ECONOMIC IMPACT OF EAST COAST FEVER INFECTION AND TREATMENT: A CASE STUDY IN UASIN-GISHU AND NANDI COUNTIES.

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DECLARATION

This research project is my original work and has not been presented for examination in any other university.

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DEDICATION

To God Almighty, this far Lord, you have brought me.

To my dear husband, Dr. Ismail Thoya Ngoka, you have been a supportive spouse in my entire academic life, pushing me to put more effort.

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LIST OF ABBREVIATIONS

AIC –	Akaike Information System
ANOVA –	Analysis of Variance
AOR –	Adjusted Odds Ratio
CBPP-	Contagious Bovine Pleuropneumonia
CI –	Confidence Interval
DVS –	Director of Veterinary Services
ECF –	East Coast Fever
ECFIM –	East Coast Fever Infection Method
FMD-	Foot and Mouth Disease
ITM –	Infect and Treat Method
OR –	Odds Ratio
PE –	Participatory Epidemiology.
SDP –	Smallholder Dairy Project
SPSS –	Statistical Packages for Social Science.
UD-	Undefined

ABSTRACT

Kenya has a vibrant small-scale based dairy industry that plays an important economic and nutrition role in the lives of many people, ranging from farmers to petty milk traders ("hawkers"), processors, and consumers. However, the high incidence of tick-borne livestock diseases in Kenya is a major challenge to the dairy industry in the country. East Coast Fever (ECF) is one of these diseases, and the ECF Infection and Treatment Method (ECFIM) is one of the novel strategies that are being promoted to control ECF in Kenya. Various socioeconomic impact studies on ECF carried out by several scholars showed that immunization of beef cattle under farm conditions was profitable. However, no recent socioeconomic study of the ECFIM vaccine had been carried out to account for the changing social and economic environment. This study sought to fill the gap by examining socioeconomic aspects of ECFIM vaccine in high potential, dairy producing areas. The study evaluated the Knowledge, Attitude, Perception and Practices (KAPP) with regard to ECF and economic impact of ECF and ECF control by use of Infect and Treat Method in high potential dairy producing areas of Kenya. A cross sectional study of a sample of 330 randomly selected households from Nandi and Uasin Gishu counties shows that the mortality and cost of treatment were the most significant economic losses due to ECF diseases with a P-value of 0.005 and < 0.001 respectively. Regarding the KAPP, only 24.5 % of the respondents were able to correctly identify ECF symptoms. Households whose head had university education level and above were 2.44 times more likely to adopt ECF vaccine compared to those who had no formal education. ECF-vaccinating households realized an overall net economic return of Kshs 44,575 (about US$ 450) per cow per year while the ECF non-vaccinating households realized a net loss of Kshs 9,975 (about US$ 100) per cow per year.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Production of milk in Kenya is based on exotic cattle, indigenous cattle, goats and camels. The average productivity per cow in Kenya is estimated to be 5-7 liters per day, and the average production per lactation is between 1,500 liters and 2,100 liters (Kenya Dairy Board, 2008). In 2010, the national herd was estimated at 3.35 million exotic cattle, 14.1million indigenous cattle, 27.7 million goats, and 2.97 million camels. Cattle account for 88% of the milk produced while the rest comes from camels and goats (MOLD, 2010). The Government is committed to raising incomes in Agriculture, Livestock and Fisheries as envisioned in the Kenyan Vision 2030 (Vision 2030, 2008). This is being done through development of commercially oriented and modern livestock practices aimed at increasing productivity of livestock. Innovation and Commercial production of ECF vaccine is one such initiative.

At independence in 1963, Kenya inherited a system of disease control, which was based on availability of veterinary services from the colonial government. The services were supplied by both public and private veterinary personnel. The system gives the Director of Veterinary Services (DVS) power to control the spread of disease, mount campaigns to contain diseases and control movement of animals (Animal Diseases Act, 2012). However this system was expensive and difficult to sustain. Through reforms the government withdrew from provision of free services by mid 1990s.

Ineffective disease control and veterinary services, inefficient breeding services, inefficient dairy research, poor animal husbandry, inadequate extension and advisory services and inadequate feeding are among the key constraints that result in the low milk production in Kenya (National Dairy Development Policy document, 2010).

The diseases that hinder development of the dairy industry in Kenya include contagious bovine pleuro-pneumonia (CBPP), east coast fever (ECF), foot and mouth disease (FMD) and trypanosomosis. The Government has put in place a National Livestock Policy, which has provided direction for the delivery; management and funding of veterinary services and disease control (Sessional Paper no 1 of 2010 on the National Dairy Development Policy).

Among the diseases that constraint dairy development are tick borne diseases, mainly ECF. These diseases are costly for the dairy industry in Kenya. Since the government withdrew from the management of dips, the performance of community-based dips has been declining due to poor management and low adherence to acaricide use guidelines. To battle the tick borne diseases, some dairy producers have resorted to individual spraying of their animals, using ineffective spray pumps. The Cattle Cleansing Act (CAP 358) emphasizes regular dipping as a requirement for tick control. Legislation providing sanctions exists, but it is rarely enforced on those who do not control ticks on their animals. The same applies to livestock movement restrictions that are often ignored. This results in increased tick burden and disease pressure for dairy farmers, especially in the case of ECF which is a major cattle disease in Eastern, Central and Southern Africa.

1.2 Problem Statement

In Kenya, East Coast fever (ECF) is one of the major diseases that pose a significant threat to the cattle livestock sub- sector due to its high morbidity and mortality, resulting in production losses in all production systems. The etiological agent of ECF is a protozoan parasite called *Theileria parva*. ECF is widespread in 11 countries in East, Central and Southern Africa. It is transmitted to cattle through the bites of the tick *Rhipicephalus appendiculats* (Merks Manual, 3rd edition 1997). East Coast fever prevents the introduction of the ECF susceptible but more productive exotic breeds of cattle to ECF endemic regions. This hampers the development of the livestock sector considerably.

Tick control is conventionally done by use of acaricide. However, this method of control has become less effective because of, poor management and maintenance of dips, the development of acaricide resistance, and uncontrolled cattle movements. Tick resistance to acaricide poses an increasing threat to livestock production in many countries because of heavy dependence on acaricide for tick control. Resistance has led to instability and increased costs in areas where the one host cattle ticks *Boophilus microplus*_and_*B. decoloratus* have acquired resistance to a variety of toxic chemicals. The costs of the measures taken to control ticks cause a financial burden to dairy farmers. The costs of acaricide application, which is the primary means of tick control, is estimated to range between US$13 and US$20 per adult animal in Kenya (MOLD, 2012). Gachohi et al. (2012) found out that economic losses due to ECF disease are concentrated on small-scale resource-poor households.

Apart from the conventional ECF control methods; tick control and chemotherapy, an alternative control strategy through immunization has been available for decades. The strategy, known as the infection-and-treatment method, involves inoculating live Theileria parva parasites into an animal while simultaneously treating the animal with a long-acting antibiotic. This combination provokes in the immunised animal a mild reaction to the parasite infection and development of immunity to further infections. This immunity lasts up to three years in the absence of further tick infestations; the immunity is life-long immunity if ticks continue regularly to challenge the immunised animal. This strategy to tick control based upon immunization and controlled exposure to ticks through strategic acaricide use is being implemented in various counties in the country, including Narok, Bomet, Kericho, Meru, Trans- Nzoia, Uasin Gishu, Nandi and Baringo counties. This strategy is called the Infection and Treatment Method (ITM).

Irvin (1984) established that the Infect and Treat Method (ITM) of immunization developed in the mid-1970s has some limitations such as the need for a cold chain, its high cost and concerns of safety. These sentiments are still being raised by the livestock stakeholders in the year 2014. Mutugi et al (1988) have documented why the Kenya Government was reluctant to sanction extensive field use of the method between 1967 and 1977. They cite the following concerns by the government:

i. Immunized cattle might show a reduction in productivity,
ii. Insufficient information was available on the various *Theileria parva* parasites prevalent in the country.
iii. Immunized animals might become carriers and thus introduce alien strains of parasites into previously uninfected regions of the country,

iv. Infection-and-treatment immunization method might be impractical and/or unsafe.

Several socioeconomic impact studies on ECF have been carried out by several scholars. Mukhebi (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 allowed a reduction in acaricide use from a frequency of twice a week to once every three weeks. Marsh (2012) found that the vaccination program against ECF was beneficial to the farmers. The findings showed that East Coast fever Infection and Treatment Method (ECFIM) vaccine provided positive benefits to average livestock-owning households due to increased milk production and lower calf deaths, including savings on tick and antibiotic treatments. However, no recent socioeconomic study of the ECFIM vaccine has been carried out to account for the changing social and economic environment.

In addition, the Marsh (2012) study may not reflect the benefits of the vaccine in the dairy high potential areas. The current study sought to fill the gap by examining socioeconomic aspects of ECFIM vaccine in high potential, dairy producing areas. Nandi and Uasin Gishu were used as a representative for the Rift Valley high potential dairy producing areas. The study also sought to identify constraints encountered in the uptake of the ECFIM vaccine by small holder dairy farmers.

1.3 Broad objective of the study

The broad objective of the study was to assess the adoption and socioeconomic gains of ECF control by use of Infection and Treatment Method in high potential dairy producing areas of Kenya.

1.4 Specific Objectives of the study

The specific objectives of the study were:

1. To establish the Knowledge, Attitude, Perception and Practices (KAPP) of the communities with respect to ECF disease.
2. To assess the economic losses of ECF disease and gains from ECF control by use of Infect and Treat Method at household level.
3. To asses factors that influence ECFIM adoption at household level.

1.5 Hypothesis

The working hypothesis of this study is that communities in high potential dairy producing area have the knowledge, positive attitude and the correct perceptions and practices with respect to ECF and its management. Further, these communities are highly aware of ECFIM and that investments in the programs of vaccination of dairy animals have positive returns at the farm level.

CHAPTER TWO: REVIEW OF LITERATURE

2.1 Dairy Production in Kenya

Kenya's dairy industry is dynamic and plays an important economic and nutrition role in the lives of many people, ranging from farmers to milk hawkers, processors, and consumers. In Kenya, two main types of cattle are kept for milk production and other purposes. These are the exotic breeds and their crosses, collectively referred to as dairy cattle, and the indigenous zebu cattle.

Kenya has one of the largest dairy industries in sub-Saharan Africa. A survey conducted by the Kenya National Bureau of Statistics (2009), asserts that there are approximately 5,311,800 dairy cattle in Kenya. Thorpe (2000) attributes the success of dairy production by smallholders to the presence of a significant dairy cattle population, the importance of milk for most Kenyan communities, a suitable climate and an enabling policy and institutional environment.

Bebe (2003) lists major challenges in the dairy industry as poor rural infrastructures, high prevalence of tick borne diseases, reliance on rainfall for production and the poor milk markets. Other challenges in the dairy industry are due to the small amount of milk output per farm this being 10kg per day.

Despite recorded successes of the dairy industry in the country, the high incidence of the tick borne disease as a challenge has not been given the required prominence in terms of studies to identify constraints in adoption of ECFIM. Previous studies clearly indicate that there is a positive return at the farm level in using ECFIM but the adoption remains at a very low level. These studies do not identify the causes of the low adoption rates.

2.2 Tick Borne Diseases

Tick-borne diseases exert their greatest impact in the tropical and subtropical regions of the developing world. De Castro (1997) estimated the annual global costs associated with ticks and tick-transmitted pathogens in cattle amounted to between US$ 13.9 billion and US$ 18.7 billion. Young (1988) found out that tick-borne diseases are economically the most important animal disease problem in Africa. Among these tick - borne diseases are babesiosis, bovine anaplasmosis and East Coast fever.

Babesiosis, or tick fever, is a febrile disease of domestic and wild animals characterized by extensive erythrocytic lysis leading to anaemia, icterus and haemoglobinuria, which can be fatal. The disease is caused by protozoan parasites of the genus Babesia transmitted by a variety of tick species (Merck Veterinary Manual, 3rd Edition, 1997).

Bovine anaplasmosis is an infectious, non-contiguous haemotropic disease of cattle characterized in the acute form by fever, anaemia, weakness, constipation, yellowing of the mucous membranes, lack of appetite, depression, dehydration, and laboured breathing. Animals surviving an acute attack often make a slow recovery, resulting in losses in milk or meat production. Generally, mortality is between 5 and 40 per cent, but may reach 70 per cent during a severe outbreak. The causative agent, *Anaplasma marginale*, may be biologically transmitted by 20 or more species of ticks and may also be mechanically transmitted by a variety of biting fly species, particularly horse flies of the family *Tabanidae* (Merck Veterinary Manual, 3rd Edition ,1997).

2.3 East Coast Fever Disease

Among the tick borne diseases, East Coast Fever is of the most economic concern.

According to the 3rd Edition of Merck Veterinary Manual (1997), East Coast fever is an acute disease of cattle and is characterized by high fever, swelling of the lymph nodes, dyspnea, and high mortality. It is caused by *Theileria parva* and is a serious problem in East and Central Africa. The pathogen is trans-stadially transmitted by the brown ear tick, *Rhipicephalus appendiculatus*. East Coast fever is by far the most economically important tick-borne disease in Kenya as documented In the Epidemiology of Ticks and Tick borne diseases in East, Central and Southern Africa workshop proceedings 1996 (Irvin *et al* 1996).

2.4 Economic Analyses of Animal Diseases

Various agricultural economists have carried out impact assessment of animal health interventions. According to Ababneh (2003), research in this field primarily deals with three interrelated aspects:

I. Quantifying the economic effects of animal diseases.
II. Developing methods for optimizing impacts when individual animals, herds or populations are affected, and
III. Determining the profitability of specific disease control and health management programs and procedures.

