American Research Journal of Humanities & Social Science (ARJHSS)
E-ISSN: 2378-702X
Volume-07, Issue-03, pp-28-53
www.arjhss.com

Research Paper Open Access

Factors Associated With Animal Health during Wildlife-Cattle Interface in Sanga Sub County, Kiruhura District

Tuwangye Innocent[1], Kalibwani Rebecca[2], Tumusiime Bernard[3]
[1, 2, 3](*Faculty of Agriculture Environmental Sciences and Technology, Bishop Stuart University Mbarara Uganda)*
Corresponding author: Tuwangye Innocent.

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. This research assessed the factors associated with animal health during wildlife-cattle interface in Sanga Sub County, Kiruhura District. The objectives of this study included: to find out the community perceptions towards risks associated with 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 risk factors associated with animal health during 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 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. 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.

Keywords – Animal health, wildlife- cattle interface, Sanga, Kiruhura District, Uganda

I. 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.

Background of the Study

As human activities continue to encroach upon natural habitats, the interactions between wild-life and cattle become increasingly common, leading to potential consequences for animal health, ecosystem integrity, and public health. According to research, 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. 2013 (Ocholla GO).

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 (Otuoma J., 2004). 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. According to Caron A. et al. (2016), 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 (Ngongolo, et al.2019). 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, Kruska, 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 (Djoghlaf A. A, 2010). About 16% of the population in sub-Saharan Africa is dependent on pastoralism (Djoghlaf 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 (Isdori, 2016). 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 savannas are home to the greatest diversity of wildlife on the planet (Reid, 2012). 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 (Sumay, 2012). 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 GF. 2012). According to Kideghesho JR and Msuya TS (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 (Shemwetta et al., 2000). 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, 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 (Chapman, 2011).

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 (Odipo, 2023)

II. PROBLEM STATEMENT

Animal stress caused by habitat loss tends to restrict access to essential resources for survival including water, pasture, and mineral salts is being amplified by the current increase in demographic pressure together with climate change and variability (Daszak et al., 2001; Olff and Grant, 2008). Thus, during dry seasons, grazing and water availability are the main points of contention in interactions between wildlife and cattle. According to Young et al. (1978) and Bourn and Blench (1999), 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 are 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 (Rasmussen, 1999; Lindsey et al., 2005). Numerous research (Daszak et al., 2001; Thompson et al., 2010) 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 was to contribute to 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.

The main objective of the study

This study examined 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

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 develop evidence-based recommendations to mitigate identified risk factors associated with animal health during wildlife- cattle interface in Sanga Sub County, Kiruhura District.

III. LITERATURE REVIEW

Community perceptions associated with risks during 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 (Odadi, 2011). 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 (Bhola et al. 2012), 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 (Coppolillo et al. 2003; Georgiadis et al. 2007; Bhola et al. 2012). 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, Daniel 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) (Grobler 1981). 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 (Fritz, de Garine-Wichatitsky, & Letessier 1996). By choosing backcountry habitats far from water, concentrations of other herbivores, predators, and human disturbance, sable and roan antelope avoid competition and predation (Hensman et al. 2013; Haveman 2014).

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 (Wilmshurst, Fryxell, and Bergman 2000; Owen-Smith 2002), 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 (Odadi et al. 2011), 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 (Homewood 2008; Fynn et al. 2015), which enhances the diet of wild herbivores throughout the dry season (Parrini & Owen-Smith 2009). 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 (Western & Gichohi 1993).

Risks of disease transmission pose a hazard to the coexistence of animals and livestock in Africa (Bengis, Kock, & Fischer 2002). (Bengis, Kock, & Fischer 2002) 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. According to Michel and Bengis (2012), 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 (de Garine- Wichatitsky et al. 2013a). Ironically, the spread of bovine tuberculosis from wildlife to livestock populations is a serious worry for the development of TFCAs in southern Africa (Michel et al. 2006; de Garine-Wichatitsky et al. 2013b).

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 (Muhwezi, 1994).

The roan antelope (Hippotragus equinus), for example, is extremely sensitive to pasture competition (Monday, 1991). 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.

