# DETERMINATION OF PREVALENCE OF TICKS AND TICK- BORNE DISEASES IN INDIGENOUS BREEDS OF CATTLE IN PASTORAL AND MIXED CROP-LIVESTOCK-FARMING SYSTEMS OF NAKASEKE AND NAKASONGOLA DISTRICTS

BY

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SEPTEMBER, 2014

# DECLARATION

I, Stephen Kwesiga do hereby declare that this dissertation is my original work and has not been submitted for any award in any institution.

Signature: .....Date 17/09/2014

# APPROVAL

This dissertation entitled "**Prevalence of ticks and tick-borne diseases in the different farming systems of Nakaseke and Nakasongola districts**" has been done under my supervision and has been submitted to the Graduate School, Gulu University for examination with my approval as the candidate's supervisor.

Supervisor: Prof. Joseph Okello-Onen.

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Signature: .....

Date....17/9/2014

# DEDICATION

I dedicate this book to all my dear siblings who mean a lot to me. May this be an inspiration to you to reach greater heights in life and to know that success does not come by accident but by a calculated design. An objective set and timely achieved is a mission well accomplished.

Also to my parents for instilling the importance of hard work and higher education and above all to Gloria my best friend for your love, care and support which have kept me going even through tough times.

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My colleagues James and Winfred who assisted me whenever I needed your help while conducting this research despite the enormous work pressures we were all facing. Africa Innovations Institute for providing me with the opportunity to conduct this study and for the financial support rendered to me while carrying out this research. I further extend my gratitude to all my lecturers and friends for your unequivocal support you gave me throughout, as always, for which my mere expression of thanks likewise does not suffice.

## List of acronyms

| | |
|---|---|
| Afrii | Africa Innovations Institute |
| ECF | East Coast Fever |
| EDTA | EthyleneDiamineTetraacetic Acid |
| FGD | Focus Group Discussions |
| GDP | Gross Domestic Product. |
| MSE | Mean Standard Error |
| TBDs | Tick-Borne Diseases |
| TTDBs | Ticks and Tick-Borne Diseases |
| PP | Percentage Positivity |
| IPCC | Inter governmental Panel on Climate Change |
| NAPE | National Action Plan on Climate Change. |
| UBOS | Uganda Bureau Of Standards |
| ELISA | Enzyme-Linked Immunosorbent Assay |
| EIA | Enzyme ImmunoAssay |

# ABSTRACT

A cross-sectional study was done between July and September 2011, in the cattle-corridor districts of Nakaseke and Nakasongola to determine prevalence of ticks and tick-borne diseases (TTBDs) in indigenous breeds of cattle in pastoral and mixed crop-livestock-farming systems of Nakaseke and Nakasongola It was also undertaken to understand the perspective of local communities and extension workers on TTBDs and the management practices they employed to control them. The farming systems under study were pastoral and mixed crop-livestock farming systems. An open ended questionnaire was administered to capture information about common cattle diseases, their clinical signs and symptoms, seasonal occurrence and out-breaks TTBDs, indigenous and modern management and control practices and their effectiveness among others. A total of 3600 questionnaires were administered to 3600 households, 1800 in each that is, of the two districts.

The tick challenge and spectrum of species were assessed on one side of animal body. The prevalent tick species were collected from different predilection sites and were further identified to species in the laboratory.

The relationship between tick burden and disease out-break, rainfall patterns, seasonal outbreaks and efficiency of treatment methods among others was determined and analysed. The results showed that *R.appendiculatus* was the most abundant tick species, followed by *A. variegatum* and lastly *R. evertsi evertsi* and their population varied greatly based on the seasons. In pastoral farming system, no ticks were found on calves below 6 months old, probably due to over-confinement in calf pens. The prevalence of *T. parva* was below 20% in calves below 4 months old, thereafter rising to 65% at 5 months, and then dropping to 20% from the age of 6 to 9 months. In mixed crop-livestock farming system, all age groups of cattle were exposed to tick challenge. The prevalence of *T. parva* increased from 1 month old calf reaching a peak in 2-3 months old calves, but drastically dropped in calves 4 months old. Thereafter, it gradually built up to 70% in animals 7 months old. Ticks were managed on a regular basis using acaricides, but the tick load on most animals was high due to application of under-strength concentration of acaricides. This was probably due to ignorance or financial difficulties, which could result in development of widespread acaricide resistance in ticks. The research findings can be enriched by conducting more studies to cover all the seasons.

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# CHAPTER ONE

# GENERAL INTRODUCTION

## 1.1 Background of study

In Uganda, animal husbandry is considered as a source of employment and livelihood representing 7.5% of the national GDP (UBOS, 2005). However, the productivity of livestock is generally constrained by ticks and tick-borne diseases (Ocaido *et al.*, 1996, Moran, 1996) that are ranked as number one constraint of livestock. Ticks and tick-borne diseases are a major health impediment to the improvement and development of livestock industry in Uganda due to the high economic costs (losses) they impose to farmers and national economies (Okello-Onen *et al.*, 2002).

Ticks cause tick worry, blood loss, damage to hides and skins, tick paralysis, reduced weight and milk production (Bram, 1983, Baylis and Githeko, 2006). Tick-borne diseases cause serious debility, morbidity, mortality and production losses in susceptible taurine cattle (*Bos taurus*), their crosses and the indigenous breeds of cattle (*Bos indicus*) raised in non-endemic areas (Rubaire-Akiiki *et al.*, 2004, Normal *et al.*, 1991). They also hinder introduction of exotic, more productive stock. Of the diseases caused by ticks and tick-borne diseases (TTBDs), East Coast Fever (ECF) is the most important and widespread (Otim, 2000). Generally, indigenous cattle are fairly tolerant to TTBDs and losses are confined to calf crop (10 – 30%)

(Latif *et al.*, 2004). The animals that recover from TBD infections may suffer from, among others; weight loss, low milk yields, low drought power, reduced fertility and delayed

maturity (Okello-Onen *et al., 2002*). In the case of ECF, the affected cattle remain carriers and may serve to disseminate the infection

(Okello-Onen *et al.*, 1995).

Tick control management practices largely depend on the use of conventional acaricides (Rubaire-Akiiki *et al.*, 2004; Okello-Onen, 1995). In most farms where they are used, the intensity of use and frequency of application varies greatly by the number of animals kept on the farm and the system of grazing (Rubaire-Akiiki *et al.*, 2004; Okello-Onen, 1995). The common methods of acaricide application include pour-on and hand spraying. Other management strategies employed by farmers to control TTBDs include bush burning during dry seasons and to a less extent the use of botanical plants to treat infected animals (Norvel *et al.*, 1991, Bell-Sakyil *et al.*, 2004). It also includes the use of breeds of cattle that are genetically resistant to tick infestations (Latiff, 1992).

## 1.2 Statement of the study problem

The TTBDs are among the major constraints to livestock productivity in the pastoral and agro-pastoral areas in Uganda (Ocaido *et al.*, 1996; Moran, 1996). They are among the eight serious livestock health issues in the cattle corridor of the country (Perry *et al.*, 2007). They are reported to be sensitive to climate variability that may influence their abundance and distribution (Randolph *et al.*, 1999, Baylis *et al.*, 2006). Small changes in tick population can foster change in tick-borne diseases distribution and increased or decreased risk of TTBDs (Livestock and global climate change conference, 2008).

Of late, the cattle corridor is experiencing severe climate variability (Nape, 2007), but its effect on ticks and tick-borne diseases is not known. In addition, during stakeholder consultations and community diagnosis, there were reports of tick-borne disease epidemics as a result of increased vector prevalence in Nakaseke and Nakasongola districts (Afrii, 2009). However, the magnitude of the burden of ticks and tick-borne diseases has not been characterised. Hence, there was a need to determine the status of ticks and tick-borne diseases and their management practices in Nakasongola and Nakaseke districts, so as to develop appropriate control strategies.

## 1.3 Justification of the study

Of late, Uganda is experiencing climate variability which has and will continue to cause major disruptions in the functioning of the ecosystem health and services (IPCC, 2007). The cattle corridor has a fragile ecosystem that suffers most from severe climate variability, which has resulted into severe drought, out-break of pests and diseases, with TTBDs inclusive among others (Ziervogel *et al.*, 2005). In order to implement effective control measures of TTBDs, there was need to determine their occurance and control practices in relation to season variability in the cattle corridor named districts.

## 1.4 Research questions

1. What ticks and tick-borne diseases exist in pastoral and mixed crop-livestock farming systems of Nakasongola and Nakaseke?
2. What are the perspectives of the local communities and extension workers on the problems of ticks and tick-borne diseases in indigenous breeds of cattle?

3. How are ticks and tick-borne diseases controlled and managed in the pastoral and mixed crop farming systems?

## 1.5 Objectives of the study

### 1.5.1 Broad objective

To determine the prevalence of ticks and tick-borne diseases and their management and control practices in the pastoral and mixed crop farming systems of Nakaseke and Nakasongola districts.

### 1.5.2 Specific objectives

1. To determine the prevalence of ticks and tick-borne diseases.
2. To understand the perspectives of local communities and extension workers on the problems of ticks and tick-borne diseases.
3. To assess and document the management practices employed in the control of ticks and tick-borne diseases.

## 1.6 Scope of the study

The study was limited to the pastoral and mixed crop-livestock farming systems in the two districts. Secondary data was collected from the department of district veterinary offices of both districts to determine the perspectives of the extension workers on ticks and tick-borne diseases and link this to the primary data obtained from selected households.

## 1.7 Expected outputs

The findings of this study are expected to;

1. Shade light on the occurrence of ticks and tick-borne diseases in Nakaseke and Nakasongola districts.
2. Provide information on perspectives of the local communities and extension workers regarding TTBDs, and their outbreaks in relation to season variability.
3. Help understand practices employed by local communities and extension workers in the control and management of ticks and tick-borne diseases. This will be captured and documented.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Types of ticks and tick-borne diseases and their distribution

Ticks are invertebrates which belong to a phylum called Arthropoda of the order Acari (Mukhebi *et al*, 1992). There are two main groups of ticks called the family Argasidae or argasids, and the family Ixodidae or Ixodids (Latif and Walker, 2004). Argasid ticks are often called soft ticks because they do not have hard plates on their bodies. The Ixodids are often called hard ticks because they have these hard plates (Herrero, 2009).

There are over 13 different tick families and more than 650 different kinds of ticks in Africa (Brightwell *et al.*, 1998). However the main families of *Ixodid* ticks that affect livestock in East Africa consist of a number of species that cause most serious problems for all livestock producers (Mukhebi *et al.,* 1992). The Blue tick (*Boophilus species*) has many species which differ in geographical distribution (Mugabi *et al.*, 2009). *Boophilus decoloratus* is one of the most important species of this group, which is normally found on the belly or anywhere on the body. The blue tick transmits *babesiosis* (also called red water disease) and *anaplasmosis* which are the major diseases of cattle in East Africa. *Babesiosis* or tick fever, is a febrile disease characterized by extensive erythrocytic lysis leading to anaemia, icterus and haemoglobinuria, which can be fatal (*Kivaria et al.,* 2004). The disease is caused by protozoan parasites of the genus *Babesia.* There are at least 14 distinct species of *Babesia* from various vertebrate hosts. In cattle, *Babesia bigemina* is distributed throughout Central and South America, Europe, Africa, Australia and Asia(Randolph *et al.,* 1999); *Babesia bovis* has been reported from Europe, Africa, Asia and the Far East; *Babesia argentina* (which may

be synonymous with *B. bovis*) is found in southeast Asia and Australia, and from Mexico down through Latin America (Tatchell, 1986).

Bovine anaplasmosis is an infectious, non-contagious haemotropic disease of cattle characterized by acute form by fever, anaemia, weakness, constipation, yellowing of the mucous membranes, lack of appetite, depression, dehydration, and laboured breathing. The disease is present in most tropical and subtropical regions, and is also found in some temperate areas (Barbour and Fish, 1993). It is caused by rickets in parasites of the genus *anaplasma*. The epizootiology of *anaplasmosis* is complicated by the life-long carrier state which occurs in animals that have recovered from the clinical disease.

The brown ear tick (*Rhipicephalus species*) prefers to attach to areas around the ears and under the tail as its key predilection sites. It is responsible for transmitting the protozoan parasite, *Theileria parva,* which causes East Coast Fever, a serious disease responsible for widespread morbidity and mortality in sub-Saharan Africa and whose impacts on calf motality is much more pronounced in East Africa (Mukhebi *et al.*,1992). *Theileria parva* is acquired by immature ticks during blood feeding and the parasite itself is only transmitted by the nymphal and adult tick stages (Kabi *et al.*, 2008). E.C.F is enzootic in East Africa and has been reported from Tanzania, Kenya, Uganda, Mozambique, South Africa, Rhodesia, Zaire, Rwanda, Burundi, Malawi and the Sudan (Latif and Walker, 2004). The disease probably exists in Ethiopia, Zambia and southern Somalia. South Africa and Mozambique have reportedly eradicated the disease through tick control (Mukhebi *et al.*, 1992).

*Hyalomma spp* often have stripped legs, but no ornamentation on the back. It transmits protozoan parasite *Theileria annulata* causing a disease called Sweating sickness of calves.

*Ambyloma* ticks have stripped legs, sometimes a distinct ornamentation on the back shield and can often be seen boring right into the skin of the animal thereby becoming very difficult

to remove by hand. These are fairly large ticks found mainly on the dewlap of host animals and transmit rickettsia *Cowdria ruminantium* that causes heart water disease. *Ambylomma spp* also transmit the protozoan parasite *Theileria mutans* (Mugabi *et al.*, 2010). Heartwater is a septicaemic, infectious disease of cattle, as well as of sheep, goats and other ruminants (Mugabi *et al.*, 2009). The disease is transmitted by at least five species of *Ambylomma* ticks most commonly by *Ambylomma variegatum*. The clinical effects of heartwater are pyrexia, diarrhoea, incoordination, hypopericardium, hydrothorax, oedema of lungs and brain (Bezuidenhout *et al.*, 1994). The enzootic areas of the disease correspond to the distribution of the vector species in southern, eastern and western African countries and in Madagascar. It has also been reported from Sudan.

Reports reveal that many important animal diseases are affected directly or indirectly by weather and climate (Randolph *et al.*, 1999). These links may be spatial, with climate affecting distribution, and weather affecting the timing of an outbreak, or intensity of an outbreak. Furthermore, other findings show that warming and changes in rainfall distribution in Africa will lead to changes in the spatial or temporal distributions of those diseases sensitive to moisture (IPCC, 2007).

Climate change will affect diseases through forces operating on the pathogen, the host, the vector, epidemiological processes and other indirect routes. Higher temperatures resulting from climate change may increase the rate of development of certain pathogens or parasites that have one or more life cycle stages outside their animal host (Herrero, 2009). This may shorten generation times and, possibly, increase the total number of generations per year, leading to higher pathogen/parasite population sizes (Tatchell, 1986).

