IMPACT OF FORMAL AND INFORMAL INTERVENTIONS IN THE CONTROL OF RIFT VALLEY FEVER DISEASE IN THIKA AND MARIGAT DISTRICTS OF KENYA

A thesis submitted in partial fulfillment of requirements for Masters Degree of University of Nairobi [**Applied Microbiology, (Virology Option)**]

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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DEDICATION

This work is dedicated to my mother, **Mary Musyoka** and sister, **Maureen Kuthea** for the time and support they have given me all these years.

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ABBREVIATIONS AND ACRONYMS

AEZ	– Agro Ecological Zones
C.B.P.P	– Contagious Bovine Pleuropneumonia
C.C.P.P	– Contagious Caprine Pleuropneumonia
DVO	– District Veterinary Officer
E.C.F	– East Coast Fever
ELISA	– Enzyme-Linked Immunoassay
ENSO	– El Niño/Southern Oscillation
F.M.D	– Foot and Mouth Disease
G1	– Glycoprotein one
G2	– Glycoprotein two
IgG	– Immunoglobulin G
IgM	– Immunoglobulin M
L.S.D	– Lumpy Skin Disease
LH	– Lower highlands
LM	– Lower Marginal
MDCK	– Mardin Derby Canine Kidney Cells
N	– Nucleocapsid protein
PCR	– Polymerase Chain Reaction
RNA	– Ribonucleic Acid
RT- PCR	– Reverse Transcriptase Polymerase Chain Reaction
RUFORUM	– Regional Forum for Agricultural Capacity Building
RVF	– Rift Valley Fever
RVFV	– Rift Valley Fever Virus
SNS	– Smithburn Neurotropic Strain
SPSS	– Statistical Package for Social Sciences
UH	– Upper highland geographical zone
UM	– Upper marginal geographical zone

LH – Lower highland geographical zone

LM – Lower marginal geographical zone

KNBS – Kenya National Bureau of Standards

KM – Kilometer

ABSTRACT

Rift Valley fever (RVF) is an arthropod borne disease, transmitted by *Aedes* mosquitoes, which was first reported in Naivasha area of Rift Valley Province of Kenya in 1912, but the virus was isolated and recognised later in 1931. It is a disease of domestic livestock and wild ruminants. It is zoonotic causing hemorrhagic fevers in humans. RVF is endemic in many African countries including Kenya.

In Kenya various studies have been done regarding RVF. They include: the presence of the virus and its serotype, presence of the transmitting vectors, the host range and also if the disease is present in wild life or not. Recently a study was done in North Eastern Kenya to evaluate the inter-epidemic and sero-positivity of RVF virus. Another study was also done in the same region in 2007 to assess the socio – economic impacts of the disease where it was shown that the communities were affected. The communities targeted in these studies were mainly the pastoralist as the disease is reported to be occurring more in these areas than other parts of the country. However, little is known about the disease in dairy farming communities.

There is little that is known about the knowledge capacity of the farmers regarding RVF, thus there was need to find out if these communities had indigenous knowledge relevant to various aspects of the disease and its control. The study assessed the farmers' knowledge of the disease, its risk factors, various traditional management practices and their perception on the formal control measures instituted by the government. These control measures include vaccinations, quarantine, closure of markets and ban of sale, slaughter and consumption of animals.

The study took place in two areas, one a pastoral community in Marigat District in the Rift Valley province and the other a dairy farming community in Thika District in Central

Province. From these two study sites, the study aimed at assessing the impacts and effectiveness of the control measures put up during the recent outbreaks both the formal, government instituted , and informal, traditional methods; and also assess the risk factors to RVF outbreaks. The data was collected using questionnaires, interviews and group discussions with more information being obtained from the government offices. The data was then analyzed using Statistical Package for Social Sciences (SPSS).

Although farmers from both sites knew about the disease, those in Marigat were more aware having experienced the disease outbreak in their livestock and family members than those in Thika. According to the farmers this was a relatively new disease and they did not have well defined traditional methods of predicting, managing or controlling the disease. They relied on the treatment and control options provided by the government. They also did not have a traditional name for the disease.

The disease and the control options instituted by the government against RVF impacted on the social, cultural and economic activities of the communities more in Marigat and these included: loss in income interference to their social and cultural ceremonies including circumcisions, weddings, "oloibon" (rain makers) ceremonies and gatherings for various reasons as these required the slaughter of animals as part of the ceremony.

Marigat had more risk factors to the spread of the disease than Thika. These risk factors included the terrain with presence of depressions that would collect water during heavy rainfall, "dambos", the major breeding grounds for the *Aedes* mosquito leading to increase in number of the disease transmitting vector, handling of the infected animals and most farmers treating the sick animals exposing themselves to infection and slaughtering their animals for various ceremonies. This involved them handling the infected carcasses and some consuming the meat leading to spread of the infection. Ignorance about the disease transmission dynamics could have been an added risk factor.

CHAPTER ONE

1.1. INTRODUCTION

Rift Valley fever (RVF) is an arthropod borne viral disease which was first reported in Kenya in 1912, (Montgomery and Stordy 1913). They reported an acute and highly fatal disease of lambs on a government farm in the Naivasha area of Rift Valley Province of Kenya. The virus was isolated and recognised 20 years later in 1931(Daubney *et al.*, 1931). RVF is primarily a disease of domestic livestock but can also affect wild ruminants. It is also a zoonotic disease causing hemorrhagic fevers in humans which can sometimes be fatal (Daubney *et al.*, 1931; Bishop *et al.*, 1980; Meegan and Bailey., 1988). Rift Valley Fever is endemic in many African countries including Kenya, Sudan, Egypt, Senegal, Mauritania, Gambia, Namibia, South Africa, Zambia, Zimbabwe, Mozambique and Madagascar (El Akkad., 1978; Saluzzo *et al.*, 1987; Meegan and Bailey., 1988; Zeller *et al.*, 1997 and Gerdes., 2004). The disease has been reported in Saudi Arabia and Yemen (Abdo-salem *et al.*, 2011; Madani *et al.*, 2003).

It occurs in these areas in cycles of 5 to 15 years after periods of heavy rainfall. There is flooding especially in arid and semi arid low lying flat landscape areas with accumulation of flood water in depressions known as 'dambos' (Davies *et al.*, 1992; Linthicum *et al.*, 2001). The disease has also been connected to El Niño/Southern Oscillation (ENSO) (Ropelewski and Halpert., 1987). Although inter-epidemic transmission cycle dynamics are not very well understood, a recent attempt to resolve this matter was made and large wild ruminants were shown to carry neutralizing antibodies to the virus indicating that they could act as reservoirs (Evans *et al.*, 2008).

During the 1997-1998 and 2006-2007 outbreaks in eastern Africa, much effort was made to contain the disease in livestock through vaccination, vector control and dealing with the disease in humans. There has also been a lot of vaccination programmes going on in the country being run by the Ministry of Livestock Development. There is little documentation to show how these control options affected the communities and whether or not these communities had any prior knowledge about RVF and how to manage or control it.

The study therefore evaluated the community's perception of the effectiveness of control measures to the disease which include vaccinations, quarantine, and closure of markets and ban of animal sale, slaughter and consumption. The study further obtained information on the knowledge capacity of the farmers regarding traditional methods used to predict and manage the disease outbreaks. It also established risk factors at village level that are associated with the occurrence of the disease and how the disease and control measures affected social-cultural and economic activities of the communities.

It is expected that the results from this study will advise the Kenyan government on designing and mounting up campaigns to create awareness of RVF and its effects to the communities at risk. This will benefit livestock owners who either depend on sales of live animals in the pastoral areas or those who keep dairy cattle and lose milk revenue whenever there is an outbreak of RVF in dairy farming areas.

1.2. OBJECTIVES

1.2.1. General objective

The general objective of the study was to assess the impacts of the formal and informal control interventions used against Rift Valley Fever disease in Thika and Marigat districts of Kenya and determine the communities' perception of socio-cultural impact of the disease.

1.2.2. Specific objectives

1. To determine the impact of Rift Valley Fever disease occurrence and the control measures put against it on the socio-cultural activities in affected communities.
2. To determine the community based knowledge on the Rift Valley Fever disease, predictions and management practices traditionally used in the study area
3. To determine risk factors associated with occurrence of Rift Valley Fever in Thika and Marigat

1.3. RESEARCH HYPOTHESES

1. The control interventions used during the RVF disease outbreaks do not interfere with the socio-cultural activities and livelihoods of the communities in the study area.
2. The communities have traditional methods used in predicting, managing and controlling RVF disease outbreaks
3. There are different risk factors associated with occurrence of RVF in Thika and Marigat Districts.

1.4. PROBLEM STATEMENT

There are various aspects of RVF disease that have been studied in Kenya including the causative agent, disease transmission dynamics, control measures, the susceptible species and the infection in humans (Bishop *et al,* 1980, Ksiazek *et al,* 1989; Besselaar and Blackburn., 1991*)*. Recently a study was done in North Eastern Kenya evaluating the inter epidemic and sero-positivity of RVF virus (LaBeaud *et al.*, 2008). Another study done in the same regions was to assess the socio – economic impacts of RVF in the 2007 where it was indicated that the disease had economic impacts on the communities affected (Rich and Wanyoike., 2010). The communities targeted in these studies were mainly the pastoral communities.

Some of the issues that still need to be clarified include the impact of RVF and the control options instituted against it on the social and cultural activities of the affected communities, comparing the dairy and pastoral farming communities and how these communities deal with the outbreaks using any indigenous knowledge on predicting and controlling the disease. The data collected from this study is to establish how the disease impacts on the communities' socio-cultural and day to day activities and how the occurrence of the disease disrupts these activities. It is also to show how much the local communities know about the disease and methods they traditionally used in predicting, treating and controlling the disease, and provide inputs into the policies on control measures and the prediction model for RVF.

CHAPTER TWO

LITERATURE REVIEW

2.1. RIFT VALLEY FEVER DISEASE

2.1.1. Aetiology

Rift Valley Fever Disease is caused by the Rift Valley Fever Virus (RVFV), a member of the genus *Phlebovirus* and family **Bunyaviridae**. RVFV is spherical with a host cell derived envelope into which virus coded glycoprotein spikes are inserted. It has a negative-sense, single stranded RNA genome comprised of three segments, L (large), M (medium) and S (small), contained in three different nucleocapsids within the virion (Donald *et al.*, 2010). The L and M are negative sense while S is ambisense and has a bi-directional coding (Besselaar and Blackburn., 1991). It has a 3′ and 5′ terminal sequences complementary to each other, forming panhandle structures, and explains why RNA appear circular when observed by electron microscopy (Elliott., 1990). The virus has three major structural proteins, two envelope glycoprotein and a nucleocapsid protein: G1, G2 and N respectively. The glycoproteins aid in the recognition of receptor sites on susceptible host cells, manifestation of hemaglutinin and inducing protective immune response (Besselaar and Blackburn., 1991).

RVFV is stable in serum stored at 4°C where it can be recovered after several months or at 56°C where it can be recovered after three hours. It is very stable at temperatures lower than -60°C and in aerosols at 23°C with 50-85% relative humidity. It is however inactivated by lipid solutions like ether and sodium deoxycholate. It is also inactivated by low concentrations of formalin and pH below 6.8 (Shimshony and Barzilai., 1983).

RVFV can be grown in almost all common continuous line and primary cell cultures. These include, vero cells, primary calf and lamb kidney or testis cells but cannot be grown in primary macrophages and lymphoblastoid cell lines (Peters and Anderson, 1981).

The disease was first reported among livestock in Kenya in 1912 by Montgomery and Stordy, but the virus was not isolated until 1931 (Daubney *et al*., 1931) and thus named after its endemic location in Kenya, the Great Rift Valley.

2.1.2. Epidemiology

Geographical distribution

Rift Valley Fever outbreaks occur across sub-Saharan Africa, with outbreaks occurring elsewhere infrequently. It is endemic in many African countries especially in arid and semi arid areas after experiencing very high rainfalls leading to flooding. Outbreaks have been reported in Kenya, Somalia, Tanzania, Zimbabwe, South Africa, Egypt, Mauritania, Senegal, and Madagascar and in the Middle Eastern Countries of Saudi Arabia and Yemen between 1951 and 2007 (El Akkad., 1978; Saluzzo *et al.*, 1987; Meegan and Bailey., 1988; Zeller *et al.*, 1997; Abdo Salem *et al.*, 2001; Madani *et al.*, 2003, Gerdes 2004).

Occurrence

The disease occurs in cycles of 5 to 15 years after periods of high rainfall leading to flooding (Davies and Highton., 1980; Linthicum et al., 1999). It has been associated with El Nino/Southern Oscillation (Linthicum et al., 1990). During these periods, there is usually very high rainfall leading to flooding and accumulation of water in depressions known as 'dambos' where the mosquito eggs containing the virus mature to adult and start spreading the disease by biting animals that graze near the dambos or come to drink water there (Davies and Highton., 1980).

