UTILIZATION OF INFORMATION COMMUNICATION TECHNOLOGIES IN THE MANAGEMENT OF TRANSBOUNDARY ANIMAL DISEASES, IN SELECTED COUNTIES IN KENYA

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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 PhD Thesis is dedicated to my beloved daughters, Tasha and Nicole Wanjala.

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List of Acronyms and Abbreviations

AGORA	Access to Global Online Research in Agriculture
AGRA	Alliance for Green Revolution in Africa
AI	Avian Influenza
AMARC	Association of Community Broadcasters
AUC	African Union Commission
AU-IBAR	Inter African Bureau of Animal Resources
AWVP	African Wildlife Veterinary Project
BSE	Bovine Spongiform Encephalopathy
CAPE	Pan-African Programme for the Control of Epizootics
CBPP	Contagious Bovine Pleuropneumonia
CDC	Center for Disease Control (CDC).
CD Rom	Compact Disc Read Only Memory
DAO	District Agricultural Officer
DCFRN	Developing Countries Farm Radio Network
DD0	District Development Officer
DVO	District Veterinary Officer
DSN	Diseases Surveillance Network
E.A	East Africa
EAIDSNET	East African Integrated Disease Surveillance Network
FAO	Food and Agricultural Organization of the United Nations
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GF TADs	Global Framework for Transboundary Animal Diseases
HA	Hemagglutinin

HIV/AIDS	Human Immune Deficiency Syndrome, Acquired Immune Deficiency Syndrome
HPAI	Highly Pathogenic Avian Influenza
H1N1	H1N1 influenza virus
H5N1	Highly Pathogenic Avian Influenza Virus
IBED	International Bureau of Animal Resources
ICT	Information Communication Technology
IAASTD	International Assessment of Agricultural Science and Technology
ILRI	International Livestock Research Institute
ISP	Internet Service Provider
JPN	Joint Project Number
KACE	Kenya Agricultural Commodity Exchange
KARI	Kenya Agricultural Research Institute
KNBS	Kenya National Bureau of Statistics
NALEP	National Agricultural and Livestock Extension Programme
NGO	Non-Governmental Organization
OARE	Online Access Research in the Environment
OIE	The World Health Organization for Animals
PPR	Pestes Des Petit Ruminants (PPR)
PARE	Pan-African Rinderpest Campaign
REC	Regional Economic Commissions
RVF	Rift Valley Fever
SACIDS	South Africa Centre for Infectious Disease Surveillance
SARs	Severe Acute Respiratory syndrome
SPSS	Statistical Program for Social Scientists
SSA	Sub Saharan Africa
TADs	Transboundary Animal Diseases
TBP	Theory of Planned Behavior

TV	Television
TEEAL	The Essential Electronic Agricultural Library
UNEP	United Nations Environmental Program.
UNECA	United Nations Economic Commission for Africa
UNOCHA	United Nations office for the Coordination of Humanitarian Affairs
UK	United Kingdom
USD	United States Dollars
US	United States

Abstract

The purpose of this study was to examine utilization of Information Communication Technologies (ICTs) for management of Transboundary Animal Diseases (TADs). The study assessed factors which favor acceptance and ultimate utilization of ICTs by livestock keepers and community based stakeholders in Kenyan counties for management of TADs. The study was informed by the Theory of Planned Behavior (TPB) and Diffusion of Innovation theory as guiding towards establishing the factors for acceptance and use of ICTs for management of TADs. A mixed-method approach was used to obtain data. Research techniques included document analysis, semi-structured interviews, and structured questionnaires. Livestock keepers and community based stakeholders (n=356), were interviewed across Uasin Gishu, Kajiado, Nandi and Trans-Nzoia counties. Qualitative data provided basis for investigating the role and type of communication methods used for management of TADs. Quantitative analysis was done using the Statistical Package for Social Scientists (SPSS). Descriptive statistics, correlations, tests of significance and regression were applied. The study investigated demographic factors based on their influence towards acceptance and utilization of ICTs for management of TADs. Of these factors, the study established that education level, occupation and social status had moderate influence towards acceptance and utilization of ICTs for management of TADs by livestock keepers. The Spearman's correlation coefficient findings on this study established a positive correlation between ICT utilization and; access to information and technologies, communication methods, interconnection with social groups, contact with change agents, and training. A negative correlation was realized between cost of ICT services and ICT utilization. The study using inferential statistics analyzed six (6) independent variables, which explained

62.7% of utilization of ICTs in management of TADs. This was represented by the R^2. The results implied that other factors not studied on this research would contribute 37.3% towards utilization of ICTs in management of TADs. The multiple regression findings established training as a highly rated factor to contribute towards acceptance and utilization of ICTs in management of TADs. However, communication methods were the least rated towards influencing utilization of ICTs in management of TADs. The study concluded that training and communication of technologies on management of TADs should not only target livestock keepers, but also public administrators, council of elders, politicians and religious leaders. The radio was the ICT highly utilized and preferred for management of TADs. The study concluded that education level attained, occupation and social status would to a moderate extent influence utilization of ICTs for management of TADs. However, gender and age were found to have limited influence towards utilization of ICTs. The use of radio, mobile telephone, CD Rom and television were the ICTs highly recommended as ideal to livestock keepers in management of TADs. This study recommends a change of attitude training to be delivered to livestock keepers on specifics of using ICTs for management of TADs. The study calls for finalization of Kenya ICT policy of 2006. Further research is recommended in establishing additional factors contributing towards utilization of ICTs in management of TADs.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION

The purpose of this study was to assess the level of utilization of Information Communication Technologies (ICTs) for management of Transboundary Animal Diseases (TADs). The emerging ICTs are the proposed means through which management of TADs would be realized according to this study. The study defines management of TADs as covering four (4) critical phases. These are disease surveillance, diagnosis, feedback and mass education to the public. Research has established that nearly two-thirds of human pathogens are zoonotic and of greater concern, nearly three-quarters of emerging and re-emerging diseases of human beings are zoonoses (Woolhouse and Gowtage 2005). The emerging diseases include Avian Influenza (AI), severe acute respiratory syndrome (SARS), West Nile virus, Nipah virus, and bovine spongiform encephalopathy (BSE), which have all received substantial media attention. There had been cases of severe TADs such as Avian Influenza (AI) and pandemic influenza assailing local communities in Kenya and Eastern Africa of which H1N1 2009 pandemic was most recent example of a TAD scaled up to pandemic level.

In the past two decades there has been a growing realization that the livestock sector in Africa was evolving, resulting from an expansion of intensive animal production systems and trade to meet a globalized world's increasing demand for livestock products. One un-intended consequence has been the emergence and spread of TADs and more specifically, the resurgence and emergence of zoonotic diseases. Concurrent with changes in the livestock sector, contact with wildlife has increased, a development which has accelerated the risk of transmission of infections from wildlife to human beings and livestock. Of concern with respect to the real and perceived threat from emerging infectious

diseases is why there is an increasing frequency of TADs and how these should be managed and controlled (Coker *et al.,* 2011). Kenya is not an exception to this development which has both livelihood and socio-economic implications to the population.

Kenya and Eastern Africa, faces the threat of Rift Valley Fever (RVF), *Peste des Petits Ruminants* (PPR), Rabies and H5N1 all of which are considered a risk to both humans and livestock, notwithstanding the destruction to fragile livelihoods. There is inadequate level of awareness and information disseminated across local communities and general public on the risk TADs pause to local communities in Kenya. On the other hand, technologies and information for control of TADs are confined to service providers, researchers and change agents.

1.1 Background Information

In examining recent research work associated with animal diseases, it is argued that new infectious diseases emerge because of a complex set of multifactorial circumstances. This includes population growth, changes in nutritional, agricultural, trade practices, and shifts in land use. Other factors are accelerated urbanization, deforestation and encroachment on wildlife (Wolfe *et al.,* 2007). Eastern Africa has witnessed these factors at play across their national economies. Additionally, the ancient zoonotic diseases such as rabies, anthrax, brucellosis, bovine tuberculosis, zoonotic trypanosomiasis and disorders associated with tapeworm infections are re-emerging due to a combination of similar factors. These include transmission of pathogens from wildlife to domestic reservoir species (Chomel *et al.,* 2007).

Research has established that increased complexity in food chains and different systems of food production and preparation are also leading to rising importance of food-borne zoonoses such as salmonella, campylobacter and Escherichia coli infections, which are all linked to livestock production and processing systems (Rushton, 2009). During the 1990s, there was a growing realization that the livestock sector was undergoing the so-called livestock

revolution (Rushton, 2009). This event was probably the second major livestock revolution, the first occurring during the 19th century as populations grew and became increasingly urbanized.

The first revolution largely affected ruminants and caused various livestock disease problems that were notable, especially in developed countries, controlled through creation of veterinary services, investment in research and education systems (Delgado *et al.*, 1999). It was thus celebrated that the benefits from these investments were felt in the control of several livestock diseases and in human health (Waddington, 2010), which coupled with advances in livestock production methods and marketing systems helped to feed a growing urban population. However this first revolution also created major zoonotic problems, such as bovine tuberculosis and brucellosis, which were left unattended for decades. By the time they were controlled in livestock populations, these diseases had caused large-scale human morbidity and mortality (Fisher, 2007).

The second livestock revolution that probably began in the 1980s originated from the rapid expansion of intensive pig and poultry production systems and, to some extent, from a growth in milk production. To some degree this revolution was spearheaded by the availability of antimicrobial and antiparasitic treatments used for preventive purposes to allow high densities of animals to be kept under suboptimum husbandry conditions. Research into pig and poultry production systems (FAO 2005) has changed breeding, feeding and management systems, leading to improvements in overall productivity and standardization of products (De Haan, 2001, Heffernan, 2004). However, the increased problems associated with management of TADs were never anticipated, which cross international borders and the resurgence and in some cases, emergence of zoonotic diseases. Kenya and the Eastern Africa region have not been spared from this risk. The situation across the years 2008 – 2013, demands increased surveillance and communication platforms which involve livestock producers and consumers in management of TADs.

Researchers argue that the second livestock revolution was associated with increased contact between wildlife and both livestock and people. This change resulted from increased settlement or farming in wildlife habitats, wildlife farming and increased diversity of animals kept as pets. There has also been increased tourism in remote areas (Wolfe *et al.,* 2007, Chomel *et al.,* 2007), a scenario which typifies Kenya and the Eastern Africa region. There is researched evidence to suggest that many emerging human pathogens have originated from wildlife, and that livestock intensification probably exacerbates the emergence of zoonotic diseases by amplification. This was irrespective of whether the infection source is livestock or wildlife (Jones *et al.,* 2008, Pavlin *et al.,* 2009).

Despite the profound animal, human health and economic consequences of zoonotic diseases, until recently these have tended to be neglected by governments and stakeholders. In his research, Shaw (2009) identified four (4) reasons for this neglect; first, veterinary services had been given responsibility for control of these diseases, but had neither the farm-level economic incentives nor the societal resource allocation to fulfill this role. Second, zoonoses in both human beings and animals are generally under diagnosed. Third, zoonoses tend to affect rural, often poor, people with poor access to health services. Fourth, mechanisms to control and to restrict food-borne diseases are difficult and complex. These reasons are not exhaustive; other factors such as challenges of interdisciplinary collaboration such as research, policy, or practice, the complex inter-sector institutional environment within which animal and human health systems operate continue to compound the management of Transboundary animal diseases. The developing nations have been worst hit.

Researchers submit that most human diseases, old and new, are caused by multi-host pathogens. In a review of 1,407 species of human pathogenic organisms, 816 (58%) were broadly classified as zoonotic (Woolhouse and Gowtage-Sequeria 2005), a term used by Virchow and defined by World Health Organization in 1959 to describe “those diseases and infections (the agents of),

which are naturally transmitted between (other) vertebrate animals and man" (Mantovani, 2001). A review of recent research works from lead disease control agencies gives projections that require immediate action by stakeholders involved with animal disease control, but most critical is an information management platform which resonates with livestock keepers and other stakeholders.

The risk of emerging and re-emerging animal diseases cannot be overstated or otherwise left to veterinarians or policy makers. According to a Kenyan media publication of July 2012, it was reported that over 1000 livestock died over a two (2) week period in the Kerio Valley due to a disease which was yet to be established. Local authorities could only suspect the disease as East Coast Fever. The report further detailed that the disease had spread to at least four (4) counties of Kenya namely Baringo East, Marakwet East, Pokot Central and Marakwet West. All these areas reported deaths of sheep, goats and cattle within a period of two weeks. Veterinary authorities were yet to establish the particular disease case and communicate the actionable measures to livestock keepers (Daily Nation, 2012).

Limited studies are available in Africa which validate the impact of livestock diseases. However global estimates indicate that average losses due to animal diseases are more than 20% (AU-IBAR, 2009).While there was hardly accurate data on losses attributed to livestock diseases in sub-Saharan Africa; it is believed that this percentage could be higher. Overall economic losses have previously been estimated at US$ 2 billion. Losses due to morbidity as reflected by reduction in growth, lactation, work output and reproduction are probably of the same magnitude.

There is evidence that animals trans-located for other human uses have also been implicated in the spread of zoonotic disease. In early 2004, outbreaks of the highly pathogenic avian influenza virus H5N1 were reported across eight (8) countries in Southeast Asia almost simultaneously. Given the pattern and timing of outbreaks, the Food and Agriculture Organization (FAO) identified the transport

of live birds reared for human consumption as a primary culprit in the rapid spread (FAO, 2007).

The Livestock sector in Kenya contributes 3.3% of GDP. Department of Veterinary Services (DVS) enforces several laws that impact livestock marketing. This includes the animal diseases Act chapter 314 of 1972 (revised in 1989), the dairy industry act chapter 336, the pig industry act chapter 361 and meat control act chapter 316 (EPZA 2009, NCST, 2009). The Meat Control Act Chapter 316 is applied by both the District Veterinary Services (DVS) and District Public Health (DPH). Approximately 88% of marketed milk in Kenya is sold unprocessed, outside regulated channels. Of the 65 slaughter houses operational in Kenya in the year 2000, only two, namely, Hurlingham Butcheries and Farmers Choice, were export standard slaughterhouses. These statistics indeed demonstrates gaps and raises questions on the safety of animal products in particular with regard to disease control and hygiene.

However, ICTs have been singled out as playing a greater role in livestock disease control, dairy herd management, livestock production and marketing of livestock and its produce (Meena and Singh, 2013). Adopting to information management approaches amongst farming communities is widely acknowledged as one of the critical factors for efficient and effective agricultural decision-making (Cash 2001, Galloway and Mochrie 2005). Sasidhar and Sharma (2006) emphasized that use of ICT tools has potential to change the economy of livestock, agriculture and rural artisans in India. Tiwari *et al.,* (2010) argue that the livestock sector should develop need-based, location specific and local language contents in the form of computer software's and other electronic material. These are viewed as requisite for livestock disease control, dairy herd management, livestock production and marketing of livestock and livestock products.

1.2. Statement of the Problem

According to animal diseases experts, pathogens circulating in animal populations threaten both animal and human health. Subsequently both the animal and human health sectors have a responsibility towards their control (WHO *et al.*, 2004). Pathogens –viruses, bacteria or parasites–have evolved and perfected their life cycles in an environment that is more favorable to them and ensures their continuity through time by replicating and moving from diseased host to a susceptible new host. The Eastern Africa region has not been spared the risks associated with TADs outbreaks and ultimately the H1N1 2009 pandemic.

Unfortunately, Eastern Africa continue to face imminent outbreaks of TADs, with cases of Rabies, Rift Valley Fever (RVF) and *Pestes des Petit Ruminants* (PPR) currently reported as prevalent. The H5NI is a TAD prevalent in Egypt and parts of North Africa; however it was yet to be detected in Kenya. In examining the problem of TADs in Eastern Africa, stakeholders cannot ignore the prominent wildlife habitats which harbor migratory wild birds across our wetlands, and as such pose a continuous risk of disease outbreaks. A review of existing interventions aimed at controlling spread of common TADs such as Rift Valley Fever (RVF) and *Peste des Petits Ruminants* (PPR), evidently reveals a problem calling for specialized interventions. Rabies is known to spread from Lions or Cheetahs, across to domestic dogs.

The level of awareness in the management of TADs by livestock keepers and communities living with wildlife remains undefined. There is lack of a shared information and communication platform linking veterinary and medical experts in Kenya, who are perceived as first line of response in control of TADs. Furthermore, it is evident that other stakeholders across the livestock industry specifically livestock keepers, donors, private sector, emergency disease response units and meteorology department lack a common platform from which critical information is communicated rapidly.

In re-visiting H1N1 2009 pandemic in Eastern Africa, Tanzania, reported the first case of H1N1 2009 influenza in September 2009. By March 2010, there were 770 cases reported, with one (1) death. Due to shortage of qualified human resources essential medicines and laboratory supplies in health facilities, it was not known how effectively prepared health-care providers in Tanzania were in responding to the pandemic (Kamuhabwa and Chavda, 2011). In Kenya and Uganda, the HINI 2009 pandemic equally disrupted national operations with both the animal and human disease sectors seeking immediate response measures. The problem which evidently prevailed during H1N1 2009 was misinformation on pandemic status and the required response action by members of the public, a situation which created anxiety and panic among local communities. This scenario typifies lack of information and communication across local communities during TADs outbreaks unless the prevailing information gaps are addressed.

1.3. The Study Objective

The objective of this study was to establish the level of ICT acceptance and ultimately utilization for management of Transboundary Animal Diseases (TADs). The ICTs were explored for their utilization in management of TADs based on acceptance levels amongst livestock keepers and community based stakeholders.

1.3.1 Specific Objectives

1) To Identify ICTs and other communication methods used by livestock keepers and community based stakeholders.
2) To investigate the role and type of information, communication methods used for management of TADs among livestock keepers.
3) To establish factors for acceptance of ICT utilization for management of TADs, among livestock keepers and community based stakeholders.
4) To evaluate existing information communication models used for management of TADs and determine their effectiveness amongst livestock stakeholders.

5) To design an ICT based model appropriate for management of TADs based on acceptance levels among livestock keepers and other stakeholders.

1.4 Research Questions

1) Which factors would you consider in order to accept ICTs for use in management of TADs among livestock keepers and community based stakeholders?
2) What is the role and type of information and communication methods used for management of TADs? What are the advantages and problems for each method?
3) What Information communication models are used by livestock stakeholders for purposes of management of TADs?
4) What are the successes and challenges of the information and communication models used for management of TADs?
5) Why would livestock, human health and wildlife stakeholders prefer ICTs for purposes of communication for management of TADs? (Specifically during disease surveillance phase, diagnosis, feedback and mass education).
6) Why would stakeholders prefer a communication platform for management of TADs? (refer to question no. 5).

1.5 Hypothesis for the Study

Hypothesis 1: Factors for ICT Utilization in management of TADs

Null: There is no relationship between various factors and acceptance of ICT utilization in management of TADs among livestock keepers and other stakeholders.

Hypothesis 2: Type of Communication Methods

Null: The type of communication methods has no effect on the management of TADs among livestock keepers.

Hypothesis 3: Information Communication Models

Null: There is no relationship between information communication models and effective management of TADs amongst livestock keepers.

1.6 Justification of Study

The severity of TADs remains a risk to human health and destruction to fragile livelihoods and can no longer be left to veterinarians and policy makers. The effects of TADs outbreaks ultimately decrease socio-economic assets of any given community affected, which calls for additional control approaches to the problem. It is evident that ICTs are global and accessible across livestock stakeholders. This presents opportunity for exploration of ICTs in management of TADs aimed at minimizing destruction to fragile livelihoods.

This study contributes new knowledge and methods in management of TADs by livestock keepers and other community representatives using ICTs as a means. Since the fragile rural and peri-urban livelihoods across East Africa cannot afford additional destruction following the severity of TADs, ICTs have inherent potential to effectively disseminate technologies and information for management of TADs. This function previously played by change agents such as government extension workers and private sector representatives, has since diminished across rural communities.

For livestock keepers who face the risk of destruction of stocks from the prevailing TADs, this study presents a solution to the problem of inadequate communication. The study benefits change agents involved with management of TADs, by proposing the development of a platform for information and communication in managing TADs. This is indeed an infrastructure solution which was validated by livestock keepers. For policy makers and agricultural researchers, the study contributes new approaches towards promoting integration of technology

with ICTs, knowledge and culture, aimed at improving communication and learning processes for management of TADs. Since information and communication remains a factor of success in animal disease control, it is justifiable that a model be designed and ultimately developed for purposes of managing TADs.

1.7 Scope and Limitation of the Study

This study does not review causes of animal diseases or other technical response measures by specialized experts. However focus of the study was on information management and communication systems. The study was limited to aspects of information and communication of selected TADs involving the period 2009 – 2013. The study was limited to exploring utilization of ICTs as a suitable platform for information and communication for management of TADs. The study considered disease surveillance methods, diagnosis, feedback and mass education to the public.

The target respondents for this study were limited to livestock keepers, sampled communities interacting with wildlife, livestock product traders, private sector representatives, animal disease control and meteorology experts. The study was limited to four (4) of Kenya's counties which were selected for their habitation by livestock keepers and prevalence of TADs. These were Kajiado, Uasin Gishu, Nandi and Trans Nzoia counties.

CHAPTER TWO

LITERATURE REVIEW

2.0. LITERATURE REVIEW

The chapter considers selected TADs that are prevalent in Kenya and Eastern Africa. The factors which favor use of ICTs in management of TADs are reviewed as well as the existing information communication models used by livestock stakeholders for animal disease control. The benefits and limitations of ICT in management for TADs are investigated with a view of designing a model for management of TADs. The chapter concludes with an inquiry into the Theory of Planned Behavioral (TPB) and Diffusion of Innovation Theories which are guiding this study.

The purpose of literature review on this study was to provide readers access to selected research findings on use of ICTs as a benefit to agricultural production. However, focus is on animal disease management. The literature review provides articles or studies relevant, meaningful and important to this study. The literature review aims at; delimiting the research problem, seeking new lines of inquiry, avoiding fruitless approaches and Identifying recommendations for further research (Gall *et al.*, 1996).

