

BISHOP STUART UNIVERSITY



**FACTORS ASSOCIATED WITH ANIMAL HEALTH AT WILDLIFE-CATTLE
INTERFACE IN SANGA SUB COUNTY, KIRUHURA DISTRICT**

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**A DISSERTATION SUBMITTED TO THE DIRECTORATE OF GRADUATE STUDIES,
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STUART UNIVERSITY**

APRIL, 2024

DECLARATION

I hereby declare that this research report, titled "*factors associated with animal health during wildlife-cattle interface in Sanga Sub County, Kiruhura District*", is my original work and it has never been submitted for any award.

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APPROVAL

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DEDICATION

I dedicate this work to my beloved parents Mr. Tuwangye Vicent and late Angela Tuwangye, my wife Dorothy Tuwangye and my daughters Angela, Gloria and Hannah for their outstanding moral, spiritual and financial support that enabled me to complete this dissertation.

ACKNOWLEDGEMENT

I acknowledge the Almighty God who has granted me healthy life and enabled me to drive through this academic journey. I also acknowledge my outstanding supervisors Dr. Kalibwani Rebecca and Mr. Tumusiime Bernard for their input throughout this supervisory journey. Their resilience and commitment towards this work has enabled me to complete this dissertation.

ABBREVIATIONS

BTB	Bovine tuberculosis
CCHF	Crimean-Congo Haemorrhagic Fever
CVI	Content Validity Index
EGV	Ecological Geographical Variety
KNP	Kidepo National Park
LMs	Livestock Markets
PPF	Production Possibility Frontier
QENP	Queen Elizabeth National Park
SHs	Slaughterhouses
SPSS	Statistical Package for Social Sciences
TBD	Tick borne diseases
TBPs	Tick-borne pathogens
URT	United Republic of Tanzania
UV	Ultraviolet
UWA	Uganda Wildlife Authority

ABSTRACT

The coexistence of wildlife and domestic cattle in shared landscapes, known as the wildlife-cattle interface, presents a unique set of challenges for both conservation efforts and livestock management. The study assessed the factors associated with animal health at wildlife-cattle interface in Sanga Sub County, Kiruhura District. The objectives of this study were to: find out the community perceptions towards risks associated with wildlife-cattle interface; determine the prevalence and patterns of disease transmission between wild-life and cattle populations at the wildlife-cattle interface and develop evidence-based recommendations to mitigate identified risk factors associated with animal health at wildlife- cattle interface in Sanga Sub County, Kiruhura District. A quantitative approach was adopted employing a descriptive survey research design, Simple random sampling was adopted to select 148 respondents accompanied by purposive sampling used to select key informants for the study. Data was collected using questionnaires and interviews and analysed using descriptive and thematic analysis. Findings revealed that wildlife cattle interface is associated with disease transmission risks, significant mortalities and production losses in cattle, competition between wild and domestic herbivores of similar dietary breadth, predation and injuries by wildlife on cattle. More so, pathogens and parasites and livestock starvation due to shortage of water contribute to diseases such as brucellosis. It was concluded that farmers and local authorities in Sanga Sub County, Kiruhura District, have taken steps to alleviate the issues related to the wildlife-cattle interface in order to promote a peaceful coexistence between domestic cattle and wildlife which include raising awareness among farmers, handling problematic animals, compensation, conservation activities, installation of live fencing system, resource and revenue sharing in terms of tangible economic benefits like fish, firewood & medicinal plants. The major recommendation in light of this research is to encourage projects for collaborative land and resource management in light of the competition for resources that exists between wild and domestic herbivores.

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CHAPTER ONE

1.0 Introduction

The coexistence of wildlife and domestic cattle in shared landscapes, known as the wildlife-cattle interface, presents a unique set of challenges for both conservation efforts and livestock management. This research seeks to assess the factors associated with animal health during wildlife-cattle interface in Sanga Sub County, Kiruhura District. This chapter presents the background to the study, statement of the problem, objectives of the study, research questions, significance of the study, justification of the study, scope, limitations of the study, study assumptions, theoretical and conceptual frameworks, and operational definition of terms.

1.1 Background of the Study

As human activities continue to encroach upon natural habitats, the interactions between wildlife and cattle become increasingly common, leading to potential consequences for animal health, ecosystem integrity, and public health. According to research by Ocholla (2013), crop devastation, livestock predation, competition for pasture and water, increased risk of livestock diseases, and direct risks to human life are the main causes of human-wildlife conflicts in the area.

Many globally endangered species, particularly the huge and uncommon mammal, are now facing a grave threat to their survival from human-wildlife conflict (Ocholla GO, 2013). According to research, access to grazing and water are the two main points of contention between pastoralists and wildlife around the world. As pastoralists and agro-pastoralists move into new areas and/or reside close to protected areas, competition for limited grazing and water resources is expanding, and the potential for confrontations between wildlife managers and livestock owners is growing (Odhiambo et al., 2008). Rising population pressure, increased cultivation, and depletion of rangeland resources brought on by privatization for commercial agriculture and ranching and nationalization for conservation are the key forces behind this shift (Ocholla, 2013).

Today, biologists and epidemiologists have shifted attention to creating specialized methods for characterizing wildlife-livestock interactions. These methods combine behavioural research on both domestic and wild species. Understanding the factors for infectious diseases is essential

for developing proper control strategies of the infection (Georgiadis, 2007). Literature identifies certain risks such as infectious diseases like trypanosome infections in cattle as a result of wild-life cattle interface however, effective control strategies to reduce trypanosome infections in cattle can be developed if a comprehensive assessment of factors that explain variation in infection among cattle is done.

According to Hobbs et al. (2008), economic dynamics often lead to the patchwork of land use within rangelands intensifying toward croplands and fragmented rangelands at the global level, where agricultural returns typically outcompete wildlife returns. The position of a rangeland on its production possibility frontier (PPF) shifts as markets, technology, and infrastructure advance (Smith, 2012), with agricultural production becoming more specialized and reducing the potential for wildlife production. As it still does in wildlife reserves, game ranches, and places where illnesses such as trypanosomiasis in Africa preclude livestock, the shift starts with a completely intact animal community. In time, livestock production becomes so specialized for example fenced paddocks, winter supplements, and fertilized grasslands that it is impossible to produce wildlife. In some circumstances, well-managed trophy and meat hunting can increase the rangeland's capacity for raising livestock. Infrastructure for example water points, access roads among others built for livestock production can also be advantageous for the sustainable use of wildlife. The move to maximizing livestock productivity, however, has already occurred in the majority of rangelands, and restoring the wildlife community will require a disproportionate reduction in agriculture production, with expensive opportunity costs. Innovative policies are needed to offer competitive and sustainable returns from wildlife to local communities and private landowners in order to avoid or overcome the costs associated with passing up land-use options that are incompatible with wildlife (Norton-Griffiths, 2010).

Wildlife and mixed wildlife-livestock companies can be profitable in semi-arid rangelands where opportunity costs are low, notwithstanding the global trend toward the deterioration and fragmentation of wildlife habitats on rangelands (du Toit, 2010). In the dry "bushveld" regions of South Africa, where climatic, political, and economic changes have boosted the relative profitability of wildlife companies, commercial wildlife management (also known as "game ranching") currently predominates over cattle ranching on private land (Carruthers, 2008). In other parts of the world, including Oceania, sections of North America, and post-Soviet Eastern

Europe (Prishchepov, 2012), socioeconomic transformations have led to severe drops in agricultural production and land abandonment. Low opportunity costs for wildlife conservation in areas of land abandonment make it possible to rebuild the resilience of social-ecological systems through initiatives that restore biodiversity and ecological processes.

Similar to biological processes, the success of livestock vs. wildlife on the Great Plains of North America depends on human facilitation of favorable conditions for livestock. This is how rangelands, which were formerly the natural homes of varied assemblages of co-evolving wild species, have come to largely dominate the herbivore biomass (du Toit, 2010). Typically, there are less than five livestock species in any given area. Hobbs et al. (2008) found a cause and effect relationship between habitat fragmentation, supplemental fodder production, predator elimination, and water availability and the global trend toward sedentary pastoralism on rangelands.

Together, these factors often perpetuate chronic overuse of the remaining rangeland and unnaturally high livestock numbers, outcompeting native herbivores (Ogutu et al., 2010). Only in the rare subsistence pastoral systems where drinking places are widely dispersed and wildlife species are not subject to heavy persecution may wild ungulates cohabit with cattle (Georgiadis, 2007). According to Sitters (2009), wild ungulates typically avoid sharing watering holes with livestock due to the activity of herders (and their dogs) in the area.

Therefore, the overall result of all aspects of cattle production on the majority of rangelands around the world is a ratcheting back of native large herbivores and their predators to isolated habitat refugia and protected reserves. However, in some regions, such as the western United States, where valuable game populations are progressively being allowed to rebound on rangelands under mixed livestock-wildlife management, that trend is being at least partially reversed (big predators excepted).

The largest pastoralist populations are found in Africa, which is home to between 60 and 70 percent of all pastoralists worldwide (Djoghla A. A, 2010). About 16% of the population in sub-Saharan Africa is dependent on pastoralism (Djoghla A. A, 2010). The percentage of pastoralists in the world is highest in Sudan, followed by Somalia, Ethiopia, and Tanzania (Tanzania, 2011). Various pastoralist tribes in Africa share scarce resources with wildlife, such as water and grazing sites (Odhiambo et al., 2008). Conflict develops between wildlife managers

and pastoralists as a result of this situation. While pastoralists perceive protected areas as a new opportunity for their livestock to have enough of grazing field, wildlife managers in protected areas make sure that all resources are maintained for wildlife.

In the struggle over wildlife regions' resources. According to Odhiambo et al. (2008), some confrontations between pastoralist communities and wildlife protection, such as cattle rustling and raiding, have a long history and have somewhat ingrained themselves into traditional pastoralist culture. However, these conflicts in Africa are getting worse and are harder to control (Mkutu, 2010). Conflicts between pastoralist and wildlife conservation efforts occur for a variety of causes, including poor land tenure laws, the deterioration and undermining of traditional governance structures, and the widespread use of small guns. Additionally, it involves insufficient drought preparedness plans, the political and socioeconomic exclusion of pastoralists, and insufficient interaction with traditional governance systems (Mkutu, 2010).

A high rate of population growth over the past few decades has coincided with an increase in the need for land for habitation, agriculture, waste disposal, and other activities that affect the environment, like mining and industries in Africa. In contrast, the pre-industrial age had very low and dispersed human and cattle populations (Boyd et al., 1999). As a result, the land's availability allowed for extensive management of livestock through movement (nomadism), which decreased the dangers of disease transmission and wild predator predation (Rasmussen, 1999). Due to the need for both broad, uncultivated tracts of land and wildlife conservation, this type of land use was typically very compatible with both. In cases where pastoralists and their livestock (cattle, sheep, and goats) coexist alongside wildlife, any communal area set aside for cattle was therefore likely to be used for wildlife as well (Sinclair, 1974). The world is one of the biodiversity-rich regions, both in terms of big wild animal populations and livestock species (Tefera 2011; EBI 2014). This is due to the world's diverse agro-ecological zones and a variety of environmental conditions. The world continues to be ideal for cattle farming and wildlife-related tourism activities due to such ecological and geographic variety (EBI 2014). These protected areas are crucial for the preservation of biodiversity, leisure, ecotourism, and employment.

East African savannahs are home to the greatest diversity of wildlife on the planet. About 70% of East African wildlife populations overlap with pastoralists as they disperse protected areas to community land, putting these places under strain from increased cattle and other anthropogenic activities (Tefera, 2011). Due to habitat loss, population expansion, poaching, and insecurity since the year 2000, more than half of this fauna has vanished (Masanja GF. 2012). Depending on the severity of the drought, pastoralists' traditional way of life puts wildlife conservation at risk because they frequently shift from one location to another in search of pasture (Masanja G.F, 2012). The conflict between pastoralists and wildlife has a range of negative effects on wildlife conservation, including habitat degradation, fragmentation, and the introduction of alien species into wildlife protected areas. The drivers of conflict between pastoralists and wildlife conservation must be identified in order to find the best solutions for both humans and wildlife (Sichewo et al., 2020, Schieltz & Rubenstein, 2015). Then, strategies should be looked for to either minimize or mitigate these factors and sources of human-wildlife conflict.

A high degree of geographical and temporal overlaps or coexistences between pastoral cattle and wildlife is prevalent in East Africa's semi-arid rangelands (Sitters et al. 2009; du Toit 2011). According to Dejene et al. (2016), during these interactions, livestock compete with wild grazers for pasture and water, are preyed upon by large carnivores, and are exposed to zoonotic diseases spread between domestic and wild animals. According to earlier studies (Prins, 2000; Georgiadis et al. 2007, competition for limited grazing and water resources leads to conflicts between pastoralists and wildlife managers because, during protracted drought periods in semi-arid rangelands of Eastern Africa, pastoralists and agro-pastoralists migrate into the vicinity of national parks and protected areas.

Growing evidence suggests that some plant-herbivore interactions unique to big non-livestock herbivores could be beneficial and should be preserved, restored, or introduced to rangelands. For instance, in East Africa's rainy season, cattle that graze alongside wild ungulates gain more weight than cattle that forage in locations where wild ungulates are not present (Odad et al., 2011). This is most likely because zebras have relatively large hind-gut fermenters, which lower the stem-leaf ratio in the sword and improve the environment for grazing ruminants like cattle.

Despite the fact that competition takes place in the dry season, weight gains from the facilitative impact in the rainy season are enough that management may be able to achieve a net benefit.

Theoretically, managers may enforce seasonal changes in the regions used for foraging by livestock (now common) as well as the combinations of livestock and wildlife species foraging together in each season and area (currently uncommon). However, in reality, there aren't many rangelands where it is feasible to actively manage both livestock and wildlife in a profitable enterprise on a landscape scale. Despite the obstacles posed by command-and-control legislation and societal inertia, there are growing scientific arguments in favor of selectively using the varied functional qualities of wildlife species (du Toit, 2010).

The primary way of life for pastoral communities around national parks in Uganda is extensive pastoral herding based on a communal grazing system (Muwanika et al., 2016). Similar to other conservation zones in Africa and across the world, livestock from the pastoral and agro-pastoral populations share resources with animals in and around KNP. In order for the livestock and wildlife sectors to play significant roles in both the local communities in particular and the overall national income, the livestock-wildlife interactions in the Sanga Sub County, Kiruhura district require adequate attention at the local level.

Understanding the perception and attitude of the local community can help determine how the pastoral community maintains its livestock and coexists with wildlife, which can help determine the impact of such interactions on wildlife conservation and livestock productivity (Naughton-Treves, 2011). Additionally, it's important to comprehend how local communities view the value of wildlife, the methods by which it must be managed, how wildlife affects communities, and how this influence influences wildlife management initiatives (Decker et al. 2001). Because the effects of the conflict between pastoralists and the protection of wildlife vary from region to region in Uganda, this requires a research-based understanding of conflict and its repercussions in the study region, filling in knowledge gaps on the causes and contributing factors, and changing people's perceptions to support wildlife.

All around the world, including tropical and subtropical areas, ruminant helminths can be found. In Uganda's Kiruhura District, Sanga Sub County is among the places where gastrointestinal helminth activity is common in cattle. All of the cases of moderate and high infection were discovered within the shared grazing system. Antiparasitic medication is used by farmers, yet helminthic diseases in cattle remain common. In conclusion, the high frequency of livestock helminthic infection in these locations may be attributed in part to the improper execution of

helminthic infection control programs and the local antiparasitic drug resistance (Bugeza et al., 2018).

