IMPACT OF THE IMMUNISATION OF CATTLE AGAINST EAST COAST FEVER IN BUGABULA COUNTY, KAMULI DISTRICT, UGANDA.

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Declaration

I Daniel Kasibule, hereby declare that the work presented here is original and never been submitted for any award to any University or Institution of higher learning.

Signed……………………………………….. Date………………………….

Kasibule Daniel

Approval

This work was done under close supervision of:

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Signed……………………………….….. Date……………………..

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Dedication

I dedicate this book to my wife Regina Birungi for her undying support and encouragement throughout this study.
Acknowledgement

Objectivity demands that I must mention my indebtedness to numerous friends, particularly those without whose help; I would never have been able to complete this book. Many people have contributed directly and indirectly to this study among whom I must mention at least a few. There are friends and colleagues in particular Dr Moses Acon Ongom, Tiberius Tumushabe, Dr Kiiza Waako, Benard Odur, Dr Kenneth Mugabi and Charles Zirimenya who helped me in forming my perspective of the study.

I must express my gratitude to my fellow extension workers, drug dealers and farmers in Kamuli for their full cooperation during data collection, an exercise without which this book would be incomplete.

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Abstract

Farmers in Bugabula County, Kamuli District were improving their cattle by crossing zebu cattle with Friesians for better dairy production. ECF was however a limiting factor towards achieving their ultimate goal. The Infection Treatment Method of controlling ECF was relatively new in this area having started in 2001. The research was therefore carried out to assess the impact of ITM in fighting against ECF.

The objectives of the study included establishing the effect of ITM on ECF prevalence, mortality of cattle, and the tick burden load and to determine the costs and benefits of adopting it as a method of controlling ECF.

The study focused on finding out the impact of ITM in Bugabula County, Kamuli District, Uganda from 2001 to 2009. Data collection was by Focus group discussion and questionnaire administration to farmers. Data analysis was by descriptive analysis and bivariate analysis using a chi-square. Economic and Financial analyses were done using Gross Margin Analysis.

The study found out that the vaccine was imported by government and delivered to farmers via government extension system. The Infection Treatment Method (ITM) of immunization against East Coast Fever (ECF) cost per head of cattle was an equivalent of US $ 12.1. Vaccine cost was found to be US $ 2.8 and treatment US $ 1.1 per head of cattle. Vaccination and treatment cost constituted 32% of the total ITM cost. The rest of the costs (US $ 8.2) were due to transport, veterinary fees and cold chain. ITM practice did not reduce acaricide use. The average half body ticks count as per head of the cattle in ITM users was 12.9±1 which were not significantly different from those in the non ITM users (13.8±0.7). The prevalence of ECF was reduced but incidence of anaplasmosis increased among ITM users. Overall crude mortality due to ECF in cattle of 7.3% among ITM herds was 3.4 times lower than among non-ITM user herds. ECF treatment costs were reduced to 2.33 times among ITM user herds, giving a saving of US $ 7.7 per head of cattle annually. Average sale prices of cattle in the ITM herds were higher than in non ITM users because the majority of the cattle in ITM farms were improved Zebu-Friesian dairy crosses (F3). Annual gross margin (GM) of cattle enterprises per farm of ITM users’ (Ug. Shs 3,708,285) was 81.4% higher than non-ITM farms.
It was shown that ITM costs were low and affordable by the farmers. It was projected that if non-ITM users adopted ITM use, cost of ITM would be 0.14 of the GM and 0.09 of gross output on the first of vaccination. These costs would reduce by 88.1% in subsequent years because only calves born would be vaccinated. The costs could further be reduced by having private companies distribute the vaccine and train Community Based Animal Health Workers and farmers to do the ITM. The farmers should be sensitized and encouraged to adopt ITM as its advantages were demonstrable in improving dairy herds. They should also be taught on how to do strategic tick control based on tick population dynamics a practice that would reduce on the tick control costs and yet protect their herds.
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<td>CBAHWS</td>
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<td>Gross Marginal Analysis</td>
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<td>IFA:</td>
<td>Immunoflorescent Antibody Analysis</td>
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<td>ILRI:</td>
<td>International Livestock Research Institute</td>
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<td>ITM:</td>
<td>Infection Treatment Method</td>
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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

East Coast Fever (ECF) or bovine theileriosis, is caused by the protozoan parasite *Theileria parva parva* transmitted by *Rhipicephalus appendiculatus* or “brown ear tick”. ECF is the second most important African cattle disease after trypanosomosis. According to Dolan (1999), ECF caused an annual loss of 1.1 million cattle and US $186 million to Africa in 1992. It is a major cattle killer in 11 countries of Eastern and Southern Africa, putting at risk the lives of about 25 million cattle, especially calves. The disease also causes reduction in the production of cattle. In addition, the epidemic also leads to failure of a breeding policy of improving productivity of indigenous cattle by cross breeding with exotic cattle breeds. There are heavy costs incurred when trying to treat and/or control it. Cattle in endemic areas, particularly the zebu type (*Bos indicus*), appear less susceptible to ECF. Introduced cattle, whether of a taurine, zebu, or sanga breed, are much more susceptible to *theileriosis* than cattle from endemic areas. The Indian water buffalo (*Bulbalis bulbalis*), for example, is as susceptible to *T. parva* infection as cattle. The African buffaloes (*Syncerus caffer*) are reservoirs of *T. parva* infection, and it has been proved that waterbucks (*Kobus ellipsiprymnus*) are also reservoirs.

ECF is a fatal disease with 100%, mortality in calves if not treated. Cattle treated can recover. In endemic areas, cattle that recover tend to become carriers (Taracha and Taylor, 2005). Tick control, vaccination and chemotherapy are the current three main methods of controlling ECF (Morzaria *et al.*, 1987). Tick control methods practiced include dipping, spraying, perimeter fencing and bush burning. Frequent dipping of cattle in acaricide and regular spraying, supported by movement control can prevent cattle and wild animals from getting into contact with infected ticks. However, all these methods are costly in terms of buying the acaricide, setting up of the infrastructure and use of technical personnel in the application of the acaricide, while bush burning destroys plant species. The Infection and Treatment Method (ITM) is relatively a new method of control of ECF (Homewood *et al.*, 2006; Kivaria, 2007 and Walker, 2007). In Uganda there is little adoption to the programme and this may be due to lack of availability of technical staff, lack of equipment such as liquid nitrogen tanks and ear tag applicators,
insufficient knowledge about ITM or high cost of the practice. Chemotherapy (using drugs such as parvaquone (Clexon®), buparvaquone (Butalex®) and halofuginone lactate (Terit®) may be too costly to the local farmers both in terms of drug purchase and accessibility to technical personnel. In addition, rapid and accurate diagnosis is required for effective therapy. Treatment is also more effective if administered in the early stages of the disease. In recovered cattle, chronic cases can occur that results in stunted growth of calves and lack of productivity in adult cattle.

In other areas, ITM has been observed to be a better method for control of ECF as compared to other treatment methods (Homewood et al., 2006; Kivaria, 2007 and Walker, 2007). Bugabula County, Kamuli district, is one of the areas where ECF was a major disease constraint and ITM had been introduced for controlling ECF. This study therefore evaluated the impact of ITM practice on livestock productivity in this geographical location. The output of this study could be used for decision making by the major stakeholders on whether to adopt ITM as method for controlling ECF in the region.

1.2 Statement of the problem

Uganda has had its fair share of livestock diseases, one of the biggest of which is ECF. This has taken a devastating toll on the number of livestock in the country and a negative impact on the incomes of millions of people in the country, whose livelihood partly depends on livestock.

As part solution to this problem, there was introduction of immunisation against ECF as one of the many ways (such as dip method) of fighting the death of livestock. However, on close inquiry, it was found out that the impact of this infection treatment method had not been evaluated in this area. Various questions were left unanswered including whether there were any remarkable changes in the prevalence, mortality, and tick burden load after the introduction of ITM practice. Also left unanswered were the costs and benefits that accrued from the intervention. This research project was therefore carried out to assess the impact of ITM in fighting against ECF.
1.3 Significance/justification of the study

The data generated from this research could be used for decision-making as to whether to continue using ITM in the fight against ECF. This would then help in policy formulation on how to control ECF.

1.4 Scope of the study

This study focused on finding out the impact of immunization of cattle against ECF in Bugabula County, Kamuli district. Although there were other methods of treatment, this study specifically looked at ITM as a method of immunization against ECF. The study considered a time scope of 9 years (2001 – 2009).

1.5 Objectives of the study

This study was carried out with the aim of establishing the impact of the immunization of livestock against ECF in Bugabula County, Kamuli district. This study addressed the following specific objectives:-

i) To establish the effect of ITM on ECF prevalence

ii) To establish the effect of ITM on the mortality of cattle due to ECF.

iii) To establish tick-burden load on cattle after ITM intervention.

iv) To determine the costs and benefits of adopting ITM as a method of controlling ECF.

1.6 Research questions

The study was guided by the following research questions:-

i) Has prevalence of ECF changed after using ITM?

ii) Has mortality of cattle due to ECF changed after using ITM?

iii) Have the tick burden load changed after using ITM?

iv) Has the use of ITM reduced the cost of tick control and improved on cattle productivity?
CHAPTER TWO
LITERATURE REVIEW

2.1 Tick borne diseases

Tick-borne diseases are diseases which are spread between animals by the bite of an infected tick. Ticks become infected by feeding on animals that are either sick from disease, or are healthy but have the parasite in their blood (carriers). Ticks infect animals when they feed on them, through their saliva. A single infected tick can pass disease on to an animal. Important tick-borne diseases in cattle include: East Coast Fever (theileriosis), heartwater (cowdriosis), red water (babesiosis) and gall sickness (anaplasmosis) (Wessels, 2009).

2.1.1 Theileriosis

Theileriosis are infections of cattle caused by *Theileria*. ECF is caused by *Theileria parva parva* and transmitted among cattle by the brown ear tick (*Rhipicephalus appendiculatus*). Other *T. parva* infections include corridor disease caused by *Theileria parva lawrencei*, January disease caused by *T. parva bovis* (Uileberg, 1999). ECF is the most important tick-borne disease in Eastern, Central and Southern Africa, causing an estimated loss of US $186 million in 1992 (Dolan, 1999). The disease was found to be enzootic along the east coast of Africa, hence deriving its name (Koch *et al.*, 1990).

ECF was introduced into Rhodesia by a consignment of cattle originating from the High Veld of Tanganyika shipped to Beira and Lourenco Marques for slaughter (Norval *et al.*, 1992). Later in 1901 a thousand heads of cattle, on their way from Australia to Rhodesia for re-stocking purposes, were detained at Beira where they were infected with ECF. After a few weeks the animals began to die in large numbers. All the survivors were sent to the High Veld of Umtali, where it was hoped the mortalities would cease. However, the animals continued to die until finally only three out of the whole shipment survived. Koch *et al.* (1990) believes that the
infection had been introduced from Tanganyika by cattle which became infected along the coast before shipment to Lourenco Marques.

*R. appendiculatus* inhabit a wide range of East African environments. Living at altitudes up to about 2,100 meters, they reproduce most successfully in cool, moist places, although they can tolerate relatively arid conditions. *R. appendiculatus* areas generally receive more than 500mm of rainfall annually. Because through most of their lives, including periods of egg hatching and molting, ticks inhabit soils and vegetation. Vegetation plays a major role in *Rhipicephalus* population dynamics. Their parasitic stages last only a few days. *R. appendiculatus* achieve greater population density in areas of high grasses.