Seasonal variations in temperature due to global warming can result in a dramatic impact on how often hosts and pathogen-carrying vectors come into contact. Changes in temperature are detected by Haller's organ; at temperatures <7°C, ticks remain inactive only venturing out of the pasture mat and up the vegetation to quest for a host when temperatures increase (Parry *et al.*, 2007). Many vector-borne diseases are highly susceptible to changes in climate. Danielová *et al* (2006) found that increasing temperatures not only increase the distribution of *Ixodes. ricinus*, but also linked the rise in temperatures to the encroachment of ticks into higher altitudes that were not previously colonized by ticks. As a consequence, a correlation is formed between increase in temperature and increase in the prevalence of tick-borne diseases, such as *Borreliosis* and tick-borne encephalitis. Disease spread may also be closely linked to local people's perception of the intensity of the burden of ticks and tick borne diseases (Lindgren and Jaenson, 2006). Other studies show that ecological niche, climate, landcover/ eco-zone, host distribution, among others, greatly affect tick species, numbers and disease outbreaks (Livestock and global climate conference, 2008).

**Figure 1: Typical Ixodid tick, *Rhipicephalus appendiculatus*, which causes ECF**

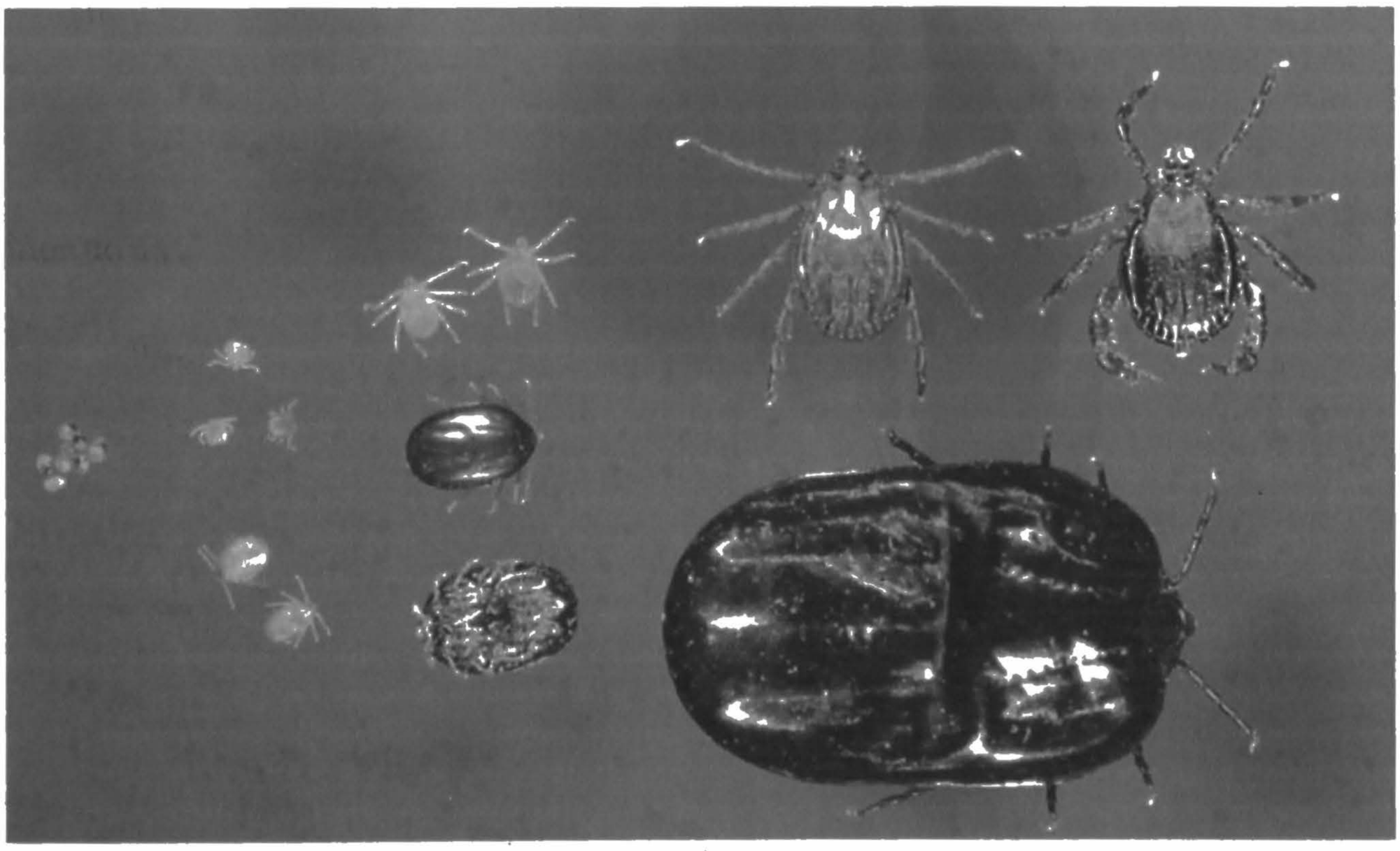


**Figure 2: Ixodid tick, *Amblyomma variegatum*. Female at left and male at right.**

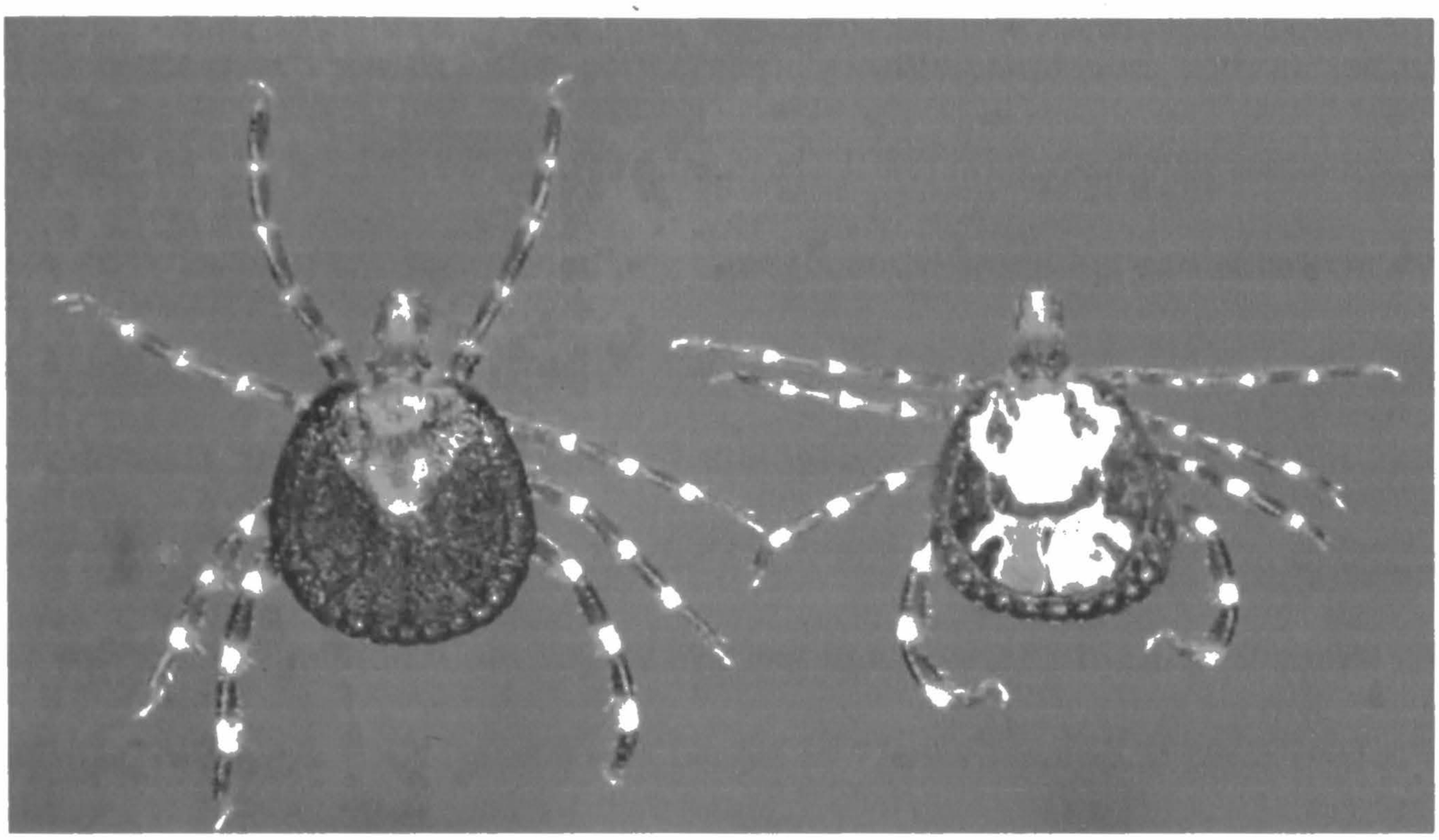
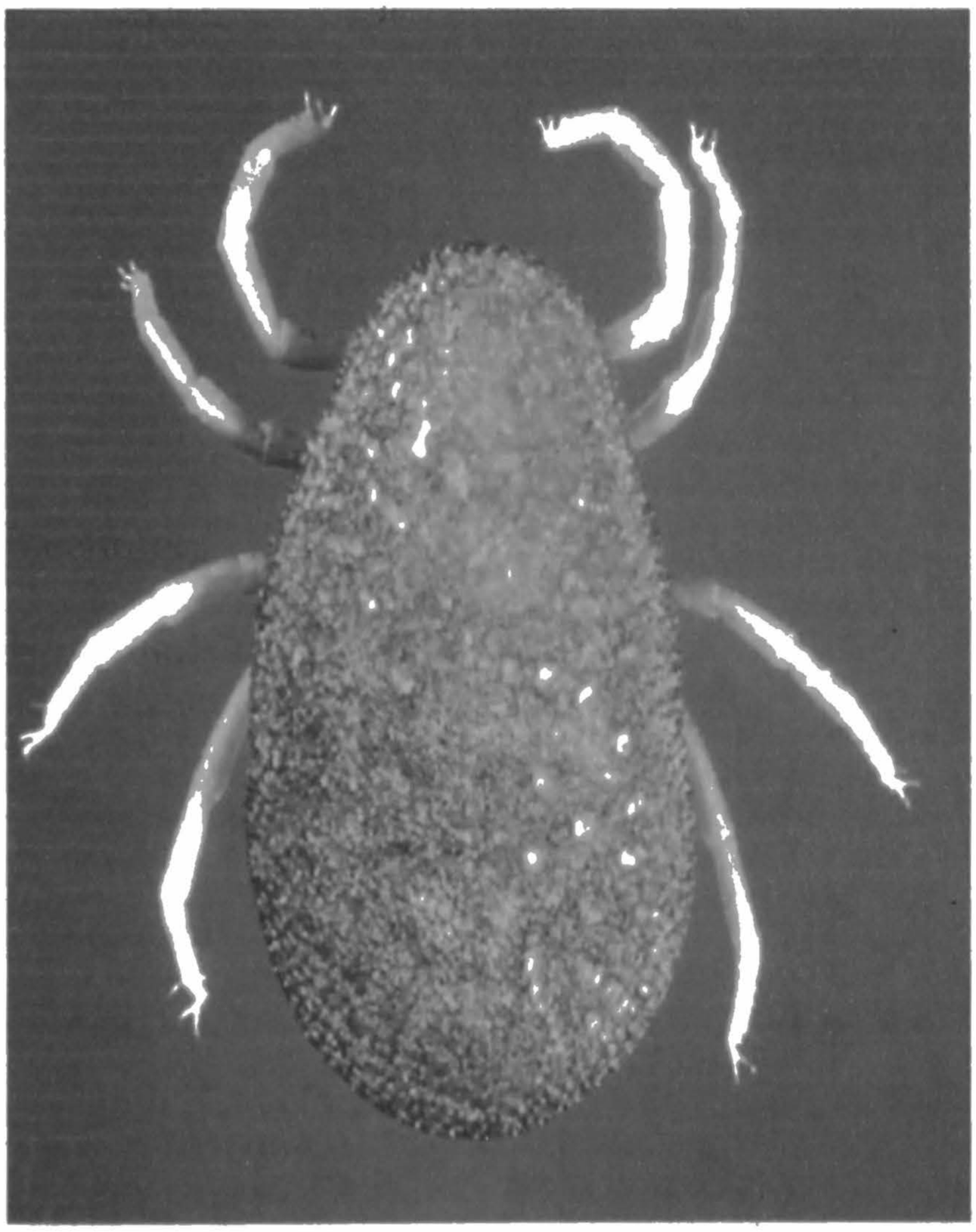
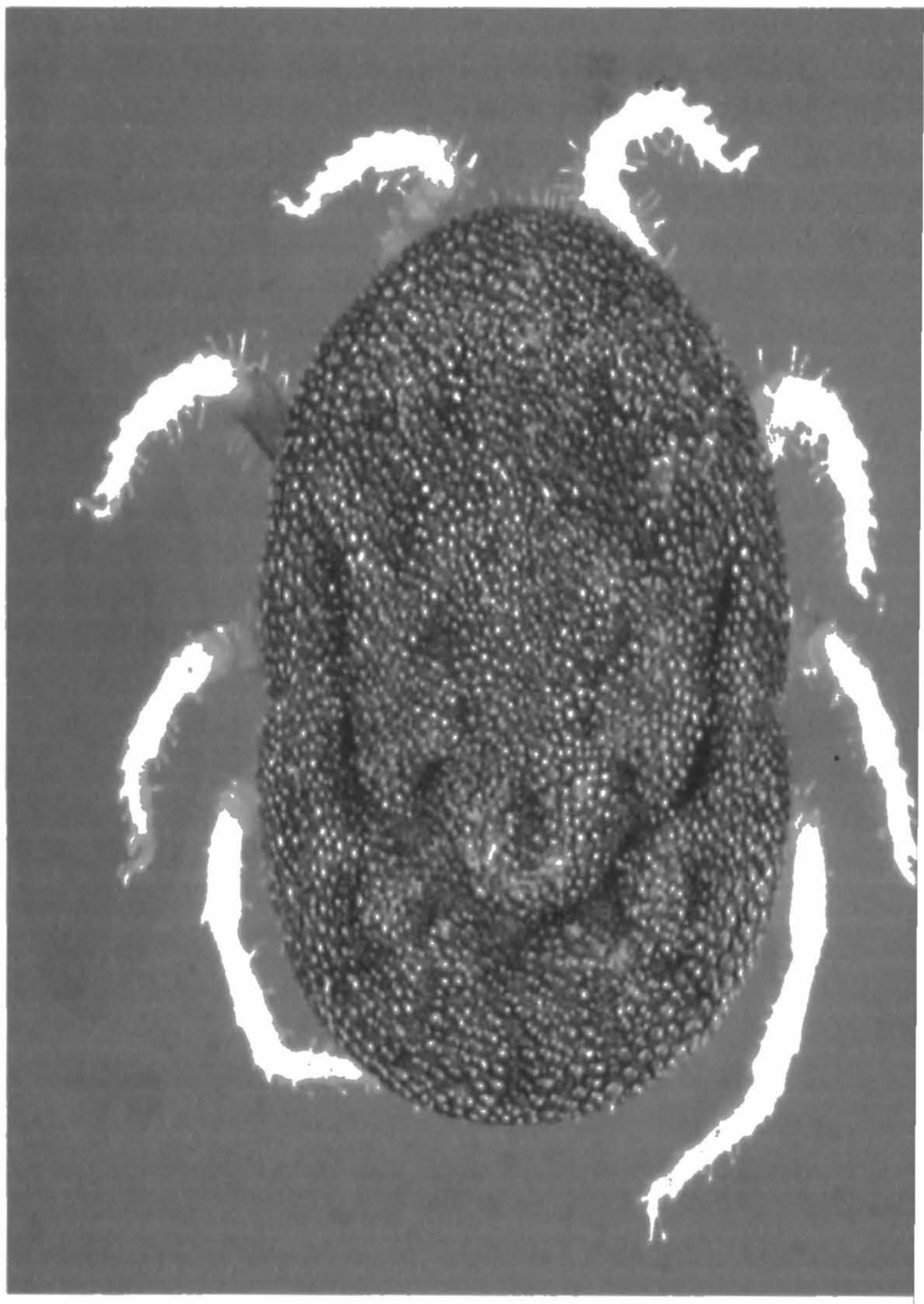


**Figure 3: Typical argasid ticks, *Argas persicus on left, Ornithodoros savignyi on right.***





## 2.2 Economic importance of TTBDs.

### 2.2.1 Distribution, abundance and impacts of TTBDs

Tick-borne diseases affect 80% of the world's cattle population, with an estimated global annual cost of US $ 14-19 billion (Young *et al.,* 1988). Ticks and their associated diseases are a major constraint to livestock farming throughout the world but particularly in Africa where socio-economic factors govern the extent to which livestock farmers can control ticks. World-wide, an estimated 600 million cattle are exposed to *Anaplasmosis* and *Babesiosis* and 200 million cattle are exposed to *Theileriosis* (Latif and Pegram 1992). In sub-Saharan Africa as many as 175 million cattle may be exposed to *Cowdriosis* In eastern, central and southern Africa *Theileriosis* (East Coast fever), caused by *Theileria parva, is* considered to be the most significant tick-borne disease of cattle.

