ECONOMIC ANALYSIS OF TRANSBOUNDARY ANIMAL DISEASE CONTROL IN NTUNGAMO AND RAKAI DISTRICTS, UGANDA. A CASE OF FOOT AND MOUTH DISEASE AND EAST COAST FEVER

BY

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Declaration

I Bayiyana Irene, hereby declare that the work presented in this thesis is my own and has never been submitted to any university for the award of a degree. Where other sources of information have been used, they have been rightly acknowledged.

Signed: Date

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This thesis has been submitted to the Directorate of Research and Graduate Training upon our guidance and advice as University Supervisors.

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Dedication

To my mother Nalongo Rose

&

Husband Paul M. Kato

&

Our lovely children Joshua, Mark and Pauline.

Acknowledgement

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Table of contents

List of acronyms

BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CBR	Cost Benefit Ratio
EFITA	European Federation for Information Technology in Agriculture, Food and the Environment
ERS	Economic Research Service
EU	European Union
FAO	Food and Agricultural Organizations of the United Nations
LPEC	Livestock Production Efficiency Calculator
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MFPED	Ministry of Finance Planning and Economic Development
NAADS	National Agricultural Advisory Services
NGOs	Non Government Organisations
NOAA	National Oceanographic and Atmospheric Administration
OIE	Office Internationale des Epizooies
PMA	Plan for Modernization of Agriculture
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SLiM	Sustainable Livestock Management
TADs	Transboundary Animal Diseases
UBOS	Uganda Bureau of Statistics
UGX	Uganda Shillings
UK	United Kingdom
UPE	Universal Primary Education
USD	United States Dollar
USDA	United States Development Agency
WAH	World Animal Health
WTA	Willingness to Accept
WTP	Willingness to Pay

List of tables

Abstract

Transboundary animal diseases (TADs) are a major threat to livestock keepers affecting growth and productivity. This study was therefore conducted specifically to: characterise agro-pastoralists in Ntungamo and Rakai districts; evaluate the farm level benefits and costs associated with the control of TADs; and determine the factors influencing farmers' willingness to pay for TADs control. A sample of 176 farmers from Rakai and Ntungamo districts was used to generate responses. Data were collected using pretested questionnaires and analysed using SPSS and STATA software. Analytical tools used included descriptive statistics, Cost Benefit Analysis and Logit models. The study revealed that 60% of the farmers were willing to pay for TADs control. Spraying and vaccination were the most commonly used methods of TADs control costing UGX 8,867 and UGX 500 per animal per year respectively. Total annual avoided losses per animal were 64% higher if TADs were controlled than if they were not controlled. The Benefits of TADS Control outweighed Costs with BC ratio of 4.4. Training in disease control, farmer's annual income, herd size and household size were key factors influencing farmers' WTP. Richer farmers had a higher probability of paying for TADs control compared to low income farmers. In order to ensure effective TADs control, Vaccination should be provided at a lower cost to encourage farmers' WTP for TADs control. Farmers need to be trained in disease control and sensitized on the importance of their payment towards TADs control as this boosts their incomes & livelihoods.

***Keywords**: Transboundary animal diseases, Agro-pastoralists, Cost Benefit Analysis, Willingness to pay*

CHAPTER ONE

INTRODUCTION

1.1 Background and setting

Livestock plays a key role in the agricultural economy of many countries in Sub-Saharan Africa, contributing over a quarter of the total value of agricultural production (Tambi *et al*., 1999). In addition to providing food, income, employment and foreign exchange earnings, livestock serves as a store of wealth and supplier of inputs and services such as draught power, manure and transportation. Despite these important roles, the growth in livestock productivity in Sub-Saharan Africa has been below that of other developing regions due to transboundary animal diseases (TADs) besides droughts and market issues (Otte *et al*., 2004).

In Uganda, the livestock sub-sector contributes about 17% of the agricultural GDP and 7% of the National GDP (UBOS, 2008). Livestock production is an integral part of the agricultural system of many parts of the country. It is estimated that mixed farming small holders and pastoralists own over 90% of the cattle herd and 100% of the small ruminants and non-ruminant stock (FAO, 2005). Cattle are the most important of all the livestock (UBOS, 2008). Livestock production has continued to grow, at a rate of over 3% per annum, in response to increasing demand for milk and meat in the domestic market (FAO, 2005). However, higher rates of growth are envisaged as Government pursues its policies of modernizing and commercializing agriculture. Presently, livestock production does not satisfy domestic market because of TADs outbreaks, which reportedly have been increasing nationally and globally (ICEID, 2008).

Transboundary animal diseases are: “those diseases affecting the environment (farms) hundreds of miles away from the source” (FAO, 2009). They can easily spread to other countries and reach epidemic proportions; and their control requires cooperation between countries” (FAO, 2009). Therefore, they are of significant economic, trade, and / or food security importance for a considerable number of countries (Otte *et al*., 2004). In the last two decades, for example, per capita production of livestock in Sub-Saharan Africa dropped by about 14% compared to a 10% fall in West Asia and 0% growth in Latin America because of the prevalence of diseases (Misra *et al*., 2007).

A number of diseases limit productivity through morbidity and mortality, resulting in loss of meat, milk, hides and skins, eggs, wool, manure and animal traction. Infectious diseases such as Foot and mouth disease, Contagious bovine pleuropneumonia (CBPP) and Rinderpest account for the largest share of the losses (Thomson, 2008). Despite the significance of TADs, most governments in Sub-Saharan Africa are unable to maintain effective surveillance and control programmes against these diseases due to inadequate budgetary funding to the agricultural sector (Tambi *et al*., 1999). However, collaboration between national governments and international donor institutions such as the European Union (EU) in the last ten years has led to significant progress in the control of TADs in Africa.

Because TADs spread quickly covering large areas, the need for public intervention frequently extends to the international level and calls for regional co-operation without which control efforts cannot be effective (FAO, 2009). However, it is practically difficult to determine the proper mix between private and public as well as national and international action because of inadequate information on costs of both TADs and control efforts (Otte *et al*., 2004).

Transboundary animal diseases (TADs) are arguably the most important diseases that have devastated most of the herds in Sub-Saharan Africa (FAO, 2009). Damage can be economic loss (loss of output, income and investment) and psychological (shock and panic) (Otte *et al*., 2004). Combating TADs is therefore necessary to farmers given that the presence of diseases on one farm poses a threat not only to adjacent farms, but even to distant locales also. In addition, the loss of food due to disease poses a threat to national food security and rural livelihoods such that government intervention is unavoidable. As a result, government control interventions for TADs are usually stronger than for diseases that only occur locally. The spread of emergent diseases and invasive species has dramatically increased in the recent years. Numerous developments such as rapidly increasing transboundary movements of goods and people, trade liberalization, increasing concerns over food safety and the environment, enhanced the need for international cooperation in controlling and managing TADs (Otte *et al.*, 2004).

TADs include Foot and mouth disease (FMD), Rinderpest, Contagious bovine pleuropneumonia (CBPP), East coast fever (ECF), Lumpy skin disease (LSD), Newcastle disease (NCD) and African swine fever (ASF) (WAH, 2004). In Uganda, TADs have been a problem for a long time (Rutagwenda, 2000). He noted that in 2000, the price for hire of a pair of oxen increased by 39% due to FMD outbreaks causing farmers to shift from growing cash crops to food crops which generate less income. During the same period, the number of pastoral households having three meals in a day reduced from 38% to 9% while more than 50% of the pastoral households could only afford one meal a day. Cattle prices fell by 55% causing pastoralists to double the number of animals sold in order to meet their financial obligations. In addition, demand for drugs and food prices increased.

Singh *et al*. (2007) noted that poor farmers are the most affected by the diseases because of the scarcity of the vaccines and lack of awareness about vaccination programmes. The group found out that economic losses due to TADs were more among marginal farmers and in animals less than three years old than in commercial farms because of the regular and proper vaccination programmes at those farms. The authors further noted that the control of TADs such as FMD depends on prophylactic immunisation of susceptible animal population. Therefore, control of these diseases could lead to at least 5% annual increase in milk production (Singh *et al*., 2007). For effective control of FMD, about 60-80% of the animals need to be vaccinated (FAO, 2009). This can be made possible only through implementation of veterinary extension education for livestock owners about the economics of diseases and by readily making vaccination services available to farmers. Absence of veterinary clinics, inaccessible distances and lack of extension advice are the reasons for non-adoption of vaccination by farmers (Koma, 2003). Educated farmers are more likely to seek professional advice and to vaccinate their animals regularly (Singh *et al*., 2007).