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 [Kock R. A., 2002]. According to Ocaido (2006), Amblyomma, Rhipicephalus, and Hyalomma ticks are the main vectors for Babesia, Theileria, Anaplasma, Ehrlichia, Rickettsia, and several viral diseases in SSA. 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 (Kabi, 2008). 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 (Magona and J. S. P. Mayende, 2002). 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 (Paling, 2011). 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, Anaplasmaovis, 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 (Djoghlaf 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 (Ocaido L. S., 2006). There are at least

843,608 indigenous and 219,904 exotic cattle in western Kenya alone (Odadi, 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 (Otim, 2000), 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 (Bhola N, 2012). 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 (Otim, 2000). 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 (Viana, 2014). 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) and Gottdenker et al. (2014), 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 Lvschal 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 offtake 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 causes 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. The Manyoni District (study area) is the most populous district in Singida, with 767,273 cattle, or 48.3% of all cattle in the area, according to URT (United Republic of Tanzania, 2016). 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).

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. 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 (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. Participant from the village of Lulanga 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).

IV. RESEARCH METHODOLOGY

Research design

This research used a descriptive-survey research design. This scientific approach entails describing and evaluating a subject's behavior 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 or questionnaires in this design. Researchers explain 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 and to test research hypotheses. Additionally, they explain the significance of the findings by linking statistical test results to earlier research projects.

Study population

The communities in the chosen study area was 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 was elderly persons with extensive knowledge of the region's history of community-park relations. Participants was visited in their homes especially early morning during milking times, evening times when cattle are returning to. For this study, a population of 300 participants was the targeted.

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 was based on their positions and familiarity with the study.

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 was included in the study's sample. A formula developed by Krejcie and Morgan (1970) was used to determine the sample size, as shown on the table in appendix G.

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.

Data collection methods

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.

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.

Data collection tools

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.

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.

Data presentation and analysis

Data Presentation

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

Data analysis and interpretation

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

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.

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 created after the study, which involved the triangulation of all data sources to strengthen and complement it.

Quality control

It presents validity and reliability of data instruments which was used during the study.

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).

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

$$CVI = n/N$$

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).

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)

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 for 20 minutes. The researcher underlined the importance of treating the findings in a discrete manner.

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) strongly Disagree and (1) 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.

Ethical considerations

A supporting letter from the faculty was obtained explaining the objectives of the research. This was taken to the relevant stakeholders seeking for 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 their benefits of participating in the research.

Dissemination of results plan

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 were distributed to raise awareness about animal health risks at the wildlife-cattle interface.

Limitations of the Study

While in the field the 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 have no time to answers the questions asked 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.

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

V. DATA ANALYSIS, PRESENTATION AND INTERPRETATION

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 below;

Table 1: 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 1 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 2: Common owned livestock in the area

Common livestock	Frequency	Percentage (%)
Cows	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 3 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 3 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-gazatted land with limited or no restrictions for anyone to graze on in Sanga Sub County.

Table 4. 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 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 5: 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 5 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 6: 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 gazzated areas inevitable.	34	90	11	12	1	3.97	.833
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

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 gazzeted 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 6 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.

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 7 and 8 below;

Table 7: Level of seriousness of wildlife-cattle interface

Level of wildlife-cattle interface	Frequency	Percentage (%)
Very serious	127	85.8
Somewhat serious	8	5.4
Not very serious	13	8.8
Total	**148**	**100**

Source: Primary data, 2023

The results of the study regarding the level of wildlife-cattle interface in table 7 revealed that 85.8% of the respondents indicated that the interface was very serious, 5.4% revealed that it was somewhat serious and 8.8% indicated that it was not very serious. 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 8: 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 8 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.

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 9 –15 below;

Table 9: 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 9 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 10: 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 10 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 11: 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 11 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 12: 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 12 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 13: 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 14: 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 14 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.

Table 15: 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 while 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 15 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 while 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

VI. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Community Perceptions towards risks associated with Wildlife Cattle Interface

The study examined the factors associated with animal health during 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 cow 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 Ndegu 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.

Prevalence of Disease Transmission during Wildlife-Cattle Interface

The study also examined the prevalence of disease transmission during 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.

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).

Study Conclusions

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.

Prevalence of Disease Transmission during 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's 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 animal miscarriages, 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 illness and parasites.

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

These objectives' conclusions 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.

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. Resource and Revenue Sharing: Encourage resource and revenue sharing agreements that offer the neighbourhoods' residents real economic advantages. Sharing resources like fish, firewood, and medicinal herbs may fall under this category. These agreements can improve community well-being in general, cooperation, and support for conservation activities.

REFERENCES

[1]. Abrantes, A. C., Lavandera, P. A., Guijosa, J. M., Serejo, J., & Vieira-Pinto, M. (2019). Identification and evaluation of factors associated to Mycobacterium bovis transmission in southeast hunting areas of central Portugal. *Galemys: Boletín informativo de la Sociedad Española para la conservación y estudio de los mamíferos*, *31*(1), 61-68.