Pritchett (2005) in his assessment states the immediate impacts of a disease outbreak as a reduction in the productive capacity of the animal and a subsequent reduction in the supply of the animal products. Bennett (2003) states that disease presence in a herd results in lower output (e.g. lower milk yields than expected) and higher levels of input use (such as more veterinary inputs). He defines the cost of disease as:

C = L + R + T+P

Where C = cost

L = Value of the loss in expected output due to the presence of a disease.

R = Increase in expenditures on non-veterinary resources due to a disease e.g. hiring extra labor to take care of the diseased animals.

T = The costs of inputs used to treat disease.

P = The cost of disease prevention measures.

Bennet (2003) cites indirect impact as impact on human health, animal welfare and international trade. The majority of impact assessment studies evaluate, in financial or economic terms, the efficiency of the development and extension of technologies using profitability measures. In the financial valuation, the benefits and costs are valued on the basis of market prices unadjusted for distortions; in the economic valuation, prices are adjusted to reflect the economic values of inputs and outputs (Bennet 2003).

Alston (1998) describes the benefit-cost method of analysis as a variant of the consumer-producer surplus method. In this method, the economic surplus changes may not be explicitly measured, but economic surplus calculations are implicitly incorporated when internal rate of return, net present value or benefit- cost ratios are calculated to place a value on the extra output or the inputs saved (cost reduction) because of the technology use.

Otte and Chilonda, (2000) state that the choice of the analytical method to be used in impact assessment depends on data availability, the objectives of the research and/or the nature of the problem (the complexity of the problem), the timing of the study and the availability of resources (such as time, money and analytical tools).

2.5. ECF and Economics of Animal Disease Control

Otte *et al* (2000) classify the effects of the disease as direct and indirect effects. The direct losses may occur when disease destroys the basic resource of the livestock production process (mortality of breeding or productive animals), lowers the efficiency of the production process and the productivity of resources employed (e.g. reduced feed conversion), and reduces the quantity and/or quality of output. The indirect losses include additional costs incurred to avoid or reduce the incidence of the disease, detriment to human health well-being through revenue foregone as a result of denied access to better markets and sub-optimal exploitation of otherwise available resources through forced adoption of production methods which do not allow the full exploitation of the available resources.

Bennett (2003) states that the presence of a livestock disease may have an effect, not only on production, but also on both output and input prices. For example, if the majority of producers adhere to the programs of disease control, the output supplied in the market increases and, as a result, the price of the product in the market may decrease.

Mukhebi (1989) noted that the direct ECF production losses can be attributed to morbidity and mortality. Berkvens (1989) estimated 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%.

Animals which recover from ECF may suffer from weight loss, produce low milk output, provide less draft power and possibly suffer from reduced fertility and delays in reaching maturity. In addition, recovered animals also remain carriers and can spread infection (Brown 1985).

Callow (1983) found that many farmers are therefore constrained from utilising improved genotypes and improving livestock productivity and efficiency in areas that are endemic to ECF. In the affected areas, farmers face a substantial risk if they try to keep exotic and crossbred cattle due to their high susceptibility to the disease.

Indirect production losses due to ECF occur when the disease acts as a constraint to the use of improved cattle. Other costs include tick control costs, losses incurred whilst driving animals through dip tanks from stress-induced abortions, drowning and physical injury. The constant trekking of animals to dip tanks often creates gullies and the frequent concentration of animals around the tanks leads to overgrazing, both of which cause erosion and environmental degradation, thus further contributing to indirect costs.

Nyangito *et al* (1996) found out that ECF immunization as a strategy is financially and economically viable for small scale farms in Kenya. The most preferred strategy was to adopt vaccination and combine it with a 75% reduction in acaricide use.

Muraguri et al. (1998) developed and used a spreadsheet model to estimate the total cost of immunizing cattle against ECF based on the infection-and-treatment method. Using data from an immunization trial carried out on 102 calves and yearlings on 64 farms in the Githunguri division, Kiambu district, Kenya, a reference base scenario of a mean herd of five animals, 10% rate of reaction to immunization and a 2-day interval monitoring regimen a total of 10 farm visits was simulated. Under these conditions, the mean cost of immunization per animal was US$16.48 (Kshs 955.78), which was equivalent to US$82.39 (Kshs 4778.90) per five-animal farm.

Musaba (2010) conducted a study to examine the socio-economic determinants of adoption of improved livestock management practices among communal livestock farmers in northern Namibia. Ten livestock management practices were disseminated to farmers. Five management practices were adopted; castration and vaccination were the most adopted while dehorning, feeding cut crop residue and livestock marketing were the least adopted. A regression analysis indicated that adoption of livestock technologies increased with education, off-farm income, farmer training in animal health, and a farmer residing near extension offices.

Another study to analyze the impacts of a vaccination program for ECF in the Maasai ecosystem of southwestern Kenya and northeastern Tanzania revealed that when the vaccine was provided on a commercial basis, poorer livestock keeping households vaccinated a smaller proportion of their calves and immature animals (30–34%) than wealthier households (up to 90%). In households that vaccinated, the extent to which they were able to take advantage of this technological advance was strongly determined by wealth, both in terms of herd size, but most importantly in terms of access to alternative and secure forms of income.

In poor pastoralist's households, access to the benefits of vaccination was deemed prohibited by the cost of vaccination which exceeded the means of the poor pastoralist households. In addition, the vaccine was provided in 'straws', influenced the odds of adoption each of which was diluted in the field to 32–35 doses, which were then required to be administered right away. In this extensive pastoralist system, with isolated homesteads scattered over a wide area, poor transport and communications, and erratic veterinary attendance, only large scale operators can gather the necessary numbers of calves for vaccination at one place and time. It is difficult for smaller producers to coordinate enough individual herd owners with a few calves each to achieve this, rendering the overall cost higher and the feasibility of adoption lower (Homewood *et al.* 2006).

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Description of Study Areas

3.1.1 Introduction

This study was undertaken in Uasin Gishu and Nandi counties of Kenya. The counties show some variability in that Nandi is a tea growing area with dairy farming while Uasin Gishu is a maize growing area that also practices dairy farming.

3.1.2 Uasin Gishu County

Uasin Gishu County covers an area of 3,327 sq km of which 2,995 sq km is arable land, 332.78 sq km is non-arable land (hilly and rocky), 23.4 sq km is water mass and 196 sq km is urban. Rainfall averages from 900mm to1200mm per annum with its peak in May and October. Temperatures range from 8.4^{o} C to 26.2^{0} C .Vegetation ranges from open grassland, with scattered acacia trees, to natural highland forests and bush land. The county has three agro ecological zones namely lower highland, upper highland and upper midland zones. Administratively, it is divided into; Turbo, Moiben, Ainabkoi, Wareng, Kesses and Kapsaret sub-counties. The sub-counties act as extension units where activities for livestock and crop production are planned and implemented. (Uasin Gishu County Integrated Development Plan 2012 -2017).

Uasin Gishu County has a human population of 894,179 people and 167,887 households (NPC, 2009). The average farm size in the county ranges between 2-10 acres. There are 375,287 dairy animals in the county of which 81,838 are high grade. The county also has 93,611sheep, 27,216 goats, 140,703 exotic birds and 400,000 local birds and 7,292 pigs. (Ministry of Livestock Development, 2013)

The study coverage in Uasin Gishu County includes Kaptagat, Strawback and Plateau locations in Kaptagat ward. Figure 1gives a map of Uasin- Gishu County.

Figure 1: Map of Uasin Gishu County

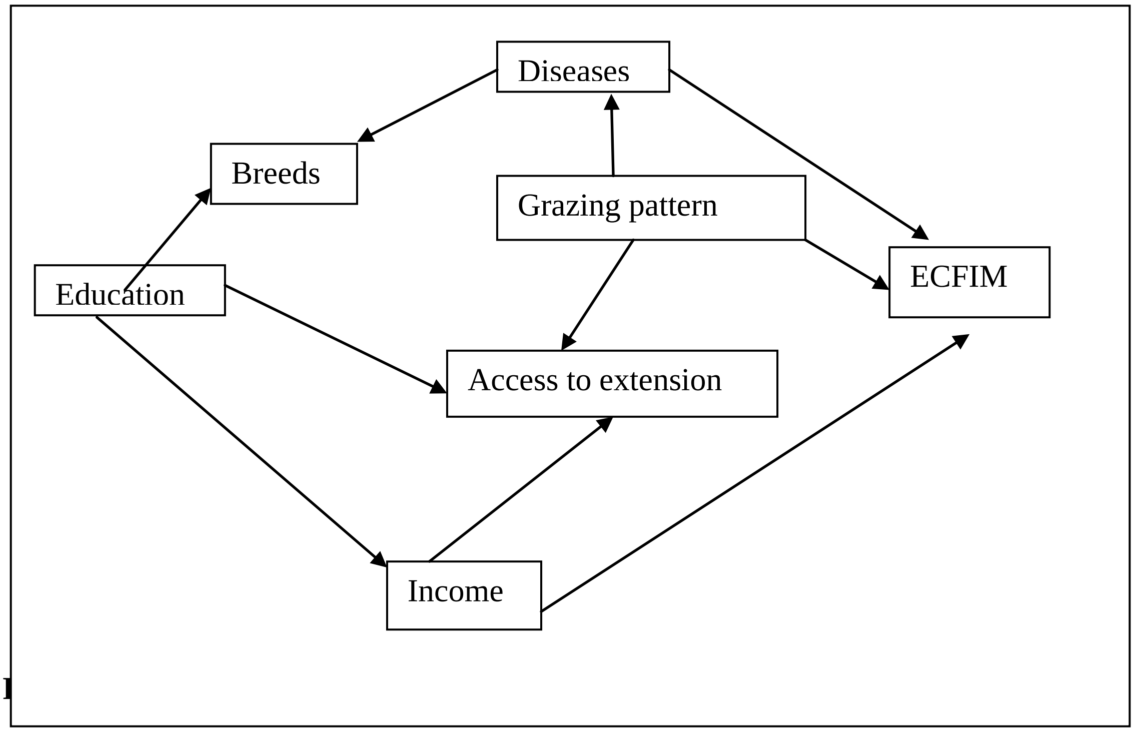
3.1.3 Nandi County

Nandi County covers 2,884 square kilometers and has 5 sub-counties namely Emgwen, Chesumei, Nandi- Hills, Tinderet, Aldai and Mosop. The average rainfall in the county ranges from 1,200 to 2,000mm per annum and is well distributed throughout the year. The county has a human population of 813,803 people with the average population density being at 286 per kilometer square. The total livestock population is 309,038 animals distributed as follows: sheep 121, 459, goats 46,669 and cattle 62,459 (Uasin Gishu County Development plan 2012-2017) In Nandi County the study covered Tinderet, Tanykina, Kapsabet, Lessos and Lelchego administrative locations. Figure 2 gives a map of Nandi County.

Figure 2: Map of Nandi County.

3.2 Conceptual Framework

Figure 3 presents a conceptual framework of factors that affect adoption of ECFIM by households in the study area.



small holder households.

Source: Author's work (2013)

3.2.1 Conceptual and Analytical Framework

The evaluation of economic benefits of a new agricultural technology consists of comparing the benefits in the situation with the particular technology to a counterfactual situation that represents what would have occurred without the technology, the two scenarios being what are known as the "with" and "without" situations. The difference is the incremental net benefit due to investment in the technology (Gittinger 1982; Alston et al. 1998). For this particular study, the "with situation" is represented by a situation where the ECFIM vaccine is used for ECF control and, in the "without situation", no vaccine is used. Effective control of ECF increases the efficiency of resource use in the affected population, through avoidance of cattle mortality due to ECF, and consequently shifts the supply curve for dairy cattle outputs to the right. The ECFIM vaccine can be considered a productivity-enhancing technology, and as a result of its use, the consumer and producer surpluses change.

According to Bennett (2003), three basic types of information are required to be able to quantify the benefits of disease control: (i) the disease incidence; (ii) the magnitude, incidence and distribution of disease effects, and (iii) the treatment and/or prevention measures undertaken. To compute the cost of the ECF disease, the following formula was applied following Bennet, *et al* (2003):

C = L + R + T+P ………………

Where;

C = cost of ECF disease

L = Value of the loss in expected output due to the presence of ECF –opportunistic cost in favor of treating the ECF disease (assumes that the percentage milk loss due ECF is equivalent to the opportunistic cost)

R = Increase in expenditures on non-veterinary resources due to presence of ECF e.g. hiring extra labor, transport costs, reporting costs to authorities to take care of the diseased animals).

T = The costs of inputs (veterinary products and consultations) used to treat disease.

P = The cost of disease prevention measures (vaccination, spraying, dipping).

A Binary Logit Regression Model is a modification of multiple regression equation that analyses data when there is binary outcome of interest. It was used to determine the effect of the explanatory variables on whether a herd has received ECFIM vaccine in the study area. Binary Logit Regression Model gives the maximum likelihood estimates. The dependent variable is a binary variable representing a household that has adopted ECFIM (1) and a household that has not adopted ECFIM (0). Independent variables included in the model are grazing patterns, farmer's knowledge on ECF disease and its management, the decision maker and the level of education, and whether the household's herd is at risk of getting ECF or not (Table 1).