Although the disease situation has generally improved, Uganda still experiences TADs outbreaks in some areas including western Uganda. According to World Animal Health (WAH, 2004), these diseases include: FMD, NCD, ASF, Rabies, CBPP, LSD, Trypanosomiasis, Anthrax and Brucellosis. Outbreaks are associated with movement of livestock in search for water and pastures (FAO, 2009). Control of TADs such as ASF has been greatly affected by a lack of vaccine and the presence of many disease reservoirs (WAH, 2004). Therefore, TADs control in Uganda is based on quarantine, sanitary measures and public sensitisation, management and hygiene.

1.2 Problem Statement

Recent surveys in the different agro-ecological zones of Uganda revealed that herders are facing various challenges relating to low rainfall, long dry season spells and the spatial variability of precipitation (FAO, 2010). The situation becomes more complex with transboundary animal disease outbreaks which have been increasing nationally and globally (ICEID, 2008). As a result, transboundary animal diseases are now a permanent threat for agro-pastoralists in Uganda.

Although a lot of effort has been put to the control of TADs in Uganda, the problem is still far from being solved. Large sums of money have been spent in the attempt to reduce TADs infestation in the country (Tambi *et al*., 1999). Unfortunately, like in other African countries, TADs infestation has not changed considerably (Otte *et al.*, 2004). Despite the many studies that have been conducted on the economics of TADs control, little has been done to accurately quantify the costs and benefits of TADs control in Uganda (Tambi *et al*., 1999; Rutagwenda, 2000; Otte *et al*., 2004; Mugasi, 2009). Furthermore, most of the studies have focused on the impact of one disease regardless of the prevailing multiple disease context (FAO, 2009). Whereas current disease control is a public good, there is lack of knowledge about farmers' willingness to pay for TADs control. Thus, the study characterises agro-pastoralists, determines their willingness to pay for TADs control, and the benefits and costs of TADs control. It also assesses the socio-economic effects of TADs on livestock producing households with a view to propose appropriate interventions to disease incidences and effects in Uganda.

1.3 Objectives of the study

The main objective of the study was to assess the socio-economic effects of TADs and farmers' willingness to pay for the control of these diseases. The specific objectives were:

1. To characterise agro-pastoralists in Rakai and Ntungamo districts where TADs are very common.
2. To determine the farm level benefits and costs associated with the control of TADs.
3. To determine factors influencing farmers' willingness to pay for TADs control.

1.4 Hypotheses

The study was guided by the following hypotheses:

1. Agro-pastoralists in Rakai and Ntungamo districts may be willing to pay for TADs control
2. The net benefits of controlling TADs are significantly different from zero.
3. Factors such as farmer's income, household size distance from the border influence willingness to pay for TADs control.

1.5 Significance of the study

In the last ten years, there have been policy changes that have led to the replacement of government funded veterinary services with privatised livestock health care provision. As a result, the burden of controlling diseases is now in the hands of farmers (Leonard, 2000). In Uganda, the National Agricultural Advisory Services (NAADS) is promoting the gradual replacement of government extension workers with private service providers. This is because the control of diseases like the TADs is increasingly becoming a responsibility of individual farmers.

The success of this policy change in the delivery of animal health services depends on the presence of sufficient incentives for farmers to demand and pay for these services (Mugasi, 2009). Therefore, this study provides highlights on how to enhance farmers' willingness to pay for TADs control hence improving the health of their animals. Furthermore, the study analyses the benefits and costs of controlling TADs hence providing guidelines to farmers as to whether TADs control is economically viable or not.

1.6 Scope of the study

The study investigates the economics of TADs control in Rakai and Ntungamo districts. The aim was to identify major cattle TADs in the area, their hotspot areas, costs and benefits incurred in controlling these diseases, characteristics of agro-pastoralists (farmers) and their willingness to pay for TADs control. In this study, the words agro-pastoralist and farmer have been used interchangeably. The focus was on cattle because they are the most important type of livestock in Uganda (MAAIF and UBOS, 2008) and two diseases namely, FMD and ECF. Another study in Eastern Uganda under the project "Assessment of Socio-economic impacts of TADs in Eastern and Western Uganda" was done by another student.

CHAPTER TWO

LITERATURE REVIEW

This chapter describes the effect of TADs on agro-pastoralists across the globe. It also examines the relevant literature on the characteristics of agro-pastoralists, benefits and costs of controlling TADs, estimation of willingness to pay and factors affecting willingness to pay.

2.1 Characteristics of African Agro-pastoralists

Agro-pastoralists are a member of people living by a mixture of agriculture (growing of crops) and livestock keeping (pastoralism). In contrast, Pastoralists are people who depend for their living primarily on livestock. According to FAO (2010), pastoralists inhabit those parts of the world where the potential for crop cultivation is limited due to lack of rainfall, steep terrain or extreme temperatures. In order to optimally exploit the meager and seasonally variable resources of their environment and to provide food and water for their animals, many pastoralists are nomadic or semi-nomadic (Katy, 2008). They rely upon several species, namely, sheep, goats, cattle and either camels or donkeys. Small stock are traded for grain and cash over the season and in good years allowed for a comparatively rapid recovery of flocks and herds (FAO, 2010).

Radney *et al*. (2006) observed that large female animals (cattle and camels) are treated as capital and are sold only in extreme circumstances. They noted that taking of large animals into commercial channels takes place mainly in years of drought, when the larger system could not absorb the many animals on offer. This shows opportunistic build-up in good years of stock populations balanced by high losses during major droughts.

Rota and Sperandin (2009) recognized that pastoralism represents a sustainable method of utilizing certain types of ecosystems, such as deserts, steppes and certain mountain areas. Their key constraints are low rainfall, the long dry season and the spatial variability of precipitation. That is why in the past pastoralists made little use of permanent investments (fencing, paddocks and irrigation) and resisted mass education because of competition for labour (Rota and Sperandin, 2009).

2.2 Significant Transboundary Animal Diseases

Some of the important TADs are:

Foot and Mouth disease (FMD) is a highly contagious and sometimes fatal viral disease of cloven-hoofed animals, including domestic animals such as cattle, water buffalo, sheep, goats and pigs, as well as antelope, bison and other wild bovids, and deer. It is caused by foot-and-mouth disease virus. The disease is spread through movement of infected animals and animal products, contaminated objects and by wind currents.

Rinderpest is an infectious viral disease of cattle, domestic buffalo, and some species of wildlife. It is commonly referred to as cattle plague or steppe murrain. The disease is characterized by fever, oral erosions, diarrhoea, lymphoid necrosis, and high mortality.

Contagious bovine pleuropneumonia (CBPP) is a contagious bacterial disease that afflicts the lungs of cattle, buffalo, zebu, and yaks. It is caused by the bacterium *Mycoplasma mycoides mycoides*, and the symptoms are pneumonia and inflammation of the lung membranes. The incubation period is 20 to 123 days. The movement of infected animals spreads the disease.

Bovine Spongiform Encephalopathy (BSE), commonly known as mad-cow disease, is a fatal, neurodegenerative disease in cattle, that causes a spongy degeneration in the brain and spinal cord. BSE has a long incubation period, about 4 years, usually affecting adult cattle at a peak age onset of four to five years, all breeds being equally susceptible. The disease is transmitted among cattle through feed supplements with meat and bone meal containing infected particles from affected animals.

Rift Valley Fever (RVF) is a mosquito-borne viral zoonosis that primarily affects animals but also has the capacity to infect humans. Infection can cause severe disease in both animals and humans. The disease also results in significant economic losses due to death and abortion among RVF-infected livestock.

Ovine rinderpest, also commonly known as *peste des petits ruminants* (PPR), is a contagious disease affecting goats and sheep in Africa (from Tropic of Cancer to Equator), the Middle-East and the Indian subcontinent. But since June 2008, the disease invaded Morocco , which indicates a crossing of the natural barrier of Sahara. It is caused by a species of the Morbillivirus genus of viruses. The disease is highly contagious, and has roughly an 80 percent mortality rate in acute cases.

Classical Swine Fever (CSF) or hog cholera is a highly contagious disease of pigs and wild boar. Swine fever causes fever, skin lesions, convulsions and usually (particularly in young animals) death within 15 days.

African Swine fever (ASF) is the main threat to the development of the African pig industry. Its extremely high potential for transboundary spread has placed all the countries in the region in danger and has raised the spectre of ASF once more escaping from Africa. It is a disease of growing strategic importance for global food security and household income.

Newcastle Disease (ND) is a contagious bird disease affecting many domestic and wild avian species. Its effects are most notable in domestic poultry due to their high susceptibility and the potential for severe impacts of an epidemic on the poultry industries. It is endemic to many countries.