According to Kahn (2006) the incubation period for ECF is 7-25 days. Initial clinical signs of ECF include anorexia, pyrexia (up to 106° F) and enlargement of the draining lymph nodes. The tick vector commonly feeds around the host’s ears, thus the parotid node is most commonly involved. Later, a generalized lympho-adenopathy occurs and the affected animal continues to lose body condition. Other signs that may be seen include lacrimation, nasal discharge, diarrhea, corneal opacity and dyspnea. Although ECF can cause a chronic wasting disease, most infections are fatal within 18-30 days. Prior to death, the animal is recumbent and there is a drop in body temperature. Anemia and leukopenia may also be present. Dyspnea intensifies and a frothy nasal discharge due to pulmonary oedema may be observed. Some animals also develop neurologic disease just before death. This condition is called "turning sickness" and occurs when affected cells block capillaries within the central nervous system causing ischaemia.

According to Mukhebi et al. (1992) ECF is a major disease of cattle in 11 countries in East, Central and Southern Africa namely: Burundi, Kenya, Malawi, Mozambique, Rwanda, Sudan, Tanzania, Uganda, Zaire, Zambia and Zimbabwe. The affected land area under ECF as by 1988 was 158 million hectare constituting 19% of the total areas of affected countries and 5% coverage of Africa. The cattle population at risk of theileriosis is 24 million constituting 38 % of the herds of the cattle in affected countries and 13% of cattle in Africa.
2.1.2 Anaplasmosis

According to Wessels (2009) anaplasmosis is a vector-borne, infectious blood disease in cattle caused by *Anaplasma marginale* and *Anaplasma centrale*. The disease is not contagious but is transmitted most commonly by ticks. It can also be transmitted via contaminated needles, de-horning equipment, castrating knives, tatoo instruments, biting flies and mosquitoes. Sick animals show signs including fever, pale to yellow eyes and gums, walking difficulty, heavy breathing and constipation which results due to stopping of rumen movements. Calves are resistant for the first 6 to 9 months. The post mortem findings include a yellowish carcass, a large spleen and a large gall bladder filled with thick brown greenish bile.

2.1.3 Babesiosis

According to Kahn (2006) babesiosis is caused by intra-erythrocytic protozoan parasites of the genus *Babesia*. The disease, which is transmitted by ticks, affects a wide range of domestic and wild animals and occasionally humans. While the major economic impact of babesiosis is on the cattle industry, infections in other domestic animals, including horses, sheep, goats, pigs, and dogs, assume varying degrees of importance throughout the world. Two important *Babesia* species: *B. bigemina* and *B. bovis* infect cattle. They are widespread in tropical and subtropical areas and are vectored by one host tick *Boophilus* species. Transmission in this tick occurs transovarially. While the parasites can be readily transmitted experimentally by blood inoculation, mechanical transmission by insects or during surgical procedures has no practical significance. Intrauterine infection has also been reported but it is rare.

The acute disease generally runs a course of 1 wk. The first sign is fever (frequently with temperatures of 105.8°F (41°C) or higher), which persists throughout, and is accompanied later by inappetence, increased respiratory rate, muscle tremors, anemia, jaundice, and weight loss. Hemoglobinemia and hemoglobinuria occur in the final stages. CNS involvement due to adhesion of parasitized erythrocytes in brain capillaries can occur with *B. bovis* infections. Either constipation or diarrhea may be present. Late-term pregnant cows may abort, and bulls
may undergo temporary infertility due to transient fever.

With virulent strains of *B. bovis*, a hypotensive shock syndrome, combined with generalized nonspecific inflammation, coagulation disturbances and erythrocytic stasis in capillaries, contribute to the pathogenesis. With most strains of *B. bigemina*, the pathogenic effects relate more directly to erythrocyte destruction. Animals that recover from the acute disease remain infected for a number of years with *B. bovis* and for a few months in the case of *B. bigemina*. No clinical signs are apparent during this carrier state. The susceptibility of cattle breeds to Babesia infections varies. For example, *Bos indicus* cattle tend to be more resistant to *B. bovis* and *B. bigemina* infection than European breeds. Lesions caused by babesiosis include an enlarged and friable spleen; a swollen liver with an enlarged gallbladder containing thick granular bile; congested, dark-colored kidneys; and generalized anemia and jaundice. The urine is often, but not invariably, red. Other organs like the brain and heart may show congestion with petechial haemorrhages.

2.1.4 Cowdriosis (heart water)

According to Kahn (2006) heartwater is a disease of cattle, sheep, goats and wild ruminants endemic to Sub-Sahara Africa, Madagascar, and portions of the Caribbean such as Antigua and Guadeloupe. It is caused by obligate intracellular rickettsial organisms that parasitize macrophages. After initially replicating in macrophages, the organism will move to the vascular endothelium where it undergoes additional replication. The rickettsial organism is now classified as *Ehrlichia ruminantium*, previously it was known as *Cowdria ruminantium*.

*E. ruminantium* is transmitted by *Amblyomma* ticks, with *A. variegatum* (tropical bont tick) and *A. habraeum* (bont tick) being the top transmitters. These are 3-host ticks that undergo transstadial transmission (any stage of the tick life-cycle from the time of infection forward may transmit the rickettsial organism). Native breeds of cattle and wildlife such as the N’Dama breed
in West Africa are said to be resistant to the clinical effects of heartwater. Animals having recovered from infection are typically immune to re-infection for 6 months to 4 years but may be carriers of the disease for 8 months or longer. Apparently an age-dependent resistance has long been demonstrated, recognizing that young animals have an innate resistance. This resistance has been shown to be due to a low-grade infection of *E. ruminantium* obtained in colostral cells. The incubation period is 1-3 weeks after transmission by an infected tick.

Clinical disease is produced by an increase in vascular permeability which leads to a leakage of fluid from blood vessels. This leakage of fluid results in edema formation, especially in the lungs, body cavities and the brain. In goats, disease is often characterized by renal ischemia and nephrosis. Irreversible kidney damage may cause death in infected goats (Khan, 2006).

Clinical disease may be classified as para-acute, acute, subacute or mild and inapparent. The clinical syndrome exhibited depends on the susceptibility of the animal infected and the virulence of the rickettsia involved. Para-acute disease is characterized by a high fever that quickly leads to prostration (extreme exhaustion) and death within 1-2 days. These animals may have terminal convulsions shortly before death. The mortality rate may be near 100% with para-acute disease. Acute disease is more common and will have a course of approximately 6 days. Initially the animal will appear febrile (feverish) followed by anorexia (inappetance), rapid breathing, lethargy, and a classical nervous syndrome characteristic of heartwater. Cattle become ataxic, have empty chewing movements, twitching of the eyelids, circling, aggression, apparent blindness, convulsions, and animals will often become recumbent shortly before death. A profuse, fetid diarrhea often accompanies the neurologic clinical signs. The mortality rate is 50 to 90% in adult animals whereas calves less than 4 weeks of age only have a 5 to 10% mortality rate (Khan, 2006). Sub-acute cases are typically less severe with similar clinical signs of disease. With sub acute infection, the course of the disease is longer, up to 2 weeks in length after which the animal will gradually recover or die. The mild form of the disease is only seen in indigenous breeds of cattle or native wildlife that have natural resistance. These animals will appear sub-clinical or exhibit mild clinical signs of infection.

Dead animals exhibit large amounts of fluid in belly, chest and the pericardium especially in sheep and goats. Oedema of the brain and lungs occurs with froth in the airways.
2.2 Economic losses caused by ticks and tick-borne diseases (TTBDs)

According to Taracha and Taylor (2005), TBDs are a major constraint to livestock productivity and food security in sub Saharan Africa. They prevent the introduction of highly productive disease-susceptible exotic breeds of cattle (Mkonyi, 1985). They cause a huge economic burden on poor smallholder farmers. Besides acaricides cause contamination of milk and environment.

Of the TTBDs, ECF is the most important economically owing to the high mortalities it causes, approaching 100 percent if untreated. Ticks besides being efficient vectors of these diseases, cause grave economic damage in areas where they occur. For example, an estimated loss of 1–3 ml of blood for every cattle tick completing its life cycle on an animal (Mutugi et al., 1988). Other losses arising include loss of draught power, damage to hides and skins, irritation and predisposition of livestock to bacterial and fungal infections as well as screw-worm attack, in the wounds left by tick bites. Economic losses due to East Coast Fever alone in Eastern, Central and Southern Africa have been estimated to be US$ 168 million, including an annual mortality of 1.1 million cattle (Mukhebi et al, 1992).

Many countries are now being encouraged to intensify their efforts to control TTBDs, in order to improve the efficiency of livestock production. The losses can be classified into direct and indirect production losses. Losses occur through costs incurred for controlling the TBDs and costs for providing research, training and extension services pertaining TTBDs. Direct production losses can be attributed to the presence of the disease in the cattle herd through morbidity and mortality. Cattle which become severely infected usually die unless treated. Taurine breeds (Bos taurus) and their crosses; and improved zebu or Sanga (Bos indicus) cattle which originate in non endemic areas are most severely affected (Morzaria et al., 1987). Indigenous breeds are also at risk in situations when they are moved from disease free to endemic areas. Mortality rates under endemically stable conditions occur mostly in calves and vary from zero to 50 %. Where endemic instability exists, mortality may be as high as 80 to 100 %. Although mortality in indigenous cattle in endemic areas can be low, calf growth is often severely retarded (Moll et al., 1984). Animals which recover from ECF may suffer from weight
loss, low milk production, less draft power and could possibly suffer from reduced fertility and delays in reaching maturity. However, extensive studies on these types of production losses caused by the disease have not yet been undertaken. These animals also remain carriers and can spread infection (Brown, 1985).

Indirect production losses occur when a disease acts as a constraint on the use of improved cattle as a result of their susceptibility to the disease. Many farmers are therefore constrained or prohibited from utilizing improved genotypes and improving livestock productivity and efficiency (Mukhebi et al., 1992). Mukhebi et al. (1992) reported that ECF is conventionally checked by the control of the vector ticks through the application of acaricides to the surface of an animal by dipping, spraying or hand washing to kill the ticks. In areas of heavy tick infestation, cattle are treated with acaricides as often as twice a week. Depending on the frequency of applications, annual costs of acaricide to farmers ranges from US $ 2 to US $ 20 per animal (Lawrence and McCosker, 1981; Young et al.; 1990; Perry et al., 1990 and Ocaido et al., 2009a). The cost of tick control varies with the different methods being used by the farmer. Mukhebi et al. (1992) estimated the costs to include plung dipping US $ 8.43, hands spraying US $ 13.62, pour on US $ 21.09. Ocaido et al. (2009a) in a study carried out around lake Mburo National Park put the cost of tick control as the cost of the acaricide and the cost of the labour spent in spraying (man hours) as US $ 4.2.

