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AN ASSESSMENT OF THE IMMUNIZATION OF CATTLE AGAINST EAST COAST FEVER IN KWENJE VET CAMP, CHIPATA DISTRICT

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Ngwabi Siankuku
ngwabisiankuku81@gmail.com
School of Engineering
Information and Communications University
Zambia Research and Development Centre
Lusaka, Zambia

Abstract - Farmers in Kwenje Vet Camp of Chipata District were improving their cattle production and productivity. ECF was however a limiting factor towards achieving their ultimate goal. 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 Martins et al., (2010). The Infection Treatment Method of controlling ECF was relatively new in this area having started in 2006.The research was therefore carried out to assess the impact of ITM in fighting against ECF. This study focused on finding out the impact of immunization of cattle against ECF in Kwenje Vet Camp of Chipata 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 (2007 – 2015). The objectives of the study included establishing the effect of ITM on ECF prevalence and mortality of cattle. Data collection was by questionnaire administration to farmers. A Systematic sampling method was used to determine the sample size from the 4 crush pens(clusters) of the camp. 40 farmers selected and representing 238 cattle Farmers from 4 crush pens of a camp. 40 cattle were sampled from selected 4 crush pens of a camp representing 1170 cattle. Data analysis was by descriptive analysis and bivariate analysis using Regression method. The study found out that the vaccine was imported by government and delivered to farmers via government extension system. The prevalence of ECF was reduced and overall crude mortality due to ECF in cattle was reduced. The farmers should be sensitized and encouraged to adopt ITM as its advantages were demonstrable in improving production and productivity, since there was a remarkable reduction in both mortality and prevalence. 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

INTRODUCTION

East Coast Fever (ECF) or bovine theileriosis, is caused by the protozoan parasite *Theileria parva* transmitted by *Rhipicephalus appendiculatus* or "brown ear tick". ECF is the second most important African cattle disease after trypanosomiasis. According to Martins et al., (2010), 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 (Lawrence *et al.*, 2004). 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). Kwenje Vet camp of Chipata 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. The feasibility of immunisation using the ITM method was established by Willi Neitz in South Africa in the 1950s, a theoretical approach using oxytetracycline was established by Brocklesby and Bailey at EAVRO in the 1960s, and a pragmatic and practical application of this method using Pfizer's then newly emergent long-acting formulation of oxytetracycline was developed by the FAO project at EAVRO in the 1970s. This happened about 40 years ago, but it is only relatively recently that vaccine production capacity has been established outside ILRI, and that vaccine has been distributed in the different ECF-affected countries.

On the specifics of applying this theory to immunization of cattle to protect against the causal agent of ECF, there were several milestone technical innovations which contributed to the development and success of the Infection and Treatment (ITM) approach. These were:

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The ability to harvest Theileria parva sporozoites from batches of infected Rhipicephalus appendiculatus ticks.

The ability to preserve T. parva stabilates (cryopreserved sporozoite preparations) in liquid nitrogen for extended periods of time without affecting their infectivity. This allowed the administration of a uniform and reproducible dose of infective material to cattle.

The ability to induce sustained protective immunity in cattle through the injection of T. parva stabilates in combination with long-acting oxytetracycline treatment

The identification and combination into a single stabilate of three parasite stocks (T. parva Muguga, T. parva Kiambu 5 and buffalo derived T. parva Serengeti transformed), which became known as the Muguga Cocktail (MC), which has been shown to afford very good protection against T. parva, both in the laboratory and the field in many parts of eastern and central Africa, despite the wide diversity of T. parva immunological strains found in the field

The adjustment of the dose of long acting oxytetracycline from 20% to 30%dramatically reduced the proportion of clinical reactors to ITM, allowing the live vaccine to be more widely applied in countries of the region.

The preparation at ILRI in 1996 of a commercial scale batch of the MC at the request of FAO and funded by FAO through a Technical Cooperation Programme – TCP.4 these stabilates were therefore designated FAO 1and FAO 2. A second commercial scale batch was produced again some10 years later in 2007 at the request of the Inter-African Bureau of Animal Resources of the African Union (AU/IBAR5). This stabilate was designated ILRI.

Fundamental to the concept of immunization, it had been observed that cattle which survive infection naturally develop long lasting immunity, and this was demonstrated experimentally by Burridge at al. (1972), which showed that solid protection against homologous challenge lasted for up to three and a half years in the absence of reinjection. Neitz (1953) in Onderstepoort, South Africa, had earlier found that when Theileria parva-infected ticks were applied to cattle that were simultaneously treated with chlortetracycline (under the trade name Aureomycin), the cattle underwent mild reactions and were immune on challenge. The drug was administered intravenously at a dosage rate of 10 mg/kg, starting 24 h after tick infestation and continuing on approximately alternate days for 2–3 weeks.