2.3 History of control of transboundary animal diseases

The situation of TADs has improved markedly in recent years particularly in Europe and some countries in South East Asia and South America to the extent that Europe, North and Central America, Pacific nations and Caribbean are free of the disease (Perry *et al*., 2002). However, the diseases remain endemic with high prevalence rates in many countries in Africa, the Middle East and Asia (ICEID, 2008). Otte *et al.* (2004) noted that many infectious diseases of animals such as rabies and anthrax have been known from ancient times. Cultural and religious taboos against eating some livestock species were used as hygiene protection against zoonotic diseases (i.e. diseases transmitted from animals to humans and vice versa).

Otte *et al.* (2004) further noted that little was known about the economic and social consequences of epidemic livestock diseases in early times. For example, the Rinderpest outbreaks in Asia and through Europe often during periods of war and social upheavals caused severe cattle deaths and much human misery (Perry *et al*., 2002). The Rinderpest crisis in 18th century in Europe and later Africa was perhaps the main stimulus for the development of public veterinary services. Although Rinderpest was eradicated from Europe by the end of the 19th century, it was re-introduced to Belgium in 1922 with imported Zebu cattle (Otte *et al.*, 2004), hence the establishment of Office International des Epizooties. There was an explosion in the incidence and economic cost of epidemic livestock diseases in the mid 19th century that persisted well into the 20th century. Diseases that advanced include foot and mouth disease, contagious bovine pleuropneumonia and classical swine fever (Perry *et al*., 2002).

The three main causes of TADs include rapid intensification of livestock production, improved transportation, and European colonisation of other regions which brought livestock into contact with new disease agents which had only previously circulated in wildlife (Otte *et al.*, 2004).

According to FAO (2009), there are three forms of TADs control, namely: regional initiatives in control and eventually eradication of disease (like the South East Asia FMD control programme); national and regional initiatives to prevent disease incursion into free areas (like concerted attempts over the past two decades to prevent entry of FMD into Western Europe, which are co-ordinated by the European Commission for FMD hosted by FAO); and stamping out of outbreaks occurring in previously free countries (like the 2001 FMD outbreak in the UK).

2.4 The economic impact of TADs outbreaks

All TADs have the potential to kill affected animals, but the severity of disease varies depending on species and breed of the animal, age, nutrition and disease agent. Many TADs have 50 to 90% mortality rates in susceptible animals (FAO, 2009). The first outbreak of Rinderpest in East Africa in 1887 was estimated to have killed about 90% of Ethiopia's cattle and more than 10 million cattle on the continent as a whole; this resulted into widespread famine (Otte *et al*., 2004). Therefore, the traditional goals of disease eradication programmes are reduction in mortality, improvement in animal productivity and access to export markets (Randolph *et al*., 2002). Improved response to outbreaks and increased access to vaccines has however reduced the likelihood of many disease epidemics.

Direct costs due to TADs include reduced livestock productivity (in terms of mortality, reduced fertility, milk yield and ability to work as traction animals) (Rutagwenda, 2000). Tambi *et al*. (1999) carried out an economic impact assessment of Rinderpest control in Africa, using cost-benefit analysis. They estimated the production losses with and without control campaigns and found benefits of disease control to exceed costs in each country. In addition, Otte *et al*. (2004) in a study to assess socio-economic impacts and institutional responses of TADs revealed that although existing studies always demonstrate a net benefit from control of TADs, externality costs associated with eradication and control efforts exist.

In their study on the economic value of animal disease control measures in Australia, Abdalla *et al*. (2000) used the producer and consumer surplus to estimate the benefits of an eradication campaign. They noted that the effect of disease is to lower the producers' total product curve hence less output is produced with the same level of inputs used in a disease free environment. They further noted that output losses were lower in the absence of the adoption of the first best practice and additional economic costs were incurred because inputs were not allocated to their best use.

2.5 Impact of TADs control on cattle productivity

The presence of TADs in Uganda is a major obstacle to the development of agriculture. Therefore, the removal of this development problem will permit increased agricultural production, economic and market development, and alleviate hunger and poverty (Feldmann *et al*., 2005). In addition, controlling costs of production is becoming critically important in modern livestock farming. Thus, improving animal health and fertility plays a major role in obtaining efficient and economically rewarding production (Dijkhuizen *et al*., 1995). The other major expected benefit of eradicating TADs is improved opportunities for exports of livestock and livestock products (Rutagwenda, 2000) and improving national productivity of livestock (Randolph *et al*., 2002).

Although studies have shown evidence of increased animal productivity resulting from TADs control, there is limited information on this in Uganda (FAO, 2005). The indicators of livestock productivity benefits cited include body weight gain and reproductive performance. Other benefits include higher output from animal traction, manure outputs as well as meat and milk production. Quantifying and analysing all these benefits is a more complex issue than tackling costs because of the need to integrate a number of variables in the model (Shaw, 2003).

2.6 Modeling benefits and costs of TADs control

One of the benefits of controlling TADs is increased revenue due to reduced production losses. Estimates of production losses are obtained under both with disease control and without disease control scenarios. The incremental benefits are derived as the difference between the two scenarios (with and without disease control) (Tambi *et al*., 1999). Since vaccination is the principal control measure used to control disease, the number of cattle vaccinated against diseases offers an obvious indicator of the activity of controlling disease (Singh *et al*., 2007). On the other hand, the costs were categorised into immediate loss of an animal, loss in milk production, cost of treatment, that is, antibiotics, vitamins, disinfectants, services by the veterinary officers and mortality costs (Singh *et al*., 2007). Livestock owners can save this amount by vaccinating their animals against FMD.

Over the last two decades, important advancements have been made in modelling costs and benefits of controlling TADs. Dijkhuizen *et al*. (1995), Tambi *et al*. (1999), Otte *et al*. (2004), Bennett (2003) and McClement *et al*. (2009) have contributed to this achievement. The studies have attempted to identify the most cost-effective strategy for control of animal diseases in a given area. Using spreadsheet models to provide a basis for the economic assessment of animal diseases, Bennett and Ijpelaar (2003) found that uncertainties about incidence of diseases and their effects on livestock production exist.

On the other hand, analysis of benefits of disease control has largely been carried out using herd models (Bennett, 2003). According to Bennett (2003), herd models are mathematical simulations of livestock demographics, incorporating different production parameters so as to simulate the health status of the populations, hence the effects of a disease, or of the control measures on the disease. In a study on economic analysis of tsetse control in South-Eastern Uganda, Mugasi (2009) used the livestock production efficiency calculator (LPEC) to evaluate and analyse the farm level benefits of tsetse and trypanosomiasis control. The main use of LPEC is to compare productivity of different production systems, or of the same production system under different conditions, such as with and without disease. Using the cost-benefit ratio (CBR), Mugasi (2009) found out that the benefits derived using the LPEC model were assumed to be the same for traps, deltemethrin spray and cypermethrin pour-on, while costs differed.

2.7 The Concept of Willingness to pay

Willingness to pay is the maximum amount a person would be willing to pay, sacrifice or exchange in order to receive a good or to avoid something undesired (Freeman, 2003). In contrast, willingness to accept payment is the minimum amount an individual is willing to receive to give up a good or to accept something undesirable (Breidert, 2005). Unlike willingness to accept, willingness to pay is constrained by an individual's wealth (Freeman, 2003). Willingness to pay assumes an individual's utility function of the form $u(w, x)$, where w is the person's wealth and x is a variable that takes the value one in the presence of a good and zero otherwise .

The utility function is assumed to be increasing in both wealth (w) and x. The person's initial wealth is also defined as w_0. Then the "willingness to pay", denoted by WTP, is defined by $u(w_0 - WTP, 1) = u(w_0, 0)$. Thus willingness to pay is the amount of payment which, combined with the presence of the good, gives the person the same level of utility as would occur if there were no payment and no acquisition of the good (Freeman, 2003).

2.7.1 Willingness to Pay for Transboundary Animal Disease control

Hojgard *et al*. (2012) noted that, one method that has been used to determine the value of TADs control is contingent valuation, in which interested groups are asked to indicate their willingness to pay to prevent loss of value. However, the challenge facing national and international authorities responsible for plant and animal protection is that, TADs control programmes involve multiple governments and organisations whose risk acceptance and willingness or ability to reduce it vary. In regions with a good infrastructure, the movement of livestock and derived products is regulated and controlled to prevent entry and subsequent spread of exotic disease agents.

Furthermore, FAO (2009) observed that the disease surveillance systems with good laboratory diagnostic back-up are maintained to ensure early detection of disease outbreaks and contingency plans are in place to rapidly respond to an epidemic. Conversely in many countries, public funding of veterinary services is insufficient and even declining (Otte *et al*., 2004). Diagnostic capacity is poor, livestock movements are uncontrolled and farmers are usually not compensated for disease losses which undermines their willingness to pay for disease control programmes (Hojgard *et al*., 2012).