Miller et al. (1977) estimated that ECF caused half a million cattle deaths per year in Kenya, Tanzania and Uganda. Mukhebi et al. (1992) estimated the annual direct costs (as a loss of beef, milk, traction and manure, in treatment, acaricide, research and extension costs) caused by ECF in the 11 affected countries to be US $ 168 million with an estimated mortality of 1.1 million cattle. Estimated regional losses in 1989 in the 11 African countries showed that the reduction in milk production represented the greatest financial loss followed by traction, beef and acaricides as US $ 78,697; 21,308; 20,607 and 3,008 respectively. There are further economic losses attributed to tick control through dipping, spraying and hand washing of animals that includes pollution of the environment that may endanger human health. This may result due to direct contact, spilled or misused acaricides (Young et al., 1988). In addition the occurrence of ticks and their control cause worry to the animals and anxiety to the farmers who have to deal with
them. Further economic losses occur during treatment of ECF which if it is to be effective requires identification of the disease through surveillance and diagnosis and then treatment. This service is mostly provided by governments at subsidized charges through the veterinary extension service. Farmers who pay for the service can spend as much as US $10 to 20 per animal per treatment (Mutugi et al., 1988; Young et al., 1988).

2.3 Control methods of Ticks and Tick Born Diseases (TTBDs)

Chemical control of ticks using arsenical compounds was introduced in the early 1900s and became the main control measure for both ticks and the diseases they transmit. This method has become less reliable 30 years ago due to many reasons. This was due to reduced government spending on livestock and extension, the cost of acaricides, acaricide resistance, poor management of dips and spray races, and poor application of cattle movement control and quarantine. However, significant advances in immunization and treatment have been made in the last 30 years, and more robust integrated strategies combining immunization, reduced frequency of acaricide application and treatment are being adopted.

Before intensification of tick and tick-borne disease control several preliminary criteria should be satisfied. According to Bram and Gray (1983) first a countrywide survey must be made to determine the incidence and distribution of the various tick-borne diseases. This should be followed by an economic assessment of the benefits expected from improved control. In addition to the classical blood smear examination for the detection of haemoprotozoa, modern serodiagnostic techniques such as the fluorescent antibody tests, card agglutination tests, complement-fixation reactions and immunodiffusion tests – should be utilized whenever possible to define disease incidence and distribution precisely.

Also systematic entomological survey is necessary to determine the distribution and incidence of tick species of veterinary significance. This survey undoubtedly defines the biology and population dynamics of the tick species in different ecological zones. This study would stimulate long-term investigations to provide the data necessary for the execution of tick control activities. Before a programme is considered, such basic factors as target species, the biology and
population dynamics of these species in different areas, the role of wildlife in maintaining tick populations, and acaricide susceptibility, must be thoroughly understood. An assessment of existing control facilities and anticipated additions to these will also be necessary.

Control of ticks in Africa relies on the use of inorganic acaricides. However, the widespread use of these chemicals has led to many ecological, medical and financial problems, including the high cost of acaricides (paid in foreign currency), acaricide resistance and contamination of the environment and food with toxic residues. Tanzania and Uganda, for instance, each spends US$ 26 million annually on the importation of acaricides. Ticks develop resistance rapidly, sometimes within 18 months, and there is no acaricide group to which ticks are not at least partially resistant, including the recently introduced synthetic pyrethroids. Although chemical control of ticks will, for the foreseeable future, form the basis of any control programme, alternate methods of control should also be incorporated whenever feasible. Raising tick-resistant cattle, adopting special management techniques and practicing strategic dipping are all methods which belong in a fully integrated programme (Mukhebi et al., 1992).

2.4 Assessment of the impact of ITM on livestock

ITM is a method of immunisation of cattle against ECF that involves the inoculation of cattle with a previously characterized and potentially lethal dose of sporozoites of T. parva and simultaneous treatment with antibiotics (Radley, 1981). It confers a lifelong immunity to the animals and calves can be immunized just one month after birth.

Mukhebi et al. (1992) reported that the limitations associated with the current methods of ECF control and the opportunities for reducing chance on intensive acaricide use in the region have prompted the research for new, safe, cheaper and sustainable control strategies through immunisation. At present the only practical method of immunizations is by the infection treatment method (GALVmed, 2010).
The method has been shown to be technically efficacious in field trials carried out in different countries of the region (Robson et al., 1977; Morzaria et al., 1985 and GALVmed, 2010). ITM has been estimated to cost US $ 1.5 – US $ 20.00 (Radley, 1981; Kiltz, 1985 and Mukhebi et al., 1989). US $ 0.01 – US $ 0.90 being the cost of producing one dose of the vaccine and the balance being the cost of delivering the vaccine to the animal in the field. The output varies among countries depending on their policies regarding the production or procurement, delivery and pricing of the vaccines (Martins et al, 2010 and GALVmed, 2010).

ITM against ECF was developed by research conducted over three decades by the East African Community, KARI at Maguga and ILRI in Nairobi, Kenya funded by DFID and other donors of the Consultative Group on International Agricultural Research (GALVmed., 2010). ECF strains are stored in liquid nitrogen until used and the final preparation is done either in office or the field. The reconstituted vaccine should be used within six hours and any other doses left over discarded. ITM vaccination is done by trained veterinary personnel, but always in conjunction with livestock keepers. Only healthy animals are presented for vaccination (GALVmed, 2010). The animal is first weighed and the correct amount of oxytetracycline 30% injected intramuscular. The reconstituted vaccine is then injected into the skin in front of the ear. Every vaccinated animal is then given an ECF ear tag (the presence of this increases the value the animal receives at market). Young calves are given a treatment to avoid worms interfering with the immunization process (GALVmed., 2010).

Mukhebi et al. (1989) showed that immunization of beef cattle under farm conditions was extremely profitable. It yielded a marginal rate of return of up to 562% and it allowed a reduction in acaricide use from a frequency of twice a week to once every three weeks and even to the mere use of prolonged release of acaricide impregnated ear tags. Perry et al. (1990) used a cost effective analysis to assess alternative TTBD control strategies in communal lands in Zimbabwe. These relied more on controlled immunization. The investigation revealed that alternative strategies were more cost effective than the previous intensive acaricide use and would reduce the cost of TTBD control by up to 68% from the estimated amount of US $ 9 million annually.
Mukhebi et al. (1992) assessed, ex-ante the economies of ITM in East, Central and Southern Africa. This showed a high potential of economic returns with a BCR in the range of 9 - 17 under various assumptions.

Success stories about the use of immunization in the fight against ECF were registered in Kenya by Morzaria et al. (1988) on a farm in Kilifi District, Coast Province of Kenya. It was shown that highest mortality and morbidity due to ECF occurred in non-immunized cattle. Overall weight gain in the immunized cattle, irrespective of the tick control regime, was better than the weight gain in the un-immunized groups. Preliminary cost/benefit analysis (CBA) showed that it was uneconomical to maintain un-immunized cattle under limited or no tick control.

Maloo et al. (2001) showed that in the high ECF-risk areas of the coconut-cassava zone of coastal Kenya, immunisation against ECF in cross-bred (B. Taurus / B. indicus) cattle should be targeted at an early age preferably within 1-2 months of birth.

For work done in Uganda, Robson et al. (1977) first showed that immunization treatment method of zebu cattle using cryopreserved stabilates of infective particles of three isolates of Theileria parva harvested from Rhipicephalus appendiculatus could protect cattle from ECF. Economics of ECF immunisation was done by Laker (1992) in Mbarara district.

In Zimbabwe, Koch et al. (1990) used Theileria parva bovis isolates for immunizing cattle under natural field challenge on Willsbridge Farm and found out that ITM provided an effective protection against ECF field challenge.

In Tanzania a field trial was carried out in Maasai homestead to assess the impact of ITM using the Muguga Cocktail showed that ITM was cost effective control option for ECF (Martins et al., 2010). Economic analysis showed that ITM generated a profit estimated to be 5.6 USD per vaccinated calf. It was also demonstrated that ITM was a better ECF control measure than natural infection and subsequent treatment.
Formerly in Tanzania ITM immunization of cattle against ECF had been done on a limited scale because of logistical and policy constraints. But of recent, large scale deployment of ITM among pastoralists in Tanzania has stimulated demand (Di Giulio et al., 2009). Concurrently, a suite of molecular tools developed from the *Theileria parva* genome, has enabled improved quality control of the immunizing stabilate and post immunization monitoring of the efficacy and biological impact of ITM in the field.

ITM has been applied on a fairly large scale in Zambia than any other country (GALVmed, 2010). In Eastern Zambia, a study done by Billiouw et al. (2002) between 1994 and 2000 showed that an efficient immunization campaign should be done during periods of low adult *R. appendiculatus* activity.

Marcotty et al. (2001) found that ITM using the Katete strain was the most efficient prophylactic technique to control ECF in the endemic areas of the Eastern Province of Zambia. They reported that maintenance of the cold chain using liquid nitrogen up to the time of inoculation and the high cost of the reference long acting oxytetracycline (Terramycin LA, Pfizer) were the main drawbacks of the method. In experimental conditions, it was shown that immunization performed with a stabilate kept on ice for up to 6hr after thawing had efficiency of 90%. But still, the sporozoites kept on ice were still surviving 32hr after thawing. Also it was found that the acid formulation of oxytetracycline was suitable compared to the alkaline formulation for the chemotherapeutic control of the Katete strain during ECF immunization.

In central province of Zambia, Minjauw et al. (1998) showed that ITM combined with strategic seasonal tick control yielded better financial benefit than with herds under intensive tick control. Minjauw et al. (1998) also in the same area in Zambia reported that efficacy of ITM in improving production parameters was not significant but it was cost effective in controlling ECF.
2.5 Limitations of the infection and treatment method

According to Mukhebi et al. (1992) the infection and treatment method of immunisation, has some technical limitations. It does not eliminate the need for acaricide application due to the potential existence of other tick-borne diseases, although it allows considerable relaxation of acaricide use. In addition, the use of live parasites in the vaccine poses some safety drawbacks for large-scale immunization purposes. This is compounded by uncertainty about the spectrum of different species, strains and antigenic types of Theileria parva in different areas, variation in the sensitivity of different parasite isolates to therapeutic drugs and the development of a potentially infective carrier state in immunized animals. Furthermore, the application of the infection and treatment vaccine requires a liquid nitrogen system for cold storage and transportation and during the pilot application stage, an extended monitoring period post-immunization to detect and treat any breakthrough infections. Both these aspects currently constitute high cost in terms of delivery of the vaccine.

Immunity by this rather crude method is long-lasting and solid, but cross-immunity problems against some field strains remain. Furthermore, immunized animals remain carriers. Immunization therefore could be contributing to attaining and improving endemic stability in endemic areas in indigenous breeds with an adequate level of genetic tolerance to ECF. On the other hand, carrier animals may constitute a risk for spreading the disease into ECF-free areas where the vector is present.

Other disadvantages of the method are that immunization of cattle during the incubation of naturally contracted ECF will not prevent the disease and jeopardize vaccine reputation. Furthermore, stabilates have to be cryopreserved, often a technical drawback and contamination with undesirable pathogens may occur in tick-derived materials. Therefore there is need for the development of effective molecular vaccines. It must be remembered that immunization must be cost-effective and sustainable. This is the only one aspect that will make successful ECF vaccination to be integrated for control of theileriosis and other tick-borne diseases. There is no universally valid strategy. Several factors have to be considered: value and susceptibility of cattle to theileriosis and to other tick-borne and tick-associated diseases, infestation by various ticks
present in the area, the type of theileriosis (ECF, Corridor disease or January disease) and the epidemiological situation where immunization is taking place. The optimal age for immunization of the calves in endemic areas needs to be determined: when calf mortality by naturally occurring theileriosis is a problem, the sooner calves are immunized the better, but a proportion will have contracted natural infection before they can be reached, and immunization of very young calves might not be fully effective.