Geographical distribution of RVF in East Africa

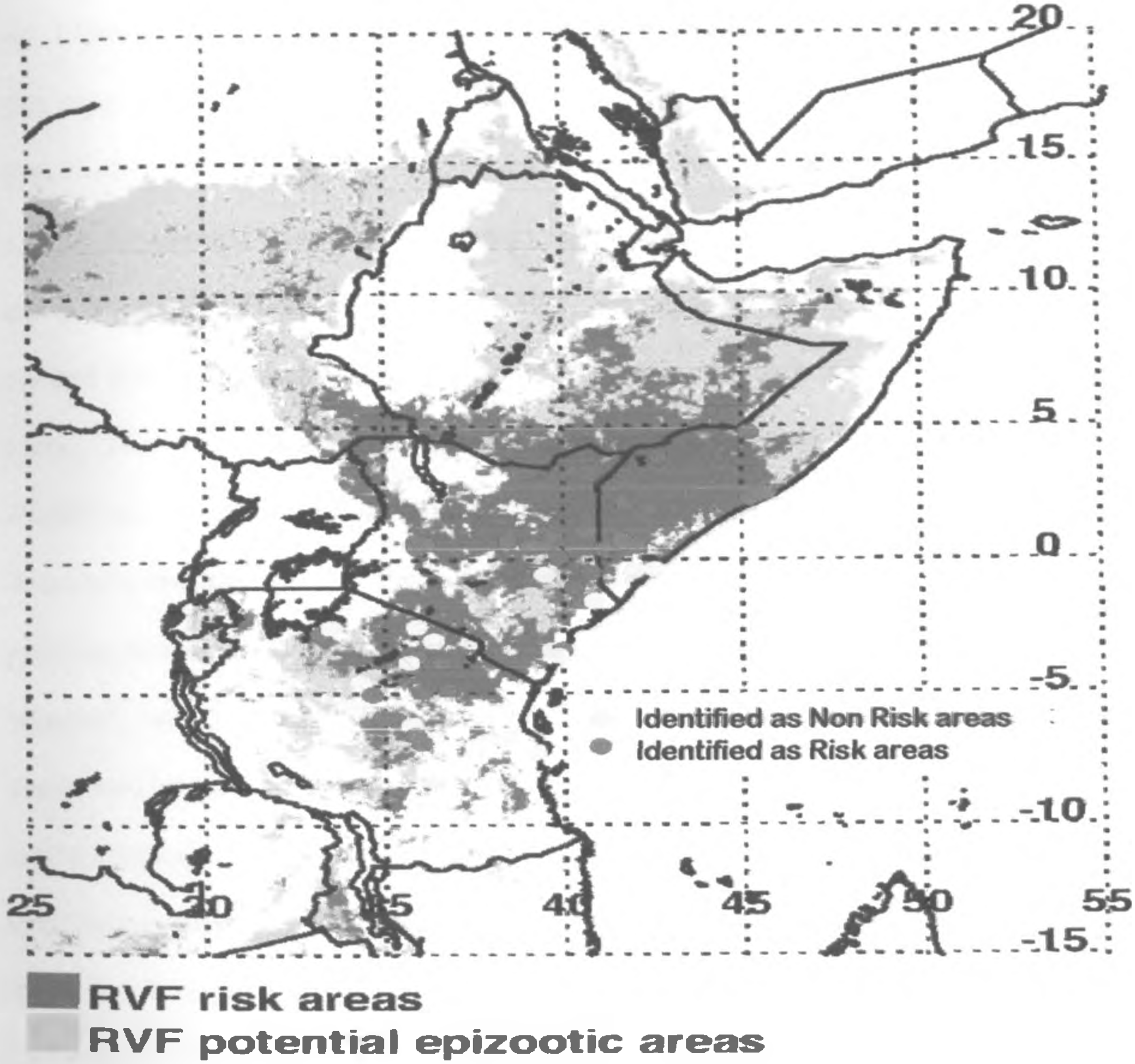


Figure 1.1 Overall RVF risk areas

(Adapted from Anyamba et al., 2009)

The RVF risk areas are shown in red for the period September 2006-May 2007 with human case locations depicted by blue and yellow dots (Anyamba et al., 2009; 106:955-959)

Transmission

The disease is known to be mainly transmitted by mosquitoes from the *Aedes* genera (Davies and Highton., 1980) but it has also been shown to be transmitted by other mosquito species. The virus was first isolated from *Aedes caballus sensu lato* and *Culex theileri* in Western Free State in 1953 (Gear et al., 1955). Certain species may dominate as vectors in different regions, for example *Culex theileri* is main vector in South Africa while *Aedes mcintoshi* is the main vector in Zimbabwe (Mcintosh 1973, Swanepoel et al., 1974). The virus has been isolated from 12 mosquito species in the subcontinent and these include: five *Aedes*, three *Culex*, three *Anopheleses* and one *Eretomapodites* (Mcintosh, 1973, Swanepoel and Cruikshank., 1974). These mosquitoes breed in temporary floodwater pools that occur throughout the Rift Valley. Epizootic occurrence of RVF has be associated with heavy persisted rainfall which raises the water table to a level where water collects in areas called 'dambos', 'walo' or 'dieri'. The flooding results in the increase of a single generation of mosquitoes where a proportion may be infected with the RVFV starting the infection to the exposed animals (FAO 2003). For the infections to lead to a full blown epizootic, the water pools have to remain for four to six weeks or more leading to secondary vector mosquitoes to breed rapidly increasing the population of mosquitoes thus increasing the spread of the infections (FAO 2003).

The virus can be transmitted to humans by mosquitoes and through the handling of infected animal tissues and fluids during slaughtering or butchering, assisting with animal births, conducting veterinary procedures, or from the disposal of carcasses or fetuses (Smithburn *et al.*, 1949, Swanepoel *et al.*, 1979 and Mcintosh *et al.*, 1980). There is some evidence that humans may also become infected with RVF by ingesting the unpasteurized or uncooked milk from infected animals (Alexander 1951; Barnard, 1981).

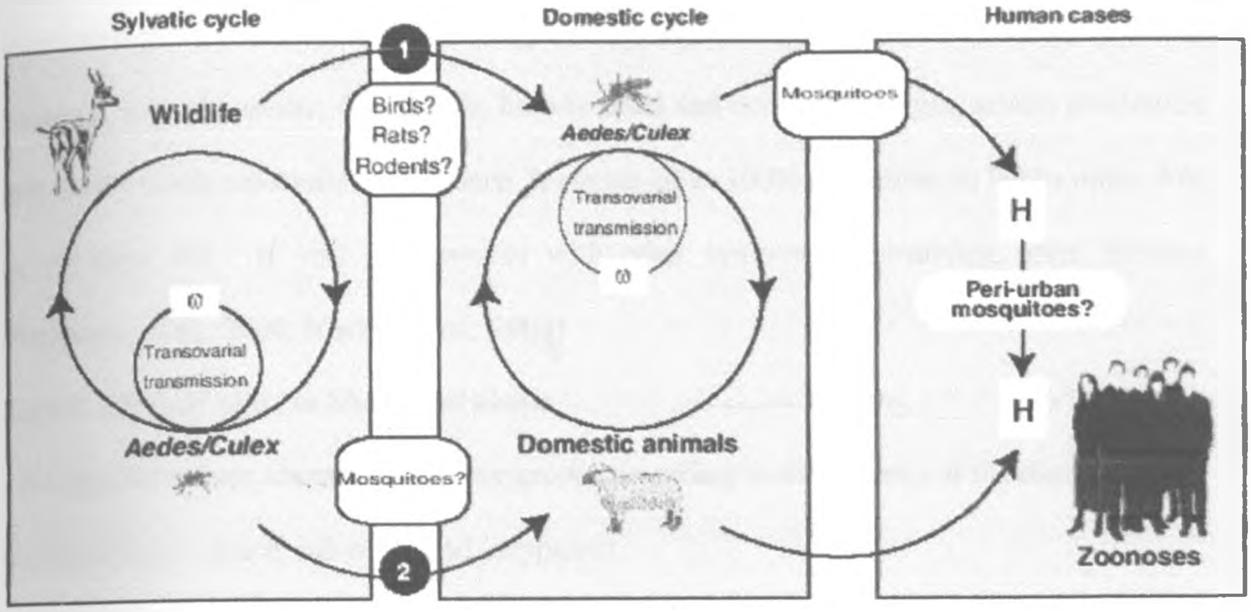


Figure 1.2 Rift Valley Fever Transmission Cycle

Host range

Rift Valley Fever affects many species of animals causing severe disease in domesticated animals including cattle, sheep, camels and goats (Davies and Highton., 1980). Sheep appear to be more susceptible than cattle or camels. Age has also been shown to be a significant factor in the animal's susceptibility and development of the severe form of the disease with high mortalities in lambs compared to adult sheep (Davies and Highton., 1980). RVF is zoonotic producing usually a febrile influenza like disease in humans but may develop in to a hemorrhagic fever syndrome (Van Velden *et al.*, 1977; Laughlin *et al.*, 1979).

The antibodies to the virus have been detected in wildlife species especially ruminants, which include the buffalo, waterbuck, rhino, kudu and impala (Evans *et al.*, 2008).

In Kenya during the 2006-2007 outbreaks, the disease was identified in above mentioned animals with sheep showing the highest sero-prevalence followed by goats and cattle (Muriithi *et al.*, 2010)

2.1.3. Clinical signs for Rift Valley Fever

In animals, RVF mainly presents with signs of stormy abortions, high fever, bloody diarrhea, jaundice, loss of appetite, dysgalactia, bloody nasal and ocular discharges, severe prostration and finally death especially in the sheep. It causes up to 100% mortalities in lambs under five to six days old. It may also present with other symptoms resembling other diseases (Radostits, *et al.*, 2000; Madani *et al.*, 2003)

2.1.3.1. Clinical signs in Sheep and Goats

The signs have been classified into four groups according to the severity of the disease. These are hyper-acute, acute, sub-acute and inapparent.

Hyper-acute Rift Valley Fever

The sheep are more affected than the goats with 90-100 percent abortions during epizootic situations. About 80-100 percent of the lambs under 10 days of age die during this period. The deaths are usually sudden occurring within 12 hours after onset of fever of about 40-42^{0}C mostly with no other clinical signs present (Scott G, *et al.*, 1963. Davies. *et al.*, 1985)

Acute Rift Valley Fever

The lambs older than three weeks and other susceptible animals show severe clinical signs with high fever, increased respiratory rate, mucopurulent and bloody nasal discharges, vomiting, abdominal pain, lymphadenitis, bloody diarrhea, abortions and some may show signs of limping. The animals may become recumbent with death occurring 24-48 hours and this goes on in the flock for up to ten days. Mortality rates range from 10-60 percent. (Madani *et al.*, 2003; Daubney *et al.*, 1931)

Sub-acute Rift Valley Fever

This is the common form of the disease in animals. There is fever of about 40.5-42^{0}C which persists for one to five days. Their conjuctival membranes are injected, there is mucopurulent and sometimes bloody nasal discharges, vomiting, abortions and diarrhea. There is also lack of coordinated movement with the animals being weak and recumbent for several days but later on most recover. After recovery, many of the animals remain weak and unproductive for several months while the mortalities range from 5-20% (Shimshony *et al.*, 1983).

Inapparent Rift Valley Fever

This is common in older animals or those resistant to the infection. They may show signs of fever which may go undetected, depression, some slight inappetence but most of these are unremarkable as they may be signs of another disease. These infections are usually detected during routine serological testing and abortions may also follow such infections. (Woods *et al.*, 2002)

2.1.3.2. Rift Valley Fever in cattle

In cattle RVF presents with four syndromes as described below.

Hyper-acute Rift Valley Fever

Calves that are less than 10 days of age may suffer from this form of the disease and die within 20-24 hours with few, if any, premonitory signs. Signs that may be observed are sero-sanguineous nasal and lachrymal discharges, an elevated respiratory rate and a temperature of 41.5-42°C. Total prostration occurs with the animal lying on its side, with opisthotomus and progressively greater respiratory distress. The course of the disease is rapid and death occurs within 48 hours. Up to 70% mortality has been experienced in genetically susceptible breeds (Scott G, *et al.*, 1963, Davies, *et al.*, 1985).

Acute Rift Valley Fever

Older calves, yearlings and even adult animals show a high febrile reaction of 41.5-42°C, nasal and lachrymal discharges that may be blood-tinged, partial or total anorexia, some depression and possibly prostration. The animals may have colic with profuse fetid hemorrhagic diarrhea that persists for several days. A moist cough may develop with evidence of respiratory distress and rales. The superficial lymph nodes generally become enlarged and there is dysgalactia in milking animals. Animals may bleed from the mouth or nose and abortion commonly occurs. The temperature reaction and sickness may persist for 3-10 days during which many animals die. Jaundice develops subsequently and, if this is severe, further mortality occurs.

Animals of any age, from three months to mature adults may show all or some of the above signs and experience mortality, most commonly in the younger age groups. Mortality varies from 10-40% depending on the age groups exposed. A5-10% mortality has been experienced among older cattle of susceptible genotypes (Geering *et al.*, 1995; Gerdes 2004)

Sub-acute Rift Valley Fever

Older cattle generally show a less obvious response to RVF, which may be manifest as a brief period of temperature rise, with nasal and lachrymal discharges and a dysgalactia of 3-7 days duration. There may be a brief period of profuse watery diarrhea, often accompanied by colic. Some respiratory signs may be noticed, a raised rate and a moist cough with some rales. Abortion is perhaps the most common consequence and this may occur during the acute phase of the disease or up to 6-8 weeks later. Some deaths may occur. A persistent ill thrift may follow such mild infections, which is usually associated with moderate to severe jaundice and liver damage. Photosensitization is a common sequel to RVF virus infections possibly due to damage to the liver thus reduces expulsion of the byproducts of chlorophyll (Bishop *et al.*, 1980; Chevalier *et al.*, 2010).

Inapparent Rift Valley Fever

RVF is usually inapparent in the majority of the adult susceptible and indigenous cattle in Africa, which are relatively resistant to RVF. Abortion may follow this infection in the susceptible genotypes but is rare in the indigenous animals in the classical RVF enzootic zones of the continent. This is the most common presentation of RVF in epizootics, where only a retrospectively noted fall in milk production, abortions and serological testing reveal the true extent of the infections (Geering *et al.*, 1995; Gerdes 2004).

2.1.3.3. Rift Valley Fever in camels

Camels do not normally show any clinical signs following RVF infections and fall into the inapparent infection group. They experience a brief period of viraemia and abortion is a common consequence of the infection and pastoralists complain of "all their camels aborting". The infections can be confirmed serologically. Deaths do occur in the early post-natal period in camel foals born during RVF epizootic periods, probably as a result of RVF (Scott G, *et al.*, 1963, Davies, *et al.*, 1985)

2.1.3.4. Rift Valley Fever in wild ruminants

Wild ruminants do not manifest any clinical signs of RVF during epizootics of the disease, which may be affecting domestic animals in shared grasslands. However, they develop antibodies to the virus and may even abort following inapparent infections, yet this is difficult to demonstrate in the field. The African buffalo, *Syncerus caffer*, has a viraemia for two days following experimental inoculation, and buffaloes may abort if pregnant (Evans, *et al.*, 2008).

2.1.3.5. *Rift Valley Fever in Humans*

The disease presents itself in two forms in humans.

Mild form of Rift Valley Fever in humans

The incubation period for RVF varies from 2 to 6 days. Those infected either experience no detectable symptoms or develop a mild form of the disease characterized by a feverish syndrome with sudden onset of flu-like fever, muscle pain, joint pain and headache. Some patients develop neck stiffness, sensitivity to light, loss of appetite and vomiting; in these patients the disease, in its early stages, may be mistaken for meningitis.

The symptoms of RVF usually last from 4 to 7 days, after which time the immune response becomes detectable with the appearance of antibodies and the virus gradually disappears from the blood (Mohamed *et al.*, 2010)

Severe form of Rift Valley Fever in humans

While most human cases are relatively mild, a small percentage of patients develop a much more severe form of the disease. This usually appears as one or more of three distinct syndromes: ocular (eye) disease (0.5-2% of patients), meningoencephalitis (less than 1%) or haemorrhagic fever (less than 1%) (WHO, 2000; Gear, 1989)

Ocular form: In this form of the disease, the usual symptoms associated with the mild form of the disease are accompanied by retinal lesions. The onset of the lesions in the eyes is usually 1 to 3 weeks after appearance of the first symptoms. Patients usually report blurred or decreased vision. The disease may resolve itself with no lasting effects within 10 to 12 weeks. However, when the lesions occur in the macula, 50% of patients will experience a permanent loss of vision. Death in patients with only the ocular form of the disease is uncommon (Siam *et al.*, 1980)

Meningoencephalitis form: The onset of the meningoencephalitis form of the disease usually occurs 1 to 4 weeks after the first symptoms of RVF appear. Clinical features include intense headache, loss of memory, hallucinations, confusion, disorientation, vertigo, convulsions, lethargy and coma. Neurological complications can appear later (> 60 days). The death rate in patients who experience only this form of the disease is low, although residual neurological deficit, which may be severe, is common (WHO, 2000)

Haemorrhagic fever form: The symptoms of this form of the disease appear 2 to 4 days after the onset of illness, and begin with evidence of severe liver impairment, such as jaundice. Subsequently signs of haemorrhage then appear such as vomiting blood, passing blood in the faeces, a purpuric rash or ecchymoses (caused by bleeding in the skin), bleeding from the nose or gums, menorrhagia and bleeding from venepuncture sites. The case-fatality ratio for patients developing the haemorrhagic form of the disease is high at approximately 50%. Death usually occurs 3 to 6 days after the onset of symptoms. The virus may be detectable in the blood for up to 10 days, in patients with the hemorrhagic icterus form of RVF.