2.7.2 Estimation of Willingness to Pay

Valid estimates of willingness to pay are essential for developing an optimal pricing strategy in marketing. Such estimates are used to forecast market response to price changes and for modeling demand functions (Balderjahn, 2003). Breidert (2005) distinguishes willingness to pay estimation methods on whether they are surveys or based on data from observations. Observations involve real data such as market data, or experiments. Experiments can be divided into field experiments and laboratory experiments. Within field experiments one can further distinguish whether the probands are aware they are participating in an experiment or not. Observations are also referred to as revealed preference.

Looking at surveys for estimation of willingness to pay, there exist direct and indirect surveys. Preference data derived from surveys is also referred to as stated preference. In direct surveys, probands are asked to state how much they would be willing to pay for some product/ service. In indirect surveys some sort of rating or ranking procedure for different products is applied. Conjoint analysis is an indirect surveying method (Balderjahn, 2003).

Market data has been used to estimate demand curves by Breidert (2005). Usually it contains sales data such as historical sales data, panel data, and store scanner data. Using historical data is based on the assumption that past demands can be used to predict future market behavior. This implies that the product for which future demand is estimated has only been exposed to minor variations in the product profile. This also applies to competitors and consumers. The problem is that often historical data does not contain the necessary price variations to cover the desired spectrum of willingness to pay.

Sattler and Nitschke (2003) classify estimation of willingness to pay based upon market data as not feasible, since only very few datasets contain the necessary variations. Demand curves based upon sales data is usually modeled with regression techniques. However, this is only possible if the requirements of the independent variables are met (Balderjahn, 2003) Single customers are usually not identified, which makes individual level estimations impossible. This is different with panel data where the actual prices paid for products are observed at the individual level. The drawbacks are that having a customer panel is very costly to companies.

Furthermore, it is often questionable, whether the customer panel adequately represents the market as a whole (Nagle and Holden, 2002). Scanner data is usually aggregated at store level. It is usually not aggregated over time. Therefore it is useful for observing response to short time price variations. Using market data the researcher can only observe whether an individual or a group had willingness to pay above the product price, because the product was actually purchased. Customers who refused to purchase the product are not reported in historical sales data.

On the contrary, experiments are distinguished between laboratory experiments and field experiments, both of which are applied in pricing studies (Breidert, 2005). In laboratory experiments, purchase behavior is simulated by giving the probands an amount of money and asking them to spend the money on a specific selection of goods. The goods and prices are varied systematically and the results are obtained quickly. A drawback is that the probands are aware of the experimental situation which might lead to subjects becoming more rational of their purchase behavior compared to their normal shopping behavior hence low external validity (Breidert, 2005).

Field experiments or in-store purchase experiments do not suffer from the problem of the artificial setup because they are performed in the natural environment of the consumers. Depending on the experimental setup the proband knows that he or she is participating in an experiment. Field experiments are often carried out in form of test markets. In different test markets the prices are systematically varied and the consumers' responses are analyzed. A crucial issue is to select test markets as similar to the target market as possible. The drawback of field or in-store experiments lies primarily in the relatively high costs (Sattler and Nitschke, 2003).

Looking at direct surveys, they can be distinguished between expert judgements and customer surveys (Breidert, 2005). Expert judgements are one of the most frequently used methods for estimating customers' willingness to pay in order to estimate demand at different price levels. They can be performed more quickly and at lower costs compared to interviewing customers. For expert judgements, usually sales or marketing people predict the willingness to pay of their customers. This type of survey is best applicable to environments with a small number of customers. With larger and heterogeneous customer bases this becomes a critical issue.

Despite the shortcomings of expert judgments described above, they are an important source of information because an educated guess is better than a random selection of a presumably adequate price from a number of price possibilities (Breidert, 2005).

Customer surveys, naturally, if one attempts to forecast consumer behavior in response to different prices, a good way is to ask the customers. Directly asking the respondents to indicate acceptable prices is referred to as the direct approach. This procedure presents the probands with several typical product profiles. These product profiles can be in an early conceptual phase or already marketable. The probands are then asked to name prices at which they consider a product to have a very good value, an average value, and a somewhat poor value. From the responses buying probabilities for different prices are derived. According to Balderjahn (2003) "a somewhat poor value" could be interpreted as a reservation price.

According to Nessim and Dodge (1995)directly surveying customers has the following flaws: An unnatural focus on price. Customers do not necessarily have an incentive to reveal their true willingness to pay. They might overstate prices because of prestige effects or understate prices because of consumer collaboration effects. Nessim and Dodge (1995) suppose that "buyers in direct responding may also attempt to quote artificially lower prices, since many of them perceive their role as conscientious buyers as that of helping to keep prices down". Nagle and Holden (2002) observe the opposite behavior that not to appear stingy to the researcher respondents could also overstate their Willingness to pay. Directly asking for Willingness to pay especially for complex and unfamiliar goods is a cognitively challenging task for respondents (Brown *et al*., 1996).

In contrast to directly asking respondents for their willingness to pay, they can be presented product profiles with a price assigned and be asked to indicate whether they would purchase the good at that price (Breidert, 2005). Since the respondent is presented a number of products with assigned prices, a real purchase situation is mimicked more closely than in direct surveys in which the respondent has to state an acceptable price. Furthermore, it is cognitively easier for a respondent to decide whether a specific price for a product is acceptable, than to directly assign a price (Brown *et al*., 1996).

One of the questioning formats used in contingent valuation method to obtain willingness to pay figures is the bidding game (Alp *et al*., 2002). Bidding price is the highest price that a buyer (bidder) is willing to pay for a good. The bidding game technique involves suggesting higher and higher amounts to the respondents until their maximum willingness to pay is reached (Hanley *et al*., 1997). The enumerator suggests the first bid and the respondent agrees or denies that he / she would be willing to pay it. Then, the starting point price is increased to see if the respondent would still be willing to pay it, and so on until the respondent declares he / she is not willing to pay the extra increment in the bid (Pearce and Turner, 1990). The final accepted bid, then, is the maximum willingness to pay. An advantage of this method is that it facilitates the respondent's thought process and encourages him / her to carefully consider his / her preferences. However, bidding games are subject to anchoring bias and can lead to a large number of outliers (Arrow *et al*., 1993).

2.7.3 Empirical Literature survey on Willingness to Pay

A number of factors and circumstances affect an individual's willingness to pay for a good. These factors are discussed differently by different researchers as follows: Saravanan and Gowda (1999) using a linear discriminate function to identify variables that affect farmers' willingness to pay in Maharashtra, Rajastan and Kerala states in India found a number of factors important in explaining farmers' willingness to pay for agricultural information received. These included age, education level, occupation, total land area, irrigated land area, income from agriculture, total household income, area under non-food grains, level of inputs used and the level of satisfaction with the primary source of information. Their results revealed that 48% of the farmers were willing to pay Rs. 25 for agricultural information.

Similarly, Malkanthi and Mahaliyanaarachchi (2001) conducted a study in Nuwara Eliya district Sri Lanka to examine the attitudes of the vegetable farmers towards privatisation of agricultural extension services. They found that 41% of the farmers had least favourable attitudes toward private extension services. Only type of labour used, monthly profit from vegetable cultivation, monthly total income and management ability of the farmers were positively associated with the farmer attitudes towards private extension services.

Yapa and Ariyawardana (2005) carried out a study on the willingness to pay for a fee-based extension service by tea smallholders in Galle district, Sri Lanka. Using a probit regression model to analyse the factors affecting the tea smallholders' willingness to pay for a fee-based extension service, their results revealed that only 24% of the smallholders were willing to pay for such a service. The average willingness to pay was Rs. 85.62 per month by a tea smallholder. According to the probit analysis, income had a significant positive influence and farming experience had a significant negative influence on willingness to pay.

Mwaura *et al*. (2010) conducted a study on willingness to pay for extension services in Uganda among famers involved in crop and animal husbandry. They used cross tabulations and the probit model to assess the farmers' attributes associated with willingness to pay for extension services. The authors found that 35% and 40% of the farmers under crop and animal husbandry respectively were willing to pay for extension services and the significant variables included sex, distance to the nearest market, age and education level.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study was conducted in two border districts from Western Uganda (Ntungamo and Rakai). Two sub-counties from Rakai and three from Ntungamo were selected based on existence of sustainable livestock management (SLiM) project and access to market. Sustainable livestock management project refers to a project whose aim is to develop a livestock management system that protects and enhances soil quality (physical and biological), protects water quality, enhances on-farm biodiversity, provides a humane and healthy environment for the livestock, and minimizes greenhouse gas emissions (Kerr, 2008).