2.6 Adoption of ITM as method of improving livelihoods of the cattle farmers

ECF is thus a major limiting factor working against small-scale farmers attempting to alleviate poverty by progressing from subsistence to market-oriented enterprises. As the demand for meat and milk in developing countries is expected to double by 2020, the majority of which will be provided by smallholders, this puts further pressure on the need to control ECF. By causing high morbidity and mortality in cattle and preventing smallholder dairy farmers from introducing new, more productive breeds of cattle, ECF is therefore a huge economic burden for poor smallholders.

Turshen (1984) reported that ECF has a major impact on livestock production in 11 countries in Sub-Saharan Africa (SSA), including Kenya, Uganda, Tanzania and Zimbabwe, and consequently there was a considerable demand for a vaccine. A 60% adoption rate by farmers was projected. Cattle markets in these four countries represented the main targets for a new vaccine. While the size of the small-scale market-oriented sector was increasing in all the 11 countries, the market was largest in Kenya, which had the greatest number of smallholder farms.

In East Africa ECF is ranked among the two top research priorities. The Kenya Agricultural Research Institute (KARI) collaborated with ILRI (International Livestock Research Institute) in the development of an improved vaccine, while Uganda and Tanzania supported integrated control approach of ECF (Turshen, 1984). The major aim was to produce a robust, cheap and easy to deliver sub-unit vaccine against ECF. Such a vaccine was supposed to improve the livelihoods of resource-poor smallholder farmers by reducing the mortality of their animals
hence increasing milk production. More milk for sale would enable farmers to raise their household incomes.

Mukhebi et al. (1992) reported that although ECF is currently managed by the control of the vector ticks with acaricides and the use of the drugs to treat infections, the wide spread application of these methods in Africa has limitations that include: extension staff who generally don’t have transport, most public dips are poorly managed and non functional, the few operational ones are often dilute in acaricides’ concentration, drugs are not readily available to government veterinarians, and if they are available in local markets, are too expensive for most small holder farmers. Other consideration which have rendered acaricide application a less reliable method include resistance to acaricide by tick populations, uncontrolled cattle movements, civil unrest, contamination of the environment or food with toxic residues of acaricides and the existence of alternative hosts for ticks (mainly wild angulates) in proximity to cattle (Young et al., 1988 and Dolan, 1999). Even when drugs for chemotherapy are readily available, their successful application requires diagnosis of the disease at its early stage of development a specialization beyond the capacity of many smallholder farmers due to the poor state of the animal health infrastructure. This factor coupled with the high cost of drugs, implies that only a small proportion of the animals which become infected with the disease receive treatment.

From the above literature review it became apparent that the small holder cattle keepers needed to adopt ITM so as to reduce costs of tick control, reduce cattle mortality, reduce costs of treatment of ECF, and reduce the cost and volume of acaricides used. This would lead to reduction of cattle production costs and increase the number of improved dairy cattle kept hence increase of milk production thereby increased household incomes and food security.
CHAPTER THREE
METHODOLOGY

3.1 Research design

The study was done in Kamuli district, specifically Bugabula County. It was a cross-sectional survey which employed participatory methods, questionnaire administration, determination of current status TBDs and tick-burdens. The study was done among cattle farmers, extension staff and drug/vaccine suppliers. Among farmers the study was done both among those who had used ITM and those who had not used ITM.

3.2 Detailed data collection

A participatory study was conducted using rapid appraisal and participatory appraisal methods. This involved focus group discussions with farmers, veterinary extension workers and drug/vaccine suppliers. These discussions were done with aid of a check list of questions (See Appendices 1, II and III). The discussions covered cattle husbandry, production parameters, and cost of ITM delivery and practice of ITM, observed benefits and adverse effects of ITM, changes of tick-burdens, dynamics of TBDs, and mortalities and morbidities. Fifteen focus group discussions were held with the farmers (one per parish).

A structured questionnaire (see Appendix IV) was administered to 100 farmers randomly selected. The sample size of 100 cattle farmers was determined using the equation given by Dohoo et al. (2003) and Thrusfield (1986) at 95% confidence level:-
\[ n = \frac{Z_{\alpha/2}^2 \cdot p \cdot q}{e^2} \]

\[ n = \frac{1.96^2 \cdot 0.07 \cdot 0.93}{(0.05)^2} \]

\[ n = 100 \]

Where:
q = 1 – P

\[ Z_{\alpha/2} = 1.96 \]

\[ e = \text{Confidence level} = 0.05; \ p = \text{Prevalence of about 7%}; \ q=0.93 \]

n=100

The sub counties and number of herds sampled were as shown in Table 1.

Table 1: The number of farmers sampled per sub county sampled based on status of ITM use.

<table>
<thead>
<tr>
<th>Sub county</th>
<th>ITM Status</th>
<th>Number of Cattle farmers</th>
<th>Sample size selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nabwigulu</td>
<td>Implementers</td>
<td>55</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Non implementers</td>
<td>645</td>
<td>20</td>
</tr>
<tr>
<td>Butansi</td>
<td>Implementers</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Non implementers</td>
<td>433</td>
<td>6</td>
</tr>
<tr>
<td>Kitayunjwa</td>
<td>Implementers</td>
<td>64</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Non implementers</td>
<td>685</td>
<td>17</td>
</tr>
<tr>
<td>Namasagali</td>
<td>Implementers</td>
<td>86</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Non implementers</td>
<td>1566</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3562</td>
<td>100</td>
</tr>
</tbody>
</table>

Questionnaires were used to collect information on ITM utilization; ITM practices; cost of ITM implementation; advantages and disadvantages of ITM; impact of ITM on incidences of TBDs,
tick populations and cattle productivity (reduced mortality, increased milk yield, good body conditions etc); and suggestions on how to improve implementation of ITM

3.5 Data analysis

Data analysis included descriptive and bivariate analysis. Comparison of variables between farms using ITM and those not using ITM were performed using ANOVA and Students t-test. Prevalence of TBDs was compared between the two treatment groups using a chi-square test. Economic and financial analyses for performance of ITM practicing farms and none ITM practicing farms were done using Gross Margin Analysis (GMA). Gross margin (GM) was taken as the gross income of an enterprise less variable costs (Putt et al., 1987).
CHAPTER FOUR

RESULTS

4.1 Household characteristics

Percentage distribution of farmers who were using ITM according to the year they started using ITM were as shown in Figure 1. It was shown that the utilization of ITM was low before 2007. Average Household size and land holdings per household were as shown in Table 2.

Figure 1: Distribution of ITM users by year when they started implementation ITM

Table 2: Average household and land size by ITM and Non ITM users

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall</th>
<th>ITM</th>
<th>Non ITM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household size</td>
<td>8.4 ± 0.4</td>
<td>8.58 ± 0.7</td>
<td>8.2 ± 0.5</td>
</tr>
<tr>
<td>Land size (acres)</td>
<td>33.3 ± 4.0</td>
<td>35.9 ± 5.9</td>
<td>30.8 ± 5.6</td>
</tr>
</tbody>
</table>
Overall, the average amount of land size was 33.3±4.04 acres. The ITM users’ land was relatively higher (35.9±5.9) but not statistically significantly different as compared to non ITM users (30.8±5.6) (Table 2)

The average numbers of cattle per age category owned by each household in ITM and non ITM were as shown in Table 3. Average cattle herd size was found to be 11.6±2.2 and 11.6±2.4 in ITM and non ITM farms respectively. There was no significant difference between herd sizes (P>0.05). The distribution of herd sizes among ITM and none ITM users were as shown in Figure 2. Most farmers (64.6%) were having less than 21 heads of cattle (above 64 %.)

Table 3: Average number of cattle per age category owned per household between ITM and non-ITM users

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall</th>
<th>ITM</th>
<th>Non ITM</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactating cows</td>
<td>3.9±0.5</td>
<td>4.4±0.9</td>
<td>3.5±0.6</td>
<td>0.9</td>
<td>99</td>
<td>0.4</td>
</tr>
<tr>
<td>Dry cow</td>
<td>2.8±0.4</td>
<td>2.6±0.4</td>
<td>3.1±0.8</td>
<td>-0.6</td>
<td>99</td>
<td>0.6</td>
</tr>
<tr>
<td>Female adult</td>
<td>6.8±0.9</td>
<td>7.0±1.2</td>
<td>6.5±1.3</td>
<td>0.3</td>
<td>99</td>
<td>0.8</td>
</tr>
<tr>
<td>Heifer less than two years</td>
<td>1.8±0.3</td>
<td>1.9±0.5</td>
<td>1.7±0.5</td>
<td>0.4</td>
<td>99</td>
<td>0.7</td>
</tr>
<tr>
<td>Heifers more than two years</td>
<td>2.2±0.3</td>
<td>2.3±0.4</td>
<td>2.2±0.5</td>
<td>0.1</td>
<td>99</td>
<td>0.9</td>
</tr>
<tr>
<td>Female calves less than 1 year</td>
<td>2.1±0.3</td>
<td>2.1±0.3</td>
<td>2.2±0.5</td>
<td>-0.2</td>
<td>99</td>
<td>0.9</td>
</tr>
<tr>
<td>Male calves less than 1 year</td>
<td>1.6±0.3</td>
<td>1.6±0.4</td>
<td>1.6±0.4</td>
<td>0.2</td>
<td>99</td>
<td>0.9</td>
</tr>
<tr>
<td>Number of calves</td>
<td>3.7±0.5</td>
<td>3.7±0.7</td>
<td>3.7±0.8</td>
<td>0.0</td>
<td>99</td>
<td>1.0</td>
</tr>
<tr>
<td>Number of bulls</td>
<td>0.5±0.1</td>
<td>0.5±0.1</td>
<td>0.6±0.1</td>
<td>-0.5</td>
<td>99</td>
<td>0.6</td>
</tr>
<tr>
<td>Overall average herd sizes per farm</td>
<td>11.5±2.2</td>
<td>11.6±2.3</td>
<td>11.6±2.4</td>
<td>-0.0</td>
<td>93</td>
<td>1.0</td>
</tr>
</tbody>
</table>
The average number of Friesian-Zebu crosses per household in the ITM and non ITM areas grouped to three levels were as shown in Table 4. There was no significance difference in herd sizes of crosses between ITM and non ITM users (P>0.05) for first and second level of crossing, however there was a significance difference in the average number of crosses between ITM and non ITM (P<0.05) during the third level of crossing.

Table 4: Average number of Friesian-Zebu crosses per household in ITM and non ITM users.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall</th>
<th>ITM</th>
<th>Non ITM</th>
<th>T</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 (First crosses)</td>
<td>1.5±0.6</td>
<td>0.7±0.5</td>
<td>2.2±1.0</td>
<td>-1.3</td>
<td>95</td>
<td>0.2</td>
</tr>
<tr>
<td>Phase 2 (Second crosses)</td>
<td>3.4±0.7</td>
<td>3.6±1.0</td>
<td>3.2±0.9</td>
<td>0.3</td>
<td>96</td>
<td>0.2</td>
</tr>
<tr>
<td>Phase 3 (Third crosses)</td>
<td>5.3±1.1</td>
<td>7.4±2.0</td>
<td>3.4±1.0</td>
<td>1.8</td>
<td>98</td>
<td>0.002</td>
</tr>
</tbody>
</table>
The percentage herd composition per age category of the cattle in ITM and non-ITM users were as shown in Table 5. There was no significant difference (P>0.05) in herd composition between ITM and non-ITM users.

