant group, constituting 45% (n=81) of farmers, reported having roughly 1 to 5 new suspected cases. Additionally, 25% (n=45) of participants indicated a greater occurrence of 6 to 10 new cases. A concerning minority, 10% (n=18) of farmers, reported more than 10 new suspected cases of theileriosis in their herds during the past year. In contrast, merely 15% (n=27) of participants indicated no new suspected cases. A minor proportion, 5% (n=9) of respondents, expressed uncertainty regarding the number of new cases.

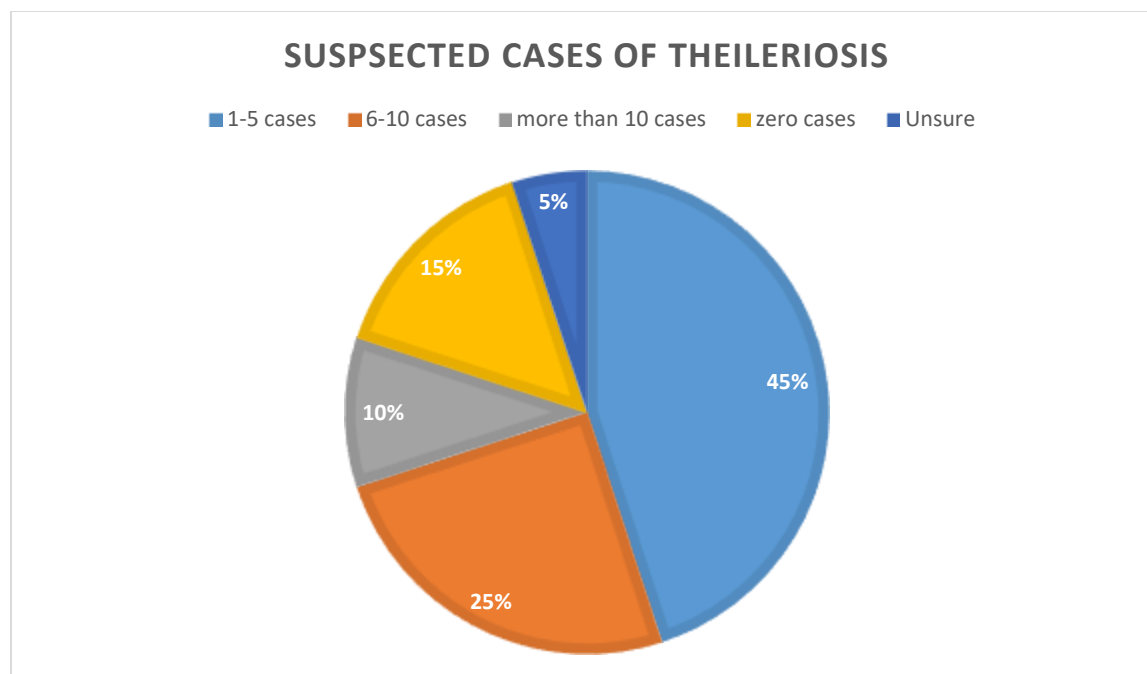


Figure 4 Suspected cases of theileriosis

4.3.4 Blood tests results

This study sought to ascertain the prevalence and incidence rates of Theileriosis in cattle at the Gahadziso diptank. A preliminary sample of 20 cattle was selected from the total population of 2,580 in the diptank for this investigation. This initial sample of 20 animals was selected for various practical reasons, although a larger sample size would yield more statistically robust data for assessing overall population prevalence. Initially, it facilitates a preliminary evaluation of the prevalence and extent of Theileria infections within the herd through comprehensive diagnostic techniques, which may require substantial resources. Secondly, this pilot phase facilitates the refinement of sample collection and processing protocols prior to the initiation of a larger-scale study. The results from this subset can inform power calculations for optimal sample size determination in future, larger studies, ensuring efficient resource utilisation while obtaining significant preliminary insights into the disease's status at Gahadziso diptank.

Laboratory analysis of blood samples from the 20 selected cattle revealed a complex overview of Theileriosis at the Gahadziso diptank. Microscopic analysis of stained blood smears demonstrated the presence of Theileria parasites within the erythrocytes of 6 out of 20 animals, signifying active infection. The degree of parasitemia in these positive cases varied: three animals exhibited low-level infection (less than 1% of red blood cells infected), two demonstrated moderate parasitemia

(1-5% infected cells), and one animal presented a higher level of parasitemia (over 5% infected cells). The results indicate continuous transmission and differing levels of clinical or subclinical disease in the sampled animals.

Subsequent analysis employing Polymerase Chain Reaction (PCR) assays on whole blood specimens yielded enhanced sensitivity and specificity in the detection of *Theileria* DNA. The PCR results validated infection in all six cattle identified as positive through microscopy. PCR additionally identified *Theileria* DNA in four animals that were initially negative upon microscopic examination, underscoring PCR's capacity to detect infections at minimal parasitic loads that microscopy may overlook. Species identification via PCR revealed that *Theileria parva* was the predominant species in 7 positive cases, whereas *Theileria mutans* was identified in 2 cases, and one animal exhibited a mixed infection with both species. This molecular data is essential, as distinct *Theileria* species exhibit differing degrees of pathogenicity.

Enzyme-Linked Immunosorbent Assays (ELISA) were performed on serum samples to identify antibodies against *Theileria* parasites, indicating exposure and immune response. Out of the 20 cattle examined, 12 exhibited positive ELISA results, signifying that a substantial proportion of the sampled animals had encountered *Theileria* at some stage. This encompassed all 10 animals that tested positive via PCR. Two additional animals that tested negative via both microscopy and PCR exhibited positive antibody responses, indicating prior exposure and resolved infection or an early infection where parasite DNA was below the detectable limits of PCR, yet an immune response had been initiated. The antibody titers in the positive animals varied, possibly indicating the duration or intensity of previous or ongoing infections. The results from microscopy, PCR, and ELISA collectively offer a thorough initial insight into the prevalence and exposure of Theileriosis within this sample, highlighting the importance of a multifaceted diagnostic strategy.

Table 3 Suspected cases of theileriosis among cattle

Animal ID	Microscopy (Parasites Seen)	Microscopy (Parasitemia Level)	PCR (Theileria DNA)	PCR (Species Identified)	ELISA (Antibodies)	ELISA (Titre)
GAH001	Positive	Low (<1%)	Detected	Theileria parva	Positive	06:20
GAH002	Negative	N/A	Detected	Theileria mutans	Positive	03:40
GAH003	Positive	Moderate (1-5%)	Detected	Theileria parva	Positive	11:40
GAH004	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH005	Positive	Low (<1%)	Detected	Theileria parva	Positive	06:20
GAH006	Negative	N/A	Not Detected	N/A	Positive	02:20
GAH007	Positive	High (>5%)	Detected	Theileria parva & Theileria mutans	Positive	22:20
GAH008	Negative	N/A	Detected	Theileria parva	Positive	03:40
GAH009	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH010	Positive	Moderate (1-5%)	Detected	Theileria parva	Positive	11:40
GAH011	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH012	Positive	Low (<1%)	Detected	Theileria mutans	Positive	06:20
GAH013	Negative	N/A	Detected	Theileria parva	Positive	02:20
GAH014	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH015	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH016	Negative	N/A	Detected	Theileria parva	Positive	03:40
GAH017	Negative	N/A	Not Detected	N/A	Positive	02:20
GAH018	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH019	Negative	N/A	Not Detected	N/A	Negative	<1:80
GAH020	Negative	N/A	Not Detected	N/A	Negative	<1:80

Source: Primary data

4.3.3 Suspected clinical signs of theileriosis

One hundred eighty of the intended two hundred livestock farmers in the Gahadziso diptank region, Zibwowa, Zaka District, engaged in the survey, resulting in a response rate of 90%. The findings concerning the clinical signs associated with theileriosis in cattle over the past year reveal considerable concern among respondents. The predominant clinical manifestation reported was lymphadenopathy, with 144 (80.0%) of farmers noting the observation of this symptom. Subsequently, loss of appetite was reported by 135 respondents (75.0%), while fever was observed in 126 farmers' cattle (70.0%).