2.1 Selected Transboundary Animal Diseases (TADs)

Rift Valley Fever (RVF)

Rift Valley Fever (RVR) is one of the TAD which continues to assail livestock in Kenya and Eastern Africa, with recent efforts by researchers undertaken for purposes of determining the pattern of RVF disease spread across Kenya since introduction in 1912. There were 38 out of 69 administrative districts in Kenya which reported RVF epizootics by end of 2007. During the 1912–1950 period, the disease was confined to a district in the former Rift Valley province that is prone to flooding and where livestock were raised in proximity with

wildlife. Between 1951 and 2007, 11 national RVF epizootics were recorded with an average inter-epizootic period of 3.6 years (range 1–7 years). In addition, all epizootics occurred in years when the average annual rainfall increased by more than 50 % in the affected districts (Mureithi *et al.,* 2010). According to this research, the first two (2) Kenyan national epizootics in 1951 and 1955 were confined to eight (8) districts. This was a sustained epizootic between 1961 and 1964 that spread the virus to over 30 % of the counties within six (6) of Kenya's former provinces.

The southwestern region of Kenya, covering the former Western and Nyanza provinces, had never reported RVF infections by 2007. It was concluded that probability of a district being involved in a national epizootic was fivefold higher (62%) in districts that had previously reported disease, compared to districts which had no prior disease activity (11%) (Mureithi *et al.,* 2010). These findings suggest a possibility of recurrent or re-emergence of RFV, which is associated with particular weather patterns. However, it was not established to what degree appropriate information and communication methods for managing this TAD had been implemented amongst stakeholders. It is probable that the worst hit were livestock keepers.

In quantifying local and national socio-economic impacts of the 2006-07 RVF outbreak in Kenya, researchers in a study focused on producers, traders, slaughterhouses and butchers. This study established that traders and slaughterhouses were affected by movement bans on livestock and decreased consumer demand for meat. Several slaughterhouses and butcheries were closed for up to three (3) months until the ban was lifted. This study concluded that the RVF outbreak resulted to Ksh 2.1 billion loss to the Kenyan economy, with most of the impacts being felt on livestock sector (Rich and Wanyoike, 2010). One of the lessons learned following the RVF outbreak was that non-agricultural sectors such as transportation, trade, chemicals and petroleum industries also experienced economic losses.

Since geographical and seasonal distributions of many infectious diseases are linked to weather, the possibility of using climate-related environmental factors as predictive indicators, in association with regular disease surveillance activities, has proved to be relevant when establishing early warning systems for these diseases. This is despite the unpredictable nature of weather patterns. RVF is one of the diseases for which early warning systems have been developed efficiently in the past. These systems have shown relevance in anticipating major vector-borne epidemics and mitigating the associated public health and economic impacts (FAO, 2012). However, for livestock keepers and community based stakeholders the challenge remains access to information and technologies. Furthermore, there lacks a shared platform for communication and feedback which is critical for TADs management.

Rabies

The first ever laboratory confirmed case of rabies for Kenya was reported in 1912 in a dog within Nairobi County, while the first human case was in a woman from South Nyanza in 1928. Records at the Central Veterinary Laboratories at Kabete research laboratory indicated that Kenya experienced rabies outbreaks in the early 1930s, later 1940s and early 1950s. However, widespread vaccinations of dogs in the 1950s and 1960s effectively controlled rabies so that by 1973, the disease was virtually eliminated from the country, except for persistent foci of infection in Machakos and Kitui districts. Following an outbreak of the disease in 1974 in Taita / Taveta District and another one in 1979 in Trans Mara district, the rabies situation changed dramatically in Kenya. To date, rabies is more widespread and prevalent than at any time in its history.

In Kenya, like in most of the developing world, the domestic dog is the major reservoir and transmitter of rabies to man. Various attempts aimed at minimizing Rabies in Kenya such as the traditional mass vaccination of dogs, movement restriction, and control of ‘stray’ dogs has failed. According to research experts, the major constraints to the effective control of rabies in the country are

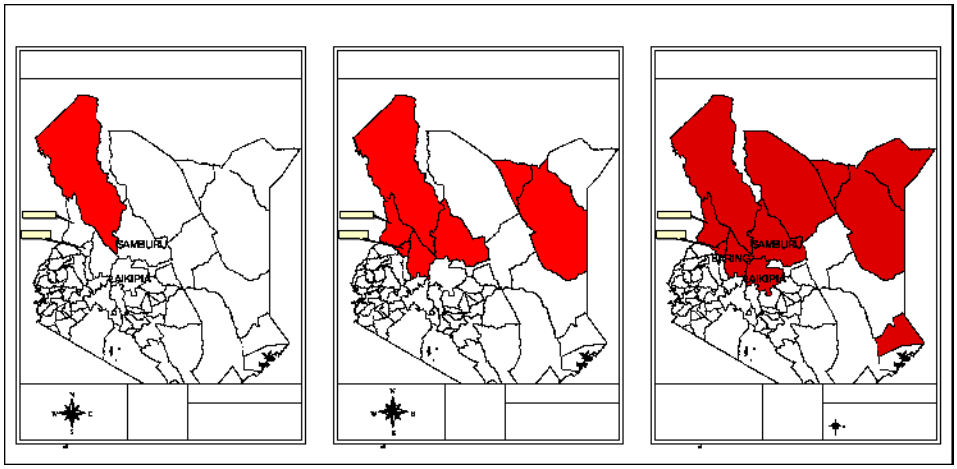
economical and logistical, rather than technical, with poor infrastructure and inadequate resources hampering control programmes. In addition, economic as well as epidemiologic data necessary to convince policy makers of the importance of rabies as a public health problem are lacking in Kenya. Also lacking are dog ecology and demography data long recognized as a prerequisite for proper planning and execution of sound rabies control programmes (Limbaso *et al.*, 2010).

Pestes Des Petit Ruminants (PPR)

Peste des Petits Ruminants (PPR), is an acute or sub-acute viral disease of goats and sheep characterized by fever, stomatitis and gastro-enteritis arid pneumonia. PPR has been described as the most destructive viral disease in small ruminants with young animals (3–18 months) most susceptible. It is the main constraint to small ruminant production especially amongst pastoral communities with production losses ranging from 50 – 90 % and mortality rates of 10– 90%. When associated with other diseases such as Capripox, mortality can reach 100%. In Kenya the 2008 PPR outbreak cost up to 4.8 million Euro, as expenses for vaccines implemented by experts out of a planned vaccination campaign of 12 million Euro (AU-IBAR, 2009).

According to Government reports the numerous diseases destroying Kenya's livestock assets require containment. This was suggested as appropriate in increasing Kenya's use of livestock as a pathway to poverty reduction and food security. It was feared that 17 other Kenyan districts which included; Garissa, Narok, Tana River, Lamu, Taita Taveta, Kitui, Machakos, Makueni, Mwingi, Tharaka, North Meru, Laikipia, Kajiado, Trans Nzoia, Keiyo, Koibatek and Isiolo were either under suspicion for PPR, or on high alert and requiring protection as a buffer to the rest of the country. (GOK, 2010). Figure 1 illustrates spread of PPR across the years 2006-2008 in Kenya.

2006 2007 2008



(GOK, 2008).

Figure 1 Spread of PPR in Kenya in 2006- 2008

Foot and Mouth Disease (FMD)

Foot and Mouth Disease (FMD) is the single most important disease influencing global livestock trade and as such the role of wildlife species in FMD has been extensively reviewed as a concern for stakeholders (Thomson *et al.*, 2003). Buffalo herds act as a reservoir for future outbreaks, transmitting infection to cattle directly or through other species, which have contracted the infection from the buffalo (Sutmoller *et al.*, 2000, Bastos *et al.*, 2000).

In Tanzania, the government proposed raising public awareness particularly to stakeholders by providing information and knowledge on the occurrence, spread and control of FMD using ICTs. The strategy however proposed that stakeholders should consider identifying suitable ICTs for application at all levels, create awareness on ICT and train technical staff on management of ICT facilities. The projected time frame for at least coverage to 30% of national population was by 2015 (GOT, 2009).

2.2 Utilization of ICTs in management of TADs in Eastern Africa.

This study defines Information Communication Technologies (ICTs) as the electronic means of capturing, processing, storing and disseminating information. These ICTs can be categorized to include information held as 1s and 0s, and comprises computer hardware, software & networks and intermediate technology, based largely on analogue information waves such as radio, television and telephone (Heeks, 1999). The phrase ICT is thus an umbrella term used to mean computing (software and hardware), telecommunications (mobile, fixed, Internet) and broadcasting. Research findings argue that emerging information technologies present new opportunities to reduce burden of malaria, dengue and other infectious diseases. For example, use of a data management system software package can help disease control programs to better manage and analyze their data, and thus enhances their ability to carry out continuous surveillance, monitor interventions and evaluate control programme performance (Eisen *et al.*, 2011).

E-readiness has been defined as the degree to which a community is prepared to participate in the networked world, with indicators such as network access, networked society, networked economy and network policy indicators (Kashorda and Wagacha, 2005)

By June 2004, there were 260,000 fixed telephone line subscribers in Kenya (teledensity of 0.75 per hundred inhabitants - world average is 19) compared with 3 million cellular mobile subscribers (teledensity of 9.75 - world average of 21), and 73 registered Internet Service Providers (ISP), of which 15 were active. As at June 2005, Kenya had 1 million Internet users and 1000 cyber cafees and telephone bureaus. There were also 16 operational television stations (accessible by 60% of the population), 24 FM radio stations (accessible by 90% of the population) and 11,500 public telephones (IST, 2012). According to Kenya National census findings of 2009, there were 3.6% of Kenya's households with at least one (1) computer, while 63.2 % had one (1) mobile telephone (GOK, 2010). These findings confirm the presence of a suitable platform from which an ICT

platform for management of TADs would be implemented in Kenya and across East Africa.

2.3. The ICT profile in Kenya

Kenya's information and communications technology sector policy guidelines have been guiding the ICT sector regulatory framework. However, the Kenya policy 2006 recognized that ICT issues which include the media sector were spread out under various legislations. These included; Science, Technology and Innovation Act number 28 of 2012, Kenya Broadcasting Corporation Act of 1988 and Kenya Information and Communications Act Chapter 411A (GOK, 2013). Unfortunately these were found inadequate in meeting immediate ICT requirements for consumers, specifically on issues of convergence, electronic commerce and e-Government.

According to the United Nations, the Kenya ICT policy published in March 2006 was not addressing the needs of specific sectors. For example, there was no attempt to analyze the value of the agricultural sector and information needs along the chain and then develop an appropriate strategy. The need to develop sector-specific ICT strategies in Kenya was thus emphasized, since the country was by then developing an ICT master plan earmarked to support the new ICT sector (UNECA, 2008).

2.4 Types of Information Communication Approaches used in management of TADs

FAO (2005) submits that for billions of people in rural areas, where illiteracy rates are high and access to electricity, phones and internet is marginal, radio is still the most accessible, economic and popular means of communication. The World Association of Community Broadcasters working with, AMARC, an international community radio network and Developing Countries' Farm Radio Network (DCFRN) was in partnership with FAO. This was to enhance networking by assisting radio stations to use internet in accessing alternative information of

interest to rural communities. This included health, education, credit and local projects (FAO, 2005). Most of emerging diseases originate and accelerate in places with the weakest borders and greatest economic and social need. This actually typifies most of the countries in Africa and parts of Asia. This realization prompted the Rockefeller Disease Surveillance Networks (DSN) to invest financially in training, increased use of innovative or relevant tools and improved information sharing. These measures were aimed at creating effective coordination networks on regional disease surveillance. However among the various approaches implemented towards managing transboundary animal diseases, information management is critical.

There have been efforts by Kenya and other regional governments to combat transboundary animal diseases. Established in 2000, the East African Integrated Disease Surveillance Network (EAIDSNet) hosted at the East African Community secretariat was established out of recognition of the increasing ability of serious and contagious diseases, such as Rift Valley fever and Ebola, to swiftly cross borders within the region. EAIDSNet had implemented a new mechanism for working within the region by conducting field simulations at border points and working across the animal and human health divide. They had put together a number of rapid response teams including both community and official members to enable quick alerts, and have formally institutionalized their operations by stewarding an agreement and operational framework between the five (5) EAC countries (Burundi, Kenya, Rwanda, Tanzania and Uganda) on cross-border surveillance within the region. One other regional platform covering 14 countries in southern Africa is the Southern African Centre for Infectious Disease Surveillance (SACIDS), which was formalized in 2008. This is a consortium of academic and research institutions established to strengthen capacity to detect, identify and monitor infectious diseases of humans, animals and plants and their interactions across the Southern Africa region.

In Kenya, mobile telephone was used for delivery of animal health services, which reduced transactions costs and increased efficiency of animal care (Kithuka, *et al.*, 2007). The system works with a community animal health worker, who purchases a veterinary drug kit and mobile phone at a subsidized price. Animal health assistants and veterinarians working with the project also receive mobile phones. The phone system allows the animal health care providers to update one another, share information, and conduct referrals. This system however targets trained animal health assistants and veterinarians. There is however need for an easy to use Information and communication platform which is acceptable to livestock keepers and community based stakeholders.

2.5 Information and Communication models used for Agricultural Benefits.

"E-agriculture" has been defined as an emerging field in the intersection of agricultural informatics, agricultural development and entrepreneurship, referring to agricultural services, technology dissemination, and information delivered or through the internet and related technologies. This involves conceptualization, design, development, evaluation and application of new (innovative) ways to use existing or emerging information and communication technologies (ICTs). E-agriculture which is associated with ICT infrastructure seeks to promote integration of technology with multimedia, knowledge and culture aimed at improving communication and learning processes between various actors in agriculture locally, regionally and worldwide. The components to "e agriculture" are facilitation, support of standards and norms, technical support, capacity building, education and extension (FAO, 2005). This study investigated most of these components.

A case study of Egypt's Vercon evidently reported that government researchers and extension workers in institutes and rural villages were actively using a web-based portal system to exchange critical information with district offices and ministries in Cairo. Following this initiative researchers and extension

workers accessed information resources such as extension brochures, statistical databases, decision support systems and could participate in special interest forums, online discussions according to FAO (2005). An online query system called Farmer's problems was programmed to provide feedback or answers to technical questions raised by smallholder farmers.

In Kenya's Nandi county, this study established that livestock officers were using an online service provided by a leading telephone and internet provider Safaricom to access critical agricultural information. By dialing *285 # on the Safaricom network one would access various agricultural resource links and information. However this service did not allow for feedback or sustained communication across users, service providers and agricultural experts. In Uganda, FoodNet comprises a national system that was established to gather and disseminate agricultural market price information via newspapers, the internet, radio and mobile phones (SMS). FAO (2005) submits that FoodNet is a typical example of an e-agriculture application that can be found in many countries. It demonstrates how small-scale farmers in rural communities can overcome their marginalization through a mix of media including ICT-based information access.

2.6 ICT model for Information and Communication in management of Transboundary Animal Diseases

In view of the advantages and opportunities which ICTs hold for the agricultural sector, the delivery of agricultural information and knowledge services such as market prices, extension services internet application and related technologies has been termed "e-agriculture". This evidence confirms the remarkable application of ICTs across various agricultural sub-sectors. Following the Kenya National census report of 2010, 3.6 % of households had access to at least one (1) computer. There were 63.2% with a mobile phone (GOK, 2010).These findings were indicative of existing infrastructure from which utilization of ICTs could be mainstreamed in management of TADs.

This study considered existing systems specifically to capitalize on, rather than replace and lose the value of existing indigenous and trusted information and communication systems. Training is critical since it would contribute towards strengthening capacity of livestock stakeholders involved in information provision to ensure the right information in the right format. Access and empowerment is critical in ensuring that relevant information actually reaches livestock keepers, in particular women and is not captured by wealthier or more powerful sections of the community. There is need to strengthen partnerships which build new horizontal and vertical inter-sectoral partnerships that are necessary to ensure information on management of TADs is available to vulnerable livestock keepers (FAO, 2005).

2.7 Theoretical Framework

This study considered insight from two (2) theories as guiding towards investigating acceptance levels of ICTs among livestock keepers and community stakeholders for management of TADs. As illustrated in Figure 2. Theory of Planned Behavior (TPB) and Diffusion of Innovation Theory guided the investigator towards establishing study objectives. The framework suggests that upon identification of factors which favor utilization of ICTs in management of TADs, there will be increased communication. These factors are the independent variables and dependent variable under investigation in this study. The problem of in access to information and technologies will be reduced since livestock keepers will have access to an ICT platform for communication purposes. Figure 2 illustrates the theoretical framework.

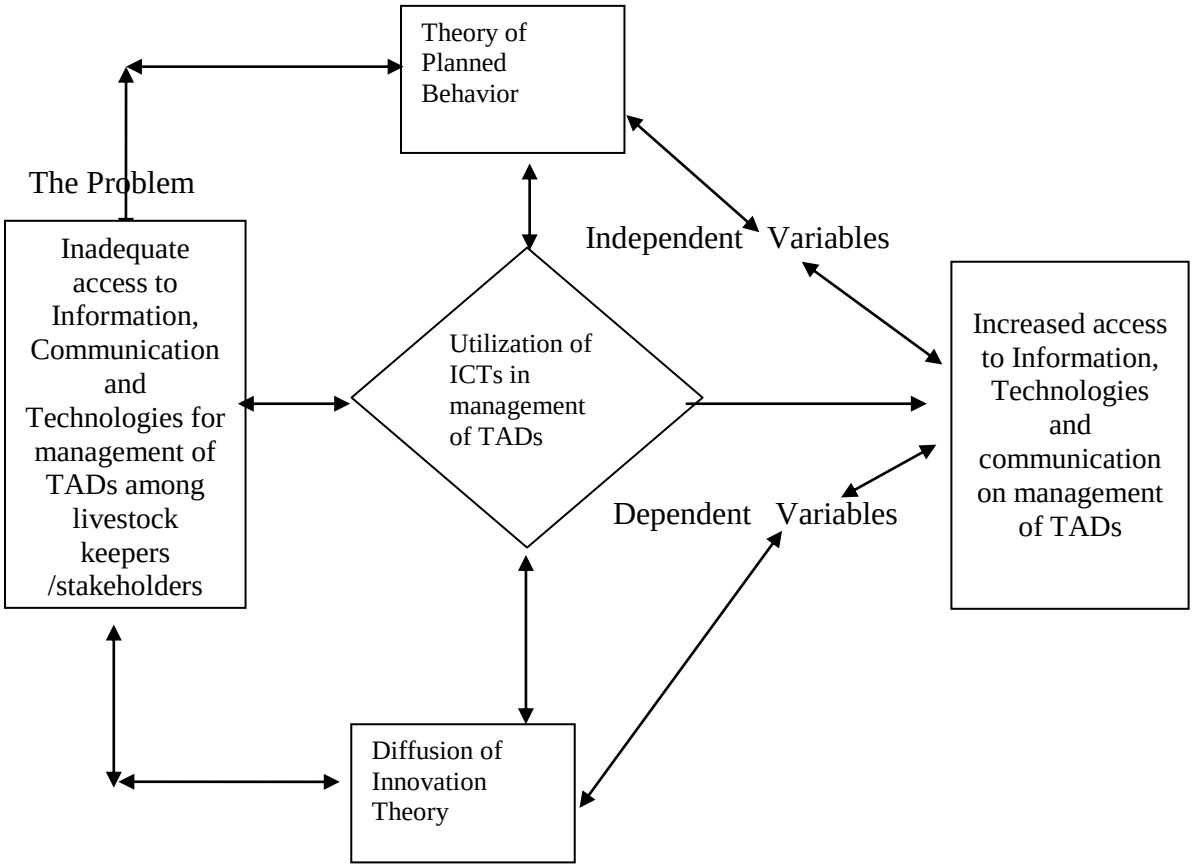


Figure 2. Theoretical Framework

Legend

↔ Indicates communication between two units

2.8 Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) predicts that planned behaviors are determined by behavioral intentions which are largely influenced by an individual's attitude toward a behavior, the subjective norms encasing the execution of the behavior and the individual's perception of their control over the behavior (Ajzen, 1991). However, as technology evolves alongside other socio-economic dynamics associated with community livelihoods, Ajzen's theory has been used to predict an array of behaviors (Martin *et al.,* 2010; Quine and Rubin, 1997; Stone *et al.,* 2010). This study considered the suitability of TPB in predicting behavior of livestock keepers in utilization ICTs for management of TADs. TPB was selected on this study to guide in predicting the factors and extend by which livestock keepers would accept, and ultimately utilize ICTs for management of TADs. Figure 3 illustrates TPB model.

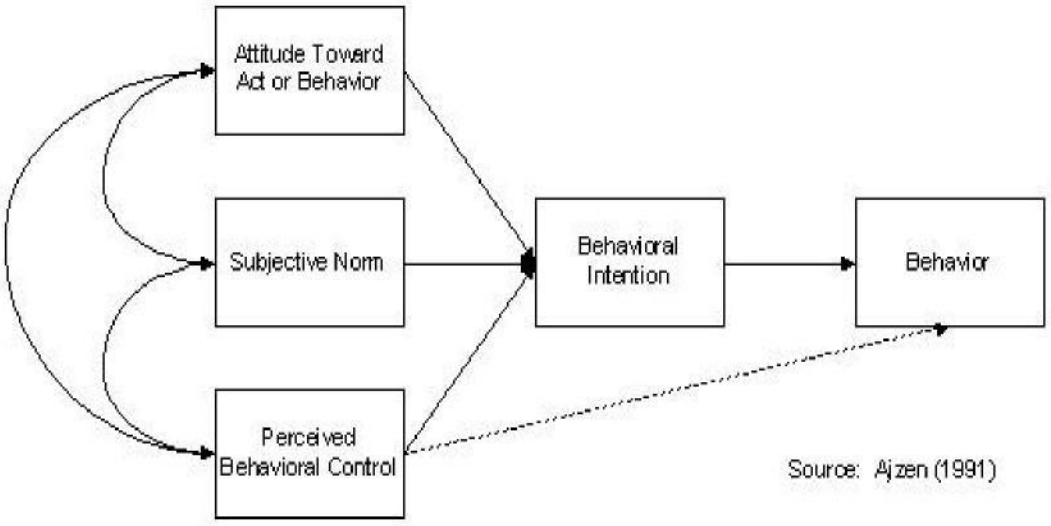


Figure 3 Theory of Planned Behavior

The TPB has been used to predict gambling behaviors. In a survey covering 80 college students which attempted to assess the utility of Ajzen's theory in predicting gambling behavior and frequency, the findings supported the efficacy of using TPB in clarifying gambling behavior in this population. They found that

perceived-behavioral control and subjective norms predicted past gambling, and subjective-norms, attitudes and perceived behavioral control predicted the frequency of gambling behaviors (Martin *et al.*, 2010). A study was undertaken seeking to support TPB in the context of the intention to quit smoking. It was hypothesized that the predictive utility of TPB model on intentions would be enhanced by past experiences with the behavior. The TPB components accounted for 12.3% of variance in the intention of quitting with the strongest impact coming from past behaviors (Hoie *et al.*, 2009).