Subsequently, Brockelsby and Bailey (1962; 1965) at EAVRO in Kenya applied T. parva-infected ticks to cattle which then received oral tetracycline at a dosage of 15 mg/kg, and they recommended these of this immunization technique in valuable exotic breeds of cattle.

This method was applied further by Jezierski et al. (1959) [22] in Rwanda and Jarrett et al. (1969) in Kenya. Under the leadership of Matt Cunningham, the FAO project made a breakthrough in the technique of ITM by the production of sporozoite stabilates, the infectious stage of T. parva that is found in ticks, known at the time as ground-up tick stabilates (GUTS). This allowed cattle to be infected with a specific predetermined dose (Cunningham et al.,1973).

During the six-year period from 1971 to 1977, a series of experiments was undertaken to reduce the amount of drug required to control infection and yet permit a protective immune response to develop. It was found that two doses (10 mg/kg) of short acting oxytetracycline given on days 0 and 4 would permit good protection with this immunization regimen.

A major breakthrough came with the introduction by the pharmaceutical company Pfizer of a long-acting oxytetracycline product (TerramycinLA, Pfizer, UK). The long-acting formulation, when given at a single dose of 20 mg/kg at the time of infection with the sporozoite stabilate, resulted in the development of immunity to homologous T.

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parva stabilate challenge with minimal clinical response.

A severe limitation to the effective immunization of cattle against T. parva using ITM has been the recognition of different strains of T. parva in the field; this is particularly important in infections derived from buffalo. It was quickly established that different immunogenic stocks existed, and this led to the search for a “master” stock or stocks which would induce broad protection in immunized animals (Mutugiet al., 1990a). In a series of experiments, a combination of three stocks (T. parva Muguga, T. parva Kiambu 5 and buffalo derived. parva Serengeti transformed), which were collectively given the name the “Muguga Cocktail (MC)”, and was shown to afford very good protection against T. parva, both in the laboratory and the field in many parts of eastern and central Africa.

During the ten years of the FAO project's life the following agencies established cooperative support projects with EAVRO: Ministry of Overseas Development, United Kingdom (latterly Overseas Development Administration ODA); United States Department of Agriculture (USDA);

Pfizer International Incorporated; International Centre for Insect Physiology and Ecology (ICIPE); International Development Research Centre

(IDRC) Canada; International Atomic Energy Agency (IAEA); Australian Volunteer Service; Nuffield Institute of Comparative Medicine, and the Rockefeller Foundation.

Cattle are highly valued in Africa, and in the eastern, central and southern regions of the continent, they play diverse roles in the livelihoods and economies of peoples and countries. So, when a highly fatal disease of cattle appears to be interfering with the exploitation of this diverse livestock resource, the call for a sustainable solution is loud. So, it has been with the call for a vaccine to protect cattle against East Coast fever (ECF). ECF is tick-borne and indigenous to the region, probably originally a parasite of the Cape buffalo (Syncerus caffer). It was first described in eastern Africa as Amoeba by Bruce et al. (1910), where it had been endemic and apparently recognised for centuries as a relatively mild disease of calves. Surprisingly, it was only when tick-infested cattle were exported by boat from eastern to southern Africa in 1901 and 1902, and the disease appeared in what is now Zimbabwe, that the disease became widely recognised. Rinderpest had earlier swept down through southern Africa, wiping out over 2.5 million cattle in South Africa alone, before it was eradicated from that country in 1899.As a result of rinderpest and of the effects of the Boer war (1899–1902), the cattle populations of southern Africa had become depleted, and were inadequate to meet the multiple needs of the region. Asa result, cattle were imported from many sources, including Kenya and Tanzania, where ECF, in its milder form in the resistant indigenous animals of the region, had been existing almost unnoticed for generations. It was only when the early European settlers started to arrive in eastern Africa, importing exotic cattle breeds, that the disease was recognised there, and it was not until 1911 that the endemic disease in eastern Africa and the epidemic highly fatal disease in southern Africa were found to be one and the same. This narrative describes the story behind the development of a live vaccine against ECF, probing the technological achievements which laid the groundwork for the innovation, the institutional settings in which this occurred, and the political dynamic of both over the last50 years. It also analyses the indicators of success and the many qualifiers of these, the impacts that the emerging technology has had, both in positive and negative terms, and maps the key contributors and milestones on the research to impact pathway. In these systems tick-borne disease control has moved from a broad public sector responsibility, administered through community cattle dips, to farmer operated backpack application, spray race systems and private dips, depending on the scale of the

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enterprise. This devolution of responsibility has provided much more effective control of ECF, even in the absence of a vaccine. But it is not only the livestock production systems that have changed; the animal disease research environment has had its own dynamic. Looking back at the veterinary research landscape in Kenya during the late 1960s and early 1970s, the period immediately following independence, the already existing and competent disease research infrastructure which had existed was replaced, at least for a decade or so, by a wave of new technical assistance attempting to provide continued veterinary service and research support to post-colonial livestock enterprises, and to train the new generation of African scientists. But the story was not that simple.