Ntungamo and Rakai districts were purposively selected for the study because they are at the border, so they are prone to TADs. The two districts greatly contribute to livestock production in Uganda (MAAIF and UBOS, 2008). The districts were selected in order to bring in diversity because of the two countries which they border, namely Rwanda and Tanzania. In addition, they are in one of the areas where the activities of the project "Assessment of spatio-temporal bovine migratory routes and trans-boundary animal diseases (TADs) infestation in Western and North-Eastern Uganda" operated.

Rakai district is located in the south-western part of Uganda. It bordered Kagera region in Tanzania to the south, Kalangala, Masaka and Sembabule districts to the east, Sembabule district to the north, Kiruhura district to the northwest and Isingiro district to the southwest. The district covered an area of 4,989 square kilometers (as per the year 2011). The dominant economic activity in the district was subsistence agriculture employing over 85% of the people in the district. The population of the district was 466,900 people and that of cattle owned was 279,594 heads of cattle (MAAIF and UBOS, 2008).

In Rakai district, the hilly terrain leaves little productive land for crop cultivation and cattle keeping, which in addition to fishing, were the main economic activities of communities in the district(in 2011). The current efforts to control TADs include; livestock movement control, surveillance, reporting, diagnosis, enforcement of quarantines, compulsory vaccinations and regional and international collaborations. Vaccination was by public and private sector, the public sector being the major player.

Ntungamo district is in western Uganda. It bordered Rwanda to the south, Isingiro district to the east, Mbarara district to the northeast, Bushenyi district to the north, Rukungiri district to the northwest and Kabale district to the southwest. The district covered 2,056 square kilometers with a population of approximately 469,000 people (in 2011). The total cattle population in the district was 229,004 heads of cattle (MAAIF and UBOS, 2008).

In Ntungamo, the foot and mouth disease outbreak was reported in 2006 and 2007. The disease spread like a bushfire in the dry season and the veterinary officials’ response was very slow. Quarantines were placed when the disease had already spread to the neighbouring districts. The spread was due to unchecked animal movements across the Uganda-Rwanda border (WAH, 2004).

3.2 Data Sources and Data Collection

Both primary and secondary data were used. Primary data were collected through stakeholder consultations; focus group discussions and key informant interviews at the village level; and discussions and surveys at the household level. A questionnaire was designed to obtain information on the extent to which respondents to the survey thought that each disease affected the performance of livestock. This was supplemented by on-farm observations. The survey was carried out between June and July of 2011. Using pre-tested questionnaires (Appendix 1), heads of selected households were interviewed. In the absence of the household head, the spouse or any other responsible adult member of the household was interviewed. The main respondent would provide most of the information, but consulted with other household members when necessary.

Qualitative and quantitative data were collected from the selected agro-pastoralists. Information on the nature and perceptions of TADs in the study sites; the vulnerability of livestock and people to TADs, adaptive or other types of responses to each TAD; factors affecting these responses and impacts of the responses to people's livelihood, economic development, local natural resource and environmental conditions were captured using the semi-structured questionnaires.

The data collected include socio-demographic data, economic data, production and marketing constraints, service delivery and information on farmers' willingness to pay for TADs control. Information on farmers' various characteristics including age, sex, marital status, incomes, number of animals owned and experience in cattle rearing was collected. In addition, information on status of TADs and geographic characteristics of the study area was collected. To collect supplementary information, key informant interviews were also conducted with the district veterinary officers, district agricultural officers, sub-county veterinary/ extension officers and local leaders. This information was used to validate what was collected from the farmers. It comprised of information on costs of vaccines/ drugs, price changes with and without TADs outbreaks, farmers' coping strategies in the event of TADs outbreaks and opinions on TADs control methods.

In order to gain a deeper understanding of TADs, focus group discussions were conducted. These were arranged into two categories (community leaders, and herders only). In total six groups were conducted; three in Rakai district and three in Ntungamo. For each district, one group consisted of only community leaders and the other two groups consisted of herders only from at least two sub-counties where the research was conducted. Each group consisted of 8-10 people for easy management. There was at least one female in each group given that fewer females were involved in livestock keeping. General questions about TADs and how they can be controlled were asked to each group. The responses were recorded and non-verbal communication noted as well.

Secondary data were obtained from various publications on livestock production including reports, newspapers, library sources, researchers, NGO's, documentaries, international and government publications such as FAO, MAAIF, Uganda Bureau of Statistics (UBOS), Ministry of Finance Planning and Economic Development (MFPED), internet and District Production Directorate for Rakai and Ntungamo.

3.3 Sampling and Sample Size

A multi-stage sampling technique which involved selection at different stages (that is, regions, districts, villages and farmers) was used. Two sub-counties: Kakuuto and Kibanda in Rakai district and three sub-counties: Rubaare, Ngoma and Rukoni in Ntungamo district were randomly sampled (Appendix 2 and 3). Lists of major livestock producing villages per sub-county were obtained from the district veterinary officers. Lists of all agro-pastoralists in the villages were obtained from Local Council One (LC.1) chairpersons. Thereafter, a sampling frame was drawn from the list of agro-pastoralists in each Local Council following a random walk. Choosing a random starting point in each village, every third household was picked until 86 and 90 agro-pastoralists from Rakai and Ntungamo districts respectively were interviewed. A total of 176 agro-pastoralists were sampled to represent all the farmers in the two districts. The number of respondents to interview for each of the 2 districts was intended to be equal but the realisation was different. This is because at the time of the survey, the households in Rakai were too scattered and at times there were no adults to interview in some households.

3.4 Data analysis

Data were analysed using Excel, Statistical Package for Social Scientists (SPSS) and STATA software. Descriptive statistics, Cost Benefit Analysis (CBA) and Logit models were used to address the three objectives. In case of continuous variables, an exploratory data analysis was done to determine their distribution. For non-normally distributed variables, an appropriate transformation was done to remove skewness or heavy tails. For example, the age variable was skewed hence a square transformation was used to correct the skewness. To achieve objective one (characterising agro-pastoralists), descriptive statistics were employed. These involved the use of percentages, t-tests, standard deviations and mean comparisons. Percentages were used to determine and explain proportions while t-tests were used to test significant differences between socio-economic characteristics of the farmers (agro-pastoralists).

To evaluate farm level benefits and costs of controlling TADs (objective two), a method following Tambi *et al*. (1999) was adopted. This involved developing a spread sheet model in excel in which the various costs and benefits of controlling TADs were entered. Benefit-cost ratio was computed and used to compare the value of incremental benefits with the value of incremental costs. Incremental costs and benefits of disease control are those costs and benefits that would occur if TADs were controlled, compared to those that would have been obtained if TADs were not controlled. The basic approach involved aggregating all incremental costs associated with the control intervention and comparing these costs to the total value of benefits generated attributable to the intervention as follows:

$$\text{BCR} = \sum \Delta B \Big/ \sum \Delta C \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where BCR is the benefit cost ratio, ΔB is the incremental benefit resulting from a disease control programme and ΔC is the incremental cost of disease control. The economic cost (C) of a disease is computed as the sum of the direct and indirect production losses (L) from mortality and morbidity plus the expenditures incurred (E) for its control represented as C = L + E (Tambi *et al*., 1999).

Direct Costs (DC) = (L+R) + T + P ……………………………………………………….. (2)

Where,

L = the loss in expected output due to disease.

R = the increase in expenditures on non-veterinary resources due to disease.

T = the cost of inputs used to treat disease.

P = the cost of disease prevention measures.

Incremental costs include costs for vaccination and those to support restructuring of livestock services. Vaccine costs were calculated as the product of the quantity used and the unit price of vaccine in the country.

On the other hand, incremental benefits include increased revenue from improved productivity and savings in control costs avoided after TADs control. The principal benefits were the physical production losses avoided by reducing the incidence of TADs, which include meat and milk products. Avoided losses due to willingness to pay for TADs control were estimated as the difference between the losses incurred if one paid for TADs control measures and those that would have been expected to occur if one did not pay for TADs control over the time horizon considered. Therefore, incremental benefits (B) were estimated as the difference between the value of output produced without the disease (PV_w) and that produced with presence of the disease over the time horizon considered (PV_d).

That is, Incremental Benefits (B) = (PV_w) - (PV_d) ………………………………………. (3)

Where,

(PV_w) = Production value without disease (Shs/litre of milk, Shs/Kg of meat)

(PV_d) = Production value with the presence of the disease (Shs/litre of milk, Shs/Kg of meat)

To determine factors influencing farmers' willingness to pay for TADs control (objective three), contingent valuation technique was used. Farmers were given a bidding price which they either accepted or rejected. Their bids were therefore judged to be a reflection of their willingness to pay for TADs control measures.