The Theory of Planned Behavior was applied to social networking. Baker and White (2010) conducted a study examining the use of the TPB to predict adolescents' use of social networking. A questionnaire was given to 160 students that measured the components of TPB by asking the students to return a week later and report their social networking site use in the preceding week. Their study found support for TPB's components of attitude, perceived behavioral control and group norms in predicting intentions to use social networking sites. This study did establish that intentions actually predict behavior.

The TPB (Ajzen, 1988) assumes that the best prediction of behavior is given by asking people if they are intending to behave in a certain way. It is noted that the intention will not express itself in behavior if it is physically impossible to perform the behavior, or if unexpected barriers stand in the way. According to TPB three (3) determinants which explain behavioral intention are; the attitude (opinions of oneself about the behavior), the subjective norm (opinions of others about the behavior) and the perceived behavioral control (self-efficacy towards the behavior). The present study measured these determinants amongst livestock keepers and other community representatives in seeking to predict likely behavior towards utilizing ICTs for management of TADs.

2.9 Diffusion of Innovations Theory

The Diffusion of Innovations (DoI) by Everett Rodgers considers diffusion an essential social process, in which subjectively perceived information about a new idea or technology is, communicated (Rodgers, 2003). Rodgers and Scott had earlier defined "Diffusion" as the process by which an innovation is communicated through certain channels over time among members of a social system (Rodgers and Scott 1999). This theory underscores the need for a sequential process, prior to adoption of an idea or technology by members of a society. In this study, the researcher considered the innovation decision process in seeking to identify probable phases by which livestock keepers would accept utilizing ICTs for management of TADs.

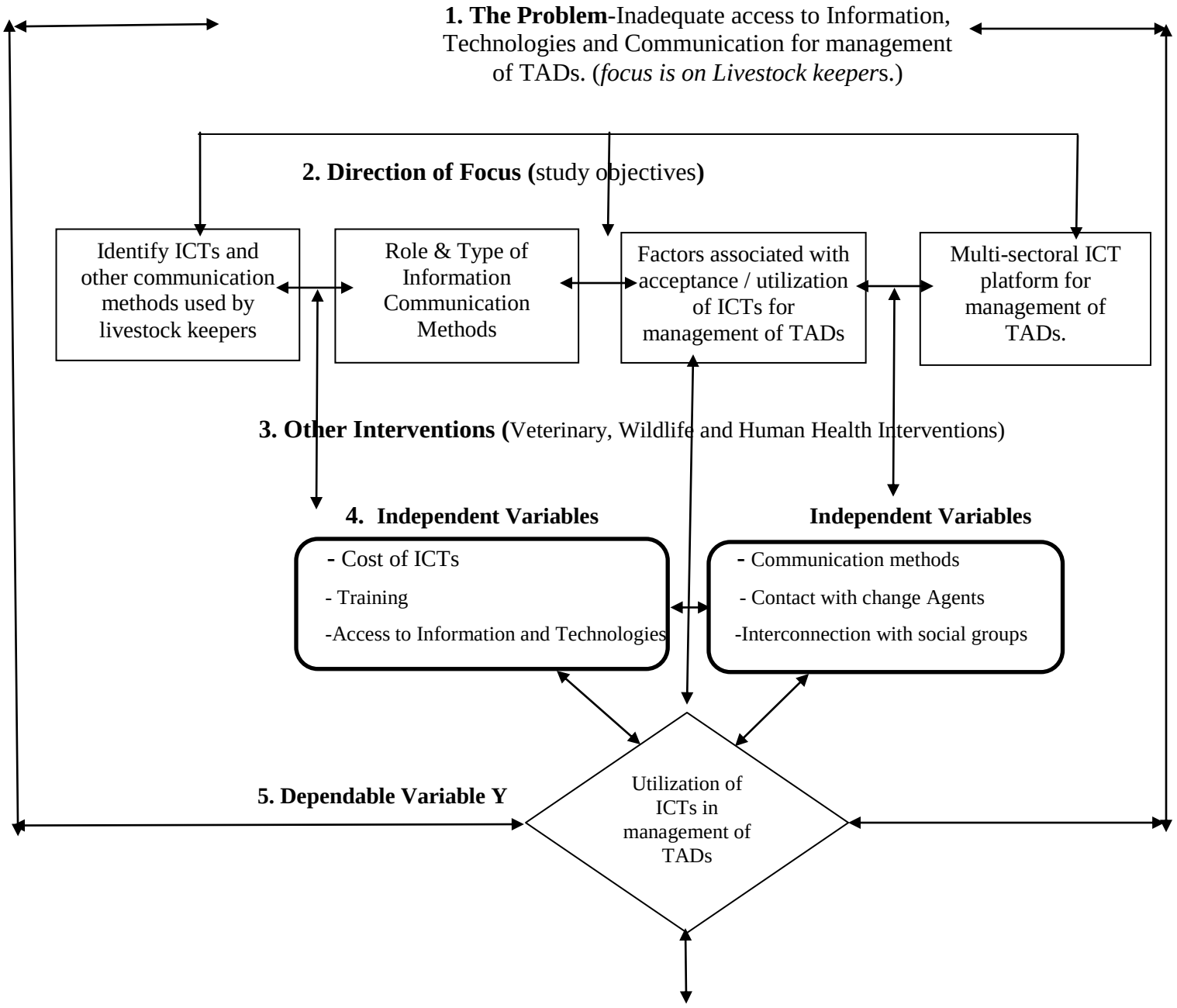
The Innovation decision stages through which a new idea or technology is adopted by a unit, group or community are; knowledge, persuasion, decision, implementation and conformation stages (Rodgers, 2003). This study investigated selected variables under the diffusion of innovation theory considered suitable in accelerating adoption rate of new ideas or technologies within a unit, group or community. For this study, focus was on the factors which would favor livestock keepers in utilizing ICTs for management of TADs. The variables under investigation in this study were; contact with change agents, interconnection with social groups, cost, communication method, access to information & technologies and training.

2.10 Conceptual Framework

This study was guided by a conceptual framework as outlined on the Figure four (4). The study problem is represented under level one (1) on the diagram. The focus was on livestock keepers. The study objectives are outlined on the framework under level two (2). These were; to identify ICT types and other communication methods used by livestock keepers, establish the role and type of information communication methods used in management of TADs, investigate

factors for acceptance and utilization of ICTs in management of TADs and design a multi- sectoral ICT platform for management of TADs. The study recognized other expert interventions addressing the problem under investigation. These include veterinary, human health and wildlife interventions, represented under level three (3) on the conceptual framework.

For this framework, communication is represented by the shape (⟷). Communication on this study was considered a two way process of convergence, from which messages or information is shared across two units. The level four (4) of the framework presents the independent variables under investigation. Level five (5) presents the dependent variable (Y). These variables were investigated using multiple linear regression and Spearman correlation statistics. The conceptual framework suggests that should the proposed study outcome fail, the situation reverts back to problem state. However, success of the conceptual framework would result to level six (6) attributes. This is a state of increased access to information, technologies and communication for management of TADs



6. Purpose (Increased access to Information, technologies and communication for management of TADs)

Legend; ⟷ Indicates communication taking place across pillars

Figure 4. Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 METHODOLOGY

This chapter presents the methods used in investigating study objectives. The chapter in effect covers survey design, population and sampling design, sample size, data collection methods, research procedures and data analysis methods. In conclusion the chapter presents study outcomes and expected impact.

3.1 The Study Areas

This study was conducted in four (4) counties of Kenya namely Uasin Gishu, Kajiado, Nandi, Trans Nzoia counties. These counties were selected due to their habitation by livestock keepers and prevalence of TADs. The investigator considered Kajiado county to represent livestock keepers in pastoral conditions, while those in Nandi and Uasin Gishu represented high altitude conditions. Trans-Nzoia county was selected to represent mixed farming conditions. According to District Veterinary Officer (2013),Uasin Gishu county covers an area of 3,327 sq.km of which, 2,995 sq. km is arable land, 332.78 is non arable (hilly and rocky), 23.4 sq. km is water mass and 196 sq. km is urban. It is a highland plateau ranging from 1500m- 2700m above sea level and soils range from red brown loam to clay. Rainfall averages 900mm to1200mm per annum with its peak in May and October, temperatures range from 8.4^0 c to 26.2^0 c. Vegetation range from open grassland with scattered acacia trees, to natural highland forests and bushland. It has 3 ecological zones [AEZ] (lower highland, upper highland and upper midland).

Administratively, Uasin Gishu county is divided into six (6) districts; Turbo, Moiben, Ainabkoi, Wareng, Kesses and Kapsaret. These sub counties act as extension units where activities for livestock and crop production are implemented. Uasin Gishu county has a human population of 894,179 and 167,887 households (District Livestock Officer, 2013). The average farm size ranges

between 2-10 acres. In Uasin Gishu the three (3) core livelihoods are; mixed farming (food crops and livestock), mixed farming (commercial crops and livestock) and formal / casual employment. Agriculture sector comprises of livestock production, veterinary, agriculture and fisheries departments. Characteristics of agricultural sector varies widely from predominantly small scale with low external inputs to highly mechanized large scale farming with very high levels of external inputs (District Veterinary 0fficer, 2013).

The livestock subsector in Uasin Gishu contributes 10% to GDP and is a source of livelihood to over 160,000 households in the county. There are 375,287 dairy animals of which 81,838 are high grade. The county has 93,611 sheep, 27,216 goats, 140,703 exotic birds and 400,000 local birds and 7,292 pigs. Average milk production from dairy cattle is 5 litres of milk per cow per day. The County has potential for export livestock and their products (milk, breeding stock, and poultry meat) to neighboring counties. However, inadequate extension services, pests and diseases, poor nutrition, inadequate provision of AI services, poor animal husbandry and lack of farmer organized marketing channels are the setback factors which impede production within livestock (District Livestock Officer, 2013). Table 3.1.a presents data for common livestock and related products found in Trans-Nzoia county.

Table 3.1.a Trans-Nzoia County Livestock data

	Dairy cattle			**Sheep**			
	Grade	**crosses**	**Total**	**Wool sheep**	**Hair sheep**	**crosses**	**Total**
2010	X	X	161,288	3,691	49,152	12,560	65,403
2011	X	X	155,816	3,693	49,317	12,560	65,570
2012	X	X	155,583	4,006	51,128	13,188	68,332
2013	91,690	63,998	119,188	X	X	X	X

(Source, Trans-Nzoia County Government, 2013)

Trans-Nzoia county covers an area of 2,468 sq. km. It has three (3) sub-counties namely; Trans-Nzoia East, Trans-Nzoia West and Kwanza. The other basic features of Trans- Nzoia are; arable land is estimated at 1980 sq. km, households are 116,122, population is at 818,206 persons, farm families account for 103,600. The altitude is given at 1400-2600 above sea level. Average rainfall is at 1200mm p.a. and the mean maximum temperature is given at: 13^{0} c – 27^{0} c. Table 3.1.b illustrates Trans-Nzoia livestock statistics as presented by District Livestock Officer (2013).

Table 3.1.a presents data for meat and dairy products from goats and poultry in Trans-Nzoia county.

Table 3.1.b Trans-Nzoia County livestock data

	Goats			**Poultry**			
	Meat	Dairy	**Total**	indigenous	Layers	Broilers	Turkeys
2010	24,270	328	**24,598**	483,767	104,334	11,627	9,073
2011	24,436	384	**24820**	485,594	104,428	12,383	9,060
2013	25,290	864	**26154**	538,689	106,820	13,350	9,185

(Source, Trans-Nzoia County Government, 2013)

The core livelihood of Trans-Nzoia community is farming-crop, livestock production, commercial business and livestock trade. The common livestock diseases as described by DVO in Trans-Nzoia were; East coast fever anaplasmosis, foot and mouth disease, lumpy skin disease and mastitis. For poultry, the common diseases in the county were identified as; new castle disease, fowl typhoid coccidiosis and mareks. The District Livestock Officer (2013) described common diseases in pigs within Trans-Nzoia as; Swine fever, Iron deficiency, pig pneumonia and pig dysentery. The common diseases facing dogs in Trans-Nzoia were rabies, canine distemper and tetanus. The sheep and goats (shoats) within the counties were characterized by foot rot and foot abseesces disease, tetanus and enterotoximia.

Table 3.1.c. presents selected livestock data common in Trans-Nzoia county, for the period 2010-2013.

Table 3.1.c Trans-Nzoia County livestock data

	Pigs					**Rabbits**
	Sows	**Boars**	**Gilts**	**Weaners**	**Total**	
2010	X	X	X	X	**3,443**	**8,729**
2011	X	X	X	X	**4,406**	**9,074**
2012	557	137	2038	1983	**4,715**	**9,320**

(Source, Trans-Nzoia County Government, 2013)

Nandi county occupies an area of 2,884.4 Km2. The county is bordered by Kakamega county to the west, Uasin Gishu, to the North East, Kericho county to the South East corner, Kisumu county to the South and Vihiga county to the South West (District Veterinary 0fficer, 2013). Generally the Nandi county receives an average rainfall of about 1200mm to 2000mm per annum. The long rains begin in early March and continue up to end of June, while short rains start in mid-September and end in November. It is rare for Nandi to experience a month without some rainfall. The dry spell is usually experienced from end of December to mid-March. Nandi county has 5 administrative Sub-counties, namely Nandi South, Nandi Central, Nandi East and Tindiret. There are 11 Divisions. The county of Nandi is covered by mobile network. The landline services were fairly distributed but mostly restricted to offices. It is reported that mobile telephones introduced an era of convenience in communication. According to Nandi county Government (2013), as of December 2012, the county was connected to fiber optic cable. There was internet connectivity available through cyber cafes and personal connections via modems and routers.

Kajiado county is divided into five (5) administrative sub-counties namely: Kajiado Central, Kajiado North, Loitokitok, Isinya and Mashuuru, with a total of

17 administrative divisions. The county is home to wildlife which are hosted within the world's famous Amboseli National Park, Lake Magadi, Ngong and Chyulu hills. which include; elephants, zebra, gnu, hippopotami, buffalo, spotted hyena, waterbuck, Maasai giraffe, bush buck, Thompsons and grant gazelle, impala, lion and cheetah. There is also rare presence of the gerenuk and the fringed –eared Oryx in the arid northern part of the par. There were about 420 different species of birds in the park, the largest being the Ostrich. According to District Development Officer (2013), most of the wildlife in the county is found in Amboseli National Park and animal conservation centres found in areas of Chyulu hills and Kimana. During the field data collection for this study, there were reported 14 dips available for livestock disease management across Kajiado county, of which only four (4) were operational. Of the operational dips, three (3) were privately owned, implying that only one (1) operational cattle dip was open for public use. Table 3.1.d presents livestock data in Kajiado county, which is categorized for each of the four (4) divisions.

Table 3.1.d. Kajiado County Livestock data

Division	Dairy Cattle	Beef cattle	Sheep	Meat Goats	Dairy Goats	Indig. Chicken	Exotic Chicken	Camel	Pigs	Rabbit	Donkey
Ewuaso	22	200,000	300,000	290,000	60	6,000	30	0	0	0	13,000
Magadi	4	26,500	25,400	30,500	476	1,500	430	15	0	24	3,500
Ngong	104,450	54,400	76,670	72,600	320	25,720	49,700	0	4,015	12,211	2,000
Ongata Rongai	12,845	6,800	9,583	9,075	100	3,215	6,212	0	500	1,526	250
Total	117,321	287,700	411,653	402,175	956	37,391	56,372	15	4,515	13,761	18,750

(Source, District Livestock Officer, 2013)

Table 3.1e presents common livestock diseases common in Kajiado County. The data further illustrates common control measures implemented by Livestock authorities and other partners in Kajiado.

Table 3.1.e Kajiado County common Livestock data

Division	**Diseases**	**Livestock affected**	**Control measures**
Ngong	C.B.P.P, Helminthiasis, pneumonia, ECF , Heart water, Anaplasmosis, diarrhea, Newcastle, coccidiosis, diarrhoea, P.P.R	Cattle, Sheep, goats, poultry , Rabbit	Vaccination Treatment Spraying/ dipping
Magadi	CCPP,ECF, Trypanosomiasis Coccidiosis, F.M.D	Cattle, sheep, Goats and Poultry.	Vaccination, Treatment dipping
Ongata Rongai	Pneumonia, E.C.F, Anaplasmosis, Enteritis, Fowl pox, Iron deficiency, Coccidiosis.	Cattle, sheep, Goats, Pigs	Vaccination and treatment
Ewuaso Kedong	PPR, foot and mouth ,E.C.F, Anaplasmosis, Heart water	Cattle, Sheep and Goats	Vaccination and spraying

(Source, District Livestock Officer, 2013)

3.2 Design of the Survey

This study was a survey targeting selected TADs prominent in Kenya. The targeted TADs were; Rift Valley Fever (RVF), Rabies, *Pestes Des Petit Ruminants* (PPR) and Foot and Mouth Disease (FMD). Rather than using samples and following a rigid protocol such as strict set of rules to examine limited number of variables, the investigator applied in-depth study of documented materials, archival records and interviews seeking to investigate factors associated with utilization of ICT in management of TADs.

The study adopted a mix of quantitative and qualitative research. The U.S General Accounting Office (1990) submits that a research design is expected to represent a logical set of statement. Researchers argue that quality of any given design could be judged according to certain logical tests. Among the concepts offered for these test include trustworthiness, credibility, conformability and data dependability.

3.3 Population and Sampling Design

Purposive sampling method was used in identifying respondents for this study. The specific purposive sampling methods used were critical case, and homogenous sampling (Kombo and Tromp 2006). The primary target groups for this study were livestock keepers, community representatives and product dealers. Table 3.2 illustrates the sampling frame for this study.

Table 3.2. The Study Sample Size

Target Counties in Kenya	**Livestock keepers**	**Community Reps.**	**Poultry traders**	**Meat product dealers**	**Livestock Venders**	**Total**
Kajiado	30	25	15	10	5	85
Nandi	33	27	16	11	6	93
Trans Nzoia	36	30	18	12	6	102
Uasin Gishu	39	33	20	13	7	111
Total	138	115	69	46	24	391

The study sampled livestock keepers, communities interacting with poultry and meat product dealers across Kajiado, Nandi, Trans Nzoia and Uasin Gishu counties. These Kenyan counties were purposely selected due to their prevalence of TADs and inhabitation by livestock keepers hence making them ideal areas of study. The enumerators interviewed livestock keepers and community representative households selected randomly. Also interviewed were poultry traders, meat product dealers and livestock venders in Kajiado, Nandi, Trans Nzoia and Uasin Gishu counties.

According to the 2009 Kenya National Census, Nandi county had 752,965 persons. Kajiado had 687,312, Trans Nzoia 818,757 and Uasin Gishu 894,179 persons. These four (4) counties presented a total of 3,092,795 possible respondents to this study (GOK, 2010). However, Ngechu (2004) emphasizes the importance of selecting a representative sample through making a sampling frame. Cooper and Schindler (2006) argue that if well chosen, samples of about 10% of a population can often give good reliability. Furthermore, owing to the large number of target population across the four (4) counties, and with limited time and resources the sampling of at least 30 elements is recommended by Mugenda and Mugenda (1999). For categorical data, 5% margin of error is acceptable while for

continuous data, 3% margin of error is acceptable based on Krejcie and Morgan's (1970) table for determining sample size for a given population of above 1,000,000. It is with this guidance that a sample size of 391 respondents was selected for this study. This was considered adequate to represent a cross-section of study population at 95% confidence level. The sampled respondents across Kajiado, Nandi, Trans-Nzoia and Uasin` Gishu counties are illustrated on table 3.2. A smaller number of units, a sample, are often chosen in order to represent relevant attributes of the whole set of units. This is actually the population.

3.4 Sources and Types of Data

Both qualitative and quantitative data for this study was collected using a questionnaire and Key Informants. There were structured interviews, archival records reviews, observations and document review undertaken. The investigator focused on asking appropriate questions related to study objectives, good listening skills, adaptability and flexibility. Any form of bias or preconceived notions including those derived from theories were discouraged (Yin, R 1994).

The selected data sources for this study were; documented materials, archival records and interviews to livestock keepers and community based stakeholders. In seeking to maintain a consistent trail of evidence related to the study findings, the investigator created and maintained all evidence detailing circumstances under which data was collected, the form of data and other pre-disposing factors deemed to have otherwise influenced data collected. Figure five (5) and six (6) present methods used in collecting data for each objective under investigation.

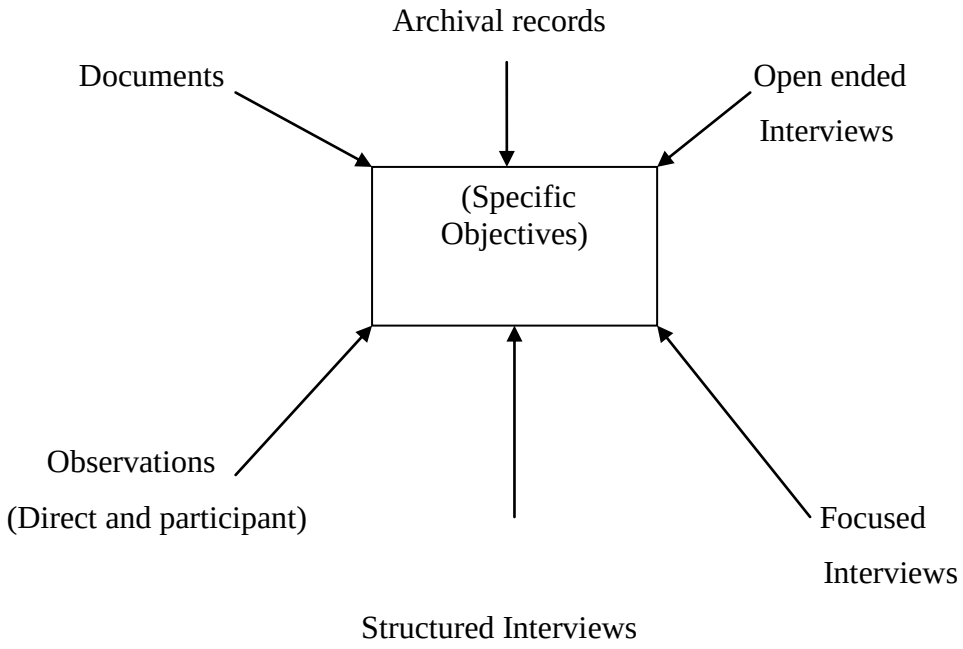


Figure 5 Convergence of multiple sources of data

Interviews → Findings → Conclusions

Survey → Findings → Conclusions

Document Analysis → Findings → Conclusions

Figure 6. Non convergence of multiple source of data

Adopted form (Yin, R 2004)

The investigator interviewed representatives from private sector, government officials responsible for animal disease control, national disease emergency response representatives, wildlife and meteorology experts interested in animal disease control in Kenya and East Africa. The study evaluated

information and communication media used by meteorology department of Kenya in disseminating information on animal disease control to stakeholders. Additional interviews were conducted in the ministry of veterinary services at Kenya's headquarters in Nairobi, information specialists at; International Livestock Research Institute (ILRI) and Food and Agricultural Organization of the United Nations (FAO). This was done in order to establish existing information and communication methods used.