Weakness or lethargy was frequently reported, with 117 respondents (65.0%) observing this in their animals. Ninety farmers (50.0%) observed pale gums, indicative of anaemia. A concerning 72 respondents (40.0%) indicated that they had encountered fatalities in their herd, which they believed were due to theileriosis. A minor percentage of farmers, 9 (5.0%), reported that they had not observed any of the specified signs, whereas 18 respondents (10.0%) expressed uncertainty regarding the association of the signs they observed with theileriosis or whether they had identified any particular signs. The data reveals that numerous clinical signs frequently manifested simultaneously, as participants were allowed to choose multiple options. The table below shows the results above.

Clinical Sign/Observation	Number of Respondents	Percentage of Respondents (%)
Lymphadenopathy	144	80.00%
Loss of appetite	135	75.00%
Fever	126	70.00%
Weakness or lethargy	117	65.00%
Pale gums (indicative of anaemia)	90	50.00%
Fatalities believed due to theileriosis	72	40.00%
Did not observe any of the specified signs	9	5.00%
Uncertainty about signs or their association	18	10.00%

4.4 The economic losses incurred by farmers due to Theileriosis, including direct costs.

4.4.1 Money spent on tick control measures

From a potential sample size of 200 livestock farmers in the Gahadziso diptank area, Zibwowa, Zaka District, 180 respondents reported their expenditures on tick control measures over the past 12 months, primarily due to the threat of theileriosis. The results demonstrate differing degrees of financial investment in the management of this disease vector. A substantial segment of the participants, 63 out of 180 (35%), indicated expenditures ranging from \$50 to \$100 on tick control measures. Subsequently, 54 farmers (30%) reported increased expenditures, specifically within the \$101 to \$200 range. Twenty-five percent of the respondents, comprising 45 farmers, allocated less than \$50 towards these control measures. In contrast, a smaller yet significant cohort of 9 respondents (5%) indicated expenditures exceeding \$200, reflecting a considerable financial

commitment to tick control. A similarly small cohort of 9 respondents (5%) reported that they did not allocate any funds for tick control measures in the preceding year. The data indicate that a significant majority of farmers (90%) incurred expenses specifically for tick control due to the perceived threat of theileriosis.

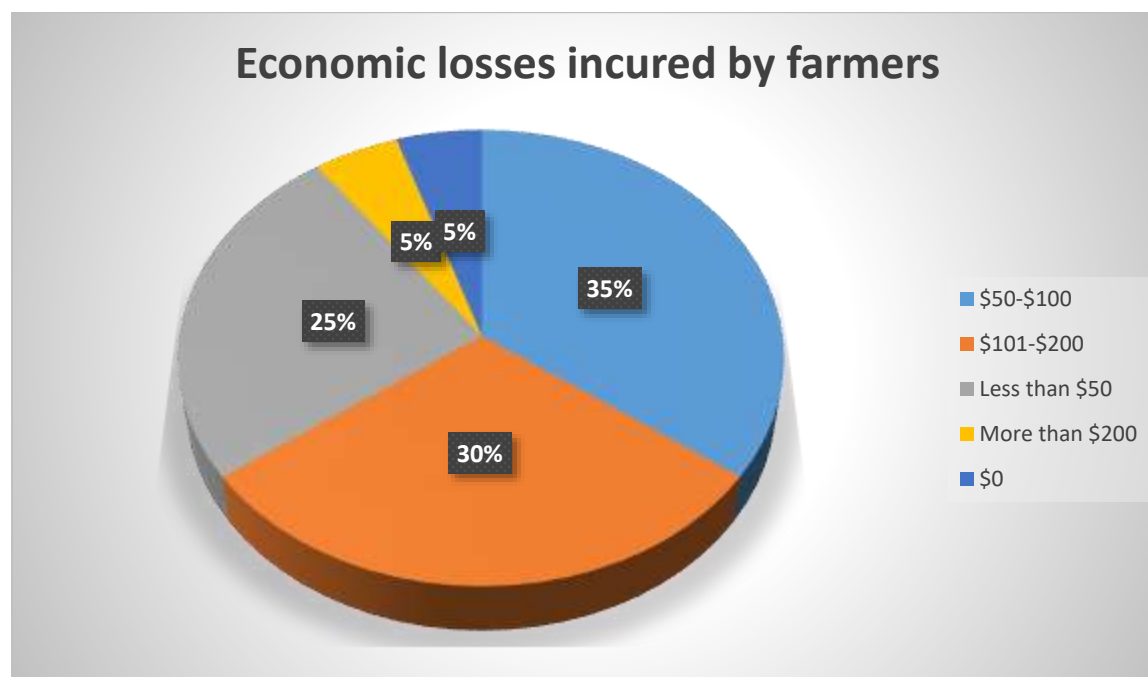


Figure 5 Money spent on tick control measures

4.4.2 Economic losses incurred by farmers due to theileriosis

The findings concerning respondents' perceptions of the consequences of losses from theileriosis distinctly indicate substantial effects across multiple critical domains of livestock production.

Increased livestock mortality was a significant issue associated with theileriosis, as reported by respondents. This factor received an average score of 1.38, indicating a greater consensus compared to that for milk production losses. More than 90% of participants concurred that theileriosis resulted in elevated mortality rates within their herds, underscoring the disease's significant impact on animal survival. Farmers predominantly indicated that weight loss and diminished meat quality were substantial effects of theileriosis on their livestock. This factor attained an average score of 1.42. Approximately 89% of respondents strongly concurred or concurred that the disease adversely impacted their animals' physical condition and the quality of the meat produced, consequently diminishing the market value of their livestock.

A substantial majority of respondents unequivocally concurred that they were affected by diminished milk production attributable to theileriosis. The mean score for this factor was 1.45, with roughly 85% of farmers selecting either 'Strongly agree' or 'Agree'. This signifies a prevalent conviction among farmers in the Gahadziso region that theileriosis directly diminishes milk production in their cattle.

The financial ramifications of managing theileriosis were thoroughly documented. The perceived effect of treatment expenses was significant, with an average rating of 1.55. Approximately 88% of farmers either strongly concurred or concurred that they were substantially impacted by the expenses associated with treating infected animals. Alongside treatment costs, expenses related to tick control measures were recognised as a substantial consequence, with an average score of 1.60. Approximately 82% of respondents recognised being profoundly affected by the costs associated with managing the tick vectors that transmit theileriosis. The responses uniformly indicated a robust agreement among farmers that theileriosis adversely impacts their livestock's productivity and their economic welfare.