1.2 Statement of the problem

Animal stress caused by habitat loss tends to restrict access to essential resources for survival including water, pasture, and mineral salts and this is being amplified by the current increase in demographic pressure together with climate change and variability. Thus, during dry seasons, grazing and water availability are the main points of contention in interactions between wildlife and cattle. Livestock owners face serious problems with disease transmission and predation as a result of contact with wildlife. As a result, livestock owners hate wildlife and try to harm it whenever they can. An excellent example is the wild animals in Africa that are now threatened with extinction because of the eradication of cattle and the spread of diseases that are typically spread by domestic dogs. Numerous researches have sought to evaluate the socioeconomic to ecological effects of human-wildlife conflict and disease contact. However, little or no research has been done in understanding the factors associated with animal health during wild-life cattle interface especially in the context of Sanga Sub-County, Kiruhura district. The overarching goal of this study is to contribute to closing this knowledge gap since there is currently a lack of information regarding the factors associated with animal health during the wildlife-cattle interface. In order to help the key stakeholders, particularly wildlife managers, livestock keepers, land use planners, and policy makers, formulate informed plans and policies for sustainable wildlife conservation without compromising livestock production; a proper understanding of the key drivers behind wild life is of the utmost importance.

1.3 The main objective of the study

This study examined the factors associated with animal health at the wildlife-cattle interface, aiming to gain insights into the complexities of these interactions and inform strategies for promoting the well-being of both wildlife and cattle populations in Sanga Sub County, Kiruhura District

1.4 Specific objectives of the study

1. To find out the community perceptions towards risks associated with wildlife-cattle interface in Sanga Sub County, Kiruhura District.

2. To determine the prevalence and patterns of disease transmission between wild-life and cattle populations during wildlife-cattle interface in Sanga Sub County, Kiruhura District.
3. To document evidence-based recommendations to mitigate identified risk factors associated with animal health during wildlife- cattle interface in Sanga Sub County, Kiruhura District.

1.5 Research questions

1. What are the community perceptions towards risks associated with wildlife-cattle interface in Sanga Sub County, Kiruhura District?
2. What is the prevalence and patterns of disease transmission between wild-life and cattle populations during wildlife-cattle interface in Sanga Sub County, Kiruhura District?
3. What are evidence-based recommendations to mitigate identified risk factors associated with animal health during wildlife- cattle interface in Sanga Sub County, Kiruhura District?

1.6 Scope of the study

This presents the content scope, time scope and geographical scope as follows.

1.6.1 Content scope

This study comprehensively understood the factors associated with animal health during the wildlife-cattle interface, aiming to gain insights into the complexities of these interactions and inform strategies for promoting the well-being of both wildlife and cattle populations in Sanga Sub County, Kiruhura District. This study covered the following objectives; to identify community perceptions associated with risks during wildlife-cattle interface, to determine the prevalence and patterns of disease transmission between wild-life and cattle populations during wildlife-cattle interface and to develop evidence-based recommendations to mitigate identified factors associated with animal health during wildlife- cattle interface in Sanga Sub County, Kiruhura District.

1.6.2 Geographical scope

The study was conducted in Sanga Sub County which is located in Kiruhura district, in Southwestern Uganda. Sanga is located approximately 36 kilometres (22 miles) east of Mbarara, the largest city in the Ankole sub-region. This is approximately 31 kilometres (19 miles), along the Masaka-Mbarara Road. The geographical coordinates of Sanga, Uganda are 0°29'54.0"S,

30°54'27.0"E (Latitude:-0.498333; Longitude: 30.907500). The average elevation of this settlement is 1,218 metres (3,996 ft) above sea level (Google map data, 2022).

1.6.3 Time scope

The research covered the period of five years that is from 2018-2023. This range of years was considered as wildlife-cattle interfaces have been increasing in Sanga Sub County and Lake Mburo National Park despite of the many measures used to reduce the vice. More recently, disease ecology has branched out to multi-host/multi-pathogen interactions (Viana et al., 2014), community-level interaction networks, and the effects of biodiversity on disease dynamics. Furthermore, the time was enough to provide more information and obtain literature for the study upon which conclusions and recommendations was based.

1.7 Significance of the study

For Ministry of Agriculture, Animal Industry and Fisheries

The study's findings provided valuable insights into the factors affecting animal health at the interface, enabling more informed and targeted management strategies. This can lead to early detection and prevention of diseases, reduced injuries, and improved well-being for both wildlife and cattle populations.

Understanding the interactions between wildlife and cattle is vital for preserving biodiversity. By identifying and mitigating risks, the study can contribute to maintaining healthy wildlife populations and protecting endangered species while promoting sustainable livestock practices. Zoonotic diseases can pose significant threats to human health.

For communities/farmers/practitioners

For communities living near wildlife habitats, understanding the risks and adopting effective risk mitigation strategies can reduce economic losses from livestock predation and disease outbreaks. This can contribute to improving the livelihoods of cattle owners and enhance human-wildlife coexistence.

By examining disease transmission patterns at the wildlife-cattle interface, the study can help identify potential zoonotic risks, allowing for the implementation of measures to reduce disease spillover and protect public health.

For policy makers

The study's findings can serve as a scientific basis for developing policies and guidelines related to wildlife management, livestock husbandry, and conservation efforts. Policymakers and wildlife managers can use this knowledge to create evidence-based measures that address the identified risks.

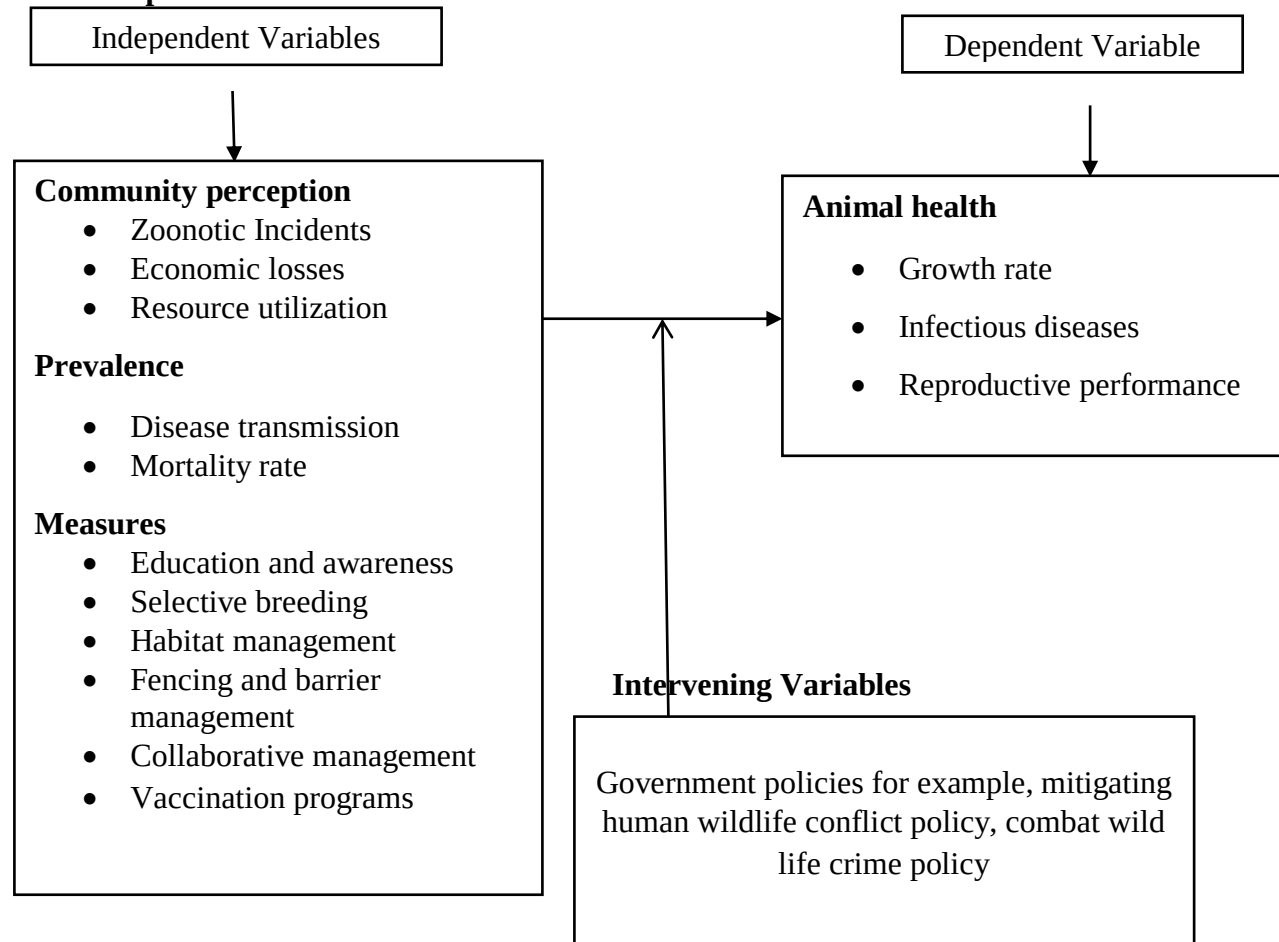
For researchers

The study adds on to literature that contributes to the scientific understanding of the complex interactions between wildlife and livestock, potentially leading to further research and advancements in animal health, ecology, and conservation. Healthy ecosystems, supported by informed wildlife and livestock management, play a role in climate resilience.

1.8 Conceptual framework

This is a diagrammatical representation of concepts as operationalized by the researcher that shows the relationship between variables.

1.1 Conceptual framework



(Developed and modified by the researcher from the review of literature, 2022)

The conceptual framework above is a diagrammatic representation of the relationship between factors and animal health during wild-life cattle interface. It shows the conceptualization of the problem from the view of the researcher. Wildlife-cattle interface practices comprise of resource utilization in regard to the proportion of shared resources (grazing areas, water sources) utilized by wildlife compared to cattle, community perception of local communities regarding the risks posed by wildlife to their cattle and livelihoods, zoonotic incidents in regard to zoonotic disease cases reported in human populations in proximity to the wildlife-cattle interface and economic loss i.e. the monetary value of losses incurred by cattle owners due to wildlife predation or disease-related issues. The factors may lead to disease transmission between wildlife and cattle and increase in mortality rate for both wildlife and cattle. However, the relationship between the factors and animal health are intervened by government policies in relation to wildlife conservation as well as animal protection. The researcher looks at mitigation strategies in terms of education and awareness, selective breeding, habitat management, fencing and barrier management, collaborative management, and vaccination programs.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter focuses on the review of the related literature in line with the study variables. This section review existing literature on the factors associated with animal health during wildlife-cattle interface as studied by various scholars. The literature review is guided by study objectives and was obtained from textbooks, journals, internet, newspapers, magazines, reports and other sources.

2.1 Community perceptions associated with risks at wildlife-cattle interface

Competition between domestic and wild herbivores with similar food ranges and body sizes, such as cattle and zebra and cattle and buffalo, has been amply demonstrated in long-term experiments and observational studies (Odhiambo et al. 2008). Domestic mesoherbivores, like sheep and goats, may have favorable effects on the abundance and reproductive success of wild mesoherbivores, like impala, Grant's gazelle, and Thomson's gazelle, at moderate densities (Bugeza et al., 2018), but much less so at high densities, which are frequently linked to greater anthropogenic influence. The creation of wildlife conservancies offers a sustainable solution to combine wildlife conservation with livestock production (Lvschal et al., 2019), but it also amplifies livestock-wildlife interactions that could lead to an increase in the transfer of infectious diseases (Nthiwa et al., 2019). If domestic herbivore populations are kept high across expansive landscapes, competitive interactions between wild and domestic herbivores will likely occur year-round (Georgiadis et al. 2007). These interactions typically occur during droughts or dry seasons when forage quantity is limited.

If these resources are contaminated with infected excreta or urine, the pathogens' capacity to survive in water or grazing areas may affect the indirect transmission pathways of zoonotic diseases (Mwachui et al., 2015). Through increasing intra- and inter-herd interactions, the sharing of these ecological resources by various livestock herds may also encourage direct transmission of zoonotic illnesses (Rajeev et al., 2017). Indeed, Nthiwa (2019) observed that our study discovered frequent use of watering points, grazing areas, or mixing of cattle herds at these crucial resources to be significant predictors of brucellosis and leptospirosis seropositivity in

cattle. Roan and sable antelope are narrow-mouthed, intermediate to tall-grass specialist grazers that are especially vulnerable to competition from other herbivores for grazing. When other herbivore species have reduced grass height below 6 cm, sable antelope (and likely the larger-bodied roan antelope) will switch from high-quality burned grassland (>12% crude protein) to taller low-quality grassland (3% crude protein) (Godfroid, 2018). Depending on group size, food availability, and the presence of competitors, differential selection mechanisms may reduce competitive interactions between sympatric herbivore species. This is demonstrated with impala, greater kudu, and cattle in Zimbabwe (Frost, 2008). By choosing backcountry habitats far from water, concentrations of other herbivores, predators, and human disturbance, sable and roan antelope avoid competition and predation.

In areas of extensive, productive habitats like high-rainfall regions, floodplains, swamps, and lowlands, where there is potential for grass biomass and height to increase to the point where forage quality limits intake rates for herbivores, facilitation can be especially important for small and medium-bodied short-grass specialists. Grazing can prevent grassland from maturing to less digestible taller grass while promoting high-quality regrowth, resulting in beneficial interactions among herbivore species (facilitation of nutrient and energy intake) (Vesey-FitzGerald 1960; Verweij et al. 2006).

Thus, regional variation in rainfall and topographic effects on soils and hydrology, as well as seasonal grass growth phases (Odhambo et al. 2008), drive the potential for facilitation to increase along grassland productivity gradients. During the wet season, when grass is actively growing and feed quality may become limiting if allowed to mature, facilitation is expected in medium productivity semi-arid environments (except from wetlands). Competition is expected, nevertheless, during the dry season when soil moisture restricts the amount of feed available, as has been shown for both cattle and wildlife (Odadi et al. 2011).

Even greater potential exists for grazing facilitation to occur both in wet and dry seasons in productive habitats such as high-rainfall regions, floodplains, swamps, and lowlands, where soils are deep and moisture is typically not limiting to plant growth at any time of the year, resulting in the development of tall less digestible grasses. Therefore, during the dry season, pastoralists routinely burn floodplains to clear them of the thick accumulation of mature grass and to encourage higher quality, fresh regrowth for their cattle which enhances the diet of wild

herbivores throughout the dry season (Queiroz, C. R., 2014). When cattle were removed from the high-rainfall Masai-Mara Game Reserve after it was established, populations of various short-grass grazers declined, demonstrating that cattle can also play this role.

Risks of disease transmission pose a hazard to the coexistence of animals and livestock in Africa (Bedelian & Ogutu, 2017). Diseases that cause major mortalities and production losses in livestock can be maintained by wild ruminants. For example, several antelope species, wild suids, buffalo, rhinoceroses, and elephants are regularly infected with different *Trypanosoma* species where tsetse flies are present, serving as maintenance hosts for nagana, a devastating chronic illness of cattle. The African buffalo serves as a crucial sylvatic maintenance host for a number of pathogens that are of great concern to the local veterinary services, including the viruses that cause foot-and-mouth disease in cattle and the *Theileria parva* that causes corridor disease and east-coast fever.