3.5 The Research Procedures

Training on data collection methods and approaches was conducted to a team of 12 enumerators. The team thereafter collected data across the four (4) Kenyan counties. The questionnaires were pretested by the investigator and enumerators. This was to correct any abnormalities or errors prior to actual data collection. According to Mugenda and Mugenda (1999), the purpose of pre-testing instruments is to ensure that, items in the tools are stated clearly and have the same meaning to all participants.

In Kajiado county, the investigator and four (4) enumerators convened at Kiserian town for training ahead of data collection. Following a pre- test of the survey, the enumerators proceeded to target 85 respondents across Kajiado West and Kajiado North sub-counties. In Uasin Gishu county, the investigator conducted training to three (3) enumerators in Eldoret West. This was followed by a pre-test of the survey. The enumerators proceeded to target 111 respondents in answering the questionnaire. In Trans-Nzoia county, the team of three (3) enumerators and investigator convened at Kitale town for training. This was followed by pre-test of the survey. The enumerators then proceeded to target 102 target respondents for questionnaire interview. In Nandi county, the team of three (3) enumerators and investigator convened at Mosoriot trading center for training. The enumerators following a pre-test of the survey proceeded to target 93 respondents for questionnaire interview. The 12 enumerators working on this

study and investigator used motor bikes, private and public service vehicles as transport means to reach livestock keepers and other community representatives targeted by this study across the four (4) counties.

Each of the 12 enumerators assigned to the four (4) counties under investigation by this study were residents and fluent in local languages. This was undertaken to ease communication while administering the questionnaire. Furthermore, all the 12 enumerators were holders of university first degree. The investigator used the Essential Electronic Agricultural Library (TEEAL), OARE and Google scholar data bases to establish the latest status on information and communication management for TADs in Kenya.

3.6 Data Coding Procedures

Coding represents the operations by which data are broken down, conceptualized and put back together in new ways. The study applied opening coding for purposes of breaking down, examining, comparing, conceptualizing, naming and categorizing data (Strauss and Corbin, 1990). The two (2) analytical procedures guiding data coding in this study were: making of comparisons and asking of questions. Conceptualizing of data was the first step in analysis, which involved taking apart an observation or paragraph, and giving each discrete incident, idea or event or name. This should be something that stands for or represents the phenomena. The specific issues emanating from different data collection instruments were grouped and classified according to their categories of relationships, in line with study objectives and research questions.

3.7. Data Presentation, Analysis and Interpretation

The process of data presentation, analysis and interpretation for this study involved organizing data in a meaningful pattern, editing, coding and thematic presentations. The study employed both quantitative and qualitative methods of data analysis. The feedback obtained from qualitative and quantitative data were analyzed and findings presented with integrity and within allowable statistical

standards. This was without any form of manipulation. In event of criticism of statistical origin, these were directed to study inquiry and not individuals or institutions reached during the study. The study applied statistical procedures without any prejudice or concern to otherwise favorable outcomes (Kombo and Tromp 2006).

Data gathered by use of different instruments were carefully checked to ensure that only complete, accurate and relevant data were finally coded. This was realized this by counter-checking the documented responses from all the instruments. The purpose of this was to detect and eliminate inconsistencies and irrelevances in documented responses. The responses were further edited to eliminate incomplete contents and errors ahead of data entry.

3.7.1 Qualitative Data Analysis

Prior to actual qualitative data analysis for this case study, the researcher developed analytic procedures. In order to ensure an effective data analysis for this case study, the investigator used a strategy encompassing three (3) dominant analytical techniques; pattern matching, explanation–building and time series analysis, all of which were aimed at ensuring the evidence collected is treated fairly so as to produce compelling analytical conclusions (Yin, R. 1994). In analyzing data collected for this study, the researcher used a pattern –matching logic, since such logic compares empirical based pattern with a predicted one, or with several alternative predictions. Thus for this study, if the patterns under investigation coincided, then it would be highly likely that the results would help the study strengthen its internal validity (Trochim, 1989).

In explanation building for this study, the researcher aimed at developing ideas for further study and not to conclude the investigation *per se* . It is defined that to explain a phenomena is to stipulate a set of causal links about it. For this study the causal links underlying the independent variables were investigated.

In analyzing qualitative data collected for this study, content and thematic analysis was used. For thematic analysis technique, the investigator reviewed relevant data on information management of TADs in form of reports, publications and scientific journals, in seeking to establish major issues, thematic events and emerging trends. These were classified in relation to study objectives and research questions. The coding system was developed for qualitative data collected, prior to classification and categorization of major topics and issues. The major themes identified were indicated on the margins, while all materials relevant to dominant topics or focal areas were placed together. In effect the study developed a summary report identifying major themes and associations between them. In describing the findings from this analysis the study used graphs and direct quotations.

In applying content analysis technique, the study developed a classification system which was used for recording study information. However in interpreting the data collected, the investigator considered the frequency with which a symbol or concept appeared which would be interpreted as a measure of importance, attention or emphasis (Kombo and Tromp 2006). In using the content analysis method, the study aimed at establishing not only themes and patterns, but further to develop a deductive outcome which quantifies frequencies of data. The expected results were descriptive and were expected to indicate trends and issues of interest to study objectives. The specific content analysis forms used were; analysis of concepts, comparative and theoretical analysis.

3.7.2. Quantitative Data Analysis

According to Mugenda and Mugenda (1999) data analysis is the process of bringing order, structure and meaning to the mass of information collected. The goal of data analysis is to produce findings that relate to the problem motivating the research and to provide insights that contribute to decision-making process. The classified data coded from the data collection instruments in this study were

thematically analyzed into themes and sub-themes. This was guided by study objectives and research questions. In addition, analyses of responses were further enhanced by use of tables, description charts and percentages where applicable.

The quantitative data collected from identified target groups were scrutinized for errors or omissions, tallied with expected returns, and validated. The valid returns were then converted into data entry code book and table. The analysis of questionnaires was processed using Statistical Package for Social Sciences (SPSS). The resulting dataset was subjected to descriptive statistics in seeking to describe the observations. Inferential statistics were applied as basis for making predictions.

Following the nature of problem under investigation the study used linear regression model to establish relationships between core variables under investigation, by fitting a linear equation to observed data. In seeking to establish association between independent variables and dependent variable (outcome), the investigator used Spearman's coefficient of correlation. The linear regression model was selected for this study since it provides the magnitude of contribution the independent variables created to outcome variable. This was with a further analysis of either positive or negative relationships. The study ensured that requisite conditions for application of linear regression model were met, specifically; ensuring that P- value was less than 0.05 and T value was greater than 1.9.

3.8 Investigating acceptance of ICTs for Management of TADs

Among the study objectives was to determine factors associated with acceptance to ICT utilization among livestock keepers for management of TADs. The aspects of ICT acceptance were β (independent variables) and dependent variable was Y. This statistic was used in testing significance of differences between two (2) or more groups. This was independent variable and in frequencies for the dependent variables. The regression model outlined was used to investigate factors which influence utilization of ICTS for management of TADs**.**

$$Y = \alpha + \beta_1 X_1 + \beta X_2 + \beta_3 X_3 + \beta_4 X_4 + \epsilon \beta_5 X_5 + \epsilon \beta_6 X_6 + \epsilon \beta_7 X_7 + \epsilon$$

Where: Y = Dependent Variable (ICT Utilization)

β_0 = Regression coefficient

β_1, β_2, and β_3 are slopes of the regression equation

X_1= Cost of ICT services and equipment

X_2= Training

X_3= Access to information and technologies

X_4= Communication method

X_5= Contact with change agents

X_6= Interconnection with social groups

While ϵ is an error term normally distributed about a mean of 0 and for the purpose of computation, α was assumed to be 0. The equation was solved using the statistical model. The SPSS platform was applied. Other inferential statistic used was Spearman's coefficient of correlation in seeking to establish relationships between independent variables and outcome variable. The multiple regression model was selected as the statistical method for this study since it allows one to predict a score of a variable, on basis of their scores on several other variables. The independent variables were; cost of ICT services and equipment, training, access to information and technologies, communication methods, contact with change agents and interconnection with social groups. The independent variables on this study were selected based on their perceived influence towards increasing adoption to new technologies. Rodgers and Scott (1999) submit that earlier knowers of an innovation have more exposure to mass media channels of communication and contact with change agents. Furthermore, earlier knowers of an innovation have more social participation than late knowers. It is with these theoretical prepositions that this study considered investigating these factors. The other independent variables were selected based on their contribution to diffusion of technologies by social units. Rodgers (2003) explains diffusion as the process

by which an innovation is communicated through certain channels over time among members of a social system. This study considered utilization of ICTs for management of TADs as an innovation.

To quantify the strength and direction of the relationship between variables, Spearman's coefficient of correlation was used. The coefficient of determination (r^2) was used to establish the degree of association between the variables. The coefficient of determination is a measure of how well a statistical model is likely to predict future outcomes.

3.9.1 Investigating the role and type of communication methods used for Management of TADs

The second objective was to investigate the role and type of information and communication approaches used for management of TADs among livestock keepers and other stakeholders. In establishing this, the investigator used Qualitative data analysis. The specific qualitative methods used were content and thematic analysis.

3.9.2 Evaluating existing models used for Information Communication Management of TADs

The existing models used by stakeholders within livestock sector for purposes of information and communication in management of TADs were evaluated. This entailed a review of existing models used by AU-IBAR, Kenya Wild Life (KWS), and Department of Veterinary Kenya. The other institutions reviewed included Meteorology department and Center for Disease Control (CDC). The existing ICT models used across Kenyan counties of Nandi, Kajiado, Trans Nzoia and Uasin Gishu for purposes of information and communication in management of TADs were also reviewed.

3.10 The Envisioned ICT model requisite for Information and Communication Management of TADs

The study envisioned a multi-sectoral ICT model as appropriate for information and communication purposes in management of TADs. This model would be applicable during critical disease management phases of surveillance, diagnosis, feedback and mass education. The problem of inadequate information and communication among livestock and wildlife stakeholders could be minimized if core actors' specifically service providers, technical experts, government and community representatives were networked via ICT platform for purposes of management of TADs.

This study proposes an ICT information management model as opportunity for enhancing dissemination of information and communication of technologies. An additional benefit would be stimulation of socio-economic benefits among livestock keepers and professional service providers within the livestock sector. It is probable that there would be minimal conflict amongst stakeholders. Further more consistent information exchange and communication amongst technical experts such as veterinary, human health, wildlife experts, emergency national disease units, donor representatives and meteorology department would create opportunity for increased development. If these service providers were networked using ICTs, there would be guaranteed optimal utilization of resources for management of TADs.

It is argued that the most essential factors in the control of any new emerging health risk is early detection of the disease and understanding of its epidemiology. This can enable the agencies responsible for disease control to attack the disease at its source, thus reducing its spread and preventing it from becoming endemic (World Bank, 2010). This actually underscores the need for an

interactive information and communication platform, which this study envisions its construction using emerging ICTs.

3.11 Developing a Training proposal on ICT utilization for Management of TADs

The use of ICTs provides opportunity for livestock keepers and other stakeholders to function effectively through a shared information and communication platform with sufficient linkages. This facilitates access to knowledge and technologies for the effective and efficient management of TADs. The study was designed on the premise that most livestock keepers and other community representatives require training on use of different ICTs for management of TADs. Following the findings of study objectives, the investigator proposed training protocols appropriate for livestock keepers training and other community representatives towards utilizing ICTs for management of TADs.

3.12. The Study Outcomes

1) An efficient information communication design model requisite for application in management of Transboundary animal diseases.
2) An ICT interactive information communication design model, appropriate for management of Transboundary animal diseases based on acceptance levels among livestock keepers.
3) Award of Doctor of Philosophy Degree (PhD) in Agricultural Information Communication Management (AICM).
4) Publication of two (2) papers based on research findings on utilization of ICTs in management of TADs amongst livestock keepers.
5) Training protocols appropriate for livestock keepers in utilizing ICTs for management of transboundary animal diseases.

3.13 The Study Impact

1) Minimized socio economic burden arising from Transboundary animal disease outbreaks. This will be realized following increased access to information and technologies by use of a communication platform by livestock stakeholders.
2) Reduced risk and financial burden to fragile development sectors responding to TADs outbreaks.
3) Increased awareness and interaction on management of TADs amongst livestock stakeholders and local communities resulting from integration of technology with ICTs, knowledge and culture. This will ultimately guarantee harmony and co-existence.

CHAPTER FOUR

RESULTS

4.0. RESULTS

This chapter presents results of this study seeking to investigate utilization of ICTs in management of TADs. The study sought views of livestock keepers and community stakeholders on factors which would influence their acceptance to utilize ICTs for management of TADs. The findings of selected models used in management of TADs are presented. The chapter does not discuss entirely the results generated from study analysis. However, chapter five (5) subsequently discusses major findings of this study to greater depths.

4.1 Questionnaire response rate

Response rate is the extent to which the final data set includes all sample members and is calculated from the number of people with whom interviews were completed divided by total number of people in the entire sample. This includes those who declined to participate and the unavailable. From the results, 356 out of 391 sample respondents filled in and returned the questionnaire accounting for 90.8 %.

4.2 Descriptive Results Findings

4.2.1 The respondent categories under investigation

The results on Figure seven (7) present the distribution of respondents' and categories as reached by this study.

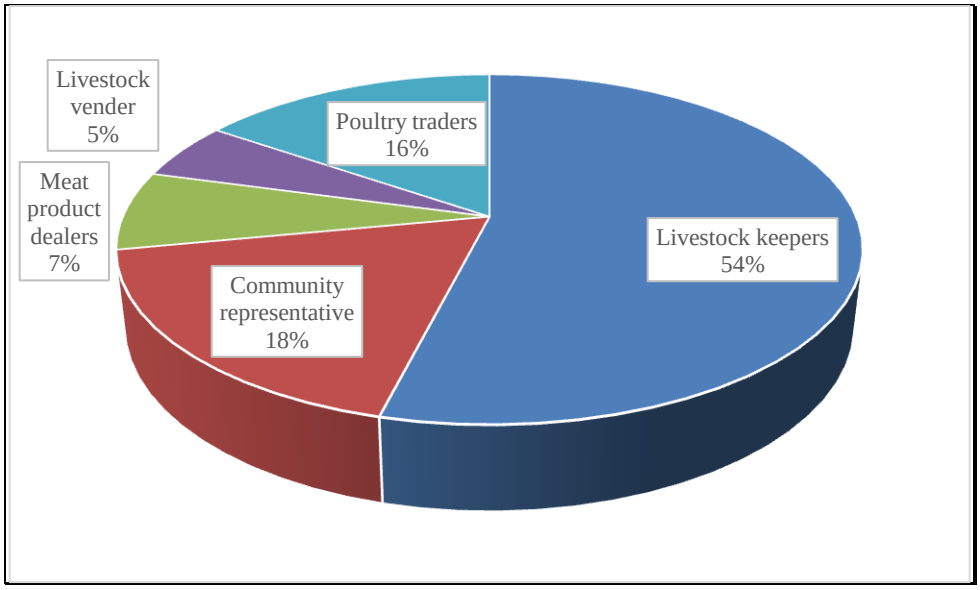


Figure 7. Distribution of the respondents by category

The study results established an overwhelming majority of the respondents were livestock keepers. This evidently depicted that study population comprised of all possible livestock keepers' and community based stakeholders. This results implied the views expressed on this study were comprehensive and representative towards investigating utilization of ICTs for management of TADs in Kenya. The majority (29.2 %) were cattle keepers as presented on Table 4.1.

Table 4.1 Livestock stakeholders' types Interviewed

Category	Specific Class	Frequency	Percentage
Livestock keepers	Cattle keeper	104	29.2
	Goat keeper	39	11
	Sheep keeper	26	7.3
	Poultry keeper	69	19.4
	Donkey keeper	11	3.1
Community representative	Public administration	4	1.1
	Elder (council of elder)	1	0.3
	Politician	11	3.1
	Religious leader	19	5.3
	Youth leader	23	6.5
Meat product dealers	Cattle product dealer	14	3.9
	Poultry product dealer	8	2.2
	Cattle Livestock vender	6	1.7
Poultry traders	poultry trader	7	2
	others	14	3.9
Total		**356**	**100**

4.3.1 Gender of respondents

The majority (73.3%) of the respondents to this study were males, compared to 26.7 % female respondents across Kajiado, Nandi, Trans-Nzoia and Uasin Gishu counties. This implies that males dominated the role of household head as compared to their female counterparts. Table 4.2 illustrates these results.

Table 4:2 Gender of study Respondents

Gender	**Frequency**	**Percent**
Female	95	26.7
Male	261	73.3
Total	356	100.0

4.3.2 Age distribution of the respondents

Livestock keeping draws people from different age groups. Accordingly, this study sought to establish the respondents' distribution across various age brackets. This was to establish how the various participants varied in terms of experiences and age. The age distribution findings across Kajiado, Nandi, Trans-Nzoia and Uasin Gishu counties are presented on Table 4.3.

Table 4.3 Age bracket of Respondents

Age Brackets (in years)	Frequency	Percent
18-25	15	4.2
26-35	88	24.7
36-45	174	48.9
46-55	40	11.2
over 55	39	11.0
Total	**356**	**100.0**

4.3.3 Education level attained

Livestock keeping draws people across varying academic qualifications. This variations might contribute to differences in Information given towards utilization of ICTs for management of TADs, and hence the responses given. The study investigated the highest academic levels attained by respondents. The findings are presented on Table 4.4.

Table 4.4 Level of Education

Level of Education	Frequency	Percent
Primary	84	23.6
Secondary or O-level	100	28.1
Certificate	65	18.3
Diploma	50	14.0
Bachelor's degree	27	7.6
Not Educated	30	8.4
Total	**356**	**100.0**

4.3.4 Occupation of the respondents

The results of this study as depicted in Figure eight (8) evidently presents a cosmopolitan set of respondents. These findings were evident from the variation in occupation status of respondents reached by this study. The farming occupation accounted for 35% of respondents. This was the dominant occupation among others.

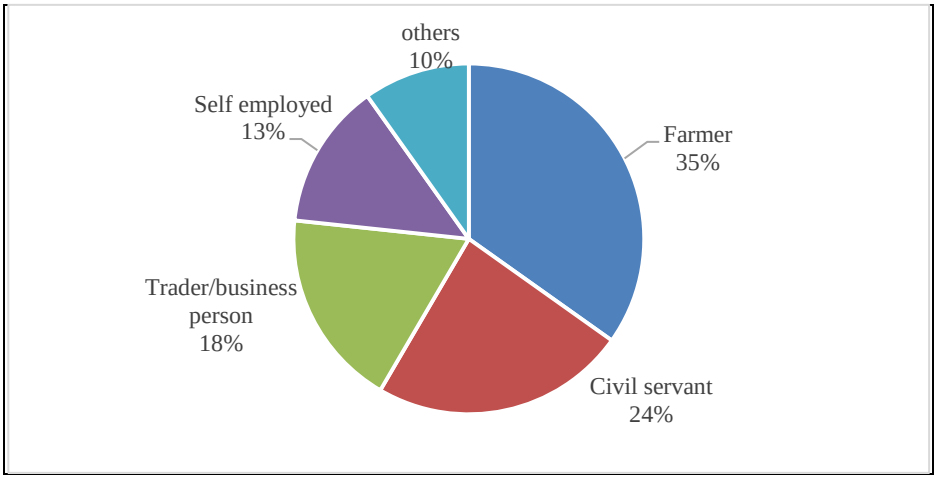


Figure 8. Occupation of respondents

According to the results depicted in Figure 8, farming, public service (civil servants) and trading / business were the dominant occupations taken up by respondents to this study.

4.4 The ICT Types used at Household Level

Objective 1: To Identify ICTs and other communication methods used by livestock keepers and community based stakeholders.

The study investigated ICTs and other communication methods used at household level. The ICTs under investigation were; internet, mobile telephone, radio, Television, Compact Disc Read Only Memory (CD ROM), video and multimedia. The results established an overwhelming majority of respondents (93.3% of study population) confirmed using ICTs for other purposes at household level. There were 6.7 % of respondents who were not using any of the ICTs. The study further investigated which of the ICTs were mostly used by respondents at household level. Figure nine (9) presents the predominant ICTs used at household level as ranked by respondents.