During the latter part of the colonial era in eastern Africa, the main centre of research on ECF and other tick-borne diseases (TBDs) was at the East African Veterinary Research Organization (EAVRO). EAVRO was one of five research organizations responsible to the East African Agricultural and Fisheries Research Council, under the East African High Commission (EAHC). The EAHC operated from 1948 to 1961, then became the East African Common Services Organization (EACSO)from 1961 to 1967, and finally the East African Community (EAC)from 1967 to 1977. The EAC collapsed in 1977, (but was revived in2000). The 1956/57 Annual Report of EAVRO stated that their laboratories at Muguga North were completed towards the end of 1954 and opened by the Governor of Kenya Sir Evelyn Baring on 21st February1957. The staff listing contained some notable names, such as Walter Plod right, who was to go on to receive the World Food Prize for his work on rinderpest tissue culture vaccine development,2which contributed significantly to the ultimate global eradication of rinderpest in2011.The tick-borne disease research group at the time was led by Steve Barnett, with colleagues David Brocklesby and Peter Bailey, among several others in the team. ECF was a major focus of their work, principally studying the transmission and chemotherapy of the infection; some research on immunization of cattle had started which involved a28-day therapy regimen of the antibiotic Aureomycin following their infestation with ECF-infected ticks, which was perhaps the first successful exploitation of an ITM approach undertaken at EAVRO. In December 1963, just five years after the opening of EAVRO at Muguga, Kenya gained its independence from the UK, and the UK government continued its support to livestock disease research. In1967 the United Nations Development Programme (UNDP) initiated the funding of a 10-year research programme on tick-borne disease research under the auspices of the Food and Agriculture Organization (FAO), based at EAVRO, Muguga.3 It was this FAO-administered research programme which was ultimately responsible for developing the ITM live vaccination against ECF. While having as its objective the study of controlling ticks and tick-borne diseases in general, the project placed special emphasis on immunological work designed to control ECF by means of a vaccine. The project started operations in May 1967 at the laboratories of EAVRO, originally a project of three years duration but as a result of two extensions it continued until the end of 1976, just prior to the collapse of the EAC. With the collapse of the EAC in 1977, EAVRO was absorbed into the Ministry of Agriculture and renamed the Veterinary Research Department (VRD) and in 1986 it was brought under the Kenya Agricultural Research Institute (KARI) as the National Veterinary Research Centre (NVRC). Research on ECF continued at Muguga at the renamed NVRC. Importantly, despite the end of FAO's important contributions to EAVRO, the organisations continued to be heavily committed to supporting research on ECF and other TBDs in eastern and southern Africa for several decades to come, and

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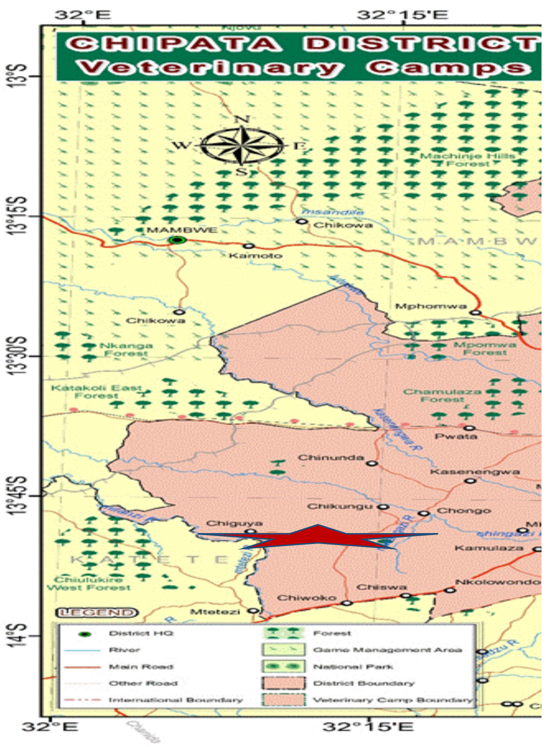
many of the subsequent regional discussion forums held were co-financed by FAO.

Zambia 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 Martins et al., (2010)

As part solution to this problem, there was introduction of immunization 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 and mortality after the introduction of ITM practice. This research project was therefore carried out to assess the impact of ITM in fighting against ECF

The main research objective was to:

1.To assess the impact of the immunization of cattle against ECF using the infection and treatment method (ITM).



In order to archive the main objective, the study had the following specific objectives:

1. To establish effect of ITM on ECF prevalence
2. To establish effect of ITM on the mortality of cattle due to ECF

MATERIAL AND METHODS

This chapter explains the coverage and the target population and the sampling method used in conducting the research.