The catastrophic consequences of rinderpest serve as an example of how, while being often asymptomatic carriers of endemic diseases, wild ruminants can nonetheless experience severe morbidity and death from exotic livestock diseases. More than 14 species of wild ruminants, carnivores, and primates are affected by the spread of bovine tuberculosis, which cattle brought to the continent (Devi et al., 2021). Ironically, the spread of bovine tuberculosis from wildlife to livestock populations is a serious worry for the development of TFCAs in southern Africa (Devi et al., 2021).

The majority of pastoralists in the research area, particularly those who live close to the park, graze and water their cattle there. Cattle and some wild species, such buffalo and impalas, interact closely in the park's northern region. However, due to the large and growing number of cattle in the park, particularly during the dry season, this coexistence has over time resulted in environmental damage. Overgrazing, soil erosion, and an increase in bare patches have been caused as a result in the park. Due to current park management priorities that include removing cattle from the park, grazing is regarded as being an inappropriate technique of rangeland management in Lake Mburo National Park (Mbishe, S., 2010).

The roan antelope (*Hippotragus equinus*), for example, is extremely sensitive to pasture competition (Mbishe, S., 2010). Therefore, when there are many cattle present, such animals typically leave these places. Accordingly, the distribution of wild animals is impacted by high

cattle density, which eventually detracts from the park's appeal to visitors interested in wild game. Despite the fact that pastoralists typically abhor game meat and do not shoot wild animals, they have taken concerted steps to eradicate some species, particularly predators like lions, leopards, and black jackals. To prevent their cattle from being murdered and eaten, they primarily poison them. The majority of carnivorous creatures, including lions, are thought to be gone. This has impacted the ecosystem of the park and will eventually have an impact on the ecological food chain. The subject merits more research.

2.2 Prevalence and patterns of disease transmission between wild-life and cattle populations during wildlife-cattle interface

The livestock business in sub-Saharan Africa suffers enormous economic losses as a result of ticks and tick-borne pathogens (TBPs), which limit livestock output (Kalema-Zikusoka et al., 2005. According to Kabuusu et al. (2011), the most frequently reported tick-borne diseases (TBDs) in Kenya are heartwater, babesiosis, anaplasmosis, and East Coast fever (*Theileria parva*, *Rhipicephalus appendiculatus*), as well as babesiosis, *Babesia bigemina*, *Rhipicephalus decoloratus*, and *Anaplasma marginale*, *Rhipice*.

There are numerous benign *Theileria* species that are also very common, including *Theileria taurotragi*, *Theileria mutans*, and *Theileria velifera* (Kiplagat, et al., 2020). Most of these TBDs are clinically inapparent due to their endemic stability in Kenya's primarily indigenous cattle herds. However, because to their subpar innate and adaptive immunological response to TBPs, exotic breeds imported into these regions frequently exhibit severe clinical illnesses. The natural resistance of native cattle may also be weakened by pregnancy or co-infection with other infections, which could result in clinical manifestations like weight loss, a decline in milk supply, and fatalities (Martin, 2017).

Although the significance of tick-borne pathogens for the production of livestock cannot be overstated, a growing number of publications indicate that these pathogens are zoonotic, posing a risk to human health (Patz et al., 2004). Among these zoonotic TBPs are viruses, bacteria, and protozoa. Human babesiosis is specifically caused by *Babesia divergens* and *Babesia microti*, whereas human ehrlichiosis and anaplasmosis are brought on by *Ehrlichia chaffeensis* and *Anaplasma phagocytophilum*, respectively (Ocaido R. T.-A., 2009). According to recent reports, *Anaplasma platys*, *Anaplasma ovis*, and *Anaplasma capra* may have zoonotic significance (Otim,

2000). Fever, myalgia, and rash are among the clinical symptoms linked to these viruses that have primarily been reported from Europe and North America (Rubaire-Akiiki et al., 2004). *Rickettsia africae*, which infects people and causes African tick bite fever (Garnett et al., 2007), is widespread in SSA but has only been associated with a small number of local cases (Mkutu, 2010).

The Crimean-Congo haemorrhagic fever (CCHF) virus is one of the most pervasive zoonotic tick-borne viruses in the world. It is conveyed by *Hyalomma* ticks. Haemorrhagic fever and a death rate of up to 30% are the hallmarks of clinical disease in humans (Djoghla A. A, 2010). The only known fatal human case of CCHF occurred in western Kenya in 2000, and multiple outbreaks with associated human fatalities were recorded in neighboring Uganda between August 2017 and January 2019 (Carruthers, 2008). Additionally, cattle have been found to have zoonotic *Babesia* spp., *Anaplasma* spp., *Ehrlichia* spp., and *Rickettsia* spp. Additionally, the CCHF virus was recently found in *Rh. decoloratus* ticks from cattle at slaughterhouses in western Kenya (Ocaido R. T.-A., 2009). Further research into the part that cattle play in the epidemiology of zoonotic TBPs is warranted given that they are CCHF virus carriers (Odad et al., 2011).

Livestock, with an estimated 17 million cattle in various production systems, is a significant source of income in Kenya in addition to having cultural and social significance (LaHue et al., 2016). There are at least 843,608 indigenous and 219,904 exotic cattle in western Kenya alone (Odadi et al., 2011), yet there have only been a few studies done to determine the frequency and epidemiology of TBDs that limit livestock output. These studies revealed a high seroprevalence of TBDs and related factors in smallholder livestock production systems in the western Kenyan highlands and Machakos County, while a different study revealed that East Coast fever was the primary cause of mortality (40%) in indigenous zebu calves tracked from birth to 51 weeks of age. in western Kenya. Another study indicated a significant animal-level frequency of TBPs in the Lambwe Valley of western Kenya, which is a wildlife-livestock interface, whereas emerging *Anaplasma* and *Ehrlichia* spp. were discovered to be infecting dairy cows in peri-urban Nairobi. However, little attention has been paid up until now to the existence of zoonotic TBPs as a gauge of the risk for human infection in this area.

Increased desire for human habitation and an expanding human population have led to increasingly fragmented landscapes and large interface areas, which facilitate the spread of zoonotic illnesses (Carruthers, 2008). The transition to intensive, market-driven smallholder livestock production systems currently being observed in East Africa is probably going to make things worse (Chachage, 2010). In East Africa, the transportation of animals across national and internal boundaries is facilitated by the livestock markets and slaughterhouses situated in peri-urban regions (Queiroz, 2014). These facilities may be significant in the epidemiology of TBDs given that animal trade and migration are thought to be crucial contributors in the introduction and development of illnesses in new, uninfected locations (Odad et al., 2011). Therefore, using molecular analytical techniques, we conducted this investigation at livestock markets (LMs) and slaughterhouses (SHs) in western Kenya to ascertain the prevalence of TBPs in cattle that are of animal and public health concern. Additionally, we identified any co-infections that can impede accurate diagnosis and prognosis of TBDs and evaluated the variables that are linked to TBP presence in cattle.

In line with other results from Uganda, the procurement of new animals constituted a significant risk factor for herd-level brucellosis (Bugeza et al. 2018). If the health status of the sourced animals is not established or a temporary quarantine is not enforced, there is a chance that diseased animals was introduced into a healthy herd, which may account for this finding. It should be made clearer through further research how the dynamics of the herd caused by the sale or purchase of animals can affect the local prevalence of *Brucella* spp. The seroprevalence of *Brucella* spp. increased as the sites drew nearer to the Mara reserve as well.

This finding might be connected to the various land use practices used in the surveyed zones. According to Patz et al. (2004) changes in land use are thought to alter the relationships between host species and hence have a direct or indirect impact on the rate of disease transmission across hosts. MMNR and wildlife conservancies are used by farmers to grow cattle in zone 1, as opposed to zones 2 and 3 that practice sedentary and crop-livestock mixed agriculture, respectively. Multiple herds can share shared grazing and drinking areas under extensive livestock production systems (such as pastoralism), which may enhance the likelihood that uninitiated cattle will come into contact with infected orb-carrier fauna (McDermott and Arimi 2002). In fact, this study found that the way cattle are raised is a strong predictor of their

susceptibility to both leptospirosis and brucellosis. Seroprevalence for *Leptospira* species varied significantly between zones 1 and 2 and zone 3 (low contact area), but not between zones 1 and 2. The lack of substantial differences in seroprevalence between zones 1 and 2 suggested that changes in land use between the two zones might not be sufficient to demonstrate exposure differences for this disease in cattle.

Given that livestock grazes within the MMNR, it's possible that the increased seroprevalence of *Brucella* species in zone 1 compared to zones 2 and 3 is perhaps a result of the possibility of numerous encounters between wildlife and livestock. The interactions between wildlife and livestock in the area are a potential factor that could possibly explain for the variations in seroprevalence of this virus in the zones, even though biological sampling of animals was not done in the study. For instance, zone 1 contains more wildlife species diversity (i.e., wildlife host species richness) than zone 3, which may result in a large reservoir of pathogens and hence accelerate the transmission of infectious diseases (Daszak et al. 2000; Keesing et al. 2010) including the cattle-transmitted *Brucella* species (Godfroid 2018). *Brucella* spp. exposure in various wildlife species, including the African buffalo (*Syncerus caffer*) and blue wildebeest (*Connochaetes taurinus*), has been documented in the Mara ecosystem (Waghela and Karstad 1986). However, information on brucellosis (Njeru et al. 2016) and leptospirosis in wildlife species is very limited in the area and in Kenya. In addition to animals, rats are significant sources of several *Leptospira* species (Allan et al. 2015) and can contaminate livestock grazing areas or irrigation supplies. According to Estrada-Pena et al. (2014), environmental parameters like ultraviolet (UV) light, pH, salinity, soil moisture, and temperature can determine how long *Leptospira* and *Brucella* spp. survive in the environment.

According to Aune et al. (2012), *Brucella* spp. can survive in water and soil for 21 to 81 days, whereas *Leptospira* spp. can survive for a few hours up to 193 days. If these resources are contaminated with infected excreta or urine, the pathogens' capacity to survive in water or grazing areas may affect the indirect transmission pathways of zoonotic diseases (Mwachui et al. 2015). Through increasing intra- and inter-herd interactions, the sharing of these ecological resources by various livestock herds may also encourage direct transmission of zoonotic illnesses (Rajeev et al. 2017). Indeed, our study discovered that frequent use of grazing areas, watering

stations, or mixing of cow herds at these crucial resources served as significant indicators of brucellosis and leptospirosis seropositivity in cattle.

The contacts between cattle and small ruminants may further raise the levels of interspecies transmission of these infections, even though the role played by small ruminants (sheep and goats) in the epidemiology of *Brucella* spp. and *Leptospira* spp. in the region is mainly unknown. According to L Løvschal et al. (2019), small ruminants are increasingly playing a significant role in local households' means of subsistence. Between 1977 and 2014, their population densities are estimated to have increased by 235.6%, while cattle populations only increased by 0.8% (Bedelian and Ogutu, 2017). A substantial pool of maintenance hosts for these viruses may also be produced by the high population densities of tiny ruminants in the region. According to this study, female cattle had greater seroprevalences of *Brucella* spp. and *Leptospira* spp. than male cattle. In the Maasai Mara ecosystem, cows often have lower off take rates than bulls because they are raised to provide milk, which is a crucial part of the community's food (Nthiwa et al. 2019), as well as for breeding purposes to replace animals that may perish as a result of frequent droughts (Huho et al. 2011). Cows may be more likely than bulls to be repeatedly exposed to these infections throughout time since they remain in herds for a longer period of time. A significant danger of transmission to male populations through natural breeding, which is prevalent in the examined zones, is also presented by the large proportion of exposed females.

The discovery that studied herds with a history of positive abortions were linked to animal-level leptospirosis may be the result of subpar husbandry techniques including improperly discarding placentas and aborted fetuses, which contaminate the environment (Mwachui et al. 2015). Retaining aborted animals in the herds may also operate as sources of infections during uterine discharges during later parturitions (Loureiro et al. 2017). Although various illnesses, such as foot and mouth disease, bovine trypanosomiasis, and infectious bovine pleuropneumonia, can cause abortions in cattle, our findings imply that *Leptospira* spp. may be one of the leading causes in the region. Further research is necessary to confirm this conclusion. The increased animal contact among larger herds may account for the significant correlation between large herd sizes (> 50 animals) and exposure to *Leptospira* spp. in animals (Barrett et al. 2018). Large herd management also entails regular travels in search of forage and water, particularly so during the dry season. This approach may aid in the spread of infectious diseases, but it also puts herds at risk of contracting ailments that may be localized (Alhaji et al. 2016).

In the vicinity of Queen Elizabeth National Park (QENP), the prevalence of bovine tuberculosis (BTB) in individual cattle is estimated to be 2.8% (95% CI 1.5-5.4) (Meunier, unpublished data), although BTB is reported to affect buffalo at a rate of 21.6% (Kalema-Zikusoka et al. 2005). It is fair to assume higher levels of BTB infection in local cattle if a high frequency of transmission from buffalo was occurring given the lack of BTB management methods in cattle. Alternatively, the prevalent local breed of Ankole cattle may be less susceptible to BTB than was anticipated (Ameni et al. 2007). The same BTB spoligotypes have been found in South African wildlife and livestock (Hlokwe et al. 2014). A clearer indicator of whether inter-species spread is taking place could be obtained by identifying the strain types that have infected the nearby wildlife and animals.

Some of the wildlife areas were historically owned by the community members who were involved in pastoralist activities before they were driven out. As a result, some of them still desire to allow their animals to graze in the places where they have been relocated. Since there isn't enough land for such large herds, other tribes in the study area are motivated to have more cattle, which necessitates grazing in protected areas. According to Fratkin (2008), the majority of pastoral tribes place cultural value on possessing a large herd of sheep. It was also discovered that huge herds of cattle represent status to their owners. "Pastoralist groups like Sukuma and Taturu always own large herds of livestock and it is something of great cultural value or prestige to them," one of the Rangers remarked during the interview. They find it difficult to destock their livestock moving forward. Because of this tradition, the number of animals in the community has increased above the carrying capacity of the village land, causing grazing in protected areas to conflict with efforts to conserve wildlife.

One of the things that cause friction between pastoralists and animals is the presence of good pasture in game reserves. Protected land is continuously monitored to preserve pastures for wildlife animals and to minimize adverse effects that will influence them and cause them to become unstable. In the meantime, village land is being overgrazed with little to no supervision, which is consistent with the tragedy of the commons thesis. According to a study by Fratkin (2008), one of the primary causes of conflict between pastoralists and wildlife is the presence of good pasture within the wildlife region. Good pasture is a feature of wildlife habitats that draws pastoralists to graze their animals there. Additionally, even during the rainy season, when

grazing is still available on village land, pastoralists nevertheless direct their cattle towards the protected region to prevent violent clashes on land that has already reached its carrying limit.