[2]. Abule E, Snyman HA, Smit GN (2005) Comparisons of pastoralist's perceptions about rangeland resource utilisation in the Middle Awash Valley of Ethiopia. *J Environ Manag* 75:21–35

[3]. Alhaji N, Wungak Y, Bertu W (2016) Serological survey of bovine brucellosis in Fulani nomadic cattle breeds (Bos indicus) of North-central Nigeria: Potential factors and zoonotic implications. Acta Tropica 153:28–35

[4]. Allan KJ, Biggs HM, Halliday JE, Kazwala RR, Maro VP, Cleaveland S, et al. (2015) Epidemiology of leptospirosis in Africa: a systematic review of a neglected zoonosis and a paradigm for 'One Health'in Africa. PLoS Neglected Tropical Diseases 9:e0003899

[5]. Ameni G., Aseffa A., Engers H., Young D., Gordon S., Hewinson G. et al., (2007), 'High prevalence and increased severity of pathology of bovine tuberculosis in Holsteins compared to zebu breeds under field cattle husbandry in central Ethiopia', *Clinical and Vaccine Immunology* 14, 1356–1361.

[6]. Aune K, Rhyan JC, Russell R, Roffe TJ, Corso B (2012) Environmental persistence of Brucella abortus in the Greater Yellowstone Area. The Journal of Wildlife Management 76:253–261

[7]. Barrett D, Parr M, Fagan J, Johnson A, Tratalos J, Lively F, et al. (2018) Prevalence of Bovine Viral Diarrhoea Virus (BVDV), Bovine Herpes Virus 1 (BHV 1), Leptospirosis and Neosporosis, and associated factors in 161 Irish beef herds. BMC Veterinary Research 14:8

[8]. Bedelian C, Ogutu JO (2017) Trade-offs for climate-resilient pastoral livelihoods in wildlife conservancies in the Mara ecosystem. Kenya. Pastoralism 7:10

[9]. Boyd, C., R. Blench, D. Bourn, L. Drake and P. Stevenson, (1999). Reconciling interests among wildlife, livestock and people in Eastern Africa: A sustainable livelihoods approach. Natural Resources Perspectives, 45.

[10]. Bugeza J, Muwonge A, Munyeme M, Lasuba P, Jacques G, Kankya C (2018) Seroprevalence of bovine brucellosis and associated factors in Nakasongola district, Uganda. Tropical Animal Health and Production:1–4.

[11]. Chaka, Hassen, et al. "Cross-sectional survey of brucellosis and associated risk factors in the livestock–wildlife interface area of Nechisar National Park, Ethiopia." *Tropical animal health and production* 50 (2018): 1041-1049.

[12]. Carruthers, J. (2008). Wilding the farm or farming the wild? The evolution of scientific game ranching in South Africa from the 1960s to the present. . *Transactions of the Royal Society of South Africa 63:* , 160–181.

[13]. Casanovas-Massana A, Pedra GG, Wunder EA, Diggle PJ, Begon M, Ko AI (2018) Quantification of Leptospira interrogans survival in soil and water microcosms. Applied Environmental Microbiology 84:e00507–e00518

[14]. Chachage C. (2010). Land acquisition and accumulation in Tanzania: The case of Morogoro, Iringa and Pwani regions; Available:http://www.commercialpressure onland.org/research-paper/landacquisation-and accumulation-Tanzania.

[15]. Daszak P, Cunningham AA, Hyatt AD (2000) Emerging infectious diseases of wildlife–threats to biodiversity and human health. Science 287:443–449

[16]. Decker DJ, Brown TL, Sicmer WF (2001) Evolution of people-wildlife relations. In: Decker DJ Brown TL Siemer WL (ed) Human dimensions of wildlife management in north America. The Wildlife Society, Bethesda MD

[17]. Dejene SW, Heitkönig IMA, Prins HHT, Fitsum A, Daniel A, Zelalem E, Tessema ZK, de Boer WF (2016) Factors for bovine tuberculosis (bTB) in cattle in Ethiopia. PLoS One 11(7):e0159083. doi:10.1371/journal.pone.015908

[18]. Devi, K. R., Lee, L. J., Yan, L. T., Syafinaz, A. N., Rosnah, I., & Chin, V. K. (2021). Occupational exposure and challenges in tackling M. bovis at human–animal interface: a narrative review. *International archives of occupational and environmental health*, *94*, 1147-1171.