3.4.1 Description of the theoretical model

Willingness to pay for TADs control was modelled in a random utility framework where the farmer had two choices; either to choose paying for disease control or not. Willingness to pay is the maximum amount of money an individual would be willing to pay rather than to do without an increase in a good or service such as improved animal health. It may also be defined as follows; "for a given level of public good provision, a respondent's willingness to pay is the dollar amount which equalizes two indirect utilities". According to Greene (2003), denoting the utility derived from choice i (that is, willingness to pay for TADs control) as U_{in}, and that of choice j (not willing to pay for TADs control) as U_{jn}, then the *n*th farmer chooses to participate in disease control if and only if; $U_{in} > U_{jn}$ .... (4)

Since the individual's utility was not known with certainty, utility is treated as a random variable. Overall utility is expressed as the sum of deterministic components expressed as a function of factors presented and a random component (Greene, 2003). This is expressed as;

$$U_{in} = V_{in} + \varepsilon_{in} \text{ and } U_{jn} = V_{jn} + \varepsilon_{jn} \quad \text{...(5)}$$

Where U_{in} is the individual $n's$ utility in choosing option i, V_{in} is the deterministic component of utility and ε_{in} is a random component which represents unobserved factors affecting the choice, measurement errors and the use of instrument variables rather than actual variables. V_{in} is the individual $n's$ indirect utility function resulting from the individuals' budget constrained utility maximising choice of option i and it is assumed to be linear in parameters (Greene, 2003).

$$V_{in}(q_{in}, Y - C, X_n) = \beta_0 q_{in} + \beta_1 X_n + \beta_2 (Y - C_i) \quad \text{.. (6)}$$

Where q_{in} are the benefits of the option i, Y is disposable income and C_i is the cost of option i or willingness to pay and X_n is individual $n's$ vector of demographic characteristics. If ε_{ij} is independently and identically distributed (iid) with type 1 extreme value distribution, then the probability of individual n choosing option i and not option j therefore is the probability that option i provides greater utility U_{in} than option j, with utility U_{jn} (Greene, 2003). This is expressed as:

$$P_{in} = \Pr(U_{in} > U_{jn}; \forall i \neq j) = \frac{\exp(V_{in})}{\exp(V_{in}) + \exp(V_{jn})} \text{ .... (7)}$$

The willingness to pay for a disease control option i is unobservable and since responses are discrete in nature with respondent's offered option, a logit model was used (Ajani, 2008). This model was used because of the binary nature of the dependent variable whether farmers were willing to pay for disease control or not (1-willing, 0-not willing). Dummy variables were created for the categorical variables and proportional willingness to pay, the percentage change in probability, and p-values were computed for each category.

3.4.2 Empirical model

The logit established the relationship between the observable index i and various independent variables. The independent variables are as indicated in (Table 3.1). The dependent variable is the probability that the respondent is willing to pay for TADs control option presented. This has a yes or no response which was captured by giving farmers a payment option which they either accepted or rejected. Following (Gujarati, 2004) the logit equation is given as:

$$L_i = \frac{\mathrm{P}_i}{(1 - \mathrm{P}_i)} = \frac{1 + \exp(\mathrm{Z}_i)}{1 + \exp(-\mathrm{Z}_i)} \text{ ....(8)}$$

Where $Z_i = \beta_0 + \beta_i X_i$ ....(9)

Taking the natural log of (8) above, $\ln\left(\frac{P_i}{(1-P_i)}\right) = \beta_0 + \beta_i \chi_i + \varepsilon_i$ ....(10)

Where,

P_i is the probability that the farmer is willing to pay for TADs control, β_i are the estimated coefficients and χ_i is a vector of explanatory variables shown in (Table 3.1).

Table 3.1: Variables in the estimation of farmers' willingness to pay for TADs control

Definition	**Unit**	**Expected Sign**	**Description**
Household size	Number	+/-	Number of people in household
Farmer's age	Years	-	Age of household head
Farmer's education level	Years	+	Years of schooling by farmer
Number of cattle owned	Number	+	Number of cattle owned by farmer
Cattle type kept by farmer	Dummy	+	Breed of cattle kept by farmer (1 for improved, 0-otherwise)
Farmer's experience	Years	-	Years of keeping cattle
Distance from market	Kilometres	-	Number of kilometres from cattle market
Distance from border	Kilometres	-	Number of kilometres from the border
Farmer's annual income	UGX	+	Total annual income of farmer
Husbandry system	Dummy	+	Livestock husbandry system (1 for fenced grazing, 0-otherwise)
Water source	Dummy	+	Location of water source (1 for on-farm, 0-otherwise)
Mode of grazing	Dummy	+	Mode of grazing different animals (1 for mixed, 0-otherwise)
Cost of vaccination	UGX	-	How much farmers paid for vaccination
Currently paying for vaccination	Dummy	+	If the farmer was already paying for vaccination (1 for yes, 0-otherwise)
Training on disease control	Dummy	+	If the farmer received training on TADs

			control (1 for yes, 0-otherwise)
Bidding price	UGX	-	How much farmers said they would pay for vaccination

3.5 *A priori* expectations

Age was expected to negatively influence the activities one participates in as well as the perception of various issues. Younger farmers were assumed to have relatively high socio-economic status (Randela *et al*., 2000). These farmers were assumed to recognise the importance of maintaining a healthy herd through intensive spraying and vaccination of their animals.

Farmer's income was expected to be positively correlated with willingness to pay, because the more money one has, the less budget constraints they face. Therefore, improved animal health services were viewed as a normal good implying that the respondent's willingness to pay for TADs control rises with income. Farmers would be willing to pay more than 80% of an extra dollar to any experiment /or survey good given the rich set of goods they could spend this money on in the real world (Horowitz and McConnell, 2000).

Education was an important explanatory variable because the level of education determines whether the respondent appreciates the danger of economic loss associated with TADs outbreaks. More educated people better understand the benefits of improved animal health. According to Jimoh *et al*. (2007), households with high level of education should be more aware of the Benefits of disease control and therefore more willing to pay for TADs control. Therefore, education was expected to positively influence farmers' willingness to pay for TADs control.

Number of animals owned was expected to have a positive sign because farmers with many animals would be expected to appreciate the economic loss, environmental and health risks associated with failure to control TADs (Mugasi, 2009). Households with large herds would be expected to have higher willingness to pay for TADs control because they have the potential for more cash earnings from off-taking of cattle hence likely to hold cash balances (Pokou *et al*., 2010).

Type of cattle kept by the farmers was included to account for the differences in responses between farmers with exotic breeds and the local breeds only. Type of cattle kept by the farmer was expected to influence farmers' willingness to pay for TADs control services either negatively or positively depending on the genetic potential of the breed kept (Randela *et al.*, 2000). Exotic (improved) breeds were more susceptible and less tolerant to diseases than the local breeds. Therefore, farmers with exotic breeds were expected to prefer an intensive TADs control programme and would be willing to pay a higher price for the service. This is because farmers with improved breeds were likely to be those with relatively higher socio-economic status and therefore had moved a step towards commercialisation compared to those with local breeds (Pokou *et al*., 2010).

Training on TADs control was expected to have a positive sign because if farmers have been made aware that part of the costs can be met by them, it becomes easier for them to pay for TADs control measures than if they were not trained. Training includes demonstrations about animal husbandry techniques and holding livestock husbandry education together with crop focused extension services (Koma, 2003). As reported by Pokou *et al*. (2010), improved extension services were needed in training programs intended for farmers in regions under disease control.

Household size was expected to influence willingness to pay for TADs control either positively or negatively. This is because a large household was expected to provide family labour that could be used in disease control hence reducing the incidence of disease, thus positively influencing the farmers' willingness to pay for TADs control. However, it was also expected to be negative because a large household constrains the budget and limits money available to meet other household demands. Pokou *et al*. (2010) observed that large households would have greater demand on available money and hence would be less willing to pay money and more willing to contribute labour to the diseases control campaign.

Bidding price was included in this model to act as a measure of affordability, (Mugasi, 2009). It was a reflection of farmers' willingness to pay for TADs control (Frick *et al*., 2003). The price was expected to negatively influence farmers' willingness to pay for TADs control because the higher the price, the less the quantity demanded of that good (Nicholson, 2005).

Farmer's experience was expected to negatively influence farmers' willingness to pay for TADs control. Farmers who had spent more years in herd management were not expected to clearly perceive the benefits of disease control as a public good. Experienced farmers tend to invest less in disease control measures (Pokou *et al*., 2010).