Following Gujarati (2007), the model was specified as:

$$P_i = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1+e^{-(\beta_1+\beta_2 x_i)}} \quad \text{………….. (Equation 1}$$

Where:

P_i Is the probability that a herd has received ECF, given X_i a set of the explanatory variables/ parameters to be estimated. For ease of exposition equation 1 can be written as

$$P_i = \frac{1}{1+e^{-z_i}} = \frac{e^z}{1+e^z} \quad \text{………………………………….. ... (Equation 2)}$$

Where $Z_i = \beta_1 + \beta_2 X_i$

Equation 2 represents what is the cumulative logistic distribution function. In this equation P_i is non-linearly related to Z_i. If the probability (P_i) of adopting the ECF vaccine is $\frac{e^z}{1+e^z}$ then probability of not using the technology is $1-P_i = \frac{1}{1+e^z}$

Therefore

$$\frac{P_i}{1-P_i} = \frac{1+e^z}{1+e^{-z}} = e^{z_i}$$

$\frac{P_i}{1-P_i}$ Is the odds ratio of adopting ECFIM

Taking natural logs of equation 2 we obtain

$$L_i = \ln \frac{P_i}{(1-P_i)} = Z_i = \beta_1 + \beta_2 X_i$$

Where L_i is called Logit hence the name Logit model

X_i is a vector of explanatory variables derived from household surveys with β as the corresponding regression coefficients.

3.2.3 Factors hypothesized to influence farmer's adoption of ITM

Table 1 defines the explanatory variables which were hypothesized to be influenced by the adoption of ITM vaccination programme.

Table 1: Definition of Explanatory Variables

Variable	**Description**	**Measurement**	**Effect**
Grazing Patterns	Whether animals graze or pass through this area	Yes = 1 / No = 0	+
Origin of animals introduced into the herd	Where do they come from and if ECF is endemic	Within area = 1 / outside = 0	+
Tick Population	Whether they pose tick borne disease risks	Yes = 1 / No = 0	+
Indigenous ECF treatment	Whether respondents do administer traditional treatment for ECF	Yes = 1 / No = 0	_
Access to ticks and Tick-borne Diseases Information	Ever heard information on ticks / tick control	Yes = 1 / No = 0	+
Methods of Tick control	Tick control methods	Vaccination = 1/ otherwise = 0	+/_
Household's Head Education level	Head of household	Post-Secondary= 1 / Otherwise = 0	+
Respondent's Knowledge on ECF	Whether respondents would be able to identify ECF	Yes = 1 / No = 0	+
Previous Household Exposure to ECF	Whether ECF disease has ever affected cattle	Yes = 1 / No = 0	+

Grazing Patterns (GRAZ): In Uasin Gishu and Nandi counties, there are two types of grazing patterns, the zero grazing and the free range. Zero grazing is normally practiced in the urban and the peri-urban areas where the land sizes are limited to ¼ an acre to 1 acre compared to the rural areas where land sizes are at least 3 acres to 20 acres. In free range grazing patterns animals freely move from one area to another in search of pasture and water and can easily mix with others that are infested with ECF infected ticks. On the other hand zero grazed units have low exposure risks to ticks infected with ECF except through cut pasture. In addition, zero grazed units could also belong to farmers who are more educated, raise high value animals and were ready to pay for vaccination in order to protect the animals from ECF. This means that farmers whose animals are in free range grazing system have a higher chance of adopting ECFIM due to the higher chance of contracting ECF disease. This effect could either be positive for free range or negative for zero grazed units.

Origin of new animals in the herd (COMFRM): Households that introduce animals into the herd from ECF endemic areas have a higher chance of ECFIM adoption compared to animals that come from non endemic ECF areas. However since ECF is endemic in the study area, regardless of whether the animals being introduced are from endemic or non endemic areas there is more likelihood of animals from non endemic areas can easily come down with disease hence the households will adopt ECFIM to protect the naïve herd.

Tick Population (TICKPOP): Tick population is highly influenced by the type of tick control practices employed by the households in the study area and the effectiveness of the acaricide used in the study area. There has been a rising concern of ticks in the area being resistant to the acaricide being currently used in the study area, hence a higher tick population. This means there is a likelihood of more households easily adopting the ECFIM, hence a positive effect.

Indigenous ECF Treatment (TradECF treatment): Indigenous ECF treatment is normally practiced by the households in the rural locations of the study area. Households that practice indigenous ECF management are less likely to adopt ECFIM due to scarcity of resources hence a negative effect.

Access to tick and tick-borne disease control information (ECFInfo): Households with access to tick and tick-borne control information are aware of the adverse effects of ECF disease and its related production loses hence are able to easily relate to the benefits of adopting the ECFIM.This is a positive effect.

Tick Control Methods used by the Households (Tick Control Methods): There are various methods of tick control used by the households in the study areas. These include but not limited to spraying, dipping and hand picking of ticks. Households that find these methods effective are less likely to adopt ECFIM.This is a negative effect.

Household's Head Education Level (HHEduc): Most decisions in the household are made by the head of the household including livestock management decisions. The education level of the household head greatly influences his ability to make economically logical decision regarding adoption of ECFIM.If the head has attained post secondary education then they are able to understand basic production losses in relation to tick borne diseases .

In addition these educated households have supplementary income in addition to livestock produce revenue and hence have a high purchasing power of the ECFIM vaccine as compared to resource poor uneducated household heads. This is a positive effect.

Farmer's Knowledge on ECF disease: The ability of farmers in the household to recognize symptoms of ECF disease and its accompanying losses greatly affects the farmer's willingness to adopt the ECFIM vaccine. This is a positive effect.

3.2.4 Partial Budget Analysis Economic Model

This is a qualitative analytical model that was used to estimate the returns for the adoption of ECFIM vaccination programme in the household's farm management practices. To analyze this, the following variables were calculated

1. The extra returns expected from the adoption of the ECFIM vaccine. These are also known as *extra revenue.* In our research study our main interest is the milk production increase and the accruing monetary value.
2. The *extra costs* that are incurred by the ECFIM adopting households such as costs for the ECFIM vaccine, labor required during the vaccination process.
3. The costs that were no longer incurred by the households that had adopted the ECFIM vaccine. These were *costs saved* on ECF treatment and related costs on labor, transport, consultation, and acaricide costs.
4. The present income that was sacrificed, *revenue foregone* which is zero in our case.

From the above model, the total gains were calculated as *(1+3)* and the total loss will be *(2+4).*The net gains for ECFIM vaccine adoption were then calculated as *(1+3)-(2+4).*

3.3 Data and Data Collection

Both qualitative and quantitative data were collected from primary and secondary sources. The primary sources included participants and non - participants of the vaccination programme, and the specialists who were implementing the programme including the vaccine distributors. The primary data were collected through sampled household survey while secondary data were collected from published and unpublished sources.

Formal sample survey was done to collect primary data. The formal survey was also supplemented by informal survey with an aim of collecting pertinent baseline information. In the informal survey group discussion and key informant interview was held using a checklist. The household survey questionnaire had seven sections; *General information, Herd size, Production system and management, Animal Health Data, Effect of ECF on productivity, Extension and Training, Tick-borne disease prevention and treatment and Socioeconomics of ECF prevention and treatment*. Ten questionnaires were pretested in Kapsoya location to endorse new information before the formal survey was carried out. Then the questionnaires were administered by enumerators from the study sites who could translate to local dialect (Nandi) to collect pertinent data on farmers' bio data, livestock population, production systems, Knowledge, Attitude, Perception and Practices to ECF and economic data.

3.4 Sample Size

A total of 1,362 households in the 2 counties had vaccinated their herds against ECF. The sample size was determined using the following formula based on Dohoo, et al 2003:

$$\text{Sample Size, } n = \frac{\left(Z_{\alpha/2}\right)^2 pq}{L^2}$$

Where Z_α = (α = 0.05 at 95 % confidence interval)

p = 0.5 (assumes that 50% of all the animals in any given farm are vaccinated against ECF)

$q = (1 - q)$

L = 0.05 (one - tail test of hypothesis)

Therefore n= 1.96 $^{2\times}$ 0.5 ×0.5/ (0.05)^2

So n= 384.

$$\text{Therefore adjusted n, } n' = \frac{1}{\dfrac{1}{n + \dfrac{1}{N}}}$$

$$\text{Hence } n' = \frac{1}{\dfrac{1}{384 + \dfrac{1}{1362}}}$$

= 299

= 300 households.

The sample animals were allocated proportionally to the size of the vaccinated population of animals across the two counties.

3.5 Sampling Procedure

The sampling frame of the study was the list of households that had vaccinated against East Coast Fever disease. A multistage sampling procedure was adapted. First, the sub-counties in the 2 counties that have the highest population of ECFIM vaccinations were selected. From the sub counties with the highest ECFIM vaccination numbers, the locations with the highest number of households that had vaccinated against ECF were selected. The households in these locations were taken as the sampling units. Within the county, sub counties and divisions were purposively selected. Subsequently, villages in the division with the most number of vaccinating households were selected. The households in these villages were randomly selected and grouped into vaccinating and non- vaccinating households. All the key informants were purposively selected.

3.7 Data Processing and Analysis

The data collected were edited, validated and coded. All the questionnaires (100%) were edited to ensure that the answers provided are in relation to the questions asked. The second step of verification of data, had ten percent of the respondents called back to check whether the original answers given during the interview were valid by presenting different but related questions to the one in the questionnaire.

The next step was to convert the observations and the answers provided in the questionnaire into codes. A data coding sheet was then prepared. Data from the questionnaires were entered into a computer using Epidata program. Epidata Entry program has an in- built error detection features such as double entry verification. All the data were analyzed using SPSS™ software. This program has a data editor that provides a convenient, spreadsheet-like method for creating and editing data files. Each code was then given a value and the analysis done using SPSS^{TM} syntax.

3.8 Methods of Data Analysis

3.8.1 Univariate Analyses: This is the simplest form of quantitative analysis was carried out with the description of a single variable in terms of the applicable unit of analysis. Statistical analyses began with descriptive statistics of continuous (means and standard deviations) and categorical (proportions) variables.

3.8.2 Bivariate Analysis: Analysis of factors associated with the dependent variable (adoption of ECF) commenced by performing bivariate analysis. Pearson's chi-squared test was used to determine the association between the dependent variable (adoption of ECFIM vaccine) and independent variables. This process assisted in identifying potential confounders and effect modifiers. Analysis of Variance (ANOVA) test was used to determine if there was difference in the cost of expenditure for those who vaccinated and those who did not vaccinate. Odds ratio (OR) and 95%CI was used to estimate the strength of association.

3.8.3 Multiple regressions Analysis: The results of the bivariate analyses were used in multivariable statistical regression models for a more thorough exploration of the dependent variable. Potential confounders and effect modifiers were tested using Binary logistic regression models on the dependent variable. All independent variables with significant association at bivariate analysis were considered together in multiple using Binary logistic regressions. Adjusted odds ratio (AOR) and 95%CI were used to estimate the strength of association. This procedure assisted in determining independent predictors (factors) of ECFIM vaccine adoption.

The dependent variable took a value of 0 for not using ECFIM and 1 for the adoption of ECFIM.

The log odds of the probability that a household is willing to adopt ECFIM vaccine is given by:-

$\log(P_i) = Z_i = \alpha + \beta_1 X_1 + B_2 X_2 + ... + B_k X_k$ ………………. (Equation 1)

The empirical model is specified as in (3) as follows

$\mathrm{ECFIM} = \beta_1 \mathrm{age} + \beta_2 \mathrm{education} + ... + \varepsilon$ ……………… (Equation 2)

3.8.4 Model Diagnostics: The models were compared using the Akaike Information Criterion (AIC) which measures the goodness of fit and complexity of the model. The preferred model was the one with the minimum AIC value. Given by;-

$$\mathrm{AIC} = -2\ln(L) + 2k$$

Where L is the maximum likelihood value, k is the number of free parameters in the model and $2k$ refers to a penalty that is an increasing function of the number of estimated parameters in the model.

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter presents the findings of the study. A total of 330 homesteads were interviewed of which 289 (87.6%) were from Nandi County and 41 (12.4%) were from Uasin Gishu County as shown in figure 4.

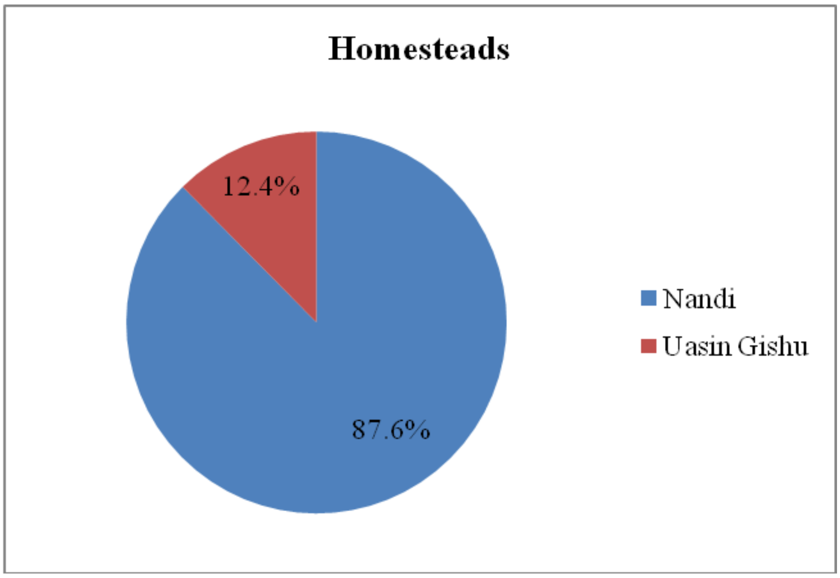


Figure 4: Homesteads adopting ECFIM

This disparity was due to the differences in the information that was gathered during phone interviews with the field extension officers and the research findings in the field. It was found out that there were more vaccinated animals in Nandi County as compared to Uasin Gishu County.

4.2 Types of cattle enterprises and cattle types

Figure 5 and 6 profiles the types of cattle and cattle enterprises found in the 2 counties.