In Africa, tick-borne diseases kill 1.1 million cattle annually resulting in economic losses of $160 million (Mugabi *et al.,* 2009). In 1989 alone, over one million cattle died of East Coast Fever in East Africa (Mukhebi *et al*, 1992). In Uganda, ticks and tick-borne diseases are a major important health impediment to the improvement and development of livestock industry due to the high economic costs (losses) they impose to farmers and national economy (Okello-Onen *et al.*, 1999, Bram, 1982). Ticks cause tick worry, blood loss, damage to hides and skins, tick paralysis, reduced weight and milk production. Tick-borne diseases cause serious debility, morbidity, mortality and production losses in susceptible taurine cattle (*Bos taurus*) their crosses and the indigenous breeds of cattle (*Bos indicus*) raised in non-endemic areas (Bram, 1982, Okello-Onen *et al.,* 1994, and Yeoman, 1996). Tick-borne diseases also hinder introduction of exotic, more productive stock. Early studies on production losses caused by the cattle tick seemed to indicate that an average of one mature tick per day caused a growth rate depression equivalent to at least 450 grams a year (Turner

and Short, 1972). Generally, indigenous cattle are fairly tolerant to TTBDs and losses are confined to calf crop

(10 – 30%). The animals that recover from TBD infections may suffer from among others; weight loss, low milk yields, low drought power, reduced fertility and delayed maturity (Okello-Onen *et al.*, 1999, Yeoman, 1996). In the case of ECF, the animals remain carriers and may serve to disseminate the infection.

Some cattle tick species of genus *Boophilus* have adverse effect on beef and milk production through loss of weight and anaemia (Brightwell *et al.,* 1998). These are partly explained by loss of appetite and failure to replace lost proteins. Infested animals may also suffer a change in body composition. Effects of an earlier infestation may persist after removal of the parasites. *Babesiosis* and *Anaplasmosis*, which are transmitted by the same cattle tick, pose additional problems in regions of sporadic infestation, by causing stock losses unless vaccination is resorted to.

### 2.2.2 Diseases associated with ticks

A number of diseases are brought about by the ticks when they feed on cattle which among others include direct parasitic damage brought about by wounds which are created in the skin of the animal when ticks are feeding (Mugabi *et al.,* 2009). This is usually a sterile abscess and will heal to form a small scar (Parry *et al.,* 2007). The inflammatory and hypersensitive reactions at the feeding site are irritating and painful.

When ticks such as *Hyalomma truncatum* attach between the claws of the feet of sheep they cause lameness (Latif and Walker, 2004). .

When *Amblyomma variegatum* attaches on the teats of cattle there is interference with suckling.

*Boophilus* ticks in large numbers on the back and flanks of cattle make many small scars in the skin, so that when the skin is processed for leather, blemishes appear that reduce the value of the leather (Mukhebi *et al.,* 1992).

Ticks suck much blood from their hosts; when they are feeding in large numbers this causes anaemia and loss of nutrients (Latif and Walker, 2004). In addition the irritation of the ticks makes cattle anorexic; reducing food intake (Rubaire-Akiiki *et al.,* 2004; Okello-Onen, 1995).

All these factors reduce the gain in liveweight of cattle: for engorging *Bo. microplus* female (known as a *standard* tick) there is 0.6g loss of liveweight gain to the cattle and for *Rh. appendiculatus* the equivalent datum is 4.0g (Latif and Walker, 2004). Similarly the feeding of *Amblyomma* ticks on cattle leads to loss of milk production (Ocaido *et al.,* 1996, Moran, 1996).

Toxicosis and dermatophilosis are other diseases caused by ticks when feeding (Norvel *et al.*, 1991, Bell-Sakyil *et al.*, 2004). During feeding, some ticks secrete toxins in their saliva. It is unclear why this happens but it causes several types of poisoning or toxicosis (Barbour and Fish, 1993).

Sweating sickness is a moist eczema caused by the feeding of *Hyalomma truncatum* (Randolph *et al.*, 1999, Baylis *et al.*, 2006).

Females of *Rhipicephalus evertsi* and *Ixodes rubicundus* may cause paralysis to sheep, goats and cattle when they are engorging (Latif and Walker, 2004). The paralysis of sheep by *Ixodid. rubicundus* is known in South Africa as Karoo paralysis (Herrero, 2009). *Ornithodoros savignyi* bites on camels and cattle is very painful and causes stress (Randolph *et al.*, 1999, Baylis *et al.*, 2006). Ticks feeding in large numbers can cause a systemic suppression of their host's immunity and this may allow other diseases to become worse (Okello-Onen *et al.*, 1999, Yeoman, 1996). Even small numbers of *Amblyomma variegatum*

ticks feeding on cattle suppress immunity such that any infection with *Dermatophilus congolensis* bacteria in the skin is aggravated to cause very severe dermatophilosis (Latif and Walker, 2004).

**2.2.2 Common diseases caused by pathogens which are transmitted by ticks.**

African swine fever is one one of these diseases and is caused by a virus of the same name of the family Iridoviridae (Brightwell *et al.*, 1998). In Africa it is transmitted to domestic pigs by *Or. porcinus domesticus* and *Or. p. porcinus*; these are in the *Ornithodorosmoubata* complex of tick species (Young *et al.*, 1988). The virus causes haemorrhage, leukopenia and pyrexia.

*Anaplasmosis* also called gallsickness is another TBD caused by a rickettsial bacterium, usually *anaplasma centrale* or *An. marginale* (Latif and Walker, 2004). These infect red blood cells and a severe anaemia may be caused. Transmission is by ticks of many species particularly *Boophilus* and this involves development within the tick (Turner and Short, 1972). *Anaplasma* can also be transmitted mechanically by biting flies and contaminated needles. The form usually seen in diagnosis appears as small densely stained bodies in red blood cells, mostly at the centre in *An. centrale*, or at the margin in *An. marginale* (Brightwell *et al.*, 1998).

Babesiosis, also called red water fever is a TBD caused by intracellular protozoans (Latif and Walker, 2004). The most important species in Africa are *Babesia bigemina* and *Ba. bovis* which parasitize cattle and *Ba. canis* which parasitizes dogs (Lodos *et al.*, 2000). These infect mainly red blood cells causing anaemia and systemic inflammation (Herrero, 2009). *Babesia bigemina* is transmitted by the cattle ticks *Boophilus annulatus*, *Bo. decoloratus* and *Bo. microplus*, whereas *Ba. bovis* is transmitted by *Bo. microplus* and *Bo. annulatus*. *Babesia canis* is transmitted by the dog tick *Rhipicephalus sanguineus* (Latif and Walker, 2004). In diagnostic blood films these pathogens are seen as the piroplasm stage within red blood cells

(Norval, 1991). They are single or paired cells, with a small nucleus at one side (Herrero, 2009).

Another TBD of economic importance is called Borreliosis which is caused by several types of spirochaete bacteria (Lawrence, 1991). Of most importance in Africa is *Borrelia duttoni* which causes relapsing fever in humans and is transmitted by *Or. porcinus domesticus* (Latif and Pegran, 1992). The pathogens multiply within the blood plasma and cause repeated fevers, hypotension and weakness (Rubaire-Akiiki *et al.*, 2004; Okello-Onen, 1995). *Borrelia theileri* commonly infects cattle blood and is transmitted by *Boophilus* ticks, but usually little disease is caused.

Crimean-Congo haemorrhagic fever is another TBD caused by a virus of the same name and of the family Bunyaviridae (Ziervogel *et al.*, 2005). The disease occurs in humans and is characterised by severe haemorrhage with kidney and liver failure (Drummond, 1983). The virus is transmitted by several species of ticks, commonly *Hyalomma marginatum marginatum* and *Hy. m. rufipes* (Brightwell *et al.*, 1998).

Cowdriosis also called heartwater disease is another common TBD and this is caused by a rickettsial bacterium, *Ehrlichia* (*Cowdria*) *ruminantium* (Okello-Onen *et al.*, 1999, Bram, 1982). This is transmitted to sheep, goats and cattle by *Amblyomma* species, mainly *Am. variegatum* and *Am.hebraeum* (Ziervogel *et al.*, 2005). The bacteria multiply in the endothelial cells of blood vessels, especially in blood vessels of the brain. Acute infection causes severe oedema, especially into the pericardium and brain (Lodos *et al.*, 2000). Diagnostic smears of brain tissue show characteristic purple staining morulae of the bacteria in endothelial cells (Latif *et al.*, 2004).

Theileriosis is yet another very important economic TBD in Africa (Okello-Onen et al., 1995).

Two forms of the disease are known and these are tropical theileriosis and ECF (Rubaire-Akiiki *et al.*, 2004; Okello-Onen, 1995). This disease is caused by protozoans that infect the lymphocytes, macrophages and red blood cells of cattle (Brightwell *et al.*, 1998). Tropical theileriosis is caused by *Theileria annulata* (Brightwell *et al.*, 1998). The pathogen is transmitted mainly by *Hyalomma detritum detritum* and *Hyalomma anatolicum anatolicum* (Bernett, 1961). These ticks in Africa are confined to countries on the Mediterranean and in Sudan (Latif *et al.*, 2004). The stages found in the tick are the gametes in the gut, the kinete which migrates from gut to salivary glands, and the sporoblast and sporozoites in the salivary gland (Ocaido *et al.*, 1996, Moran, 1996). Field collected ticks can be dissected and their salivary glands removed and stained to show sporoblasts (Okello-Onen et al., 1995). This gives the data of infection prevalence and abundance, which are important for epidemiology.

ECF is caused by *Theileria parva* (Latif *et al.*, 2004). This protozoan is transmitted by *Rhipicephalus. appendiculatus* which occurs in eastern, central and southern Africa. Theileriosis is characterised by lymphoproliferation leading to severe oedema (Lawrence, 1991). Smears of enlarged lymph nodes reveal the schizont and merozoite stages within leucocytes and blood smears reveal the piroplasms as small nucleated cells within red blood cells (Sonenshine *et al*, 1979).

## 2.3 Management of ticks and tick-borne diseases.

A complex of problems related to ticks and tick-borne diseases of cattle created a demand for methods to control ticks and reduce losses of cattle (George *et al.*, 2004). Reports show that the epidemiology of ticks and tick-borne diseases is related to the available methods of control employed and their effectiveness, correct application of treatment measures and community methods employed in keeping cattle (Lawrence, 1991). There are several methods currently being applied for control of ticks and tick-borne diseases with chemical

control being the method most used (in form of dipping, spraying and pour-on) to protect livestock against ticks. Direct application of acaricides to animals is the most popular method of controlling ticks on livestock (Latif and Walker, 2004). Acaricides used to control ticks on livestock or in the environment are applied in such a manner that the ticks are killed, but will not harm livestock or applicators. The tissues of treated animals will not contain chemical residues, and the environment will not be adversely affected (Walker *et al.*, 2003). The conventional control methods include the use of chemical acaricides which has certain implicit drawbacks, such as the presence of residues in the milk and meat and the development of chemical resistant tick strains (Drummond, 1983).

With the advent of immunization, integrated tick and tick-borne disease management becomes desirable (Mukhebi *et al.*, 1992). Tick-resistant breeds of cattle and concurrent reduced use of chemicals are the crucial elements in the control strategy (Soneshine, 1991). The integrated tick and tick-borne disease management package is economically and technically attractive and practically desirable. However, the social and political feasibility of tick-borne- disease control needs to be addressed. Most indigenous cattle in areas where tick-borne diseases occur possess a natural resistance to these diseases (Zimmerman *et al,* 1985). The association between the parasites and cattle has produced states of endemic stability in which cattle are immune and parasites are transmitted constantly between cattle and ticks. Cattle that are exposed to *Anaplasma, Babesia* or *Cowdria* organisms early in life do not usually develop the clinical disease and are subsequently immune (Okello-Onen, 1995). This form of age-related immunity does not occur with *T. parva*. The host's resistance to tick infestation manifests itself against attacking ticks of different species and at varying stages. Highly resistant cattle keep tick populations low. Several indigenous breeds have been found to have high levels of resistance, including among others the East African Zebu (Sonenshine *et al,* 1979). Resistant animals have a tendency towards light tick burdens and require less

dipping, making control relatively easy and cheaper. In addition, other biological control methods could be used in support of control methods, e.g. anti-tick grasses (Drummond, 1983) and application of aggregation-attachment pheromone-baited acaricide to single sites on bovine hosts (Rechav *et al,* 1977). These approaches require an understanding of the parasites that exist in a particular environment and their epidemiology. It is also necessary to have access to acaricides, vaccines and drugs and to be able to monitor tick infestations and disease outbreaks.

### 2.3.1 Limitations in management of ticks and tick-borne diseases

Control of tick infestations and the transmission of tick-borne diseases remain a challenge for the cattle industry in tropical and subtropical areas of the world. Tick control is a priority for many countries in tropical and subtropical regions (Lodos *et al*., 2000). There are various ways to control ticks, but every method of tick control has certain shortcomings. Chemical control with acaricides was considered as one of the best methods, but it was shown recently that ticks have developed resistance against a range of acaricides (Martins *et al*., 1995). In much of East and Southern Africa intensive compulsory use of acaricide by dipping, supported by legislation on cattle movement did much to keep ECF to an acceptable level during the colonial period (Norval, 1991). Short interval dipping at frequencies sometimes as great as three per week was necessary to prevent cattle from becoming infected with *T. parva*. However due to rising costs of acaricides, declining budgets for veterinary disease control and development of acaricide resistance led to a widespread abandonment of this practice which was vital in control of TTBDs (Latif and Pegran, 1992).