Distance from the nearest border was expected to have a negative relationship with farmers' willingness to pay for TADs control. Farmers far away from the border thought that their animals were safe and could not easily mix with those from other countries to get TADs (FAO and OIE, 2010).

Distance from the nearest cattle market was expected to influence willingness to pay for TADs control negatively. Farmers far away from the live-animal markets thought that their animals were safe and could not easily mix with those from other farms to get TADs. Live-animal markets are obvious mixing points and a potential source of disease spread (FAO and OIE, 2010).

Animal husbandry system, this factor characterizes livestock farmers in western Uganda in regard to the level of risk to TADs. Herding exposes livestock to higher risk of contracting diseases. Herders were expected to spend less on TADs control measures due to fear of their animals getting re-infected having spent a lot of money on them (Pokou *et al*., 2010).

Location of the nearest water source dummy was expected to be positive for those having watering points on their farms. Farmers having watering points on their farms were expected to be risk averse thus having a higher probability of paying for TADs control than those relying on communal watering points (FAO and OIE, 2010).

Mode of grazing different animals was expected to be positive for those practicing mixed grazing than those grazing different animals separately. Those practicing mixed grazing were expected to have a higher willingness to pay for TADs control because their animals would be at risk in situations of high disease incidence. They would fear different animals catching disease and spreading it to others (Mugasi, 2009).

Cost of vaccination was expected to negatively influence farmers' willingness to pay for TADs control. Although vaccination reduces pressure of disease in a given area, farmers were expected not to pay for it if the cost went so high. As reported by FAO and OIE (2010), vaccination reduces the pressure of pathogens, shedding and disease pressure in the region.

The variable if the farmer was already paying for vaccination dummy was expected to be positive for farmers already paying for vaccination of their animals. Vaccination is the immunisation of susceptible animals through the administration of a vaccine comprising antigens appropriate to the disease to be controlled. Farmers who were already paying for service had possibly seen the benefits of vaccination in preventing diseases thus were likely to have a higher willingness to pay for TADs control. Vaccination of livestock for TADs has been suggested as a mitigation measure to reduce the clinical impact of these diseases and potentially to reduce shedding in animals (FAO and OIE, 2010). A farmer who decides to protect his herd against a particular disease by vaccinating or adopting strict bio-security measures (spraying, hygiene, quarantine, for example) would create a positive externality, in that his action would benefit other farmers by lowering the infection pressure (risk of occurrence of the disease). In contrast, a farmer could be encouraged to behave as a free rider seeking to benefit from the efforts of his neighbours, without bearing the costs. This behaviour would generate a negative externality since this behaviour would help to maintain the disease within the geographic area considered.

This results in strong interrelationships of individual decisions to control animal disease at the area level (Bennett and Ijpelaar, 2003).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Characterisation of Sampled Agro-pastoralists

A number of socio-economic characteristics hypothesized to influence farmers' decisions on Transboundary Animal Diseases (TADs) control are summarized and discussed in this section. They include farmer's characteristics such as age, experience and education, household size and number of cattle owned. Survey responses were obtained from 176 farmers. These farmers were from five sub-counties of Kakuuto and Kibanda in Rakai district; and Rubaare, Ngoma and Rukoni in Ntungamo district.

The mean farming experience was 25 years with average land under farming as 37.6 ha. Tables 4.1-4.3 summarize some of the descriptive statistics for the interviewed farmers. Average household size was 10 people. Over 30% of farmers hired laborers to work on their farms. However, payment for this labor took on many forms including payment in kind (live animals, part of farm produce), cash or exchange of labor.

Farmers were classified as “willing to pay for TADs control” and “not willing to pay” farmers basing on their socio-demographic and socio-economic characteristics as indicated in Tables 4.1 and 4.2. They were also classified basing on the enterprises they owned (Table 4.3). “Willing to pay” farmers were those who gave a yes response when asked if they would pay for TADs control in case there was an outbreak in their area while “Not willing to pay” farmers were those who gave a no response. Sixty percent of the farmers were willing to pay for TADs control while 40% were not willing to pay for the exercise.

Comparing household size for farmers willing to pay for TADs control with those not willing to pay, those not willing to pay had more people in the household than those who were willing to pay for TADs control (Table 4.1). This was significant at 5%. This was expected because a large household constrains the budget and limits money available to meet other household needs. This is similar to Pokou *et al*. (2010) who found that larger households have greater demand on available money and hence less willing to pay money to control diseases.

Table 4.1: Continuous socio-demographic and socio-economic characteristics of the sample of farmers in Ntungamo and Rakai districts

Variable	Total (n = 176)		WTP (n = 106)		Not-WTP (n = 70)		t - value	P-Value
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.		
Farmer's age (years)	48.74	13.44	48.25	13.81	49.49	12.92	0.53	0.59
Farmer's annual income ('000' UGX)	8,021	9,563	9,682	10,540	5,471	7,032	-2.937	0.004
Household size	9.56	4.116	9.05	3.748	10.33	4.539	2.009	0.046
Farmer's experience (years)	25.81	12.309	25.13	12.737	26.84	11.644	0.864	0.389
Number of Cattle	62.97	63.726	57.57	45.547	71.16	83.844	1.422	0.157
Farmer's education (years)	5.56	4.625	5.93	4.961	4.99	4.031	-1.305	0.194
Land (ha)	37.73	46.733	37.012	44.584	38.824	50.122	0.122	0.304

Farmer's annual income was significant at 1%, with farmers who were willing to pay for TADs control having more income than those not willing to pay (Table 4.1). This is because the more money one has, the less the budget constraints they face. Therefore, payment for disease control is viewed as a normal good implying that the respondent's willingness to pay for disease control rises with income. Similarly, Regmi and Gehlhar (2005) and Ngigi *et al*. (2010) found that income level of individuals increases their demand for credence attributes such as environmental friendliness, safety, hygiene and ethics involved in the production and marketing process.

The other socio-economic and socio-demographic parameters (farmer's age, farmer's experience, number of cattle owned, education level of the farmer and total land used for farming) were not significantly different among agro-pastoralists willing to pay for TADs control and those not willing to pay. Results show that the average number of cattle owned was 63 animals per farmer (Table 4.1). Those not willing to pay for TADs control had more cattle than those who were willing to pay.

Education levels in the study area were quite low. The average number of years of education of the farmers was 6 years, which corresponds to primary level education (Table 4.1). Only 5% of the farmers proceeded to tertiary institutions while 24% of them never went to school at all.

Age was also an important consideration in livestock production because it had an implication on labour productivity on the farm. The farmers who were interviewed were found in the age range of 23 to 92 years, with a mean age of 48.7 years (Table 4.1). The mean age of those willing to pay for TADs control (49 years) was greater than that of those not willing to pay (48 years).

All sampled farmers reared cattle on land ranging from 0.8 ha to 266 ha. The average land size owned by farmers was 37.7 ha (Table 4.1). The main uses of land were livestock and crop production. Land is an important factor of production on which agriculture largely depends. Those willing to pay for TADs control had less land (37.0 ha) put to farming compared to those not willing to pay (38.8 ha).

Table 4.2 shows that significant differences (5%) also existed between marital status of those willing to pay for TADs control and those not willing to pay. There were more married farmers not willing to pay for TADs control (91%) than those willing to pay (86%) (Table 4.2). Married persons had larger demand on the available resources hence less willing to pay for TADs control. Similar findings were reported by Pokou *et al*. (2010) that those who were married had a lower willingness to pay for TADs control because they had greater demand on the limited available resources. On the other hand, marriage provides additional farm labor for the farmers (Oladele and Oladele, 2011).

Another factor to consider was who makes management decisions in livestock production (significant at 10%). Table 4.2 shows that management decisions for both goats and cattle were mainly influenced by the husband. Among those willing to pay, there were more husbands influencing management decisions than wives. This was expected because most of the households were headed by men who owned most of the land needed for livestock farming. This finding is in line with that of Gbetibouo *et al.* (2010) that women have less access to critical resources such as land, cash and labour which often determines their ability to carry out labour intensive agricultural innovations.

Other parameters (sex of the farmer, main occupation and type of cattle owned) were not significantly different among agro-pastoralists willing to pay for TADs control and those not willing to pay. Table 4.2 shows that majority (94%) of the agro-pastoralists were males. There were more men (95%) willing to pay for TADs control than those not willing to pay (93%).

Sixty nine percent of the farmers had some improved breeds of cattle while 31% owned only local breeds (Table 4.2).