Research site

Chipata Town is located in the Eastern Province of Zambia about 570 km east of Lusaka, the capital of Zambia. It is located at 32 09 60`E and 13029`S with a population of approximately 455,783. It is situated at elevation 1147 m above sea level. The district has 4 constituencies and 22 wards. The mean annual maximum temperatures in the district range from 26.6"C, to 32.3"C while mean annual minimum temperatures ranges between 26.6"C, 12"C to 20.1" C. The average rainfall in the district is 997.2mm. There are three main soil types namely Acrisols, Fersiallitic soils, and Lithosols. There are four vegetation types the main one being the Brachystegia (Miombo) woodland and Munga vegetation types (Kribek et al., 2010). Agriculture and cattle rearing are the major economic activities in Chipata District and main source of income for the population. The majority of the people in Chipata practice cattle rearing and livestock products such as milk, meat, hides and skins and bee keeping provide household income. Indigenous cattle kept by the agro-pastoralists and pastoralists comprise over 95% of the cattle herd in the district. The farming system in the study areas could be described as agro-pastoralist and communal grazing system is the main cattle management system in Chipata District.The study was carried out in Kwenje Ward of Kasenengwa constituency in Kwenje Vet Camp, Chipata District, which is located west of the district.

Sample size and design

The Research covered all Livestock household populations in all the four areas of the camp in the sampled area. The design for the survey called for a representative probability sample that was large enough to produce reliable estimates at camp level. Overall, a representative probability sample of at least 238 livestock households was covered from 4 Areas of the camp.

Stratified cluster sampling method was used in the selection of the sample. This meant that crush pens were selected and each and every household in the selected crush pen was enumerated. The method was appropriate as the probability of finding Livestock-raising households is increased. The other advantage of this was that the cost of listing the households in order to draw a sample of household as the final stage of sampling was cut.

The sample size was determined based on the minimum sample size that would be required for analysis at camp level.

A Systematic sampling method was used to determine the sample size from the 4 crush pens (clusters) of the camp. 40 farmers selected and representing 238 cattle Farmers from 4 crush pens of a camp. 40 cattle were sampled from selected 4 crush pens of a camp representing 1170 cattle.

The sample sizes were determined using the following formula (Martin *et al.*, 1987).

(1) $$n = z^x \frac{n(1-p)}{d^x}$$

Where: -

Z = Confidence level (confidence interval CI 95%)

P = Estimated prevalence (50%)

(1-P) = The probability of having no disease

d = Precision level (allowable error 0.05%)

n = Sample size

Level of confidence will be 95%

Precision 0.05 (5%)

n= 1.962 x 0.5(1-0.5) = 40.16

0.052

Approximately 40 cattle.

The main considerations that affect the size of the sample were: the expected estimate of an indicator of interest (proportion rearing livestock in this case), margin of error desired, level of confidence desired, design effect, expected response rate and number of domains (clusters of the population for which separate estimates are required).

A structured questionnaire: administered to 40 farmers systematically selected and representing 238 cattle Farmers from 4 crush pens(clusters) of a camp.

Lab tests using Giemsa stain method.

40 cattle were sampled systematically from selected 4 crush pens of a camp representing 1170 cattle.

Socio-economic survey

The aim of this study was to determine the prevalence rate and mortality rate after using ITM in controlling East Coast Fever (ECF). Techniques used to collect social-economic data were individual interviews using semi-structured questionnaire (Appendix 1). The technique is widely used and recognized as effective way of getting valid and detailed information from local communities (Bayer and Waters-Bayer 1994). The selected farmers were individually interviewed using questionnaire which targeted the household heads or their representatives. Both closed and open-ended questions were included in the questionnaire administered to the respondents in order to seek information on household socio-economic characteristics such as age, education, experience on cattle keeping, major activities, herd size, common tick species, control measures and farmers perception on immunization against ECF.

Blood samples collection

During socio-economic survey, blood samples were collected from cattle in the same households where the questionnaire was administered. A total of 40 blood samples were collected from animals of different age (25 calves and 15 yearlings). Blood was collected by jugular venipuncture using 10-ml vacutainer tubes (Becton Dickson Vacutainer Systems, England). Verified correct labelling of the tubes was done after which they were kept in cool boxes with ice for some few hours, and at the end of the day refrigerated in Laboratory. The blood samples were centrifuged at 3000 rpm for 20 minutes to obtain sera. Approximately 2 millilitres aliquots in cryotubes, were made from each sample and stored in a freezer at -20 C until the testing time. No parasitological examinations done due to the shortage of funds but this can be planned for future studies.