According to Garnett et al. (2007), a lack of water ranks as the sixth most likely cause of conflict between pastoralists and wildlife. The study area is in Central Tanzania, a semi-arid region with a major water shortage issue. Villagers compete with one another due to a lack of water. The most susceptible area is the wildlife area as a result of competition over the use of water between the parties that drives pastoralists to seek water from other locations. According to URT (United Republic of Tanzania, 2015), there is a severe lack of water for cattle, particularly during the dry season, notably in the central region of Tanzania, which includes the research area. As in the instance of Muhesi Game Reserve, this causes tension between pastoralists and wildlife conservation in wildlife protected areas. Furthermore, Hariohay et al. (2017) revealed that violence in many protected areas that are surrounded by pastoralist communities is caused by a lack of water for cattle.

It was also found that the large number of cattle in the research areas contributed to conflicts between pastoralists and wildlife. Large herds that are larger than the study's carrying capacity cause fierce rivalry over the usage of grazing land. A study found that pastoralists look for new grazing areas to minimize conflict among themselves. It was noted that as range area shrank and herd size per individual increased, access to and movement between essential resources became more difficult, and pastoralist options became more limited (Galvin, 2009). This suggests that in order to lessen competition for resources, pastoralists choose to drive their cattle in protected areas. Despite the fact that some of the study area's villages have land use plans. The provision of water and collective ownership of pasture in relation to stocking rates and land carrying capacity, however, continue to present difficulties. These issues require attention (Nyhus, 2016).

2.3 Measures to mitigate factors associated with wildlife- cattle interfaces

Simbarashe (2012) contends that discrepancies in land tenure between granted and customary land rights are a contributing factor in conflicts over a lack of land, particularly those involving wildlife protection and livestock keepers. The acquisition of land in Tanzania (Morogoro, Iringa, and Pwani) by large national and international corporations has left small-scale farmers without any land, according to another study by Chachage (2010). Local pastoralists have been more impacted by these two issues than other resource users. Pastoralists are currently losing their

traditional grazing areas almost everywhere in the nation to sedentary cultivation and national reserves. Lack of grazing land: According to the findings, 90.8% of respondents cited a lack of grazing land as one of the factors contributing to conflict. Farming and other social activities are among the diverse economic and economic activities in the region. These operations take up a sizable percentage of the land and have an impact on livestock management in terms of available grazing pasture, prompting pastoralists to move their herds into the Muhesi Game Reserve.

Most of the outreach programs offered by wildlife managers in cooperation with non-governmental organizations like the Wildlife Conservation Society and Marera hunting safaris focused on educating pastoralists and the local community about conservation. Aiming to ensure that even newcomers are aware of their obligations to ensure the conservation of animal resources, conservation education is reportedly delivered four times a year. People were being educated about all connected conservation legal framework concerns as part of conservation education programs (Devi et al., 2021). Village meetings serve as a forum for both education and discourse regarding ongoing conflicts. Assistance from wildlife managers: Within the research region, in particular, pastoralists who are members of the community avoid shooting carnivores when doing so in favor of seeking help from wildlife managers. Due to the fact that pastoralists are not permitted to shoot wild animals, this avoids confrontation (Mayengo, 2017). To lessen the dispute, relocation of those residing 500 meters or less from the GR boundary was implemented.

Schieltz JM (2015) observed that, in violation of Section 74 of WCA No. 5 of 2009, the majority of people erected their settlements within 500 meters of the boundary of game reserves. These individuals have a sizable herd of cattle. According to the study, the majority of the residents of these areas were immigrants who had no experience with game reserve protection. This action was conducted on a regular basis as a means of resolving the disagreement between pastoralists and those who protect animals. Additionally, the implementation of several associated legal frameworks and land use planning helped the resettlement of persons who were living 500 meters or less from the GRs boundary. Participants from the village of Lulunga remarked during the focus group discussion that "the village government," working with village members inside the study areas, develops places for grazing that are far away from wildlife areas. This action lessens friction between the parties to some extent.

To increase adaptive ability at the landscape scale, wildlife must interact with cattle and other land users and make a significant economic contribution to local communities. Although still frowned upon by many in the wildlife field in North America, such ideas have been tried overseas and there are lessons to be learnt. For instance, integrated conservation and development projects (ICDPs) have formed the cornerstone of the majority of plans to address converging problems in human welfare and biodiversity protection in developing nations since the latter decades of the twentieth century. Success depends on higher levels of government delegating the proper authority to lower levels, or at the very least permitting income sharing, so that rural communities can create a proprietary interest in their local wildlife resources. One such idea first appeared in Zimbabwe in the late 1980s under the name CAMPFIRE, a program that enabled peasant farmers on communal grounds to gain immediate benefits from the local animals.

Due to CAMPFIRE's quick success in supporting bottom-up conservation and rebuilding rural communities, it has become a case study in the field of international development (Frost, 2008). Although entrenched corruption and autocracy can make ICDP schemes vulnerable (Garnett et al., 2007), this does not lessen the concept's potential in nations with superior governance. It provides an illustration of how a top-down, strictly regulated approach to managing wildlife can be changed into a bottom-up approach that allows animals to contribute to the resilience of social-ecological systems, with a focus on rangelands (Ranglack and du Toit, 2016).

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents methods that were used to understand the factors associated with animal health during wildlife-cattle interface. It includes; study design, study population, sample size, sampling techniques, and methods of data collection, data quality control (validity and reliability), research procedure and data analysis.

3.1 Research design

This research used a descriptive survey research design. This scientific approach entails describing and evaluating a subject's behaviour without in any way affecting it (Mertler, 2014). When little is known about a certain phenomenon, it is employed. A phenomenon is observed, and the researcher records various characteristics of it. The phenomenon is not the subject of any variable manipulation or cause-and-effect analysis. Additionally, it defines what truly exists, calculates how frequently it occurs, and organizes the data in Sanga Sub County's Kiruhura district. Participants responded to questions posed via interviews and questionnaires in this design. Researcher explained the responses provided by participants after they have responded to the questions. In this process, quantitative, numerical data was gathered using questionnaires and interviews for survey research. The data was then statistically analyzed to identify trends in response patterns.

3.2 Study population

The communities in the chosen study area were sampled from the communal-wide wildlife-cattle interface. The selection of key informants was based on data from neighbourhood administrators and park management; the majority of participants were elderly persons with extensive knowledge of the region's history of community-park relations. Participants were visited in their homes especially early morning during milking times, evening times when cattle are returning to rest. For this study, a population of 300 participants was the targeted.

3.3 Sampling procedure

During the data collecting procedure, the researcher combined the simple random sampling technique with purposive sampling. While simple random sampling helped the researcher to ensure that all respondents have an equal chance of being selected, the researcher used purposeful sampling methods because it allows the selection of a sample with experience and knowledge about the study variables. The selection of the key respondents based on social positions and historical knowledge of the area.

3.4 Sample size

Sandelowski (1995) defined sample size as the quantity of entities in a population subset chosen for study. Out of the overall target group, 169 respondents were selected to represent the population. A simple random table by Krejcie and Morgan (1970) was used to determine the sample size, as shown below in appendix G.

3.5 Data Sources

Data analysed in this study was primary in nature given the fact that it was collected from primary sources. Primary data refer to raw data got from the respondents. This source offered first-hand information directly from respondents via surveys and interviews with pertinent study stakeholders. On this source, all the findings were drawn.

3.6 Data collection methods

3.6.1 Questionnaires

According to Adams (2007), a questionnaire is a group of questions that are often constructed logically and systematically to accomplish particular study goals. In the area of Lake Mburo National Park, the researcher used structured and self-administered questionnaires to gather information from farmers and local residents. The most common primary data collection method that enabled the researcher to quickly get responses to the predetermined questions is the use of questionnaires. To collect quantitative information regarding research variables, this technique was employed.

3.6.2 Interview method

The researcher interviewed respondents to get key information necessary to elaborately explain study from the respondents in the park employees and Sanga Sub county leaders. Interviews helped to eliminate the bias that would occur while using questionnaires. While conducting interviews, the study involved face to face contact. It provided the specialized and expertise information from the respondents who are farmers neighbouring the park. This method was used to get qualitative data about study variables.

3.7 Data collection tools

3.7.1 Questionnaire survey

The researcher used a close ended questionnaire where predetermined answers were provided on each item on which the respondents answered by ticking. This questionnaire was arranged according to the study objectives. It generated the quantitative data of the study. The researcher approached respondents and distributed Likert type of questionnaires with pre-determined opinion statements from which respondents ticked what is appropriate to their opinion. The researcher used this set of questions to collect data from respondents.

3.7.2 Interview guide

The researcher prepared an interview guide with research open-ended questions relevant to study objectives. The interview guide generated uniform responses from respondents in the local community. The interview guide helped to generate the rich insights for the study. The interview guided the oral conversation between the researcher and the key respondents.

3.8 Data presentation and analysis

3.8.1 Data Presentation

Data from the field was sorted, coded and then entered into a computer and then presented using tables, graphs and pie-charts which was generated from the questions that was relevant to the study. In addition, data was presented according to the study objectives.

3.8.2 Data analysis and interpretation

Data and information collected through different tools was summarized and analyzed under different methods. Data generated through questionnaires was analysed using descriptive analysis and statistics such as mean, frequencies, and percentages were generated to explain and describe the issues under research. For this, descriptive data tables were used in their presentation. However, the information and data that was generated from open-ended questionnaires and key informant interview was analysed using thematic analysis.

3.8.2.1 Quantitative analysis

Editing of the quantitative data is sorting the information gathered to obtain data that is pertinent to the research variables. The researcher then reviewed each response while assigning codes to the choices that were selected. The Statistical Package for Social Scientists (SPSS) was then used to evaluate the data and provide statistics in the form of frequency and percentages tables.

3.8.2.1 Qualitative analysis

Since the researcher recorded the responses to the interviews, qualitative data was produced from them. In order to reinforce the information offered by the surveys, it was sorted and refined before being utilized to interpret quantitative data from the questionnaires. A report was generated after the study, which involved the triangulation of all data sources to strengthen and complement it.

3.9 Quality control

Quality was assured through emphasising validity and reliability of instruments as explained below;

3.9.1 Validity

The expert judgment method was used to determine the validity of the questionnaire. Two participants received the surveys to test if the questions addressed the study variables and objectives. The research instruments was regarded as valid when the average rate of the questionnaire is found to be over 75% after doing the calculation. The researcher utilized the following formula to establish the content validity of the instrument (C.V.I).

$$C.V.I = \frac{\text{No. of items regarded relevant by judges}}{\text{Total no. of items}}$$

Total No. of items

CVI= n/N

Where: CVI= content validity of instruments, n = Number of items indicated relevant, N=Total number of items in the questionnaire.

The items in both the questionnaire and the interview guide was valid if the CVI for each instrument was 0.70 and above (Amin, 2005).

3.9.2 Reliability

When a research tool produces consistent results, this is referred to as its reliability. The Chronbach Alpha coefficient was used to determine the questionnaire's reliability. The reliability of the questionnaire was determined using the Cronbach Alpha coefficient. The score determined at an alpha value of 0.70 and higher indicates strong credit, making it preferable for use (Amin, 2005)

3.10 Data collection procedure

Each chosen household in the study region received an interview guide and pre-tested structured questionnaire. There was both closed- and open-ended questions on the survey. The researcher (together with a qualified assistant) gave the head of the household the questionnaires, and each interview lasted roughly 20 minutes. The researcher underlined the importance of treating the findings in a discrete manner.

3.11 Measurement of study Variables

The researcher measured variables using the nominal scale of 5-Point Rating Scale. (5) Strongly Agree, (4) Agree, (3) Not sure, (2) Disagree and (1) strongly Disagree. Using the Likert type of questionnaires to measure the respondents' perceptions about the assessment of the factors associated with wildlife-cattle interface evidencing from Sanga Sub County-Kiruhura district.

3.12 Ethical considerations

A supporting letter from the faculty was obtained explaining the objectives of the research. This was taken to the relevant stakeholders seeking clearance to obtain any necessary data. Ethical clearance was obtained from Bishop Stuart University Research Ethics Committee. Questionnaires have been structured in such a way that there is no mention of the respondent's name for participants' privacy and anonymity. A statement as to the strict confidentiality with which data would be held was expressly stated in the questionnaire. Informed consent was also sought by the researcher from the respondents briefing them on the purpose of the research, their relevance in the research process, and expectations from them, their right to withdraw, compensation of their time as well as the benefits of participating in the research.

3.13 Dissemination of results plan to the community

The researcher intends to write a comprehensive research paper detailing the study's methodology, findings, and conclusions. Submit the paper to a peer-reviewed journal in the field of animal health, wildlife ecology, or veterinary science, present the study's key findings at relevant national and international conferences, such as those focused on wildlife health, livestock management, and zoonotic diseases, organize meetings with relevant stakeholders, including wildlife managers, veterinarians, farmers, and conservation groups, present the study's findings and engage in discussions to foster practical applications and potential collaboration and design educational materials, including brochures and fact sheets, tailored for local communities, schools, and agricultural extension services. The materials will be distributed to raise awareness about animal health risks at the wildlife-cattle interface.

3.14 Limitations of the Study

While in the field the researcher encountered the following problems;

Failure of the respondents to provide the necessary information about the research study because some of them were expected busy and had no time to answer the questionnaire administered by the researcher. The researcher solved the problem by giving thorough explanation about how the study would be helpful to them and the organization at the same time in order to give the exact information required.

Delay of data collection tools. Some respondents delayed to return the questionnaires in time which affected the researcher to get information in a time given for the research study. The researcher made sure that data collection tools are delivered to the respondents in time such that they have ample time to answer them and be returned in time.

The researcher was unable to identify a role for wildlife in the reported seroprevalence and observations in this regard remain hypothetical because this study did not sample wildlife to determine their exposure status in relation to disease prevalence.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

This chapter consists of data analysed using descriptive analysis, presentation of data using tables, and interpretation of data collected from the field regarding factors associated with animal health during wildlife-cattle interface, the prevalence and patterns of disease transmission between wild-life and cattle populations during wildlife-cattle interface, evidence-based recommendations to mitigate identified negative factors associated with animal health during wildlife- cattle interface. Findings of this study are presented inform of descriptive statistics that is frequencies, percentages, mean and standard deviation that were generated with the help of Statistical package for social scientists (SPSS V.23). This chapter also introduces the respondent's biographic information. The study recovered 148 research tools (questionnaires) from the field out of the 152 administered questionnaires. These formed a response rate of 97.4% which is considered very good by Mugenda & Mugenda, (2003) and Saunders, et al (2007) who observed that 50% response rate was adequate, 60% good and 70% very good and considered for further statistical analyses.

4.1 Demographic Characteristics of Respondents

On the demographic characteristics, a number of variables were examined. Background variables were analysed that is gender, age of respondent in years, marital status and level of education. The results on the demographic data of the respondents are presented in table 4.1 below;

Table 4.1: Demographic data

Gender	Frequency	Percentage (%)
Male	121	81.8
Female	27	18.2
Total	148	100
Marital status		
Single	22	14.9
Married	120	81.1
Divorced/separated	1	0.7

Widowed	5	3.4
Total	148	100
<hr/>		
Age		
< 21	3	2.0
21-30	36	24.3
31-40	68	45.9
>41	41	27.7
Total	148	100
<hr/>		
Educational level		
Primary	72	48.6
Secondary	32	21.6
Tertiary	26	17.6
University	9	6.1
Others	9	6.1
Total	148	100

Source: Primary data, 2023

4.1.1 Gender

Results from table 4.1 indicate the respondent's gender and revealed that 81.8% were males while 18.2% were females. These findings imply that majority of the respondents (81.8%) were males. This is because in Sanga Sub County like any other cattle keeping society in Uganda, males are largely in charge of cattle rearing, other livestock and wild life in general while females undertake other household activities.