Table 5: Average percentage age category composition of cattle in ITM and non ITM users

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall</th>
<th>ITM</th>
<th>Non ITM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactating cows</td>
<td>15</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Dry cow</td>
<td>11</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Female adult</td>
<td>27</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Heifer less than two years</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Heifers more than two years</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Female calves less than 1 year</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Male calves less than 1 year</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Number of calves</td>
<td>15</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Number of bulls</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

There was no significant difference in employment status between ITM users (80%) and non ITM users (68.6%) (P>0.05, $X^2=1.708$). Different areas of employment of cattle farmers were as shown in Table 6. However, most of the non ITM users (64.7%) were dealers in agricultural produce (P<0.01, $X^2=9$) and ITM users were employed in social services (60%) (P<0.05, $X^2=4$)

Table 6: Areas of employment of cattle farmers in ITM and none ITM users

<table>
<thead>
<tr>
<th>Variables</th>
<th>ITM (%)</th>
<th>Non ITM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dealer in Agricultural produce</td>
<td>35.3</td>
<td>64.7</td>
</tr>
<tr>
<td>Social Service</td>
<td>60.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Other Business</td>
<td>58.8</td>
<td>41.2</td>
</tr>
</tbody>
</table>

Some of the farms had employed managers, herdsmen, farm cleaners whose average salaries were shown in Table 7. Overall, the average annual salaries of herdsmen were found to be above
all the other employees followed by managers. It was also observed that, annual salaries of people employed in the farm using ITM were higher relative to those paid under non ITM users.

Table 7: Annual average salaries of different employees ITM and non ITM farms

<table>
<thead>
<tr>
<th>Employment level</th>
<th>Overall</th>
<th>ITM</th>
<th>Non ITM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>60,100 ± 6,660</td>
<td>63,300 ± 8,450</td>
<td>50,000 ± 6,830</td>
</tr>
<tr>
<td>Herdsmen’s</td>
<td>82,400 ± 15,820</td>
<td>75,200 ± 11,710</td>
<td>98,300 ± 45,310</td>
</tr>
<tr>
<td>Farm cleaners</td>
<td>57,300 ± 8,470</td>
<td>66,500 ± 12,420</td>
<td>43,200 ± 8,820</td>
</tr>
<tr>
<td>Payment to relatives</td>
<td>30,700 ± 7,130</td>
<td>42,000 ± 14,740</td>
<td>20,800 ± 3,230</td>
</tr>
</tbody>
</table>

4.2 Perception of farmers to ITM use

The perception of farmer on the use of ITM in the areas of knowledge, methods, benefits, costs, advantages and disadvantages was explored. Overall, about 85% of the farmers were aware of ITM use in the areas although about 60% of the FGD members acknowledged using the method.

The study revealed that improved cattle health, reduced death, increased milk production, increased marketability and profitability of their cattle enterprises were benefits and advantages of using ITM. Of those using ITM, 62% revealed that the utilization costs were high averaging 21,840 Ugandan shilling per head of cattle which significantly reduced the adoption rate of ITM in the areas. The disadvantages reported however were high costs, inaccessibility of the service, irregular availability of ITM and emergence of other cattle TBDs despite the use of ITM.
4.3 ITM practice

ECF vaccine was purchased by Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and stored at Veterinary Epidemiological Unit, MAAIF Entebbe. Each district had to collect the vaccine from MAAIF. Each district had an extension staff member who was assigned to manage ITM activities.

Originally from 2001-2007 cold chain was integrated with Artificial insemination (AI) by using the same nitrogen flask provided by MAAIF. Later in 2008, ECF vaccine flasks were provided by MAAIF. Usually district extension staff assigned to ITM activities mobilized and registered farmers. Farmers made payments before the vaccine was collected. Usually farmers who could consume 2 vials of vaccine were mobilized. Each vial contained 30 doses. Each vial costed Ug. Shs 150,000 (Ug. Shs 5,000 per dose) from MAAIF store. Extension staff travelled to MAAIF stores to collect the vaccine.

The extension staff charged on average Ug Shs 21,840 (range Ug. Shs 20,000-25,000) to perform ITM ECF per head of cattle. This cost covered veterinary fees, transport costs, tag fees, treatment cost, cold chain cost and vaccine cost. Each animal was vaccinated with 1 ml of vaccine. All the herd was vaccinated irrespective of breed. Upon vaccination, the cattle were treated using 30% oxytetracyclines. A calf was given 10mls, sub-adults 20 mls and adults 35 mls of oxytetracyclines. Each ml of 30% oxytetracyclines costed Ug. Shs 100.

The challenges faced by extension workers were that: they were overloaded, lacked transport and the vaccine once reconstituted had to be used within 6 hours.
4.4 Impact of ITM

4.4.1 ITM effect on tick control

There was no significant difference in the tick control regimes between the ITM users and the non ITM users. In the FGDs, both categories reported tick control on their farms with over 98% using spraying as the method of acaricide application and 2% using hand washing. None reported dipping of cattle. The spraying frequency was twice a month during the wet season and once a month during the dry season.

The acaricides being used by farmers in both categories were cypermethrines (63%) and amitraz (37%) under trademarks of cooperthion, Decatix©, Tsetsetic©, Tactic©, milbitraz among others. The average cost of acaricide per head per spraying of cattle was Ug. Shs 500 giving an annual cost of Ug. Shs 9,750 per head of cattle.

4.4.2 Tick-burden load on cattle

The average half body tick counts for cattle from ITM user herds was 12.91 ± 1.04 as compared to 13.85 ± 0.72 for non-ITM users. However there was no significant difference (P=0.458, df (1, 90), F=0.554) between ITM user counts and non ITM counts.

4.4.3 The effects of ITM on the prevalence of ECF

Table 8 shows the knowledge of farmers about morbidity due to TBDs. The knowledge of TBDs were found to be significantly different ( $\chi^2 = 21.997, df, 5, P < 0.001$) between ITM and non-ITM users. The ITM users were knowledgeable about morbidity of their cattle with anaplasmosis, heartwater and babesiosis. Meanwhile non ITM users were knowledgeable about ECF. Similarly, there was same trend with the proportion of farmers who reported certain TBDs in their cattle herds (Table 9). There was a significant association between the use of ITM in
reducing ECF compared to other diseases. ITM users did not mention ECF as a major TBD. Non ITM users did not know about babesiosis.

Table 8: Percentage of farmers with knowledge about morbidity due to TBDs

<table>
<thead>
<tr>
<th>TBDs</th>
<th>Intervention status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ITM (%)</td>
</tr>
<tr>
<td>Anaplasmosis</td>
<td>75</td>
</tr>
<tr>
<td>Heart water</td>
<td>75</td>
</tr>
<tr>
<td>Babesiosis</td>
<td>100</td>
</tr>
<tr>
<td>ECF</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 9: Percentage of farmers who had TBD in their herds

<table>
<thead>
<tr>
<th>TBD</th>
<th>ITM</th>
<th>Non ITM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaplasmosis</td>
<td>75.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Heartwater</td>
<td>75.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Babesiosis</td>
<td>100.0</td>
<td>0.0</td>
</tr>
<tr>
<td>ECF</td>
<td>31.7</td>
<td>68.3</td>
</tr>
</tbody>
</table>

Percentage prevalence of TBDs was as shown in Table 10. It was indicated that, ITM was very significantly effective in reducing the prevalence of ECF as compared to non ITM. However, the prevalence of anaplasmosis still remained high in the ITM user herds than non ITM users.
### Table 10: Percentage prevalence of TBDs by ITM and non ITM

<table>
<thead>
<tr>
<th>TBD</th>
<th>ITM</th>
<th>Non ITM</th>
<th>Overall</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaplasmosis</td>
<td>36.0</td>
<td>13.7</td>
<td>24.8</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Heart water</td>
<td>4.0</td>
<td>7.8</td>
<td>5.9</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Babesiosis</td>
<td>6.0</td>
<td>2.0</td>
<td>4.0</td>
<td>P&gt;0.05</td>
</tr>
<tr>
<td>ECF</td>
<td>24.0</td>
<td>60.8</td>
<td>42.6</td>
<td>P&lt;0.001</td>
</tr>
</tbody>
</table>

#### 4.4.4 Impact on mortality rates of cattle due to ECF

The average cattle mortality by age categories was as shown in Table 11. There was higher mortality of cattle among non ITM users than in ITM herds with calves having higher mortality rate as compared to other age groups. ITM significantly reduced the mortality of cattle. On average $1.36 \pm 0.22 (11.7\%)$ and $2.88 \pm 0.05 (24.8\%)$ heads of cattle in ITM and non ITM farms respectively died annually.

Table 11: Average mortality number of cattle per household due to ECF among ITM and non ITM users

<table>
<thead>
<tr>
<th>Cattle category</th>
<th>ITM user</th>
<th>Non ITM</th>
<th>t value</th>
<th>p level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactating cows</td>
<td>0.20 ± 0.08</td>
<td>0.39 ± 0.09</td>
<td>-2.598</td>
<td>0.013</td>
</tr>
<tr>
<td>Dry cows</td>
<td>0.08 ± 0.049</td>
<td>0.08 ± 0.047</td>
<td>0.047</td>
<td>0.963</td>
</tr>
<tr>
<td>Heifers&lt;2 years</td>
<td>0.05 ± 0.02</td>
<td>0.00 ± 0.0</td>
<td>1.010</td>
<td>0.315</td>
</tr>
<tr>
<td>Heifers&gt;2 years</td>
<td>0.07 ± 0.04</td>
<td>0.10 ± 0.069</td>
<td>-1.429</td>
<td>0.156</td>
</tr>
<tr>
<td>Immature male</td>
<td>0.00 ± 0.00</td>
<td>0.22 ± 0.067</td>
<td>-2.732</td>
<td>0.016</td>
</tr>
<tr>
<td>Female Calves &lt;1yr</td>
<td>0.21 ± 0.19</td>
<td>0.57 ± 0.164</td>
<td>-2.428</td>
<td>0.036</td>
</tr>
<tr>
<td>Male Calves &lt;1 year</td>
<td>0.22 ± 0.224</td>
<td>0.41 ± 0.146</td>
<td>0.257</td>
<td>0.798</td>
</tr>
<tr>
<td>Bulls &gt;3 years</td>
<td>0.02 ± 0.028</td>
<td>0.24 ± 0.087</td>
<td>-2.126</td>
<td>0.036</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.85 ± 0.22</strong></td>
<td><strong>2.01 ± 0.05</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The percentage mortality of cattle per age category due to ECF per household per annum in ITM and non ITM were 7.3% and 17.3% respectively. The result indicated high death in calves accounting for 51% and 60% of total cattle deaths per household respectively for ITM and non ITM users.

4.4.5 Impact ITM on ECF treatment costs

The average ECF treatment cost per cattle in the given cattle age category were as shown in Table 13. The result showed that, the average cost for treating adult cattle was higher compared to sub adults and calves. There was no significant difference (P>0.05) in treatment costs per each cattle group incurred by ITM and ITM users.