Sera testing

The enzyme-linked-immunosorbent assay (ELISA) as described by (Katende *et al.*, 2009), was used to estimate prevalence of ECF in the study area. The system adopted was based on indirect Enzyme Linked Immunosorbent Assay (indirect ELISA) using *T. parva* kit batch number NDEC 12#123 from International Livestock Research Institute (ILRI-Nairobi Kenya). The kit is designed to detect specific antibodies against *Theileria parva*. *Theileria parva* specific recombinant antigen from ILRI - was bound on the surface of the walls of microplates and the free spaces on the walls of the microplates and the non-specific sites on the bound antigen were blocked using blocking buffer supplied together with the kit. The presence of antibodies specific to *T. parva* was tested by addition of the test sera to the wells. Anti-bovine IgG1 monoclonal antibody (MoAb) conjugate to horse radish peroxidase (HRP) from ILRI was then added to demonstrate that the initial antigen and antibody reaction took place. The amount of the second antibody bound on the first antibody determines the strength of the signal.

The reaction was revealed by the addition of the substrate /chromogen containing 1% hydrogen peroxidase substrate and 40 mM 2,2'-azino-bis (3-ethylbenz-thiazoline-6-sulfonic acid) diammonium salt (ABTS) from ILRI as chromogen in sodium citrate buffer pH 4.0. The intensity of the colour, which developed following hydrolysis of the substrate by the enzyme and the oxidation of the chromogen by the oxygen liberated from hydrogen peroxide, was determined by using an ELISA reader (Multiskan Dichromatic Version 1.03) with 405 nm filter. Results were recorded in the computer, connected to the reader, and runs ELISA data interchange (EDI version 2.1.1) software programme. The raw data obtained from the ELISA reader were expressed as percentage positivity (pp) relative to strong positive standards. The results were expressed as percent positivity (pp) as follows: pp = (optical density of test serum/optical density of strong positive) x 100 (According to Wright *et al.*, 1993). A sample was considered positive if the PP value was 20 or above, hence, animals were classified as positive or negative depending on whether the pp values were above or below 20.

Data analysis

CRUSH PEN	NUMBER OF CATTLE	NUMBER SAMPLED
Masala	350	12
Kabudama	300	10
Katobo	250	9
Kalinde	270	9
Total	1170	40

Data derived from questionnaires were coded and recorded into the spreadsheets for statistical analysis. The data were analyzed using the SPSS (2000) statistical package (version 10) statistical software and the following descriptive statistics were generated: means, standard deviations, frequencies and percentages. Significant results were subjected to least significant differences (LSD).

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Table 1: The number of farmers sampled per crush pen.

CRUSH PEN	NUMBER OF CATTLE FARMERS	SAMPLE SIZE SELECTED
Masala	52	9
Kabudama	75	12
Katobo	47	8
Kalinde	64	11
Total	238	40

Lab tests using Giemsa stain method.
40 cattle were sampled from selected 4 crush pens of a camp.

Table 2: The number of cattle sampled per crush pen

RESULTS AND DISCUSSIONS
PARASITOLOGICAL RESULT

Out of 40 sampled animals 14 came out negative and 16 with very small traces of Theileria piroplasm present and cannot be considered positive as the area under research is Endemic.

Prevalence of Serum Antibodies

Prevalence of serum antibody for *Theileria parva*. A total of 40 animals were tested for the presence of antibody to *Theileria parva*. Overall 31 animals tested positive hence 8.1% prevalence of antibodies to *Theileria parva.* The age of the animals did not significantly (P > 0.05) affect the prevalence of antibodies to *Theileria parva*. However, slightly higher seroprevalence was observed in the yearlings (9.6%) compared to calves (8.2%)

SURVEY RESULTS SHOWED:

Respondent Socio-economic Characteristics

Forty (40) respondents were interviewed in Kwenje Vet. Camp, 36 (90.6%) were males and 4 (9.4%) were females. More than half of respondents 25 (54.7%) had age of less than 40 years and others 15 (45.3%) were aged above 40 years. Almost half of the respondents 22 (49.1%) had no education at all while 16(47.1%) had primary school education and few 2 (3.8%) had an adult learning education. The major economic activities in the study areas is livestock keeping 33 (79.2%) with few farmers 7(20.8%) who practice agro-pastoralism. The majority 22 (52.8%) of the respondents reported that they had been keeping cattle for more than 20 years and 18 (47.2%) farmers said that they had 10-20 years of keeping cattle.

Table 3: ECF PREVARENCE FOR THE PAST NINE YEARS.

YEAR

		2007	2008	2009	2010	2011	2012	2013	2014	2015
Prevalence	Very High	32	18	4	1	0	0	0	0	0
	High	6	1	1	0	0	0	0	0	0
	Moderate	2	19	27	19	6	1	0	0	0
	Low	0	2	7	20	30	30	25	10	7
	Very Low/Nil	0	0	1	0	4	9	15	30	33