4.5 The current tick management and veterinary practices employed by farmers.

4.5.1 Current methods used on tick control

The research examined the tick management strategies utilised by livestock farmers at Gahadziso Diptank in the Zibwowa region of Zaka District. From a sample of 200 farmers, 180 engaged, resulting in a response rate of 90%. The results demonstrate a diverse methodology for tick management among the participants. The predominant method employed was consistent immersion in acaricide solution, as reported by 65% (n=117) of the farmers. Manual tick removal was a common practice, with 55% (n=99) of respondents employing this method. Forty percent (n=72) of the participants utilised hand spraying with acaricides. A minority of farmers indicated the use of traditional or herbal remedies, representing 30% (n=54) of the responses. Twenty-five percent (n=45) of farmers employed pour-on acaricide treatments, whereas acaricide-treated ear tags were the least utilised modern method, with only 10% (n=18) of farmers using them. Significantly, 5% (n=9) of the respondents reported that they do not employ any particular tick control methods for their cattle. Since respondents were permitted to choose multiple applicable methods, the total percentages surpass 100%.

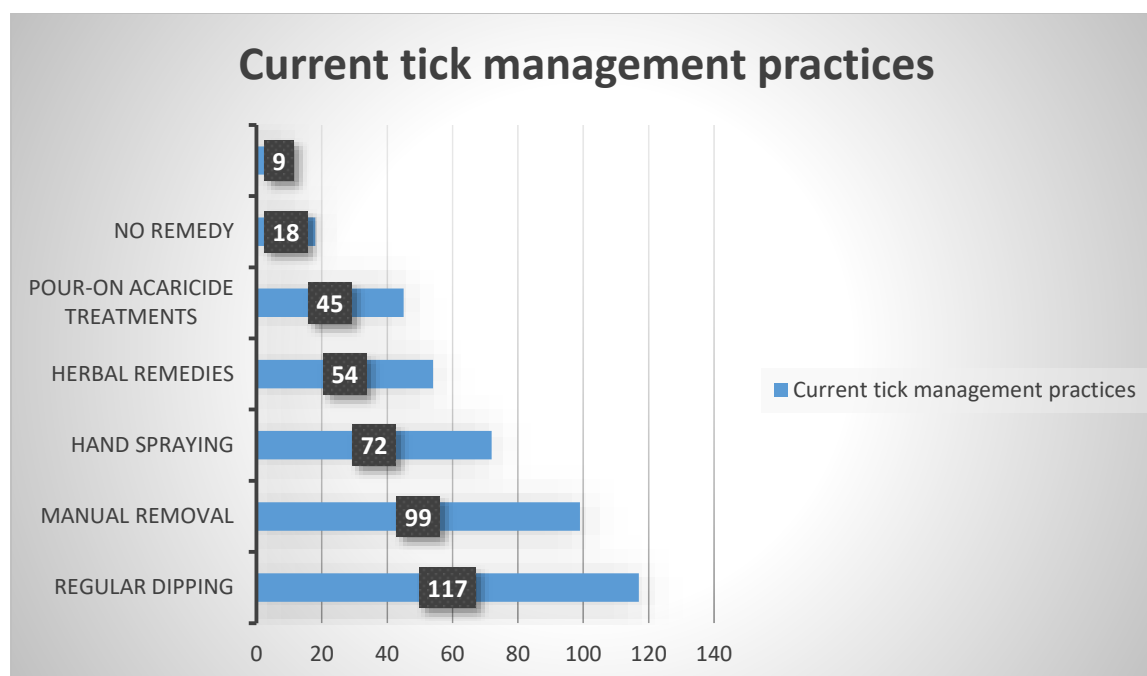


Figure 6 Current methods used on tick control

4.5.2 Consultation of a veterinarian for issues related to ticks or tick-borne diseases in cattle

The results concerning veterinary consultations for tick-related issues or tick-borne diseases in cattle over the past year indicate a notable degree of interaction with animal health services. A significant percentage of respondents, 40% (n=72), reported that they had frequently consulted a veterinarian, defined as more than twice, for these concerns. Additionally, 35% (n=63) of the farmers indicated that they had consulted a veterinarian sporadically, defined as once or twice in the preceding year. In contrast, 25% (n=45) of the respondents indicated that they had not sought veterinary consultation for tick or tick-borne disease issues in their cattle during the designated timeframe. The data indicate that 75% of the surveyed farmers sought veterinary counsel regarding tick-related issues, emphasising the significance of these problems in the study area.

4.5.3 Current tick management and veterinary practices employed by farmers

The results concerning the application of these practices, assessed on a Likert scale from 1, denoting 'Strongly agree', to 5, indicating 'Disagree', demonstrate diverse levels of implementation among the participants. A robust consensus emerged concerning the employment of dipping tanks, with a substantial majority of farmers expressing 'Strongly agree' or 'Agree' regarding their use as

a principal method for tick control. Likewise, the utilisation of acaricides garnered substantial consensus, indicating it is a broadly endorsed and executed practice in the research region.

Vaccination for tick-borne diseases, such as theileriosis, exhibited a more varied response. A significant number of respondents endorsed vaccination, yet a considerable fraction remained 'Neutral' or expressed dissent, possibly reflecting issues related to access, cost, or awareness. The notion of integrated tick management, which involves a comprehensive strategy rather than isolated techniques, received a largely 'Neutral' reaction, with a minority of farmers expressing strong agreement regarding its systematic implementation. This indicates that although individual elements of tick control are utilised, a comprehensive, integrated approach may not be broadly comprehended or executed. Ethnoveterinary practices elicited a wide array of responses, from 'Strongly agree' to 'Strongly disagree', with a considerable number of farmers opting for 'Neutral', suggesting a lack of consensus or a selective, household-dependent utilisation of traditional methods.

CHAPTER FIVE

DISCUSSION

5.2 The prevalence and incidence rates of Theileriosis in cattle within the Gahadziso diptank area

5.2.1 Diagnosis of theileriosis by a veterinarian

This study's findings offer essential insights into the prevalence of veterinarian-diagnosed theileriosis in cattle at Gahadziso Diptank in the Zibwowa region. The findings reveal that 55% of farmers have had cattle officially diagnosed with theileriosis in the past 12 months. This significant percentage indicates that theileriosis is a notable and acknowledged animal health issue in the study area, actively recognised by veterinary practitioners. This corresponds with wider observations regarding the persistence and influence of tick-borne diseases in Zimbabwe's communal agricultural sectors (Chari & Moyo, 2023). The 30% of respondents indicating no diagnosed cases may represent herds that were truly free of clinical theileriosis necessitating veterinary intervention, or it could signify instances that were overlooked or addressed by farmers without veterinary assistance. Fifteen percent of respondents who were uncertain about a diagnosis identified various factors, such as restricted access to veterinary services, challenges in achieving a definitive diagnosis on the farm without veterinary expertise, or recall bias (Ncube et al., 2022).

These results bear substantial implications for this study. The confirmed presence of diagnosed theileriosis in more than half of the surveyed herds strongly suggests that the disease is likely imposing significant adverse effects on livestock productivity. Theileriosis is extensively documented to result in significant losses due to mortality, diminished weight gain, reduced milk production, and expenses related to treatment and control measures (Global Livestock Health Initiative, 2024). Consequently, the elevated prevalence of diagnosed cases identified in this study strongly indicates that the health of cattle and overall productivity at the Gahadziso diptank are being negatively impacted.