Table 12: Average ECF treatment costs for each animal category

<table>
<thead>
<tr>
<th>Cattle category</th>
<th>ITM users</th>
<th>Non ITM users</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment cost for adult cattle</td>
<td>52,700 ± 7,700</td>
<td>53,780 ± 7,700</td>
<td>53,240 ± 5,400</td>
</tr>
<tr>
<td>Treatment cost for sub-adults</td>
<td>29,000 ± 1,700</td>
<td>28,000 ± 2,100</td>
<td>28,500 ± 1,350</td>
</tr>
<tr>
<td>Treatment cost for calves</td>
<td>16,200 ± 1,250</td>
<td>15,000 ± 1,000</td>
<td>15,600 ± 800</td>
</tr>
</tbody>
</table>

Average price of Oxyteracycline was Ug Shs 100 per ml, Bulatex Ug Shs 2,500 per ml and Imizol Ug Shs 1,500 per ml. Cost of treatment of TBDs per herd was Ug shs 400,000 for ITM users and Ug Shs 812,327 for non ITM users. ECF treatment accounted for Ug Shs 120,000 (30% of the total treatment costs) for ITM users and Ug Shs 280,000 (34.5% of the treatment costs) for non ITM herds. ECF treatments costs in non ITM users were 2.3 times more than the amount used in ITM herds.
4.4.6 Impact of ITM on sale prices of live cattle

Average sales prices of cattle per categories as reported by the farmers were as shown in Table 14. Prices of cattle in the ITM herds were higher than in non ITM users simply because majority of the animals in ITM were in phase three. The average values of the cattle in the ITM and non ITM were found to be significantly different (p<0.05) and it was only Steers, male calves less than 1 years, whose prices were found not to be statistically different between the groups.

Table 13: Average sales prices of cattle per category

<table>
<thead>
<tr>
<th>Category</th>
<th>ITM</th>
<th>Non ITM</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactating cows</td>
<td>1,485,000 ± 23,000</td>
<td>721,150 ± 57,100</td>
<td>0.0017</td>
</tr>
<tr>
<td>Dry cow</td>
<td>1,201,500 ± 78,000</td>
<td>550,000 ± 16,900</td>
<td>0.0000</td>
</tr>
<tr>
<td>Female adult</td>
<td>1,737,000 ± 150,000</td>
<td>820,065 ± 100,250</td>
<td>0.0021</td>
</tr>
<tr>
<td>Heifer less than two years</td>
<td>500,000 ± 130,000</td>
<td>210,000 ± 21,000</td>
<td>0.0034</td>
</tr>
<tr>
<td>Heifers more than two years</td>
<td>755,050 ± 105,000</td>
<td>400500 ± 20,000</td>
<td>0.0042</td>
</tr>
<tr>
<td>Female calves less than 1 year</td>
<td>310,000 ± 21,000</td>
<td>189,000 ± 10,670</td>
<td>0.0351</td>
</tr>
<tr>
<td>Male calves less than 1 year</td>
<td>215,800 ± 28,000</td>
<td>159,050 ± 57,000</td>
<td>0.0612</td>
</tr>
<tr>
<td>Number of bulls</td>
<td>1,250,000 ± 35000</td>
<td>818,050 ± 87,000</td>
<td>0.0035</td>
</tr>
<tr>
<td>Steer (Immature males)</td>
<td>500,570 ± 31,200</td>
<td>340900 ± 150,000</td>
<td>0.0778</td>
</tr>
</tbody>
</table>

4.7 Impact of ITM on Gross margin

Summary of gross margin analysis of cattle enterprises ITM and non ITM users were as shown in Table 15. Summary of gross margin analysis of cattle enterprises for non ITM users when they adopt ITM use for the first year were as shown in Table 16. Details of gross margin analysis of current cattle enterprises in ITM and non ITM users and when non ITM users adopt ITM use in the first year were as shown in Appendices 5, 6 and 7.
Milk output constituted 78.9% and 71.1% of the total output in ITM and non ITM cattle enterprises respectively. ITM costs were 0.14 times the gross margin and 0.09 times of gross output of the non ITM users’ on the first year when it would be introduced. Subsequently ITM could only be done on a new crop of calves that were borne.

Table 14: Gross margin analysis (Ug Shs) of ITM and non ITM user farms

<table>
<thead>
<tr>
<th>Attribute</th>
<th>ITM</th>
<th>Non ITM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross variable costs of all farms sampled</td>
<td>36,815,058</td>
<td>47,366,100</td>
</tr>
<tr>
<td>Gross output of all farms sampled</td>
<td>222,229,300</td>
<td>149,594,817</td>
</tr>
<tr>
<td>Gross margin of all farms sampled</td>
<td>185,414,242</td>
<td>102,228,717</td>
</tr>
<tr>
<td>Average gross margin per farm</td>
<td>3,708,285</td>
<td>2,044,574</td>
</tr>
<tr>
<td>Average gross margin per head of cattle</td>
<td>370,088</td>
<td>204,049</td>
</tr>
<tr>
<td>Average gross margin per acre</td>
<td>103,295</td>
<td>66,382</td>
</tr>
</tbody>
</table>

Table 15: Gross margin analysis of cattle enterprises of non ITM users when they adopt ITM use for the first year

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Amount (Ug Shs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross variable costs of all farms sampled</td>
<td>60,273,540</td>
</tr>
<tr>
<td>Gross output of all farms sampled</td>
<td>149,594,817</td>
</tr>
<tr>
<td>Gross margin of all farms sampled</td>
<td>89,321,277</td>
</tr>
<tr>
<td>Average gross margin per farm</td>
<td>1,786,426</td>
</tr>
<tr>
<td>Average gross margin per head of cattle</td>
<td>151,136</td>
</tr>
<tr>
<td>Average gross margin per acre</td>
<td>58,001</td>
</tr>
</tbody>
</table>
CHAPTER FIVE
DISCUSSION

5.1 Description of household characteristics
In comparison to farmers in other areas of East Africa in general and Uganda in particular, farmers in Bugabula had relatively higher amount of land which was in agreement with what was reported by Salami et al (2010). Large sizes of landholdings was observed by Mwesigwa et al. (2009) among cattle keepers in Kiruhura district. This area lies along the cattle corridor that has semi arid conditions with relatively low population density. There was no major difference in the average household size in the two groups which was about eight people.

The average herd sizes of cattle between ITM and non ITM were the same. This gives a stocking density of 1 head cattle per 2.9 acres of land. This stocking density was lower than what was reported for pastoralists who were settled in same ecological settings in Ankole Ranching Scheme (Ocaido et al., 2009b).

The overall average number of cattle in the third crosses were higher followed by second crosses and then first crosses. However, the average number of third cattle crosses was higher among ITM users as compared to non ITM users. The number of second crosses and the first crosses owned by ITM users and non-ITM users were the same. This analysis showed that the ITM users had started improving their cattle earlier in the course of which had experienced ECF as a big challenge. Therefore they needed to protect their highly susceptible improved cattle with ITM ECF vaccination. This finding was in agreement to what was found by Robson et al. (1977). The non ITM users could have just started keeping crossed dairy cattle and soon they were going to adopt ITM ECF vaccination when challenged with high mortalities of their newly acquired crosses with ECF.

The herd composition of adult cows in the area was high constituting 54% and 52% in herds of ITM users and non-ITM users respectively. This showed that farmers were geared towards milk
production. A similar herd composition biased towards milk production has been reported in Ankole (Ocaido et al., 2009b and Mwesigwa et al., 2009).

There was no difference in employment opportunities between the ITM users and non ITM except that ITM users were involved in provision of social services and non-ITM users were dealers in agricultural produce. ITM users had higher social status with higher level of education which made them more employable in social services deliveries and other businesses. Significant number of non ITM users (31.4%) was only keeping cattle without any outside source of income. This category was solely dependent on their cattle enterprises. This was in agreement to what was observed by Mwesigwa et al. (2009) in Kiruhura district.

It was shown (Table 7) that cattle farmers employed people in four key areas as managers, herdsmen, farm cleaners and relatives. Higher payments were made for herdsmen and relatives respectively and yet farm cleaners and managers were least paid. This was because managers were only hired to pay on-spot routine visits to the farms where as the herdsmen and the relatives were permanently on the farms. Although there were big disparities in the payment across both categories, cattle farmers utilizing ITM paid relatively higher salaries as compared to non ITM users. Amongst non ITM users, the disparity between salaries was very high.

5.2 Perception of farmers on practice of ITM use

In Uganda, ECF vaccine is purchased by Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). It is stored at The Veterinary Epidemiological Unit, MAAIF Entebbe. Each district arranges for the collection of the vaccine from MAAIF. Each district had an extension staff member who was assigned to manage ITM activities. This varied with what was being practiced in Tanzania where the field logistics involved in mass vaccinations had been greatly improved owing to the work of a private company called VetAgro Tanzania LTD (GALVMed, 2010). The basics of the practice don’t differ with the straws being stored in liquid Nitrogen until the final preparation in the office or the field and the reconstituted vaccine being used within 6 hours and any doses left over discarded. The injection was made in the skin in front of the ear and an ear number was tagged to the vaccinated cattle.
In Bugabula County, the district extension staff assigned to ITM activities mobilized and registered farmers who were ready to immunize their cattle. Farmers made payments before the vaccine was collected. Usually farmers who could consume 2 vials of vaccine were mobilized. Each vial contained 30 doses. Each vial costed Ug. Shs 150,000 (Ug Shs 5,000 per dose equivalent to US $ 2.8 at exchange rate of 1 US $: UG SHS 1800) from the MAAIF store. This cost was similar to the amount paid for in Kenya, Tanzania and Zambia (Mukhebi et al.1989, Kiltz, 1985 and Radly 1981).

The extension staff charged on average Ug Shs 21,840 (range Ug. Shs 20,000-25,000) to perform ITM ECF per head of cattle an equivalent of US $ 12.1. This fell within the range reported by Mukhebi et al.(1989) who reported the ITM cost up to US $ 20 depending on the variation of the distribution and delivery channels.

Vaccine cost was found to be US $ 2.8 and treatment US $ 1.1 per head of cattle. Vaccination and treatment cost was constituting 32 % of the total ITM cost. The rest of the costs(US $ 8.2) were due to transport, veterinary fees and cold chain. The major cost was incurred in transport and veterinary fees since cold chain was a fixed cost where the flask was purchased once and liquid nitrogen occasionally refilled. This implied that the cost of transportation needs to be reduced by having ECF vaccine distribution outlets nearby to the farmers. Private drug companies should be encouraged to distribute the vaccine as has been done in Tanzania. Logistics of distribution of ECF vaccine in Masailand was greatly improved when a private company VetAgro Tanzania Ltd got involved in its distribution (GALVmed, 2010). Veterinary costs could further be reduced by having farmers or community animal health workers trained on how to treat and administer the ECF vaccine. When compared to what was practised in Tanzania, vaccinated calves weren’t routinely given worms treatment to avoid interference instead only animals in sound health were selected for ITM a finding that could have lowered the immunity build up.
The challenges faced by extension workers were that: they were overloaded, lacked transport and the vaccine once reconstituted had to be used within 6 hours given the fairly long distances between the registered farmers.

ITM was reported by the farmers as being cost effective in controlling ECF which was in agreement with the findings in Zambia (Minjaw et al., 1998). It was also evident that ITM did not reduce acaricide use as reported by Mukhebi et al. (1992) due to presence of other TBDs. The farmers reported ITM as helping them to keep cattle of higher improved breeds, decreased incidences of ECF outbreaks on their farms, reduced expenses on cattle treatment, reduce veterinarian visits on their farms, reduced calf morbidities and mortalities. These observations were similar to those in Tanzania, Kenya, Zimbabwe and Zambia (Perry et al., 1990 and GALVmed, 2010).