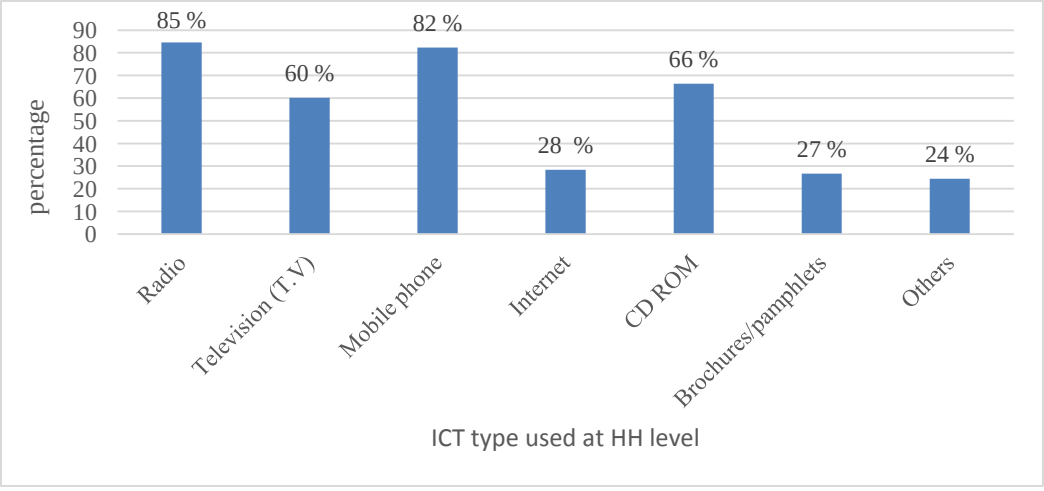


Figure 9. The predominant ICTs used at HH level

The findings on Figure 9 evidently ranked the radio, mobile phone, Compact Disc Read Only Memory (CD ROM), and Television (T.V) as most utilized ICTs at household level. This was for various other purposes and not for management of TADs per se. This study further sought to establish whether the respondents had received adequate and satisfactory information on management of TADs within their district / county. The types of TADs the respondents were to identify included; Rift Valley Fever (RVF), Foot and Mouth Disease (FMD), Contagious Bovine Pleuropneumonia (CBPP), *Pestes Des Petit Ruminants* (PPR) and Rabies. However, the study did not limit respondents to any other common TADs across their counties. From the study findings, 52 % of respondents had not received adequate or rather satisfactory information on management of TADs. However, there were 48% of respondents who affirmed having received information for managing TADs common within their counties. The study further established that 77 % of respondents had received information on wildlife diseases which could affect, or had affected livestock within their county / district or village. On the contrary, there were 23 % who lacked information on possibility of wildlife diseases attacking their livestock.

4.5 Most helpful sources of technical information for Management of TADs

This study investigated the most helpful sources of technical information for management of TADs available to livestock keepers across the four (4) counties. Table 4.5 illustrates the results, which evidently depict the Television (T.V), radio and mobile phone as most helpful sources of technical information for management of TADs. However, the extension worker, Compact Disc Read Only Memory (CD ROM), Internet, Farmer Field Day (FFD), brochures, pamphlets, books, and magazines were rated least helpful sources of technical information for management of TADs.

Table 4.5 Most Helpful sources of Technical information in Management of TADs used by Livestock keepers

Source	Mean	Std. Dev.
Radio	1.7893	0.89631
Television	2.8230	1.21476
Mobile phone	2.3230	1.00681
Internet	3.6067	0.94488
CD ROM	3.5730	1.00576
Books	3.7275	0.77017
Extension worker	3.5309	0.90796
Brochures	3.7163	0.74748
Farmer Field Day	3.6713	0.80936
Pamphlets	3.7163	0.78066
Magazines	3.8736	0.56497
Others	3.7978	0.64007

4.6. The role of information and communication in management of TADs

Objective 2: To investigate the role and type of information, communication methods used in management of TADs among livestock keepers.

The second objective for this study was investigating the role and type of information and communication methods used in management of TADs among livestock keepers and community based stakeholders. To establish this objective, the study carried out a qualitative investigation.

The respondents submitted that information and communication methods were affordable and cost effective means of managing TADs. Others recapped that information and communication methods enable early disease diagnoses which would reduce death losses of livestock arising from misinformation on

management of TADs. Some of the respondents interviewed preferred the internet for reasons that it was detailed and accurate source of information in management of TADs. However these respondents were minimal compared to those who preferred radio and mobile phones. Irrespective of the methods used, most respondents reiterated that information was key in guiding their actions on management of TADs. Among the actions mentioned included avoiding certain livestock products during TADs outbreaks and quarantine enforcement. Most of the respondents interviewed highly regarded ICTs an important knowledge source on management of TADs. Ultimately the respondents submitted that information and communication methods would contribute towards minimizing the spread of TADs across their counties.

This study sought to investigate why respondents would consider accepting ICTs for management of TADs. From the results, the respondents indicated they would consider ICTs for convenience, reliability and availability in communication. The respondents were in agreement that ICTs were accessible across their home counties and as such preferred using them. The respondents preferred radio and mobile phones since they were fast in transferring information, as opposed to other ICT types. Most of respondents interviewed reiterated that ICTs enabled information to be equally distributed to a large population with clarity, notwithstanding the simplicity and ease required while communicating. This was confirmation of the adequacy of ICTs in disseminating information as a mass media.

This study further investigated the first or rather immediate information contact centers available to respondents during TADs outbreaks. The results established that outbreaks of TADs such as Rabies, Rift Valley Fever (RVF), Foot and Mouth Disease (FMD), *Contagious Bovine Pleuropneumonia* (CBPP), *Pestes Des Petit Ruminants* (PPR) were learned from neighbors, market places, cattle dips, slaughter houses, and other social functions. This finding demonstrated a high degree of connectedness to social groups by respondents, since information

and messages on TADs were to a great extent communicated through social groups.

4.7. The Benefits and Limitations of ICTs in management of TADs

This study sought to investigate benefits and limitations of information or communication technologies used by livestock keepers and community stakeholders while seeking information on management of TADs. Among the benefits cited by respondents were that ICTs such as mobile phones and radio disseminates information faster than other manual methods. The respondents explained that ICTs transferred information equally to most farmers, notwithstanding the affordable cost while communicating. In Nandi and Uasin Gishu counties, respondents commended ICTs as an available 'education source' on management of TADs. In Kajiado, respondents entirely relied on radio as their available information source on matters regarding management of TADs. In particular *Nosim* FM radio service was highly regarded across Kajiado by respondents to this study. Furthermore, the portable nature of mobile phones and radio was considered a benefit by the pastoral respondents of Kajiado county. Since management of TADs requires immediate actionable measures, the respondents preferred ICTs for timely dissemination of alert messages regarding the spread of TADs.

However, respondents cited limitations of information and communication methods used for management of TADs. Among the limitations were difficulties in understanding various languages broadcasted by media. In Kajiado and Nandi counties, respondents reiterated their preference for local dialect radio stations for communication on management of TADs. It was notable across the four (4) counties reached by this study that respondents lamented high costs levied on mobile phone services. The cost of Short Message Services (SMS), and that of buying batteries for radio were considered high by respondents. The respondents generally cited cost of ICT devices as a limitation. There were mentioned cases of

information overlaps arising from ICTs which caused confusion. In Kajiado, respondents particularly lamented instances where they misinterpreted information on disease management communicated by ICTs. The lack of adequate electrical power was a limitation cited across all four (4) counties. Frequent loss of power was blamed for delayed information transmission and feedback. There were similar complaints of frequent loss of mobile telephone and television network. This according to respondents caused lapses in communication regarding management of TADs. A notable limitation reported among selected respondents were cases of illiteracy. These respondents instead preferred face to face methods of communication in management of TADs, as opposed to ICTs.

4.8 Factors associated with acceptance for ICT utilization amongst livestock keepers

Objective 3: To establish factors for acceptance of ICT utilization in management of TADs, among livestock keepers and community based stakeholders.

The third objective of this study was investigating factors which favor acceptance and utilization of ICTs for management of TADs among livestock keepers. However, community based stakeholders were also included as respondents. The factors under investigation were; demographic factors, technological factors, cost, socio-cultural factors and interconnection with social groups. The results for these factors as investigated are presented in sections 4.8.1 – 4.8.4.

4.8.1 Demographic factors

The respondents to this study were required to indicate the extent to which various demographic factors would influence their acceptance and utilization of ICTs in management of TADs within their resident counties. A scale of 1 to 5 was provided where 1= no extent, 2= little extent, 3= moderate extent, 4= great extent and 5 was to a very great extent. Figure 10 illustrates the factors influence as rated by respondents.

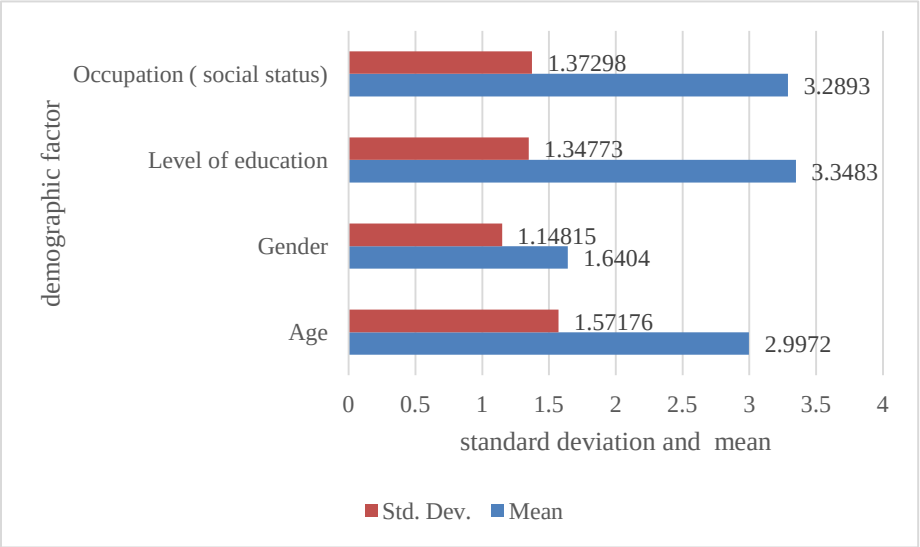


Figure 10. Demographic factors as they influenced utilization of ICTs

The results demonstrated that education level attained, occupation or social status would influence acceptance and utilization of ICT for management of TADs to a moderate extent. These variables generated means of 3.3483 and 3.2893 from a possible 5, as illustrated on Figure 10. However according to respondents, age and gender would influence acceptance and utilization of ICTs in management of TADs to a lesser extent. This generated relatively low mean scores as illustrated on Figure 10.

4.8.2 Technological factors' Influence towards utilization of ICTs

Technological factors were found to have an influence on utilization of ICT in management of TADs across the four counties. According to results on Figure 11, majority of respondents affirmed that training and in particular demonstration on ICT applications would highly influence acceptance and utilization of ICT for management of TADs. This was rated by a mean score of 4.368, out of a possible 5.This results were similar to those of contact with change agents, telecommunications infrastructure, network connectivity and computer skills. However, with regard to perceived advantage of ICTs, the respondents rated this variable as moderate in influencing their acceptance and utilization of ICTs for management of TADs.

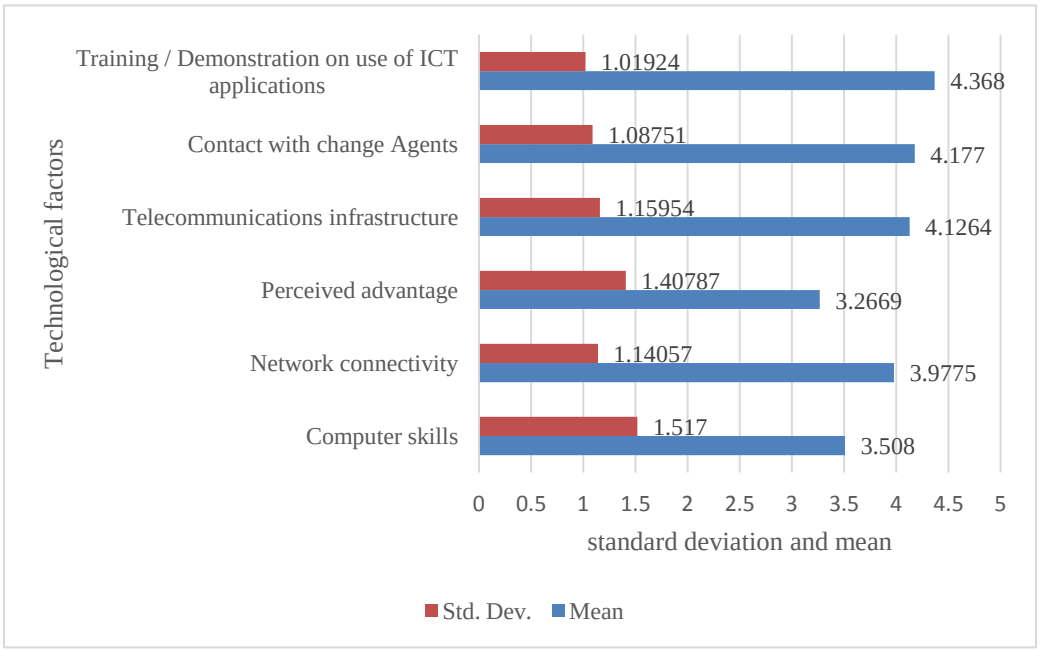


Figure 11. Extent to which technological factors influence utilization of ICT

4.8.3 Change agents involvement with management of TADs

The respondents in this study were required to indicate whether they had contact with various change agents for purposes of management of TADs within their home counties. This analysis was investigating Objective 1. Table 4.6 presents the results.

Table 4.6 Change agents involved in management of TADs

Change Agents	**Yes**		**No**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
NGOs	100	28.1	256	71.9
Extension workers	80	22.5	276	77.5
Government officers	115	32.3	241	67.7
Religious Groups	83	23.3	273	76.7
Private companies	109	30.6	247	69.4
Famer Field Day	42	11.8	314	88.2
Others	87	24.4	269	75.6

The study established that 52 % of respondents were in agreement that change agents influence ICT utilization to a very great extent. There were 28 % of respondents who indicated to a great extent, 10 % moderate extent, 6 % indicated little extent, while 4 % of respondents indicated that change agents would not influence ICT utilization. This results implied that livestock keepers considered change agents as having significant influence towards ICT utilization. Figure 12 illustrates these results on how respondents rated change agents towards influencing their acceptance to utilizing ICTs for management of TADs.

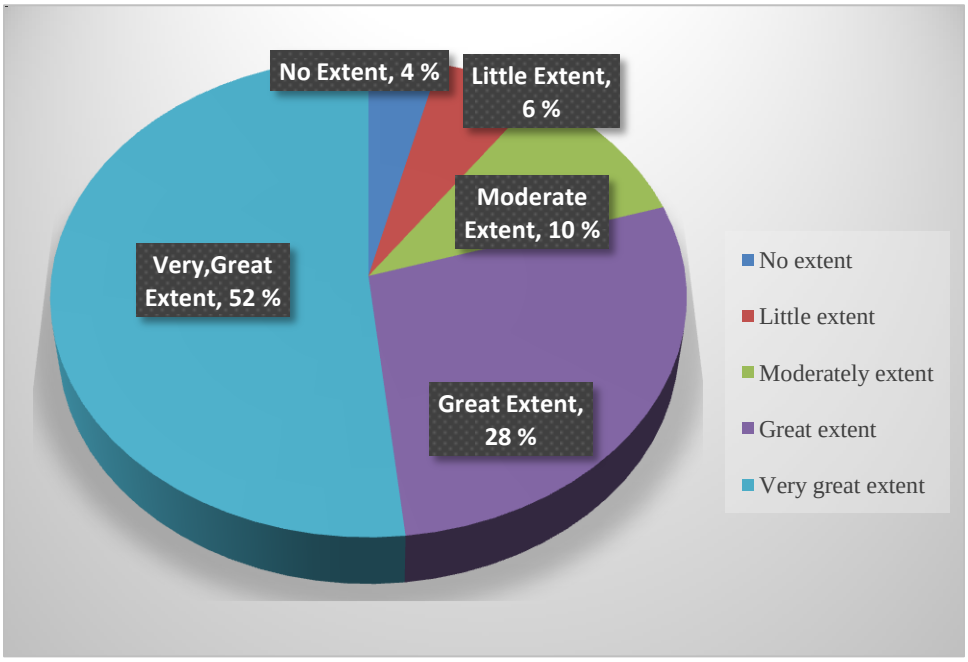


Figure 12 Extent to which change agents influence utilization of ICTs

4.8.3 Economic Factors' Influence towards utilization of ICTs

The cost factor for ICT services and equipment were found to influence acceptance and utilization for management of TADs. The study required respondents to rate the extent to which various economic factors would influence their acceptance and utilization of ICTs in management of TADs. Figure 13 illustrates these results.

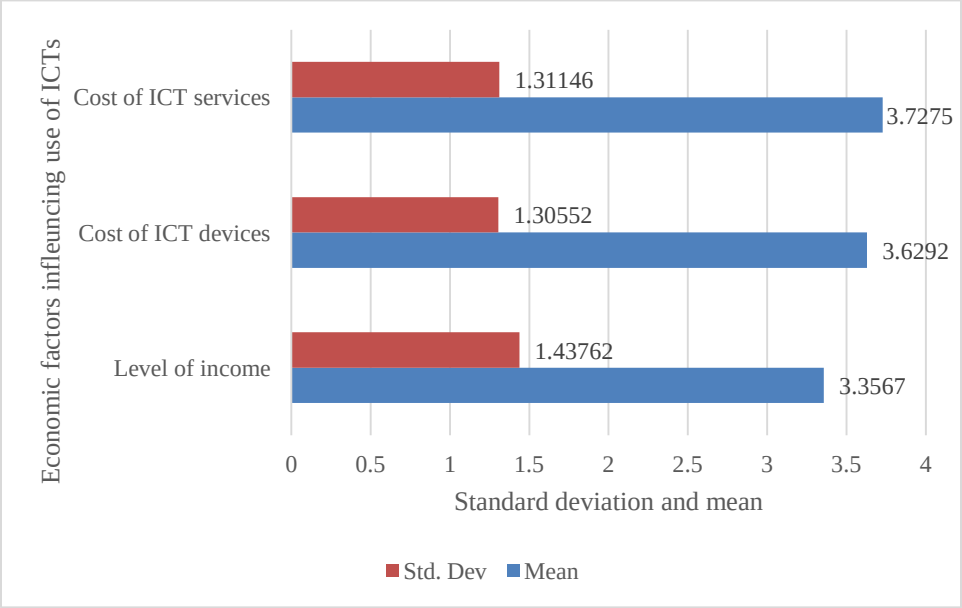


Figure 13. Economic factors influence towards utilization of ICTs

4.8.4 Socio-cultural factors' Influence towards utilization of ICTs

The study questioned respondents across Kajiado, Nandi, Trans-Nzoia and Uasin Gishu counties to rate the extent to which socio-cultural aspects would contribute towards acceptance and utilization of ICTs in management of TADs. Table 4.7 presents these results.

Table 4.7 Socio- cultural aspects as they influenced utilization of ICTs

socio-cultural aspects	mean	std deviation
Beliefs and taboos from the traditions	1.3876	.96488
Attitudes towards ICT	2.8736	1.54127
Social lifestyles	2.2865	1.45426
Social norms	1.4073	.88483
Perception / views of others	2.0787	1.36123

4.8.6 Interconnection of respondents with social groups

This study established an overwhelming majority (81.2%) of the respondents confirming their interconnection with social groups or networks within their counties. This indeed was a high level of active participation in social groups by respondents. There were 18.8 % of respondents who were not interconnected to any social groups. Table 4.8 presents these results.

Table 4:8 Respondents Interconnection with Social Groups

Response	Frequency	Percent
Yes	289	81.2
No	67	18.8
Total	356	100.0

4.9. Empirical Results Findings

4.9.1 Results of Inferential statistics investigating Objective 3.

This study applied inferential analysis to determine the relationship between an intervention and an outcome if any and further determine the strength of that relationship. The inferential statistics aimed at reaching conclusions which extent beyond the immediate data presented between the independent variables on this study and dependent variable. This was basis for which coefficient of determination was introduced. The study applied multiple regression analysis to establish relationship between selected variables under investigation. The independent variables were; cost of equipment, training, access to information and technologies, communication method, contact with change agents, and interconnection with groups. The dependent variable was utilization of ICTs.

4.9.2 Spearman's Coefficient of Correlation Findings

This study used Spearman's correlation coefficient to establish the degree of correlation, or association between ICT utilization and six (6) independent variables. Spearman's correlation coefficient is best applied in identifying and

testing the strength of a relationship between two (2) sets of data. The results on Spearman's Rank correlation coefficient are presented on Table 4.9.a. Additionally, Table 4.9.b. illustrates results on analysis which established the coefficient of determination.

Table 4:9.a Spearman's Rank Coefficient Correlation findings, testing strength of relationship between ICT utilization with; access to information and technologies, cost of equipment, communication methods, interconnection with social groups, training and contact with change agents

Spearman's rho		ICT utilization	Access to information and technologies	Cost of equipment	Communication methods	Interconnection with social groups	Training	Contact with change agents
ICT utilization	Corr Coeff	1.000	.178	-.206	.067	.156	.421	.435
	Sig.(2 tailed)	.	.140	.000	.205	.003	.699	.103
Access to information and technologies	Corr Coeff	.178	1.000	.301	.470	.068	.089	.461
	Sig.(2 tailed)	.140	.	.000	.000	.199	.092	0.097
Cost of equipment	Corr Coeff	-.206	.301	1.000	.234	.206	.014	.213
	Sig.(2-tailed)	.000	.000	.	.000	.000	.791	.102
Communication methods	Corr Coeff	.067	.470	.234	1.000	.047	.100	.123
	Sig.(2-tailed)	.205	.000	.000	.	.381	.059	.335
Interconnection with social groups	Corr Coeff	.156	.068	.206	.047	1.000	.160	.123
	Sig.(2-tailed)	.003	.199	.000	.381	.	.003	.335
Training	Corr Coeff	.421	.089	.014	.100	.160	1.000	.218
	Sig.(2-tailed)	.699	.092	.791	.059	.003		.413
Contact with change agents	Corr Coeff	.435	.461	.213	.335	.123	.218	1.000
	Sig.(2-tailed)	.103	0.097	.102	.009	.335	.413	

Table 4.9.b. Coefficient of determination explains extent to which changes in the dependent variable can be explained by the change in the independent variables, or percentage of variation in the dependent variable

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.792	.627	.303	.125

4.9.3 Coefficient of determination Findings

The coefficient of determination is a measure of how well a statistical model is likely to predict future outcomes. The coefficient of determination, r^2 is the square of the sample correlation coefficient between outcomes and predicted values. For this study it explained the extent to which changes in dependent variable could be explained by the change in the independent variables. This is percentage of variation in the dependent variable (utilization of ICTs in management of TADs), which is explained by the independent variables (access to information and technologies, cost of equipment, communication methods, interconnection with social groups, contact with change agents and training). Table 4.9.b presents the coefficient of determination findings.

Predictors: (Constant), access to information and technologies, cost of equipment, communication methods, interconnection with social groups and contact with change agents and training.