The total case fatality rate has varied widely between different epidemics but, overall, has been less than 1% in those documented. Most fatalities occur in patients who develop the haemorrhagic icterus form (Kahlon et al., 2010)

2.1.4. Pathology of Rift Valley Fever

The most important pathological changes are to be found in the liver. The severity of the lesions that develop will depend upon the age group and susceptibility of the animals affected. They are likely to be more severe in young lambs and less severe in older animals.

Hepatic necrosis is present in all RVF carcasses, for the lesions develop early in the course of the disease. In the early stages, the liver is congested, swollen and engorged with rounded edges and many scattered petechial hemorrhages. Later, the necrosis may be evident as small 1-3 mm foci, which coalesce to form larger areas of necrosis and these changes involve the whole of the liver.

There may be widespread petechial and ecchymotic hemorrhages throughout the parenchyma and visible in sub capsular tissues. The necrotic changes induce jaundice and a stage is reached when the liver has a medium brown color appearance as the congestion, necrotic areas and icterus develop. At later stages the liver turns completely yellow with jaundice.

Petechial and ecchymotic hemorrhages may be found throughout the carcass in lambs. They are especially noticeable on the serosal and pleural surfaces of the body cavities, and on the heart, gall bladder, kidneys, bladder and other organs. There may be some bloodstained ascitic fluid.

The alimentary tract usually shows some level of inflammation from catarrhal to hemorrhagic and necrotic. The serosal surfaces may have hemorrhages and also the mucosal lining of the bowel, particularly of the abomasum and small intestine and ileo-caecal areas.

The lungs may be congested with edema and emphysema and sub pleural hemorrhages are commonly found. The heart will show subepicardial and endocardial hemorrhages. There is a generalized lymphadenopathy involving the superficial and visceral lymph nodes. These are oedematous with petechial hemorrhages. The spleen may or may not be enlarged with sub capsular hemorrhages.

Similar changes will be found in the fetuses, particularly in the liver where various levels of necrosis will be seen. There is also a necrotic placentitis (Pepin *et al.*, 2010; Gerdes 2004).

2.1.5. Differential diagnosis

Single cases of RVF can be confused with many other diseases, which cause sudden death in sheep and present with similar signs. These include: Nairobi sheep disease, Bluetongue, Heartwater, Ephemeral fever, Toxoplasmosis, leptospirosis, brucellosis, Q fever and salmonellosis due to various similar clinical signs (Geering et al., 1995; Gear 1989; Ksiazek et al., 1989)

2.1.6. Diagnosis Rift Valley Fever

Acute RVF can be diagnosed using several different methods. Serological tests such as enzyme-linked immunoassay (ELISA) may confirm the presence of specific antibodies to the virus namely; IgM in recent infections and IgG antibodies in past infections or vaccinations (Niklasson *et al.*, 1984, Ksiazek *et al.*, 1989). The virus itself may be detected in blood during the early phase of illness or in post-mortem tissue using a variety of techniques including virus propagation in MDCK cell cultures or inoculation in baby mice, antigen detection tests e.g. RT-PCR and virus neutralization tests (Garcia *et al.*, 2001, Drosten *et al.*, 2002).

2.1.7. Control of Rift Valley Fever

There are various modes of controlling the disease in animals and humans. The most effective mode of control is through vaccinations. For animals, there are two types of vaccines. The first is the attenuated live virus vaccine, the Smithburn Neurotropic strain (SNS). This vaccine is highly immunogenic which confers immunity lasting 3 years after one inoculation. Although it may confer immunity it has been shown to lead to fetal abnormalities and abortions in susceptible genotypes of sheep and may be pathogenic to humans (Barnard

1979; Kark *et al.*, 1982). The other vaccine in use comprises of a formalin inactivated-virus which requires two inoculations due to its poor antibody response. It requires a booster three to six months after first inoculation and thereafter an annual vaccination. This type of vaccine is safe to use in pregnant animals and is recommended in pregnant cows to confer colostral immunity to their young (Davies *et al.*, 1992).

A human live attenuated vaccine, MP-12, is currently undergoing trials, but is not approved for human use. This vaccine was developed by mutagen induced changes in the ZH548 strain of the RVFV obtained from a field strain isolated from a mild human case in the Central African Republic. A naturally attenuated clone known as Clone-13 has also been developed to be used as a vaccine and is also under trials not yet released for field use (Frank, 2000). Other attenuated vaccine strains have been developed as potential live human vaccines together with formalin-inactivated vaccines and they have been used for a while to protect laboratory workers likely to be exposed to the virus (Eddy *et al.*, 1981; Frank, 2000).

Other control measures used in livestock operations include restricting or banning livestock movement, trade, slaughter, and consumption and closure of markets. Establishment of an active animal health surveillance system to detect new cases is essential in reducing the risk of animal-to-human transmission as a result of unsafe animal husbandry and slaughtering and consumption practices. Other useful control measures against mosquitoes is the use of impregnated mosquito nets, personal insect repellent if available, wearing light colored clothing (long-sleeved shirts and trousers) and by avoiding outdoor activity at peak biting times of the vector species. Use of larvicides on mosquito breeding sites is also effective (Logan *et al.*, 1990; Whittler *et al.*, 1993).

Rift Valley Fever in Kenya, focusing on the 2006 – 2007 outbreaks.

Rift Valley fever has occurred in Kenya since 1912, the first case having been reported in Kenya, but other outbreaks have occurred with the most recent being in 2006-2007. The disease has spread to many African countries becoming enzootic and has also been reported outside Africa in Saudi Arabia and Yemen (El Akkad., 1978; Saluzzo *et al.*, 1987; Meegan and Bailey., 1988; Zeller *et al.*, 1997; Gerdes., 2004; Abdo-salem *et al.*, 2011; Madani *et al.*, 2003). It has been predicted that the risk for more epizootics is increasing due to changing global warming (Anyamba *et al.*, 2009).

A study was done following the 2006 – 2007 outbreaks that indicated that although RVF was not the most prevalent disease in North Eastern Kenyan, it proved to be the disease that had the greatest impact on the livelihoods of Somali pastoralists in the area. The RVF outbreak was also less widespread in northern Tanzania than in other regions and due to this had less of an impact on traditional knowledge systems (Jost *et al.*, 2010). Another study was done focusing on the risk factors associated with severe RVF disease and death (Amwayi *et al.*, 2010). This study indicated that consuming or handling products from sick animals was significantly associated with acute RVF infection, severe illness, and death. The study also documented that mosquito-related exposures were difficult to quantify and were not associated with infection or severe disease. Contact with animals (cows, sheep, or goats) was significantly associated with acute infection with RVFV and with severe RVF disease. From the study they also indicated that a high proportion of acute RVF infections were in housewives. This was associated with their handling sick animal products during food preparation procedures. The study also showed that association of male gender with acute RVF infection was related to their day to day activities like herding, which increased animal to human exposures. Because of their close proximity to animal herds, herdspersons would also be at greater risk of being bitten by mosquitoes that have bitten infected animals. (Amwayi *et al.*, 2010)

Another study was done in 2006 focusing on the Somali community of North Eastern Kenya which shows the variability in exposure and RVFV seropositivity among Kenyan villages. The study emphasized on the effect of age, gender, location, and animal husbandry in RVFV transmission (LaBeaud *et al.*, 2008). Male participants were more likely to be seropositive than female participants, a risk that had been noted following the 1997 RVF outbreak investigation (Woods *et al.*, 2002). As RVF extends into other parts of the world it is becoming a disease of global importance for human and animal health and therefore more research is needed to define the most accessible control measures (LaBeaud *et al.*, 2008). It has also been indicated that for these control measures to be effective, early warning and surveillance systems need to be put in place by incorporating the livestock keepers. Therefore, one has to understand the very crucial role played by livestock keepers in veterinary surveillance which can take advantage of livestock owner observations through the integration of participatory disease surveillance (Jost *et al.*, 2007). In addition to surveillance, providing warnings based on models that place more emphasis on climatic information will increase the lead time before events. It would thus be beneficial if national stakeholders could reinforce local climate monitoring and disease surveillance in known high risk areas, and alert response systems to begin preliminary mobilization of resources before there is a full blown epidemic (Martin *et al.*, 2008).

In Tanzania during the 2006-2007 RVF outbreaks, most of the central and northern parts of the country were affected. There were effects on rural people's food security and household nutrition. There were also direct and indirect losses to livestock producers in the country in terms of morbidity and mortality. Incomes of livestock dependent communities decreased due to the reduction in the consumption of red meat. Again as more people were getting infected and sick, they became incapacitated and this led to interference with their normal economic ventures and this led to lack livelihood. During this outbreak the Tanzania government spent about US$3.84 million to control the disease and thus the economic impact attributable to the disease are perceived to be substantial (Sindato *et al.*, 2011).

In addition to the toll on health, the outbreak likely had substantial economic impact. Bans on slaughtering were imposed in each of the affected areas and aggressive attempts were made to stop movement of livestock from affected areas to unaffected areas. In areas like Northeastern Kenya Province where the principal source of food is livestock and where a substantial number of people work in the livestock industry, the quarantines and slaughter bans were in effect for more than 2 months. While likely effective at minimizing the severity of the outbreak, these interventions had devastating impact on livelihoods (Nguku *et al.*, 2010). Karl Rich and Francis Wanyoike focused more on the socio – economic impacts of RVF following the 2006-2007 outbreaks in Kenya valuing the total economic losses from livestock deaths at over 7.6 million US dollars. They also showed that these losses had negative spin-off effects on household food security and future income. The slaughterhouses and other livestock traders were affected by movement bans on livestock and decreased consumer demand for meat which greatly affected sales of live animals and meat products. The economic loss from closure of slaughterhouses in Garissa and Mwingi was estimated at U.S. $2,360 dollars and U.S. $660 dollars per month. At national level, the study estimates that the Rift Valley fever outbreak led to a U.S. $26 million loss to the Kenyan economy. However, non-agricultural sectors such as transportation, petroleum, trade and chemical shops also experienced economic losses (Rich and Wanyoike 2010).

The communities targeted in these studies were mainly the pastoral communities. However, little is known about the disease in dairy farming communities. Therefore this study was done to investigate the impacts of the disease and control option instituted against it. The study compared the impacts on the pastoral and dairy farming communities and found out how these different communities dealt with the disease during an outbreak. The study also aimed to gather any available traditional knowledge regarding the disease from these communities and the risk factors that may have lead to the spread of the disease.

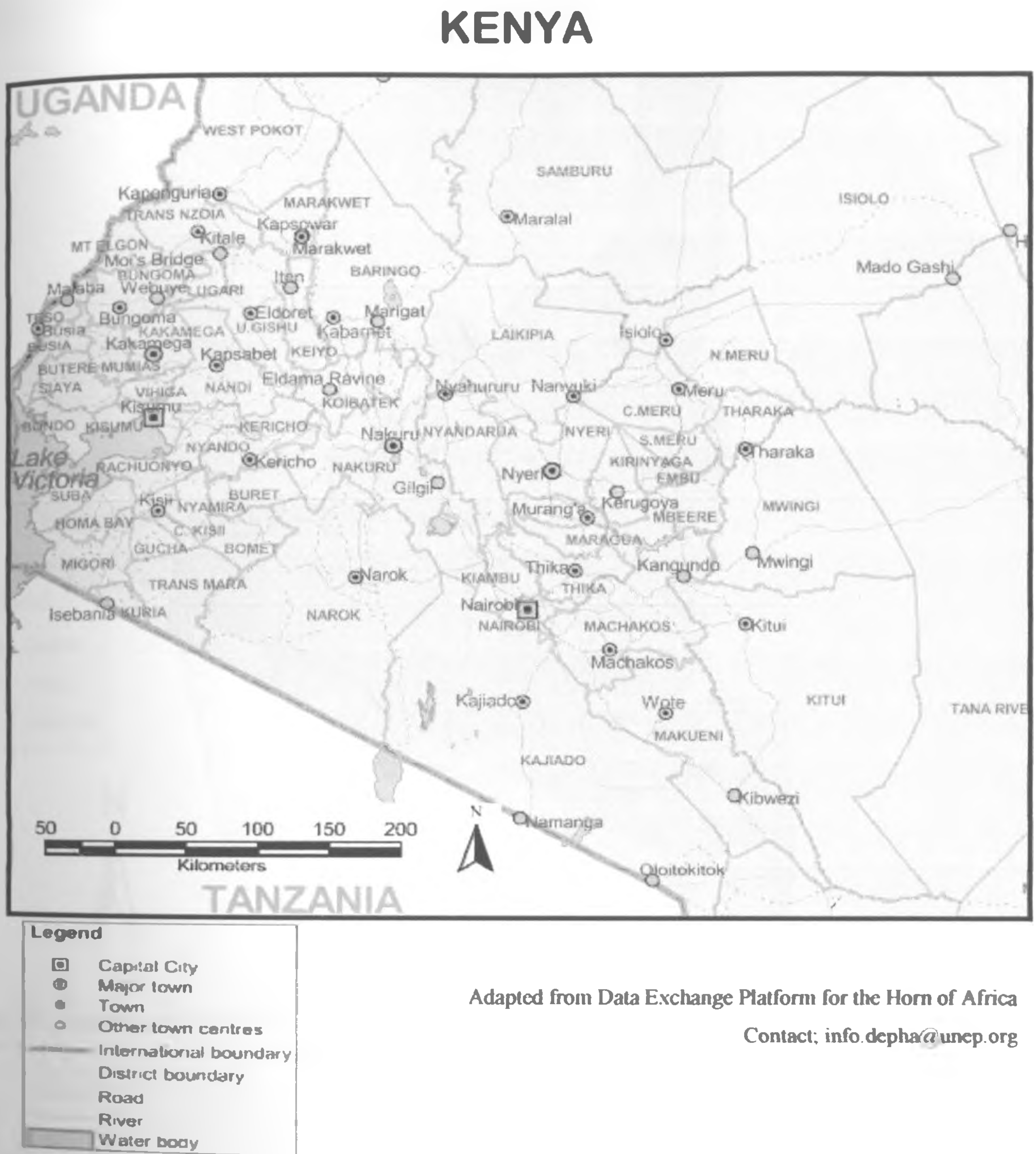
CHAPTER THREE

MATERIALS AND METHODS

3.1. Study area

The study was carried out in Marigat District in Rift Valley, for the pastoral farming system and Thika District in Central Kenya, for the dairy farming system. Thika District was selected because it is a District where RVF outbreaks have occurred and confirmed since 1962 (Meegan and Bailey, 1988) some of which were confirmed during the 2006-2007 RVF outbreaks in Kenya (Rich and Wanyoike, 2010). It is also a majorly dairy farming area, one of the livestock systems targeted by this study in order to compare risk factors and management practices between dairy and pastoral farming systems. It has areas that are flat and prone to flooding during heavy rains providing ideal breeding grounds for the mosquitoes carrying the disease virus. Marigat district was selected because among the six districts of Baringo County, it was the one most affected by RVF and the farmers mainly practice pastoral farming. Another criterion for deciding on the two areas was because they have had their animals vaccinated against the disease in the last five years. This was to assess the impact of the control option on their socio- cultural and economic activities.