[19]. Djoghlaf A. A. (2010). Good Practice Guide Pastoralism, Nature Conservation and Development, Secretariat of the Convention on Biological Diversity, Montreal.

[20]. du Toit, J. R. (2010). Wild rangelands: Conserving wildlife while maintaining livestock in semi-arid ecosystems.

[21]. EBI, Ethiopian Biodiversity Institute (2014) Government of the Federal Democratic Republic of Ethiopia. In: Ethiopia's Fifth National Report to the Convention on Biological Diversity Ethiopian Biodiversity Institute. May, 2014 Addis Ababa, Ethiopia

[22]. Estrada-Pen˜a A, Ostfeld RS, Peterson AT, Poulin R, de la Fuente J (2014) Effects of environmental change on zoonotic disease risk: an ecological primer. Trends in Parasitology 30:205–214

[23]. Fratkin E. (2008). Age-sets, households and the organization of Pastoral production: The Ariaal, Samburu and Rendille of Northern Kenya. Research in Economic Anthropology; 8:295-314.

[24]. Frost, P. a. (2008). The CAMPFIRE programme in Zimbabwe: Payments for wildlife services. . *Ecological Economics 65:*, 776–787.

[25]. Galvin KA. (2009). Transitions: Pastoralists living with change. Annual Review of Anthropology. 38(1):185–198.

[26]. Garnett et al. (2007). Improving the effectiveness of interventions to balance conservation and development: A conceptual framework. . *Ecology and Society 12(1):* , 2. .

[27]. Georgiadis, N. J. (2007). Savanna herbivore dynamics in a livestock-dominated landscape: I. Dependence on land use, rainfall, density, and time. . *Biological Conservation 137:*, 461–472. .

[28]. Godfroid J (2018). Brucella spp. at the Wildlife–Livestock Interface: An Evolutionary Trajectory through a Livestock-to-Wildlife ''Host Jump''? Veterinary Sciences 5:81

[29]. Hariohay KM, Fyumagwa RD, Kideghesho JR, Røskaft E. (2017). Assessing crop and livestock losses along the Rungwa-Katavi Wildlife Corridor, South-Western Tanzania. International Journal of Biodiversity and Conservation. 9(8): 273-283.

[30]. Hlokwe T.M., Van Heiden P., Michel A.L., Van Helden P. & Michel A.L, (2014), 'Evidence of increasing intra and inter-species transmission of *Mycobacterium bovis* in South Africa: Are we losing the battle?', *Preventive Veterinary Medicine* 115, 10–17.

[31]. Hobbs et al. (2008). *Fragmentation of rangelands: Implications for humans, animals, and landscapes. Global Environmental Change 18: 776–785.*

[32]. Huho JM, Ngaira JK, Ogindo HO (2011) Living with drought: the case of the Maasai pastoralists of northern Kenya. Educational Research 2:779–789

[33]. Kalema-Zikusoka G., Bengis R.G., Michel A.L. & Woodford M.H, (2005), 'A preliminary investigation of tuberculosis and other diseases in African buffalo (*Syncerus caffer*) in Queen Elizabeth National Park, Uganda', *Onderstepoort Journal of Veterinary Research* 72, 145–151.

[34]. Keesing F, Belden LK, Daszak P, Dobson A, Harvell CD, Holt RD, et al. (2010) Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature* 468:647

[35]. Kiplagat, S. K., Kitala, P. M., Onono, J. O., Beard, P. M., & Lyons, N. A. (2020). Factors for outbreaks of lumpy skin disease and the economic impact in cattle farms of Nakuru County, Kenya. *Frontiers in veterinary science*, *7*, 259.

[36]. LaHue, N. P., Baños, J. V., Acevedo, P., Gortázar, C., & Martínez-López, B. (2016). Spatially explicit modeling of animal tuberculosis at the wildlife-livestock interface in Ciudad Real province, Spain. *Preventive veterinary medicine*, *128*, 101-111.

[37]. Loureiro AP, Pestana C, Medeiros M, Lilenbaum WA (2017) High frequency of leptospiral vaginal carriers among slaughtered cows. Animal Reproduction Science 178:50–54

[38]. Løvschal M, Ha°konsson DD, Amoke I (2019) Are goats the new elephants in the room? Changing land-use strategies in Greater Mara, Kenya Land Use Policy 80:395–399

[39]. Marera hunting safari company report. Hunting report. Manyoni, Singida; 2016.