The problem of development of acaricide resistance has led to the use of succession of classes of compounds for control of ticks and TTBDs (Sonenshine *et al.,* 1979). Initially, arsenic products were used which was followed by development and widespread use of

various compounds including DDT, BHC, toxaphene, dieldrin, organophosphate and carbamates but many of these classes pose significant problems with toxicity to both cattle and dip operators (Bernett, 1961).

Problems of acaricide resistance, chemical residues in food and the environment and the unsuitability of tick resistant cattle for all production systems make the current situation unsatisfactory. Strict acaricide application results in highly susceptible cattle populations because the cattle are not exposed to the parasites; when tick control breaks down, enormous losses can occur. An extreme example was the breakdown of dipping infrastructure during the war of independence in Zimbabwe, where a compulsory dipping policy had been in force since 1914. Between 1974 and 1979 an estimated one million cattle died, mainly of tick-borne diseases (Lawrence, 1991). In order to reduce on associated challenges that come along with the chemical application of acaricides in control of ticks and tick-borne diseases, a lot of debate on development of alternate and absolute control methods is ongoing which is expected to provide a sustainable solution of ticks and tick borne-diseases(Lodos *et al.*, 2000). Research has also shown that game animals of various species maintain populations of TTBDs which is a big hindrance in control and management process of ticks and tick-borne diseases (Young *et al.*, 1988).

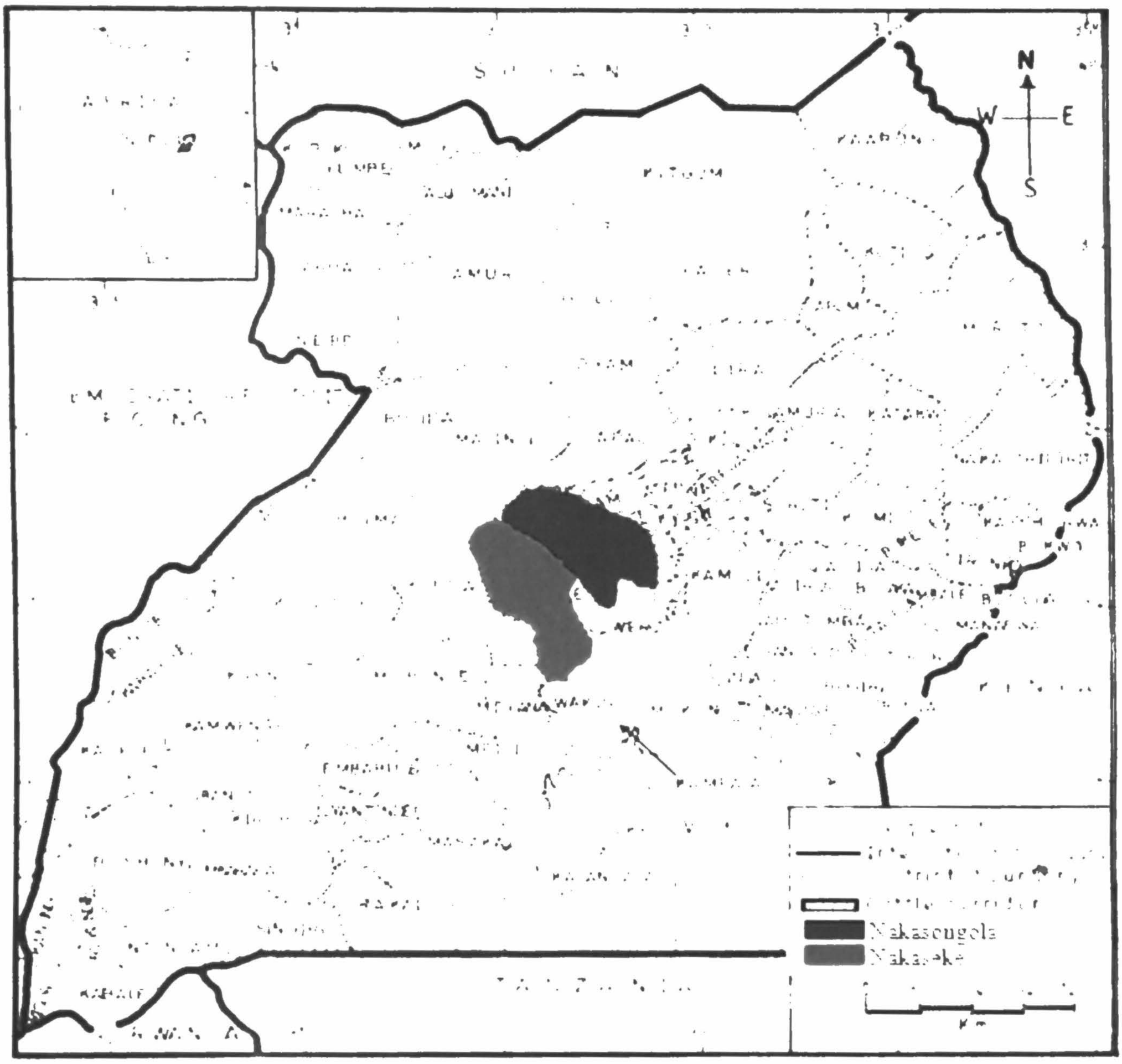
# CHAPTER THREE

# METHODS

## 3.1 Study area description

The study was conducted in Nakaseke and Nakasongola districts in the centre of the cattle corridor, in central Uganda. Nakasongola district boarders Nakaseke district to the North and North-East. Their location is as shown in figure 1 below. They had populations of 178, 000 and 125,297 people, respectively by 2010, and Lururi and Luganda are the major languages of the regions. The most outstanding features of natural resources are: savannah grasslands, bush and thicket areas, swamps, lakes, streams, expansive rangeland among others. In these two districts, farming is the main economic activity, which includes the cultivation of coffee, maize, beans, cassava, sweet potatoes, bananas, vegetables (such as tomatoes, cabbage) and fruits (such as pineapples and mangoes). Other activities include fishing in swamps, rearing of cattle (for meat and milk), goats and chicken.

**Figure 4: Map of Uganda showing location of Nakaseke and Nakasongola districts.**




Source: Uganda Government, Districts by 2007

## 3.2 Research Design

The study was a cross-sectional survey, using both quantitative and qualitative techniques for data collection.

### 3.2.1 Study population

The study population comprised of only two categories; the pastoral and the mixed crop and livestock communities in the two study districts.

### 3.2.2 Inclusion criteria

The category of people considered in the study were those who are *bonafide* residents of the selected farming systems, whose names appear on the Local Council 1 (LC1) register and are above eighteen years of age. The District Agricultural Officer, District Entomology Officer, District Veterinary Officer, District Environment Officer, the elderly people were considered as key informants. This is because they had knowledge about periodic out-breaks of tick-borne diseases, management and control practices of ticks and tick-borne diseases, and seasonal variations in climate overtime. Only those who were residents in the selected sub-counties were to be included in the study.

### 3.2.3 Exclusion criteria

Communities outside the pastoral and mixed crop farming systems in the two study districts were not considered together with individuals below eighteen years of age. Individuals who were not on parish registers were not considered.

### 3.2.4 Sample size determination

This project is part of a bigger project on *"Adaptation to the Impact of Climate Variability on Food and Health Security in the Cattle Corridor of Uganda*", whose sample size was determined in such a way that; in each of the two districts, communities were stratified into; (i) pastoral-majority areas; (ii) areas where pastoralists were a minority among settled agriculturalists; and (iii) areas of extensive grazing by mixed crop-livestock producers. In each of the three (3) strata in each district, 30 villages (a total of 180 villages) were randomly selected, using the registers at the Parish Local Council Chairpersons offices as sampling frame. In each of the selected villages, 20 households (making a total of 3,600 households) were randomly selected, using the registers at Village Local Council Chairman offices. The neighbouring 5 villages in each stratum were the sampling unit for the socio-economic and

gender analysis using the Development context and Livelihood analysis toolkits. Focus group discussions (FGDs) were conducted in the 5 neighbouring villages in each stratum. Three persons (male, female and youth) represented each village, making 15 persons for each FGD".

### *3.2.4.1 Household surveys*

In each of the two study districts, communities were stratified into pastoral-majority areas and areas of mixed crop-livestock producers. In each of the two strata in each district, 30 villages (a total of 120 villages) were randomly selected, using the registers at the parish local council chairpersons' offices as the sampling frame. In each of the selected villages, 20 households (making a total of 2,400 households) were selected; using registers at village local council chairman offices. A computer generated random numbers were used to select the samples.

Selected people who were knowledgeable on ticks and tick-borne diseases, seasonal outbreak of the diseases in relation to climate variability and their management and control practices were selected in both districts for FGDs. These constituted among others extension workers, veterinary officers, bonafied citizens of the area among others.

### *3.2.4.2 Cattle population*

The sample size was determined according to Thrusfield (2005) taking an absolute precision of 5% at the 95% level of confidence. On an assumption of prevalence of infection of East Coast Fever in cattle being 50% since there was no previous research work done on prevalence of TTBDs in the study area, farms were randomly selected in each village using standard epidemiological procedures. Therefore, a total of 384 cattle were obtained for the

study using formula. But to increase precision and to get more accurate, the sample size was taken as 400.

$$n = \frac{1.962\ P\ exp\ (1- P\ exp)}{d^2}$$

Where n = sample size, Pexp = expected prevalence, and D = desired absolute precision.

A total of 400 sheep were selected from the target population, and were sampled (50% prevalence and d = 0.05% was considered).

## 3.3. Data collection

### 3.3.1 Secondary data

Data was obtained from district veterinary offices of both districts to rapidly assess the status of ticks and tick-borne diseases in the two districts in relation to rainfall distribution and other factors.

### 3.3.2. Primary data

### 3.3.2.1 Quantitative data

***Household surveys***

Data was collected using structured open-ended questionnaires. Research assistants were trained on how to deliver questionnaires to respondents and record their responses. The questionnaire was pre-tested before administering it. Local guides were used to guide research assistants in each of the selected villages. While in the field, data collection process was monitored to ensure that the questionnaires were filled correctly. After data collection process, research assistants met to share challenges and difficulties encountered in the data collection process.

A hand-held Global Positioning System (GPS) was used to geo-reference the selected households for the study. Coordinates were taken in the WGS 84 geographical coordinate

system in decimal degrees, the level of accuracy of household location taken at 3 metres, and data exported to Universal Transverse Mercator for calculation of distances and map drawing. Geo- referencing was done for easy location of households when obtaining empirical data of blood samples which was done in the second phase of data collection after household surveys.

***Assessment of prevalence of ticks and tick-borne diseases***

The tick challenge and spectrum of species was assessed *in situ* on one side of animal body. This number was later doubled to give total tick count per animal. The ticks were sexed and their stages of feeding categorized as flat, fed and standard ticks. The ticks were collected from calves using strong steel forceps of medium size with blunt ends and serrated inner surfaces which gripped the ticks firmly over the scutum and mouth parts as closely to the host's skin as possible. The ticks were then pulled strongly and directly out but carefully without damaging the mouth parts and were then placed in labeled tick sampling tubes containing 70% ethanol. Inside the tick sampling tubes was placed a paper written on using a lead pencil containing data regarding date of collection, site of collection, name of collector, host species and predilection site. The prevalent tick species were collected and transported to the laboratory for further identification. Identification was done using a dichotomous key method based on external morphological features (walker *et al.*, 2003).

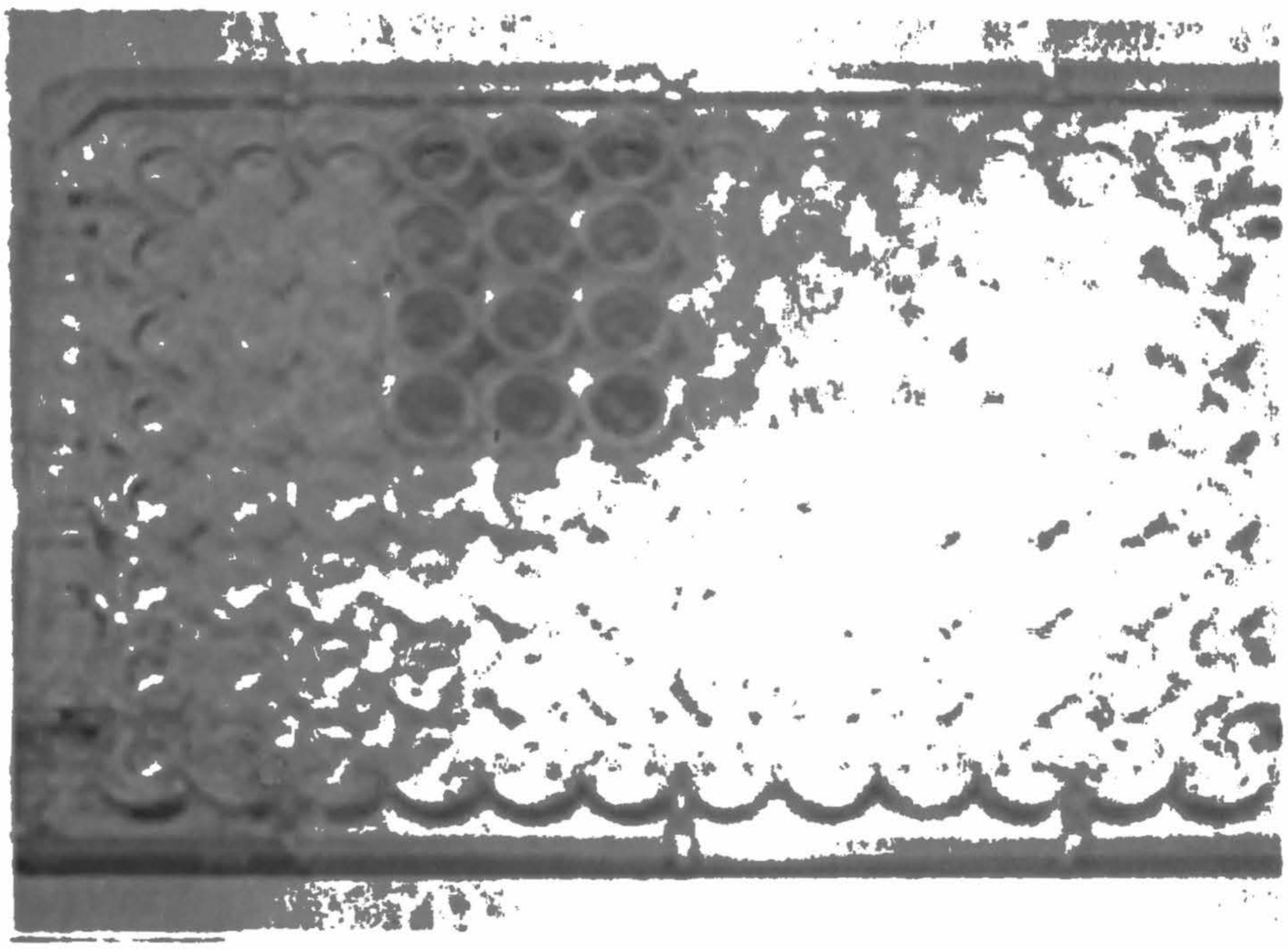
The prevalence of tick-borne diseases in livestock was assessed by collecting whole blood in EDTA tubes following veni-puncture. Thin and thick blood smears were made to assess the presence of haemoparasites of *Theileria, parva.* The animals were examined to assess clinical cases of TBDs. In the case of suspected ECF, lymph node biopsy smears were made from animals with clinical signs to assess the morbidity and causes of mortality due to the

disease. Serum samples were collected for serological tests and determination of sero-prevalence of ticks and tick-borne diseases, using ELISA technique.