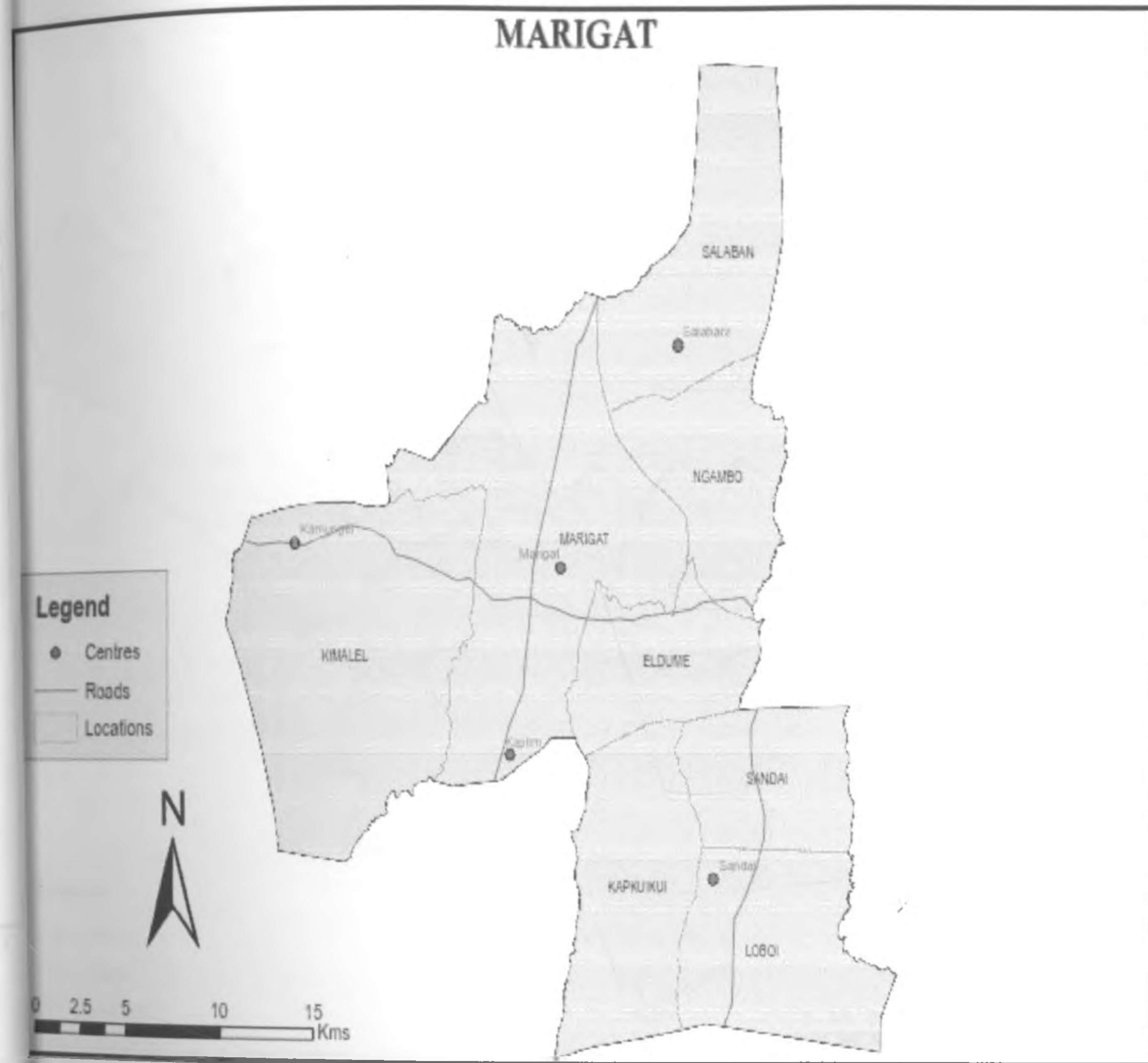
The locations and households were selected according to the areas that had vaccinated their animals against RVF with one group being selected from a location that had experienced the disease during the outbreaks and the other had not experienced the disease thus acted as a control. This information was gathered from office of the District Veterinary Officer. A total of 80 households were surveyed in each of the two districts.



Adapted from Data Exchange Platform for the Horn of Africa

Contact: info.depha@unep.org

Figure 3.1 The Map of Kenya showing Thika and Marigat Districts, the Study Area



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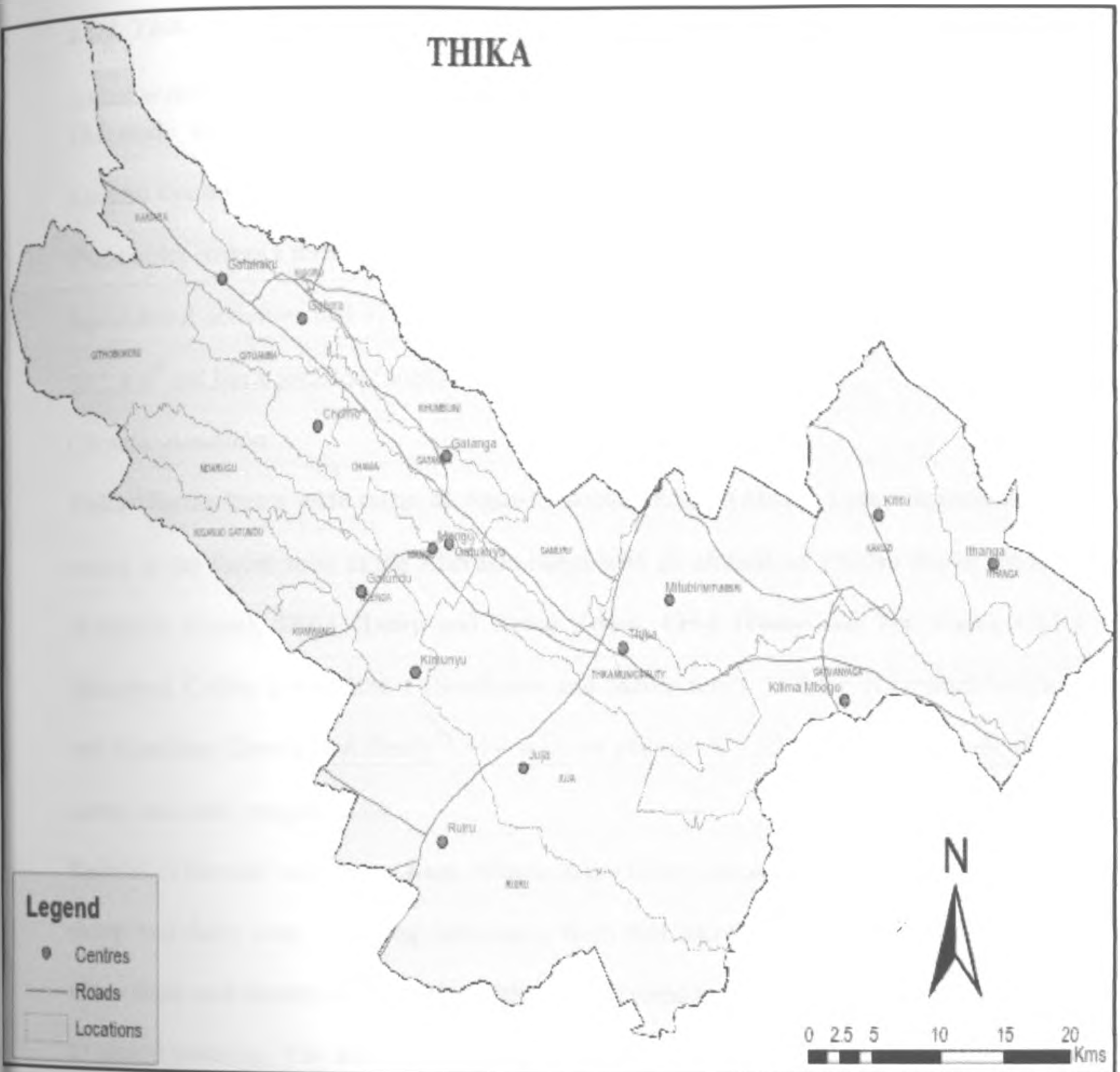
Contact; info.depha@unep.org

Figure 3.2 The Map of Marigat District showing different locations with the Head quarters as Marigat town.



Adapted from Data Exchange Platform for the Horn of Africa

Contact; info.depha@unep.org

Figure 3.3 The Map of Thika District showing different locations with the Headquarters at Thika Town

3.1.1. Thika district

Location and land area

The study focused on Thika district located in the southern part of Central Province in Kiambu County.

The district covers a total surface area of 1960 Km^2 with 1464.5 Km^2 being potential land for Agricultural activities and 423.5 Km^2 being non-arable land. The water mass covers about 13.5 km^2 and has a gazetted forest of 21.3 km^2.

Climatic condition

Thika District has a wide range of Agro-Ecological Zones (AEZs). Upper highlands UH-0 which is the forest zone in the Aberdare range with an altitude of 2,435m above sea level (Kamakia forest), UH-1 (Dairy and Sheep Zones, LH-1 (Dairy and Tea Zone), UM-3 (Marginal Coffee zone), UM-4 (Sunflower and Maize zone), UM-5-6 (Livestock/sorghum and Ranching Zones), and finally LM-4 with an altitude of 1,555m above sea level, this is cotton and sisal marginal zone.

Rainfall is bimodal and ranges from 500mm in the lower cotton zone to 1300mm in the high sheep and dairy zone. The long rains occur from mid March to June while the short rains occur from mid October to December although this trend is changing which can be attributed to global warming. The district receives an average annual rainfall of between 1000 – 2500 mm in the UM-1-2 and UH-0-1 Zones; 500 – 900 mm in the UM3-6 and LM-4.

Economic activities

In Thika district dairy farming is a major enterprise being practiced in most parts of the district. Majority of the dairy animals are being kept in zero-grazing units or being stall-fed. There are a few large scale commercial Dairy farmers such as Gicheha farm (Brookside) and Mongolia among others. Free range farming is practiced in the marginal zones of the district where beef cattle, sheep and goat rearing are the major economic activities an example being in Juja. Rabbit keeping is another enterprise many farmers in the district have started and the Ministry of Livestock Development is offering the farmers technical support in order to improve food security and livelihoods. Other enterprises include dairy goats and bee-keeping and this has been adopted by fewer farmers.

As a result of the drought in 2008, there was a big influx of livestock from Kajiado and Narok districts. Though it is sometimes a common practice for Maasai animals to migrate into the district during the dry spell, the year 2008 witnessed a higher influx than the previous years. As measure to control diseases due to the huge influx of livestock, and mitigate the effects of drought, livestock were vaccinated against FMD, LSD, RVF, Blanthrax and Sheep and Goat pox. Treatment of livestock was also done concurrently with vaccinations especially of the weak animals (Personal communication – DVO Thika).

Population

The main ethnic community in Thika is the Kikuyu although it is fast becoming a cosmopolitan area with the influx of communities from around the country especially the Maasai. The estimated population is 645,700 persons with a density of 329 persons per Km^2 (KNBS census, 2009).

3.1.2. Marigat District

Location and land area

The other district targeted for the research was Marigat District in Baringo County in the Rift Valley Province. Baringo County is divided into six districts namely, Baringo Central, Baringo North, Marigat, East Pokot, Mogotio and Koibatek districts. The District had 17 locations with reported RVF outbreaks with five of these having high number of positive cases during the 2006-2007 RVF epidemics. The area is flat with depressed regions that flood when it rains. These water pools form the points for multiplication of mosquitoes that spread the disease. The outbreak affected both animals and humans with human deaths occurring in some households. During the outbreak, the veterinary office did not carry out a vaccination campaign as in the other parts of the country but concentrated on quarantine and control of mosquitoes by providing sleeping nets and insect repellants. This was done to minimize the risk of spreading of the infection through the use of one needle in multiple inoculations of many animals. The five locations affected were Ngambo, Salabani, Ilchamus, Kiserian and Ilng'arua with Ngambo and Kiserian reporting the highest number of infections (Personal communication – DVO Marigat).

Climatic condition

Marigat district lies in the midlands of Rift Valley province and experiences an average rainfall of 600-1000mm per year. It is serviced by two perennial rivers, Perkerra, and Molo which support the irrigation schemes in the area. The district borders East Pokot to the North, Laikipia West to the East, Baringo Central to the West and Mogotio District to the South. It covers an area of approximately 1,514.92km, with an estimated population of 56,146 of which males are 27,884 and females are 28,262 (KNBS census,. 2009).

Economic activities

The district is fast growing with the growth being supported mainly by the Perkerra irrigation scheme where they practice horticulture with growing of onions, pepper, pawpaw, watermelon, tomatoes and maize among other crops. Marigat town is about 20 Km from Lake Baringo where residents get a supply of various types of fish. Lake Bogoria in Baringo County is mainly a tourist attraction as it has hot springs and a large number of flamingoes. The main economic activities in the district include horticulture through the Perkerra irrigation scheme, sale of livestock especially goats and sheep, fish in the Lake Baringo region a place known as 'Kambi ya samaki'(fish camp) just next to the lake and the fish is transported to the town and sold to the locals and the tourists. Selling of honey which is locally known as 'kumnyate' is also another big source of income to the locals and this honey is collected from commercially made beehives hanging from trees or a more traditional way from underground. Another source of income is selling of charcoal which they make from the readily available *Prosopis juliflora*. The plant grows very fast colonizing farms and pasturelands eventually forming dense impenetrable thickets which lead to impairment of various activities especially farming and livestock keeping as it has led to elimination of forage grass. The tree is also being used for building poles and enhances beekeeping as it flowers continuously. Art such as braided calabashes, Ilchamus clubs and sheets and the Tugen bow and arrows are also sold to tourists as source of subsistence to some families (Personal communication – DVO Marigat).

Population

The district is mainly inhabited by the Tugen (Samor) to the South, southeast and southwest while the Njemps (Ilchamus) occupy mainly the low regions northwards. There are also some western Pokot communities integrated with the two main ethnic groups. The district has an estimated population of 56,146 of which males are 27,884 and females are 28,262 (KNBS Census,. 2009).