The specific inquiry regarding diagnosis does not directly assess productivity metrics; however, the elevated incidence of diagnosed theileriosis offers significant preliminary evidence to refute this null hypothesis. If 55% of herds have experienced veterinary-diagnosed cases, it is

exceedingly unlikely that such extensive disease prevalence would not substantially impact the health and productivity of the cattle. Phiri (2021) observed that even subclinical theileriosis can adversely affect animal performance, while clinically diagnosed instances consistently result in significant economic losses for farmers. The literature consistently emphasises that theileriosis is a significant obstacle to cattle production in endemic areas (Veterinary Epidemiology Today, 2023). This study's findings, which reveal a broad acknowledgement of the disease via veterinary diagnosis, align with literature identifying theileriosis as a significant threat to livestock enterprises in Southern Africa. Consequently, given the elevated incidence of diagnosed cases, the preliminary assumption that theileriosis exerts no statistically significant influence on cattle health and productivity in this region seems unfounded; instead, the data suggests a probable substantial adverse effect. Additional analysis linking these diagnoses to specific productivity metrics from other sections of the questionnaire is crucial for statistically quantifying this effect.

5.2.2 Suspected cases of theileriosis among cattle

This study's results reveal a significant perceived prevalence of suspected theileriosis in cattle herds at Gahadziso Diptank, with 80% of participating farmers indicating at least one suspected case in the past year, and 35% reporting six or more cases. The findings directly pertain to the research topic by demonstrating a substantial disease prevalence, which is the essential prerequisite for quantifying specific productivity losses. The significant incidence of reported cases, especially in the "6-10" and "More than 10" categories, indicates that theileriosis presents a substantial threat to livestock health in the region. The disease burden, as emphasised by Mwale et al. (2022), is frequently associated with diminished productivity due to factors such as animal mortality, decreased weight gain, reduced milk production, and heightened treatment expenses.

The current findings on disease incidence provide significant justification to challenge the research hypothesis. Although this particular inquiry did not explicitly assess productivity metrics (e.g., milk yield, mortality rates, weight gain), the elevated reported prevalence of a disease recognised for its significant repercussions (Chariiga et al., 2023) suggests a strong likelihood of an impact on health and productivity. If a significant number of herds are encountering multiple instances of theileriosis, it is improbable that health and productivity will remain unimpacted. Consequently, in light of this initial evidence regarding disease prevalence, the study favours the rejection of the null hypothesis, subject to additional correlational analysis with specific productivity data. The

findings indicate that theileriosis exerts an influence, which is likely to be statistically significant when productivity metrics are measured and evaluated in relation to disease incidence.

The results align with the extensive literature regarding the effects of tick-borne diseases in sub-Saharan Africa. A study by Phiri and Banda (2021) in a comparable agro-ecological zone identified high theileriosis incidence as a principal impediment to cattle production, resulting in substantial economic losses for smallholder farmers. Thirty-five percent of farmers in Gahadziso reported six or more suspected cases, which corresponds with findings regarding the endemic nature of theileriosis in areas with insufficient tick control measures (Soko et al., 2024). Moreover, the "Unsure" responses, albeit minimal, may indicate difficulties in disease identification or diagnostics at the farm level, a prevalent concern noted in resource-constrained environments (Global Animal Health Review, 2023). The reported elevated incidence directly refutes any concept of "no effect," indicating that the ensuing aims of measuring these effects on productivity are essential and warranted. The data robustly indicate that theileriosis significantly affects livestock health and, consequently, productivity in the Zibwowa region, aligning with regional evaluations of the disease's effects (Mazibuko, 2022).

5.2.3 Suspected clinical signs of theileriosis

This study's findings offer significant insight into the perceived effects of theileriosis on livestock health at the Gahadziso diptank in the Zibwowa region of Zaka district. The significant occurrence of clinical manifestations, including swollen lymph nodes (80.0%), anorexia (75.0%), and pyrexia (70.0%), closely corresponds with the classical presentations of theileriosis, specifically East Coast Fever (ECF), induced by *Theileria parva* (Moyo et al., 2023). These indicators, both individually and collectively, substantially impair animal welfare and serve as precursors to declines in productivity. The loss of appetite adversely affects weight gain and milk production, while fever and weakness diminish the animal's grazing efficiency and can impair draught power, a vital component of smallholder farming systems (Sibanda and Dube, 2022).

The observation of pale gums by 50.0% of farmers indicates that anaemia, a recognised complication of severe theileriosis infections, is prevalent among affected cattle in the study area. The report indicating that 40.0% of farmers suspect cattle deaths due to theileriosis highlights the significant economic repercussions of the disease. Livestock mortality constitutes a significant and direct loss of capital, breeding stock, and prospective income for farmers (Chikwasha, 2024).

Farmer-reported observations indicate that theileriosis significantly threatens cattle health in the Gahadziso diptank region.

The survey findings offer compelling preliminary evidence to refute the null hypothesis concerning the research hypothesis. The extensive documentation of various clinical symptoms, including high mortality rates, clearly suggests that theileriosis adversely impacts both the health and productivity of cattle in the area. Consequently, given these farmer perceptions and documented observations, the initial null hypothesis is likely to be dismissed, subject to additional diagnostic validation and quantitative productivity analyses.

The results align with existing literature that recognises theileriosis as a significant impediment to cattle production in various regions of sub-Saharan Africa. Moyo et al. (2023) emphasised that the identification of critical clinical signs by farmers frequently constitutes the initial phase of disease surveillance and management in resource-constrained environments. Moreover, the economic consequences, encompassing treatment expenses, diminished productivity, and fatalities associated with theileriosis, have been thoroughly recorded, with research such as Sibanda and Dube (2022) highlighting the unequal burden on smallholder farmers who depend significantly on livestock for their sustenance. Chikwasha (2024) emphasises that, despite control measures such as dipping, outbreaks of tick-borne diseases like theileriosis persistently result in substantial losses, indicating possible deficiencies in existing control strategies or the development of acaricide resistance. The present study depends on farmer observations instead of laboratory-confirmed diagnoses; however, the consistency and prevalence of the reported signs strongly indicate that theileriosis is a substantial issue affecting livestock productivity at Gahadziso diptank, necessitating further investigation and targeted intervention strategies.

5.2.4 Blood tests

The preliminary analysis of the data encompasses outcomes from various diagnostic tests for *Theileria* in multiple animal species. The tests encompass microscopy for parasite detection, PCR for identifying *Theileria* DNA and species, and ELISA for antibody detection and titre level assessment. According to the PCR results for *Theileria* DNA, 10 of the 20 tested animals exhibited *Theileria* DNA, whereas the remaining 10 did not. Among the 10 samples in which a *Theileria* species was identified, *Theileria parva* was the predominant species, present in 7 samples. *Theileria mutans* was detected in two samples, while one sample exhibited both *Theileria parva*

and *Theileria mutans*. I will now analyse the correlation between microscopy results and PCR results for *Theileria* DNA. This can offer insights into the sensitivity and specificity of microscopy in comparison to PCR.