**Figure 5: Summary of steps involved in ELISA technology**



**Figure 6: Typical ELISA output.**



Darker wells indicate higher levels of analyte (antibodies or antigens) in the sample under test.

### 3.3.2.2 Qualitative data

People who were knowledgeable on ticks and tick-borne diseases, their seasonal outbreaks in relation to climate variability and their management and control practices were selected in both districts for focus group discussions and key informant interviews using check-lists.

## 3.4. Study variables

### 3.4.1. Independent variable

The variables of ultimate consideration as independent variables were treatment, measures employed effectiveness of treatment measures, prevention/control measures and effectiveness of prevention measures. Education levels were considered in relation to diseases' spread and outbreak. Rainfall distribution was related as well to spread and outbreak of ticks and tick-borne diseases. Knowledge and understanding/awareness of ticks and tick-borne diseases by the study local communities and extension workers, among others, constituted this variable.

### 3.4.2 Dependent variable

This study was focused on characterizing communities and extension workers to understand their perspectives on ticks and tick-borne diseases, and control and management practices employed and factors associated/thought to influence spread and outbreak of ticks and tick-borne diseases. Factors like community control and management practices employed, their effectiveness among others were thought to play a vital role in the disease spread, transmission and out-break. There was, therefore, a need to look at the influence of these factors.

## 3.5 Data management

Research assistants had water-proof bags for carrying questionnaires to and from the field to avoid rain and other incidences from destroying the information. Data was entered into Epidata version 3.1, cleaned, coded, edited and exported to STATA for analysis. Collected data was stored in a safe place to avoid unauthorized access, and back-up made. Meeting with research assistants was done on daily basis before departure to ensure that all requirements were packed, including the questionnaires.

## 3.6 Data analysis

### 3.6.1Quantitative data

***(a) Univariate Analysis*** Summary statistics were displayed for categorical variables into bar graphs, polygons, frequencies, percentiles, proportions and pie charts for general descriptions.

***(b) Bivariate analysis*** was done to determine association between percentage positivity of *Theileria parva* and mean number of ticks per animal of calves between 4-10 months

### 3.6.2 Qualitative data

Data was analyzed both quantitatively and manually using content analysis. The qualitative data was triangulated with the quantitative data.

## 3.7 Ethical considerations

The study was approved by the Faculty of Science (Biology department) of Gulu University, followed by the Institutional Review Board (IRB) at Faculty of Medicine, Gulu University. Permission was sought from Nakaseke and Nakasongola local governments to conduct the study. Informed consent was obtained from research participants who were 18 years and above, and informed consent forms were signed by participants as a proof of participant's consent.

## 3.8 Dissemination plan for research findings

The study findings will be published in peer review journal and presentations will be made at national and other conferences. Study findings shall be disseminated to Gulu University, Biology Department, and Faculty of Science. It will also be shared with Nakaseke and Nakasongola District governmental officials.

## 3.9 Study limitations

The study, being a cross-sectional one, did not capture information on the seasonal status of ticks and tick-borne diseases in the two study districts.

# CHAPTER FOUR

# RESULTS

## 4.1 The perspectives of local communities and extension workers on TTBDs

The perspectives of local communities on TTBDs were assessed in mixed crop-livestock and pastoral farming systems that comprised of 88.1% and 11.9% of households respectively (Table 1). It was found that their people mainly kept cattle as well as cultivated gardens (crops). That the majority people of Nakaseke and Nakasongola districts practicing mixed farming was not a surprise. This practice was of symbiotic benefit because cattle provided manure to crops and crops provided animal feeds (forage).

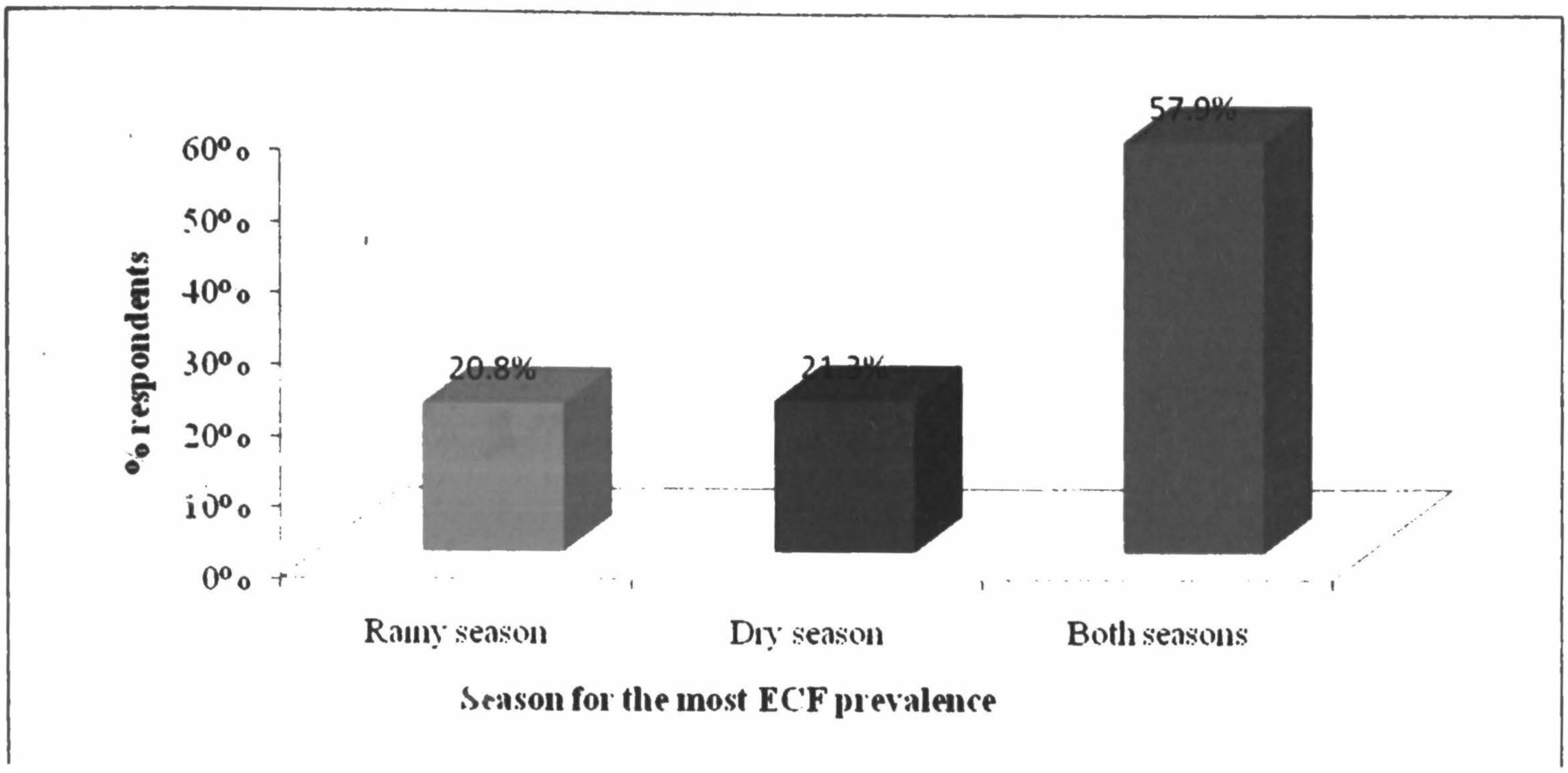
**Table 1: Farming systems practiced by households**

| Farming system | Frequency | Percentage (%) |
|---|---|---|
| **Mixed farming (crop and livestock)** | 1683 | 88.1 |
| **Pastoralism** | 228 | 11.9 |
| Total | **1911** | 100.0 |

### 4.1.1 The occurrence of ECF in different seasons

About 58% of respondents reported that ECF was common in both rainy and dry seasons (Fig 1). However, only 20.8% and 21.3% respondents believed that ECF was a problem in rainy and dry seasons, respectively.

**Figure 7: The occurrence of ECF**




## 4.1.2 Perceived Causes of ECF

About thirty two percent (31.8%) of households wrongly perceived the cause of the ECF as being flies such as Tsetse flies (Table 2). This was then followed by the ticks at 19.7%. ECF was also perceived (12.1%) to spread when animals were brought in contact with other animals. Lack of pastures in the districts, hence poor feeding of the animals was perceived by 9.1% of respondents to bring about the disease. At a lower level or spread, the diseases in animals could also be brought about due to dirty water, prolonged drought, dust and high temperatures.

**Table 2: The perceived Causes of ECF**

| Causes of ECF | Frequency | Percentage (%) |
|---|---|---|
| **Lack of pasture/ poor feeding** | 6 | 9.1 |
| **Dirty water** | 4 | 6.1 |
| **Ticks** | 13 | 19.7 |
| **Flies like Tsetse flies** | 21 | 31.8 |
| **High temperature** | 3 | 4.5 |
| **Contact with other animals** | 8 | 12.1 |
| **Dust** | 3 | 4.5 |
| **Prolonged drought** | 4 | 6.1 |
| **Others** | 4 | 6.1 |
| Total | **66** | **100** |

### 4.1.3 Percentage distribution of the symptoms of ECF

The respondents documented a diverse range of symptoms of East Coast Fever (Table 3). Of these, about 20% and 21% of respondents perceived fever or high temperature and enlarged lymph nodes as the most important symptoms of ECF. These were followed by raised hair (16.0%) and loss of appetite (13.5%).

**Table 3: Percentage distribution of the symptoms of ECF**

| Clinical signs and Symptoms of ECF | Frequency | Percentage (%) |
|---|---|---|
| **Fever/High temperature** | 108 | 19.6 |
| **Nasal discharge** | 34 | 6.2 |
| **Diarrhoea** | 46 | 8.4 |
| **Coughing** | 36 | 6.5 |
| **Enlarged lymph nodes** | 115 | 20.9 |
| **Loss of appetite** | 74 | 13.5 |
| **Loss of appetite/emaciation** | 24 | 4.4 |
| **Raised hair** | 88 | 16.0 |
| **Lameness** | 10 | 1.8 |
| **Others** | 15 | 2.7 |
| Total | **550** | **100** |

### 4.1.4 Source of Information on ECF

About 34.9% cattle keepers reported to have got information on East Coast Fever treatment from the veterinary doctor, (25.6%) were advised by relatives and (10.5%) by local leaders(Table 4). It is evident that both local leaders and government had not done much in sensitizing the farmers on East Coast Fever in the cattle corridor areas of Nakaseke and Nakasongola.

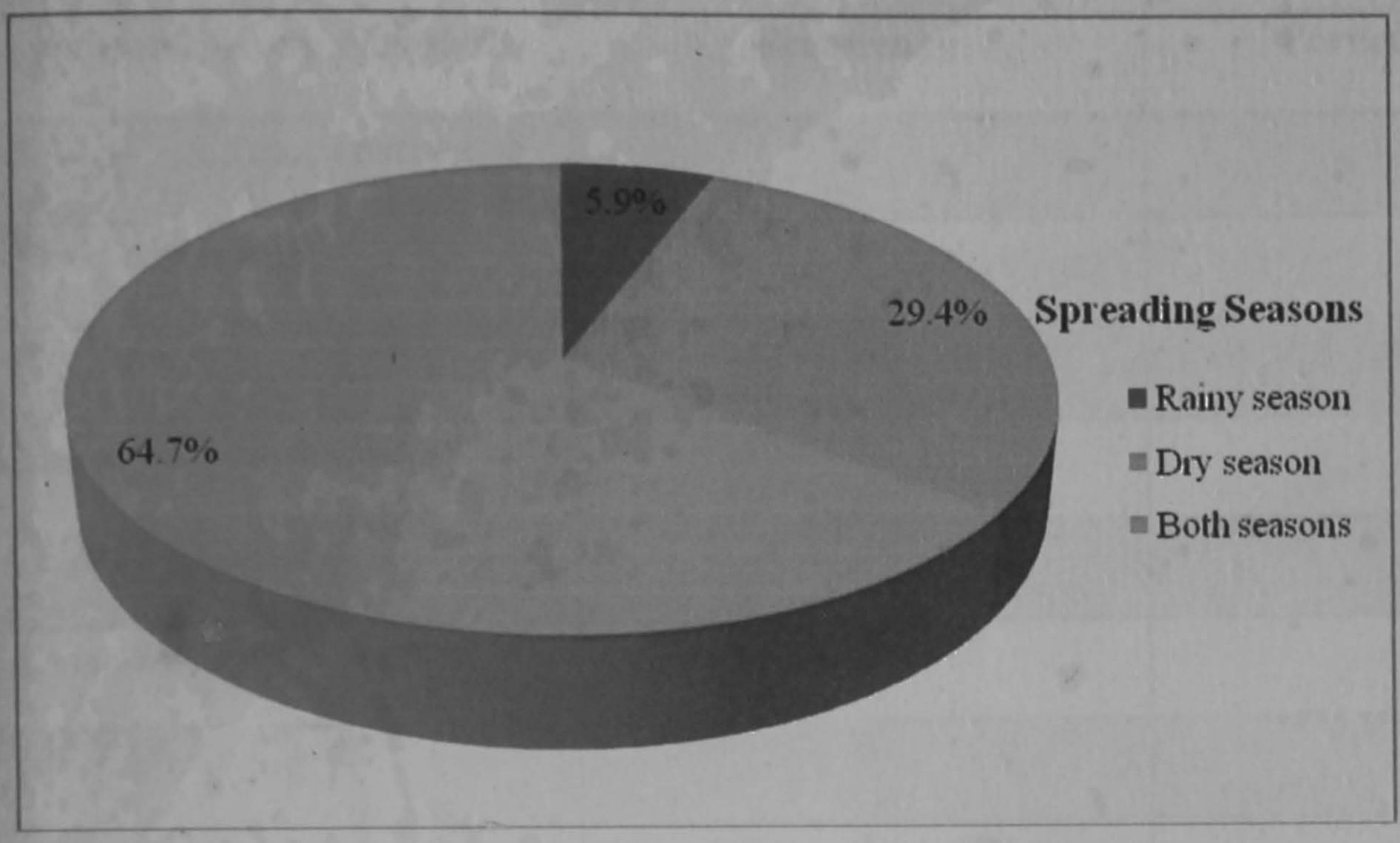
**Table 4: Source of information on the ECF**

| Source of information on ECF treatment | Frequency | Percentage (%) |
|---|---|---|
| **Government** | 4 | 4.7 |
| **Veterinary doctors** | 30 | 34.9 |
| **Local leaders e.g LC1,2 or 3** | 9 | 10.5 |
| **Fellow farmers** | 20 | 23.3 |
| **Relatives** | 22 | 25.6 |
| **Others** | 1 | 1.2 |
| **Total** | **86** | **100** |

### 4.1.5 Occurrence of *anaplasmosis* disease in different seasons.

Based on the perspectives of the respondents, 64.7% of them reported the occurrence of *anaplasmosis* in both rainy and dry seasons. However, only 5.9% and 29.4% of the respondents reported the occurrence of *anaplasmosis* in rainy and dry seasons, respectively.