Herd size, production system and management

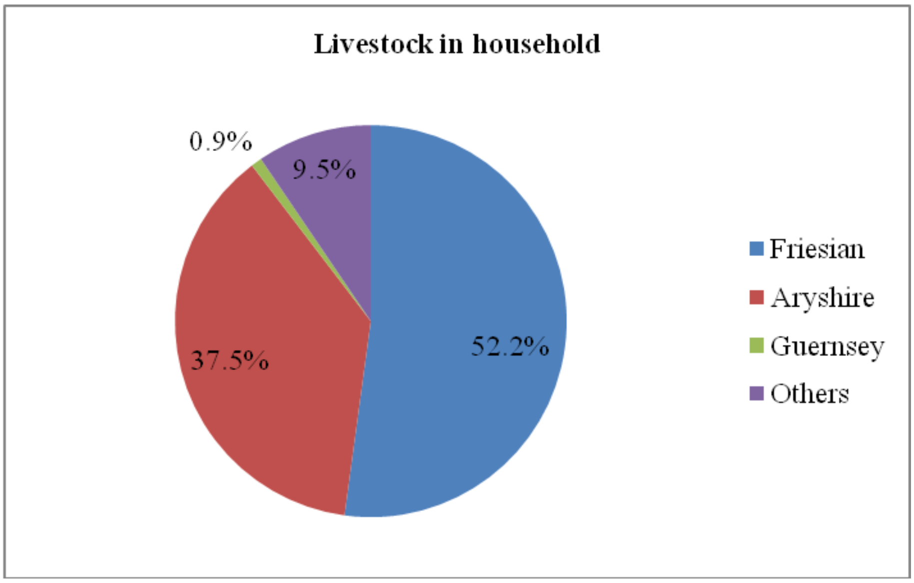


Figure 5: Livestock in household

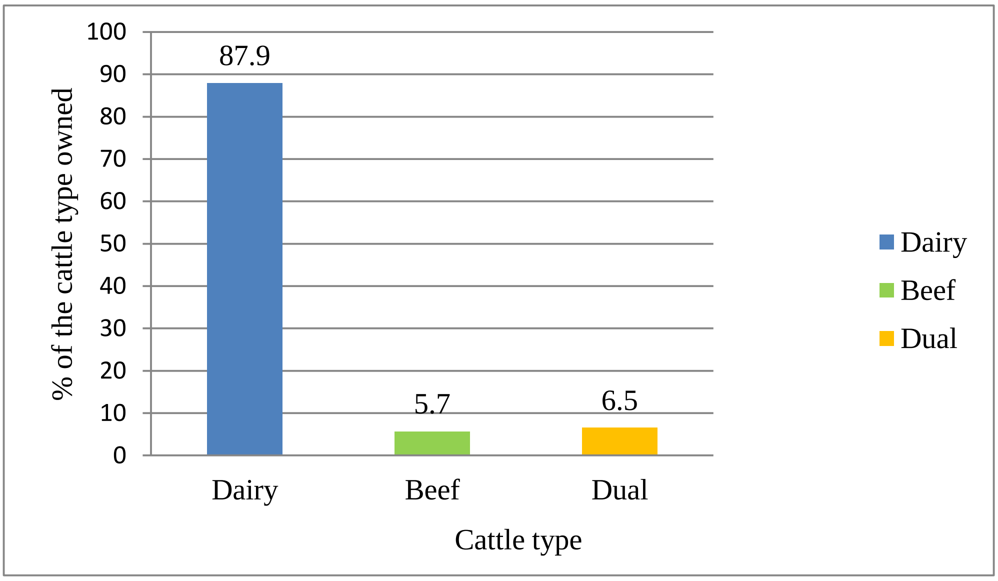


Figure 6: Cattle type

Source: Author's work (2014)

The Friesian pedigree and its crosses was the most preferred cattle breed 52.2% while Guernsey and its crosses was the least preferred breed 20.9%. In terms of the cattle enterprises kept by the interviewed households, 87.9 % of the herd was reared for milk production while 6.5 % of the households reared dual purpose cattle.

4.3 Social-Demographic Profile

Decision making role is a significant factor in determining whether the household adopts ECFIM vaccination programme or not. The study sought to determine the profile of the decision maker and its influence on ECFIM adoption. The results are shown in table 2.

Table 2: Decision making profile by county

	Nandi			Uasin Gishu			Overall Total		
	Count	%.	n	Count	%.	n	Count	%.	n
Head of household									
Male	83	80.6%	103	112	82.4%	195	195	81.6%	239
Female	20	19.4%		24	17.6%		44	18.4%	
N/A	186								
Highest level of education for head of family									
Post- secondary	64	34.0%	188	55	40.5%	136	119	36.8%	324
Secondary	60	31.9%		45	33.1%		105	32.4%	
Primary	36	19.1%		27	19.9%		63	19.4%	
Adult education	10	5.3%		6	4.4%		16	4.9%	
None	18	9.6%		3	2.2%		21	6.5%	
Who makes decisions in the management of livestock									
Male (head of family)	76	51.0%	149	65	58.0%	141	141	54.0%	261
Wife	11	7.4%		7	60.3%		18	6.9%	
Sons	5	3.4%		4	3.6%		9	3.4%	
Males (unspecified)	36	24.2%		27	24.1%		63	24.1%	
Female (unspecified)	15	10.1%		5	4.5%		20	7.7%	
Others	6	4.0%		4	3.6%		10	3.8%	
Highest level of education for decision maker									
Post- secondary	60	31.9%	188	43	32.1%	134	103	32.0%	322
Secondary	71	37.8%		53	39.6%		124	38.5%	
Primary	35	18.6%		28	20.9%		63	19.6%	
Adult education	12	6.4%		7	5.2%		19	5.9%	
None	10	5.3%		3	2.2%		13	4.0%	

Source: Author's work (2013)

Out of 239 households interviewed, 81.6% of the households were headed by men. With respect to highest level of education of the head of household, 69.2% had attained post-primary education. Regarding household decision making about livestock, 78% of all the decisions were made by men.

Table 3: Ranks the most important to the least important sources of livelihood in the study areas.

Table 3: Ranking of the sources of livelihood

1 (most important)	Employment
2	Crop farming
3	Livestock keeping
4	Livestock trade
5	Business (other than livestock)
6	Land leasing
7	Bee keeping
8 (least important)	House renting

Source: Author's work (2013)

Nandi and Uasin Gishu Counties have several sources of livelihoods as listed above. The study found that the most important source of livelihood is formal employment, followed by crop farming and then livestock keeping which was ranked third as most important livelihood source.

4.4 Knowledge, Attitude, Perception and Practices (KAPP) of the communities with respect to ECF disease and its management

Among the specific objectives of this study was to determine the respondents knowledge on ECF disease symptoms. The results are shown in Figure 7.

4.4.1. Knowledge of ECF symptoms

This study established that only 24.5% of the respondents were able to list at least two symptoms associated with ECF as shown in figure 7. The most commonly mentioned symptoms were swollen lymph nodes, labored breathing, soft coughing, and dull hair coat. Respondents who had no idea about ECF symptoms constituted 35.8%.

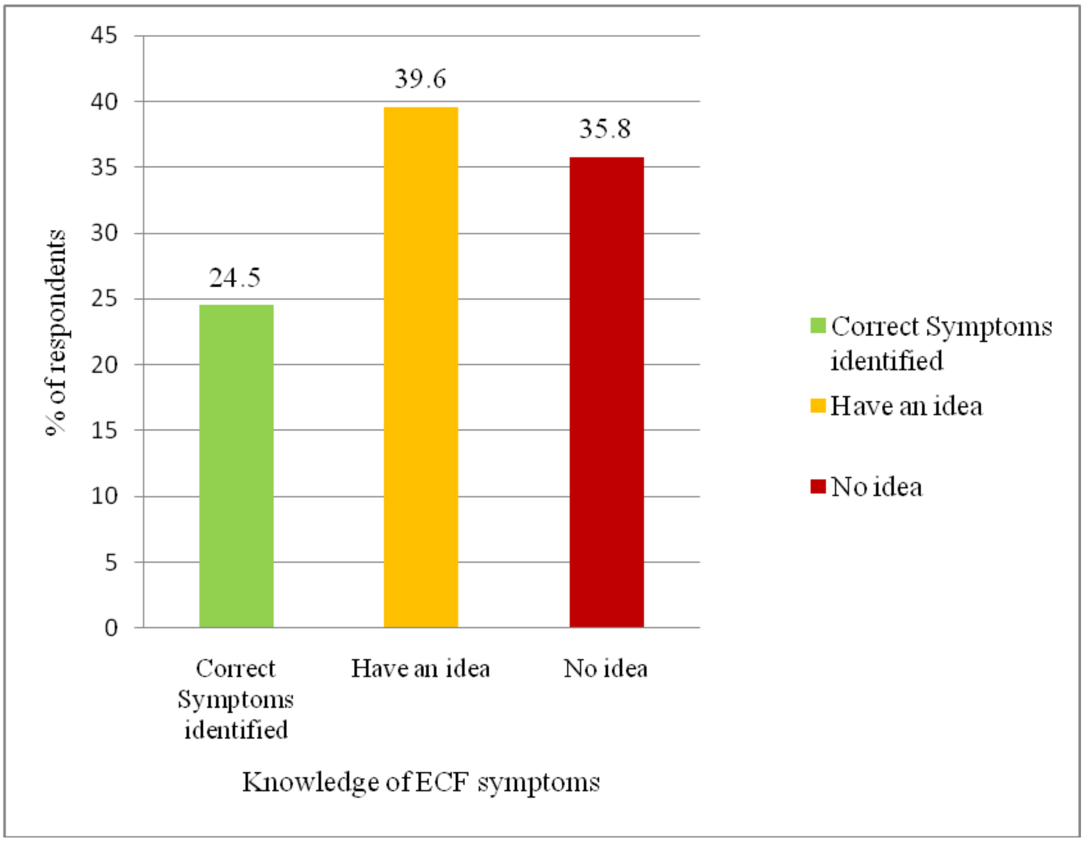


Figure 7: Knowledge of ECF symptoms

4.4.2: Attributes that cause ECF

Regarding the community's perception of attributes that cause ECF, 32.5% believe that ECF is attributed to communal grazing while only 4.3 % attribute ECF to livestock-wildlife interaction. This is summarized in figure 8.

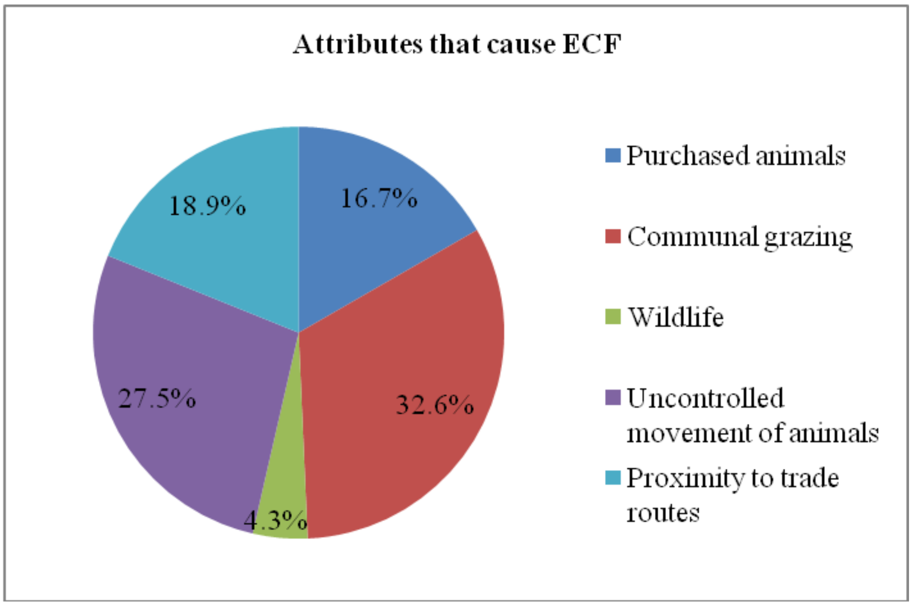


Figure 8: ECF risk factors

4.5 Movement of animals within the county and risk of spreading tick borne disease

Table 4 summarizes animal movement patterns in both counties.

Table 4: Unrestricted movement of animals within the county and risk of spreading tick borne disease

Variables	Overall Total (N=330) n	%.	Nandi (n=239) n	%.	Uasin Gishu (n=41) n	%.
Whether animals graze or pass through this area						
Yes	165	50	152	52.6	13	31.7
No	165	50	137	47.4	28	68.3
Where do they come from?						
Within the neighborhood / area	142	86.1	130	85.5	12	92.3
Outside the location	23	13.9	22	14.5	1	7.7
Missing	165		87		28	
Whether they pose tick borne disease risks						
Yes	138	48.8	117	47.7	21	58.3
No	145	51.2	129	52.3	15	41.7

Source: Author's work (2013)

In Nandi County, 52% of the respondents reported that their neighbor's livestock come to graze / trade or pass through their farmlands. This is in contrast with Uasin Gishu where 31.7% reported that animals do pass-by their farms. Over 80% of the respondents reported that these animals pose a risk of spreading tick-borne disease.

4.6 Perception and Practices (PP) of the communities in management of ECF disease

The study established that communities in the study area have various perceptions and practices as it regards ECF management as shown in table 5.

Table 5: Management of ECF

Variables	N=330	%
Do you administer traditional treatment for ECF to your animals?		
Yes	17	6.3
No	253	93.7
Not Applicable	60	
Do you have your animals vaccinated against ECF		
Yes	156	58.9
No	109	41.1
Not Applicable	65	
Management of ECF in the event of an outbreak		
Treat	68	60
Report	34	30
Vaccinate	4	4
Slaughter	6	5
Selling	1	1
Not Applicable	217	

Source: Author's work (2013)

Majority of the respondents (93.7%) interviewed do not administer traditional treatment to their animals. Most farmers (58.9%) have vaccinated against ECF. In the event of ECF outbreak, 60% of the farmers treat, 30% report to the veterinary authorities near them while 4% will go ahead and vaccinate against ECF.