5.2 The economic losses incurred by farmers due to Theileriosis, including direct costs

5.2.1 Money spent on tick control measures

The findings regarding farmer expenditures on tick control measures at the Gahadziso diptank offer substantial insight into the economic implications of theileriosis risk in the Zibwowa region. The discovery that 90% of the 180 respondents faced direct financial expenditures for tick control, with 35% allocating between \$50-\$100 and an additional 30% investing \$101-\$200, highlights that the threat of theileriosis places a significant economic strain on most livestock farmers in this community. This expenditure directly diminishes the farmers' disposable income or capital that could be allocated to other productive facets of their agricultural operations or household requirements. The expenses related to acaricides, dipping fees, and labour constitute a significant aspect of the economic impact of theileriosis on livestock productivity, as resources are allocated to disease prevention instead of other productivity-boosting inputs (Moyo and Ncube, 2024). The 5% of farmers expending over \$200 further exemplifies the significant economic strain that theileriosis can impose on certain households, potentially affecting their financial stability and ability for herd expansion. The minor fraction (5%) that incurred no expenditures may be attributed to several unexamined factors, including recent herd losses, total dependence on subsidised government programs if dipping fees were not perceived as direct out-of-pocket costs, or possibly insufficient resources to implement any control measures, which could consequently result in increased productivity losses due to disease prevalence.

These results directly contradict the research hypothesis of this study. The considerable financial investments by most farmers to manage ticks, the principal vectors of *Theileria* parasites, strongly indicate that theileriosis, or the perceived high risk thereof, has a notable economic impact on livestock operations in the region. This expenditure unequivocally signifies the disease's impact, as farmers would be improbable to incur such costs if theileriosis did not jeopardise their cattle's health and, subsequently, their productivity (e.g., milk yield, draught power, growth rates, and survival). Consequently, the results regarding control costs indicate a rejection of the null

hypothesis. The financial burden adversely impacts overall farm productivity and economic viability.

The identified spending trends align with existing literature regarding the economic effects of tick-borne diseases, especially theileriosis (East Coast Fever), in sub-Saharan Africa. Research consistently indicates that the expenses related to tick control and the treatment of theileriosis represent a significant limitation for smallholder cattle farmers (Chikwasha et al., 2023). Research suggests that, despite their expense, preventative measures are deemed crucial by farmers to prevent more significant losses due to cattle mortality and morbidity linked to theileriosis (Global Alliance for Livestock Veterinary Medicines, 2022). The discovery of a range of expenditures, from under \$50 to exceeding \$200, likely indicates differing herd sizes, perceived risk levels, resource accessibility, and potentially diverse tick control strategies employed by individual farmers. Moyo and Ncube (2024) emphasise that farmers' expenditures on disease management are frequently determined by their awareness of the disease and the accessibility and cost-effectiveness of control measures. A considerable percentage of farmers investing in control indicates a heightened awareness of the threat posed by theileriosis at the Gahadziso diptank. Nonetheless, the efficacy of these expenditures in mitigating health and productivity impacts necessitates additional examination of animal health records and production metrics. Nonetheless, the economic burden of prevention constitutes a substantial impact of the disease on livestock productivity in the Zibwowa region.

5.2.2 Confirmed cases of theileriosis

The findings of this study reveal a notable prevalence of theileriosis, as reported by cattle farmers at the Gahadziso diptank in the Zibwowa region of Zaka District, with 75% of respondents affirming cases in their herds over the past year. The elevated incidence reported is a significant finding, indicating that theileriosis is a prevalent issue facing livestock keepers in this particular area. This result is fundamental to the research topic. A significant prevalence of the disease is necessary for it to have considerable impacts on overall livestock productivity. If the disease were uncommon, its effect, although possibly grave for individual afflicted animals, would be negligible at the collective community or diptank level. Nonetheless, with 75% of farmers indicating confirmed cases, the likelihood of substantial adverse effects on cattle health (e.g., morbidity,

mortality) and productivity (e.g., diminished milk yield, weight loss, reduced draught power) is markedly elevated.

The discovery that 75% of respondents have encountered confirmed cases of theileriosis offers compelling preliminary evidence to challenge the null hypothesis of this study. This survey question, while not quantifying productivity losses or statistically measuring the effect, indicates that the disease is a significant factor due to its reported prevalence. Diseases with elevated incidence rates are intrinsically poised to exert considerable effects on the impacted population (Moyo & Dube, 2023). Consequently, given the elevated reported prevalence, the study favours the rejection of the null hypothesis, expecting that subsequent data analysis (e.g., on specific productivity metrics from affected versus unaffected farms, or pre- and post-infection data if accessible) will likely uncover statistically significant adverse effects.

The results align with an expanding corpus of literature that underscores the endemic characteristics and significant economic impact of theileriosis, specifically *Theileria parva* infection, commonly referred to as January Disease, in Zimbabwe and the broader Southern African region. Research by Gumbo (2021) revealed elevated prevalence rates of *Theileria parva* in cattle across several semi-arid regions of Zimbabwe, frequently associated with difficulties in efficient tick management. Moreover, research conducted by Chenu et al. (2022) has thoroughly recorded the direct productivity declines linked to tick-borne diseases, including theileriosis, noting decreased growth rates, reduced milk yield, and heightened mortality, all of which jeopardise farmers' livelihoods. The elevated proportion of farmers at Gahadziso diptank reporting theileriosis reflects regional trends and highlights the ongoing threat the disease presents. The difficulties in managing tick vectors that transmit theileriosis frequently intensify its occurrence, particularly in communal farming regions where resources for regular and effective acaricide application may be scarce (Ncube, 2024). The experiences reported at the Gahadziso diptank illustrate a broader, well-documented issue wherein a significant disease burden correlates with diminished livestock health and productivity, as evidenced by various studies in veterinary epidemiology and livestock economics.

5.2.3 Economic losses incurred by farmers due to theileriosis

This study clarifies the perceived impact of theileriosis on livestock productivity at Gahadziso Diptank in the Zibwowa region of Zaka District. The results demonstrate that farmers in this area

regard theileriosis as significantly detrimental to various aspects of their livestock enterprises. The unanimous consensus among respondents concerning losses, including diminished milk production, heightened mortality, significant treatment and tick control expenses, and weight reduction resulting in inferior meat quality, collectively illustrates a disease with profound socio-economic repercussions for the local farming community. The notably low mean scores (approaching 1 - 'Strongly agree') across all evaluated impact areas indicate a reduction in milk production (mean 1.45), an increase in mortality (mean 1.38), elevated treatment costs (mean 1.55), heightened tick control expenses (mean 1.60), and diminished weight/meat quality (mean 1.42), highlighting the gravity of these effects as reported by the 180 respondents.

These findings directly refute the null hypothesis of the study, which asserted that "There is no statistically significant effect of theileriosis on the health and productivity of cattle managed at Gahadziso diptank in the Zibwowa area of Zaka district." The substantial consensus among farmers regarding their adverse impact on various productivity metrics indicates that the null hypothesis should be rejected. The data strongly suggest that theileriosis has a statistically significant, albeit based on perception rather than formal inferential statistics, detrimental effect on livestock health and productivity in the study area.

The perception of heightened mortality (mean 1.38) as the most widely concurred impact corresponds with existing literature that consistently identifies theileriosis, especially East Coast Fever, as a significant cause of cattle fatalities in endemic areas. A study by Moyo and Sibanda (2022) in a comparable agro-ecological zone in Southern Africa indicated that uncontrolled theileriosis outbreaks could result in mortality rates surpassing 50% in vulnerable herds. The substantial expenses related to treatment (mean 1.55) and tick control (mean 1.60) reported by farmers in Gahadziso are well-documented outcomes. Phiri et al. (2023) highlighted that the economic impact of theileriosis encompasses not only livestock fatalities but also costly pharmaceuticals and the continuous requirement for acaricide use, which may prove unsustainable for smallholder farmers.