4.1.2 Age

Results from table 4.1 above indicated that 2% of the respondents were aged less than 21, 24.3% were in the age bracket of 21-30, 45.9% were aged 31-40 and 27.7% were aged above 40. This implies that majority of the respondents (45.9%) were in the age group between 31-40 years. This is because most farmers and animal keepers in Sanga Sub County are adults who are establishing themselves and diversifying their revenues through rearing animals alongside working in Lake Mburo National Park.

4.1.3 Marital status

Results in table 4.1 above regarding the marital status of the respondents indicated that 14.9% of the respondents were single, 81.1% were married, 0.7% were divorced and 3.4% were widowed. The results imply that majority of the respondents (81.1%) were married which can be attributed to the age group to which majority respondents belong as evidenced by the age in 4.1.2 above. The shared responsibilities in a family by married people also give chance to the farmers to rear/herd animals as a source of livelihood to the families.

4.1.4 Level of Education

The results from table 4.1 indicated that 48.6% of the respondents had studied up to only primary level, 21.6% had studied up to secondary level, 17.6% had studied up to tertiary institutions level and 6.1% respondents had attained university education and other levels of education. This implies that majority of the respondents (48.6%) had only studied up to primary level. This is because the study was conducted in a rural area that is predominantly occupied by residents with low levels of education. This is also because the study was conducted in farmers who operate at small scale that is practiced by persons with low levels of education.

4.2 Community Perceptions towards risks Associated with Wildlife Cattle Interface

The first objective of the study targeted to identify the community perceptions towards risks associated wildlife cattle interface in Sanga Sub-county Kiruhura district. To answer this objective, there was need to first identify the livestock kept in the area, grazing systems used in the area, why livestock interfaces with wild life and whether livestock specifically cattle interfaces with wildlife. A set of statements on the factors associated with animal health during wildlife cattle interface were among the items in the questionnaire form which respondents indicated their level of agreement. The findings are presented in tables 4.2–4.7 below;

Table 4.2: Whether there is livestock in the area

Response	Frequency	Percentage (%)
Yes	111	75.0
No	37	25.0
Total	148	100

Source: Primary data, 2023

As shown in table 4.2 above, 75% of the respondents consented that there was livestock in the area while 25% respondents with a no. this implies that the majority of the respondents (75%) consented that there is livestock which is an indication that in Sanga Sub County has various categories of livestock reared.

Table 4.3: Common owned livestock in the area

Common livestock	Frequency	Percentage (%)
Cattle	133	39.5
Goats	87	25.8
Hens	51	15.1
Sheep	17	5.0
Other	49	14.5
Total	337	100

Source: Primary data, 2023

The study findings regarding the livestock kept in Sanga Sub County revealed that 39.5% of the kept livestock is cattle, 25.8% are goats, 15.1% are hens, 5% is sheep and 14.5% were other types of livestock. This implies that there several categories of livestock kept by farmers in Sanga Sub County with cattle being the most reared. This is because Sanga Sub County is a predominantly cattle rearing area like other parts of Kiruhura district. With various types of livestock reared, it was necessary to find out the systems on how the kept livestock is managed and this would shed light on whether there is room for cattle to interface with wildlife in Sanga sub-county.

Table 4.4: Grazing Systems of Livestock

Grazing systems of livestock	Yes		No	
	f	%	f	%
Extensive open grazing during dry season	130	87.8	18	12.2
Extensive open grazing during wet season	34	23.0	114	77.0
Paddock grazing	31	20.9	117	79.1
Dry season supplementation	8	5.1	140	94.6

Source: Primary data, 2023

Results of the study in table 4.4 above revealed that 87.8% of the respondents practiced extensive open grazing during dry season while 12.2% didn't, 23% practiced extensive open grazing during wet season while 77% did not, 20.9% practiced paddock grazing while 79.1% did not and 5.1% practiced dry season supplementation while 94.6% did not. This implies that extensive open grazing during the dry season is the most practiced grazing system of livestock in Sanga Sub County. This is because there is plenty of free un-gazetted land with limited or no restrictions for anyone to graze on in Sanga Sub County.

Table 4.5: Whether cattle interfaces with wildlife

Response	Frequency	Percentage (%)
Yes	140	94.6
No	8	5.4
Total	148	100

Source: Primary data, 2023

Results from table 4.5 above indicate that cattle interfaces with wildlife. 94.6% of the respondents indicated that cattle interfaces with wildlife while 5.4% of the respondents said that they don't. This implies that majority of the respondents (94.6%) acknowledge that cattle interfaces with wildlife. This is because a section of Sanga Sub County is covered by Lake Mburo national park which makes it easy for cattle and other livestock from the local community to always interface with wildlife in the park. This could also be attributed to extensive open grazing due to plenty of un gazetted land both for the local community and the park therefore

either cattle or wild life are free to move from one place to another due to reasons stated below as per the study findings.

Table 4.6: Why Cattle interfaces with wildlife

Reasons why cattle interfaces with wildlife	Frequency	Percentage (%)
Search for pasture	37	48.1
Limited land owned by some families	19	24.7
Negligence by some locals/families	3	3.9
Absence of clear boundaries	11	14.3
Lack of proper policies restricting any encroachment	7	9.1
Total	77	100

Source: Primary data, 2023

Findings in table 4.6 above revealed that 48.1% of the respondents identified the search for pastures, 24.7% attributed the interface to limited land owned by some families in the area, 3.9% attributed to negligence by some locals on the animals, 14.3% was attributed to absence of clear boundaries and 9.1% attributed the interfacing of livestock with wildlife to lack of proper policies restricting any encroachment. This is an indication that cattle interfaces with wildlife because of search pastures for the animals, limited land owned by some families which pushes them to opt for extensive open grazing system and absence of clear boundaries between the land owned by the local community and the national park.

Table 4.7: Community perceptions towards risks that result from wildlife cattle interface (N=148)

Risks	5	4	3	2	1	Mean	S.d
Disease transmission risks threaten wildlife–cattle coexistence.	127	20	1	0	0	4.85	.376
Face challenges in cattle production.	40	67	32	9	0	3.93	.854
Significant mortalities and production losses in livestock.	47	54	31	11	5	3.90	1.032

Environmental degradation due to the high and increasing numbers of cattle in the park especially in the dry season.	3	90	16	22	17	3.27	1.110
Competition between wild and domestic herbivores of similar dietary breadth.	5	98	22	19	4	3.55	.860
Predation and injuries by wildlife on cattle.	11	96	26	9	6	3.66	.863
Rising human population and increased demand for human habitation.	8	73	32	28	7	3.32	.997
Cultural practices in the area inspire people to have large animal numbers without adequate land making encroachment on gazetted areas inevitable.	34	90	11	12	1	3.97	.833
<hr/> 5 = Strongly Agree, 4 = Agree, 3 = Not Sure, 2 = Disagree, 1 = Strongly Disagree <hr/>							
Mean Scale: >4.50=Strongly Agree, 3.50-4.50=Agree, 2.50-3.49=Not Sure, 1.00-2.49=Disagree, <1.00=Strongly Disagree <hr/>							

Source: Primary data, 2023

The results from the table above indicated that majority respondents strongly agreed that disease transmission risks threaten wildlife–cattle coexistence among the factors that associated with animal health (mean= 4.85; S.d= .376). This implies that cattle-wildlife interface is largely associated with disease transmission risks that threaten the coexistence of the two animal categories.

Study findings also revealed that majority of the respondents agreed that wildlife-cattle interface is associated with challenges in livestock production (mean= 3.93, Sd= .854), significant mortalities and production losses in livestock (mean= 3.90. Sd= 1.032), competition between wild and domestic herbivores of similar dietary breadth (Mean= 3.55, Sd= .860).

Further findings revealed that majority respondents also agreed that the interface of cattle with wildlife is associated with predation and injuries by wildlife on cattle (Mean= 3.66, Sd= .863), and cultural practices in the area inspire people to have large animal numbers without adequate land making encroachment on gazetted areas inevitable (mean= 3.97, Sd= .833). This implies

that cattle-wildlife interface is associated with so many factors such as challenges in livestock production, significant mortalities and losses in production, domestic herbivores, and the prevailing cultural practices.

The findings in table 4.7 above revealed that some respondents were not sure whether wildlife-cattle interface is associated with environmental degradation due to the high and increasing numbers of cattle in the park especially in the dry season (mean= 3.27, S.d= 1.110), and rising human population and increased demand for human habitation (mean= 3.32, S.d= .997). This implies that respondents were not certain about whether interface of wildlife and cattle is associated with environmental degradation and rising demand for human habitation.

In an interview conducted with one of the key informants (park employee) about community perceptions towards risks Associated with Wildlife Cattle Interface, it was revealed that; *“Communities are heavily reliant on cattle ranching and therefore view wildlife as a threat to their livelihoods. They perceive wildlife as competitors for resources such as grazing land and water, leading to conflicts and economic losses”*

In another interview conducted with key informant it was said that; *“communities perceive wildlife as predators that pose a threat to their cattle. Predation by carnivores such as leopards, wolves, or hyenas could lead to livestock losses, causing financial strain for farmers and ranchers, he further reported that in some communities, wildlife holds cultural or spiritual significance. People have traditional beliefs and practices associated with certain wildlife species, influencing their attitudes towards coexistence with wildlife”*

4.3 Prevalence of Disease Transmission during Wildlife-Cattle Interface

This study examined the prevalence of disease transmission during wildlife-cattle interface in Sanga Sub County Kiruhura district. This was the study’s second objective as stated in chapter one. The study examined the level of seriousness of wildlife-cattle interface and the disease prevalence by presenting statements on which respondents showed their level of agreement using the provided scale. The results are presented in the tables 4.8 and 4.9 below;

Table 4.8: Level of seriousness of wildlife-cattle interface

Level of wildlife-cattle interface	Frequency	Percentage (%)
High	127	85.8
Intermediate	8	5.4
Low	13	8.8
Total	148	100

Source: Primary data, 2023

The results of the study regarding the level of wildlife-cattle interface in table 4.8 revealed that 85.8% of the respondents indicated that it was high, 5.4% revealed that it was intermediate and 8.8% indicated that it was low. The results imply that majority respondents (85.8%) indicated that there were very serious interfaces between wildlife and cattle which is an indication of how frequently cattle visits the park and interfaces with wildlife.

Table 4.9: Prevalence of disease transmission during wildlife-cattle interface (N=148)

Risk prevalence	5	4	3	2	1	Mean	S.d
Abortions have occurred in last 5 years in livestock	29	65	22	19	13	3.53	1.198
Long calving intervals as an indicator of infertility of cows.	16	59	18	34	21	3.10	1.276
Livestock starvation due to shortage of water	3	106	14	18	7	3.54	.906
Pathogens and parasites	43	86	12	6	1	4.11	.766
Herd-level brucellosis	31	75	15	18	9	3.68	1.119

NB: 5 = *Strongly Agree*, 4 = *Agree*, 3 = *Not Sure*, 2 = *Disagree*, 1 = *Strongly Disagree*

Mean scale: >4.50 strongly agree, 3.50-4.50 agree, 2.50-3.49 not sure, 1.00-2.49 disagree, <1.00 strongly disagree

Source: Primary data, 2023

Results from table 4.9 above showed that majority of the respondents agreed with the provided statements. The results indicated that respondents agreed that there have been abortions in animals that have occurred in last 5 years in livestock as a result of disease transmission during wildlife- cattle interface (mean= 3.53, S.d= 1.198), Pathogens and parasites (mean= 4.11, S.d= .766), and livestock starvation due to shortage of water (mean= 3.54, S.d= .906).

Majority respondents also agreed that wildlife-cattle interface is likely to put animals to a herd-level brucellosis risk (mean= 3.68, S.d= 1.119). This is an indication that the interface of wildlife with cattle leaves a great risk that largely lies in disease and parasite spreading. Both wildlife and cattle are likely to transmit pathogens and parasites that may result into herd-level brucellosis, and abortions in animals.

The study findings also indicated that other majority respondents were not sure whether there were risk prevalence of disease transmission during wildlife-cattle interface would result into long calving intervals as an indicator of infertility of cows (mean= 3.10, S.d= 1.276). This implies that the respondents were not certain on whether disease risks associated with disease transmission during wildlife-cattle interface would result into infertility of cows. This is because this is a condition that could not have happened before to most of the households that rear animals hence lacking knowledge regarding the situation.

In an interview conducted with one of key informants, it was said that; “ *the major diseases which were mostly transmitted between cattle and wild animals were, Foot and mouth disease (FMD) which the informant further reported that it is a highly contagious viral disease that affects cloven-hoofed animals such as cattle, pigs, sheep, and goats. While primarily transmitted through direct contact between infected animals, wildlife such as buffalos, impalas and warthogs are the most carrier of the virus and contribute to its spread, he further mentioned East Coast Fever which he further reported that ECF infects cattle and could eventually lead to reproductive losses, respiratory disease, immunosuppression and death. Other diseases like Brucellosis and Tuberculosis were also reported as transmitted diseases*”.

Based on the available data, a consistent pattern emerges suggesting that most respondents concur that there have been animal abortions in the last five years as a result of a variety of factors related to the wildlife-cattle interface, including disease transmission, pathogens, parasites, and livestock starvation. The majority also agree that this interface poses a serious risk, especially in terms of herd-level brucellosis. Regarding whether disease transmission at the wildlife-cattle interface will result in extended calving intervals, respondents appear unsure, which may be a sign of ignorance or lack of expertise with this particular aspect of disease transmission. All things considered, the statistics point to a complicated interaction between animals and livestock that could have a major impact on cattle populations' health, while some details may still be unclear or call for more research.

4.4 Measures to mitigate factors associated with wildlife-cattle interface in Sanga Sub County

The study also aimed at identifying possible measures to mitigate factors associated with wildlife-cattle interface in Sanga Sub County Kiruhura district. This was the third and last objective of the study. This was examined by establishing the types of animal husbandry practiced, sources of fodder, how domestic animals are protected against wildlife, and how the cattle are protected from wild animal attacks. A number of statements on the possible measures to mitigate factors associated with wildlife-cattle interface were presented from which respondents showed their level of agreement. The results regarding this objective are presented in table 4.10 – 4.16 below;

Table 4.10: Type of animal husbandry practiced

Type of animal husbandry	Frequency	Percentage (%)
Zero grazing	6	4.1
Mixed free range and zero grazing	8	5.4
Free range	130	87.8
Other	4	2.7
Total	148	100

Source: Primary data, 2023

Results in table 4.10 regarding the type of animal husbandry practiced revealed that 4.1% respondents practiced zero grazing, 5.4% practiced mixed free range and zero grazing, 87.8% practiced free range and 2.7% of the respondents practiced other forms of animal husbandry. The results imply that the most practiced and used form of animal husbandry is free range system. This is because there is plenty of unrestricted land and favourable land policies for free range grazing in Sanga Sub County.