4.8 Economic losses due to ECF disease

A bivariate analysis of productive losses was done using the 'with' and 'without' approach. The 'with' approach was represented by the vaccinating households while the 'without' approach was represented by the non-vaccinating households. The findings are tabulated in table 6, below.

Table 6: Results of bivariate analysis of the types of productivity losses.

Types of productivity Losses	(N=459) n	%.	Not Vaccinated (n=162)	Vaccinated (n=168)	OR	95% C.I. Lower	Upper	p-value
Mortality	76	16.60	48	28	2.1	1.24	3.57	**0.005**
Abortions	8	1.70	4	4	0.77	0.17	3.51	0.74
Decrease in calving rate	27	5.90	12	15	0.82	0.37	1.8	0.614
Increase in calving interval	24	5.20	10	14	0.72	0.31	1.68	0.450
Decrease in weight gain	67	14.60	34	33	1.08	0.64	1.86	0.761
Increase in labor	50	10.90	25	25	1.04	0.57	1.91	0.889
Incurred costs in ECF treatment	184	40.10	97	67	2.55	1.63	3.98	**<0.001**
Incurred other losses	23	5.00	12	11	1.54	0.64	3.71	0.331

Source: Author's work (2013)

From the analysis only two types of productive losses are significant; these are **mortality** and **incurred ECF treatment costs** with a P-value of 0.005 and < 0.001 respectively. The predominant productivity losses associated with ECF disease are cost of treatment (40%), mortality (16%) and decrease in weight gain (14.6%).

However from the sampling done, the Odds Ratio calculation it is evident that non-vaccinated animals are 2.1 times more likely to die from ECF disease than the vaccinated animals. Other effects of ECF diseases on productivity include abortions, increase in calving intervals, decrease in calving rates, decrease in weight gain, increase in labor and other unspecified losses.

4.9 Effects of ECF diseases on milk production

Dairy farming is among the most important economic activities in the study location. The study sought to find out the effect of ECF disease on the milk production in cows at various lactation stages. The findings as reported by the respondents are summarized in table 7.

Table 7: The milk loss due to ECF disease

Lactation stage	% of milk loss	Duration of milk loss
Early stages 60% Middle 30% Late 10%	Average 64% milk loss S.D. = ± 25.0 Mix = 1% Max = 100%	Average 29.8 days S,D. ± 56.1 Median 14 days Min = 2 days Max = 360 days

Source: Author's work 2013

Young cows (3 years and above) accounted for 84% of the cattle that were affected by ECF diseases and were in their early lactation stages (60%). Farmers lost an average of 64% of milk yield. The period of low milk production lasts for an average of 14 days depending on the severity of the status of the cow and clinical stages of ECF illness with future milk production remaining sub optimal even after recovery of the dairy cows.

4.10 Factors influencing adoption of ECF vaccination

Five out of ten factors were significantly associated with influence the adoption of ECFIM vaccination programme ($P<0.05$) as shown in table 8.

Table 8: Factors associated with adoption of ECF Vaccination

Variables	Vaccinated (N=156) n	%	Not Vaccinated (N=109) n	%	OR	95% CI Lower	Upper	P value
Do you administer traditional treatment for ECF to your animals (0.649)								
Yes	9	52.9	8	47.1	1.25	0.457	3.398	0.65
No	140	58.6	99	41.4	Reference			
Is anyone in your family a member of any organized group (0.08)								
Yes	83	64.3	46	35.7	Reference			
No	63	53.4	55	46.6	0.635	0.38	1.056	0.08
What is the level of education of the family head (0.002)								
None	8	44.4	10	55.6	Reference			
Adult education	7	50	7	50	1.25	0.26	6.07	0.777
Primary	20	40.8	29	59.2	0.86	0.29	2.62	0.790
Secondary	62	71.3	25	28.7	3.1	1.1	9.02	**0.033**
College	26	52.0	24	48	1.34	0.46	4.03	0.587
University	31	73.8	11	26.2	3.52	1.12	4.03	**0.032**
What is the level of education of the decision maker? (0.026)								
None	3	27.3	8	72.7	Reference			
Adult education	10	55.6	8	44.4	3.33	0.7	19.33	0.145
Primary	24	47.1	27	52.9	2.37	0.61	11.77	0.239
Secondary	69	69	31	31	5.93	1.59	28.51	**0.012**
College	30	58.8	21	41.2	3.81	0.98	18.98	0.068
University	19	67.9	9	32.1	5.63	1.29	30.76	**0.028**
Do you know ECF? (0.374)								
Yes	126	60	84	40	0.752	0.403	1.42	0.375
No	26	53.1	23	46.9	Reference			
ECF ever affected your cattle? (0.432)								
Yes	112	59.9	75	40.1	0.799	0.457	1.403	0.432
No	37	54.4	31	45.6	Reference			
County (0.713)								
Nandi	135	58.4	96	41.6	Reference			
Uasin Gishu	21	61.8	13	38.2	1.15	0.55	2.46	0.713
What is the production system? (0.02)								
Mixed farm	118	55.7	94	44.3	Reference			
Cooperative ranch	5	100	0	0	UD	UD	UD	0.988
Zero-grazing	0	0	2	100	UD	UD	UD	0.992
Semi-zero grazing	32	71.1	13	28.9	1.96	0.994	4.066	0.059
Are there animals that come for grazing/trade or pass through this area? (0.001)								
Yes	68	49.3	70	50.7	2.32	1.41	3.87	**0.001**
No	88	69.3	39	30.7	Reference			
Do they pose tick borne disease risks? (0.603)								
Yes	76	63.3	44	36.7	0.869	0.513	1.47	0.603
No	69	57	52	43	Reference			
Ever heard any information on ticks/tick control/tick borne diseases from anyone (0.025)								
Yes	136	56.4	105	43.6	3.04	1.27	8.47	**0.019**
No	20	83.3	4	16.7	Reference			

Source: Author's work (2013)

Level of education of the household head was significantly associated with adoption of ECF vaccine, (P=0.002). Households whose head had attained university level education were 3.52 [95% CI, 1.12-4.03, P=0.032] times more likely to adopt ECFIM vaccine (73.8%) compared to those with no formal education (44.4%). Level of education of the decision maker was significantly associated with adoption of ECFIM (P=0.026). High proportion of households whose decision maker had university level of education were 5.63 [95% CI, 1.29-30.76, P=0.028] times more likely to adopt ECFIM vaccine (67.9%) compared to those with none of the education level (27.3%).

There was a significant relationship between adoption of ECFIM and whether animals came for grazing/traded or passed through the area (P=0.001). There was high proportion of households whose herds interacted with animals which came for grazing or were on transit for trade adapting ECFIM (69.3%) compared to those that did not (49.3%). A household which had a grazing area through which animals came for grazing/traded or passed through was 2.38 [95% CI = 1.41 – 3.87] times more likely to adopt to ECFIM compared to households whose animals did not come for grazing/traded or passed through their area.

Whether a household had ever heard of any information on ticks/tick control/tick borne diseases from anyone was significantly associated with adoption of ECFIM (P<0.025). Households which had ever heard of any information on ticks/tick control/tick borne diseases were 3.04 [95% CI=1.27-8.47] times more likely to adopt ECFIM compared to the ones who had never heard any information on ticks/tick control/tick borne diseases.

4.11 Multivariate Analysis

Binary logistic regression was used to identify variables predictive of ECF vaccine adoption. Six factors associated with adoption of ECF vaccine at P<0.05 in bivariate analysis were considered for multivariate analysis. The findings are shown in table 9.

Table 9: Predictors of Adoption to ECFIM Vaccine.

		95% CI		
Variables	**AOR**	**Lower**	**Upper**	**P-value**
Is anyone in your family a member of any organized group				
Yes	0.57	0.31	1.06	0.08
No	Reference			
Level of education of the family head				
None	Reference			
Adult education	0.25	0.31	1.06	0.366
Primary	0.24	0.01	4.74	0.173
Secondary	0.95	0.02	1.72	0.963
College	0.28	0.01	5.44	0.235
University	2.44	1.34	13.31	**0.044**
Level of education of the decision maker				
None	Reference			
Adult education	15.38	0.79	420.49	0.082
Primary	9.85	0.08	167.2	0.084
Secondary	6.22	0.06	91.28	0.139
College	12.12	0.09	227.53	0.069
University	3.95	0.23	84.22	0.352
Animals come for grazing/trade or pass through the area				
Yes	2.49	1.32	4.79	**<0.001**
No	Reference			
Heard information on ticks/tick control/tick borne diseases				
Yes	2.67	1.20	8.14	**0.032**
No	Reference			
Production system				
Mixed farm	Reference			
Cooperative ranch	UD	UD	UD	0.988
Zero-grazing	UD	UD	UD	0.994
Semi-zero grazing	1.76	0.72	4.41	0.234

Source: Author’s work (2013)

AOR- Adjusted Odds Ratio,   UD –Undefined

Adjusting for other factors, 3 out of 6 factors were significantly associated with adoption of ECF Vaccine. The households whose head had university education level and above were 2.44[95% CI: 1.34-13.31, P=0.044] times more likely to adopt ECF vaccine compared to those who had no formal education. Households who experienced other animals coming to graze/trade or passing through their area are 2.49 [95% CI: 1.32 – 4.79, P=0.005] times more likely to adopt ECFIM compared to those that did not experience other animals coming to graze/trading or passing through their area.

Households who had ever heard information on ticks/tick control/tick borne diseases were 2.67[95% CI: 1.20 - 8.14, P=0.032] times more likely to adopt ECF vaccine compared to those who had never heard information on ticks/tick control/tick borne diseases.

4.12 Economic costs associated with the ECF intervention

In determining the economic costs of ECF disease, respondents were asked how much money they spend annually on reporting the disease to an animal health service provider, veterinary consultation, ECF drugs. An average amount for all the farmers who responded to this question was then calculated and the findings summarized in tables 10(a) to 10(c).

Table 10(a): direct costs incurred in seeking ECF treatment / intervention (Kshs)

Intervention Cost (Kshs.)	No of Respondents (n)	Median	Min	Max
Reporting cost	52	100	20	2,800
Treatment Drugs	191	2,000	200	50,000
Veterinary Consultation	53	200	50	10,000
Vaccination	14	1,325	500	52,000
Slaughter	19	40,000	25,000	300,000
Selling	4	40,000	3,000	52,000
Quarantine	1	1,200	1,200	1,200
Purchase of new animals	4	29,000	18,000	40,000

Source: Author's work (2013)

The median cost of ECF treatment was Kshs. 2,000 (drugs costs and treatment combined). Vaccination costs were Kshs. 1,325. Table 10 (b) shows the indirect costs in seeking ECF intervention quantified in Kshs

Table 10 (b): indirect costs incurred in seeking ECF treatment / intervention

	No. of respondents	Statistics (Kshs.)		
Indirect cost	(n)	Median	Minimum	Maximum
Interference with dowry, ceremonies	7	27,000	5,000	150,000
Opportunity costs	50	1,450	200	200,000
Unable to market produce	16	29,000	300	600,000
Increased labour	48	500	200	20,000

Source: Author's work (2013)

The indirect costs of ECF consist of opportunity cost whose median cost was Kshs. 1,450; unable to market produce was Kshs. 29, 000, increased labor Kshs.500 and interference with dowry ceremonies Kshs. 2,700.

4.13 Average Economic cost of ECF Disease per Household (Kshs.)

One of the main objectives of the study was to calculate the average cost of ECF disease in the household. This used Bennet (2003) model who defines the cost of disease as value of the loss in expected output due to ECF (L), Increase in expenditures on non-veterinary resources due to ECF (R), the cost of input used to treat ECF, (T) and the cost of disease prevention measures (P). This model is summarized as C= (L+R) + (T+P). From the above calculation, the total cost of ECF as a disease to a household is Kshs.34, 875 as shown in table 11 (a). This was then computed as a percentage of the average annual income of Kshs.210,000 per household tabulate in table 11 (b)

Table 11 (a) Economic cost of ECF disease per household in Kshs.

C	Description of the cost variable	Median Cost (Kshs.)
L	**Value of the loss in expected output due to the presence of a disease** –	
	i. opportunistic costs in favor of treating the ECF	1,450
	ii. Unable to market produce	29,000
R	**Increase in expenditures on non-veterinary resources due to a disease**:-	
	i. Hiring extra labor,	500
	ii. Reporting costs	100
T	**The costs of inputs used to treat disease**	
	i. Veterinary consultation fee	200
	ii. Drugs	2,000
P	**The cost of disease prevention measures**	
	i. Vaccination	1,325
	ii. Home Spraying	200
	iii. Public dipping	100
C	**Total Cost of ECF disease**	**34,875**

Number of valid responses (n) = 48

Table 11(b): The average income per household

Sources of income	N	Min	Max	Std Deviation	Mean	Median
Milk	265	1150	1674000	108016.8	163057.4	64,800
Livestock	137	2000	1100000	131303.6	51272.96	55,000
Crop produce	235	800	1000000	5499037.5	3162784	60,900
Salary	47	6000	960000	227948.6	285000	240,000
Others	155	300	3024000	262772.8	88635.17	60,000
Total	**315**	**1200**	**10010960**	**5500610.7**	**343029.9**	**210,000**

The average income per household was Kshs.210,000 per annum. A proportion of 16.7% of the total household income was spent on ECF disease.

4.14 Access to Extension Services

Out of 330 respondents, 244 (74.2%) have heard about ticks and tick control methods. Figures 9 and 10 profiles the population of respondents that had heard of ticks and tick control methods and type of tick control information received respectively.