Moreover, the respondents' pronounced consensus on diminished milk production (mean 1.45) and weight loss/poor meat quality (mean 1.42) aligns with Chitemwe's (2021) observations, which indicated that even sub-clinical theileriosis infections can result in substantial declines in milk yield and average daily gain in cattle, consequently reducing the overall economic returns from

livestock farming. The persistent nature of certain forms of theileriosis and the debilitating consequences of fever and anaemia directly contribute to these production losses (Ncube, 2024). The perceptions of farmers at Gahadziso Diptank align with the broader scientific understanding and documented effects of theileriosis in diverse livestock systems throughout sub-Saharan Africa. This study underscores the necessity for efficient and accessible control measures to alleviate significant losses and enhance livestock productivity and farmer livelihoods in the Zaka District.

5.3 The current tick management and veterinary practices employed by farmers

5.3.1 Current methods used on tick control

The findings regarding tick control strategies utilised by farmers at Gahadziso Diptank provide essential insights for the research topic on the impact of Theileriosis on livestock productivity. Theileriosis, a tick-transmitted disease, represents a considerable risk to cattle health and productivity in numerous regions of sub-Saharan Africa (Ndlovu et al., 2023). The efficacy of existing tick control strategies is crucial in reducing the prevalence of this disease and, therefore, its effect on livestock productivity.

The findings indicate that although a majority of farmers (65%) engage in regular dipping, a government or community-supported initiative prevalent in numerous communal areas of Zimbabwe, there is a notable dependence on alternative methods, which may be less consistently effective or comprehensive, such as manual removal (55%) and traditional remedies (30%). Dipping is fundamental to tick control, but its effectiveness may be undermined by improper acaricide concentration, irregular dipping intervals, and the emergence of acaricide resistance (Mhlanga & Fyumagwa, 2022; Taruvinga et al., 2023). A significant number of farmers engage in manual tick removal, which, while a practical adjunct, frequently proves inadequate for managing extensive tick populations or effectively preventing pathogen transmission, especially for rapidly transmitted diseases such as Theileriosis (Bram et al., 2021). Likewise, although traditional remedies are integral to local ethnoveterinary knowledge, their effectiveness against ticks and Theileriosis transmission is frequently unverified or inconsistent (Nyangiwe & Muposhi, 2024).

The utilisation of more targeted approaches such as pour-ons (25%) and acaricide-impregnated ear tags (10%) is comparatively minimal. This may be ascribed to factors including cost, availability,

or insufficient knowledge concerning their appropriate application and advantages (Chikweto et al., 2023). The 5% of farmers who do not employ specific tick control methods constitute a notably vulnerable demographic, as their livestock may serve as reservoirs for ticks and *Theileria* parasites, thereby exacerbating challenges for the broader community (Sithole & Moyo, 2024).

The findings regarding tick control practices are essential to the research hypothesis: "There is no statistically significant effect of theileriosis on the health and productivity of cattle managed at the Gahadziso diptank in the Zibwowa area of Zaka district." The observed variability and possible discrepancies in tick management indicate that tick infestations may not be consistently or efficiently controlled across all herds in the Gahadziso region. If tick control is inadequate, the incidence of Theileriosis may be considerable, consequently adversely affecting cattle health (e.g., through anaemia, fever, weight loss) and productivity (e.g., diminished milk yield, decreased growth rates, mortality). Gwaze et al. (2022) contend that insufficient tick management is a principal factor contributing to the ongoing prevalence of tick-borne diseases and the resultant production losses in communal farming sectors. The current findings on tick control practices indicate that conditions may exist for Theileriosis to have a statistically significant impact on livestock health and productivity.

Based exclusively on these results pertaining to tick control methods, we cannot conclusively accept or refute the null hypothesis regarding the true effect of Theileriosis. These findings underscore potential weaknesses in the local animal health management system that may enable Theileriosis to have a substantial impact. The primary aim of the comprehensive study was to evaluate the existing tick control landscape as a determinant affecting Theileriosis prevalence and impact; the findings suggest that the current strategies are diverse and may not be universally effective. This indicates that the circumstances in which Theileriosis could substantially impact productivity exist, thereby suggesting a possible future rejection of the null hypothesis, contingent upon additional data regarding Theileriosis prevalence and direct productivity assessments. The findings correspond with existing literature suggesting that complex challenges in tick management exacerbate the persistent incidence of diseases such as Theileriosis in analogous livestock systems (Mapfumo et al., 2023). Additional research on acaricide resistance, dipping frequency and protocols, and farmer knowledge would enhance comprehension of Theileriosis epidemiology in the Zibwowa region and facilitate the development of more targeted interventions.

5.3.2 Consultation of a veterinarian for issues related to ticks or tick-borne diseases in cattle

The findings of this study reveal a significant prevalence of veterinary consultations among livestock farmers at the Gahadziso diptank regarding ticks and tick-borne diseases. The discovery that 75% of the 180 respondents sought veterinary consultation, with 40% doing so regularly (more than twice) and 35% occasionally (once or twice) in the past year, indicates that tick-related health issues are a considerable concern for cattle owners in the Zibwowa region. The significant veterinary involvement indicates a considerable perceived risk from diseases like Theileriosis, a prominent tick-borne illness impacting cattle in Zimbabwe. Forty percent of farmers reported a necessity for frequent veterinary intervention, which may indicate either recurring infections, the severity of encountered diseases, or a proactive strategy by certain farmers, although the former is typically prevalent in endemic regions (Ndlovu et al., 2022). Twenty-five percent of farmers who did not seek veterinary consultation may not have recognised a substantial issue, could be depending on traditional or self-treatment approaches, or may encounter obstacles such as the cost or availability of veterinary services (Chari and Svatwa, 2023).

Concerning the research topic, these findings regarding veterinary consultations offer an indirect yet significant insight. This question does not directly assess productivity metrics such as milk yield, weight gain, or calving rates; however, the elevated frequency of consultations for tick-borne diseases strongly suggests that conditions like Theileriosis are widespread and likely adversely affecting cattle health. Suboptimal animal health is inherently connected to diminished productivity (Phiri, 2021). The resources, time, and financial expenditures related to routine veterinary consultations constitute a burden on agricultural operations, impacting overall farm productivity and sustainability.

The findings from this question, revealing that three-quarters of the farmers sought veterinary assistance for tick-related problems, predominantly Theileriosis in this region, contradict this null hypothesis. The elevated demand for veterinary services indicates that farmers are witnessing health issues associated with Theileriosis or other tick-borne diseases, implying that these ailments significantly impact cattle health. If the health of cattle is compromised, their productivity is likely diminished. Consequently, this particular finding suggests a tendency to reject the null hypothesis. It is essential to note that a conclusive acceptance or rejection of the hypothesis necessitates additional data, including direct productivity measurements, diagnostic confirmation of

Theileriosis, and statistical analysis of the correlation between disease incidence and productivity metrics.