[40]. Mbisse, S., (2010). Discussion on incidences for livestock grazing inside Meru Catchment Reserve [Cell Phone] (Personal communication, 5 June 2010).

[41]. McDermott JJ, Arimi S (2002) Brucellosis in sub-Saharan Africa: epidemiology, control and impact. Veterinary Microbiology 90:111–134

[42]. Mkutu. (2010). Pastoralism and conflict in the Horn of Africa. University of Bradford.

[43]. Muwanika V, Kabi F, Masembe C. (2016) Population genetic structure of Theileria parva field isolates from indigenous cattle populations of Uganda. Tick and Tick-Borne Diseases. 7:291–297.

[44]. Mwachui MA, Crump L, Hartskeerl R, Zinsstag J, Hattendorf J (2015) Environmental and behavioural determinants of leptospirosis transmission: a systematic review. PLoS Neglected Tropical Diseases 9:e0003843

[45]. Ndengu, M., Matope, G., Tivapasi, M., Scacchia, M., Bonfini, B., Pfukenyi, D. M., & de Garine-Wichatitsky, M. (2018). Sero-prevalence of chlamydiosis in cattle and selected wildlife species at a wildlife/livestock interface area of Zimbabwe. *Tropical animal health and production*, *50*, 1107-1117.

[46]. Naughton-Treves L, Alix-Garcia J, Chapman CA.(2011) Lessons about parks and poverty from a decade of forest loss and economic growth around Kibale National Park, Uganda. Proceedings of the National Academy of Sciences of the U S A.; 108:13919–13924.

[47]. Njeru J, Wareth G, Melzer F, Henning K, Pletz M, Heller R, et al. (2016) Systematic review of brucellosis in Kenya: disease frequency in humans and animals and factors for human infection. BMC Public Health 16:853

[48]. Norton-Griffiths, M. a. (2010). *The future of wildlife on Kenya's rangelands: An economic perspective. In Wild rangelands: Conserving wildlife while maintaining livestock in semi-arid ecosystems, ed. J.T. du Toit, R. Kock, and J.C. Deutsch.* Chichester, UK:: Blackwell Publishing.

[49]. Nthiwa D, Alonso S, Odongo D, Kenya E, Bett B (2019) A participatory epidemiological study of major cattle diseases amongst Maasai pastoralists living in wildlife–livestock interfaces in Maasai Mara, Kenya. Tropical Animal Health and Production 51:1097–1103

[50]. Nyhus PJ. (2016). Human–wildlife conflict and coexistence. Annu. Rev. Environ. Resour. Research Report No. 03.5, Mkuki na Nyota Publishers.41:143–71. [ISBN 9987-686-67-2]

[51]. Ntivuguruzwa, Jean Bosco, Francis Babaman Kolo, Richard Simba Gashururu, Lydia Umurerwa, Charles Byaruhanga, and Henriette Van Heerden. "Seroprevalence and associated risk factors of bovine brucellosis at the wildlife-livestock-human interface in Rwanda." *Microorganisms* 8, no. 10 (2020): 1553.

[52]. Ocholla GO, K. J. (2013). *Assessment of traditional methods used by th Samburu Pastoral Community in Human Wildlife Conflict Management. Department of Environmental Planning and Management, Nairobi Kenya.*

[53]. Odhiambo et al. (2008). *Conflicts in Ngorongoro District: Causes Causes, consequences and possible solutions a report of a consultancy commissioned jointly by ERETO Ngorongoro Pastoralist Project and Ngorongo district Local Govermnet and managed by Ngorongoro NGO Network.*

[54]. Ogutu, J.O., H.-P. Piepho, R.S. Reid, M.E. Rainy, R.L. Kruska, et al. (2010). Large herbivore responses to water and settlements in savannas. . *Ecological Monographs 80:*, 241–266.

[55]. Patz JA, Daszak P, Tabor GM, Aguirre AA, Pearl M, Epstein J, et al. (2004) Unhealthy landscapes: policy recommendations on land use change and infectious disease emergence. Environmental Health Perspectives 112:1092

[56]. Prins HHT (2000) Competition between livestock and wildlife in Africa. In: Prins HHT, Grootenhuis JG, Dolan TT (eds) Wildlife conservation by sustainable use. Kluwer, Boston MA

[57]. Prishchepov, A. V. (2012). Effects of institutional changes on land use: Agricultural land abandonment during the transition from state-command to market-driven economies in post-Soviet Eastern Europe.