4.10 Multiple Regression Findings

Multiple regression is a statistical technique which allows one to predict a score of one variable on basis of scores on several other variables. The study conducted multiple regression analysis to establish the relationship between various dimensions of mergers or acquisitions, and utilization of ICTs in management of TADs. The purpose of multiple regression in this study was to establish the relationship between independent or predictor variables, so as to explain variations of the dependent or criterion variable. The dependent variable for this study was utilization of ICTs in management of TADs. The independent variables were; access to information and technologies, cost of equipment, communication methods, interconnection with social groups, contact with change agents and training. This statistics were investigating objective 3 of this study.

In seeking to quantify reliability of the estimates, the investigator made assumption of linearity. The assumption of independence (Durbin Watson test

indicated a result of 2.123. This meant there was no auto-correlation between the residual values). For the assumption of constant variance (there were no outliers in the independent variables as the results were less than 0.50). The assumption of normality (sample size was more than 30; hence met the central limit theorem). These assumptions were met to a significant extent, thus results obtained were consistent to assumptions made and hence positive. Table 4.10 presents the results of multiple regression analysis.

Table 4.10: Multiple Regression analysis findings showing the relationship between independent variables, and dependent variable

	Unstandardized Coefficients		**Standardized Coefficient**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	3.432	.412		4.009	0.0000
Cost of ICT services and equipment	-0.318	.084	.023	-0.358	0.0045
Training	0.553	.146	0.330	1.379	0.0041
Access to information and technologies	0.474	.064	0.314	1.284	0.0041
Communication methods	0.169	.116	.080	0.849	0.0046
Contact with change agents	0.248	.107	.145	0.263	0.0045
Interconnection with social groups	0.205	.105	.089	0.737	0.0041

Dependent Variable: Utilization of ICTs in management of TADs

The regression equation ($\mathbf{Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6}$) now becomes:

$$\mathbf{Y = 3.432 + 0.318X_1 + 0.553X_2 + 0.474X_3 + 0.169X_4 + 0.248X_5 + 0.205X_6}$$

Whereby

Y = ICT utilization

X_1 = Cost of ICT services and equipment

X_2 = Training

X_3 = Access to information and technologies

X_4 = Communication methods

X_5 = Contact with change agents

X_6 = Interconnection with social groups

According to the regression equation, taking all factors (access to information and technologies, cost of equipment, communication methods, interconnection with social groups, contact with change agents and training) constant at zero, the utilization of ICTs in management of TADs realized would be 3.432. This was as generated by the Beta Value.

4.11 Chi- Square Test

The Chi Square test is a statistical test which consists of three (3) different types of analysis. These are goodness of fit, test for homogeneity and test of independence. The test is commonly used to compare observed data with that we would expect to obtain following a specific hypothesis. The null hypothesis was undertaken for analysis on this study. To achieve this, a Chi-square X^2 test of significance was used to determine whether or not a relationship other than chance, existed between the variables under investigation.

Hypothesis 1: Factors for ICT Utilization in management of TADs

Null: There is no relationship between various factors and acceptance of ICT utilization in management of TADs among livestock keepers and community based stakeholders.

The null hypotheses implied that the variable- acceptance for ICT utilization and management of TADs are independent of each other. The researcher investigated any notable relationship between factors associated with ICT utilization, and respondents' response on whether livestock keepers and

community based stakeholders were utilizing ICT as a method in management of TADs. Table 4.11 shows how livestock keepers and community based stakeholders responded to factors influencing their utilization of ICTs for management of TADs. The specific ICTs under investigation were; internet, mobile telephone, radio, Television (T.V), Compact Disc Read Only Memory (CD ROM), video and multimedia.

The Chi-Square Tests

Table 4.11 Chi – Square Tests

	DF (degree of freedom)	**Value**	**P-Value**
Chi-square	6	2.692	0.46

Hypothesis 2: Type of Communication Methods

Null: The type of communication methods has no effect on the management of TADs among livestock keepers and community based stakeholders.

The null hypothesis indicates that both variables, the type of communication methods and management of TADs among livestock keepers were independent of each other. Table 4.12 presents results on chi- square test for type of communication methods and management of TADs.

Table 4.12 Chi- squared Test for type of communication methods and management of TADs

	DF	**Value**	**P-Value**
Chi-Square	6	7.833	0.251

Hypothesis 3: Information Communication Models

Null: There is no relationship between information communication models and effective management of TADs amongst livestock keepers and community based stakeholders.

The null hypothesis indicates that both variables, information communication models and effective management of TADs are independent of each other. Table 4.13 presents chi-square tests for information communication models and effective management of TADs.

Table 4.13 Chi-Square Tests for information communication models and effective management of TADs

	df	**Value**	**Asymp. Sig. (2-sided)**
Chi-Square	24	24.345 (a)	.044

4.12 Information and communication models used for management of TADs

Objective 4. To evaluate existing information communication models used for management of TADs amongst livestock stakeholders and other stakeholders.

This study reviewed various information and communication management models used for management animal diseases within East Africa and globally. In undertaking the evaluation, the study considered selected models used for information and communication in management of animal diseases. Ryan and Wilson (1991) established that 'National Disease Control Information System' (NDCIS) of New Zealand, comprised of independent computer database on animal diseases such as tuberculosis and brucellosis, which typified application of ICT in managing animal diseases. A decision support system for managing Foot-and-Mouth Disease (FMD) epidemic was also developed at Massey University on behalf of the New Zealand Ministry of Agriculture and Fisheries. This system comprised of a database management system, a geographic information system, a spatial simulation model of FMD disease and a number of expert systems (Sanson *et al.,* 1999). However for the case Kenya and East Africa, there lacked a specialized TADs information management system.

Jalvingh *et al.,* (1995) and Sanson *et al.,* (1999) reported that, due to their economic importance, contagious animal disease outbreaks require rapid identification and elimination of all virus sources. The use of computerized

Decision Support Systems (DSS) was reported as promising and indeed embraced as appropriate in managing the vast amount of data. It was effective in setting the correct priorities. According to Santos (1993), EpiMAN of New Zealand was the first decision support system for controlling FMD outbreaks. The system was initially developed to control FMD but was progressively expanded to manage other exotic and endemic diseases in New Zealand. Santos (2002) reported that, national FMD task force of Philippines used an information system in managing data regarding disease situation, vaccination, and animal movement. This actually gives accurate information on the animal disease situation of an area at the quickest possible time.

Perhaps the overarching objective in developing animal disease information management systems is the requirement to rapidly collect and disseminate information regarding the disease. For the case of common TADs in Kenya, there has not been a dedicated information management platform which collates and disseminates technical information to authorities and stakeholders for specialized response. Local communities and indeed livestock keepers interviewed in this study across Uasin Gishu, Nandi, Trans Nzoia and Kajiado counties, lacked an information management network through which critical messages and feedback on prevailing TADs would be channeled.

In Italy, the Blue Tongue disease in cattle was effectively managed using an established surveillance system that included clinical, entomological and serological surveillance elements. The national reference centre for veterinary epidemiology developed a web-based National Information System (NIS) and a Geographical Information System (GIS) to collect and manage data from veterinary services across Italy. Surveillance data were displayed to the user in different ways which included; reports, tables and interactive maps (Conte *et al.,* 2005). Garner *et al.,* (2005) reported that Department of Agriculture, fisheries and forestry in Australia, developed a sophisticated spatial model (AusSpread) for FMD control, which operated within a geographic information system framework.

The model allowed for interactions between herds or flocks of different animal species and production types. Further considered was the role such interactions were likely to play in the epidemiology of a regional outbreak of FMD.

There are selected factors constraining animal health authorities in developing countries in terms of the amount and level of detail of animal health information able to be routinely recorded. Firstly is that majority of production units are small-scale and managed at individual household level. For example, backyard poultry are ubiquitous in most of rural Kenya, as was evident across the four (4) counties reached by this study. There were limited households raring poultry in Kajaido county as established by this study. In addition, the distribution of backyard herds and poultry flocks (in particular) are under a constant state of change as stock are frequently moved and sold (Nguyen *et al.,* 2011). Rural areas, where animal disease problems tend to be greater, are characterized by poor communication networks and transport infrastructure (Baldock *et al.,* 1999). Livestock owners are therefore often unable to contact veterinary staff and it is difficult for veterinary staff to access livestock. This implies that provision of services and collection of the necessary information related to outbreak events is either delayed or non-existent. Such problems were observed across the four (4) counties reached by this study.

One key difference between developed and developing countries in terms of recording of animal health information is that developing countries often lack a system for identifying and recording the location of individual farm enterprises. A second point of difference is that recording of disease event information in developing countries is generally restricted to diseases classified as List A by the OIE (Nguyen *et al.,* 2011). Furthermore since sampling frames listing the identity of individual farm enterprises are not available in developing countries, it is common for animal health details to be aggregated at the tertiary administrative unit level. For the case Kenya, these units would refer to district or sub-county levels, which are managed by District Veterinary Officer (DVO).

The cost factor as a determinant of establishing information management models for TADs requires attention by related stakeholders. Given the expense in designing and implementing such models Nguyen *et al.,* (2011) proposed that a standardized format for recording and storing animal demographic, productivity and health data should be agreed on. However widespread adoption of such a standard would help to make information management platforms more readily transferable from one jurisdiction to another, ultimately reducing their cost and in doing so helping to alleviate one of the important obstacles to more widespread uptake of this technology. ICTs are indeed suitable in meeting the priorities identified by the study by Nguyen *et al.,* (2011). The suitability of ICTs in management of TADs is based on their universal application across most sectors within developing countries. Kenya has made significant steps towards expanding ICT utilization across various sectors as outlined in the draft national ICT policy of 2006.

Objective 5. To design an ICT based model appropriate for management of TADs based on acceptance levels among livestock keepers and other stakeholders

As an output of this study, the multi-sectoral ICT model in Figure 14 is proposed for further development. The model is considered suitable for information and communication in management of TADs. This model would be applicable for critical disease management phases, specifically for; diseases surveillance, diagnosis, feedback and mass education. The problem of inadequate information technologies and communication among livestock keepers would be reduced through communication using ICTs as established in this study.

The use of radio, mobile telephones and training through demonstration are prioritized as success factors by this study. However, utilization of ICTs in management of TADs requires involvement by livestock keepers, community stakeholders and other experts as illustrated on the model on Figure 14. This study proposes technical experts and government support agencies be linked through ICTs on a common platform.

CHAPTER FIVE

DISCUSSION

5.0. DISCUSSION

This chapter presents discussions on results established on this study in line with objectives, research questions and hypotheses. The chapter logically discusses the meaning and implications of major results presented in Chapter four (4).

5.1 The study Questionnaire response rate

The successful response rate on this study was made possible following personal calls and visits to remind target respondents to fill-in and return the questionnaires as well as explaining the importance of their participation to this study. The enumerators maintained contact with target respondents and picked up processed questionnaires.

This response rate was representative to Mugenda and Mugenda (1999) stipulation that a response rate of 50% is adequate for analysis and reporting. A rate of 60% is good, while a response rate of 70% and over is excellent. The questionnaires that were not returned were due to reasons such as, unavailability of target respondents at required times despite persistence follow-ups. However, the overall response rate across four (4) Kenyan counties demonstrated a willingness of target respondents to participate in this study.

5.2 The respondent categories under investigation

From the results presented on Figure 7 and Table 4.1, it was evident that livestock keeping in Kenya encompass various people background whose responsibilities and exposure vary significantly. Of the 54 % livestock keepers reached by this study, cattle keepers were the majority. Poultry and sheep keeping and were other common livestock reared across the four (4) counties. This results demonstrates common livestock types in Kenya requiring TADs management as

investigated by this study. This study encountered very low levels of donkeys reared across Uasin Gishu, Nandi, Trans-Nzoia and Kajiado counties. Donkey keepers accounted for only 3 % of livestock keeper categories reached by this study. Of the community based stakeholders involved in livestock keeping, youth leaders accounted for 6.5 %, and religious leaders 5.3%.These were the most active categories involved in livestock keeping across the counties reached by this study.

5.3 Gender and Age distribution of respondents

The males evidently dominated the role of livestock keeping and sale of related products. This was observed not only among household heads interviewed, but across other livestock keepers' categories reached by this study. The study established 48.9 % of respondents were within the age bracket of 36-45 years. These were the most active age group in livestock keeping and trade of livestock products. These were followed by 26-35 year olds. It was evident that these age groups dominated livestock keeping across Uasin Gishu, Nandi, Trans-Nzoia and Kajiado counties.

These findings were indication that livestock keeping draws people of different ages and indeed both genders. It is was also evident that respondents were fairly distributed in terms of age, and were active in technological advancement and productivity. This implied that livestock keepers across target Kenyan counties were capable of contributing towards utilization of ICTs in management of TADs.

5.4 Education Level and Occupation of respondents

The results of this study indicated that 28 % of respondents had attained secondary or O-level education as illustrated on Table 4.4. This was indication that majority of respondents understood the information sought by this study. The findings evidently proofed that respondents were academically qualified and could effectively dispense their duties which would include management of TADs.

This study established that common occupations held by respondents across the four (4) target counties were, public service, business activities and other forms of self-employment. The theory of diffusion of Innovation, asserts that cosmopolitan persons have a higher likelihood of adopting faster to new technologies than the non-cosmopolitan. Cosmopoliteness is the degree to which an individual is oriented outside a social system (Rodgers and Scott 1999). The results depicted on Figure 8 confirmed a degree of cosmopoliteness amongst livestock keepers in target Kenyan counties. This results demonstrated a high likelihood of livestock keepers adopting faster to utilization of ICTs in management of TADs

5.5 The ICT Types and other communication methods used at Household Level

The results on Figure 9 evidently confirmed that livestock keepers across Kajiado, Nandi, Trans-Nzoia and Uasin Gishu counties utilized ICTs for various purposes at household level. The underlying use of ICTs at household level thus presents a platform and basis from which ICTs would be utilized for management of TADs. The findings on Figure 9 confirmed the radio, mobile phone, Compact Disc Read Only Memory (CD ROM), and Television (T.V) as most utilized ICTs at household level. The other communication methods commonly used by respondents included; Farmer Field Day (FFD), extension worker, books, magazines and pamphlets.

From the study findings, it was evident that 48 % of local livestock keepers had received information on wildlife diseases which could affect livestock within their county / district or village. However, the challenge for these livestock keepers were the measures to implement should a TAD strike. In Kajiado county, livestock keepers explained their local coping mechanism against wildlife diseases, which they used as a safeguard against disease transmission to their livestock. The respondents would relocate their herds to alternative grounds during the birth season for wilder beasts. According to respondents, most of the wildlife diseases would attack their livestock during the calving season. In Nandi, Uasin Gishu and

Trans-Nzoia counties, livestock keepers lamented frequent attacks to their livestock by wild dogs. According to respondents, the wild dogs had potential to transmit diseases to both human and livestock. However, the respondents cited the lack of such critical information across various ICTs disseminating technologies on management of TADs

According to study respondents, the radio was moderately helpful source of technical information in management of TADs. This statistic generated a mean score of 1.7893. The mobile phone generated a mean score of 2.3230, which was moderate as rated by respondents. These results are depicted on Table 4.5. The Television (T.V) was moderately rated as helpful source for technical information in management of TADs by a mean score of 2.8230. However, the extension worker, Compact Disc Read Only Memory (CD ROM), internet, farmer field day, brochures, pamphlets, books, and magazines were rated less helpful. These generated mean scores ranging between 3.5309 and 3.8736, out of a possible five (5). This finding implied that respondents were not benefiting much from the communication methods listed.

5.6 The Factors associated with acceptance of ICT utilization amongst livestock keepers

This study categorized the factors which influence acceptance for ICT utilization in management of TADs amongst livestock keepers. These were demographic, technological, economic and socio-cultural categories. For demographic factors, majority of respondents reiterated that level of education would influence their level of acceptance and utilization of ICTs in management of TADs to a moderate extent. This generated a mean score of 3.3483. Similarly, occupation or social status would influence level of acceptance and utilization of ICT in management of TADs to a moderate extent as given by a mean score of 3.2893. However, gender and age were rated with less influence given mean scores of 1.6404 and 2.9972 respectively. These results are depicted on Figure 10.

With regard to technological factors influence towards acceptance and

utilization of ICTs for management of TADs, majority of study respondents rated training with demonstration on use of ICT applications to a great extent. This generated mean score of 4.3680. Similarly, contact with change agents generated a mean score of 4.1770, telecommunications infrastructure a mean score of 4.1264, network connectivity 3.9775, and computer skills 3.508. However, perceived advantage factor would influence level of utilization of ICTs in management of TADs to a moderate extent. This generated a mean score of 3.2669. These results are presented on Figure 11.

In seeking to investigate the influence of economic factors towards utilizing ICTs for management of TADs, majority of the respondents indicated that current cost of ICT services would affect their level of utilization to a great extent. This generated a high mean score of 3.7275. The cost of ICT devices would influence acceptance and utilization to a great extent, while income levels were found to moderately influence acceptance and utilization of ICTs for management of TADs.

5.7 Implications of Theory of Planned Behavior in predicting utilization of ICTs by Livestock keepers

Theory of Planned Behavior (Ajzen, 1988) submits that the best prediction of behavior is given by asking people if they are intending to behave in a certain way. Here we note that the intention will not express itself in behavior if it is physically impossible to perform the behavior, or if unexpected barriers stand in the way. Since intentions actually predict or rather can explain behavior as established by Azjen (1988) in his theory, he argues that three (3) determinants explaining behavioral-intention are; the attitude (opinions of oneself about the behavior); the subjective-norm (opinions of others about the behavior) and the perceived- behavioral control (self-efficacy towards the behavior). The livestock keepers and community based stakeholders interviewed in this study submitted their attitudes on ICTs would to a moderate extent influence their decision in utilizing ICTs for management of TADs. This statistic generated a mean score of 2.8736 out of a possible 5. However the same respondents differed with the view

that subjective norms, or opinions of others would influence their decision in utilizing ICTs for management of TADs. This was given by mean score of 2.0787. The respondents also submitted that social lifestyles, perceived norms or otherwise perceived behavioral control had no influence towards their decision in utilizing ICTs for management of TADs. These variables generated mean scores below the average. Table 4.7 illustrates these findings.

The respondents positively rated change agents as suitable in influencing their acceptance and utilization of ICTs for management of TADs. As illustrated on Figure 12, there were 52% of study respondents who highly rated change as appropriate in influencing their acceptance to utilizing ICTs for management of TADs. Walter Bagehot (1873) asserted that one of the greatest pains to human nature is the pain of a new idea. It makes you think after all, your favorite notions may be wrong, your firmest beliefs ill-founded. Naturally therefore, common men hate a new idea, and are disposed more or less to ill-treat the original man who brings it. This ancient truth perhaps explains why change agents are never easily welcomed, in particular while seeking to introduce a new technology. It is evident from study results that government officials, private companies and NGOs were the change agents highly rated as having effected regular contact on management of TADs across the counties reached. These results are presented on on Table 4.6. However, religious groups, extension workers and Famer Field Days were rated with minimal contact on management of TADs. This study results established a strong degree of interconnection to social groups by the respondents. There were 81 % of study respondents interconnected to various social groups across the four (4) counties reached. Among the common social groups identified by respondents were; religious groups, business clubs, family and peer groups. Rodgers (2003) argues that earlier adopters have more social participation than do late adopters. The high degree of interconnection to social groups established in this study underscores potential for fast adoption to utilization of ICTs by livestock keepers across Kenyan counties reached by this study.

5.8 Inferential Statistics Implications

5.8.1 Spearman's Coefficient of Correlation Implications

From the results illustrated on Table 4.8 on Spearman's correlation findings, there was a negative correlation between ICT utilization and cost of equipment. This statistic generated a correlation of 20.6%. There was a positive correlation between the ICT utilization and interconnection with social groups as shown by a correlation of 15.6%. There was a positive correlation between ICT utilization and training with a correlation of 42.1%. Access to information and communication technologies generated a positive correlation with utilization of ICTs in management of TADs, with a correlation coefficient of 17.8 %.There was a positive correlation between communication methods and utilization of ICTs as given by a correlation of 6.7 %. The variable contact with change agents generated a positive correlation with utilization of ICTs in management of TADs, following a correlation coefficient of 43.5 %.

According to the coefficient of determination results presented on Table 4.9.b, the six (6) independent variables under investigation on this study explained 62.7 % of utilization of ICTs in management of TADs. This was represented by the R2. This implied the six (6) independent variables only contributed about 62.7% towards utilization of ICTs in management of TADs amongst livestock keepers. However, other factors not studied in this research would contribute 37.3%.

5.8.2 Multiple Regression Implications

The multiple regression results on this study indicated that taking all other independent variables at zero, a unit increase in cost of equipment will lead to a 0.318 decrease in utilization of ICTs in management of TADs. The results indicated an indirect relationship between cost of equipment and utilization of ICTs in management of TADs. This was the Beta value generated by the set of data analyzed. The corresponding t-value was 0.3580, and a p-significant value of

0.00452. This was a clear indication that the regression model was acceptable to derive conclusions and make recommendations from the data.

According to the Beta value, a unit increase in training will lead to 55.3 % increase in utilization of ICTs in management of TADs. Accordingly, the t-value for the variable was 1.379 and a p-significant value of 0.00411. These values satisfy the requirements for 5% level of significance, for a given set of data from which to make inferences and recommendations. In addition, the beta value recorded for access to information and technologies showed that a unit increase in access to information and technologies will lead to 47.4 % increase in utilization of ICTs in management of TADs. The corresponding t-value is 1.284 and a p-significant value of 0.00414. This was also a clear indication that the regression model is acceptable to derive conclusions and make recommendations from the data.

If communication methods were increased by 1 unit, the realized utilization of ICT in management of TADs would be 16.9 %, as shown by the Beta value on the regression model. The t-value is 0.849 and a p-significant value of 0.00464. Furthermore, according to the Beta value from the regression model, a unit increase in contact with change agents would lead to 24.8 % increase in utilization of ICTs in management of TADs. These results were in agreement with the requirement for making recommendations and conclusions since the t-value recorded was 0.263, and the p-value was 0.00456. These met the required threshold of 5% level of significance, and 95% level of significance.

From the regression model, the Beta value recorded showed that a unit increase in interconnection with social groups would lead to 20.5 % increase on utilization of ICTs in management of TADs. The corresponding t-value was 0.737 and p-value was 0.00413. These both satisfy the 5% level of significance and 95% level of significance requirement to make inferences and recommendations from a given model.