4.14.1 Tick control related information

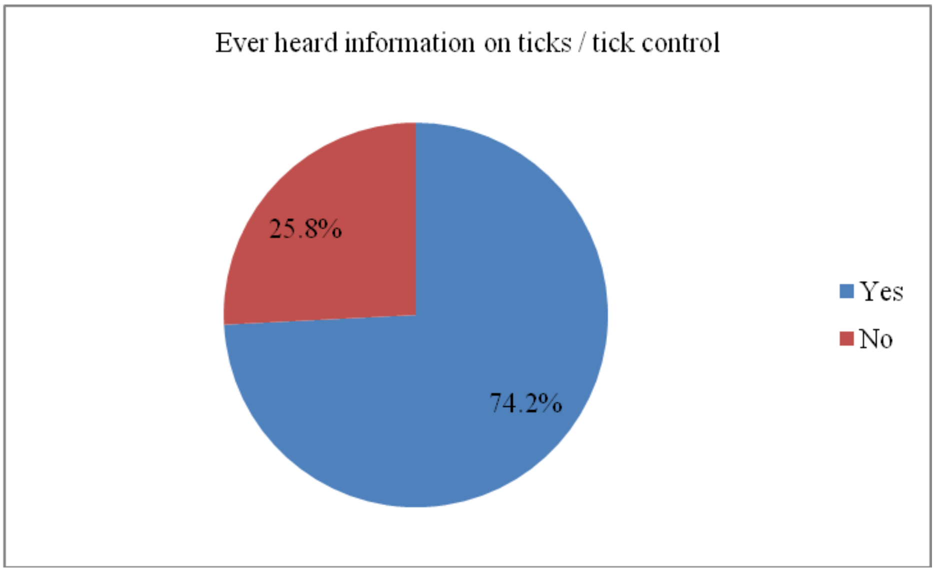


Figure 9: Ever heard information on ticks/ tick control

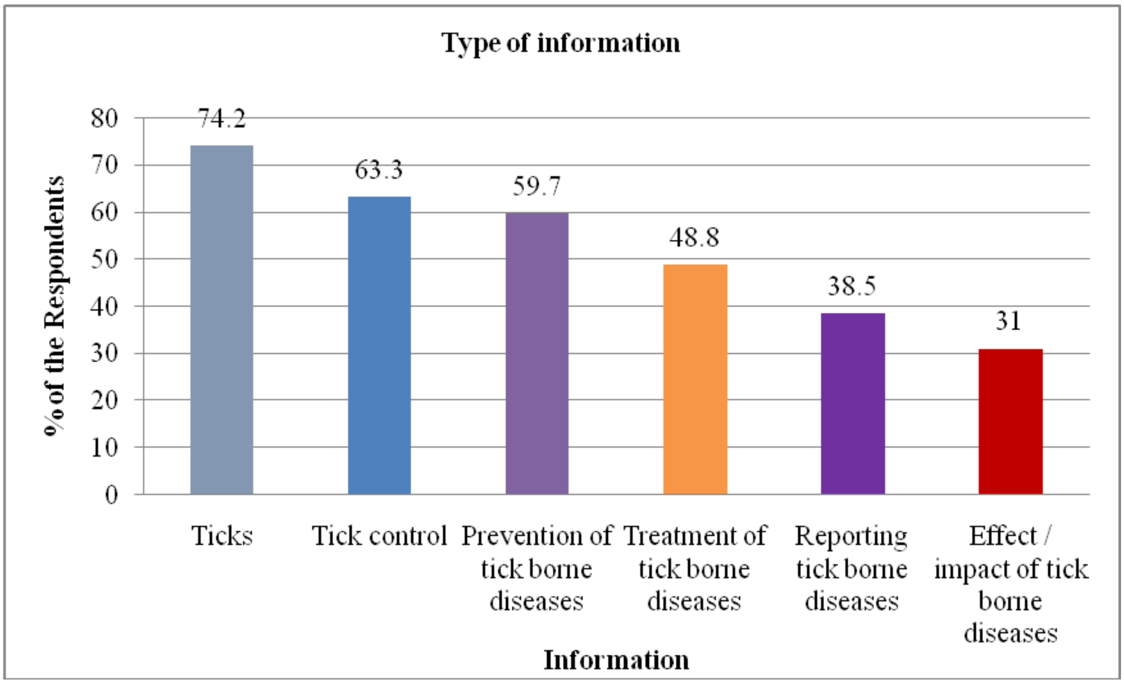


Figure 10: Type of information

74.2 % of the respondents had heard of ticks and tick control methods with most of the information passed to respondents by extension agents being on types of ticks, followed by tick control methods. Information on impact of tick borne diseases was the least dwelled on by the extension agents. There is no significant difference in the percentage in adoption of ECFIM between households who have had access to tick control related information and those who have not.

4.14.2 Methods of tick control

The three types of dips for the control of ticks include public dips (45.2%), private dips (3.6%) and home spraying (14.2%). Figures 11(a) and 11(b) are box-plots of the median, minimum and maximum distances to the public and private dips.

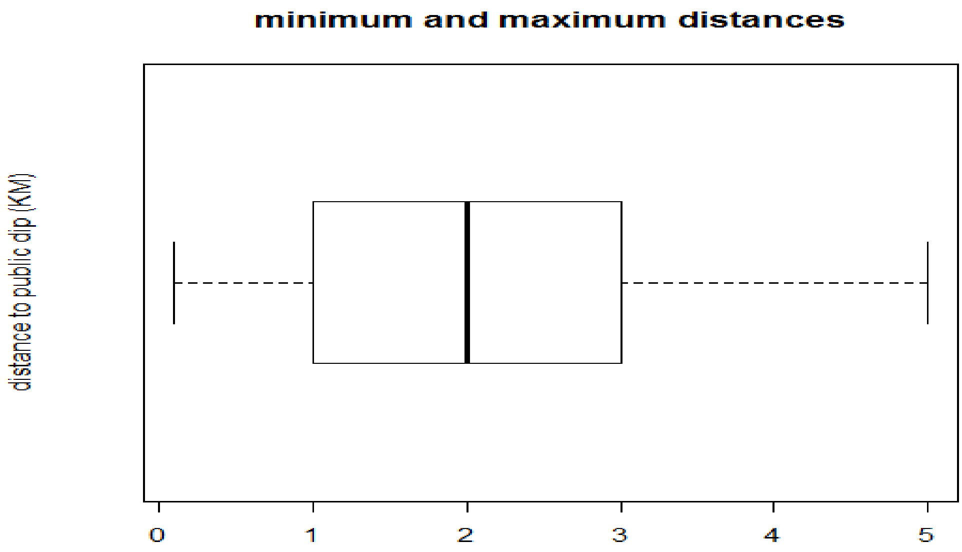


Figure 11(a) Median, minimum and maximum distances to public dips

The median distance to public dip was 2Kms with the shortest and the longest distances being 0.1Kms and 5Kms respectively.

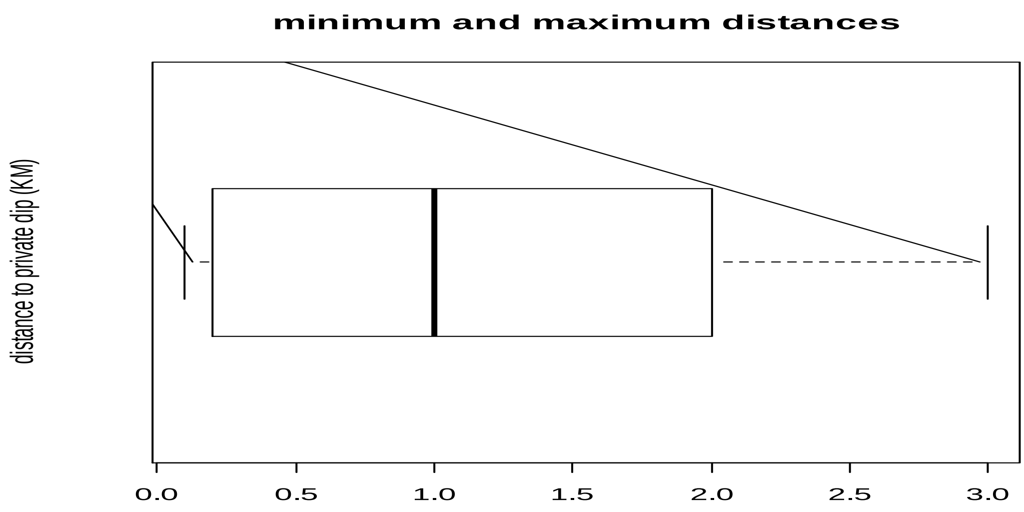


Figure 11 (b) Median, minimum and maximum distances to private dips

The median distance to private dip was 1Km with the shortest and the longest distances being 0.1Kms and 3Kms respectively.

4.14.3 Frequency of use of tick control method

The study also sought to determine the most commonly used method of tick control in the study location. The results are shown in Table 11(a).

Table 12(a): Frequency of use of tick control methods

Characteristics	Count (n=330)	Percentage %
Tick control methods		
1. Home spraying	158	51
2. Private dipping	7	2.3
3. Public dipping	144	46.5
4. Vaccination	1	0.3
5. N/A	20	
How often used		
1. Weekly	255	77.3
3. After 2 weeks	27	7.8
4. Monthly	9	2.9
5. Twice a month	6	2
6. After 3 weeks	5	1.6
7. Once a month	3	1
8. Every 2 years	1	0.3
9. N/A	23	

Source: Author's work (2013)

Home spraying was the most common method of tick control which accounted for 51% of tick control method, while public dipping accounted for 46.5%. High proportion of farmers sprayed their animals weekly (77.3%, 255).

4.14.4 Reasons for the choice of tick control method

The study sought to establish the reasons that influenced the choice of tick control methods used by dairy farmers. The findings are tabulated in table 12 (b).

Table 12b: Reasons for the choice of tick control method

Characteristics	Count (n=330)	Percentage %
1. Prevention purposes	189	57.3
2. Available and cheap	185	56.1
3. Effective / kills all ticks / total immersion of the animal	127	38.5
4. Dips in the area collapse (home spraying only)	87	26.4
5. Better managed (private dips only)	55	16.7
6. Easy and sure (home spraying only)	23	7
7. You are in control (home spraying only)	8	2.4

Source: Author's work (2013)

The reasons for the choice of method include availability and affordability (56.1%) and effectiveness (57.3%) of the method.

4.14.5 Cost of acaricide by method of tick control and cost of vaccination

The study went further to determine the cost of vaccination and acaricide used in each tick control method. The results are as shown in table 13.

Table 13: Cost of acaricide by method of tick control and cost of vaccination

Tick control method	n	Cost of Acaricide				
		Mean (Kshs.)	Std. Deviation	Median (Kshs.)	Minimum (Kshs.)	Maximum (Kshs.)
Home spraying	156	461.0	1329.42	200	20	16,000
Private dip	6	529.2	1210.968	20	10	3,000
Public dip	140	221.1	878.8296	20	1	7,000
Vaccination	1	850.0	_	850	850	850
Total	303					

Source: Author's work (2013)

The median cost of vaccination was Kshs. 850 while the median cost of public dip and private dip was Kshs. 20. The median cost of home spraying was Kshs. 200 .

4.15 The estimated expenditure on consumables in one calendar year, in controlling ECF.

ECF control costs are incurred by the small holder dairy farmers both in terms of costs of consumable items and on fixed items. To estimate this, the researcher asked the farmers to give an estimate of these costs incurred throughout one calendar year. Table 14 shows the results.

Table 14: The estimated expenditure on consumables in one calendar year, in controlling ECF.

Consumables	N	Minimum	Maximum	Mean	Std. Deviation	Median
Water	18	240	18,000	6,219	6,326.81	3,600
Acaricide	180	100	48,000	6,021	6,593.05	4,800
Labor	101	1,000	756,000	29,510	86,493.51	5,000
Vet	17	200	144,000	19,154	36,610.73	6,000
Drugs	131	180	276,000	6,649	25,075.65	2,400
Syringe	24	25	12,000	1,574	3,365.11	100
Protective Cloth	82	200	27,000	3,130	5,345.66	800
Dipping	119	20	60,000	4,103	6,461.30	2,840

Source: Author's work (2013)

Veterinary consultation was the most expensive item in controlling ECF at a cost of Kshs.6,000. This was followed by labor at Kshs.5,000, Acaricide at Kshs.4,800 and water at Kshs.3,600 respectively**.**

4.16 Estimated cost of expenditure on fixed items in ECF control

On the fixed items, spray pump was the most expensive item with the cost being 3,000 followed by building of crush at 1,500 while protective clothes was Kshs.800 as shown in table 15.

Table 15: estimated of expenditure on fixed items in ECF control

Fixed Items	n	Mean	Std. Deviation	Median	Minimum	Maximum	Duration of use (life span)
Building of facility (dips, crush)	121	12,478	64,052	1,500	60	600,000	1 - 50 years
Spray pump	141	5,694	16,944	3,000	200	200,000	1-26 years
Dip tank	9	_	_	_	_	_	_
Protective clothing	91	1,552	2,981	800	100	27,000	1 month - 36 months
Others	1	1,000	_	1,000	1,000	1,000	

Source: Author's work 2013

4.17 Economic gains from ECF control by use of Infection and Treatment Method

Analysis of Variance was used to determine economic gains from ECF control by use of Infection and Treatment Method. The sum of squares, degrees of freedom and the mean squares were calculated as shown in table 16.