In 2008 and 2009, the Ministry of Livestock Development decided to vaccinate the animals in the area against RVF. The veterinary personnel managed to vaccinate the majority of the animals in the four locations experiencing the worst outbreaks except Ngambo where they managed to do about 80% of the animals before the vaccine run out. By the time the vaccines were replenished, the farmers had gathered information from the others that there animals were aborting upon vaccination which is a common side effect of the Smithburn Neurotropic strain vaccine provided by the Ministry of Livestock Development, so most of the farmers declined to have their animals vaccinated for fear of abortions (Personal communication – DVO Marigat).

3.2. Study design

The study was carried out in Thika and Marigat Districts of Kenya. While selecting the households, a consideration was made to select the locations purposefully based on whether they had vaccinated or not vaccinated cattle against RVF in the past and then select the household from a given list before getting to the field to collect the data. This information was obtained from the administrative offices, District Veterinary officer and the assistant chiefs in collaboration with the village elders. Data was collected from 80 selected households from each district giving a total of 160 households from the two districts.

The study utilized the crossectional study design where data was collected from one area within a given period of time. Primary data was collected from the households through questionnaires, observations and interviews. These included questions on farm management practices, disease history, disease management both traditional and conventional and effects of the disease and its control measures on the social and cultural activities of the communities. Other questions included an assessment of the socio- cultural activities affected by the disease outbreak. More information was collected from available records in the government offices which included data on the areas that had outbreaks, government's interventions and assistance to the communities.

Data collection in Thika

Data was collected from eleven locations within the district including: Juja and Ruiru where the disease had been reported and confirmed to have occurred earlier. The other locations were Karibaribi, Makongeni, Kiahura, Gatuanyaga, Wema, Kariminu, Maboromoko, Ndurumo, and Tana where there was no evidence of disease but they had vaccinated their animals against RVF. In these locations questionnaires were administered to a total of 80 households.

Data collection in Marigat

Data was collected in Marigat from the five affected locations that is, Ng'ambo, Kiserian, Salabani, Ilchamus and Ilng'arua. The other locations were used as controls and these were; Santai, Arabal, Loboyi and Marigat. In these locations, questionnaires were administered to 80 households.

3.3. Data analysis

The data collected was analyzed using Statistical Package for Social Science (SPSS) (The IBM Corp. Web site, www.ibm.com). Descriptive analysis was carried out on data collected through personal interviews, group discussions and also incorporated the secondary information obtained from the government offices. The data were summarized in terms of frequencies and graphs and used to compare different attributes between the two districts. Analysis for statistical difference was done using hypothesis testing for difference between proportions. Statistical difference was calculated using the formula below (Wayne., 2010, Kothari., 2004) The difference is significant when Z* if greater that 1.96 (confidence interval of 5%). The assumptions are:

i) The two populations are independent

ii) n1p1 x observations > 5., n2p2 x observations > 5

iii) There is equal variance between the two populations

$$Z^* = \frac{p1-p2 \ldots\ldots\ldots}{\sqrt{\frac{p1q1}{n1} + \frac{p2q2}{n2}}}$$

Z* is the calculated significance difference

CHAPTER FOUR

RESULTS

A total of 160 questionnaires were administered with 80 in each district. The information obtained was summarized in tables and graphs incorporating information from the group discussions, personal observations and the government offices.

4.1. Effect of occurrence of RVF on socio-cultural and economic activities in Thika and Marigat Districts

The occurrence of RVF disease in 2006/2007 in the two districts was reported to have various impacts on the communities affected. The disease was reported to affect many economic activities in the various homesteads in the two districts as shown in Table 4.1. The activities included, selling of milk, selling of animals especially sheep and goats and selling of meat. The social and cultural activities affected were social gatherings, circumcision ceremonies, wedding ceremonies and oloibon ceremonies. In Thika, the sale of milk was affected with 12.5% (10/80) farmers losing their main source of income. In Marigat, the farmers interviewed did not depend on sale of milk for income but 98.8% (79/80) lost their main source of income as they could not sell their animals while 6.3% (5/80) in Thika lost income from lack of sale of animals. This shows that Marigat was more affected in terms of loss of income, with a significant difference of Z*=31.04, from sale of animals as shown in Table 4.1. Other losses incurred were related to the fact that the farmers had to spend money in buying other sources of protein as they could not consume the products from the animals and this affected all farmers in Marigat 100% (80/80).

Table 4.1 Effect of RVF outbreak on economic activities in Thika and Marigat districts

Effect on economic activities	Thika	%	Marigat	%	Significant difference Z*
Interfered with income from sale of milk	10	12.5	0	0	
Interfered with income from sale of animals	5	6.3	79	98.8	31.04
Spend money to buy other sources of proteins	0	0	80	100	

The disease also interfered with socio-cultural activities that normally took place throughout the year as shown in Table 4.2.In Marigat 96.3% (77/80) farmers stated that ceremonies like social gatherings e.g. elders' gatherings were interfered with while in Thika 6.3%(5/80) farmers talked of interference with social gathering. The significant difference between the two was Z*=26.09 showing that Marigat was the most affected as it is a close knit community which relies on gatherings to transmit information and educate the masses. Due to this it had various impacts on the society as there was interference with dissemination of information from the chief and the village elders to the community. Other activities affected in Marigat included circumcision where 62.5% (50/80) farmers were affected. This also meant interference in weddings as one could not wed until they had undergone circumcision and are initiated into adulthood. Interference of 'Oloibon' (rainmakers) ceremonies also affected 27.5% (22/80) of the farmers in Marigat. One of the women farmers from Marigat mentioned interference in the women meetings to contribute money to assist each other in improving their lives and their businesses as shown in Table 4.2 this in a way according to her impaired progress.

Table 4.2 Effects of RVF on socio-cultural activities in Thika and Marigat Districts

Effects on socio-cultural activities	Thika	%	Marigat	%	Significant difference Z*
Interfered with social gatherings	5	6.3	77	96.3	26.09
Interfered with oloibon ceremonies	0	0	22	27.5	
Interfered with circumcision ceremonies	0	0	16	20	
Interfered with weddings	1	1.3	50	62.5	
No merry go round	0	0	1	1.3	

The prices of various commodities changed according to the shift in what the people consumed during the outbreak as shown in Figure 4.1. The prices for beef, goat and sheep meat and milk dropped during the outbreak as people could not consume animals' products compared to before and then went up after the outbreak as people could now consume animals' products. Beef was being sold for between shillings 120 and 150 per kilogram before the outbreak in Thika and between 100 and 120 in Marigat but during the outbreak the prices went down in Thika to range from 100-180 but no beef was sold on Marigat. After the outbreak the prices went up ranging from 180 to 300 in Thika and 200 to 250 in Marigat for a kilogram of beef. A kilogram of goat or sheep meat in Thika before the outbreak was 180 while in Marigat it ranged from 140-160 shillings. During the outbreak it dropped to 100 shillings per kilogram in Thika while in Marigat they did not sell any goat. After the outbreak the prices shot up with a kilogram of goat or sheep meat being sold for 210 shillings in Thika while in Marigat it ranged from 240-300 shillings. Chicken prices also fluctuated by going up during the outbreak as the people preferred to consume chicken to beef, goat or sheep meat for fear of contacting the disease. In Thika the price was 200 shillings per bird before the outbreak and it increased to more than double the price to 500 shillings per bird during the outbreak but dropped to 350 shillings per bird after the outbreak as the people slowly went back to consuming beef, goat and sheep meat. In Marigat the prices also changed but not as drastic as Thika with a bird being sold for 80-180 shillings before the outbreak, 150-300 during the outbreak and then dropped slightly to 200-250 after the outbreak as people could now eat beef, goat or sheep. Milk prices also changed slightly as shown in Figure 4.1.

During the 2006-2007 RVF outbreaks, the people in both districts were forced to look for other sources of protein other than meat, milk and blood as indicated in Table 4.3. The other sources of protein included; chicken with 50% (40/80) in Thika, 96.3% (77/80) in Marigat, fish was also consumed, eggs, vegetables, pork especially Thika with 13.8% (11/80) consuming pork while in Marigat the farmers did not consume pork at all. Vegetables were widely consumed in both districts with 93.8% (75/80) in Thika and 100% (80/80) in Marigat. Pulses were also widely consumed in both districts 98.8% (79/80) and 85% (68/80) in Marigat.

Table 4.3 Protein sources consumed during the 2006-2007 RVF outbreaks in Thika and Marigat Districts

Protein sources	Thika	%	Marigat	%
Products consumed during the RVF outbreak				
Chicken	40	50	77	96.3
Fish	21	26.3	71	88.8
Wild game	0	0	0	0
Eggs	37	46.3	73	91.3
Vegetables	75	93.8	80	100
Pork	11	13.8	0	0
Pulses and legumes	79	98.8	68	85
Duck	1	1.3	0	0
Geese	0	0	0	0
Turkey	0	0	0	0

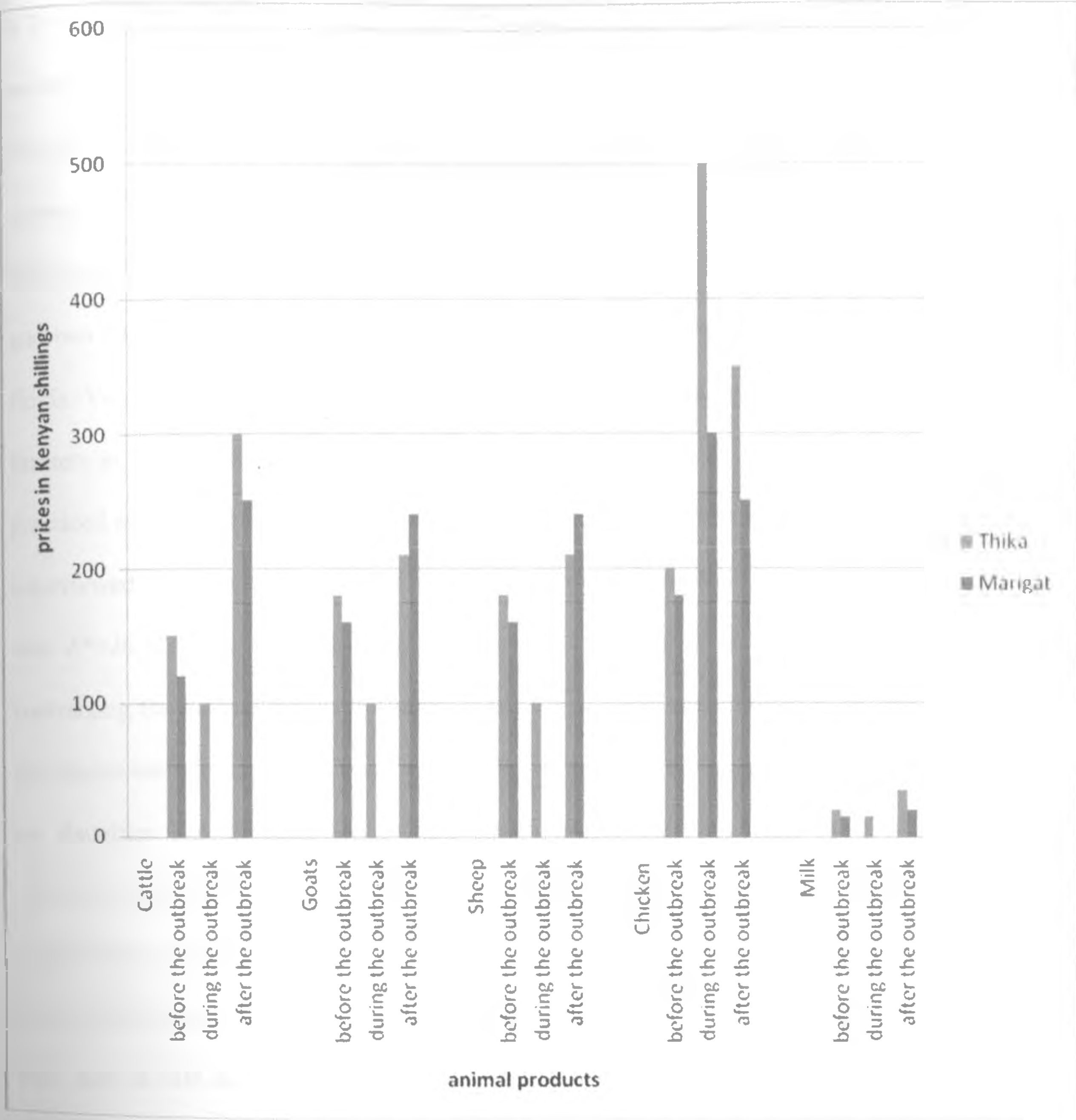


Figure 4.1. The prices of various animal and animal products before, during and after the RVF outbreaks of 2006-2007 in Thika and Marigat districts of Kenya

Note: *The prices indicated for cattle, goat and sheep are per a kilogram of meat while for the chicken it is for a whole piece and the milk for a litre.*

4.2. Formal control measures against RVF disease and their effect on social and cultural activities.

In both districts, it was reported that the government had put control measures to prevent the spread of the disease during the outbreaks of 2006/7 as shown in Table 4.4 and these included vaccinations, quarantine, ban on sale and consumption of animal's products, meat and milk, and ban on slaughter of animals and preventing contact of people with animal's tissues and fluids. Vaccinations were the most commonly reported control measures with 100% (80/80) farmers in both districts having had their animals vaccinated. In Thika, quarantine was not practiced extensively with 10% (8/80) farmers practicing it while in Marigat all the farmers interviewed quarantined their animals. The significant difference between the two locations was Z*=26.47and this was because in Marigat, the farmers had a fear of their animals contracting the disease since the outbreaks were quite extensive thus more of them followed the quarantine initiative. This they were informed through the media and chief barazas. Ban on slaughter and consumption of animals products was practiced by all the farmers interviewed in Marigat while in Thika about 20% (16/80) did not sell or consume meat and milk with the significant difference of Z*=17.8. This showed that Marigat the farmers were keen to follow the directions given by the local authorities as the risk for getting infected was high. Ban on sale of the animals was also practiced by all the farmers interviewed in Marigat and 18.8% (15/80) in Thika did not slaughter animals with a significant difference between the two being Z*=18.45. This was also due to the risk of getting infected in Marigat which was higher than in Thika.

Due to the control measures put up by the government as shown in Table 4.4, there were some reported impacts on the farmer's ways of earning a living. These effects included loss of income from sale of milk mostly experienced in Thika as most farmers reported reliance on their animals for milk with 22.5% (18/80) reporting loss of income from ban on sale of animal products specifically milk. In Marigat, the farmers did not report reliance on sale of milk for income but on sale of whole animals thus due to ban on animals' sale about 65% (52/80) of farmers reported very heavy losses as this was the main source of income while in Thika 10%(8/80) reported loss due to ban of sale of animals. The significant difference between the two was Z*=8.7 with Marigat having more loss than Thika. The farmers in Thika reported an increase in the sale of chicken and eggs during outbreak when there was a ban on consumption of meat or milk as shown in Table 4.4.