This study results infer that training contributes the most towards utilization of ICTs in management of TADs. This would be followed by access to information and technologies, contact with change agents and interconnection with social groups. This study thus established that communication methods would contribute the least to utilization of ICTs in management of TADs, previously not published in scientific literature.

5.8.3 The Chi Square Test Implications

According to the results for hypothesis 1 on this study, the calculated sample Chi-Square value of 2.69 falls within the rejection region. The associated P-Value (Asymptotic significance) was 0.46. This value is less than 0.5 (5% level of significance). These results are presented on Table 4.11. Therefore we reject the null hypothesis that there was no relationship between the various factors and acceptance of ICT utilization in management of TADs. A conclusion drawn from the study was that 'there was a relationship between various factors and acceptance of ICT utilization for management of TADs, among livestock keepers and community based stakeholders.

As for the results investigating Hypothesis 2 on this study, the calculated Chi-square value was 7.8. The associated P- value (Asymptotic Significant Value) was 0.251. This value being less than 0.5 indicates that there was evidence against the null hypotheses and therefore we reject it. These results are presented on Table 4.12. In conclusion, the type of communication methods has effect on management of TADs among livestock keepers and stakeholders. In a similar analysis seeking to investigate Hypothesis 3 on this study, the calculated Chi-square value was 24.345(a) and the associated P- value (Asymptotic Significant Value) was 0.44. This value is less than 0.5 indicating that there was evidence against the null hypotheses. We thus reject the null hypothesis, and conclude that there was a relationship between information communication models and management of TADs amongst livestock keepers and community based stakeholders. This results are presented on Table 4.13.

CHAPTER SIX

CONCLUSIONS AND RECOMMEDATIONS

6.0. CONCLUSIONS AND RECOMMEDATIONS

The chapter provides conclusions and recommendations based on study results and discussions. The chapter outlines specific conclusions and recommendations based on major findings of this study.

6.1 Specific Conclusions

This study concluded that active categories of livestock keepers within Kenyan counties reached were; cattle, goat, sheep, poultry and donkey keepers. However of these, donkey keepers were minimal compared to other categories.

The study concluded that both genders were equally adequate in utilizing ICTs for management of TADs. It was concluded that education levels such as 'O' level, certificate, diploma and bachelor's degree were all suitable towards supporting utilization of ICTs for management of TADs.

This study concluded that attitudes of livestock keepers and community based stakeholders towards ICT would only to a moderate extent influence their decision towards utilizing ICTs for management of TADs. The study similarly concluded that education level attained, occupation or social status would to a moderate extent influence the decision by livestock keepers to utilize ICTs for management of TADs.

It was concluded that radio was the most highly utilized ICT type across Kenyan counties reached by this study. This was followed by mobile phones and Television (T.V).

6.2 Specific Recommendations

This study recommends to the Kenyan government and development partners to prioritize use of radio, mobile phone, and Television (T.V) as suitable ICTs for communication in management of TADs across rural counties. It is further recommended that local dialect radio stations in Kenya consider broadcasting technical agricultural information, which should include technologies on management of TADs. The mobile service providers in Kenya should develop specific agricultural communication platforms, from which the local communities would communicate with technical experts on management of TADs.

This study recommends to the Kenyan government and partners involved in costing ICTs services and equipment, to consider lowering current prices. A reduced acquisition and service cost for ICTs would increase utilization of ICTs by livestock keepers and community based stakeholders. Such a benefit would not only increase ICT utilization for management of TADs, but ultimately increase agricultural production.

The Kenyan county governments and development partners are called upon to initiate change of attitude public sessions which favor utilization of ICTs. Due to the homophilous state of livestock keepers established by this study, it is recommended that training programs and demonstration sessions on management of TADs are communicated to various social groups across Kenya's rural counties.

6.3 Policy recommendations on utilization of ICTs in Management of TADs

It is imperative that ICTs are harnessed for use in communication of various aspects of agricultural information. Much as the use of technology seems relatively easy once in place as opposed to human-based services such as extension, this study recommends for finalization and roll-out of Kenya ICT policy of 2006 (GOK, 2013).This policy should consider a review of Kenya's rural infrastructure and capacity problems which limit utilization of ICTs across agricultural sub-

sectors. The Kenya ICT policy should guide formulation of a training curriculum targeting rural based communities. Such an ICT curriculum should broadly cover other agricultural sub-sectors as a step towards scaling up utilization of ICTs.

Munyua (2008) conducted a scoping study on ICTs and small-scale agriculture in Africa, and found low usage patterns and anecdotal adoptions. It was argued that ICT initiatives were scattered and uncoordinated. The study summarized the challenges and factors which influence the use of ICTs as; high cost of available technologies, inadequate infrastructure and low ICT skills. The study further identified poor and expensive connectivity, inappropriate ICT policies, language barriers, low bandwidth, inadequate and / or inappropriate credit facilities. The conclusions by Munyua typifies the findings of this study. The Kenya county governments should consider formulating policy guidelines which compel ICT service providers towards implementing a threshold of the missing factors identified by this study.

6.4 Recommended Training protocols for utilization of ICTs by Rural based Kenyan communities

This study recommends for training on utilization of ICTs for management of TADs. This is to be implemented with demonstration sessions to livestock keepers and community based stakeholders. The recommended communication methods include; Farmer Field Days (FFD), local markets, cattle dips and other village meetings as established by this study. As noted by this study, training on use of ICTs for management of TADs should involve stakeholder categories such as; public administrators, council of elders, politicians and religious leaders. It is beneficial that specialized training programs should further target youth leaders, livestock product dealers and vendors across selected counties dominated by livestock keepers in Kenya.

The study established that developing a training program on utilization of ICTs for management of TADs should equally target all genders and age groups.

However such training should not only target livestock keepers, but other occupations particularly; public service (civil servant), traders /business and self-employed. The recommended ICTs for training livestock keepers are radio, mobile phones and Television (T.V). Other communication methods suitable for consideration include Compact Disc Read Only Memory (CD ROM) and the internet.

6.5 The Recommended ICT model for information and communication in management of TADs.

This study recommends the ICT model on Figure 14 for further development in management of TADs. The recommended model is based on acceptance levels established from livestock keepers and community based stakeholders by this study. As illustrated, level one (1) on the model depicts the problem under investigation, which is inadequate access to information, technologies and communication for management of TADs. The result has been epizootic disease risks, emerging and re-emerging animal diseases and TADs. The model considers other expert interventions addressing the problem as adequate. These include veterinary, human health and wildlife expert, meteorology among other interventions. However, all these stakeholders require a common ICT communication management platform in addressing the problem.

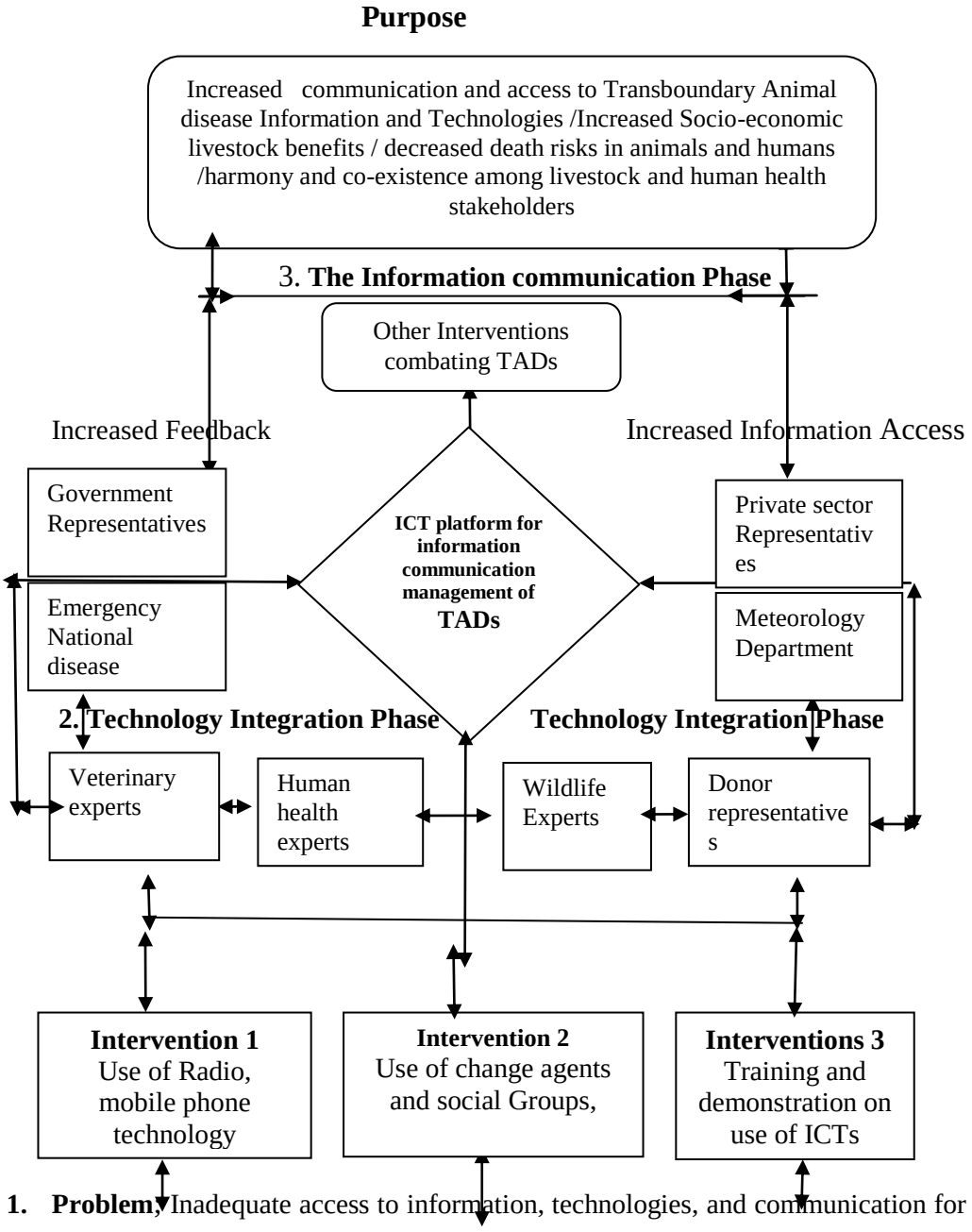
The shape (⟷) indicates communication is taking place across the designated pillars. The model underscores the suitability of ICTs such as radio and mobile phones for communication purposes in management of TADs. However use of change agents and training are prioritized means of communication. It is recommended that technical experts specialized in management of TADs are networked via ICTs for purposes of communication. This is suitable for disease surveillance phase, diagnosis, feedback and mass education to the public. This is proposed to occur at the technology integration level two (2). Ultimately an operational and successful model results to the communication phase depicted at

level 3. This is actually the study purpose. Figure 14 illustrates the recommended model as an output of this study.

6.6 Further Research Areas

Following the above conclusions and recommendations, further areas of research are outlined as follows:

1) This study established that the independent variables under investigation explained 62.7% of utilization of ICTs in management of TADs. Further research is thus needed to investigate additional factors influencing utilization of ICTs in management of transboundary animal diseases. The intended research should target livestock keepers and community based stakeholders, in identifying other factors contributing at least 37.3%.
2) There is need for research on the limitations of ICTs utilization by rural communities in Kenya. This study identified cost as a limitation, however further research is required in establishing other limiting factors and appropriate mitigation strategies.
3) Further development of an ICT model for communication purposes in management of TADs targeting Kenya's rural counties is needed. Research on this requirement should consider learning from experiences of already established communication management platforms, as was noted of Italy's National Information System (NIS), and EpiMAN of New Zealand.



Inadequate access to information, technologies, and communication for management of TADs.

Epizootic disease risk (human health), emerging and re-emerging animal diseases, and TADs

Figure 14. The ICT model recommended for communication management of TADs

BIBLIOGRAPHY

AU-IBAR (2011). African Union/Interafrican Bureau for Animal Resources. The Eradication of Rinderpest from Africa; a great milestone. AU- IBAR Nairobi, Kenya.

AU-IBAR (2009). *African Union/Interafrican Bureau for Animal Resources* .Strategic plan, 2009 AU- IBAR Nairobi, Kenya available at: http//www.au-ibar.org.[Accessed 22 August 2012]

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50 (2) 179-211.doi:10.1016/0749-5978 (91)90020-T

Bagehot, W., (1873) *Physics and politics*. New York: Appleton –Centaury.

Baldock, C., Forman, A., Geering, W. and Taylor, W. (1999). New Technologies in the Fight against Transboundary Animal Diseases. FAO Animal Production and Health Paper, Technical report, Food and Agriculture Organization

Available http://www.fao.org/docs/eims/upload/138251/newtech.[Accessed 5 November 2012]

Baker, R., and White, K. (2010). Predicting adolescents' use of social networking sites From an extended theory of planned behavior perspective. Computers in Human Behavior, 26, 1591-1597. doi: 10.1016/j.chb.2010.06.006

Barrett,T., Forseth,M.A., Inui, K., Wamwayi, H., Kock,R.,Wambua,J., Mwanzia J., and Rossiter,P.B. (1998). Rediscovery of second African lineage of rinderpest pest virus; its epidemiological significance. Veterinary Record 669-671.

Bastos, A.D.S., Boshoff, C.I., Keet, D.F., Bengis, R.G., and Thomson, G.R. (2000). *Natural transmission of foot-and-mouth disease virus between African buffalo (Syncerus caffer) and impala (Aepyceros melampus) in the Kruger National Park*. South Africa. Epidemiological Infectious. 124:591–598

Cash, D,W. (2001). In Order to Aid in Diffusing Useful and Practical Information: Agricultural Extension and Boundary Organizations. Science Technology and Human Values 26 (4): 431-453.

Chambers, R. (1997). Whose reality counts? Putting the last first. London, UK: Intermediate.

Chambers and Conway (1992). *Sustainable rural livelihoods*. London UK:

Chomel, B.B., Belotto A., Meslin, F. (2007). *Wildlife, exotic pets, and emerging zoonoses*. Emerging Infectious Diseases ; 13: 6–11.

CIRAD, (2001). Final report of the African wildlife veterinary project. Montipellier. France. CIRAD EMVT.

Colorado State University, Fort Collins, Colorado, USA. Available at: http//www. http://www.plosntds.org/article/info%3Adoi%2F10.13. [Accessed 5 Feb 2012]

Conte A., Colangeli P., Ippoliti C., Paladini C., Ambrosiani M., Savini L., Dall'Acqua F. and Calistri, P. (2005). *The use of a Web-based interactive geographical information system for the surveillance of bluetongue in Italy*. Revue Scientifique-et-Technique-Office-International-des-Epizooties 24 (3), 857–68.

Cooper, D. R., and Schindler, P. S. (2006). *Business Research Methods* (4th ed.). New York, NY: McGraw-Hill.

Coker, R.J., Hunter, B.M., Rudge, J.W., Liverani, M., and Hanvoravongchai, P. (2011) Emerging infectious diseases in southeast Asia: regional challenges to control. Lancet ; published Jan 25. Available at. DOI:10.1016/S0140-6736(10)62004-1. [Accessed 13 Jan 2013]

Cutler S, J., Fooks, A., R, and van der Poel W.H (2010); Public health threat of new, reemerging, and neglected zoonoses in the industrialized world. Emerging Infectious Disease 16: 1–7.

Cueller, M., Hedland,H., Mbai.J., and Mwangi, J. (2006).The National Agricultural and Livestock Extension Program (NALEP) Phase I impact assessment. Sida Evaluation 06/31.Stockholm: Swedish International Development Cooperation Agency.

Daily Nation. (2012): Unknown bug leaves 1000 animals dead. Daily Nation, 07/2012, Page 38.

De Haan, C. (2001). Livestock development: implications for rural poverty, the environment, and global food security. Washington, DC, USA: World Bank.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui S., and Courbois, C. (1999). Livestock to 2020. The next food revolution. Food, Agriculture and the Environment Discussion paper 28. Washington, DC, USA: International Food Policy Research Institute.

District Development Officer (2013). Kajiado North District Agricultural Report 2013.

District Livestock Officer (2013). Uasin Gishu County Livestock Office Report 2013.

District Veterinary Officer (2013). Uasin Gishu County Veterinary Office Report 2013.

Eisen, L., Coleman, M., Lozano-Fuentes, S., McEachen, N., and Orlans, M.(2011). *Multi-disease data management system platform for vector-borne diseases*. Journal PLoS Neglected Tropical Diseases Vol. 5 No. 3 pp. e1016.

EPZA Meat Production in Kenya (2005). Export Processing Zones Authority 2005.

Farrar, D.E., and Glauber, R,R. (1967). Multicollinearity in regression analysis: the problem revisited. Review of Economics and Statistics 49, 92–107.

FAO. Food and Agricultural Organization of the United Nations. (2005). Bridging the rural digital divide. Rome, Italy: Food and Agriculture Organization. Available at http://www.fao.org. [Accessed 14 January 2012]

FAO. Food and Agricultural Organization of the United Nations (2012). Rift Valley Fever: vigilance needed in the coming months. EMPRES WATCH, Vol. 27, December 2012. Rome. Available http://www.fao.org [Accessed 23 February 2013]

FAO. Food and Agricultural Organization of the United Nations. (2010). Global Programme for the Prevention and Control of Highly Pathogenic Avian Influenza. Rome, Italy: Food and Agriculture Organization. Available http://www.fao.org [Accessed 23 February 2013]

FAO. Food and Agricultural Organization of the United Nations (2005). Livestock policies and poverty reduction in Africa, Asia and Latin America. Pro-poor livestock policy initiative policy brief. Rome, Italy: Food and Agriculture Organization. Available http://www.fao.org [Accessed 25 January 2013]

FAO/WHO. Food and Agricultural Organization of the United Nations/World Health Organization. (2005). Practical Actions to Promote Food Safety: Regional conference on food safety for Africa, Final Report. Harare, Zimbabwe. 3 – 6 October. Available at: www.fao.org [Accessed 20 February 2013]

IRIN (2009), Flu trackers; report on H1N1 pandemic outbreaks in Kenya. Available http://www.irinnews.org/Report.aspx?ReportId=86386. [Accessed 21 July 2012]

FAO. Food and Agricultural Organization of the United Nations (2007). Avian Influenza—questions & answers: The facts of bird flu. Agriculture Department Animal Production and Health Division. Available http://www.fao.org [Accessed 3 February 2013]

Fisher J,R. (2007). *Review of the bovine scourge*: meat, tuberculosis and public health, 1850–1914. *Bull Hist Med*; 81: 875–76.

Gall, M. D., Borg, W. R., and Gall, J. P. (1996). *Education research*: An introduction (6th ed.). White Plains, NY: Longman.

Galloway, L., and Mochrie, R. (2005). *The use of ICT in rural firms*: *a policy-orientated literature review*. The Journal of Policy, Regulation and Strategy for.Telecommunications 7 (1), 33-46.

Garner, M.G., and Beckett, S.D. (2005). *Modeling the spread of foot and- mouth disease In Australia*. Australian Veterinary Journal 83(12), 758–66.

GOK. Government of Kenya, (2013). Ministry of Information, Communication and Technology, Working Draft the Information and Communications Technology sector (amendment) policy guidelines Nairobi.

GOK. Government of Kenya (2008). Ministry of Livestock and Fishery Development, Department of Veterinary Services: emergency project for the control of Pestes Des Petit Ruminants (PPR) in Kenya*:* situation analysis and concept note. Nairobi.

GOK. Government of Kenya, (2010). Population and Housing Report. National Bureau of Statistics (KNBS), National Census Report. Nairobi: Government Press.

GOT. Government of Tanzania, (2009). Ministry of Livestock and Fisheries Development. Strategy for the control of Foot and Mouth Disease in Tanzania Mainland 2008/9– 2014/15.

Hair, J.F., Jr., R,E. Anderson, and R,L.Tatham. (1987). Multivariate Data Analysis with Readings, Macmillan, New York.

Heeks, R. (1999). Information and Communication Technologies, poverty and development. Development of Informatics working paper no.5. Institute for development policy management, University of Manchester. Available at: http//idpm.man.ac.uk/idpm/diwpf5.html. [Accessed 19 December 2011]

Heffernan, C. (2004). Livestock and the poor: issues in poverty focused development. In: Owen E, Smith T, Steele MA, et al, eds. Responding to the livestock revolution. The role of globalization and implications for poverty alleviation. Nottingham, UK: Nottingham University Press: 229–45.

Hiroshi, K. (2009), Influenza development, including H1N1, surveillance and post-Vaccination monitoring of H5N1.Hokkaido University, Kita-18, Nishi-9, Kita-ku, Sapporo 060-0818, Japan.

Hoie, M., Moan, I., and Rise, J. (2009). An extended version of the theory of planned behavior: Prediction of intentions to quit smoking using past behavior as moderator. Addiction Research and Theory, 18(5), 572-585. Available at :doi: 10.3109/16066350903474386. [Accessed 26 March 2013]

H.R. Meena., and Y.P. Singh. (2013). *Importance of information and communication technology tools among livestock farmers*: A review. Scientific Journal of Pure and Applied Sciences. Indian Veterinary Research Institute, Izatnagar-243 122, Uttar Pradesh (India). Available at: http//www.Sjournals.com. [Accessed 16 March 2013]

Hugh-Jones, M.E., Ellis P.R., and Felton, M.R. (1975). An assessment of the eradication of bovine brucellosis in England and Wales. Reading, UK: Department of Agriculture and Horticulture, University of Reading.

IST Arica (2012). Guide to ICT policy in IST- Africa partner countries, version 2.2 Available at: www.ist-africa.org/home/default.asp?page=ictpolicies. [Accessed 17 Feb 2013] Published by IIMC International Information Management Corporation Ltd.

Jalvingh, A.W., Nielen, M., Dijkhuizen, A.A., and Morris, R, S. (1995). A computerized decision support system for contagious animal disease control. Pig News Information 16 (1), 9–12.

Jones, K.E., Patel N.G., and Levy M, A. (2008). Global trends in emerging infectious diseases. *Nature;* 451: 990–93.

Lloyd-Smith, J.O., George D., and Pepin, K.M. (2009). Epidemic dynamics at the human-animal interface. *Science;* 326: 1362–67.