Table 4.11: Source of fodder for cattle

Source of fodder for cattle	Frequency	Percentage (%)
Graze in the field	136	91.9
Buying commercial fodder	7	4.7
Cut and carry fodder	3	2.0
Other	2	1.4
Total	148	100

Source: Primary data, 2023

The results of the study in table 4.11 above revealed that 91.9% of the respondents obtain animals fodder by grazing in the fields, 4.7% buy commercial fodder, 2% cut and carry fodder from places of growing to animals feeding places, 1.4% of the respondents indicated that they were using other forms of fodder for their animals. This is an indication that the majority of the respondents were providing their cattle with fodder by grazing in the fields. This could be because this is the most affordable and convenient form of animal feeding in Sanga Sub County.

Table 4.12: Whether cattle are protected against wild animals

Response	Frequency	Percentage (%)
Yes	142	95.9
No	6	4.1
Total	148	100

Source: Primary data, 2023

The results of table 4.12 above revealed that 95.9% of the respondents protected their livestock against wildlife while 4.1% did not. This is an implication that livestock in Sanga Sub County is constantly protected from wildlife. This is because of the potential harm wildlife most especially animals may bring to livestock.

Table 4.13: Protection of animals

Protection of animals	Frequency	Percentage (%)
Dogs	92	62.2
Security personnel	25	16.9
Hire an ordinary person	25	16.9
Other	6	4.1
Total	148	100

Source: Primary data, 2023

Findings from table 4.13 above regarding the protection of animals revealed that 62.2% respondents protect their animals using dogs, 16.9% have employed security personnel and hire of an ordinary person who protects cattle, 4.1% respondents use other means. This is an implication that domestic animals in Sanga Sub County are largely protected against any harm and danger using dogs.

Table 4.14: Cattle's sleeping place

Cattle's sleeping place	Frequency	Percentage (%)
Field	20	13.5
Kraal at home	121	81.8
Other	7	4.7
Total	148	100

Source: Primary data, 2023

The results of the study regarding where cattle sleep showed that 13.5% of the respondents leave their cattle in the fields, 81.8% keep them in Kraals at home and 4.7% of the respondents had other places where their animals sleep. This implies that majority respondents have gazetted places for their cattle at home (kraal) where they always sleep. This is because this is the traditional way of looking after cattle in the nights and to many it is safer.

Table 4.15: Prevention of attacks from animals

Prevention of attacks from animals	Frequency	Percentage (%)
Keep out from zones with wild animals	107	72.3
Report to the Uganda Wildlife authority	31	20.9
Consult a veterinary official	4	2.7
Hunt down the wild animal	0	0
Others	6	4.1
Total	148	100

Source: Primary data, 2023

The results of the study in table 4.15 above revealed that 72.3% respondents prevent attacks from their animals by keeping them out from zones with wild animals, 20.9% report any wild animal attacks to the Uganda Wildlife Authority authorities, 2.7% conduct consultations from a veterinary official, 4.1% use other means while there were no respondents that hunt down the wild animals. The results imply that majority people in Sanga Sub County protect their animals against wildlife attack by keeping their livestock out of zones that are reached by wild animals. There were no respondents that hunt down wild animals because it is against the laws as stipulated by Uganda Wildlife Authority and would be highly punishable if found guilty.

In an interview conducted with one of the key informants (park employee), it was revealed that; “ *one of the ways of preventing cattle from wild animal’s attack was implementing exclusion measures such as electric fencing or barriers specifically designed to deter wildlife from entering cattle grazing areas as this could reduce the risk of disease transmission, he further revealed that they would try to use, implementing strict biosecurity protocols, including controlling visitor access to grazing areas, preventing contact between cattle and potentially infected wildlife, and disinfecting equipment, could help minimize the spread of diseases*”.

Table 4.16: Measures to mitigate wildlife-cattle interface (N=148)

Measures to mitigate wildlife-cattle interface	5	4	3	2	1	Mean	S.d
Community member participation to avoid killing carnivores which kill their cattle	3	81	31	18	15	3.23	1.026
Provision of conservation education to the pastoralists and community surrounding and outreach program provided by wildlife managers	0	89	58	0	1	3.59	.534
Wildlife has to contribute meaningfully to community-level economies and become integrated with livestock and other land uses to enhance adaptive capacity at the landscape scale	4	89	51	3	1	3.59	.583
Ensuring even immigrants have awareness about their responsibilities to ensure conservation of wildlife resources	0	79	56	8	5	3.41	.746
Resettlement of the people living within 500M radius from park boundary is taken to reduce the conflict	4	80	43	9	12	3.34	.930
Fencing the wildlife protected area from pastoralists	0	102	20	10	16	3.46	.965
Encourage paddocking by cattle keepers	5	91	44	4	7	3.57	.705
Construction of water dams for cattle and wildlife	0	98	40	1	9	3.53	.795

Source: Primary data, 2023

The results of the study in table 4.16 above indicate some of the measures adopted by pastoralists and herdsmen to mitigate the risk factors associated with cattle health during wildlife-cattle interface in Sanga sub-county, Kiruhura district. It was revealed that majority of the respondents adopt the provision of conservation education to the pastoralists and community surrounding and outreach program provided by wildlife managers since they have the highest mean (3.59) whereas the least respondents support community member participation to avoid killing carnivores which kill their cattle. These results imply that majority people in Sanga Sub County have adopted conservation education and output programs as a measure to mitigate risk factors that may affect animal health during wild-life cattle interface.

In another interview conducted with one of the key informants on measures to mitigate the wildlife-cattle interface, it was said that, some major measures were“ *implementing habitat management practices that discourage wild animals from congregating near cattle grazing areas, such as reducing food sources or modifying landscape features as this could help to minimize contact between wild animals and livestock and regular monitoring of wild animals and cattle populations, as well as surveillance for signs of disease, could help detect and respond to potential risks promptly*”

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, RECOMMENDATIONS AND AREAS FOR FURTHER STUDY

5.0 Introduction

This chapter presents the discussions of findings in relation to the study objectives. It should also be noted that findings from interviews were largely integrated at the stage of discussion since this was not a mixed study but the research employed a skillful technique of mixing methods at only data collection stage without necessarily conducting a mixed study as guided by Creswell for purposes of complementarity. This chapter also consists of conclusions in line with the study objectives as well as recommendations and suggested areas for further studies.

5.1 Discussions

In the chapter, the major findings are discussed in line with the specific objectives;

5.1.1 Community Perceptions towards risks associated with Wildlife Cattle Interface

The study examined the factors associated with animal health at wildlife cattle interface in Sanga Sub county Kiruhura district. The study findings revealed that wildlife cattle interface is associated with disease transmission risks, significant mortalities and production losses in cattle, competition between wild and domestic herbivores of similar dietary breadth, predation and injuries by wildlife on cattle.

This research shows that there is a significant danger of disease transmission along the wildlife-cattle interface. This is mostly caused by the proximity and interaction of domestic livestock and wildlife. These populations can spread illnesses in communal settings, generating worries about both the health of the animals and the potential for disease to infect people. Brucellosis, other zoonotic illnesses, and bovine tuberculosis are a few examples of diseases that can be spread. An increase in mortality rates, decreased production, and financial losses for livestock farmers can all result from such transmission, which can also have severe impacts on cattle. Strategies like consistent health monitoring, vaccination campaigns, and biosecurity precautions are crucial in order to address this and reduce the danger of disease transmission.

According to the study's findings, cattle that are in contact with wildlife suffer large output losses as well as mortalities. These losses may be brought on by a number of things, such as illnesses, predatory behavior, and wildlife-related injuries. Such losses generate ethical concerns regarding

the wellbeing of these animals in addition to concerns for the economic viability of cattle farming. Farmers might need to put in place improved protective measures, such as the use of safe cages, guardian animals (such dogs or llamas), and, in some situations, targeted predator management, to lessen these losses. Programs for compensation and insurance might also lessen farmers' financial burdens.

The study emphasizes the competitiveness that results when cattle and wild herbivores fight for scarce food supplies while having identical dietary demands. Because of the competition, both groups may consume less food, which could harm their growth and health. Competition between wildlife and cattle in habitats with scarce resources may upset the ecosystem's equilibrium and result in overgrazing or malnourished animals. To lessen this competition and preserve the wellbeing of both animals and cattle, it is essential to implement sustainable land and resource management techniques, such as rotational grazing, habitat preservation, and feed availability monitoring.

Another key issue raised by the study is wildlife predation on cattle. Particularly in areas where predators are protected or endangered, predation can result in cattle losses, farmer stress, and moral dilemmas. Secure enclosures, guardian animals, and wildlife management techniques that concentrate on reducing conflict and safeguarding cattle without adversely affecting wildlife populations are a few possible solutions that might be used to address this issue. These solutions should be adapted to the local ecology. A challenging but essential part of managing the wildlife-cattle interaction is striking a balance between the preservation of predators and the protection of livestock.

According to the study, cattle can get hurt when they come into contact with wildlife. These wounds can be excruciatingly painful, crippling, and expensive to treat. Physical confrontations with wildlife or attempts to flee from predators both have the potential to cause injuries. To lower the danger of injury, fencing, herding techniques, and habitat alteration are possible alternatives. Farmers can lessen veterinary expenses, lessen the suffering of the animals, and protect the health of their cattle by minimizing injuries.

Previous studies acknowledge that the permeable livestock-wildlife interface in Malipati is where cattle (livestock) and wildlife (buffaloes, impalas) come into contact (Miguel et al. 2013; Zengeya et al. 2015). Therefore, it is likely that wildlife could contract chlamydial infection from

livestock. The study of Ndegue et al, (2018) confirmed that the existence of chlamydiosis in cattle and a few species of wildlife, in conclusion. Cattle's seropositivity to Chlamydia was unaffected by previous abortions, sex, parity, or proximity to wildlife.

According to Ntivuguruzwa et al, (2020), majority of cattle keepers have little knowledge of zoonotic brucellosis, as evidenced by the fact that they assisted with calving without protective equipment and disposed of abortion tissues improperly. Through zoonotic brucellosis education programs, all stakeholders should be made more aware of this issue. Since there is currently no vaccination for human brucellosis, the One Health concept, which involves veterinarians, environmentalists, and medical professionals, could effectively reduce zoonotic brucellosis.

5.1.2 Prevalence of Disease Transmission at Wildlife-Cattle Interface

The study also examined the prevalence of disease transmission at wildlife-cattle interface in Sanga Sub County Kiruhura district. The results from farmers and interview responses from community leaders and park officials revealed that wild-life interface was very serious and this contributed to high prevalence of disease transmission in the area. Both the responses from the survey and interview revealed that there have been abortions in animals in last 5 years, pathogens and parasites and livestock starvation due to shortage of water all of which contribute to diseases such as brucellosis. This indicates that the wildlife interface with cattle leaves a great risk that largely lies in disease and parasite spreading.

According to the study, a crucial element in the region's high prevalence of disease transmission is the wildlife-cattle interaction. There are potential for disease transmission between these two populations when wildlife and cattle live in the same area. This relationship can be particularly dangerous since some diseases can infect both domestic cattle and wildlife, spreading viruses more widely. In these settings, infections might spread more easily due to the close quarters and shared supplies. Because some of these illnesses have the potential to be zoonotic that is, they can spread from animals to people risk management is essential to protect both animal and human health.

The frequency of animal abortions over the previous five years in the research area is one of the important findings. Animal abortions are frequently a symptom of underlying health problems, particularly infectious illnesses. Due to the loss of offspring and lower output, these abortions

may cause financial losses for livestock farmers. The presence of wildlife nearby cattle might increase stress and the spread of disease, potentially leading to such unfavorable reproductive effects. To minimize these losses, it is crucial to monitor and take care of the livestock's health as well as comprehend the function of wildlife in disease transmission.

Pathogens and parasites were also a key finding in the study area, according to the study. Direct contact or indirect transmission of pathogens and parasites through the sharing of resources like water and grazing areas are also possible. The wildlife-cattle interface raises the danger of disease spread by acting as a conduit for the transfer of these germs between the two species. Particularly alarming are illnesses like brucellosis, which may spread from cattle to wildlife and vice versa. In order to manage and lower the prevalence of these viruses and parasites, effective disease control techniques are essential. Examples include immunization, deworming, and hygiene practices.

One of the most important problems related to the wildlife-cattle interface is cattle starvation brought on by a lack of enough water and pasture since the study area is dry corridor. Wildlife and cattle may compete for dwindling water supplies, which could cause starvation and dehydration in animals. In addition to having a negative effect on the cattle's health and wellbeing, this weakens their immune systems and increases their susceptibility to illness. It is critical to address this issue by ensuring that cattle have adequate access to water sources, which may entail putting in place water management systems or carefully placing water sources to reduce conflict with wildlife.

This finding corroborates with Nthiwa et al, (2019) whose research showed that *Leptospira* spp. and *Brucella* spp. are common in Maasai Mara region, Kenya and that there is a high incidence of co-exposure in animals. Cattle grazing in wildlife areas was likewise strongly related with the seropositivity of both illnesses. Due to the possibility that these viruses could spread from wildlife reservoirs to cattle in places with high animal contact

The findings of the present study confirmed the high prevalence of brucellosis among cattle at the wildlife-cattle interface. Contrary to the study findings Simpson et al, (2018) who assessed risk factors of selected diseases at the human-wildlife-livestock interface in Mpumalanga province South Africa and recorded low proportion of brucellosis among livestock and viral infections. However, the present study findings agree with the findings of Ntivuguruzwa et al,

(2020) who demonstrated that the history of abortions and the addition of new animals to herds are the main predictors of brucellosis and confirmed that the disease is endemic in cattle raised near the wildlife-livestock-human interface. Therefore, pregnant cattle and replacement animals should be tested, confined, and the positives killed.

5.1.3 Measures to mitigate factors associated with wildlife-cattle interface in Sanga Sub County

The study investigated the possible measures to mitigate factors associated with wildlife-cattle interface in Sanga Sub County Kiruhura district. The results of the study revealed that most farmers prevent attacks from their animals by keeping them out from zones with wild animals and reporting wild animal attacks to the Uganda Wildlife Authority. The interview responses with local leaders revealed that measures to mitigate factors associated with wild-life cattle interface include rising awareness among farmers, handling problematic animals, compensation, conservation activities, installation of live fencing system, resource and revenue sharing in terms of tangible economic benefits like fish, firewood & medicinal plants.

According to the findings of this study, many farmers have taken proactive measures to reduce the dangers related to the wildlife-cattle interface. They take several precautions, one of which is to keep their livestock out of regions where wild animals are known to congregate. It is possible to lessen direct contact and potential conflicts between farmed cattle and wildlife by doing this. It permits the coexistence of these two populations while reducing the risk of predation, injury, and disease transfer.

From the qualitative findings, it was revealed that farmers in the area actively report wild animal attacks to the Uganda Wildlife Authority (UWA), which is another interesting result. This action accomplishes two goals at once. First off, it aids in tracking and keeping an eye on the behavior of wild animals and any troublesome ones that might endanger livestock. Second, it develops a cooperative strategy between farmers and organizations in charge of wildlife conservation, allowing them to cooperate in order to solve problems relating to the wildlife-cattle interface.

Local leaders' perceptions in interviews highlight how crucial it is to educate farmers. This action entails educating farmers on the dangers and difficulties related to the wildlife-cattle interface, as well as the methods they might use to reduce these dangers. Farmers can be empowered to make

knowledgeable decisions about herd management, safety precautions, and how to participate in conservation efforts by education and awareness campaigns.