Socio-cultural activities were also affected by the control measures put up by the government and these included social gatherings as reported by 6.3% (5/80) of farmers in Thika and 96.3% (77/80) in Marigat with a significant difference of Z*=26.09. The most affected gatherings were chief's barazas (public gatherings) and elders' gatherings and any other gathering that involved the slaughter of animals or consumption of animals' products more in Marigat than Thika. In Marigat, other socio-cultural activities reported affected were circumcision 20% (16/80), weddings 62.5% (50/80), 'Oloibon' ceremonies (rain makers ceremonies) 27.5% (22/80) as they relied on consumption of animals products, meat, milk and blood.

Table 4.4 Formal control measures and their effects on socio, cultural and economic activities of the farmers in Thika and Marigat Districts

Control measures and their effects	Thika	%	Marigat	%	Significant difference Z*
Control options put up by the government					
Vaccinations	80	100	80	100	
Quarantine	8	10	80	100	26.47
Ban on sale and consumption of meat and milk	16	20	80	100	17.8
Ban on slaughter of animals	15	18.8	80	100	18.45
Control measures effect on economic activities					
Loss of income from sale milk	18	22.5	1	1.3	
Loss of income from sale of animals	8	10	52	65	8.7
Increased income from sale of chicken	2	2.5	1	1.3	
Increased income from sale of eggs	1	1.3	0	0	
Control measures effect on socio-cultural activities					
No gatherings	5	6.3	77	96.3	26.09
No circumcision	0	0	16	20	
No wedding ceremonies	1	1.3	50	62.5	
No oloibon ceremonies	0	0	22	27.5	
No grazing out had to bring feed to animals	0	0	1	1.3	

4.3 Community based knowledge on RVF disease in animals and management by farmers in Thika and Marigat

As indicated in Table 4.5, it was evident that the people in Marigat were more aware of RVF 100% (80/80) than those of Thika 93.8% (75/80) with a significant difference of Z*=. In Marigat, most people learnt about the disease through experiencing it in their animals while in Thika most learnt from the media or the local authorities since very few experienced it in their farms. According to all the farmers in both districts 100% (80/80) the disease was relatively new to them and so they did not have a local name for it as they did for other commonly occurring diseases.

With regard to other diseases reported alongside RVF, some farmers 1.3% (1/80) experienced East Coast fever and 3.8% (3/80) experienced pneumonias in Thika while in

Marigat the farmers interviewed 100% (80/80)) did not report any other disease that could be associated with outbreaks of RVF as shown in Table 4.5.

Table 4.5 Rift Valley Fever Disease awareness by farmers in Thika and Marigat Districts

RVF disease awareness by farmers	Thika	%	Marigat	%
Farmers aware of RVF disease	75	93.8	80	100
Availability of a local name for RVF				
None	80	100	80	100
Other diseases seen at the same time as RVF				
E.C.F	1	1.3	0	0
Pneumonias	3	3.8	0	0
None	76	95	80	100
animals species reported to have been affected by RVF				
Cattle	2	2.5	11	13.8
Goats	2	2.5	16	20
Sheep	2	2.5	19	23.8

The animals reported to have been affected most by RVF were sheep and goats where in Thika 11 and 13 goat and sheep were affected respectively with 20 sheep dying from the disease as shown in Table 4.6. In Marigat there were 210 goats reported showing signs of RVF with 503 reported to have died from the disease while 212 sheep were showing the signs and 356 reported dead from the disease. In both districts, cattle were also reported to be affected by RVF with 1 cow having been reported sick and died from the disease in Thika while in Marigat there were about 68 cattle reported sick and 92 that were reported to have died from the disease. The animals were also reported to experience abortions with a high number reported in the sheep and goat especially from Marigat district where 145 and 196 goat and sheep aborted respectively unlike in Thika where there was one goat and 13 sheep reported to have aborted.

Table 4.6 Animals reported by farmers to have been sick, aborted or dead in their farms during the 2006-2007 RVF outbreaks in Thika and Marigat Districts

Animal status	Thika			Marigat		
	Cattle	Goats	Sheep	Cattle	Goats	Sheep
sick	1	11	13	68	210	212
aborted	1	1	13	9	145	196
dead	1	0	20	92	503	326

Table 4.7 shows various clinical signs reported by the farmers in the animals that were suspected to be suffering from RVF. The Table shows that some clinical signs were commonly reported while others were reported by individual farmers. The Table further shows that the most common clinical signs reported were abortions especially in Marigat with 35.1%,28/80, (cumulative percentage from all animals), observed in the three animals species in focus, but in Thika it was 3.8%,3/80, and this was due to the fact that in Thika few animals experienced the disease. In Thika, the clinical sign most reported was drop in milk production by 7.5%, 6/80, (cumulative percentage from all animals) of farmers since most farmers in Thika were dairy farmers. In Marigat the other common observation reported was death by 36.3%, 29/80, (cumulative percentage from all animals) of farmers with goats reported mortality of 15%, 12/80, and 13.8%, 11/80, in sheep. Bleeding from orifices was another common clinical sign reported in Marigat by 21.3%, 17/80, of farmers but was not reported in Thika.

Table 4.7 Disease signs described by farmers as seen during the 2006-2007 RVF outbreaks in Thika and Marigat

Disease signs	Thika				Marigat			
	Cattle	Goats	Sheep	cum	Cattle	Goats	Sheep	cum
Fever	2		1	3	1	2	3	6
Lack of Appetite	2	1	1	4	3	4	3	10
Reduced Milk Production	2	2	2	6	1			1
Abortions	2		1	3	4	11	13	28
Bloody Diarrhea	2		1	3	1	6	4	11
Bleeding					4	5	8	17
Shedding Hair					2	4	5	11
Bloated					2	1	1	4
Foaming at the Mouth					3		1	4
Restless					1			1
Weakness					1			1
Bloody Urine					1	2		3
Shrunken Udder					1			1
Depressed						1		1
Jaundice						1		1
Coughing						2		2
Death	1	1		2	6	12	11	29

Key: Cum – Cumulative total of animals with a particular disease sign

Treatment of the suspected animals was done by animal health assistants in Thika 3.8%, (3/80) as shown in Table 4.8 while in Marigat most farmers preferred to treat their own animals 30% (24/80). A few farmers in Marigat 2.5% (2/80) preferred animal health assistants and another 2.5% (2/80) in Marigat and 1.3% (1/80) in Thika preferred veterinary doctors. The drug commonly used in treating the suspected cases in Thika was Betamox® an amoxicillin antibiotic while in Marigat the drug used was Adamycin® with 27.5% (22/80) reporting to use it in combination with penicillin and 21.3% (17/80) with streptomycin. Some farmers also gave multivitamin.

One farmer in Marigat reported to have used "*chang'aa*" (a highly concentrated locally made alcohol brew) to treat his animals while another farmer washed the animals with detergent, OMO®. Since the farmers said RVF was a relatively new disease, most did not seem to have traditional control measures for the disease in existence.

Table 4.8 shows that two farmers in Thika reported knowledge on traditional methods of control with one suggesting use of herbs boiled and the water administered to the animals while the other suggesting cleaning the animals and their sleeping areas. In Marigat, one farmer reported the traditional use of herbs as a control measure.

Table 4.8 Methods practiced by farmers in managing and controlling RVF disease in Thika and Marigat Districts

Management and control of RVF	Thika	%	Marigat	%
Person treating animals suspected of RVF				
Veterinary Doctor	1	1.3	2	2.5
Animal Health Assistant	3	3.8	2	2.5
Owner	0	0	24	30
Drugs used during the management of RVF				
Betamox	3	3.8	0	0
Pen strep	0	0	17	21.3
Dexamethasone	1	1.3	0	0
Adamycin	0	0	22	27.5
Multivitamin	0	0	5	6.3
Mwarubaine	0	0	1	1.3
Changaa	0	0	1	1.3
Dewormer	0	0	2	2.5
Novidium	0	0	2	2.5
Beridin	0	0	3	3.8
Wash them with OMO	0	0	1	1.3
Ox tetracycline	0	0	1	1.3
Presence of traditional ways of controlling the disease	2	2.5	1	1.3
Use of herbs	1	1.3	1	1.3
Cleaning the animals and their sleeping areas	1	1.3	0	0

4.4. Communities awareness of occurrence of RVF in humans and its management in Thika and Marigat.

The disease was also reported to affect humans but this was reported more in Marigat than in Thika as shown in Table 4.9. In Thika, not all farmers reported awareness of the disease affecting humans with 58.8% (47/80) reporting that they were aware while the rest 41.3% (33/80) not aware. In Marigat, all the farmers interviewed 100% (80/80) were aware that the disease affected people. This shows that in Marigat the farmers were more aware of the

Z*=0.175 indicating that the farmers from both districts were aware that the disease was transmitted from consumption of contaminated animals products.

Table 4.9 RVF disease in humans during the 2006-2007 outbreaks in Thika and Marigat Districts

Rift Valley Fever in Humans	Thika	%	Marigat	%	Significant difference Z*
Awareness that RVF affects humans	47	58.8	80	100	7.49
Mode of transmission					
Mosquito bites	3	3.8	1	1.3	
Consumption of contaminated food	26	32.5	28	35	0.33
Handling sick animals or their products	2	2.5	3	3.8	
Do not know	16	20	48	60	5.66
Symptoms observed in humans suffering from RVF					
Fever	5	6.3	19	23.8	
Loss of appetite	3	3.8	2	2.5	
Vomiting	0	0	21	26.3	
Diarrhea	2	2.5	21	26.3	
Death	2	2.5	13	16.3	
Heavy breathing	1	1.3	0	0	
Bleeding	1	1.3	11	13.8	
Dizziness	0	0	2	2.5	
Weakness	0	0	3	3.8	
Headache	0	0	6	7.5	
Joint pains	0	0	1	1.3	
Jaundice	0	0	2	2.5	
Control of RVF in humans					
Mosquito nets	1	1.3	1	1.3	
Drain stagnant water	1	1.3	0	0	
Live away from animal shed	1	1.3	0	0	
Boil milk more than once before consumption	3	3.8	2	2.5	
Do not consume contaminated food	26	32.5	27	33.8	0.175
Use gloves when handling sick animals	2	2.5	3	3.8	

disease than in Thika with a significant difference of Z*=7.49. The farmers from both districts 32.5% (26/80) in Thika and 35% (28/80) in Marigat reported that the disease was transmitted by consuming contaminated food i.e. meat, milk and blood with a significant difference of Z*=0.33 as indicated in Table 4.9. This shows that the difference was not significant as the farmers from both locations were equally aware of the major mode of transmitting the disease. Some reported that it was transmitted from handling sick animals and their products 2.5% (2/80) in Thika and 3.8% (3/80) in Marigat while 3.8% (3/80) farmers in Thika reported that it was transmitted by mosquitoes and one farmer from Marigat reported the same. About 60% (48/80) of farmers in Marigat did not know how the disease was transmitted to humans and while in Thika, this was about 20% (16/80) with a significant difference of Z*= 5.66. This difference was significant indicating that in Marigat some farmers were not aware of how the disease was transmitted increasing their risk of contracting the disease.

The symptoms observed in humans in both districts included fever, loss of appetite, diarrhea, bleeding from orifices among others as shown in Table 4.9. The most reported clinical sign was fever with 6.3% (5/80) reporting it in Thika and 23.8% (19/80) in Marigat. In Marigat, vomiting and diarrhea were other common signs reported at 26.3% (21/80) while bleeding by 13.8% (11/80). The other signs less commonly reported are shown in Table 4.9. Control of the disease was done using various methods such as use of mosquito nets, draining stagnant water, living away from the animal shed, boiling milk more than once before consuming, using gloves when handling sick animals and the most common in both districts was avoidance of consumption of meat, milk or blood from infected animals which was reported by 32.5% (26/80) in Thika and 33.8% (27/80) in Marigat with a significant difference of

4.5. Communities knowledge on predicting the occurrence of RVF.

In both districts the majority of the farmers 98.8% (79/80) did not report knowledge on ways of predicting the disease as it was relatively new to them Table 4.10. One farmer in Thika mentioned that huge clouds showing possibility of heavy rainfall could be a way of predicting the disease while in Marigat a farmer suggested observing the animals' intestines. This he said was done by medicine men who predicted occurrence of disease by observing the way the intestines were coiled in the abdominal cavity. Both these methods were vague as they did not predict specifically for occurrence of RVF but just occurrence of disease which can be any disease. There were a few environmental observations before and during the disease outbreaks in 2006/7 with 6.3% (5/80) reporting flooding and one farmer reporting increased number of carcasses in the field before there was the disease outbreak. Two farmers in Marigat reported the large number of carcasses in the field during the outbreak possibly as a result of the animals' deaths due to the disease.

Table 4.10 Prediction methods used by farmers for RVF disease and environmental observations before and during an outbreak in Thika and Marigat

Prediction methods and environmental observations	Thika	%	Marigat	%
Farmers who had knowledge on predicting occurrence of RVF	1	1.3	1	1.3
Prediction methods				
Huge clouds showing possibility of heavy rainfall	1	1.3	0	0
Observing animals intestines	0	0	1	1.3
Environmental observation before outbreak				
Flooding	0	0	5	6.3
Increase in number of dead carcasses in the field	0	0	1	1.3
Environmental observation during an outbreak				
Large number of carcasses in the field	0	0	2	2.5

4.6. Risk factors associated with occurrence of RVF

The farmers in the two districts practiced different modes of animal husbandry and management. In Thika 88.8% (71/80) of the farmers practiced zero grazing and about 12.5% (10/80) practiced semi intensive farming as indicated in Table 4.11. One of the farmers practiced both zero grazing and free range depending on the season where during the dry season he did zero grazing and during the wet season the animals were taken out to graze. In Marigat, all the farmers 100% (80/80) practiced free range grazing where the animals were released into communal fields. The animals were either grazed together 6.3% (5/80) in Thika, 30% (24/80) in Marigat significant difference of Z*=4.079, different species in different areas 93.8% (75/80) in Thika and 70% (56/80) in Marigat with a significant difference of Z*=4.1. These two differences were significant showing a greater risk of the animals in Marigat getting infected than those in Thika. In Marigat some farmers 2.5% (2/80) housed adults different from the young.

In Thika, most of the day to day management of the animals was done by employees 60% (48/80) while in Marigat 13.8% (11/80) with a significant difference of Z*=6.89 indicating that the employees in Thika were more at risk of getting infected due to contact with the animals than those in Marigat. In Marigat most of the day to day management of animals was done mainly by the wives 43.5% (35/80) and in Thika 22.5% (18/80) with a significant difference of Z*=2.93. This difference is significant in that it shows the wives in Marigat were more at risk of getting infected than those in Thika. The husbands were also involved in management of animals with 15% (12/80) in Thika and 21.3% (17/80) in Marigat with a significant difference of Z*=1.03 as shown in Table 4.11. The difference is not significant and this shows that the husbands in both districts are equally at risk of getting infected. The children were involved after the schools closed in both districts.