**Figure 8: The occurrence of *anaplasmosis* disease in different seasons.**




### 4.1.6 Symptoms of *anaplasmosis*

The respondents enlisted several symptoms of *anaplasmosis* disease (Table 5). Of these, the major symptoms of *anaplasmosis* disease reported were raised hair (35.9%), followed by fever or high temperature (17.6%), diarrhea and loss of appetite both at (11.8%). The minor symptoms of the disease were enlarged lymph nodes, loss of weight and nasal discharge (all at 5.9%). The total number 17 represents people who were identified by extension worker to be knowledgeable in diagnosis of TBDs.

**Table 5: Clinical signs and symptoms of *anaplasmosis***

| Symptoms of *anaplasmosis* | Frequency | Percentage (%) |
|---|---|---|
| **Fever/High temperature** | 3 | 17.6 |
| **Nasal discharge** | 1 | 5.9 |
| **Diarrhoea** | 2 | 11.8 |
| **Enlarged lymph nodes** | 1 | 5.9 |
| **Loss of appetite** | 2 | 11.8 |
| **Loss of weight/Emaciation** | 1 | 5.9 |
| **Raised hair** | 6 | 35.9 |
| **Others** | 1 | 5.9 |
| **Total** | **17** | **100** |

## 4.2 Occurrence of TTBDs

### 4.2.1 Types of ticks.

From the study conducted in Nakaseke and Nakasongola districts, it was found out that ticks belonging to Genus *Rhipicephalus* were the most common. In particular, Species *Rhipicephalus appendiculatus* was the most common, followed by *Rhipicephalus evertsi*, and *Amblyomma variegatum*. No other species of ticks were recorded.

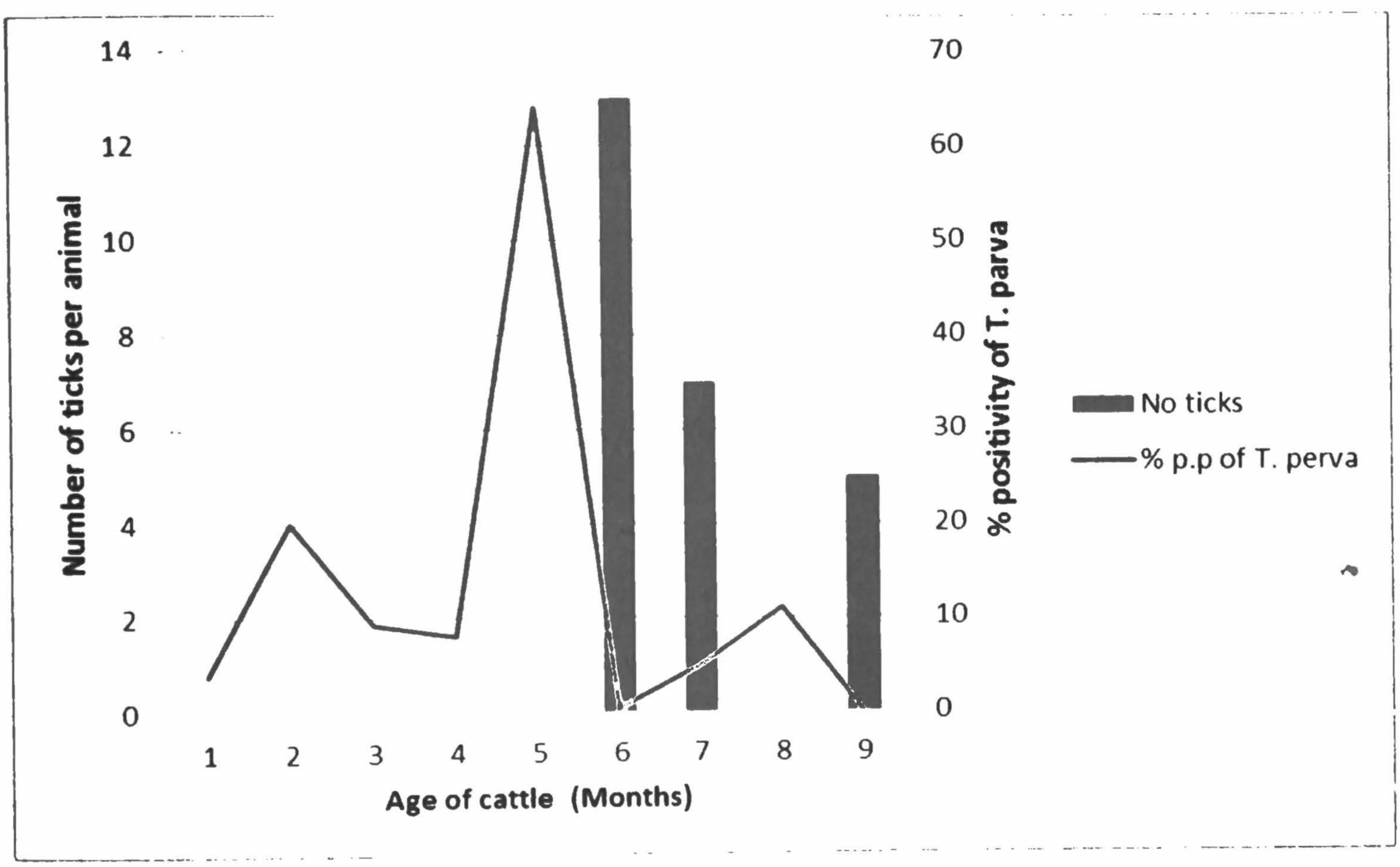
### 4.3.2 Prevalence of TBDs in Nakaseke district

In Nakaseke district, in pastoral farming system, the number of *R. appendiculatus* ticks per animal ranged between 0 and 15. No ticks were found on calves below 6 months. This could be due to the predominant calf management practices whereby young calves are kept in calf

pens. The serological tests show that the prevalence of *T. parva* was below the cut-off point of 20 within the age groups of calves below 4 months only.

However after 5 months, the prevalence shot up to 65% and drastically dropped at the age of 6 months to below cut-off point of 20 and this was maintained up to the age of 9 months.

**Figure 9: Variations of number of ticks and % positivity of *T.parva* with age of the calf in pastoral farming system in Nakaseke district.**




*i) Number of ticks per animal = total number of ticks per animal divided by the total number of animals*

*ii) Age of cattle considered = below 12 months*

*iii) % positivity of T. parva = percentage positivity of T.parva pathogens*

Under this farming system, increase in the mean number of ticks did not necessarily mean increases in the prevalence of ECF in the animals since there was a negative correlation between mean number of ticks per animal and percentage positivity of *T.parva*, with mean number of ticks having a MSE value of 1.5.

**Table 6: Showing correlation between mean number of ticks and percentage positivity of *T.parva***

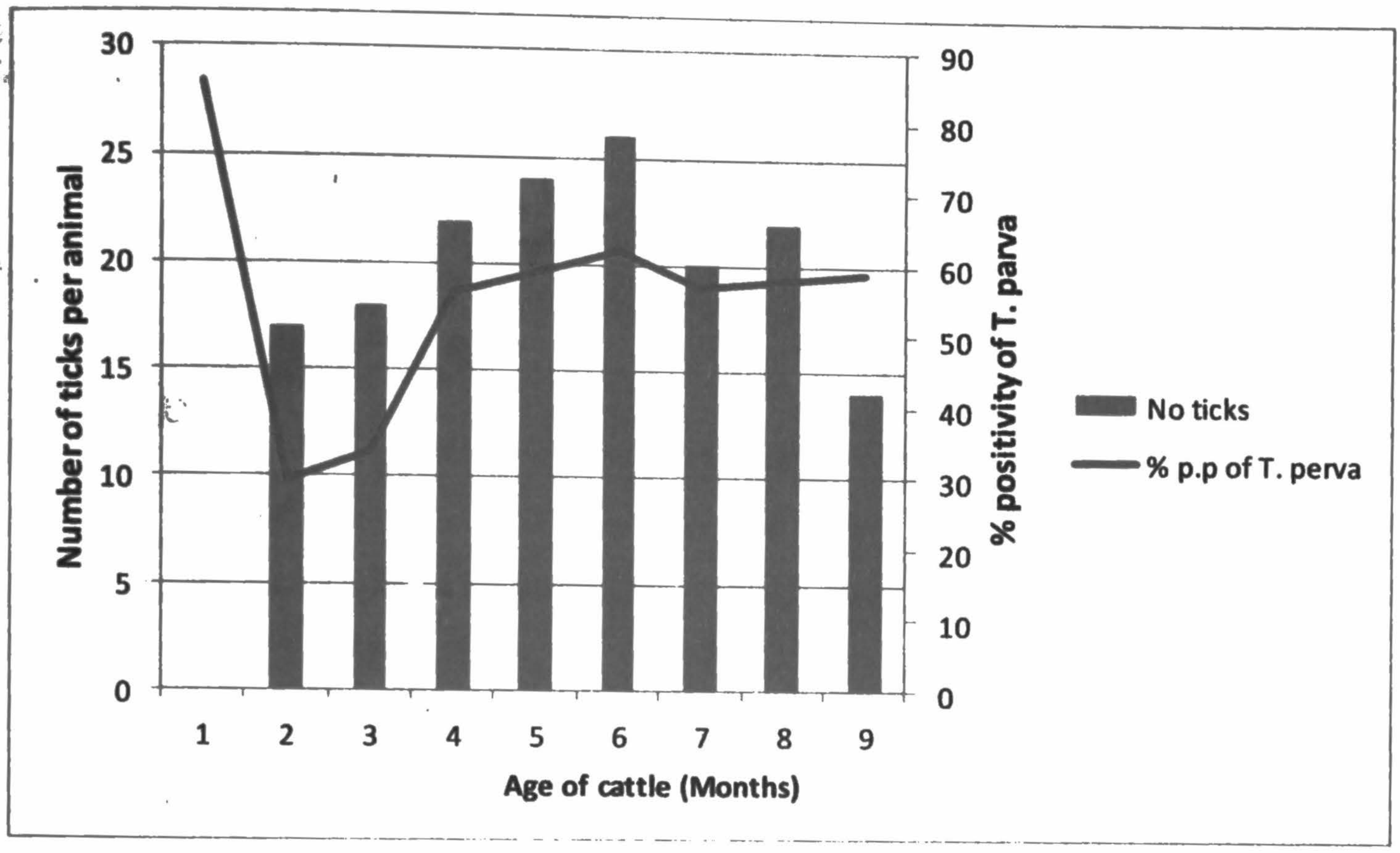
| | No. of ticks | % pp of *T parva* |
|---|---|---|
| No. ticks | 1.0000 | |
| % pp of *T parva* | -0.4056 | 1.0000 |

**Table7: Showing a summary of regression of mean number of ticks and percentage positivity of *T.parva***

| % pp of *T parva* | Coef. | Std. Err | t | p>1t1 | [95%Conf. Interval] |
|---|---|---|---|---|---|
| No. ticks | -1.734955 | 1.477973 | -1.17 | 0.279 | -5229806 |
| -cons | 18.26376 | 7.679772 | 2.38 | 0.049 | 1.759895 |
| | | | | | .1039885 |
| | | | | | 36.42354 |

In the mixed crop-livestock farming system, the mean number of ticks per animal varied greatly ranging from about 2 to 24. All the age groups of calves were exposed to tick challenge. The prevalence of *T. parva* is a mirror image of the tick population at different age in months. The prevalence of *T. parva* increased from 1month old calf and reached a peak in calves of 2-3 months old, but drastically dropped in calves 4 months old. Thereafter, it gradually built up to the age of 8 months reaching a peak of about 64%.

**Figure 10: Variations of number of ticks and % positivity of *T.parva* with age of the calf in mixed crop-livestock farming system in Nakaseke district.**




*i) Number of ticks per animal = total number of ticks per animal divided by the total number of animals*

*ii) Age of cattle considered = below 12 months*

*iii) % positivity of T. parva = percentage positivity of T.parva pathogens*

For this farming system, there was a positive correlation between mean number of ticks and percentage positivity of *T. parva* with mean number of ticks per animal having a MSE value of 2.84. Increase in the tick burden on animals led to increase in prevalence of ECF.

**Table 8: Showing correlation between mean number of ticks and percentage positivity of *T.parva***

| | **No. if ticks** | **% pp of *T parva*** |
|---|---|---|
| No. ticks | 1.0000 | |
| % pp of *T parva* | 0.6362 | 1.0000 |

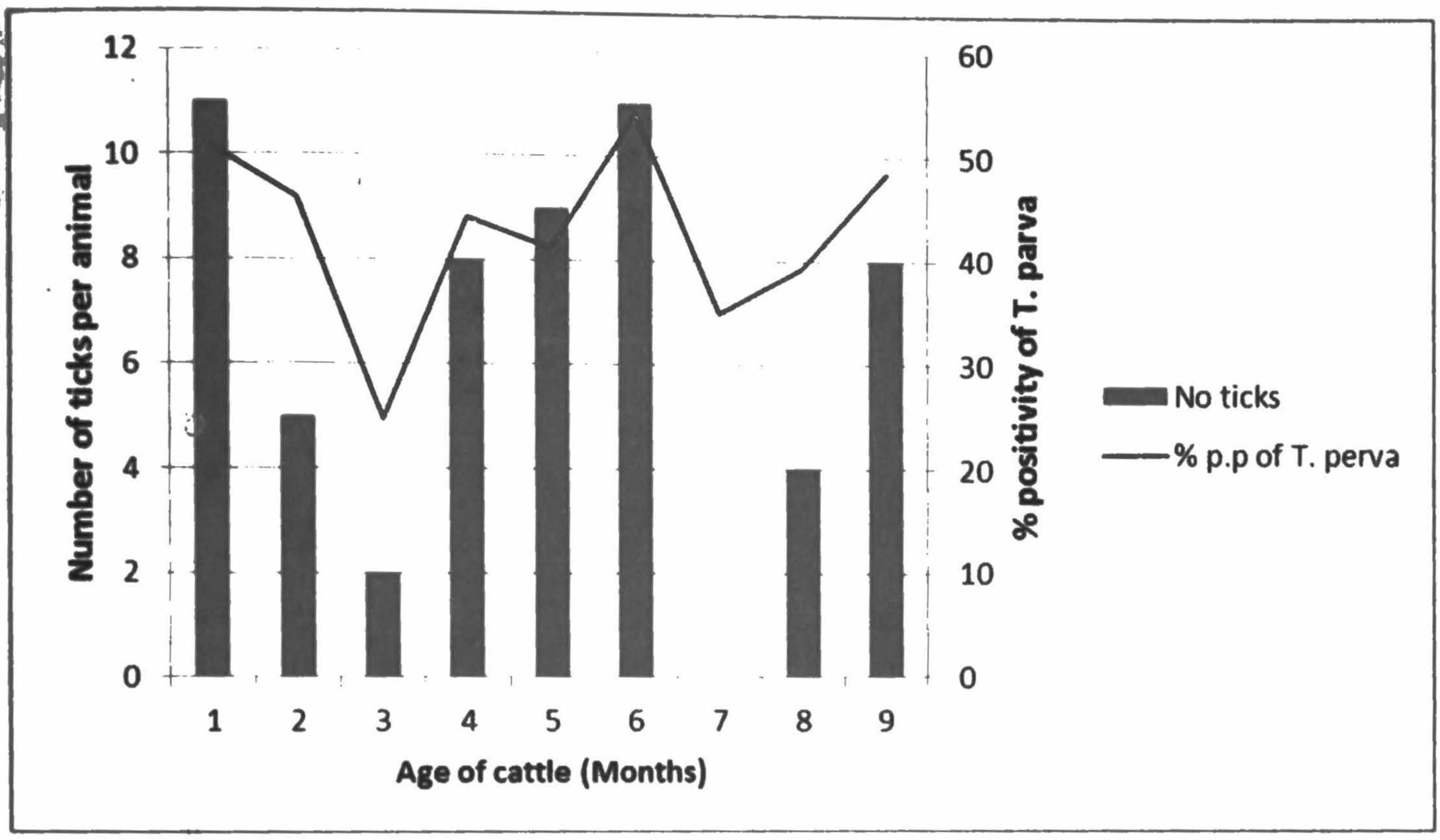
**Table 9: Showing a summary of regression of mean number of ticks and percentage positivity of *T.parva***

| % pp of *T parva* | Coef. | Std. Err | t | p>1t1 | [95%Conf. Interval] |
|---|---|---|---|---|---|
| No. ticks | 1.895017 | .8686184 | 2.18 | 0.065 | -.158939 |
| -cons | 16.8798 | 12.23625 | 1.38 | 0.210 | 3.948973 |
| | | | | | -12.05434 |
| | | | | | 45.81395 |