Local authorities recognized compensation as a crucial factor. Programs for compensation can help farmers who suffer losses as a result of wildlife interactions, such as predation or crop damage. Farmers are encouraged to assist conservation efforts by participating in these initiatives, which are crucial in fostering strong connections between the farming community and wildlife conservation authorities. The wildlife-cattle contact is also greatly mitigated by conservation efforts. These initiatives include management and conservation of habitat with a focus on maintaining natural ecosystems. By maintaining acceptable habitats for both wildlife and cattle, conservation efforts support the long-term coexistence of these two groups.

Live fencing systems must be installed as another useful strategy. Typically, these systems are made up of bitter or thorny plants that keep animals out of cattle regions. A physical barrier, such as live fence, can serve to prevent direct contacts and confrontations between cattle and wildlife.

In order to reduce the problems associated with the wildlife-cattle interaction, it is important to deal with problematic animals. Finding and controlling specific wildlife members who pose a risk to cattle can be a successful tactic. Such animals may occasionally need to be relocated or isolated in order to stop subsequent fights. This strategy promotes the preservation of both domestic cattle and endangered or threatened wildlife species.

Agreements for the sharing of resources and income are suggested as a way to lessen the effects of issues that pertain to the wildlife-cattle interaction. These agreements entail providing the neighborhood with concrete economic benefits like fish, firewood, and medicinal herbs. These projects encourage cooperation between local citizens and conservation authorities by offering financial incentives, and they can be used as a tool to increase support for conservation efforts.

The present study finding agree with previous studies such as the study of Sichewo et al, (2019) who posits that the design of control and management strategies that will lessen the impact of the disease on human health is important due to the presence of *M. bovis* in animal products that are known to be ingested by farmers without specific precaution.

Ntivuguruzwa et al, (2020) recommends control initiatives like immunizations, testing, and slaughter, as well as the necessity of an annual brucellosis-free certificate for domestic and

international trade, should be more specifically targeted at the interface. According to Chaka et al, (2018) brucellosis is prevalent in domestic animals in the border region. This raises the need for additional, thorough epidemiological research on the illness in livestock, people, and wildlife using 'one health' unified research methodologies in addition to raising public awareness. Public and animal health groups can explore control strategies for common diseases at this time. Expanded zoonotic surveillance should be maintained, and veterinarian and public health services should be knowledgeable about these illnesses, their diagnoses, and treatments in order to better inform their clients and owners about prevention strategies and seeking medical attention (Simpson et al., 2018).

5.2 Study Conclusions

5.2.1 Community Perceptions towards risks associated with Wildlife Cattle Interface

The results of this study illuminate the complex dynamics and effects of the wildlife-cattle interface, exposing a complex web of variables influencing animal health. The increased risk of disease transmission linked to this interaction may be the most significant issue. A route for the spread of illnesses between these two populations is made possible by the coexistence of wildlife and cattle in similar settings. Additionally, to posing a serious threat to domestic cattle's health, this also raises questions about the likelihood of disease spreading back to wild animal populations. Understanding and controlling the hazards of disease transmission should be a top concern. To protect both animals and cattle, vaccination programs, habitat management, and regular monitoring should be used.

The study also highlights the significant output declines and mortalities in cattle exposed to the wildlife-cattle interface. These losses, whether brought on by illnesses, predators, or accidents, can have a significant financial impact on cattle ranchers and even put their livelihoods in danger. Strong herd management procedures, secure cow fencing, and the use of techniques to prevent or control wildlife predators are essential to reducing these losses. These findings also highlight the necessity of insurance or compensation schemes for farmers who are financially burdened by losses due to wildlife.

The competition that develops between wild and domestic herbivores with comparable nutritional habits is another fascinating finding from the study. Because of the competition, both

groups may consume less food, which could have an impact on the animals' general health and welfare. To solve this problem, it is necessary to implement properly thought out land and resource management techniques, such as rotational grazing, habitat preservation, and fodder supply monitoring. According to the study findings, wildlife predation on cattle causes economic losses as well as ethical and environmental concerns. To limit the risk to cattle and prevent any retaliatory actions against wildlife, coexistence methods such as secure enclosures, guardian animal programs, or the responsible removal of problem predators must be designed and put into practice. These tactics essentially work to balance the competing needs of safeguarding domestic livestock and wildlife.

The results of this study highlight the significance of comprehensive and integrated management strategies for the wildlife-cattle interface. These findings highlight the need for adaptive management techniques that account for the complexity of the problem, combining farmer livelihoods with the health and well-being of domestic cattle and wildlife populations. To encourage peaceful coexistence at this interface and ensure the sustainability of both animal husbandry and wildlife conservation activities, effective management of disease risks, predation, competition for resources, and the prevention of injuries is essential. Addressing these intricate and connected problems would require cooperation between experts in wildlife, livestock, and conservation as well as active community participation.

5.2.2 Prevalence of Disease Transmission at Wildlife-Cattle Interface

Basing on findings of this objective, there is an engrossing tale about the major issues surrounding the wildlife-cattle interface and the alarmingly high prevalence of disease transmission in the study area. This interaction, where domestic cattle and animals coexist and frequently exchange resources, emerges as a key driver for the accelerated spread of illnesses. These discoveries have broad repercussions that include issues with public health, economic viability, and animal health. The evidence of a high prevalence of disease transmission highlights the urgent need for efficient management techniques. Pathogens can easily be transferred between wildlife and livestock due to their close proximity and common surroundings. Public health is also at risk from zoonotic illnesses, which are those that can spread from animals to people. In order to safeguard not only animal populations but also the welfare of the

communities live in these areas, a multidisciplinary strategy is required that places a high priority on studying and mitigating these illnesses.

The frequency of animal abortions during the previous five years is one of our survey's and interviews' alarming findings. Animal abortions can serve as sentinels for underlying health problems, particularly infectious illnesses. This poor reproductive outcome is a result of the interaction between wildlife and cattle, which includes stress effects and probable pathogen transfer. Such occurrences result in financial losses for livestock farmers due to decreased productivity and lost offspring. The importance of comprehending and taking care of livestock health cannot be overstated because it has a direct impact on the sustainability of livelihoods based on animals.

This research has shown that there are infections and parasites in the study region, which increases the danger of disease transmission. These germs can spread directly through touch or inadvertently through the use of communal resources like water and grazing grounds. Diseases like brucellosis, which can spread from cattle to wildlife, need to be given extra consideration. Effective disease control measures are essential for minimizing the prevalence of these viruses and parasites and lowering the health hazards to both animal and human populations. These strategies include immunization, deworming, and improved hygiene practice.

Another alarming finding relates to the malnutrition of animals caused by water and pasture shortages, which is made worse by the wildlife-cattle interface. In addition to causing dehydration and hunger in livestock, competition for scarce water resources also weakens their immune systems, making them more prone to illness. Making sure animals have appropriate access to water sources is crucial for solving this problem. This could entail employing water management systems, strategically placing water sources to reduce conflicts with wildlife, and using sustainable land management techniques.

In general, this study has shed light on the severity of the cattle-wildlife interface in the study area and its significant influence on disease transmission. It was discovered that disease transmission was extremely common, and that wildlife had a considerable impact on how quickly infections spread among sheep. Data from our study and interviews showed a number of alarming occurrences in the previous five years, including cow abortions, the existence of diseases and parasites, and cattle malnutrition as a result of water shortages. Events like these

contribute to the increased prevalence of illnesses like brucellosis. The study emphasizes that there is a significant risk at the wildlife-cattle interface, particularly in terms of the spread of illnesses and parasites.

5.2.3 Measures to mitigate factors associated with wildlife-cattle interface in Sanga Sub County

This conclusion shed light on the practical and coordinated steps taken by farmers and local authorities to lessen the complex problems brought on by the wildlife-cattle interaction in Sanga Sub County, Kiruhura District. The study clearly shows that these actions are intended to promote not only the least possible confrontation between domestic cattle and wildlife, but also their peaceful cohabitation. One of the important conclusions is that farmers actively participate in averting attacks on their livestock. They accomplish this by avoiding areas where wild animals congregate, so lowering the possibility of face-to-face encounters. This sensible strategy contributes to the protection of both cattle and wildlife. In addition, the practice of informing the Uganda Wildlife Authority (UWA) about wild animal attacks exemplifies a positive and collaborative relationship between the farming community and wildlife conservation authorities. This cooperation is essential for identifying and resolving problems related to the wildlife-cattle interface.

Local officials' comments in interviews highlight the significance of efforts to educate farmers. These efforts give farmers the information they need to make wise choices regarding herd management and safety precautions by educating the community about the possible risks and difficulties associated with the wildlife-cattle interface. This greater understanding lessens the likelihood of confrontations and promotes peaceful cohabitation. Another strategy recommended by the study is the handling of troublesome animals, which is essential for dealing with particular wildlife members that are dangerous to cattle. This strategy ensures the sustained coexistence of these two groups by safeguarding domestic cattle as well as the conservation of threatened or endangered animal species.

Programs for compensation are considered as being necessary to lessen farmers' financial burden when losses result from interactions with wildlife. In order to generate support for conservation efforts, these programs are essential in building strong partnerships between the farming

community and wildlife conservation authorities. Maintaining acceptable environments for both wildlife and livestock depends on conservation efforts. By protecting natural ecosystems and lowering conflicts, habitat conservation and management measures help these two populations coexist sustainably. Installation of live fence systems reduces the possibility of direct contacts and conflicts by acting as a physical barrier to keep wildlife out of livestock areas. It provides a workable answer for encouraging security and harmony.

Collaboration between locals and conservation authorities is facilitated via resource and revenue sharing agreements, which involve providing the community with concrete economic benefits including fish, firewood, and medicinal herbs. These actions promote conservation efforts and improve the general wellbeing of the neighborhood.

In light of the study's findings, it was concluded that farmers and local authorities in Sanga Sub County, Kiruhura District, have taken steps to alleviate the issues related to the wildlife-cattle interface in order to promote a peaceful coexistence between domestic cattle and wildlife. These steps range from practical ones like avoiding wildlife areas and setting up live fencing systems to group initiatives like educating farmers, dealing with problematic animals, offering compensation, and resource and revenue sharing schemes. A promising commitment to not only eliminating conflicts but also fostering responsible cohabitation and the protection of these interconnected populations in shared environments is shown by the community's proactive participation and cooperation with wildlife conservation authorities.

5.3 Recommendations

Basing on the study findings, the following recommendations were made;

- i. It was recommended that community engagement practices and stakeholder collaboration should be enhanced that is including the community in the development of suitable educational programs that take into account wildlife and livestock relationships as well as the social, cultural, and economic realities of the area.
- ii. In light of the research, it was recommended that there is need to enhance disease surveillance and management by responsible authorities working both in the ministry of agriculture and the local government especially on the likelihood of a disease spreading, it is essential to create and maintain reliable disease surveillance programs. Use practical

steps like regular health checks, timely vaccinations, and the creation of disease-free zones to reduce the likelihood of disease transmission.

- iii. To address the problem of wildlife harm and predation on cattle, adopt non-lethal predator deterrence tactics. The effect of wildlife on cattle herds can be lessened with the use of guardian animals, safe enclosures, and carefully thought-out herding techniques.
- iv. Encourage projects for collaborative land and resource management in light of the competition for resources that exists between wild and domestic herbivores. In order to ensure that both wildlife and cattle's nutritional needs are addressed while reducing competition, this may involve habitat preservation, rotational grazing, and sustainable resource allocation.
- v. Community Education and Awareness: Fund educational initiatives and public awareness efforts to lessen the spread of disease. These should emphasize the significance of illness prevention, early diagnosis, and the benefit of reporting to the appropriate authorities, and should target both farmers and local residents.
- vi. Management of Wildlife Problematic Animals: Establish procedures for dealing with problematic animals, both domestic and wild. This could entail using non-lethal techniques to resolve wildlife issues as well as the translocation of aggressive or diseased animals.
- vii. Develop cooperative compensation schemes that are open and effective to help farmers who suffer losses as a result of interactions with wildlife. In order to secure just compensation and preserve community goodwill, the projects should be carried out in collaboration with regional authorities and wildlife conservation organizations.
- viii. Encourage the development of live fence systems, especially in regions where encounters between wildlife and livestock are frequent. Implementing such physical barriers with prickly or disagreeable plants can successfully lower the possibility of direct meetings and confrontations.
- ix. Prioritize conservation efforts and habitat management initiatives in order to retain acceptable habitats for animals and cattle. By preserving shared resources and natural habitats, these actions reduce conflict.
- x. There is a need to visit offices of the affected areas like Lake Mburo National park to acquire more knowledge on wildlife interface.

5.4 Areas for further research

- i. Understanding the dynamics of disease transmission at the wildlife-cattle interface may require further study. This could entail conducting more in-depth epidemiological research to pinpoint specific disease vectors, reservoir hosts, and routes of disease transmission between cattle and wildlife. Such research might aid in the creation of more focused and successful illness management techniques.
- ii. It would be beneficial to conduct research on the creation and application of sustainable coexistence techniques at the wildlife-cattle interface. This could entail researching the effectiveness of various non-lethal livestock management techniques, conflict-free land-use planning, and predator deterrence strategies. Finding the finest coexistence techniques can help farmers' livelihoods and conservation efforts.

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APPENDICES

Appendix A: Questionnaire for respondents (Local Community)

Dear Sir/Madam.

I am **Tuwangye Innocent**, a Post Graduate student of Bishop Stuart University undertaking a research study on “*factors associated with animal health during wildlife-cattle interface in Sanga Sub County, Kiruhura district*”. This is a study for a requirement of the award of a degree of Master of Agriculture and Rural Innovations. It has no bearing on any one or company. Confidentiality of respondents is assured. You have been identified as one of the resource persons for the study and your genuine response is of great importance to the study.

SECTION A: BIOGRAPHIC DATA

(N.B Answer by Ticking (☑) where applicable)

1. Gender

(a). Female ☐

(b). Male ☐

2. Marital Status

(a) Single ☐

(b) Married ☐

(c) Divorced /separated ☐

(d) Widowed ☐

3. Age

(a) Below 21

(b) 21-30

(c) 31-40

(d) 41& above

4. Education Level

(a) Primary

(b) Secondary

(c) Tertiary

(d) University

(e) Others

SECTION B: Community perceptions towards risks associated with wildlife-cattle interface in Sanga Sub County, Kiruhura District.

1. Do you own livestock in your area?

a) Yes ☐

b) No ☐

2. If yes, what are the common owned livestock in your area? Please identify in the space provided

.....

.....

.....

3. What is the management of the owned livestock in your area?

Management of livestock	Yes	No
Extensive open grazing during dry season		
Extensive open grazing during wet season		
Paddock grazing		
Dry season supplementation		

4. Do cattle interface/contact with wildlife in your area?

a) Yes ☐ b) No ☐

5. If yes in 4 above, explain why?

.....

.....

.....

6. What are the factors are associated with cattle and wildlife interface/contact do you know?

Note: Tick(✓) in the space on the right to: SA = Strongly Agree, A = Agree, D = Disagree, and SD = Strongly Disagree with the statement.

Factors associated with wildlife-cattle interface	5 SA	4 A	3 NS	2 D	1 SD
Disease transmission risks threaten wildlife–livestock coexistence					
Face challenges in livestock production					
Significant mortalities and production losses in livestock					
Environmental degradation due to the high and increasing numbers of cattle in the park especially in the dry season					
Competition between wild and domestic herbivores of similar dietary					

breadth					
Predation and injuries by wildlife on cattle.					