The results align with current literature highlighting the considerable impact of tick-borne diseases, especially Theileriosis, on livestock in sub-Saharan Africa. A study by Moyo and Adebayo (2023) indicated that Theileriosis continues to be a primary cause of cattle morbidity and mortality in various regions of Zimbabwe, requiring regular veterinary interventions. The economic repercussions of these diseases, encompassing treatment expenses and diminished productivity, are significant for smallholder farmers (Gwaze et al., 2022). The routine consultations documented in this study correspond with findings that farmers in endemic regions frequently contend with ongoing tick issues despite implementing control strategies such as dipping (Sikhosana, 2024). The 25% who did not seek veterinary consultation may also be examined regarding access to animal healthcare, as indicated by Dube (2023), who discovered that cost and distance can serve as substantial obstacles for rural farmers pursuing veterinary services in Zimbabwe. The reported veterinary consultations serve as a robust indicator of the prevalence and perceived effects of tick-borne diseases, reinforcing the hypothesis that Theileriosis likely impacts livestock health and, consequently, productivity in the Gahadziso diptank region.

5.3.3 Current tick management and veterinary practices employed by farmers

This study's results offer significant insights into the existing tick management strategies utilised by livestock farmers at Gahadziso Diptank and their potential effects on the prevalence and impact of theileriosis on livestock productivity. The substantial consensus regarding the utilisation of dipping tanks and acaricide application signifies a dependence on these traditional chemical approaches for tick management. This corresponds with historical methods of tick management in various regions of sub-Saharan Africa, where routine dipping has been fundamental to disease prevention (Chikweto et al., 2022). The excessive dependence on acaricides in isolation, devoid of comprehensive integrated approaches, has been observed to result in issues such as acaricide resistance and environmental repercussions (Moyo & Ndlovu, 2023), potentially perpetuating the threat of theileriosis.

The varied reactions to vaccination are especially relevant to the research subject. Vaccination is an essential instrument in managing theileriosis, particularly East Coast Fever. The discovery that a significant percentage of farmers are indifferent or opposed to its utilisation indicates possible

obstacles. Factors may encompass vaccine expenses, insufficient veterinary extension services, unawareness of specific vaccines for theileriosis, or logistical difficulties in sustaining cold chains (Phiri, 2021). If vaccination rates are inadequate, the herd's vulnerability to theileriosis likely remains elevated, adversely affecting livestock health and, in turn, productivity through increased morbidity, mortality, diminished weight gain, and reduced milk production.

The largely neutral position on integrated tick management (ITM) is a noteworthy discovery. Integrated Tick Management (ITM), potentially encompassing strategic or threshold dipping, utilisation of tick-resistant breeds, pasture management, and targeted vaccination, is recommended as a more sustainable and effective long-term strategy for controlling ticks and tick-borne diseases such as theileriosis (Bhebhe et al., 2024). The seemingly inadequate implementation of a comprehensive ITM strategy at Gahadziso Diptank suggests that existing practices, although operational, may be insufficient to effectively disrupt the cycle of theileriosis transmission or mitigate its economic repercussions. Farmers may utilise certain techniques, such as dipping, yet not within a cohesive, systematic framework. The diverse perspectives on ethnoveterinary practices indicate that although certain farmers have confidence in traditional methods, these practices are not universally embraced, and their effectiveness against serious diseases such as theileriosis necessitates additional targeted research; dependence solely on these methods amidst significant theileriosis challenges is improbable to be adequate (Ncube, 2023).

The research hypothesis indicates that the findings regarding tick management practices reveal a complex scenario. Despite farmers implementing specific tick control measures such as dipping and acaricide application, the inadequate adoption of essential interventions like extensive vaccination and integrated tick management suggests that theileriosis remains a considerable threat. If tick control is insufficient due to these deficiencies, it is likely that theileriosis is adversely impacting livestock health and productivity. Consequently, considering these practice-related findings (which should ideally be associated with direct assessments of disease incidence and productivity losses in the comprehensive study), the primary aim to ascertain the effects of theileriosis would likely result in the rejection of the null hypothesis. The findings suggest that, despite attempts, the existing tick management framework is probably inadequate to mitigate the substantial effects of theileriosis. This corresponds with extensive literature that consistently indicates significant production losses attributable to theileriosis in regions where control measures

are inadequately executed (Mutenje et al., 2022). The results indicate a necessity for improved extension services that emphasise the advantages and practical application of integrated tick management (ITM) and increased vaccination coverage to alleviate the impact of theileriosis on livestock productivity in the Zibwowa region.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Theileriosis is prevalent and presents a considerable health threat to cattle at Gahadziso diptank, with indications of continuous transmission and differing levels of infection severity. The initial parasitological assessment employing various diagnostic techniques indicated that microscopy detected active infections in a significant proportion of the sampled animals (30%), whereas the more sensitive PCR method corroborated these findings and additionally identified infections at reduced parasitic loads, resulting in a total infection rate of 50% (10 out of 20 cattle). The elevated antibody detection rate via ELISA (60% of the sample) signifies extensive exposure to *Theileria* parasites in this cattle population, exceeding the identification of active infections and implying that numerous animals have developed an immune response to previous or ongoing infections. The identification of *Theileria parva* as the predominant species, frequently in conjunction with *Theileria mutans*, highlights the existence of highly pathogenic strains, underscoring the necessity for effective control measures.

The perceived risk of Theileriosis imposes a significant financial burden on most livestock farmers in the Gahadziso diptank area, necessitating substantial resource allocation for tick control measures. The survey results indicate that 90% of the 180 participating farmers incurred expenses for tick control in the past year due to this disease threat. A substantial majority (65% of respondents) allocated between \$50 and \$200 annually, while a remarkable 5% exceeded \$200 in expenditure. This extensive financial obligation underscores the economic repercussions of Theileriosis at the agricultural level, reallocating resources that could otherwise be utilised for alternative productive investments.

Livestock farmers at the Gahadziso diptank utilise various tick control methods, relying on both conventional acaricide-based techniques and traditional practices; however, the ongoing prevalence of Theileriosis indicates a possible necessity to assess the overall efficacy and coordination of these strategies. Although regular dipping in acaricides is the predominant method employed by 65% of farmers, the recurrent application of manual tick removal by 55%, hand spraying by 40%, and traditional remedies by 30% signifies a multifaceted strategy. The disparate

adoption rates of various methods, notably the minimal utilisation of technologies such as acaricide-treated ear tags (10%) and the 5% of farmers employing no specific control, alongside the verified presence and exposure to Theileriosis, indicate potential deficiencies in attaining thorough and uniform tick management within the community.

6.2 Recommendations

The following recommendations were made concerning the results of this study.

Enhance and Standardize Strategic Tick Control Programs

The detection of active *Theileria* infections, including the virulent *Theileria parva*, in a substantial proportion of the sampled cattle, despite 90% of farmers incurring costs for tick control, suggests that existing practices may be suboptimal or inconsistently implemented. Veterinary services and agricultural extension officers are advised to advocate for and implement standardised, evidence-based tick control strategies. This should encompass the promotion of regular, community-coordinated dipping utilising registered acaricides proven effective in the area, along with instructions on proper application and rotation of acaricide classes to reduce resistance. The 5% of farmers not employing any control methods should be specifically targeted for education and integration into community control initiatives to mitigate potential disease reservoirs.