5.3 Impact of ITM on tick control practice

There was no significant difference in the tick control regimes between the ITM and non ITM users. The spraying frequency was twice a month during the wet season and once a month during the dry season. This finding contradicted to what is supposed to be that is the reduction of acaricide use when using ITM (Mukhebi et al., 1989). The acaricide use could have been reduced by third to half of the usual volume. The finding could be due to the fact that majority of the farmers practiced communal grazing and also lacked awareness of this ITM associated advantage. The farmers should therefore be sensitized on the advantage of using ITM alongside reduced intensity/ frequency of acaricide application with consequent increase in profitability of the cattle enterprise. Strategic tick control methods based on tick population dynamics should be developed as advocated by Ocaido et al. (2006) for cattle around Lake Mburo National Park, Uganda. This tick control practice could reduce acaricide control costs by a third.
The average annual cost of acaricide per head of cattle was Ug Shs 9,750 equivalent to US $ 5.27 which conforms to what was reported by Ocaido et al. (2009a), Lawrence and McCosker (1981), Young et al. (1990) and Perry et al. (1990) elsewhere.

5.4 Effect of ITM on the tick-burden load on cattle
The average number of ticks count as per head of the cattle in ITM users was 12.9±1 which were not significantly different from those in the non ITM users (13.8±0.7). This could be due to the fact that farmers always kept the cattle in the same place as they were being exposed to the same tick burden they were practicing communal grazing. This implied that use of ITM did not reduce on the tick burden load but rather reduced the average morbidity and mortality resulting from immunity developed against ECF. Therefore in order for better results to be obtained from the above treatment, farmers should also adopt other sustainable cheaper methods of tick control in order to make the cattle get better productivity. Similar findings were reported by Morzaria et al. (1988) in Kenya.

5.5 The effects of ITM on the prevalence of ECF and other TBDs
The knowledge of the farmers to the type of TBDs prevalent in their farms was positively correlated with the prevalence of these diseases on their farms (Table 8, 9 and 10). The ITM farmers were more knowledgeable of anaplasmosis, heartwater and babesiosis than non ITM users (Table 8). This was because these were TBDs which were prevalent on their farms (Table 10). Similarly non ITM users were more knowledgeable of ECF because it was most prevalent on their farms (Table 8, 9 and 10). This shows that ITM was effective in reducing the prevalence of ECF not other TTBDs. Results in Table 8 indicated significant difference in the knowledge of farmers about the morbidity due to ECF and other TBDs between ITM and Non ITM users. ITM users were knowledgeable because they had more experience since they had started keeping graded cattle earlier than their counterparts.

The percentage of farmers with ECF in their cattle was highest amongst Non ITM users (68.3%) as compared to ITM farmers (31.7%) (Table 9). This implied that the use of ITM had helped to significantly reduce the number of farms with ECF reported cases. Very low prevalence of ECF
in cattle was reported in farms using ITM (24%) as compared to non ITM users (60.8%). This showed that immunization of cattle against ECF by ITM reduced ECF prevalence. This finding agreed with earlier findings done elsewhere (Robson et al., 1977; Morzaria et al., 1985 and Mutugi et al., 1989).

The prevalence of other TBDs was high among ITM users as compared to non ITM users. The use of ITM however led to the increase in the percentage prevalence of anaplasmosis. This has been shown to be true elsewhere due to the relaxing of tick control regime (Mukhebi et al., 1992).

5.6 Effect of ITM on the mortality of cattle

Although the prevalence of ECF was reduced due to ITM use, the mortality rate was still relatively high due to poor management of ECF cases due to lack of knowledge about the disease by the farmers in addition to lack of deworming the calves before vaccination and the lack of routine vaccination follow up program.

Number of cattle deaths out of ECF was significantly reduced in ITM farms. Overall mortality in cattle was reported to be 11.7% and 24.8% in ITM and non-ITM respectively of which 7.3% and 17.3% occurred due to ECF in ITM and non-ITM users. High deaths were in calves of 51% and 60% in ITM and non ITM users respectively. These results were in agreement with the results obtained by other researchers like Taracha and Taylor (2005), Morzaria et al. (1988) in Kenya and Robson et al. (1977) in Uganda in which they argued that ECF if not taken care of leads to high mortality and low productivity of cattle. They also reported that other TBDs especially anaplasmosis, arise after taking care of ECF through ITM.

5.7 Impact of ITM on treatment costs for ECF

Treatment costs of ECF per each cattle category were the same for ITM and non-ITM. However, the average total costs for treating against TBDs in non-ITM herds per annum (Ug. Shs. 812,000) was 2.03 times more than amount used in ITM herds (Ug Shs 400,000). Similarly, ECF
treatment costs (Ug. Shs 280,000) were 2.33 times more in non-ITM herds than in ITM herds (Ug. Shs 120,000). There was net saving of Ug Shs 160,000 per herd equivalent of Ug. Shs 13,800 (7.7 USD) per head of cattle. This showed that ITM reduced ECF treatment costs.

However, treatment costs of ECF accounted for 30% and 34.5% of treatment costs in ITM and non-ITM farms respectively this slight difference could be to the fact that there was no vaccination follow up practice, lack of deworming of the calves to be vaccinated in addition to only vaccinating the health looking ones thereby leaving out others. This could also be a result of the ITM users having relatively lower knowledge of ECF plus the communal grazing practice in addition to the indifferent tick control regime this is in agreement with findings by Minjauw et al. (1998) in Kenya that herds under intensive tick control had little financial benefit.

5.8 Impact of ITM on prices of cattle

Average sale prices of cattle in the ITM herds were higher than in non ITM users. This was because the majority of the cattle in ITM farms were improved Zebu-Friesian crosses (F3) which fetched higher prices. ITM therefore should be adopted so that improved cross breeds with higher live sale prices can be kept. The farmers reported that ITM had enabled them keep highly improved crosses of cattle that they couldn’t keep before this practice. These crosses produced more milk and had a higher carcass weight. It was observed that psychologically, also the presence of the ECF ear tag raised the market price of cattle. The finding was also reported by GALVmed, (2010) in Tanzania.

5.9 Financial analysis of ITM

Milk was the major output of cattle enterprises in Bugabula county constituting 78.9 and 71.1% of total gross output. Gross margin (GM) per farm was higher in ITM (Ug. Shs 3,708,285) than non-ITM farms (2,044,574). ITM users’ GM was 81.4% higher than of non-ITM users which was in line with Mukhebi et al, (1989) findings in Kenya where ITM yielded a marginal rate of return in beef cattle of up to 562%. Perry et al. (1990) in Zimbabwe also reported that the
practice could save the cost of TTBDs control by up to 68%. In Eastern, Central and Southern African Mukhebi et al (1992) reported that ITM showed economic returns with a benefit-cost ratio in the range of 9 to 17. In this study gross return per acre of land in ITM farms was 55.6% higher than of non-ITM users.

In this area, it was shown that ITM costs were low and affordable by the farmers. It was projected that if non-ITM users adopted ITM use, cost of ITM would be 0.14 of the GM and 0.09 of gross output on the first of vaccination. These costs would reduce by 88.1% in subsequent years because only calves borne would be vaccinated. ITM was only done once in the life of the cattle preferably calves of 1-2 months (Maloo et al., 2001) thereby eliciting a lifelong immunity.

6.0 The costs and benefits of adopting ITM as method of controlling ECF.

ITM as a method of controlling ECF was accompanied by various benefits. There was very significant reduction in calf morbidity and mortality due to ECF morbidity. The reduction in losses caused by ECF enabled farmers to improve their cattle for dairy production. The improved cattle fetched higher prices and produced more milk resulting in higher gross margins as compared to non-ITM farms. The costs of ITM were shown to be affordable. This cost could further be reduced by availing local outlets for the vaccine and training farmers on how to administer the vaccine.

The biggest cost of adopting ITM was the increase of incidences of other TBDs namely- heartwater, babesiosis and anaplasmosis. Anaplasmosis was the major threat being the highest threat. This finding is in agreement with Homewood et al, (1990); Mukhebi et al, (1989); Morzaria et al, (1988); Taracha and Taylor (2005) and Robson et al, (1977).

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions
1. The prevalence and mortality due to ECF among ITM herds were significantly reduced.

2. ECF treatment costs were 2.33 times more in non-ITM herds than ITM herds.

3. The average half body tick counts in ITM and non-ITM users were not significantly different because ITM users did not reduce the frequency of acaricide use. However the incidence of anaplasmosis increased.

4. ITM promoted the keeping of improved dairy crosses leading to increased milk yields and higher cattle sale prices hence increased gross margins.

5. ITM costs were low and were affordable by the farmers. If non-ITM users adopted ITM use, cost of ITM would be 0.14 of the gross margin and 0.09 of gross output on the first vaccination. These costs would reduce by 88.1% in subsequent years because only calves born would be vaccinated.

6.2 Recommendations

1. The costs of ITM could be further reduced by having private companies distribute the vaccine and train Para veterinarians, Community Based Animal Health Workers (CBAHWs) and farmers to do ITM vaccination.

2. Cost of ITM vaccine is affordable therefore people should be encouraged to take up ITM.

3. Farmers should be sensitized and encouraged to adopt ITM as its advantages were demonstrable in promoting improvement of dairy herds hence milk leading to increased household incomes and food security.

4. ITM users should be taught on how to do strategic tick control based on tick population dynamics so as to reduce costs and also take care of other TBDs like anaplasmosis.
Given time and financial constraints, the researcher could not exhaust everything to do with ITM and ECF and suggested the following areas for future research.

- The role of Doctors in the treatment of ECF.
- Challenges to the implementation of ITM.
- Knowledge and utilization of other tick control methods after using ITM.
- The contribution of ITM only without any other control method on ECF.
- Factors affecting the adoption of ITM.
REFERENCES


APPENDICES

APPENDIX I

Farmers’ Questionnaire

Title of the investigation: Impact of ECF Immunization in Bugabula County, Kamuli district.

1. Date of investigation

2. Household head

3. Size of household/family

4. Size of the land (acre)

5. Year of immunization by ITM

6. Name and give numbers of each breed of cattle kept

7. What is the herd structure of your cattle?
   a) Lactating cows
   b) Dry cows
   c) Heifers (beyond 2 years)
   d) Heifers 1-2 years
   e) Immature males (1-3 years)
   f) Female calves (< 1 year)
   g) Male calves (< 1 year)
   h) Bulls (> 3 years)

8. Is the household owner employed or has another business? (Yes/No). If yes, specify the occupation

9. If you have employed people in your farm, give the job description, with numbers employed in each category, giving the nature of payment. Also indicating the role played by relatives (wife, son, etc).