Table 16: Analysis of Variance (ANOVA) between various expenditure items and vaccination

	Vaccinated N=156					**Not Vaccinated N=109**					
Variables	**n**	**Mean**	**sd**	**M in**	**Ma x**	**n**	**Mean**	**sd**	**M in**	**Ma x**	**P-value**
Acaricide	91	6395.16	944 5.4	10 0	720 00	54	6795.74	774 7.3	20 0	480 00	0.727
Water	8	6430	682 0.3	24 0	180 00	6	7800	750 3.6	24 00	180 00	0.096
Labour	58	20858.62	447 74	12 00	300 000	28	56610.36	149 174	15 00	756 000	0.564
Vet	6	12423.33	235 87.6	20 0	600 00	7	26211.43	521 34.4	48 0	144 000	0.179
Drugs	66	4019.85	765 1.97	18 0	600 00	50	10735.4	394 18.4	30 0	276 000	0.26
Syringe	11	2113.64	441 7.97	50	120 00	11	538.64	896. 014	25	300 0	0.946
Protective Clothing	35	3056.57	569 0.6	20 0	240 00	25	2956.4	542 9.07	50 0	270 00	0.388
Dipping	61	4588.36	853 7.04	20	600 00	37	3338.65	245 5.49	30	840 0	0.793

Source: Author's work (2013)

The appropriate mean expenditure on items was compared for those who vaccinated and those who did not. There is no statistical association between whether the livestock was vaccinated or not against expenditure costs on various items.

4.18 Partial Budget Analysis of Vaccinating and Non Vaccinating Households

Households were asked a question about the increased milk yield which was then cross tabulated with another question on ECFIM vaccination. Households that had vaccinated against ECF had a milk output of 7-10 liters as compared to the non vaccinating household whose output averaged 5-7 liters. Hence, the economic gain would be increase in milk yield; median 45% milk gain over non-vaccinated livestock.

In addition a Partial Budget Analysis was conducted whereby a tabulation of expected gains and losses due to adoption of ECFIM vaccine at the farm level was carried out. Items of income and expenses that change due to a household's adoption of ECFIM were tabulated as shown below in table 17(a) and 17(b).

Vaccinating household had a net gain of Kshs.44, 575 form adoption of ECFIM vaccine that resulted to more milk yield and reduced expenses on ECF treatment and its related charges.

Table 17(a): Partial budget analysis for Vaccinating Households

GAINS	LOSSES
1. *Extra Revenue* Milk sales 675 liters @60 Kshs =40,500Kshs 40,500	2. *Extra Costs* ECF vaccine 1325
3. *Costs Saved* Vet consultations 4,000 Vet drugs 1,400 Acaricide 2,400 5400	*4.Revenue Foregone* Nil
	Net Gain ***44,575***
Total 45,900	Total 45,900

Source: Author's work (2013)

The non-vaccinating households had a net loss of Kshs.9, 975 by not adopting ECFIM vaccine. This resulted from milk loss of 45% from ECF related sickness, increased costs in the use of Water and acaricide for tick control and ECF treatment costs.

Table 17 (b): Partial budget analysis for Non Vaccinating Households

GAINS		LOSSES	
1. *Extra Revenue*	Nil	2. *Extra Costs*	
		ECF treatment	4,000
		Vet Drugs	1,400
		Water for tick control	1,800
		Acaricide	2,400
		Milk loss due to ECF	2,700
3. Costs Saved		*4.Revenue Foregone*	Nil
ECFIM vaccine purchase	1,325		
Labor	1,000		
Net Loss	***(9,975)***		
Total	12,300	Total	12,300

Source: Author's work (2013)

4.19 Challenges faced by respondents in controlling tick borne diseases

The greatest challenge faced by respondents while attempting to control tick borne diseases is that the public dips are either far away or poorly managed 71.2%. Other issues include existence of rampant pets / common drinking points for community animals which accounted for 63.9% as shown in figure 12.

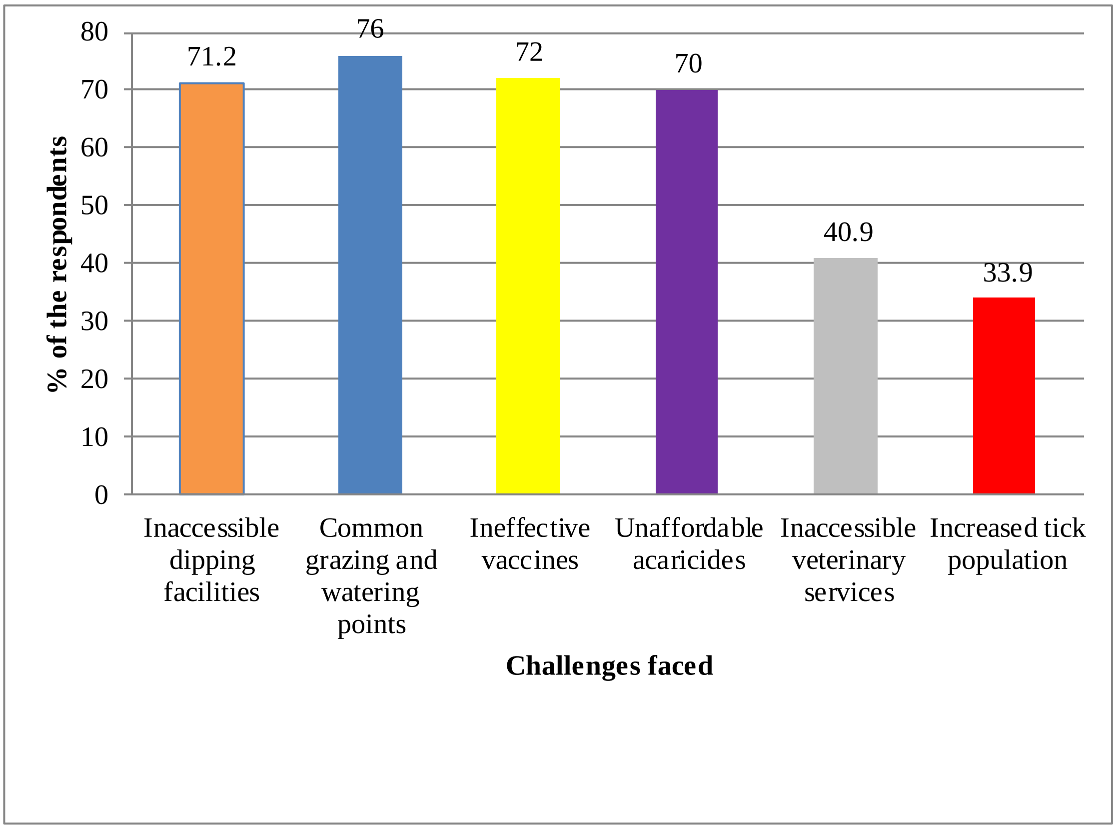


Figure 12: Challenges faced by respondents in tick and tick borne disease control

Source: Author's work (2013)

4.20 Suggestions for improvement of tick and tick borne disease control

To control tick borne diseases, 33.9% of the respondents reported that the cost associated with treatment and drugs of tick borne diseases should be re-considered including subsidizing the vaccination drugs. Other ways include having the right acaricides (31.8%) and issues associated with dip management (29.7%). This is summarized in Figure 13.

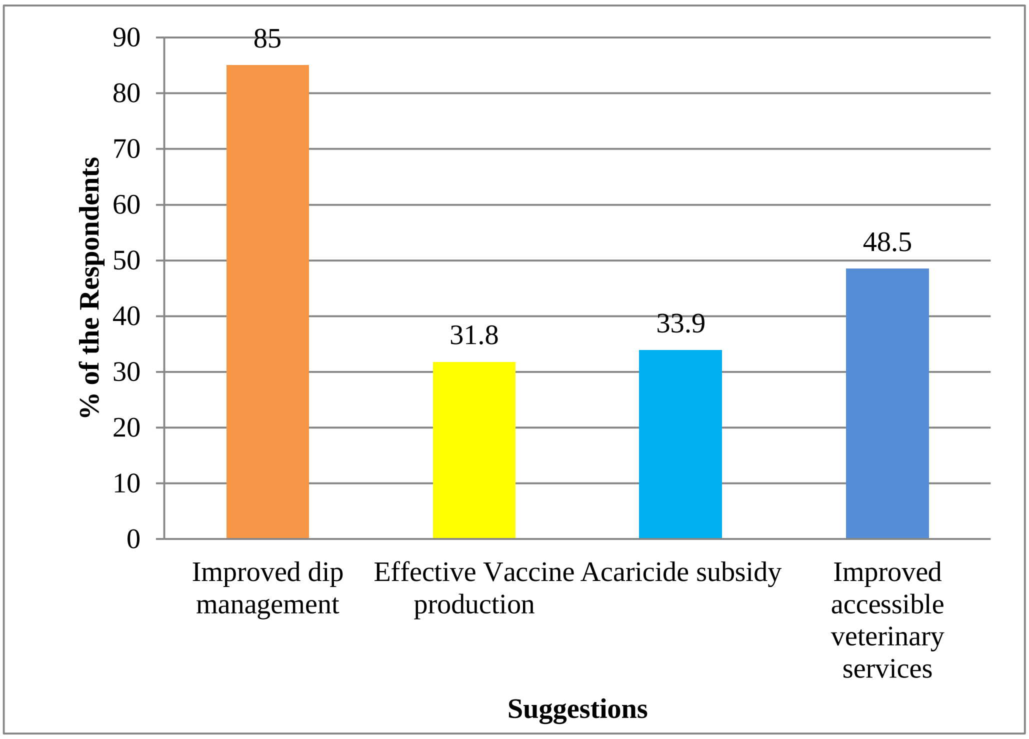


Figure 13: Suggestions for improvement of tick and tick borne disease control

Source: Author's work (2013)

CHAPTER FIVE: DISCUSSION

Milk production is among the main reason why the interviewed household kept cattle as reported by 87.9 % of the respondents. This was followed by 6.5 % of the respondents who reared cattle for dual purposes. The Friesian breed of cattle was the most preferred dairy breed by the respondents while 37.5% of the respondents preferred Ayshire breed. The average stocking density was 1 head of cattle on 1.5 – 2.9 acres of land. It is worth noting however that livestock enterprise was ranked 3rd after crop and employment as the major sources of livelihoods in the study location.

Adoption of ECFIM is a major decision to be undertaken by the households. The decision making role is mainly undertaken by the men in 78% of the households. Education is a key determinant in effective decision making. In the study area, 69.2% of the decision makers had attained post primary education.

Regarding the KAPP, only 24.5 % of the respondents were able to correctly identify ECF symptoms. The most common symptoms mentioned were swollen lymph nodes, labored breathing, coughing and dull hair coat. Majority of the respondents 35.8% had no idea of ECF symptoms while the rest had a vague idea of ECF symptoms. The results compare with findings obtained in a similar study by Kiprono *et al*, (2011) in Baringo and West Pokot districts which found out that the signs associated with ECF by the two communities were swollen lymph nodes, deep cough, anorexia, lacrimation, nasal discharge and bloody diarrhea. Communal grazing was considered as a cause of ECF disease by 52% of the respondents. Kiprono *et al* (2011) also found out that 27.3% of the respondents in participatory epidemiology exercise reported grass as the etiology of ECF. This explains why households whose herds grazed and watered in a communal place were

2.49 times more likely to adopt ECFIM at a P-value of 0.005. This finding agrees with that of Gachohi *et al*, (2012) who found out that livestock production system has an important influence as far as the exposure of cattle to ECF disease is concerned.

ECF mainly affected young heifers (84%) leading to the loss of future dairy herd. In addition there are various economic losses resulting from ECF disease. A bivariate analysis done on the types of production losses resulting from ECF resulted to two significant losses; mortality at a P- value of 0.005 and ECF treatment costs. Households that had opted not to adopt ECFIM were 2.1 times more likely to suffer death of their dairy cows to ECF and 2.55 times more likely to incur ECF treatment costs averaging Kshs 6,000 annually. These findings are similar to those of Marcellino *et al* (2011) study in Central Equatorial State of South Sudan which listed mortality (representing 81.5% of the losses) as the major economic impact of ECF disease.

The same study indicated each household normally needed to sell three to five bulls every year to pay for cost of antitheilerial drugs, antibiotics and chemical acaricides. Milk loss is among the major production losses resulting from ECF disease. Milking cows that were affected by ECF had reduction of milk production of 64% for 30 days during which the disease is active. Milk production never got back to optimal production even after the recovery of the diseased animal. In addition there are other costs related to ECF disease such as increased labor of Kshs 5,000, veterinary fees of Kshs 6,000. The cost of the measures taken to control ticks in small scale farms is a financial burden to dairy farmers. In this study, the costs of acaricides application, which is the primary means of tick control, was reported to range between Kshs. 1500 and Kshs. 2300 which is consistent with Ministry of Livestock, Kenya, which estimates drugs costs only at US$13 and US$20 per adult animal (MOLD, 2012).

The average economic costs of ECF disease per household was calculated using Bennet (2003) model and yielded a result of Kshs 34,875 per household. The average annual income per household was calculated at Kshs 210, 000.This translates to 16.7% of the total annual income being spent on the management of ECF disease. This finding is in agreement with Gachohi *et al.* (2012) who found out that economic losses due to ECF disease are concentrated on small-scale resource-poor households leaving them vulnerable with no other sources of primary household income.

ECFIM adoption has various economic gains as revealed by the study. Though there is no significant difference in the annual expenditure on consumable and fixed items of ticks and tick borne disease between the ECFIM adopting and non adopting households, a 45% increase in milk production was reported in the ECFIM adopting households. A partial budget analysis showed a net gain of Kshs 44,575 in ECFIM adopting households. 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 what is supposed to be the reduction of acaricides use when using ITM (Mukhebi *et al.,* 1989). The acaricides use could have been reduced by a third to half of the usual volume. This would then translate to more money saved in the household.