In Marigat, some farmers 11.3% (9/80), opened for the animals to leave their kraals in the morning and left them to go graze on their own after which they would return home later in the afternoon after eating their fill. In Thika, 98.8% (79/80) of the farmers housed different species in different premises whereas in Marigat, 75% (60/80) housed them differently with a significant difference of Z*=4.77. This difference is significant as it indicates that in Thika their mode of housing ensured reduced risk of transmitting infection from animal to animal than in Marigat. In Thika one farmer preferred to house all of them together while 25% (20/80) farmers in Marigat housed all the animals together in one kraal. In some parts of Marigat the community housed all the animals together in a common kraal due to insecurity and the morans took turns to watch over the animals throughout the night and during the day animals would also be herded communally.

Table 4.11 Animals' management practices by the farmers in Thika and Marigat Districts

Animals management practices	Thika	%	Marigat	%	Significant difference Z*
Types of management systems practiced					
Zero grazing	71	88.8	0	0	
Free range	1	1.3	80	100	
Semi intensive	10	12.5	0	0	
Person doing day to day management of animals					
Husband	12	15	17	21.3	1.03
Wife	18	22.5	35	43.8	2.93
Children	2	2.5	8	10	
Employee	48	60	11	13.8	6.89
Let to go feed on their own	0	0	9	11.3	
Animal housing					
All of them together	1	1.3	20	25	
Different species in different houses	79	98.8	60	75	4.77
Adults different from the young	0	0	5	6.3	
Young in house and adults outside	0	0	0	0	
Grazing of animals					
All of them together	5	6.3	24	30	4.079
Different species to different areas	75	93.8	56	70	4.1
The adults different from young	0	0	2	2.5	

The farmers in both districts reported facing various problems while managing their animals. Lack of feed was a problem reported by 25% (20/80) of the farmers in both Thika and Marigat as indicated in Table 4.12. In Thika they complained that there were no feeds in the shops while in Marigat they relied on grazing and during the dry season there was no feed and so they had to move over long distances in search of feed mixing herds from differerent homesteads increasing the risk of transmitting infection. Lack of water was reported more in Marigat 21.3% (17/80) than in Thika 7.5% (6/80) significant difference of Z*=2.53. In Thika the lack of water was due to problems from the water company while in Marigat they had to move for miles in search of water especially in the dry season. This increased the risk when the animals got mixed from one homestead to another in strategic drinking holes. When the animals fell ill, they were handled by different people. In Thika 16.3% (13/80) husbands handled sick animals while in Marigat 37.5% (30/80) husbands handled the sick with a significant difference of Z*=3.08. This indicated that the husbands in Marigat were at more risk of getting infected than those in Thika. On the other hand about 23.8% (19/80) of the wives in Thika handled the sick animals and in Marigat 43.8% (35/80) wives, with a significant difference of Z*=2.72, took care of the sick animals putting them at risk. The children were involved when they closed school. Since most farmers in Thika employed farm hands 58.8% (47/80) took care of the sick animals while in Marigat 11.3% (9/80) employees with significant difference of Z*=7.26 handled the sick animals. The difference is significant as it shows that the employees in Thika were more at risk of getting infected than those in Marigat. When it came to treatment the farmers in Thika 88.8% (71/80) preferred calling an animal health assistant as they were more available while in Marigat 12.5% (10/80) actually called the animal health assistants significant difference of Z*=14.93. This difference comes in due to the fact that there are fewer animal health assistants in Marigat than in Thika and also that the farmers in Marigat preferred to treat their own animals. The veterinary doctors were rarely called in both districts with 8.8% (7/80) in Thika and 1.3% (1/80) in Marigat. In Marigat 86.3% (69/80) farmers preferred treating the animals for themselves after consulting with the veterinary authorities while in Thika only 2.5% (2/80) treated their own animals.

Table 4.12 Problems faced and management of sick animals by farmers in Thika and Marigat Districts

Problems and management of sick animals	Thika	%	Marigat	%	Significant difference Z*
Management problems					
Lack of feed	20	25	20	25	
Lack of water	6	7.5	17	21.3	2.53
Handling of sick animals					
Husband	13	16.3	30	37.5	3.08
Wife	19	23.8	35	43.8	2.72
Children	1	1.3	6	7.5	
Employee	47	58.8	9	11.3	7.26
Treatment of sick animals					
Owner	2	2.5	69	86.3	
Veterinary doctor	7	8.8	1	1.3	
Animal health assistant	71	88.8	10	12.5	14.93

Table 4.13 shows how the farmers in the two districts handled animals and their products when they fell sick and it was suspected to be RVF. In Thika, 5% (4/80) milked the animals but to avoid infection they poured away the milk. When the animals died from a suspected case of RVF, they were either buried whole, 25% (20/80) in Marigat and 3.8% (3/80) in Thika, or burned 18.8% (15/80) in Marigat. A few farmers 1.3% (1/80) and 10% (8/80) either slaughtered the animals for the dogs or threw them into the bushes respectively in Marigat. In Marigat, most of the farmers chose not to slaughter the animals for fear of getting infected and so only a few 3.8% (3/80) slaughtered some animals. After slaughtering the animals the people observed various changes in the animals' tissues like enlarged liver 5% (4/80),

yellowing of membranes 3.8% (3/80) and frank blood or clots 7.5% (6/80) in the carcasses in Marigat as shown in Table 4.13. Since in Thika the farmers did not slaughter they did not observe any changes.

During the process of data collection personal observation of the environment was an important factor. Table 4.14 shows the relationship between the terrain and the occurrence of RVF outbreak in 2006/2007. The table shows that most of the areas with disease outbreaks had flat terrain but the areas with hilly and rocky terrain had no report of cases of the disease. The flat areas with disease outbreak in Thika were Juja and Karibaribi while in Marigat the locations were Ilchamus, Ilngarua, Kiserian and Ngambo.

Table 4.13 Farmers actions on suspected cases of RVF Disease during the 2006-2007 outbreaks in Thika and Marigat Districts

Farmers actions	Thika	%	Marigat	%
Fate of sick animals and their products during				
Sick animals				
Slaughtered and consumed by family	0	0	0	0
Slaughtered and given to the dogs	0	0	0	0
Sold in the market	0	0	0	0
Treated and kept	3	3.8	42	52.5
Milk				
Consumed by the family	0	0	1	1.3
Given to pet animals(dogs and cats)	0	0	0	0
Sold in the market	0	0	0	0
Poured	4	5	0	0
Boiled more than twice and consumed by the family	0	0	2	2.5
No milking done at all	0	0	41	51.3
Dead animals				
Burry them whole	3	3.8	20	25
Burn them whole	0	0	15	18.8
Slaughter for the family members	0	0	0	0
Slaughter for the dogs	0	0	1	1.3
Throw away in the bushes	0	0	8	10
Person slaughtering the animals				
Husband	0	0	2	2.5
Wife	0	0	0	0
Children	0	0	0	0
Employee	0	0	1	1.3
Description of organs in the sick slaughtered animals				
Enlarged liver	0	0	4	5
Yellow	0	0	3	3.8
Blood clots	0	0	6	7.5

Table 4.14 Relationship between the terrain of the different locations in Thika and Marigat and the occurrence of RVF

Location	Terrain	District	Presence of disease
Arabal	Hilly and rocky	Marigat	No
Gatuanyaga	Flat with major gullies	Thika	No
Ilchamus	Flat	Marigat	Yes
Ilngarua	Flat	Marigat	Yes
Juja	Plateau	Thika	Yes
Karibaribi	Flat and other parts hilly	Thika	Yes
Kariminu	Hilly	Thika	No
Kiahura	Hilly	Thika	No
Kiserian	Flat with rivers passing through it	Marigat	Yes
Loboyi	Hilly and rocky	Marigat	No
Maboromoko	Hilly	Thika	No
Makongeni	Hilly	Thika	No
Marigat	Rocky	Marigat	No
Ndurumo	Hilly and rocky prone to earth tremors	Thika	No
Ngambo	Flat and with dambos	Marigat	Yes
Ruiru	Hilly and rocky	Thika	No
Salabani	Flat	Marigat	No
Santai	Hilly and rocky	Marigat	No
Tana	Flat	Thika	No
Wemba	Flat	Thika	No

CHAPTER FIVE

5.1. DISCUSSION

5.1.1. Introduction

The study created an open and interactive opportunity between the researcher and the livestock keepers in Thika and Marigat Districts. This was important in understanding the livestock management systems and challenges facing pastoralists and dairy farmers from two different ecological zones and how they deal with them. It was also important to appreciate the communities' perception and knowledge on Rift Valley Fever and the various methods employed in the control of the disease.

Marigat and Thika were selected as representatives from a list of the districts affected by the 2006/2007 Rift Valley Fever outbreaks. Marigat represented pastoralist system and Thika represented dairy farming systems. The results of the study showed that there were important variations between the two locations in relation to communities' management of RVF outbreaks.

During the study, the farmers openly discussed problems affecting their livestock especially the pastoralists from Marigat district as most of them solely depended on their animals for their livelihood. Various problems affecting livestock production in both areas were identified with livestock diseases ranking as the main problem. In Marigat lack of water due to drought was another major constraint.

5.1.1. Effects of the occurrence of RVF and the control measures put up against it on the economic activities

The study showed that the disease and the control measures put up by the government affected the farmers' ability to earn a living. During the period of the disease outbreak, the people were not consuming milk or meat for fear of contracting the disease and so the farmers could not sell their products even from the healthy animals leading to a major loss of income as the farmers were dairy farmers and could not sell their milk. They also had to adhere to the withdrawal period after vaccinating against RVF. This was not so in Marigat since the farmers did not sell their milk but used it for household consumption and if a neighbor had no milk they would share with them what they milked. Ban on sale of animals affected both communities with those in Marigat being more affected as most of the farmers there kept animals, especially small stock, to provide income and easy money mostly when there was an emergency like a medical reason or when they needed to pay for their children school fees and had no other source of income. Some farmers profited from sale of chicken and eggs mainly in Thika and more people turned to alternative sources of protein and this too ate into the families' income. In Tanzania a study was done which indicated that incomes of livestock dependent communities decreased due to the reduction in the consumption of red meat and loss of animals due to the disease. The Tanzania government also spent about US$3.84 million to control the disease and thus the economic impact due to disease were felt nationally (Sindato *et al.*, 2011)

This is comparable to a study which was done focusing on the Northeastern region of Garissa and Ijara districts. The study focused mainly on pastoralist communities and indicated that the disease had impacts on the livestock sector and other segments of the economy that are often overlooked in the analysis of animal disease. These impacts included production impacts, employment losses (particularly for casual labor), and a reduction in operating capital among slaughterhouses and butchers that slowed the recovery of the livestock sector once the disease had abated. On a macroeconomic basis, they estimated that RVF induced losses of over Ksh 2.1 billion (US$32 million) on the Kenyan economy, based on its negative impacts on agriculture and other sectors alike (Rich and Wanyoike, 2010).

5.1.2. Effect of RVF disease occurrence and the control measures on social and cultural activities

In this study it was demonstrated that the disease together with the control measures put up by the government interfered with social and cultural activities in the two districts. These included interference in various ceremonies like circumcisions, weddings, oloibon ceremonies (rainmakers ceremonies), various other gatherings like elders gatherings or women 'merry go round' meetings more so in Marigat. In Thika the activities affected were mainly social gatherings and wedding ceremonies. There is little documentation to support this and thus more research needs to be done in this area.

5.1.3. Effect of RVF on the sale and consumption of animals and animal products

During the study, it was noted that prices of animal products which include: beef, goat meat, mutton, chicken meat and milk changed during the time for the outbreaks. The price for beef in Thika reduced during the outbreak but increased drastically after the outbreak to retail at twice the price it was retailing at before the outbreak. In Marigat the price also doubled from what it was before to what it became after the outbreak. During the outbreak however, due to the widespread infection they did not sell or buy any meat of any kind except chicken. For goat meat and mutton the prices were similar and dropped during the outbreak then went up after in Thika but in Marigat as indicated earlier they did not sell during but the prices also went up comparing the before and after the outbreak prices. Chicken farmers on the other saw a slightly booming business during the outbreak as most people opted to buy chicken as a substitute to meat and thus the prices went up during the outbreak but dropped after as people returned to consuming meat. Prices of milk also fluctuated dropping during the outbreak and then going up after.

During the outbreak, as indicated by the farmers in the study, they chose to consume other products instead of consuming meat and these included; pulses and legumes and vegetables which were the most consumed items in the two districts. Chicken and eggs were also highly consumed in both districts but more so in Marigat than in Thika. Another product consumed was fish which was more consumed in Marigat especially in those locations living near Lake Baringo as it was readily available and affordable. Other products consumed but not extensively are pork and ducks. These products were costly during that time so they ate into the families' income and some families had to do without a source of protein as they could not afford.

5.1.4. Awareness and community knowledge of RVF

Most farmers in Marigat were aware of RVF as they had experienced in their farms or the neighbors' and could describe the clinical signs while in Thika, very few had any knowledge of the disease and most of them heard about it from the media and neighbors' rather than experiencing it firsthand. The animals mostly affected were the sheep and goats with cattle least affected in Marigat while in Thika the three species were equally affected. It has been indicated in other studies that sheep are more susceptible to the disease than the other species, goats and cattle (Shope R,. 1980). In Egypt a study done in 1977 showed that the highest number of RVFV isolates were obtained from sheep and one from the other species tested which included cattle, goat, horse, camel and rat (Samia K,. 2011)

The farmers described the clinical signs to include abortions, bloody diarrhea, bleeding from various orifices, bloody urine, retained placenta and foaming at the mouth as the common signs. These clinical signs were close to those documented in various studies that would lead one to conclude that this could be RVF (Shope R., 1980; Samia K,. 2011). In Marigat where the disease incident was high, most of the farmers described more of the signs while in Thika the signs described were fewer. The signs that made the farmers more alert regarding the disease were abortions and death occurring more in sheep than goats and cattle. From a study in awareness of clinical signs and knowledge in early warning, it was concluded that the local lay members of the community still had minimal awareness of the disease thus interfering with the control options (Jost *et al,* 2010).

5.1.5. Handling and treatment of animals suspected to be infected with RVF

In this study, most of the farmers in Marigat preferred to treat their own animals with few calling the Veterinary doctor or the Animals Health Assistants in the location but in Thika the farmers preferred to call the Animal Health Assistants than the Veterinary doctor due to various personal reasons which included lack of availability of the Veterinary Doctors and also a better rapport with the animal health assistant who they said their services were cheaper. A study done in Northeastern Kenya on sero-positivity of RVF indicated that handling of animal carcasses, aborted fetuses and any other animal product during slaughter or disposal posed a major risk of disease transmission to humans (LaBeaud *et al, 2008).* Thus the farmers in Marigat stood a higher risk of contracting RVF than those in Thika.

5.1.6. Traditional methods of predicting occurrence of the disease

According to the farmers in this study, the disease was generally new to them. From the study, most of the farmers from both districts were not aware of any method of predicting the disease before it occurs. Some though indicated that by observing the skies and seeing huge clouds showing the possibility of heavy rainfall was a way of indicating a possible occurrence of the disease but it was not certain. A study on the Maasai of Northern Tanzania indicated that availability of veterinary services and dependence on ecotourism and crop cultivation has greatly reduced the utilization of indigenous knowledge (Jose *et al.*, 2010). Again since the disease occurrence in cycles of 5-15 years it may be difficult for the community members to recognize the start of an outbreak (Fyumagwa *et al.*, 2011).