<table>
<thead>
<tr>
<th>Category</th>
<th>Number Employed</th>
<th>Daily/ weekly/ Monthly Payments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. What implements do you have in your house hold (tractors, dips, spray race, crush,
motorcycles, water pumps, etc). List -----------------------------------------------
--------------------------------------------------------------------------------

11. Have you got a loan from the bank or any financial institution? (Yes/ No). If yes, state the Lenders and nature of payment including the interest rate) ---------------------------------
--------------------------------------------------------------------------------

12. What problems do you encounter? List -----------------------------------------------
--------------------------------------------------------------------------------

13. Which of the four TBDs do you consider most important?
--------------------------------------------------------------------------------

14. Which problems do you associate ticks and tick borne diseases? ------------------------
--------------------------------------------------------------------------------

15. Do you control ticks on your animals? (Yes/No). If yes, by what method?
a) Dipping   b) spraying   c) dipping and spraying   d) others like hand picking, please specify ----------------------------------

16. Why do you control ticks on your animals? -----------------------------------------------
--------------------------------------------------------------------------------

17. Do you associate the presence of ticks with ECF? (Yes/No). If yes which species ------
--------------------------------------------------------------------------------

18. What do you hope to achieve by controlling ticks? List -----------------------------------------------
--------------------------------------------------------------------------------

19. What animals do you control ticks on? a) All animals  b) Only calves  c) others, specify -----------------------------------------------

20. At what age do you begin tick control for calves?----------------------------------------

21. At what time of the year do you carry tick control? a) All year around  b) Wet season alone

22. Is your method of tick control different for adults and calves? (Yes/No)
If yes, describe -----------------------------------------------

23. If you dip, which tank do you use? a) Personal tank  b) Communal tank  c) state distance -----------------------------------------------
24. If you use a communal dip how much do you pay for each animal dipped
------------------------------------------------------------------------
------------------------------------------------------------------------

25. i) If you have a personal dip, name the acaricide(s) you use
-------------------
ii) What is the cost per liter
-------------------------------
iii) At what rate do you refill your dip
------------------------------------
iv) Give the source where the acaricide is bought
-----------------------------------------------

26. i) If you spray, what product do you use?
-----------------------------
ii) At what rate do you mix your product with water?
-----------------------------
iii) How much volume of the diluted spray do you use per animal? a) adult---
b) Medium sized cattle-
c) calves
-------------------------
iv) What is the price of the product?
-----------------------------

27. If you use other means of tick control, state:

<table>
<thead>
<tr>
<th>Method</th>
<th>Product</th>
<th>Cost / unit quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28. Do you consider tick-borne diseases as the major constraint in your farming enterprise? (Yes / No). If yes, name them:
------------------------------------------------------------------------
------------------------------------------------------------------------

29. If one of disease problems is East Coast Fever (ECF), how many animals die due to it? State the number and each age category that dies:
------------------------------------------------------------------------
------------------------------------------------------------------------
 a) Lactating cows
 b) Dry cows
 c) Heifers (<1 year)
d) Heifers (>2 years)
e) Immature males
 f) Female calves (< 1 year)
g) Male calves (<1 year)
h) Bulls (> 3 years)

30. How do you determine that the animal is sick form a particular tick-borne disease?
 a) Local veterinary diagnosis
 b) Previous experience, state in detail
 c) Other methods, specify

51
31. What is your milk production during?
   a) Rainy season (months-----------------------------------)-----------------------------Litres.
   b) Dry season (months-----------------------------------)-----------------------------Litres.

32. i) From your experience, when lactating animals succumbs to specific tick-borne Disease particularly ECF, what happens to milk production?
   a) Nothing  b) decreases  e) Increases
   ii) If it decreases by how many liters per animal for each specific tick-borne diseases?

33. At what price do you sell your milk? -----------------------------------------------

34. At what age do female cows first calve down?------------------------------------------

35. i) Do you use your animals for traction? (Yes/ No). If yes, explain the activities)
   ii) If they fall sick from a specific tick-borne disease for how long do you rest them?
   iii) How many animals do you use for traction? --------------------------------------
   iv) Do you hire animals for traction, if so at what rate?-------------------------------

36. i) Do you keep animals for beef? (Yes / No).
   ii) If yes, approximately how many do you sell per year?
   a) Calves-----------------------
   b) Immature---------------------
   c) Adult cows-------------------
   d) Bulls--------------------------

37. What criteria do you use for selecting animals for sale?
   a) Age, explain-----------------------------------------------
   b) Weight, explain--------------------------------------------
   c) Others, explain---------------------------------------------

38. What is the price of an animal in this area?
   a) Adult cow---------------- b) Bull---------------------- c) Heifer (> 2 years)--------
   b) Heifer (> 2 years)--------- e) Calf------------------ f) Breeding in-calf cow--
   g) Breeding bull----------------- h) Immature male---------

39. How much is a Kilogram of meat here?-----------------------------------------------

40. Do you make use of animal manure? Yes/No. If yes, explain in details---------------

41. i) Is your herd increasing? Yes/No. If yes, at what rate-----------------------------
   ii) What is the full stocking rate of your farm?--------------------------------------
   iii) How do you raise your replacement stock? ---------------------------------------
   iv) If you raise from the herd, what criteria do you use for selection?---------------
42. i) What drugs do you use for treating tick-born diseases and what are their prices?-----
ii) According to your records for the last four years, how much do you use for treating tick-born diseases per year?

43. To what use do you put your manure?

44. Do you think the cost you incurred through ITM can be/has been recovered?
   Yes/No. Give reasons

45. What are your future plans and dreams?

THANK YOU FOR YOUR TIME
APPENDIX 2

EXTENSION STAFF QUESTIONNAIRE

TITLE: Impact of ECF immunization in Bugabula County, Kamuli District

1. Name of Extension Worker
2. Area of jurisdiction
3. Which of the 4 TBDs do you commonly encounter
4. How do you deal with 3 above
5. What are your charges like
6. Have you done ITM
7. What are your charges
8. How many animals do you cover annually
9. What benefits does ITM have
10. What challenges do you find during the practice of ITM
11. Where do you get your vaccines from
12. What is the unit cost of the vaccine
   i) Calf to sub-adult
   ii) sub-adult to adult
13. a) Cost liquid nitrogen equipment
    b) Transport costs
    c) Label costs
13. On ITM treated herds what is the probability of survival
   a) Exotic
      i) Calf to sub-adult
      ii) sub-adult to adult
   b) Crosses
      i) Calf to sub-adult
      ii) sub-adult to adult
   c) Locals
      i) Calf to sub-adult
      ii) sub-adult to adult

THANK YOU FOR YOUR TIME
APPENDIX 3
DRUG / VACCINES SUPPLIERS’ QUESTIONNAIRE

1. Name of supplier and Location  ……………………………………………………………
2. What drugs/vaccines do you major in? ……………………………………………………………
3. What is the unit cost of your supplies in 2 above? ........................................................
4. Who are the main customers of your stock? .................................................................
5. What accompanying package do you offer your customers? ........................................
6. What is the cost of the package in 5 above? .................................................................
7. Prices of LAT (20% and 30%). ....................................................................................... 
8. How plentiful are LATs? ................................................................................................. 

THANK YOU FOR YOUR TIME
APPENDIX 4

FOCUS GROUP DISCUSSION GUIDE QUESTIONS:

1. What breeds of cattle are kept on your farms?
2. What are the challenges experienced on the farms
3. How do you solve them?
4. What diseases do you encounter on your farm?
5. What is ECF?
6. What ticks cause you problems on your farm?
7. How do you control diseases on your farm?
8. What type of acaricide do you use on your farm?
9. How often do you spray your animals?
10. What costs do you incur to spray your animals?
11. What changes are there on the tick burdens on your farms?
12. What is ITM?
13. Have you ever used ITM?
14. What are the benefits of the practice?
15. What challenges/problems did you encounter in using ITM?
16. What should be done to improve the intervention?
17. Any other concern on livestock health issues?

THANK YOU FOR YOUR IDEAS
APPENDIX 5

Gross margin analysis for using ITM

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Number</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vet fees</td>
<td>501cattle</td>
<td>21,840</td>
<td>10,941,840</td>
</tr>
<tr>
<td>Tag fees</td>
<td>0</td>
<td>21,840</td>
<td>0</td>
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<tr>
<td>Treatment costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drugs</td>
<td>501cattle</td>
<td>20,000,000</td>
<td>20,000,000</td>
</tr>
<tr>
<td>Tick control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acaricide</td>
<td>501cattle</td>
<td>500</td>
<td>1,503,000</td>
</tr>
<tr>
<td>Labour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager</td>
<td>20</td>
<td>63,300</td>
<td>1,266,000</td>
</tr>
<tr>
<td>Herdsmen’s</td>
<td>36</td>
<td>75,200</td>
<td>2,707,200</td>
</tr>
<tr>
<td>Farm cleaners</td>
<td>30</td>
<td>66,500</td>
<td>1,995,000</td>
</tr>
<tr>
<td>Relative costs</td>
<td>186</td>
<td>42,000</td>
<td>7,812,000</td>
</tr>
<tr>
<td>Variable annual cost</td>
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<td>35,283,200</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td>46,225,040</td>
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</tbody>
</table>

**Out puts**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Milk consumed at home</td>
<td></td>
<td>13,500,000</td>
</tr>
<tr>
<td>Animals sold</td>
<td></td>
<td>10,000,000</td>
</tr>
<tr>
<td>Ceremonies</td>
<td></td>
<td>5,700,000</td>
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<tr>
<td>Milk sales</td>
<td></td>
<td>173,340,000</td>
</tr>
<tr>
<td>Total output</td>
<td></td>
<td>202,540,000</td>
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</tbody>
</table>

**Percentage of milk output**

85.6%
APPENDIX 6  
Gross Margin Analysis for Non ITM users

<table>
<thead>
<tr>
<th>Non ITM</th>
<th>Number of cattle</th>
<th>Rates</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drugs</td>
<td>591</td>
<td>40,000,000</td>
<td>40,000,000</td>
</tr>
<tr>
<td>Tick control</td>
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</tr>
<tr>
<td>Acaricide</td>
<td>591</td>
<td>500</td>
<td>1,182,000</td>
</tr>
<tr>
<td>Labour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager</td>
<td>6</td>
<td>50,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Herdsman</td>
<td>15</td>
<td>98,300</td>
<td>1,474,500</td>
</tr>
<tr>
<td>Farm cleaners</td>
<td>26</td>
<td>43,200</td>
<td>1,123,200</td>
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<tr>
<td>Relative costs</td>
<td>158</td>
<td>20,800</td>
<td>3,286,400</td>
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<tr>
<td>Total Annual cost</td>
<td></td>
<td></td>
<td>47,366,100</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sale of animals</td>
<td></td>
<td></td>
<td>14,500,000</td>
</tr>
<tr>
<td>Milk consumed at home</td>
<td></td>
<td></td>
<td>6,700,000</td>
</tr>
<tr>
<td>Ceremonies</td>
<td></td>
<td></td>
<td>7,870,000</td>
</tr>
<tr>
<td>Milk sales</td>
<td></td>
<td></td>
<td>106,380,000</td>
</tr>
<tr>
<td>Total output</td>
<td></td>
<td></td>
<td>135,450,000</td>
</tr>
<tr>
<td>Milk sale percentage</td>
<td></td>
<td></td>
<td>78.5%</td>
</tr>
</tbody>
</table>
# APPENDIX 7

Analysis of revenue over the five years

<table>
<thead>
<tr>
<th>Years</th>
<th>ITM</th>
<th>Non ITM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output</td>
<td>Cost</td>
</tr>
<tr>
<td>Year1</td>
<td>202,540,000</td>
<td>62,285,040</td>
</tr>
<tr>
<td>Year2</td>
<td>202,540,000</td>
<td>51,343,200</td>
</tr>
<tr>
<td>Year3</td>
<td>202,540,000</td>
<td>51,343,200</td>
</tr>
<tr>
<td>Year4</td>
<td>202,540,000</td>
<td>51,343,200</td>
</tr>
<tr>
<td>Year5</td>
<td>202,540,000</td>
<td>51,343,200</td>
</tr>
</tbody>
</table>

- Cumulative gross margin: 745,042,160
- Annual gross margin per animal: 297,420
- Annual gross margin per acre: 82,780
- Annual gross margin per farmers: 2,980,170