There are various factors associated with adoption of ECFIM at household level. Adjusting for other factors, 3 out of 6 factors were significantly associated with adoption of ECF Vaccine. The households whose head had university education level and above were 2.44 times more likely to adopt ECF vaccine compared to those who had no formal education. Frontline extension workers had accessed 74.2% of the respondents where information on types of ticks, methods of tick control and treatment of tick borne disease was emphasized.

Households who had information on ticks, tick control and tick borne diseases were 2.67 times more likely to adopt ECF vaccine compared to those who did not. This finding agrees with Lumumba *et al* (2015) study in North Rift Kenya who found out that among the household head's characteristics, education of the household head emerged as a key variable that significantly and positively influenced the probability of adoption of the ECF vaccine. The positive coefficients of these factors indicate that farmers who were more educated were more likely to understand the benefits of the vaccine, and hence vaccinated their cattle against ECF. However in the extension information to dairy farmers there was no strong emphasis on impact of ticks and tick borne diseases. This could explain why only 59.3% of the respondents had had adopted ECF yet 74.2 % had information on ticks, tick borne diseases and tick control methods. Households who experienced other animals coming to graze/trade or passing through their area are 2.49 times more likely to adopt ECFIM compared to those that did not experience other animals coming to graze/trading or passing through their area.

Various challenges were listed by the respondents as hindrance to effective control of tick borne diseases. They include inaccessible dipping facilities, communal grazing and watering points and unaffordable acaricides. The respondents' suggestion on improvement of tick borne diseases included improved dip management and availing veterinary service provision.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1: Conclusions

The study concludes that;

I. Knowledge on ECF disease and its symptoms and the potential effect on dairy production among the respondents is low.

II. Investments in ECFIM and related schedule of vaccination of dairy animals has a positive economic return in terms of milk yield in small holder dairy farming households.

III. Key among factors that influence ECFIM adoption are the literacy levels, grazing systems and access to information on ticks and tick borne diseases. Improved awareness creation will therefore improve ECFIM adoption.

6.2: Recommendations

The study recommends that:

i. Farmers need to be sensitized on the need to reduce the number of dipping and spraying after vaccinating their animals against ECF. This will help them realize more financial benefit of adopting ECFIM apart from increased milk yield.

ii. For resource poor vulnerable households, vaccine subsidy would greatly benefit the farmers. This model can be worked out through the county governments.

iii. This study has examined the socioeconomic impact of ECFIM vaccine in small holder dairy households in two counties in the Rift Valley region. It is recommended that similar studies be carried out for small holder dairy production areas in other counties in other regions of the country to generate a better understanding of the economics of the ECFIM vaccine in Kenya.

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APPENDIX I: QUESTIONNAIRE

A. General information

Enumerator number: -------------------Mobile Tel. No. ---------------------Date-----------

Sub – County ----------------------------County: --

Place name: Location: -----------------------Sub-location---------------------------------

Village--

Name of the farmer/spouse/herdsman (i.e. the person interviewed):----------------------

Address: --Mobile No. ---------------------------

B. Herd size, production system and management

1. Please indicate the livestock you have in the table. Write the breeds and the number of animals under the breed.

Livestock	**Breed 1** ---------------	**Breed 2** -------------	**Breed 3** -----------------	**Breed 4** ---------------	**Breed 5** ---------------
Cattle					
Sheep					
Goats					
Donkeys					
Pigs					
Rabbits					

2. Indicate the type of cattle:

Cattle Type	Number in the herd
Dairy	
Beef	
Dual	
Other (Specify)	

3. Indicate the Grazing pattern:
   - Communal
   - Enclosed
   - Zero
   - Semi-zero to where?
   - Other (specify)

4. What is the production system?
   - Traditional pastoralist
   - Agro-pastoralist
   - Mixed farm
   - Cooperative ranch
   - Commercial ranch

- o Zero-grazing
- o Semi-zero grazing
- o Urban
- o Other (specify)

5 Are there animals that come for grazing/trade or pass through this area? (Tick)

o Yes No

From where? --

6. Do they pose tick borne disease risks?

o Yes No

Explain ---
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

C. Animal health data

7. Name the diseases you experience in your animals in order of importance (**most important first**) stating the criterion for ranking. **If possible indicate name of the disease in the local language or the clinical signs**

Rank	**Disease**	**Local name of disease**	**Clinical signs and post mortem lesions**	**Criterion for ranking**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

8. Name the tick borne diseases you have experienced in your animals in the last 12 months. **Indicate in the table.**

Year	**Month**	**Disease**	**Local name**	**Species affected**	**Age groups affected**

9. What are the major clinical signs and post-mortem lesions of the tick borne diseases you have problems within your animals? **Indicate in the table. Do not ask the clinical signs and post-mortem lesions if mentioned in 1 above.**

Disease	Species	Clinical signs	Post-mortem lesions

10. What are the causes of the diseases? **Indicate in the table**

Disease	Cause

11. What would you attribute to the spread of the diseases? **Tick as many as apply**

- Purchased animals
- Communal grazing
- Wildlife
- Movement of animals
- Proximity to trade routes
- Others, specify

12. Do you know ECF?

Yes No

13. If yes, what are the symptoms…………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

14. What is its local name?..

15. Has it ever affected your cattle? Yes No

16. a. In which month(s) did the disease first occur? ....

b. For how long did the disease persist ....months?

17. **How many animals were present in the herd during the outbreak?**

Age category	Number
<1 male	
<1 female	
1-3 years male	
1-3 years female	
>3 years male	
>3 years female	

18. How many were affected, died or recovered? What were the clinical signs, post mortem lesions?

Age category	Affected	Dead	Recovered	Severity of disease + ++ +++ ++++	Clinical/Post mortem lesions
<1 M					
<1 F					
1-3 yrs M					
1-3 yrs F					
>3 yrs M					
>3 yrs F					

19. What would you attribute to the cause of the disease? (Can be more than one)

- Purchased animals
- Communal grazing
- Wildlife
- Movement of animals
- Proximity to trade routes
- Other, specify ------------------------

20. What did you do in case of ECF? Fill in the table

Age category	Report	Treat	Vaccinate	Slaughter	Sell	Move	Quarantine	Separation	Other (specify)	Give away
Yes or no										
<1 M										
<1 F										
1-3 yrs M										
1-3 yrs F										
>3 yrs M										
>3 yrs F										

21. **What was the cost of action?**

Intervention	**Cost (Ksh)**
Report	Time……………………transport………………………
Treat	Time……………………drugs……………………
Vaccinate	Time……………………charges…………………treat reactors…………..social………..
Slaughter	Real value minus salvage value…………………
Sell (prematurely)	Real value minus sale value……………………………………
Move	Time……………………effect on other herds………………………………
Quarantine/separation	Time…………………….extra labour……………………social……………………….
Give away	
Purchase new animals	
Other (specify)	

22. What were the other costs of the disease?

Other costs	**Cost (Kush)**
Interference with dowry, ceremonies	
Opportunity costs	
Unable to market	
Increased labour	
Other-specify	

23. Do you administer traditional treatment for ECF to your animals? Yes No

If yes, fill in the table below

Treatment	Mode of application	Recovery rate

24. Do you have your animals vaccinated against ECF? Yes No

25. If so, indicate in the table below

Year	Vaccinator	Age groups vaccinated	Cost per animal	Reason for vaccination	Problems encountered in vaccination

26. Has any of the animals come down with ECF after vaccination, how many, when, how long after?..
....
....
....
....
....
....

D. Effect of ECF on Productivity

27. In a case of ECF, indicate the losses you incurred in the table below

Disease	Duration of the disease	Mortality (number and age group)	Abortions	Decrease in calving rate	Increase in calving interval	Decrease in weight gain.	Increase in labor	Other Losses

28. Indicate in the table below the milk loss due to ECF if any

Cow/heifer	Age	Lactation stage	% Milk loss	Duration of milk loss

29. What was the effect of intervention on disease/productivity?

Intervention	Effect
Treat	Recovery ……………..out of………………….. *How long after………………………months*
Vaccinate	Reduced abortions/stillbirths………out of…… Increased draught power………………acres Increased milk yield……………………..litres Reduced calving interval……………months Increased calving rate……………………..calves Increased weight…………………………….kgs Increased cow dung………………………… *How long after………………………months*
Slaughter	Decreased morbidity……………………..no Decreased mortality……………………no *How long after………………………months*
Sell	Decreased morbidity……………………..no Decreased mortality……………………no *How long after………………………months*
Move	Decreased morbidity……………………..no Decreased mortality……………………no *How long after………………………months*
Quarantine/separation	Decreased morbidity……………………..no Decreased mortality……………………no *How long after………………………months*
Give away	Decreased morbidity……………………..no Decreased mortality……………………no *How long after………………………months*
Other (specify)	

12. In controlling ECF, estimate your expenditure on consumables in one year

Item	Expenditure/month (Kshs.)	Expenditure/year (Kshs.)
Water		
Acaricide		
Labour		
Veterinary advice		
Drugs		
Syringes etc		
Protective clothing		
Dipping Fee		
Other (specify		
Other(specify)		
Other(specify)		

13. In controlling ECF, estimate your expenditure on fixed items

Item	Expenditure	How long does the item last
Building of facility e.g. dip, crush		
Spray pump		
Dip tank		
Protective clothing		
Other (specify)		
Other(specify)		

F. Extension and Training

30. Have you ever heard any information on ticks/tick control/tick borne diseases from anyone?

Yes

No

31. If yes to 1, fill the table below

Type of information	Year	By whom
Ticks		
Tick control		
Prevention of Tick borne diseases		
Treatment of tick borne diseases		
Reporting tick borne diseases		
Effects/Impact of tick borne diseases		
Other (specify)		

32. What kind of information would you like to receive and through whom? **Indicate in the table**

Information	Through whom?

33 Is anyone in your family a member of any organised group(s) Yes No.

If yes which one and what service does it offer? **Indicate in the table**

Family member	Group	Service **(as many as apply)**
1		[, , ,]
2		[, , ,]
3		[, , ,]
4		[, , ,]

Service 1=marketing; 2=loans; 3=advice; 4=credit; 5=information; 6 =other (specify)

F. Tick borne disease prevention and treatment

34. What tick control methods do you use?

Communal/Public dip: Name-------------------------------Distance from home-----------Km

Private dip: Name--Distance from home------------Km

Crush pens: Name--Distance from home------------Km

Spray race: Name--Distance from home------------Km
Home spraying
Pour on
None
Other (Specify)--

35. Give reasons for using these methods and how often you use them. **Indicate in the table**

Tick control method used	**Reasons**	**Cost of Acaricide**	**How often used**

36. Who makes the decision to change the acaricide type? ----------------------------------

37. Name other methods you use in control of tick-borne diseases ----------------------------
----

38. How do you rate your tick and tick borne disease control methods and why? **Indicate in the table**

Control method	**Hopeless**	**Very poor**	**Poor**	**Satisfactory**	**Good**	**Very Good**	**Excellent**	**Why**

39. What are the challenges you face in tick and tick borne disease control?

1. ---

2. ---

3. ---

4. ---

5. ---

40. What suggestions do you have for improvement of tick and tick borne disease control?

1. ---

2. ---

3. ---

4. ---

5. ---

G. Socio-economics of ECF prevention and control

41. How many family members are there in the household? ------------------------------------
-

42. Who is the head of the family? (F/M)----------------------

43. What is the level of education of the family head? ---

- University
- College
- Secondary
- Primary
- Adult education
- None

4a. Who makes decisions in the management of animals? --------------------------------------

4b. What is the relationship with the family head?

- Self
- Spouse
- Son or daughter
- Manager
- Other (specify)---

5. What is the level of education of the decision maker? (**Ask if the decision maker and the family head are different people**)

University
College
Secondary
Primary
Adult education
None
Other (specify) ---

6. What is the total annual household income? Kshs. ……………………………………

7. What are your sources of livelihood? Indicate in the table.

Source of livelihood	**Rank 1=most important 12=least important**
Livestock keeping (specify species)	
Livestock trade (specify species)	
Employment	
Crop farming	
Business (other than livestock trade)	
Land leasing	
Bee keeping	
Landlord	
Aid/relief	
Selling curios	
Entertaining tourists	
Other(specify)	

8. What is the estimated household income (per month, year) from? ***(Enter per month or per year, whatever the farmer is able to give)***

Income source	**Amount of produce**	**Amount sold**	**Price per unit (Kshs.)**	**Amount per month (Kshs.)**	**Amount per year (Kshs.)**
Milk					
Livestock Cattle Sheep Goats Poultry Eggs Other (specify)					
Sale of crop produce Maize Beans Cassava Other (specify) Other (specify) Other(specify)					
Manure					
Honey					
Draught power					
Salary					
Remittances from family members					
Curios					
Rental houses					
Shops					
Posho mills					
Livestock trade					
Land leasing					
Dividends from shares					
Entertaining tourists					
Pension					
Other(specify)					
Other(specify)					
Other(specify)					
Other(specify)					

11. What is the expenditure on income and what are the sources of supplementation?

Social service	**Amount per month**	**Amount per year**	**Other sources**	**Amount from other sources per year**
Human health				
School				
Treatment of animal diseases				
Food for humans				
Payment of Bills				
Water for humans (if not in bills)				
Labour				
Other animal related activities				
Social events				
Taxes				
Clothing				
Purchase of new animals				
Transport				
Animal feed				
Water for animals (if not in bills)				
Payment of Bills				
Support of other family members				
Buying of shares				
Purchase of new animals				
Other investments				
Other groceries (soap etc)				
Purchase of household items				
Other (specify)				
Other (specify)				
Other (specify)				

15. Indicate any other comments or suggestions? (About ECF disease management)

1. ……………………………………………………………………………………..
2. ……………………………………………………………………………………..
3. ……………………………………………………………………………………..
4. ……………………………………………………………………………………
5. ……………………………………………………………………………………..
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10. ……………………………………………………………………………………