[58]. Queiroz, C. R. (2014). Farmland abandonment: Threat or opportunity for biodiversity conservation? A global review. . *Frontiers in Ecology and the Environment 15:*, 288–296.

[59]. Rajeev M, Mutinda M, Ezenwa VO (2017) Pathogen Exposure in Cattle at the Livestock–Wildlife Interface. EcoHealth 14:542–551

[60]. Ranglack and du Toit. (2016). Bison with benefits: Towards integrating wildlife and ranching sectors on a public rangeland in the western USA. . *Oryx 50(3):*, 549–554.

[61]. Rasmussen, G.S.A., (1999). Livestock predation by the painted hunting dog *Lycaon pictus* in a cattle ranching region of Zimbabwe: A case study. Biological Conservat., 88: 133-139.

[62]. RO., N. (2016;4(2):). Implications of humanwildlife conflict on food security among smallholder agro-pastoralists: Acase of smallholder maize (Zea mays) farmers in Laikipia county, Kenya. *World Journal of Agricultural Research.*, 43-48.
[63]. S., I. (2016). Land use conflicts between local communities and management of Mkungunero Game Reserve, Simanjaro Tanzania. 95.
[64]. Schieltz JM, Rubenstein DI. (2015). Evidence based review: Positive versus negative effects of livestock grazing on wildlife. What do we really know? Environ. Res. Lett. 11. Research Report No. 03.5, Mkuki na Nyota Publishers. [ISBN 9987-686-67-2]
[65]. Sichewo, P. R., Michel, A. L., Musoke, J., & Etter, E. M. (2019). Risk factors for zoonotic tuberculosis at the wildlife–livestock–human Interface in South Africa. *Pathogens*, *8*(3), 101.
[66]. Sichewo, P. R., Etter, E. M., & Michel, A. L. (2020). Wildlife-cattle interactions emerge as drivers of bovine tuberculosis in traditionally farmed cattle. *Preventive veterinary medicine*, *174*, 104847.
[67]. Simbarashe M. (2012). Land: Efforts needed to end conflicts between farmers and Cattleelders; Available:http://www.dairlynews.co.tz/index.php/ features/popular features/5820-landefforts needed-to-end-conflict-betweenfarmers-and cattle-helders.
[68]. Simwango M, Ngonyoka A, Nnko HJ, Salekwa LP, Ole-Neselle M, et al. (2017) Molecular prevalence of trypanosome infections in cattle and tsetse flies in the Maasai Steppe, Northern Tanzania. Parasit Vectors 10: 507.
[69]. Sinclair, A.R.E., (1974). The natural regulation of buffalo populations in East Africa: The food supply as a regulating factor and competition. Afri. J. Ecol., 12(4): 291-311.
[70]. Sitters J, Heitnig IMA, Holmgren M, Ojwang GSO (2009). Herded cattle and wild grazers partition water but share forage resources during dry years in East African savannas. Biol Conserv 142:738 750
[71]. Sitters, J. I. (2009). Herded cattle and wild grazers partition water but share forage resources during dry years in East African savannas. . *Biological Conservation 142:* , 738–750.
[72]. Smith, e. a. (2012). Biodiversity and agriculture: Production frontiers as a framework for exploring trade-offs and evaluating policy. *Environmental Science & Policy 23:*, 85–94.
[73]. Simpson, G. J., Quan, V., Frean, J., Knobel, D. L., Rossouw, J., Weyer, J., ... & Blumberg, L. H. (2018). Prevalence of selected zoonotic diseases and risk factors at a human-wildlife-livestock interface in Mpumalanga Province, South Africa. *Vector-Borne and Zoonotic Diseases*, *18*(6), 303-310.
[74]. Tanzania, U. R. (2011). Livestock development sector programme, ministry livestock and fisheries development,Dares salaam, Tanzania
[75]. Tefera M (2011) Wildlife in Ethiopia: Endemic large mammals. World J Zool 6(2):108–116
[76]. Waghela S, Karstad L (1986) Antibodies to Brucella spp. Among blue wildebeest and African buffalo in Kenya. Journal of Wildlife Diseases 22:189–192
[77]. Wiethoelter, A. K., Beltrán-Alcrudo, D., Kock, R., & Mor, S. M. (2015). Global trends in infectious diseases at the wildlife–livestock interface. *Proceedings of the National Academy of Sciences*, *112*(31), 9662-9667.

Corresponding Author: Tuwangye Innocent
(*Faculty of Agriculture Environmental Sciences and Technology, Bishop Stuart University Mbarara Uganda****)***