### 4.3.2 Prevalence of TBDs in Nakasongola district.

In Nakasongola district, in pastoral farming system, the mean tick number per animal also varied greatly at different age groups of calves ranging from 0 to 11 (figure 5). The prevalence of *T. parva* decreased steadily from newly born calves, up to three months old calves. Thereafter, the prevalence increased steadily reaching a peak of about 54% in calves six months old. Subsequently, it fluctuated up to the age of nine months.

**Figure 11: Variations of number of ticks and % positivity of *T.parva* with age of the calf in pastoral farming systems in Nakasongola district.**




*i) Number of ticks per animal = total number of ticks per animal divided by the total number of animals*

*ii) Age of cattle considered = below 12 months*

*iii) % positivity of T. parva = percentage positivity of T.parva pathogens*

For this farming system, there was a positive correlation between mean number of ticks and percentage positivity of *T. parva* with mean number of ticks per animal having a MSE value of 1.16. Increase in the tick burden on animals led to increase in prevalence of ECF.

**Table 10: Showing correlation of mean number of ticks and percentage positivity of *T.parva***

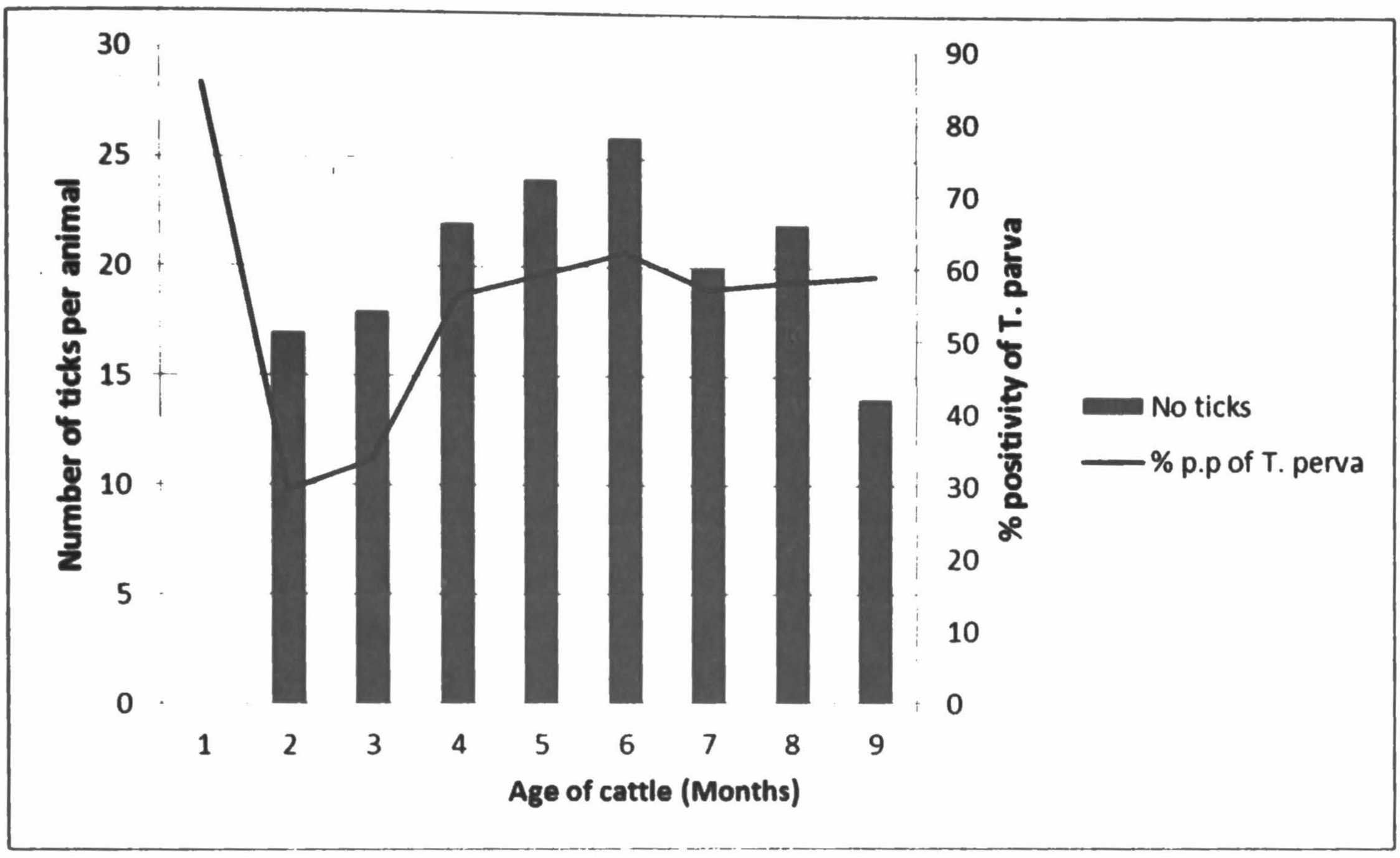
| | No. if ticks | % pp of *T parva* |
|---|---|---|
| No. ticks | 1.0000 | |
| % pp of *T parva* | 0.8399 | 1.0000 |

**Table 11: Showing a summary of regression of mean number of ticks and percentage positivity of *T.parva***

| % pp of *T parva* | Coef. | Std. Err | t | p>1t1 | [95%Conf. Interval] |
|---|---|---|---|---|---|
| No. ticks | 2.291391 | .6045986 | 3.79 | 0.009 | .8119911 |
| -cons | 26.88742 | 4.760615 | 5.65 | 0.001 | 3.77079 |
| | | | | | 15.23861 |
| | | | | | 38.53622 |

In mixed crop-livestock farming system, the mean number of ticks per animal ranged from 14 to 28 and no ticks were found on calves up to 1month old (figure 6). The prevalence of *T. parva* sharply decreased from newly born calves to calves two months old, reaching a level of 30%, thereafter it increased gradually for some months up to the age of 6 months, reaching a peak of 63%.

**Figure 12: Variations of number of ticks and % positivity of *T.parva* with age of the calf in mixed crop-livestock farming system in Nakasongola district.**




*i) Number of ticks per animal = total number of ticks per animal divided by the total number of animals*

*ii) Age of cattle considered = below 12 months*

*iii) % positivity of T. parva = percentage positivity of T.parva pathogens*

Increase in the number of ticks per animal in this farming system mirrored prevalence of ECF. The mean tick number bearing a value of MSE equal to 2.57.

**Table 12: Showing correlation of mean number of ticks and percentage positivity of *T.parva***

| | **No. if ticks** | **% pp of *T parva*** |
|---|---|---|
| **No. ticks** | 1.0000 | |
| **% pp of *T parva*** | 0.4291 | 1.0000 |

**Table 13: Showing a summary of regression of mean number of ticks and percentage positivity of *T.parva***

| % pp of *T parva* | Coef. | Std. Err | t | p>1t1 | [95%Conf. Interval] |
|---|---|---|---|---|---|
| No. ticks | -.9026095 | .7181596 | -1.26 | 0.249 | -2.600787 |
| -cons | 71.79171 | 14.01792 | 5.12 | 0.001 | .7955682 |
| | | | | | 38.6446 |
| | | | | | 104.9388 |

## 4.3 Management of TTBDs

Cattle keepers used different methods to treat their animals against ticks and tick-borne diseases (Table 6). The biggest percentage of the cattle keepers (65.3%) bought drugs in order to treat their animals, followed by 17.2% who used private veterinary officers, (10.4%) who used government veterinary officers while only 5.6% used local herbs.

**Table 14: Control strategies for TTBDs**

| **Practices used (treatment methods)** | **Frequency** | **Percentage (%)** |
|---|---|---|
| Use local herbs for treatment | 64 | 5.6 |
| Buy drugs | 752 | 65.3 |
| Call government veterinary officers | 120 | 10.4 |
| Use private veterinary officers | 198 | 17.2 |
| Just look on (no option to do) | 6 | 0.5 |
| Others | 11 | 1.0 |
| **Total** | **1151** | **100** |

# CHAPTER FIVE

# DISCUSSION OF RESULTS

The use of a questionnaire to identify the extension workers and farmers' perspective on TBDs constraints to livestock production was useful in providing an insight into the most important TBDs in the districts of Nakaseke and Nakasongola both in pastoral and mixed crop-livestock farming systems. The farmers were able to identify the main diseases prevalent in the districts and their seasonal occurrence. In both farming systems, the farmers reported that tick-borne diseases were spread mainly in both dry and wet seasons. The farmers in both farming systems were also able to precisely identify the symptoms of TTBDs though a fairly big percentage of the farmers wrongly perceived the cause of ECF. This requires sensitization of the communities about the actual symptoms of the disease such that a right treatment should be given to avoid wastage of drugs as wrong diagnosis would lead to wrong treatment by the local farmers since some of them treat their animals. They were also able to clearly state and rank the control and management strategies for ticks and tick-borne diseases. Although most of them managed the tick challenge by use of acaricides, the challenge of TTBDs is still big. Probably there was a need to investigate the brands of acaricides used, the frequency of their application, dosage applied, the way and how the acaricides were applied on the animals to determine whether there could be issues related to drug resistance. The majority of the farmers reported that they bought drugs themselves to treat the animals. This could have led to wrong treatments resulting from wrong diagnosis. The high tick challenge could largely be attributed to a breakdown in tick control services formerly supported by the government not only in the two districts, but generally in the rest of the country.

The empirical data collected provided a basis for identification of the types of ticks and tick-borne diseases present in both farming systems in the two districts. The qualitative techniques were carried out in combination with quantitative epidemiological methodology (serological survey) to check the accuracy of the perceived perspectives of farmers on TBDs. This was important because wrong information could be given due to lack of appropriate technical information to diagnose TBDs. Results of the serological tests indicated a high prevalence of antibodies to *Theileria parva* which was expressed as percentage positivity, taking 20% value as a cut-off point as (Katende *et al.*,1998) in identification of a theileria mutans-specific antigen for use in an antibody and antigen detection ELISA. This was not surprising as the challenge of *Rhipicephallus* ticks was high in nearly both farming systems in the two districts.

The detection of antibodies to *T.parva* pathogens in calves as young as 0-3 months was expected since, at this age, passively transferred colostral antibodies are still in high titre in the serum of the animals (Burrdge and Kimber 1973). So, in this study, and so, effort was made to scrutinize the sero-prevalence of antibodies to *T. parva* pathogens in calves (4-12 months old). This was done because it is known that by the age of 2-4 months, the passively transferred colostral antibodies have waned to undetectable levels (Burridge and Kimber, 1973). So it was assumed that the antibodies detected in this age group (4-12 months) were due to infection from infected ticks and so indicated exposure to tick infection.

In Nakaseke district, farmers practice regular tick control on their animals in both pastoral and mixed crop-livestock farming systems. This was evidenced by ticks not being found on calves up to the age of 6months in the pastoral farming system. However, calves above 6months were found with ticks. The mean number of ticks per animal did not necessarily result into increase in prevalence of ECF due to the fact that the animals were more exposed

to the tick challenge in the rangelands as pastoralists kept on moving from one place to another with their large hards in search for pasture. The animals were therefore endemically stable. An endemically stable state is characterized, among other things, by high antibody prevalence (>70%) and a constant tick challenge; while endemic instability is characterized by low antibody prevalence of <30% (Norval *et al.*1992, Young 1988). In addition the low prevalence of *T. parva* below the cutting point up to the age of 4months old calves was evidence that the calves had low maternal protective antibodies against. Compared to pastoral farming system, the animals the mixed crop-livestock farming system were endemically less stable as the mean number of ticks mirrored the prevalence of ECF. Probably this was due to the fact animals were less resistant compared to those in the pastoral farming system. It could also be due to issues associated with wrong acaricide formulations and laxity in drug application. All the calves were exposed to the tick challenge and the %PP was above the cut-off point of 20%

In Nakasongola district under pastoral farming system, prevalence of ECF was mirrored by the mean number of ticks per animal. This revealed a state of endemic instability in the animals. Animals were exposed to the tick challenge even at an early age due to poor management practices were calves are left to move with their mother cows to breast feed them while they in turn were grazing in the pastures. Under the mixed crop-livestock farming system, a scenario similar to that in pastoral farming system was observed in a sense that tick loads on animals mirrored prevalence of ECF and in calves of all ages in both farming system the prevalence of ECF was high since it was above the cut-off point of 20% much as they applied acaricides. Statistically there was a correlation between mean number of ticks and percentage positivity of *T. parva*. The results obtained in Nakasongola and Nakaseke districts about TTBDs agree with previous report Mugabi *et al.*, 2009) indicating that these two

districts have animals with a big challenge of TTBDs, though not ECF mentioned as the major TBD in the area.

In addition, ticks of species *Amblyomma variegatum* were found on calves which transmitted the causative agent of the disease *cowdriosis*. Since *boophilus* ticks which transmit the pathogen for *anaplasmosis* were not sampled on calves, it could be that the farmers mistook *Cowdriosis* to be *anaplasmosis*. This needed further investigations.

It was evident from discussions that although most of the farmers applied acaricides on livestock on a regular basis, the tick load on most of the animals in both farming systems were high. This was so even in instances where farmers had indicated that they applied acaricides on the animals a few days prior to the visit. It could be that the farmers applied understrength concentration of acaricides either due to inability to follow instructions or due to financial difficulties. This improper application of acaricides, especially the use of understrength concentrations could result in ticks developing widespread resistance to the acaricides in the districts. This called for urgent investigation on tick resistance to common acaricides used.