SECTION B: The prevalence risk of wildlife-cattle interfaces in Sanga Sub County, Kiruhura District. 1. How serious is wildlife-cattle interface in your area (tick only one)

Very serious ☐ Somewhat serious ☐ Not very serious ☐

2. What is the prevalence risk wildlife-cattle interface do you know in your area? *Note: Tick(✓) in the space on the right to: SA = Strongly Agree, A = Agree, D = Disagree, and SD = Strongly Disagree with the statement.*

Prevalence risks	5. SA	4. A	3. NS	2. D	1. SD
Prevalence Abortions occurring in last 5 years in livestock					
Wildlife plays role in abortions in livestock					
Long calving intervals as an indicator of infertility of the cows					
Shortage of water is the range sixth among the factors which lead to conflict between wildlife and pastoralists					
Geographical/grazing area of farmers					
Changes in climate risks wildlife-cattle interface					
Size of the herd risk wildlife-cattle interface					
Pathogens and parasites wild origin are a risk factor associated with wildlife cattle interface.					
Presence of good pasture in game reserves is among of the factor, which leads to the conflict between pastoralist and wildlife					
The acquisition of new animals through purchase was an important risk factor for herd-level brucellosis					
Rising human population and increased demand for human habitation have resulted in increasingly fragmented landscapes and extensive interface areas					
Cultural practice in the study area inspire them to have large					

number of cattle while there is no land available for such large herds therefore grazing in protected area is inevitable					
--	--	--	--	--	--

SECTION B: Measures to mitigate factors associated with wildlife- cattle interfaces in Sanga Sub County, Kiruhura District

1. What animal husbandry do you practice in your area?

a). Zero grazing ☐ b). Mixed free range and zero grazing ☐

c). Free range ☐ d). Other (Specify).....

2. Where do you get fodder for your cattle?

a). Graze in the field ☐ b). Buys commercial fodder ☐ c). Cut and carry fodder ☐

d). Other (Specify).....

3. Do you protect your cattle against wild animals?

a). Yes ☐ b). No ☐

4. If yes in 3 above, how?

a). Dogs ☐ b). Security personnel ☐ c). Hire an ordinary person ☐

d). Others (specify)

5. Where does your cattle sleep?

a). Field ☐ b). Kraal ☐ at home c). Others specify
.....

6. How do you prevent attacks from wild animals?

a). Keep out from zones with wild animals ☐

b). Report to the Uganda wildlife authority ☐

c). Consult a veterinary official ☐

d). Hunt down the wild animal ☐

e). Others specify

7. What measures have you put in place to prevent the risks associated with wildlife-cattle interface?

Note: Tick(☑) in the space on the right to: SA = Strongly Agree, A = Agree, D = Disagree, and SD = Strongly Disagree with the statement.

Measures to mitigate wildlife-cattle interface	5. SA	4. A	3. NS	2. D	1. SD
Community member participation to avoid killing carnivores while kill their cattle					
Provision of conservation education to the pastoralists and community surrounding and outreach program provided by wildlife managers					
Wildlife has to contribute meaningfully to community-level economies and become integrated with livestock and other land uses to enhance adaptive capacity at the landscape scale					
Ensuring even immigrants have awareness about their responsibilities to ensure conservation of wildlife resources					
Resettlement of the people living within 500M radius from park boundary is taken to reduce the conflict					
Fencing the wildlife protected area from pastoralists					
Encourage paddocking by cattle keepers					
Construction of water dams for cattle and wildlife					

Others specify in the spaces provided;

.....

.....

.....

Thank you for your cooperation

Appendix B: Interview guide for respondents (park employees and sub-county leaders)

Dear Sir/Madam.

I am **Tuwangye Innocent**, a Post Graduate student of Bishop Stuart University undertaking a research study on “factors associated with animal health wildlife-cattle interface in Sanga Sub County, Kiruhura district”. This is a study for a requirement of the award of a degree of Master of Agriculture and Rural Innovations. It has no bearing on any one or company. Confidentiality of respondents is assured. You have been identified as one of the resource persons for the study and your genuine response is of great importance to the study.

1. Do you own livestock in your area?
2. What are the common owned livestock in your area?
3. What is the management of the owned livestock in your area?
4. Do cattle interface/contact with wildlife in your area?
5. What are the factors are associated with cattle and wildlife interface/contact do you know?
6. How serious is wildlife-cattle interface in your area
7. What is the prevalence risk wildlife-cattle interface do you know in your area?
8. What animal husbandry do you practice in your area?
9. Where do you get fodder for your cattle?
10. Do you protect your livestock against wild animals? how?
11. Where do your cattle sleep?
12. How do you prevent attacks from wild animals?
13. What could the diseases transmitted between livestock and wild animals in the area?
14. What measures have you put in place to prevent the risks associated with wildlife-cattle interface?

Thank you for your cooperation

Appendix C: Interpreted Questionnaire in Runyakitara

Ekibuuzo ky'abokugarukamu (Abantu ba butoosha).

Sebo/Nyabo,

Nyowe ndi Tuwangye Innocent omwegi orikushomera omu itendekyero rikuru rya Bishop Stuart kandi orikukora ahaby'okucondooza ahari "Ebizibu ebikwatiraine n'obusyo bw'ente Hamwe nenyamaisha Zomu Irindiro ry'enyamaiswa omugomborora ya Sanga, omu district ya Kiruhuura". Ebyokushoma ebi ninyenda bimpitsye ahakuheebwa diguri y'orurengo rwahaiguru omuby'obuhingi n'okuhangahanga omu by,obuhingi.

Eki tihaine oku kiine akakwate aha muntu nari ekitongore kyona. Abantu ebi baraagarukemu byoona n'ebiintu byaitu omumubonano. Omuri eki, iwe odoorainwe nk'omuntu w'obujunaanizibwa omu kucondooza oku kandi ebi oraahayo, okagarukamu nibyaija kuhwera munonga omuby'okushoma ebi.

EKICWEKA KYA 'A'. EBIRIKUKWATA AHA BACONDOOZIBWA, (Kyebeera ekihikire)

- 1 Omukazi Omushaija
- 2 Oshwairwe (b) Toshwirwe (c) Nkataana
(d) Nkaferwa omushaija/omukazi
- 3 Emyaka yaawe.
(a) Ahansi ya 21 (b) 21-30 (c) 31-40 (d) 41 Nokweyongyerayo
4. Obwegyese
(a) Obwa purayimare (b) Obwasiniya (c) Obwa ebyemikono
(d) Univasite (e) Ekyindi kigambe.

EKICWEKA KYA "B": Ebizibu ebyeine akakwate n'obutsyo bw'ente omuri Sanga nk'egomborora

1. Otungyire amatungo.
(a) Ego (b) Ngaha
2. Ekigarukwamu kyawe kukiraabe kiri "Ego" Nimatungo ki agarikutungwa omukicweka eki?

.....

-
3. Nimitendero ki eyi erikureebereramu amatungo omu kicweka eki

Emitendero	Ego	Ngaha
Okuriisa burihamwe omu kyanda		
Okuriisa burihamwe omunjura		
Okuziitira nkariisa omu bicweka		

4. Amatungo gaine okugari kubugaana bugaana n'enyamaishwa z'omu iswa?

(a) Ego (b) Ngaha

5. Ekigarukwamu kyawe kyaba kiri ego shoboroora?

-+
6. Ni bizubu ki ebirukuruga, omu matungo kuhikaana na enyamaishwa z'omu iswa ebiri orikumanya?

Note (Engyenderwaho: Ninyikiriza buzima “NB”, Ninyikiriza “N” Ngaha tindikwikiriza “NT” Tindikwikiriza nakakye TN (“Kyebeera”)

Ebizubu

Okutumura endwara amatungo	NB	N	NT	TN
Amatungo tigakukanya				
Amatungo nigaitwa enyamaishwa				
Okushisha eby'obuhangwa omu irindiro ryenyamaishwa aha bwa amatungo mingi omu kyanda				
Akahaaya haayano aha gaati y'enyamaishwa eziri kurya obunyatsi burikushushana				
Okwitana n'okutunga ebironda				

EKICWEKA KYA “C” OKUBAHO KW'EBIZUBU AHAGATI YAMATUNGO G'ENTE NA ENYAMAISHWA Z'OMWISHWA KUHIKANA.

1. Okuhikana kw'amatungo, n'enyamaishwa z'omwishwa kwine maani ki omu kicweka eki

(a) Nizihiikana munonga (b) Kakye kakye (C) Tikwamaani

2. Ebizubu ebirikubaho omumatungo kuhikana na enyamaishwa z'omwishwa? (Kyebeera)

Okubaho kw'ebizubu	4	3	2	1
Omu myaka etaano abairemu obutoorogye				
Obutoorogye niburetwa enyamaishwa z'omwishwa				
Ente nizontsya munonga zitakwenda kweema				
Okubura kw'amaizi omu irindiro ry'enyamaishwa nikuretaaho eburwaire ahagaati y'abariisa na abarinzi benyamaishwa				
Empiduuka yobwire				
Obwingi bw'ente				
Endwara hamwe n'obukooko bw'omwishwa nibukwata amatungo				
Okubaho kw'obunyatsi omu irindiro ryenyamaishwa				
Okutunga ente z'omuringo ogundi				
Obwingi bw'abantu oburugiremu kubaaganisa itaka				
Emituurire y'abantu, kutunga ente nyingi omukyanga				

EKICWEKA KYA “D” EKYAKUBAASA KUKORWA KWERINDA AMATUNGO KUTAHIRIIRA ENYAMAISHWA Z'OMWISWA.

- Nimiringo ki eyi orikuriisamu ente?
 - Kusiibika aha muguuha (b) Kuzyenzya amatungo gakarwa burihamwe
 - Ogundi muringo shoboorera
- Ebinyatsi by'okuriisa amatungo gawe nobyihaahi?
 - Nindiisa (b) Nimbiguura (c) Nimbiteema mbitwara
 - Ogundi muringo shoboorora
- Norinda ente zaawe enyamaishwa z'omwishwa?
 - Ego (b) Ngaha
- Ekigarukwamu kyaba kiri ego aha 3 nozirinda ota"
- Ente zaawe niziraara nkahi?
 - Omu ihamba (b) Omurugo (c) Ogundi muringo gugambe.....
- Nozirinda ota kukwatwa enyamaishwa z'omwiswa
 - Ninyerinda kuriisa ahu enyamaiswa ziri

(b) Ninyetereera omuranga omu barinzi b'enyamaishwa

(c) Ninkoragana n'omushaho w'ebyamatungo

(d) Nimpiga enyamaishwa nziita

7. Otaireho miring ki kurinda amatungo gawe kuhikana n'enyamaishwa z'omwiswa

Omuringo	4	3	2	1
Okwita enyamaishwa ezirikurya amatungo				
Kwegyesa abariisa bey'okurinda enyamaishwa z'omwirindiro				
Abari kutaahirira enyamaishwa bamanye omugasho gwazo				
Kurondera obutuuzze obundi abutaaho abarikutuura haihi na irindiro				
Irindiro ry'enyamaishwa rizitiirwe				
Kuhabura abariisa kuzitira amataka gabo				
Okutaaho amaizi g'amatungo omu bantu				

Webare

Appendix D: Okubuuza Omuntu Omwe aha Ryomwe (Abakozi Ba Irindiro Na Abegoboorora

Ekibuuza ky'abokugarukamu (Abantu ba butoosha)

Sebo/Nyabo,

Nyowe ndi Tuwangye Innocent omwegi orikushomera omu itendekyero rikuru rya Bishop Stuart kandi orikukora ahaby'okucondooza ahari "Ebizibu ebikwatiraine n'obusyo bw'ente omugomborora ya Sanga, omu district ya Kiruhuura". Ebyokushoma ebi ninyenda bimpitsye ahakuheebwa diguri y'orurengo rwahaiguru omuby'obuhingi n'okuhangahanga ebyokushemeza obuhingi.

Eki tihaine oku kiine akakwate aha muntu nari ekitongore kyona. Abantu ebi baraagarukyemu byoona n'ebiintu byaitu omumubonano. Omuri eki, iwe otoorainwe nk'omuntu w'obujunaanizibwa omu kucwondooza oku kandi ebi oraaheyo, okagarukaho nibyaija kuhwera munonga omuby'okushoma ebi.

- (1) Oyine amatungo omu mwanya ugu?
- (2) Nimatungoki agarikushangwa omukicweka eki?
- (3) Amatungo aga nigariisibwa gata?
- (4) Amatungo haine okugari kubuugana bugaana na enyamaishwa z'omwirindiro?
- (5) Nogira nibuzibu ki oburikuruga omu nyamaiswa z'omu irindiro kurya n'amatungo ganyu?
- (6) Ekya amatungo kurya na enyamaishwa z'omu irindiro nikingana ki?
- (7) Nimiringo ki eyi orikurisizamu amatungo gawe?
- (8) Ebinyatsi bw'amatungo nob.....haahi?
- (9) Oyine oburinzi bwona obu oteireho kurinda amatungo gawe.
- (10) Ogarinzire ota?
- (11) Ente zaawe niziraara nkahi?
- (12) Amatungo gawe nogarinda ota obutaataahirwa nyamaishwa z'omwiswa?
- (13) Oteireho bwerinzi ki kurebuka ngu amatungo gawe tigahikaana na nyamaishwa z'omuiswa?

Webare

Appendix E: Work Plan and Time Schedule

This plan includes all research activities that were done all through the research period as indicated below;

ACTIVITY	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023 to Apr 2024
Formulation of topic & Presentation of draft proposal									
Review of proposal by supervisors & designing of questionnaire by researcher. Concept presentation.									
Proposal presentation, corrections and amendments of proposal and submission through Director of Graduate Studies Research and Innovations to Research Ethics Committee (REC).									
Data collection									
Data analysis									
Report writing									
Report review by supervisors and submission of Research findings									
Research defense and Viva									
Research corrections and amendments									
Final research submission									

Appendix F: Proposed Budget for the Research

ACTIVITY	COST/Ugandan shillings
PHASE 1 : PRELIMINARY	
• Internet access(admin)	400,000
• Photocopying and printing of relevant material	450,000
• Transport and communication	200,000
	1,050,000
PHASE 2 : DATA COLLECTION	
• Travel to field	500,000
• Compensation of participant's time	600,000
• Personnel	450,000
	1,550,000
ANALYSIS AND PRESENTATION	
Purchase of stationary and other relevant materials	300,000
Results Dissemination	800,000
Miscellaneous	150,000
	1,250,000
Total	3,850,000/=

Appendix G: Krejcie and Morgan Tables

N	S	N	S	N	S	N	S	N	S	N	S
10	10	60	52	110	86	210	136	320		550	226
15	14	65	56	120	92	220	140	175		600	234
20	19	70	59	130	97	230	144	340		650	242
25	24	70	59	140	103	240	148	181		700	248
30	28	75	63	150	108	250	152	360		750	254
35	32	80	66	160	113	260	155	186		800	260
40	36	85	70	170	118	270	159	380		850	265
45	40	90	73	180	123	280	162	191		900	269
50	44	95	95	190	127	290	165	400		950	272
55	48	100	80	200	132	300	169	191		1000	278
								420			
								201			
								440			
								205			
								460			
								210			
								480			
								241			
								500			
								217			
Note: N is Population size S is Sample size						Source: Krejcie & Morgan,1970					