5.1.7. Traditional modes of controlling the disease

The study also indicated that most farmers were not aware of any traditional control methods used against RVF mainly because to them this was a relatively new disease but some indicated use of herbs boiled and given to the animals or cleaning the animals and their sleeping areas, it is not indicated if these methods would be effective or not as they have not been tested in controlled and structured environment to prove their efficiency. In the recent 2007 outbreaks the Maasai of northern Tanzania had limited traditional knowledge of regarding livestock diseases RVF being one of them (Jost *et al*, 2010). It is also indicated that the Maasai have more access to Veterinary Services and thus do not rely on indigenous knowledge on the diseases (Jost *et al*, 2010). The control measures in the two areas were instituted by the government officials. These were vaccinations, quarantine, ban on sale and consumption of meat and milk and ban on slaughter of animals. Farmers in the two locations adhered to dutifully in Marigat with fear of contacting the disease and dying as they had seen some of their neighbors falling sick and dying due to RVF.

5.1.8. Environmental conditions before and during the disease outbreak

From the study it is evident that the farmers were not so keen on observing the changes in the environment before or during the disease outbreak as they did not have much to say about it. Some farmers indicated observing flooding before the outbreak while others indicated increase in number of dead carcasses in the field but this was assumed to be due to the onset of the acute form of the disease before it progressed to a full blown outbreak. The observation during the outbreak was increase in number of carcasses in the field and this was assumed to be due to the disease causing an acute infection and death in the animals.

5.1.9. Communities' awareness of disease occurrence in humans

From this study, most of the farmers were aware that the disease affected humans and this was more evident in Marigat than in Thika. According to most farmers interviewed in Marigat they had observed someone suffering from the disease either from their families or their neighbors and this made them fear the disease so much such that when a family had a member suffering from the disease the neighbors shunned them and avoided any gathering or celebrations held in that compound. The latter resulted to stigmatization of such families and fear of associating with them as long as they suspected the disease had reached that particular homestead either in the animals or the family members. In Thika however, most of the farmers did not see the disease first hand but obtained information from the media and local authorities and were less affected than those in Marigat.

Upon enquiring if the farmers knew how the humans got infected most of them indicated that they did not know but a good number said it got to humans from consuming contaminated animal products from sick animal. These products include milk, meat and blood and especially when it was not thoroughly cooked. The latter was in agreement with what has been reported in the literature (Alexander 1951; Barnard, 1981) although in a recent survey on awareness of the disease among the agro pastoral and pastoral communities in Serengeti ecosystem, it showed that 5.3% of the community members were aware of the zoonotic risk of RVF (Fyumagwa *et al.*, 2011). For control of the disease from affecting humans, most farmers indicated that one had to refrain from consuming contaminated food or cook the food for a long time before consuming it to make sure that all the microbes were destroyed. This is because they had observed that those who had handled the sick animals or ate their meat had been infected with the disease. Other control methods mentioned included: building your house a few meters from the animal sheds to avoid being bitten by mosquitoes that were biting the animals, use of gloves and polythene bags when handling sick animals and to a more extreme extent not to handle the sick animals at all. This has also been documented in a study showing that knowledge on risk practices that may enhance the transmission of the disease are still limited (Amwayi *et al.*, 2010) Use of mosquito nets and draining stagnant water were not common methods mentioned although they are major control methods recommended (Logan *et al.*, 1990; Whittler *et al.*, 1993).

5.1.10. Risk factors associated with the disease occurrence

The results of this study show that during the outbreak of RVF in 2006/2007 the farmers handled sick animals, their products and dead animals differently. This was more apparent in Marigat where the farmers were more aware of the disease than in Thika where there were few cases and most of the farmers did not experience the disease in their farms as in Marigat. When the animals got sick most farmers in Marigat chose to treat and keep hoping they will get better. When the animals died they either buried them whole or burned them while others chose to slaughter for the dogs or throw into the bush. The slaughtering of the animals was done by either the husband of the house or a male employee and this posed a great risk of human exposure and especially male. This was also indicated in a study that showed that animal handlers, especially those who slaughtered them and herdspersons, due to their close proximity to animal herds, would be at greater risk of getting infected. (Amwayi *et al.*, 2010)

In Marigat the farmers observed various pathological changes in the slaughtered sick animals which were, enlarged liver, yellowing of the membranes and blood clots and these were in accordance to typical pathological changes documented in a case of RVF (Pepin *et al.*, 2010; Gerdes 2004). According to the farmers interviewed none of them chose to consume the meat of either sick animals or dead as they had been informed by the local authorities of the dangers of doing so and some had witnessed the effects as their neighbors fell ill and some died after consuming infected meat. As for the milk in Thika the farmers chose to pour it away while in Marigat most farmers preferred not milk the animals at all and just let the young suckle while the few who chose to milk boiled the milk thoroughly, preferable more than twice before consuming it. This increased the risk of the farmers in Marigat to getting infected by the disease as handling or consumption of infected product may lead to disease transmission. This has also been documented in other studies showing that knowledge of these communities especially the pastoral communities in risk factors like consuming raw meat, raw milk, touching and herding sick and aborted animals or consuming products from such animals is still limited (Amwayi *et al.*, 2010)

Another aspect that could play a role as a risk factor is the terrain. In most parts of Thika the land mainly hilly thus when it rains the water runs off instead of stagnating in one area but in Juja where the land is more of a plateau the water manages to collect and support the growth of mosquitoes. Another aspect is the availability of 'dambos' which are more common in Marigat that in Thika. Rain water collects in these dambos and supports the increase and maturity of the Aedes mosquitoes after long rains increasing the transmission potential of the disease. In Marigat there were also differences in the terrain in areas that had a high rate of infection and those that did not. From observation the regions that were in hilly and rocky areas which include Santai, Arabal, and Loboyi had low rates of infection compared to lowland flat areas which included Ng'ambo, Kiserian, Salabani, Ilchamus and Ilng'arua. This could be attributed to the presence of low lying depressions that collect water during heavy rainfall and lead to an increase of the vector. It may also be that water flowing from hilly bushy areas carries with it most of the eggs in the soil depositing them in the low lying regions increasing vector numbers and transmission. More research need to be done to clarify why there are more transmissions of the disease in low lying areas than hilly areas.

5.2. CONCLUSION AND RECOMMENDATIONS

From the study we can draw the following conclusions:

1. The disease and the control options instituted by the government against RVF impacted on the social, cultural and economic activities of the communities affected. This was more so in Marigat than in Thika as they greatly relied on the animals for their sustenance and income. These control options which were quarantine, ban in animal movement, ban in sale and slaughter of animals and vaccinations had various impacts. They lead to loss in income as the farmers could not sell their animals or animal products for income and to some extent some had to pour the milk as they could not drink it. Due to these control options they could not hold their cultural ceremonies which included, circumcision and oloibon ceremonies as these required the slaughter of animals as part of the ceremony.

2. Most of the farmers from the two communities of Thika and Marigat were aware of the disease especially those in Marigat as they experienced the disease more in their livestock and family members than in Thika. Although they were quite aware of the disease to them it was a relatively new disease and thus they neither had a traditional name for it nor any method of predicting, managing and controlling the disease so they relied on the treatment and control options provided by the government.

3. Marigat had more reported risk factors for the spread of the disease than Thika and these include:

i) The terrain with presence of dambos that collected water when it rained leading to increase and maturation of the disease transmitting vector, Aedes mosquitoes, thus leading to wide spread of the disease.

ii) Handling of the infected animals where most farmers chose to treat the sick animals exposing themselves to infection while in Thika they chose to consult an animal health assistant or veterinary doctor.

iii) Due to the traditional activities of the famers in Marigat, they slaughtered their animals for various ceremonies and this lead to them handling the infected carcasses

iv) Consumption of infected meat leading to spread of the infection. This was more due to ignorance as they did not know the dynamics of the disease spread and transmission.

RECOMMENDATIONS

1. Campaigns should be mounted by the government to create awareness in the affected communities and those at risk on methods of preventing human exposure to the disease.
2. Data generated by this study on terrain, risk factors and socio-cultural activities affected by the disease outbreak to be incorporated in policy formulation to control the disease and prevent human and animal to animal transmission.

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APPENDIX I: QUESTIONNAIRE

QUESTIONNAIRE ON IMPACTS OF FORMAL AND INFORMAL INTERVENTIONS IN THE CONTROL OF RIFT VALLEY FEVER IN DAIRY FARMING AREA, THIKA AND PASTORAL AREA, MARIGAT DISTRICTS OF KENYA

Questionnaire serial number: ------------------ Date of interview: -------/------/------

Latitude -- Longitude ------------------------------

(A) Background information

1. Name of respondent-- (1) Male (2) Female
2. Location: ----------------------Sub-location------------------------Village-----------------
3. a. What is the main occupation? (1) Dairy farming (2) pastoral farming (3) mixed farming (4) Others, specify ---

   b. What group represents you age (1) Up to 30 years (2) >30 – 60 years (3) Over 60 years
4. What is your relationship (as the respondent) to the household head? (1) Self (2) Spouse (3) Son (4) Daughter (5) Employee (6) Relative (7)specify --
5. What kind of animals do you keep?

Species	Number	Males	Females	Purpose for keeping the livestock (* see below)
Cattle	------------	-----------	-----------	---------------
Calves	------------	-----------	-----------	---------------
Goats	------------	-----------	-----------	---------------
Kids	------------	-----------	-----------	---------------
Sheep	------------	-----------	-----------	---------------
Lambs	------------	-----------	-----------	---------------
Chicken	------------	-----------	-----------	---------------
Donkey	------------	-----------	-----------	---------------

Camel	-------------	------------	------------	------------------
Pigs	--------------	-------------	------------	------------------
Others (specify	------------	------------	------------	------------------

Key: *: 1=as family food, 2= for selling to earn money, 3=for ceremonies, 4= as wealth and social

value, 5=for manure, 6=for draught, 7=other, specify................................

(B) <u>Management of the animals</u>

6. Which of the following types of management systems do you practice?

(1) Zero grazing

(2) Free range

(3) Semi intensive

7. Who does the day to day management of the animals?

(1) Husband

(2) Wife

(3) Children

(4) Employee

(5) Others, specify ---

8. How are the animals housed?

(1) All of them together (2) different species in different houses (3) the adults different from the young (4) the young kept in the house and the adults outside

9. How are the animals grazed?

(1)All of them together (2) different species to different areas (3) the adults different from the young

(4) others (specify) --

10. What problems do you face in keeping the animals?

(1) Diseases (2) predation (3) accidents (4) lack of feed

(5) lack of water (6) lack of market (7) lack of medication/vaccines (8) others, specify---------

----

1. What diseases do you commonly encounter in your livestock (listed: first ---in order of importance)?

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2. Who handles the animals when they fall sick? (1) husband (2) wife (3) children (4)employee (5) others, specify ------------------------------

3. Who treats the animals? (1) Owner (2) veterinary doctor (3) animal health assistant (4) other, specify---------------------------------

(C) <u>Community based knowledge of RVF disease</u>

4. Are you aware of a disease that last occurred widely in Kenya in 2006/2007 after very heavy rainfall with signs of abortions, bleeding and death in cattle (Rift Valley Fever)?
(1) =Yes / (0) = No ;   **If yes, answer the questions that follow:**

15. What is the local name for it? --

6. What other diseases are seen at the same time as the disease? ----------------------------------

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17. In your farm or the neighboring farms, which other animals were affected?

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18. What were the symptoms in these animals:

cattle ---

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sheep ---

----

goats ---

----

donkeys ---

----

camels --

Others --

----

19. How many animals were sick? Cattle --------- Sheep ------------Goats-----Camels -----------

Donkeys ---------- others (specify) ---------------------

20. How many animals died? Cattle --------- Sheep ------------Goats---------- Camels -----------

Donkeys ---------- others (specify) -------------------

21. How many animals aborted? Cattle-------------Sheep ---------------Goats----------------

Camels---------------Donkeys---------------others (specify) ----------------

22. Who treats the animals with the disease? ---

23. What medications do they use to treat the animals with? ---------------------------------

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24. Are there traditional ways you use to control the disease that occurred in cattle in 2006/2007(RVF)? 1=(Yes) / 0=No)

25. If yes, describe these traditional controls for RVF disease? ----------------------------------

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26. a. List the control measures for the disease (if any) put up by the government in your location?

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b. In what way(s) did these control measures affect the things you do to earn a living?

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c. In what way(s) did these control measures affect socio - cultural activities?

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27. Do your animals undergo vaccination? If yes fill the following.

Type of Vaccines	age of animals	how often they are vaccinated
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28. Are there methods of predicting or getting to know when the disease RVF will occur in your area?

(1) =Yes / (0) = No

29. If yes which ones? --

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30. Whenever these predicting methods are used does RVF always occur?

(1) =Yes / (0) = No

31. If yes what actions do you take to avoid disease outbreaks in your livestock? -----------------

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32. What do you observe in the environment before the outbreaks of RVF occurs that could be associated with these RVF outbreaks? ---

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33. What else is observed during the disease outbreaks? ---

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34. Do you know if the disease affects human beings?

(1) =Yes / (0) = No

35. If Yes, how do you think they get to be infected by the disease ?-----------------------------

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36. a. If yes what are the symptoms in humans? ---

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b. How would the humans avoid getting sick from RVF? --

(D) Impacts of the disease on social and cultural activities

37. When the disease occurred in your area:

a. In what way(s) did the disease affect the things you do to earn a living?

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b. In what way(s) did the disease affect the socio - cultural activities in your family and village?

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38. What were the prices for the animals before, during and after RVF occurrence of year 2006-07?

Species	before	during	after
Cattle	------------	------------	------------
Goats	------------	------------	------------
Sheep	------------	------------	------------
Chicken	------------	------------	------------
Donkey	------------	------------	------------
Camel	------------	------------	------------

39. What do you eat other than cattle, goat and sheep meats during the time the animals fall sick due to RVF? (1) chicken (2) fish (3) wild game (4) eggs (5) others-------------------------

40. What social, cultural and economic activities are not practiced during RVF occurrence? ---

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41. How does this interference in social, cultural and economic activities impact on the community? ---

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42. What economic activities do you not practice when control measures are put up during RVF occurrence? ---

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43. What do you do with the sick animals? (1) slaughtered and consumed by the family (2) slaughtered and given to the dogs (3) sold in the market (4) others specify ------------------

44. What do you do with milk from sick animals?

(1) Consumed by the family

(2) Given to pet animals (dogs or cats)

(3) Sold in the market

(4) Others, specify ---------------------------

45. What do you do with the animals dying from RVF?

(1) Burry them whole

(2) Burn them whole

(3) Slaughter for the family members

(4) Slaughter for the dogs

(5) Others, specify ----------------

46. If you slaughter the animals, who does the slaughtering? --

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47. If you slaughter the sick animals what do you see in these slaughtered sick animals? -------

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Thank you for your cooperation and assistance