Veterinary extension services are necessary in assisting farmers to effectively apply the hand spray technique of tick control as it is not as reliable as dips. Farmers need to be trained on how to prepare the correct dilution of the acaricides and the predilection sites of the ticks where the spraying should be focused on the body of animals. Since most of the farmers (63.5%) buy the drugs themselves to treat the animals, it was possible that there are inadequate veterinary extension services in the districts to provide the farmers with the required technical information on tick control.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 CONCLUSIONS

The research carried out targeted prevalence of ticks and tick-borne diseases in the cattle in Nakaseke and Nakasongola cattle corridor districts of Uganda, where earlier diagnostic studies carried out had revealed that this region experienced extremes of weather events summarised as climate variability and local communities depended on agriculture as their mainstay. The study also revealed that there was a big problem of TTBDs which required a lot of attention since it so much affected livestock production and paused great economic set back among the impoverished local communities which seemed to offer less explanations on how to solve it yet there was some anticipation that probably on the increase as climate variability effects were becoming much pronounced in this area which phenomenon also seemed to be out of their control. This proved earlier report obtained from diagnostic studies in the area on the magnitude of TTBDs (Afrii, 2009).

The findings revealed that there was a correlation between farmers' practices in the two farming systems and the magnitude of TTBDs. For instance in Nakaseke district alone especially in the pastoral farming system, calves are kept in the calf pens immediately after birth up to the age of four months. This reduced early exposure of these calves to the challenge of TTBDs and hence this was a better management strategy employed by this community unlike in the mixed crop-livestock farming system where the tick challenge on calves was observed as they never used to keep calves in calf pens and hence the observed trends TTBDs. It was therefore clear that pastoral farming communities had a good management strategy to control the challenge of TTBDs.

The burden of TTBDs was still big in both dry and wet seasons in the local breeds of cattle and all communities were affected thought differently to a varying extent. The local communities fairly managed the challenge through mainly application of acaricides though there was a great need to train the farmers on how to do it, who should do it and when to do it. Thought this was being carried out it was also observed that land was mainly communal and hence the communities carried out communal grazing which even exposed the animals more to the challenge of TTBDs as the animals were likely to be so much into contact with the ticks during the grazing period all the time. This farming practice escalated the magnitude of the challenge of TTBDs in the area posing even greater challenges in introduction of improved exotic breeds of cattle which offer more quality meat, high milk yields among others which could greatly improve on the livelihood of these communities. There was therefore less correlation between regular tick control through application of acaricides and tick load reduction on cattle.

The breakdown of government livestock diseases control infrastructure left no effective alternative control strategy of TTBDs to the economically poverty stricken cattle keeping communities of the cattle corridor which now have a range of challenges besides that of TTBDs to handle and yet less has been done by the government to improve the livestock industry in this area.

Basing on the study conducted, the prevalent tick species were the brown ear ticks, *Rhipicephalus appendiculatus* which transmit the causative of ECF disease which was found out to be the most common TBD in both districts.

The research findings can be enriched by conducting more studies to cover all the seasons under a longitudal survey in both districts.

## 6.2 RECOMMENDATIONS

The management and control of TTBDs in the cattle corridor districts of Nakaseke and Nakasongola called for urgent applicable measures to reduce the challenge to the minimum so as to cub the effects of TTBDs on livestock production in the climatically sensitive and fragile agro-ecological zone of the cattle corridor. In the first case, control of ticks and the diseases they transmit was largely through the application of acaricides mainly through sprays and therefore there was a need for urgent sensitisation and evaluation on the brands of acaricides being used to manage ticks on the animals. The strict short time-interval application of proper dosage and formulation of acaricides would prevent transmission of the parasites which if could be used in conjunction with control on animal movement especially during feeding of animals in the communal grazing land farming practice of theses societies, quarantine, slaughter among others would greatly lead to reduction of tick loads on the cattle and result into less application of the acaricides which are hard to aquire by the economically stricken farming communities of this area.

Inappropriate use of acaricides emerged to be a very crucial point in the management of TTBDs in the two cattle corridor districts as a number of farmers treated their animals themselves without the help of qualified personel yet they were not well informed on how to do the treatment well thereby abusing chemical methods of tick control. There was therefore an urgent need to carry out research on brands of acaricides used to avoid issues related with wide spread acaricide resistance.

Though the observed challenge of TTBDs was big, treatment of the animals never necessitated complete eradication of ticks from the animals as to some extent, a small exposure of the animals to the tick challenge would help them develop tick resistance through production of appropriate antibodies towards the TBD antigens. This boosts up the immunity

of the animals against the challenge of TTBDs and further more would bring about endemic stability required in the effective management of TTBDs. This would be of great advantage in reduction of calf mortality brought about by presence of naïve immune compromised animals which have never at all been exposed to the challenge of TBD infection.

There was a need to determine the sero-prevalence for other TBDS, since the local people reported the existence of other tick-borne diseases such as *anaplasmosis*.

Improved exotic breeds could be introduced in the area in order to improve on the livelihood of these cattle keeping communities but after restricting animal movements through establishment of proper land management policies to help local communities reduce on the contact between their animals and the ticks in the field. The exotic breeds yield more milk and quality meat yet they are very fragile to manage in the presence of TTBDs which greatly led to their death and this can partly be achieved through zero grazing and also using a paddock system of cattle feeding in the grazing land which encourages farmers to separate their animals during feeding rather than using the current communal grazing farming practice.

Introduction of resistant breeds of cattle could also help to reduce the burden of TTBDs as some animals, or whole breeds, consistently carry fewer ticks than others kept in the same environment. Such differences are caused by variation in the animals' abilities to respond immunologically to tick infestation and this ability to develop resistance is heritable and the actual manifestation is acquired. It is stable over longer periods, although stresses such as lactation or sickness cause a drop in resistance. Different levels of resistance occur in all breeds, but this is manifested more strongly in zebu cattle and their crosses which can be introduced in this area since a number of local farmers are affected by the escalating costs of buying acaricides required for regular tick control on the animals. This could turn out to be one of the most effective methods to deal with the challenge of TTBDs in this area.

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# *APPENDIX A: QUESTIONNAIRE FOR HOUSE HOLD SURVEYS*

PROJECT: Adaptation to the impact of climate variability on food and health security in the cattle corridor of Uganda.

Date of interview.....

Questionnaire number.....

District.....

Sub county.....

Parish.....

Village.....

Household Number/code.....

Community farming System.....

Longitude.....

Latitude .....

Time started.....

Time ended .....

Enumerator .....

Signature.....

Checked by.....

***Diseases***:[1] Ephemeral fever;[2]East coast fever/'amakebe'/ Amashiyo;[3]Trypanosomiasis/'ekipumpuru;[4] Orf/'Obunwanwa;[5] Worms/ helminthosis;[6] Mange;[7] Mastitis;[8] Swine fever;[9] Others (specify)

***Indigenous treatment measure:***

***Source of treatment / advice or prevention/ control measure:*** [1] Government;[2] Veterinary doctors/ personnel;[3] Local leaders eg LC1,2 or 3;[4] Neighbours/fellow farmers;[5] Parents/ relatives;[6] Others(specify)

***Effectiveness of treatment or prevention/ control measure***: [1] High/ very effective;[2] Moderately effective;[3] Low / Not as effective;[4] Don't know

12. How have you or your household adjusted/ coped with the increased occurrence of livestock diseases in the dry or wet season?

.....

***Table 3.coping mechanisms against livestock diseases***

| No. | Livestock species | Livestock diseases(three most important diseases only) | Coping mechanisms/ strategies |
|---|---|---|---|
| 1 | Cattle | | |
| | | | |
| | | | |
| | | | |

***Livestock diseases:*** [1] Ephermeral fever;[2] East coast fever/'Amakebe'/ Amashiyo;[3] Trypanosomiasis/'ekipumpuru;[4] Orf/'obunwanwa;[5] Worms/ helminthosis;[6] Mange;[7] Mastitis;[8] Swine fever[9] Others(specify)

***Copying measures***: [1] Treat them using local herbs;[2] Buy drugs(e.g. antibiotics, anthelminths etc) from vet drug shops;[3] Call on sub county / government veterinary officers;[4]Call on private veterinary officers;[5] Don't know/ Not sure/ just look on;[6] Others(specify)

## APPENDIX B: CHECK LIST FOR FOCUS GROUP DISCUSSIONS (FGDs)

Date of interview .....

District ..... Sub county .....

Parish .....

Locality for FGD.....

Community farming system.....

Time started..... Time ended .....

Enumerator.....

Signature ..... Checked by .....

**Socio-economic stratification** – ethnicity, wealth, age, production system and education level of individuals in the area.

**Seasonal calendar**

•Domestic and animal water availability patterns.

•Occurrence of ticks and tick-borne diseases in the area.

•Changes in rainfall and temperature patterns in the past 5-10 years and presently by season.

•Occurrence/frequency and magnitude of extreme weather events/natural hazards/catastrophic events e.g droughts, floods/EL-Nino in the past 5-10 years

**Impact of Climate Variability (CV) on Livestock Health**

•Community's perception of ticks and tick-borne diseases

•Seasonal variations of these diseases.

•**Records taken**; shall be represented in form of say maps for the areas of interview, disease patterns map and seasonal occurrences noted in form of pie-chats and many others.

# APPENDIX C: Informed consent form

**ID Number**.....
**Name**.....

(*For adults (≥ 18 years old) at enrolment*)

**Introduction**

My name is ..... and I have been engaged to conduct this survey about effect of climate variability( frequency of extreme weather events) have affected the spread, transmission and out-break of ticks and tick-borne diseases in livestock.

**Purpose of consent**

We are seeking your permission to kindly respond to the questions we shall ask, which will help us understand the way you live and how climate variability and extreme weather events have affected livestock health and security.

**Confidentiality:**

Whatever information you provide to us will remain confidential and will be accessed by only by the top senior staff involved in the study. Even then, all your personal identification will not be used.

There are no risks at all related to your consent, and there are no benefits that come with consenting to the interview. The sole purpose of this study is to help us advise the Government and other stake holders on the effects of climate variability in this area and how they can best be addressed.

**Consent**

I ..... agree to participate in this study.

Signature/thumb print of client ..... Date .....

Name of witness (LC)

.....Signature/thumbprint.....

Date .....

Name of staff obtaining the consent..... signature

.....

Date .....

# APPENDIX D: Tick Data Capture Sheet

District .....

Date .....

Sub-county: .....

Parish .....

House hold number: .....

Longitude ..... Latitude .....

| Animal number | R.A | | B.D | | A.V | | HYA | | IMM (+) | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | M | F | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Grand total | | | | | | | | | | | | |

**Key;**

**R.A = *Rhipicephalus appendiculatus***

**B.D = *Boophilus decoloratus***

**A.V = *Amblyoma variegatum***

**HYA = *Hyalomma species***

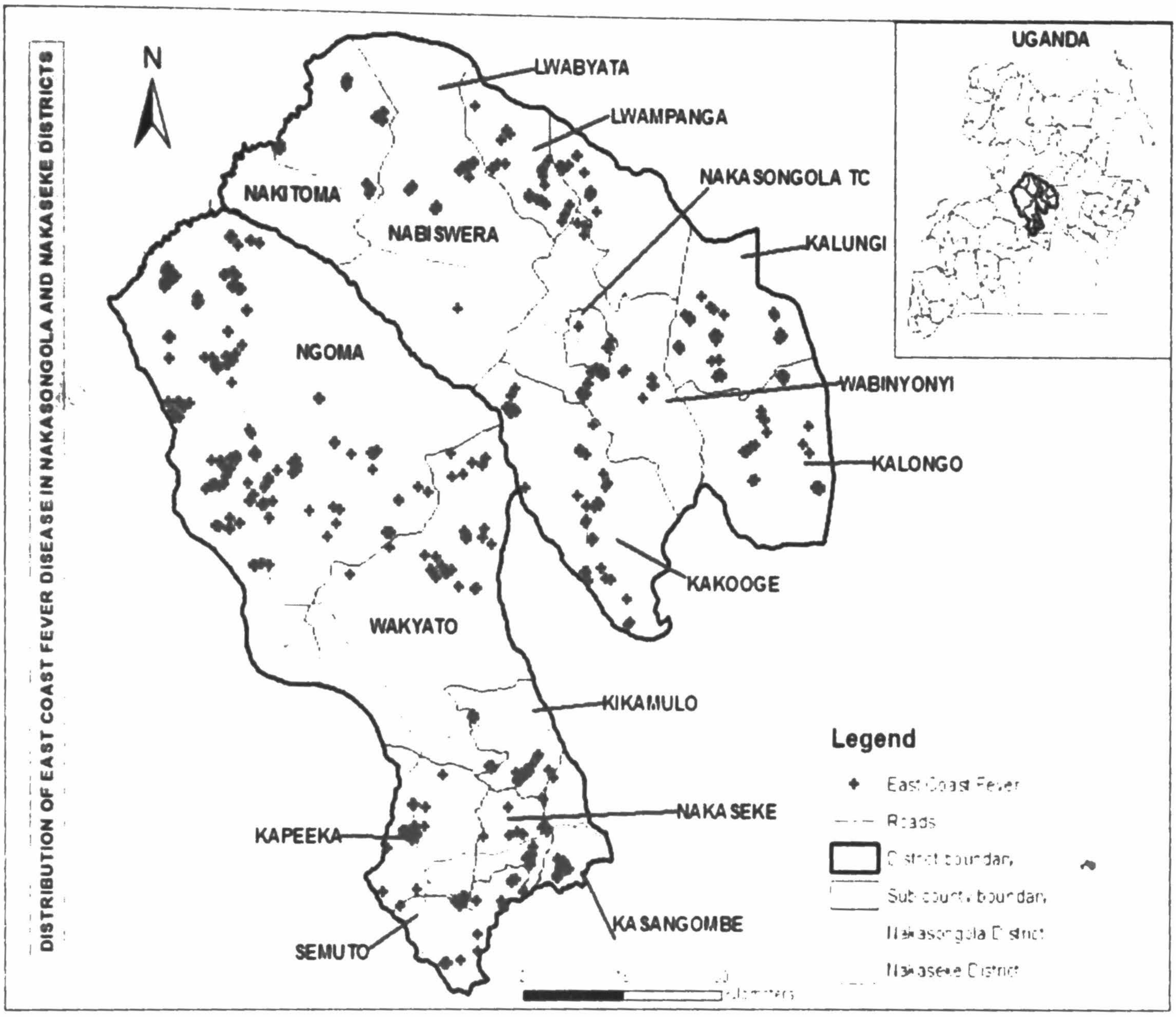
**M = male tick(s)**

**F = female tick(s)**

## APPENDIX E: Field data capture sheet for cattle blood samples.

| House hold number and name | Calf Number | Age | weight | Serum sample label | EDTA Sample blood | Blood Smear label | Lymph Node Biopsy label | Body Condition |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |

# APPENDIX F: Map showing perceived prevalence of ECF in Nakaseke and Nakasongola Districts.



## APPENDIX G: Collection of blood samples in the field from calves



# APPENDIX H: Some of the local breeds of cattle in Nakaseke pastoral farming system