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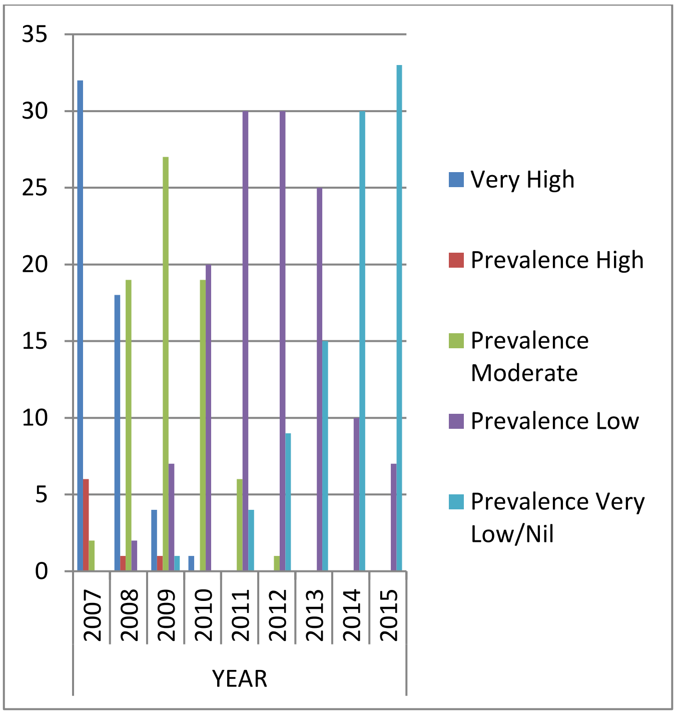
Table 4: ECF MORTALITY TRENDS FOR THE PAST NINE YEARS

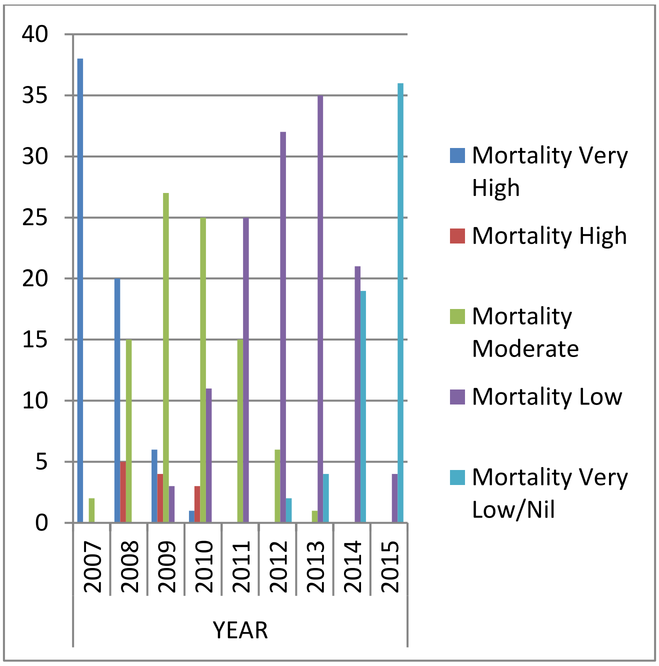
		YEAR								
		2007	2008	2009	2010	2011	2012	2013	2014	2015
Mortality	Very High	38	20	6	1	0	0	0	0	0
	High	0	5	4	3	0	0	0	0	0
	Moderate	2	15	27	25	15	6	1	0	0
	Low	0	0	3	11	25	32	35	21	4
	Very Low/Nil	0	0	0	0	0	2	4	19	36

Graph 1 Showing the Survey Results/ EFC prevalence trends



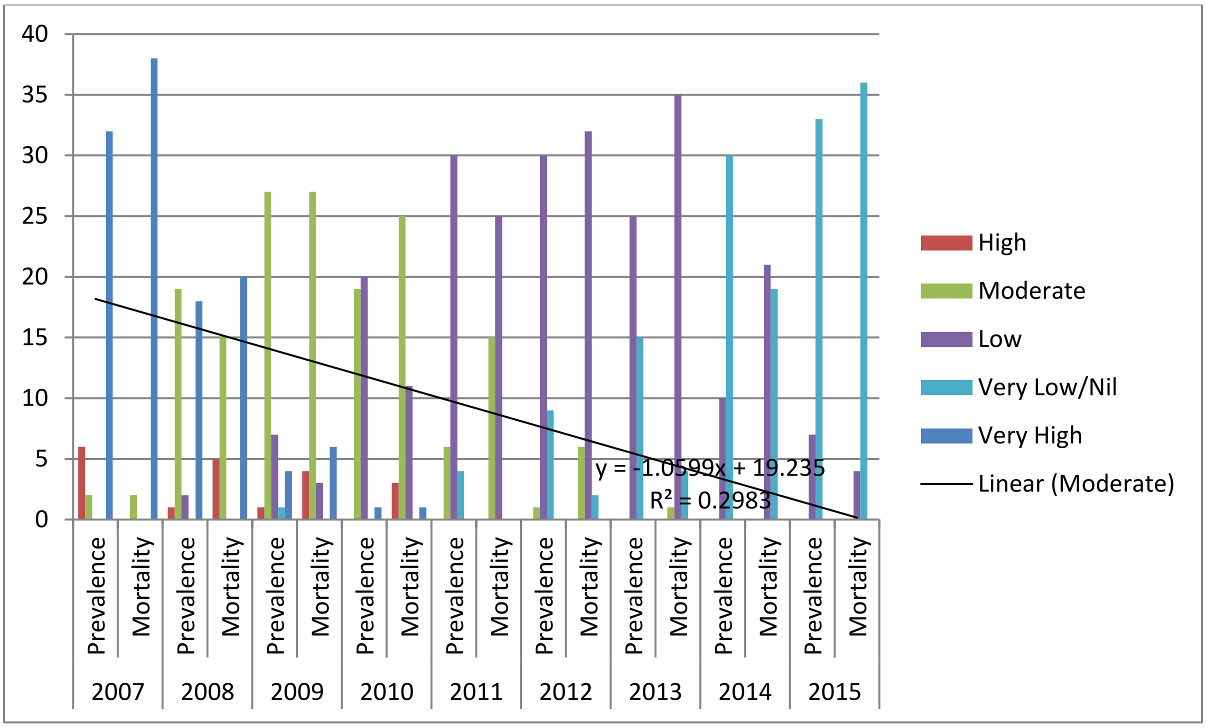
As can be seen from the figure above, in 2007 the was high prevalence, as we go on the prevalence reduces and we can see that from 2011, the prevalence ranges from moderate prevalence to very low prevalence and for 2013 going on to 2015 the prevalence was either low or very.