Kamuhabwa, A.R., and Chavda, R. (2011) Health-care providers' preparedness for H1N1/09 influenza prevention and treatment in Dar es Salaam, Tanzania. Unit of Pharmacology and Therapeutics, School of Pharmacy, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania.

Kashorda, M., and Wagacha, M. (2005) ICT, Trade and Economic Growth ICT policy, regulation and diffusion.

Kithuka, J., Mutemi, J., and Mohamed, A. H. (2007). Keeping up with Technology: The use of mobile telephony in delivering community-based decentralized animal health services in Mwingi and Kitui Districts, Kenya'. FARM-Africa Working Paper 10. London: FARM-Africa.

Kombo, K.D., and Tromp, A. L. (2006). *Proposal and Thesis writing*; An Introduction. Pauline's publication Africa, Nairobi Kenya.

Krejcie, R. V., and Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30,607-610.

Limbaso, S. K., Schnabel, D., Breiman R.F., Yingst, S., Muchane, M., Lindstrom, S., Macharia, M., Mwasi, J., Muthon, L., Junghae., Ithondeka, M.P., Carlos, De. M., Katz, M., and Njenga, M. Karuiki. (2010). *Detection of Avian Influenza among Wild Birds in Kenya*, 2006 -2009. African Journal of Health Sciences, Volume 20, Number 1-2

Mantovani, A. (2001). Notes on the development of the concept of zoonoses. WHO Mediterranean Zoonoses Control Centre Information Circular 51.

Martin, R., Usdan, S., Nelson, S., Umstattd, M., LaPlante, D., Perko, M., and Shaffer, H. (2010). Using the theory of planned behavior to predict gambling behavior.Psychology of Addictive Behaviors, 24(1), 89-97. doi: 10.1037/a0018452

McGowan, Jr., J.E., (2001). Economic impact of antimicrobial resistance.*Emerging. Infectious. Disease*. 7, 286–292.

Miles, M., B and Huberman, A. (1994). Qualitative data analysis: an expandedsource Book (2nd edition). Thousand Oaks, CA: Sage.

Mugenda, O., M and Mugenda A.G. (1999). *Research Methods: Qualitative and Quantitative Approaches*. Nairobi: African Centre of Technology Studies Press.

Munyua, H. (2008). ICTs and small-scale agriculture in Africa: a scoping study. International Development Research Centre (IDRC).

Mureithi, R.M., Munyua.P., Ithondeka.P.M ., Macharia J.M., Hightower.A., Luman.E.T., Breiman.R.F and Karuiki, M.N. (2010). *Rift Valley Fever in Kenya: history of epizootics and identification of vulnerable districts*. Cambridge University Press. U.S.A.

Nandi County Government (2013). Nandi County Integrated Development Plan 2013.

NCST. National Council for Science and Technology. (2009) A Proposed Coordination Structure for Biosafety Regulatory Agencies in Kenya. March

Ngechu, M. (2004), *Understanding the research process and methods*. An Introduction to Research methods. Acts Press, Nairobi.

Nguyen., V. L., Mark, S., and Bryan, O. (2011). Decision support systems in Animal health, Efficient Decision Support Systems- Practices and Challenges in Biomedical related Domain, Prof Chiang Jao Ed.), ISBN: 978-953-307-258-6,InTech.Available at:http://www.intechopen.com/books/efficient-decision-support-systems-practice-and-challenges-in-biomedical-related-domain/decision-support-systems-in-animal-health. [Accessed 17 Feb 2013]

Orodho, A.J., and Kombo, D.K. (2002). *Research methods*. Nairobi. Kenyatta University, Institute of Open Learning.

Owen, E., Best, J., Devendra, C., Kitalyi, A., Jayasuriya, N., and Smith, T. (2005).eds. Introduction—the need to change the 'mind-set': Livestock and wealth creation. Improving the husbandry of animals kept by resource-poor people in developing countries. Nottingham, UK: Nottingham University Press, 2005: 1–11.

Pavlin, B. I., Schloegel L.M., and Daszak, P. (2009). Risk of importing zoonotic diseases through wildlife trade, United States. *Emerging Infectious Disease* 2009; 15: 1721–26.

Plowright, W. (1963). *Some properties of strain of rinderpest virus recently isolated in Eastern Africa*. Res vet sci 4 ; 96-108.

Quine, L., and Rubin, R. (1997). *Attitude, subjective norm, and perceived behavioral control as predictors of women's intentions to take hormone replacement therapy*. British Journal of Health Psychology, 2(3), 199-216.

Rao, N.H, (2006). A framework for implementing information and communication technologies in agricultural development in India. Technological Forecasting and Social Change 74 (4), 491-518.

Rich, K.M., and Wanyoike, F. (2010). *An assessment of the regional and national socio-economic impacts of the 2007 Rift Valley fever outbreak in Kenya*. American Journal of Tropical Medicine and Hygiene 83(2 Suppl): 52-57.

Rockefeller Foundation (2013). The Rockefeller Foundation Initiative Disease Surveillance Networks. Available at www.rockefellerfoundation.org [Accessed 29 July 2013]

Rogers, E. M. (2003). *Diffusion of innovations* 5th ed. New York, NY: The Free Press.

Rodgers, E.M., and Scott, K.L. (1999).The Diffusion of innovations model and outreach from the national network of libraries of medicine to native American communities. Available at: http://nnlm.gov/pnr/eval/rodgers.html. [Accessed 15 December 2011]

Rushton, J. (2009). Preface. In: Rushton J, ed. Economics of animal health and production. Wallingford, UK: CABI.

Ryan, T.J., and Wilson, D,A. (1991). Future development of the national disease control database. Symposium on tuberculosis, pp. 245–50. April 1991. Palmerston North Massey University, New Zealand.

Sanson, R. (1993). The Development of a Decision Support System for an Animal Disease Emergency, PhD thesis, Massey University.

Sanson, R.L., Morris, R.S., and Stern, M.W. (1999). EpiMAN-FMD: *A decision support system for managing epidemics of vesicular disease*. Revue-Scientifique-et-Technique-Office-Internationaldes- Epizooties 18 (3), 593–605.

Santos, I.J. (2002). *FMD information management system as a disease surveillance tool in FMD control and eradication program in the Philippines*. Special Research Journal Edition 6 (10), 108–115.

Sasidhar, P.V.K., and Sharma, V. (2006). Cyber livestock outreach services in India: a model framework. Livestock Research for Rural Development. Volume.18, Article#2Available http://www.lrrd.org/lrrd18/1/sasi18002.htm. [Accessed 23 Feb 2013]

Shaw, APM. (2009). Economics of zoonoses and their control. In: Rushton J, ed. Economics of animal health and production. Wallingford, UK: CABI,: 161–68.

Strauss, A., and Corbin, J. (1990). *Basic qualitative research: ground theory. procedures and techniques*. Newbury Park, California U.S.A : SAGE Publications

Stone, T., Jawahar, I., and Kisamore, J. (2010). Predicting academic misconduct intentions and behavior using the theory of planned behavior and personality. Basic and Applied Social Psychology, 32(1), 35-45. doi: 10.1080./01973530903539895

Sutmoller, P., Thomson, GR., Hargreaves, SK., Foggin, C.M., and Anderson, E.C. (2000).*The foot-and-mouth disease risk posed by African buffalo within wildlife* Conservancies to the cattle industry of Zimbabwe. Prev Vet Med.; 44:43– 60.

The Laws of Kenya. The Meat Control Act Cap 356. Available at: http:// www.Kenyalaw.org. [Accessed 23 August 2012]

The Laws of Kenya (1991). The Fisheries Act Chapter 378, revised edition. www.kenyalaw.org

Thomson, G.R., Vosloo, W., and Bastos. (2003) A.D.S. Foot and mouth disease in wildlife. Virus Res.; 91:145–161.

Trans-Nzoia County Government (2013). County Agricultural Office report 2013.

Trochim,W. (1989). Outcome pattern matching and program theory. *Evaluation and program planning, 12, 355-366.*

Tiwari, R., Phand, S., and Sharma, M,C. (2010). *Status and scope of information and communication technology for livestock and poultry production in India*– A review. Indian Journal of Animal Sciences 80 (12), 1235–1242.

Thewlis, J. (Ed.) (1973). *Concise Dictionary of Physics*. Oxford: Pergamon Press, p. 248.

UNECA. United Nations Economic Commission for Africa (2008). E-Trade and Economic growth in Africa. ICT, Science, Technology Division United Nations Economic Commission for Africa. Addis Ababa, Ethiopia Available at: www.uneca.org. [Accessed 26 April 2013]

UNOCHA. United Nations Office for Coordination of Humanitarian Affairs, (2010); pandemic preparedness and response in southern and eastern Africa. Monthly situation update No 13 April 2010. Available at: www.unocha.org. [Accessed 9 April 2012]

U.S. General Accounting Office, Program Evaluation and Methodology Division. (1990). *Case study evaluations.* Washington, D.C: Government Printing Office.

Waddington, K. Safe meat and healthy animals: BSE and bovine TB. History and Policy. Available at: http://www.historyandpolicy.org/papers/ policy-paper-04.html [Accessed 17 August 2012]

Wolfe, N.D., Dunavan C,P., and Diamond, J. (2007). Origins of major human infectious diseases. *Nature*; 447**:** 279–83.

Woolhouse, M.E., and Gowtage–Sequoias, S. (2005). *Host range and emerging and Re-emerging pathogens*. Emerging Infectious Diseases. 11, 1842–1847.

World Bank (2010). People, Pathogens, and Our Planet. Volume 1: Towards a One Health Approach for Controlling Zoonotic Diseases. The World Bank 1818 H Street, NW. Washington, DC 20433.

World Health Organization, Food and Agriculture Organization of the United Nations, World Organization for Animal Health (WHO/FAO/OIE). 2004. Report of WHO/FAO/OIE joint consultation on emerging zoonotic diseases. Available at: <whqlibdoc.who.int/hq/2004/WHO CDS CPE ZFK 2004.9.pdf>. [Accessed 23 September 2012]

Yin, K. R. (1994). *Case Study Research, Design and methods*, 2nd Edition, Applied social research methods series; V5. Sage publications, Inc 2455 California, USA.

Yin, K. R. (2004). *Complementary methods for Research in Education*, 3rd Edition, American Education research Association, Washington DC.

APPENDICES

Appendix 1: Informed Consent for Participation in the Study

Research Topic: Utilization of Information Communication Technologies (ICT) in Management of Transboundary Animal Diseases (TADs), in selected counties of Kenya

Investigator: My name is Titus Wanjala. P.O. Box 103528-00101, Nairobi Kenya.

Introduction: I am currently a Doctor of Philosophy Degree (PhD) candidate at the University of Nairobi, faculty of Agriculture. I' am writing to seek your agreement and cooperation in collecting information regarding management of Transboundary Animal Diseases (TADs) in your villages, locations and the entire County.

Purpose: The purpose of my research is to investigate the acceptance levels of using Information Communication Technologies (ICTs), in management of Transboundary Animal Diseases (TADs). The research seeks your views and suggestions, on acceptance levels of ICTs in management of TADs.

Procedures: Participation is entirely voluntary. If you accept to participate in the study, you will be required to fill in a questionnaire seeking information on Utilization of Information Communication Technologies (ICT) in Management of Transboundary Animal Diseases (TADS)

Benefits: There are no direct benefits to you but to the society. The outcome of this study will be used to help the government, the relevant authorities and other agencies interested in human and animal health to create awareness among the society on the related issues of Utilization of

Information Communication Technologies (ICT) in Management of Transboundary Animal Diseases (TADs) and make recommendations on the best policies that should be implemented to increase knowledge, communication and management of Transboundary animal diseases.

Risks: Your participation in the study involves no physical risk. However, there is the possibility of psychological risk if your answers are made public at any point. However, I wish to assure you that I will maintain strict control over all information provided and will only be used for academic purposes.

Confidentiality: The research questionnaires bear no names. All your views, answers will be treated with utter most confidentiality. Furthermore your answers will not be linked to your names of any personalized profiles.

Compensation: Please note that there is no compensation in participating in this research, however the findings will be presented to the University of Nairobi and the wider Agricultural sector in Kenya, which is purposed to contribute not only to knowledge but provide additional mechanisms by which the negative effects of TADs could be minimized in Kenya and Eastern Africa.

Study Approval: This study is approved by **University of Nairobi, faculty of Agriculture Nairobi Campus: P.O. Box 30197-00100 Nairobi, Kenya Tel: +254-20-2091967**

Should you have any pressing matters, views or ideas you feel may otherwise inform my research, please feel free to share this with me via my email ; tituswanjala@yahoo.com.

Consent & Signature

Before you sign this consent form, do you have any question?

.....

I voluntarily agree to participate in this research procedure

Respondent's Signature: …….. or Respondent's Thumb print: _____

Date……..…

Enumerator / Principle Investigator ---------- Date ----------

Appendix 2: The Questionnaire

County ---------- District ----------

Village ----------

Sub location ---------- Division ----------

Please fill the questionnaire by ticking (✓) or writing the correct answers precisely on the spaces provided.

Part A: Background Information

1. Category of the respondents (Tick appropriately on the category that applies and the corresponding specific class)

Category	**Specific Class**	**Tick**
Livestock keepers	Cattle	
	Goat	
	Sheep	
	Poultry	
	Donkey	
	Others (Specify……)	
Community representative	Public administration	
	Elder (council of elder)	
	Politician	
	Religious leader	
	Youth leader	
	Others (Specify……	
Meat product dealers	Cattle	
	Goat	
	Sheep	
	Poultry	
	Donkey	
	Others (Specify……	
Livestock vender	Cattle	

	Goat	
	Sheep	
	Poultry	
	Donkey	
	Others (Specify……	
Poultry traders	Specify ……	

2. Gender of respondent

   Female [ ] Male [ ]

3. Age of Respondent (Years) ----------

4. What is your highest Education level attained?

   Primary [ ] Secondary or O-Level [ ]

   Certificate [ ] Diploma [ ]

   Bachelor's degree [ ] Not Educated [ ]

   Others (Specify.....)

5. What is your occupation? (Or social status?)

   ---

6. Are you interconnected to any social group or network in your Village, District or County?

   Yes [ ] No [ ]

7. If yes in six (6) above which social interconnections are you involved with in your Village, District or County? (Please name two (2) main social interconnections)

i.----------

ii.----------

8. Do you have contact with any of these change agents involved in Management of TADs in your District / County? Please tick accordingly.

   NGOs [ ] Extension workers [ ]

Government officers	[ ]	Religious Groups	[ ]
Private companies	[ ]	Famer Field Day	[ ]

Others (Specify.....

Part B: Use of ICT in Management of Transboundary Animal Diseases (TADs)

9. Does your household Utilize ICTs (internet, mobile telephone, radio, T.V, C.D, video, multimedia) for any other purposes?

Yes [ ] No [ ]

10. If yes in question nine (9) above, which of these ICT are used in your Household? (Rank 1,2,3)

Radio	[ ]	Television (T.V)	[ ]
Mobile phone	[ ]	Internet	[ ]
CD ROM	[ ]	Brochures/pamphlets	[ ]

Others ----------

11. What reasons would you consider accepting using ICTs for management of Transboundary Animal Diseases (TADs)? Give any three (3).

i.……

ii……

iii……

12. During outbreak of TADs such as RVR, AI, FMD, PPR and Rabies etc., where did you first learn of the disease outbreak in your District or County?

……

13. Did you receive adequate and satisfactory information regarding TADs (RVR, CMPP, FMD, PPR, Rabies etc.) within your district / County?

Yes [ ] No [ ]

14. What would you consider as the role / advantage of technical Information and Communication methods for management of TADs? List any two (2).

i.----------

ii.----------

15. Do you have Information regarding wildlife diseases which could affect / or have affected Livestock in your County / district / village?

    Yes [ ] No [ ]

16. List and rank your three (3) most helpful sources for technical information in management of Transboundary Animal Diseases (TADs)? (Rank 1, 2, 3 from choices).

Radio	[ ]	Television	[ ]
Mobile phone	[ ]	Internet	[ ]
CD ROM	[ ]	Books	[ ]
Extension worker	[ ]	Brochures	[ ]
Farmer Field Day	[ ]	Pamphlets	[ ]
Magazines	[ ]		

Others ----------

17. What are the advantages and disadvantages / problems of the information and communication methods you use for management of Transboundary animal diseases? (Provide any major two (2)

Advantages

i.----------

ii. ----------

Disadvantages

i. ----------

ii.----------

18. To what extent do the following demographic factors affect the level of acceptance and utilization of ICT in management of Transboundary animal

diseases in this area? Use a scale of 1 to 5 where 1= no extent, 2= little extent, 3= moderate extent, 4= great extent and 5 is to a very great extent.

Demographic factors	**1**	**2**	**3**	**4**	**5**
Age					
Gender					
Level of education					
Occupation (social status)					
Others (Specify……)					

19. How would you rate the effect of the following technological factors in influencing the level of acceptance and utilization of ICT in management of Transboundary animal diseases in this area? Rate on a scale of 1 to 5 where 1= no extent, 2= little extent, 3= moderate extent, 4= great extent and 5 is to a very great extent.

Technological factors	**1**	**2**	**3**	**4**	**5**
Computer skills					
Network connectivity					
Perceived advantage					
Telecommunications infrastructure					
Contact with change Agents					
Training / Demonstration on use of ICT applications					
Others (Specify……)					

20. In your own opinion, how do the following economic factors affect the level of acceptance and utilization of ICT in management of Transboundary animal diseases in this area? Use a scale of 1 to 5 where 1= no extent, 2= little extent, 3= moderate extent, 4= great extent and 5 is to a very great extent.

Economic factors	**1**	**2**	**3**	**4**	**5**
Level of income					

Cost of ICT devices					
Cost of ICT services					
Others (Specify……)					

21. To what extent do the following socio-cultural aspects contribute to acceptance and utilization of ICT in management of Transboundary animal diseases in this District County? Use a scale of 1 to 5 where 1= no extent, 2= little extent, 3= moderate extent, 4= great extent and 5 is to a very great extent.

Socio-cultural aspects	**1**	**2**	**3**	**4**	**5**
Beliefs and taboos from our traditions					
Attitudes towards ICT					
Social lifestyles					
Social norms					
Perception / views of Others					
Others (Specify……)					

22. Rate your level of agreement with the following statements on the various factors that affect the level of acceptance and utilization of ICT in management of Transboundary Animal Diseases in this area? Use a scale of 1 to 5 where 1 is strongly disagree, 2 is disagree, 3 is neither agree nor disagree, 4 is agree and 5 is strongly agree.

Statements	**1**	**2**	**3**	**4**	**5**
Information technology has received acceptance among young / middle aged educated people in this area than the elderly who are still in the ties of social traditions					
I am not able to use ICT services (internet, mobile telephone, radio,T.V, C.D,video multimedia) because of my level of education or Training					
ICT services (internet, mobile telephone, radio,T.V, C.D,video) are expensive and out of reach to the poor in the rural areas					
The tax burden passed to the consumers through increase in prices of commodities, lead to unaffordability of ICT to majority of people in the rural areas where levels of income are low					
The costs of ICT devices (internet, mobile telephone, radio, T.V, C.D, video multi media) are still beyond the means of low income consumers.					
High recurring costs of ICT services (internet, mobile telephone, radio,T.V, C.D,video) discourage ownership and usage of ICT devices like mobile phones					

Our cultural practices do not encourage use of new technologies such as ICTs (internet, mobile telephone, radio,T.V, C.D,video)					
My lifestyle do not allow me to use ICTs (internet, mobile telephone, radio,T.V, C.D,video)					
Language barrier could be a factor that affects ICT penetration in this County / village					
Training and demonstration would increase our participation in using ICT (internet, mobile telephone, radio, T.V, C.D, video) for management of TADs.					
Social norms affect my acceptance and use of ICT related services					
Most people in this area often follow some cultures that bar them from using ICT which is sometimes considered "westernization"					
Opinions and influence of friends, family, and relatives matter in making a decision to adopt ICT services in general					
I think that using ICT makes communication and management of trans-boundary diseases effective					
My knowledge/ experience on use of ICT technology affects the level of use for communication and management of Trans-boundary Animal diseases					
I think that learning to use of ICTs in communication and management of trans-boundary diseases is easy.					
I think that interaction with information technology for management of TADs does not require a lot of mental effort					
I think that it is easy to use ICT to accomplish communication and management of Trans-boundary Animal diseases tasks					
I submit it is expensive to use ICT technology (internet, mobile telephone, radio,T.V, C.D,video, multimedia) in communication and management of trans-boundary diseases					
Change agents (NGOs, Religious groups, Famer Field Day, Extension workers, Private companies) make it easy for us to adopt / use ICT for management of Trans-boundary Animal diseases (TADs).					
Interconnection with social groups / linkages makes it easy for us to use ICT (internet, mobile telephone, radio, T.V, C.D, video, multimedia) for management of Trans-boundary Animal diseases.					

Thank you for Participation!!

Appendix 3: Technical Expert Interview Guide (Qualitative)

Date.....

Job title / profession.....

Name of organization.....

Research Topic: **Utilization of Information Communication Technologies (ICT) in Management of Transboundary Animal Diseases (TADs), in selected counties of Kenya**

5.1 What methods do you use for disseminating and communicating Tehnologies and Information on management of Transboundary Animal Diseases (TADs) to stakeholders?

5.2 During outbreaks of Transboundary Animal Diseases (TADs), which methods did you use to communicate Information to stakeholders ? what were the advantages and disadvantges of the methods you applied ?

5.3 In your profession, what do you consider the role of Information in management of Transboundary Animal Diseases (TADs)? This involves disease surviallance, diagnosis, feedback and mass education.

5.4 What lessons and success factors have you learned as useful for Information management of TADs in Kenya and Eastern Africa ?

5.5 What reasons would you consider Information Communication Technologies (ICTs) as suitable for management of TADs? consider the ICT Box below.

1. Radio
2. Television
3. Mobile phone
4. Internet
5. CD ROM
6. Books
7. Pamphlets
8. Magazines
9. Brochures
10. Others ----------

5.6 Why would you prefer ICTs for purposes of communication and Information in management of TADs ?

5.7 What would be the advantage(s) of a shared common ICT platform from which livestock, human health and wildlife experts would communicate information and technologies on management of TADs?

5.8 Any other comment or remarks regarding Utilization of Information Communication Technologies (ICTs) for management of Transboundary Animal Diseases (TADs) ?

Thank you for Participation!!