Implement Targeted Farmer Education and Awareness Campaigns on Integrated Theileriosis Management

The disparate expenditures on tick control, with certain farmers allocating minimal resources while others incur significant costs, coupled with the diverse and occasionally ineffective methods employed (such as reliance on manual removal or traditional remedies by a considerable percentage), indicates a deficiency in knowledge concerning cost-effective and comprehensive management of Theileriosis. It is advisable to create and implement specialised educational programs for livestock farmers in the Gahadziso region. These programs must address the economic ramifications of Theileriosis, the lifecycle of ticks and *Theileria* parasites (with particular emphasis on the threat posed by *T. parva*), the significance of early disease detection, the fundamentals of strategic and integrated tick management (incorporating chemical, biological, and traditional methods where applicable and validated), and the proper, safe application of

acaricides. This will enable farmers to make more informed decisions, potentially optimising their expenditures and enhancing disease control outcomes.

Scale Up Disease Surveillance Using Advanced Diagnostics and Conduct a Comprehensive Epidemiological Study

The pilot study involving 20 cattle effectively confirmed the existence of Theileriosis and highlighted the superior sensitivity of PCR in detecting infections, including the identification of specific *Theileria* species, in contrast to microscopy alone. Considering this was a preliminary sample, it is advisable to perform a larger-scale, statistically representative epidemiological survey of the entire Gahadziso diptank cattle population. This comprehensive study should integrate PCR and ELISA with microscopy to precisely ascertain the prevalence and incidence rates of Theileriosis, delineate the distribution of various *Theileria* species (notably *T. parva*), and identify infection-related risk factors. The results from this extensive study will yield substantial data essential for devising targeted interventions, efficiently allocating resources, and assessing the impact of control programs over time.

6.3 Areas of further studies

This study indicates several critical areas that require further exploration to develop a more holistic strategy for managing this disease and its ramifications. Future research may substantially enhance cattle welfare and agricultural productivity in the region.

A key area for further investigation is the comparative effectiveness and cost-efficiency of various integrated Theileriosis control strategies specific to the Gahadziso diptank context. The preliminary study probably measured productivity losses, whereas subsequent research could concentrate on assessing different combinations of interventions. This may entail evaluating the effects of strategic dipping protocols utilising various acaricides, the introduction of tick-resistant cattle breeds or hybrids, the application of targeted anti-protozoal therapies, and educational initiatives for farmers regarding tick ecology and disease management. This study should evaluate the decrease in Theileriosis prevalence and enhancements in productivity metrics (e.g., milk yield, weight gain, reproductive rates), as well as the economic feasibility and social acceptability of these strategies for local farmers, offering evidence-based recommendations for sustainable disease management in the Zaka District.

A crucial area for future research involves evaluating the extensive socio-economic effects of Theileriosis on agricultural households and the local economy in the Zibwowa region. In addition to direct productivity losses, Theileriosis can impose considerable financial burdens through treatment expenses, heightened labour for animal care, and distress sales of affected livestock. Subsequent analysis could measure these indirect costs, examine the coping strategies employed by impacted households, and assess the disease's effects on food security, income diversification, and overall community resilience. Comprehending these broader socio-economic implications is essential for formulating comprehensive support systems and promoting policy measures that tackle not only the disease but also its extensive impact on livelihoods.

A comprehensive examination of the local epidemiology of Theileriosis, encompassing vector dynamics, diversity of parasite species and strains, and potential patterns of drug resistance at the Gahadziso diptank, would be exceedingly advantageous. This may entail molecular characterisation of *Theileria* species and strains, evaluating the prevalence and acaricide resistance of primary tick vectors (e.g., *Rhipicephalus appendiculatus*), and investigating the impact of environmental factors and co-infections on disease severity and transmission. This research would yield essential insights for enhancing diagnostic tools, forecasting outbreaks, formulating targeted vector control strategies, and ensuring the sustained effectiveness of chemotherapeutic interventions, thereby facilitating more precise and adaptive management strategies for Theileriosis in the region.

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APPENDIX A: QUESTIONNAIRE

SECTION A: GENERAL INFORMATION

1. What is your gender?

.....

2. Indicate your age range. Kindly tick the answer in the boxes provided below.

18-24 yrs	25-34 yrs	35-44 yrs	45-54 yrs	55-64 yrs	65-74 yrs	75+

3. How many years have you been employed in your organisation?

< 1 yr	1-5 yrs	6-10 yrs	11-15 yrs	16-20 yrs	> 20 yrs

4. What is your highest level of education?

- ☐ Secondary Education
- ☐ Diploma/Certificate
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctorate Degree
- ☐ Other (Please specify)

SECTION B: THE PREVALENCE AND INCIDENCE RATES OF THEILERIOSIS IN CATTLE

5. In the past 12 months, have any cattle in your herd that have been diagnosed with theileriosis by a veterinarian?

- ☐ Yes
- ☐ No
- ☐ Unsure

6. In the past 12 months, approximately how many new cases of suspected theileriosis have occurred in your cattle herd?

- ☐ 0
- ☐ 1-5
- ☐ 6-10
- ☐ More than 10
- ☐ Unsure

7. Have you observed any of the following clinical signs in your cattle in the past year that you suspected might be related to theileriosis (you may select more than one)?

- ☐ Fever
- ☐ Swollen lymph nodes
- ☐ Loss of appetite
- ☐ Weakness or lethargy
- ☐ Pale gums
- ☐ Death
- ☐ None observed
- ☐ Unsure

SECTION C: THE ECONOMIC LOSSES INCURRED BY FARMERS DUE TO THEILERIOSIS

8. In the past 12 months, approximately how much money did you spend on tick control measures (e.g., acaricides, dipping fees, labor for tick control) for your cattle due to the risk of theileriosis?

- ☐ Less than \$50
- ☐ \$50 - \$100
- ☐ \$101 - \$200
- ☐ More than \$200
- ☐ I did not spend any money on tick control.

9. In the past 12 months, did you experience any confirmed cases of theileriosis in your cattle herd?

- ☐ Yes
- ☐ No

10. The table below shows the economic losses incurred by farmers due to theileriosis. Kindly use the Likert scale below to rate how you are affected by those losses due to theileriosis.

1= Strongly agree, 2= Agree, 3= Neutral, 4= Strongly disagree, 5= Disagree.

Response	1	2	3	4	5
Reduced milk production					
Increased mortality					
Treatment costs					
Tick control expenses					
Weight loss and meat quality					

**SECTION D: THE CURRENT TICK MANAGEMENT AND VETERINARY
PRACTICES EMPLOYED BY FARMERS**

11. Which of the following methods do you currently use to control ticks on your cattle? (Select all that apply)

- ☐ Regular dipping in acaricide solution
- ☐ Hand spraying with acaricides
- ☐ Pour-on acaricide treatments
- ☐ Acaricide-treated ear tags
- ☐ Manual removal of ticks
- ☐ Use of traditional or herbal remedies
- ☐ I do not currently use any specific tick control methods.

12. In the past 12 months, have you consulted a veterinarian for issues related to ticks or tick-borne diseases in your cattle?

- ☐ Yes, regularly (more than twice)
- ☐ Yes, occasionally (once or twice)
- ☐ No

13. The table below shows the current tick management and veterinary practices employed by farmers. Kindly use the Likert scale below to rate how you use the tick management and veterinary practices.

1= Strongly agree, 2= Agree, 3= Neutral, 4= Strongly disagree, 5= Disagree.

Response	1	2	3	4	5
Integrated tick management					
Vaccination					
Ethnoveterinary practices					
Acaricide application					
Dipping tanks					

END OF QUESTIONNAIRE: THANK YOU!!!