Graph 2 Showing the Survey Results/ EFC Mortality trends



The figure above shows that mortality was very high in 2007, but starts to reduce between 2008 and 2009 with at least moderate mortality being the highest. In 2011 going on to 2014 the mortality was between low and very low depicting reduced mortality. In 2015 there was low to no mortality as the mortality rate drastically reduced.

Graph 3 showing the survey results-ECF mortality trends and prevalence trends



Data collected through the survey were input into SPSS for analysis.

Using Rovai's approach (2002b) the mortality and prevalence indexes were calculated by summing the mortality and prevalence related survey questions respectively. The scale resulted in a reliability coefficient Cronbach's alpha of *.90*. As the widely accepted cut-off is that the alpha should be .70 or higher for a set of items to be considered a reliable scale (Garson, 2008; Mertler & Vannatta, 2004); this instrument can be considered reliable for measuring these variables.

Correlation and multiple regression analyses were conducted to examine the relationship between ITM use and (mortality and prevalence).

$$Y = a + bX$$

$$r = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{[\Sigma(x-\bar{x})^2(y-\bar{y})^2]}}$$

Multiple regression model with all predictors produced $R^2 = .2983$, N = 40, $p < .001$. As can be seen, the Analytic and Quantitative scales had significant positive regression, indicating Mortality and Prevalence with higher scores on these scales were expected to have reduced rate, after controlling for the other variables in the model.

The analysis implemented a Pearson's Correlation between (mortality and prevalence) index scores and ITM use related questions. The results showed a significant positive correlation between ITM use and Mortality*r = .324, p = <.001(n = 40)* and ITM use and Prevalence*r = .2983, p = <.001 (n = 40)*. The positive correlation between these variables suggests rate of mortality and prevalence was affected by ITM use.

The positive correlation between the learning index and students' investment in time and energy for the requirements of a course suggests that the more each student puts into the course, the more likely they are to learn and meet the course objectives as well as their own expectations. Similarly, the strong positive correlation between the learning index and students' active participation helps to show that participation in class discussions results in higher self-reported learning and the ability to meet the course objectives.

Number of cattle deaths out of ECF was significantly reduced in all the four sampled crush pens of the camp, this was due to increased usage of ITM. 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.

These results were in agreement with the results obtained by other researchers like; 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.

As a result of reduced mortality, there is increased income and protein intake among households.These results were in agreement with the results obtained by other researchers like Taracha and Taylor (2005),Homewood, K., Trench, P., Randall, S., Lynen, G. and Bishop, B. (2006) 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.

Production Constraints

The present studies have shown that Tick-borne Diseases (TBDs are the most important diseases that affect cattle production in Kwenje. This corroborates previous observations by Swai *et al*. (2007), Kivaria *et al*. (2007) and Chenyambuga *et al*. (2010) who reported that livestock diseases were ranked above the other production constraints. Shortage of pastures/grazing land and water especially in the dry season, and high price of veterinary drugs were important constraints to cattle production in the study area. Swai *et al*. (2005), and Chenyambuga *et al*. (2010) reported that the major cattle production constraints are diseases, shortage of forages and water during the dry season, expensive veterinary drugs and lack of livestock market.

The majority of livestock farmers were aware of ECF, but most of them considered ECF as not a big problem. The same observation was made by Chenyambuga *et al*., 2010 who reported that the farmers around Lake Victoria considered their breeds to be resistant to ticks and ECF, the reason given being that animals always carry ticks without getting sick. This is because adult cattle were regarded as tolerant to ticks and they can harbour a large number of ticks without being very much affected. Also, when the adult animal show signs of the disease the use of chemotherapy such as oxytetracycline can suppress the condition. This is in agreement with Chenyambuga *et al*. (2010) and Ocaido *et al*. (2005) who reported that many farmers attach little importance to ECF since it is considered a disease of calves for the reason that these are the ones that suffer most severely. Majority of the farmers in Kwenje knew different types of ticks (brown ear ticks, blue ticks and bont ticks), but they were not aware of the one which transmits ECF. They reported that ticks were abundant after rain season and that it is the time when most diseases also show up. This also was observed by Ndamukong (1993) who reported that large numbers of ticks, mainly *R. appendiculatus*, were active during the rainy season. The amount of rainfall is the principal stimulus to *Rhipicephalus appendiculatus* activity (Yeoman, 2007). The behaviour of active unfed ticks (questing) has been reported to be affected by many external factors of the environment and the physiological state of the ticks. *Rhipicephalus appendiculatus* activity is not only determined by season, but also hydration status of the tick is also the most important determinant factor.

Prevalence of Serum Antibodies against *Theileria parva* Infection

Seroprevalence studies are useful in establishing herd immunity, and therefore evidence of either the need for vaccination or for no intervention. The development of appropriate and effective control strategies for theileriosis is based on the concept of endemic stability (Kivaria *et al.,* 2007).

Prevalence of *Theileria parva* infection in cattle is useful information for determining the response of the animals to natural infection and the levels of endemic stability in the study area (Chenyambuga *et al*., 2010). Norval *et al.* (2009) describe endemic

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stability as the ecological balance between hosts, parasite, vector and environment in which all coexist with the virtual absence of clinical theileriosis. Endemic stability is characterized by a high (70%) seroprevalence but low incidence of theileriosis, and low theileriosis fatality rates (Norval *et al.*, 2009). Endemic instability on the other hand means an incomplete relationship in which clinical disease occur. Endemic instability is mainly found in the local Zebu cattle maintained under extensive management conditions with little or no efficacious acaricide application and where *R. appendiculatus* can undergo at least two generations annually (Norval *et al*., 2009). Under such condition greater numbers of cattle are reservoirs of *T. parva* at low levels of parasitaemia which is transmissible. Calves born in these areas become immune through natural infection before they are three months old and therefore little or no clinical disease occurs.

A total of 40 samples were tested for the presence of antibodies to *T. parva*. The seroprevalence for *T. parva* was less than 70%, suggesting that the cattle in Kwenje district exist in a state of endemic instability. Prevalence is usually low (63%) in the endemic instability state (Medley *et al*., 2007 and Perry and Young,2006). Endemic stability is likely to exist where the prevalence of serum antibodies to infection is equal or greater than 70% (Lynen *et al.,* 2009). Animals in endemic areas respond to *Theileria parva* infection by mounting humoral responses that decline over months in the absence of challenge.

The overall prevalence of antibodies to *Theileria parva* in Kwenje was 8.1%. The prevalence of antibodies to *Theileria parva* was not significantly different between the three age groups ($p > 0.05$). However, slightly higher seroprevalence was observed in the yearlings 9.6% compared to calves 8.2%. These observations suggest that calves, yearlings and adult animals are exposed to tick challenge at a low level so they do not maintain the immunity and sero-positivity. The observed low levels of seroprevalence in this study reflect low levels of exposure of the animals to ticks. When the seroprevalence show low seropositivity findings may provide an entry point for future disease control strategies such as acaricide application, vaccination (Maloo *et al*., 2001). Sometimes factors such as inherent resistance of cattle to ticks and tick-borne diseases, virulence of the pathogens and infection rate in ticks can also influence the results. A single cross-sectional study can only serve as an indicator of the probability of endemic stability because prevalence can vary with climatic conditions and over time.

Regarding the presence of antibodies in calves, it is not known whether they were acquired from colostrum or from infection acquired congenitally or after birth. The detection of antibodies to tick-borne disease pathogens in calves of less than three months is possible as at this age the passively transferred colostral antibodies are still in high in the serum of the young animals (Rubaire-Akiiki *et al*., 2004).

CONCLUSION

The purpose of this study was to assess the impact of the immunization of cattle against ECF using the infection and treatment method (ITM) in Kwenje Vet. Camp of Chipata district.

This research suggested that, prevalence and mortality due to ECF among the households were significantly reduced. The study reveals that the most important constraints to cattle production in Kwenje are livestock diseases, followed by shortage of forages and water during the dry season. Among the diseases, tick-borne diseases are the most important diseases that affect cattle production in the district. The majority of the farmers in Kwenje know that ticks cause diseases but they do not associate ticks with ECF. Most livestock keepers are aware of the disease symptoms of ECF

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