Table 4.2: Categorical socio-demographic and socio-economic characteristics of Farmers in Ntungamo and Rakai districts

Variable		Total (n=176) (%)	WTP (%)	NotWTP (%)	Chi-Square	P-Value
Sex of farmer	Male	94.3	95.3	92.8	0.46	0.52
	Female	5.7	4.7	7.2		
Marital Status	Married	88.1	85.8	91.3	9.12	0.03
	Separated /divorced	1.7	0	4.3		
	Single	5.7	8.5	1.4		
	Widowed	4.5	5.7	2.9		
Farmer's main occupation	Farming	94.3	95.3	92.8	0.46	0.79
	Business	4.5	3.8	5.8		
	Employment	1.1	0.9	1.4		
Cattle management	Husband	58.5	63.2	52.2	8.43	0.08
	Wife	5.1	3.8	7.2		
	Both husband and wife	33	27.4	40.6		
	Children	0.6	0.9	0.0		
	Family	2.8	4.7	0.0		
Cattle type	Local cattle only	31.2	30.2	32.9	0.14	0.74
	Some improved cattle	68.8	69.8	67.1		
Goat management	Husband	25.6	31.1	17.4	7.78	0.17
	Wife	15.9	12.3	21.7		
	Both husband and wife	30.7	27.4	36.2		
	Children	0.6	0.9	0.0		
	Family	0.6	0.9	0.0		

Another characteristic that was looked at was the type of farming that was practiced in the study area. Results of the study show that 94% of the people who were interviewed were agro-pastoralists (Table 4.2). These agro-pastoralistss had a wide range of enterprises including livestock such as cattle, goats, sheep and poultry, and crops. Crops which represented the highest percentage included bananas (matooke), groundnuts, cassava, maize, beans, sweet and irish potatoes (Table 4.3).

Table 4.3: Common crops/ livestock in Ntungamo and Rakai districts

Crop/ Livestock	**Percentage of farmers (n = 176)**		
	WTP	**Not WTP**	**Total**
Livestock			
Goat	43.2	28.4	71.6
Sheep	16.5	26.1	42.6
Poultry	34.1	14.2	48.3
Piggery	1.7	0.6	2.3
Duck	1.7	0.0	1.7
Crop			
Maize	51.7	35.8	87.5
Bean	54.6	35.8	90.3
Banana	56.8	36.9	93.8
Sweet potato	28.4	14.8	43.2
Irish potato	10.8	8.5	19.3
Cassava	44.9	30.1	75.0
Groundnuts	15.9	12.5	28.4
Coffee	4.6	7.4	11.9
Sorghum	5.7	2.8	8.5
Tomato	4.0	1.7	5.7
Fruit	9.1	2.3	11.4
Vegetable	5.7	1.1	6.8

Farmers had a variety of income sources including livestock such as cattle, goats, sheep, poultry and piggery, coffee, crop harvests, salary, remittance and business. Cattle were the most important source of income to most of the farmers with an average income of UGX 5,820,604 (USD 2,328) annually followed by business and crop harvests (Table 4.4). Most of the famers (irrespective of whether they were willing to pay for TADs control or not) obtained their income from livestock, so income was looked at as an indicator of the importance of livestock to farmers. The results show that majority of farmers (77%) earned income from livestock in the range of UGX (100,000 – 1,000,000) per annum, with few of them earning more than UGX 2 million from livestock annually. However, there were wide variations in the income farmers received as predicted by the standard deviations. The variations were attributed to inequalities that existed among farmers.

Table 4.4: Common sources of income for the farmers in Ntungamo and Rakai Districts in 000's UGX (n=176)

Income source	Minimum	Maximum	Mean	Std. Deviation
Coffee	150	750	475	260
Cattle	200	40,000	5,820	6,865
Crop harvests	40	60,000	1,588	5,386
Goats	50	6,000	564	890
Salary	300	3,600	2,220	1,140
Piggery	160	400	255	117
Poultry	10	1,200	272	342
Remittances	200	3,480	966	1,150
Sheep	50	7,500	437	1,150
Shop /business	50	10,800	678	2,845

The low annual income earned by majority (77%) of the farmers from livestock can be largely attributed to two reasons, namely; the small herd sizes and the low productivity of cattle due to several factors including diseases such as foot and mouth disease and east coast fever, poor feeding, and low genetic potential (Mugasi, 2009). These findings corroborate reports that households that keep livestock in developing countries obtain between two and 24% of their income from this activity, with the average of 12% (Pica-Ciamarra *et al*., 2011). In pastoral areas of East Africa a minimum herd size of two cattle or more per family was estimated to be necessary for households to make a living above the poverty threshold if they relied exclusively on livestock farming (Lybbert *et al*., 2004). In the Andean highlands, according to the International Alpaca Association, 2,000 heads was the minimum herd size needed for alpaca rearing to be commercially viable (ECLAC, 2004).

Nevertheless, even if for most households livestock were not the main source of income, they were still important complements to other sources of income (for example, draught animals for crops) and / or provided income at critical times of the year. Ellis *et al*. (2003) found that in Zomba district of Malawi, livestock contributed less than 5.3% to the income of households in the top income quartile, and 7.1 and 7.5% to the income of households in the first two quartiles. Akter *et al*. (2007) showed that in the Indian State of Andhra Pradesh, livestock contributed over 25% to the income of the poorest quintiles and only 7% to the income of the richest ones.

4.2 History of disease attacks in Ntungamo and Rakai districts

Animal diseases are a permanent threat to agro-pastoralists (Otte *et al*., 2004). Based on Focus Group Discussions (FGDs) with the farmers, they each reported at least one outbreak of TADs in their villages in the past. However, farmers reported that the situation of TADs had improved markedly in recent years particularly in Ntungamo district. In Rakai district, farmers reported that the diseases remained endemic and at a high prevalence. The disease outbreaks with economic significance to farmers were East Coast fever, Foot and mouth disease, Trypanosomiasis (nagana) and lumpy skin disease (Table 4.5).

Table 4.5: Major causes of cattle death mentioned by farmers in Ntungamo and Rakai Districts

Cattle category	Major cause of death	Percentage of farmers (n = 176)
Calves	East Coast Fever (ECF)	85.8
	Foot and mouth disease (FMD)	5.7
	Neonatal diarrhoea	2.3
Cows	East Coast Fever	37.5
	Foot and mouth disease	28.4
	Nagana	7.4
Bulls	East Coast Fever	36.4
	Foot and mouth disease	30.7
	Nagana	9.1
	Lumpy skin disease	5.7

For calves, the most commonly mentioned disease was East Coast Fever. For cows, East Coast Fever and Foot and Mouth Disease were the most commonly mentioned diseases while for bulls, farmers mentioned Nagana and Lumpy skin disease in addition to East Coast Fever and Foot and Mouth Disease as the commonest diseases (Table 4.5). Discussions with veterinary officers showed that goats, sheep and pigs were susceptible to FMD yet they were not vaccinated during FMD outbreaks due to the high cost and scarcity of the vaccine, plus the restricted nature of their movements as compared to cattle. However, they could pose as a disease reservoir.

The most serious livestock diseases reported by agro-pastoralists during the survey were summarized in Table 4.6. Forty eight percent of the agro-pastoralists said East Coast Fever was the most serious disease followed by Foot and Mouth Disease (29.5%) (Table 4.6). Lumpy skin disease, Nagana and heart water were the least serious diseases. These findings were consistent with those of FAO (2009) on the Tanzania-Uganda interface ecosystem to the west of Lake Victoria that the frequently mentioned disease problems were East Coast Fever, Contagious Bovine Pleuropneumonia, Foot and Mouth Disease and worms.

Table 4.6: Degree of seriousness of disease in Ntungamo and Rakai districts (n =176)

	Percentage of farmers	
Disease	**Most serious**	**Least serious**
East Coast Fever	48.3	3.4
Foot and Mouth Disease	29.5	40.9
Lumpy Skin Disease	4.8	90.3
Nagana	12.0	76.1
Heart water	4.0	92.0

East Coast Fever (ECF) is a non-contagious, febrile disease accounting for the greatest loss of cattle in Ntungamo and Rakai districts. Reports by the district Veterinary Officers indicate that East Coast Fever occurs in the districts in both enzootic and epizootic forms and is characterized by high mortality rates. During the survey, farmers reported that they were aware that the disease is spread by ticks, that it affects cattle of all ages and that it leads to mortality if infected animals are not treated at an early stage. The disease is controlled by weekly spraying of infected animals using spray races and hand spray pumps. According to FAO (2009), effective control of ticks is necessary for the control of the disease but this requires a combination of methods rather than dependence on one method, whether based on chemicals, physical removal of ticks from animals, or burning of grass to destroy the ticks and their habitats.

Another disease that was reported by farmers in Ntungamo and Rakai districts was foot and mouth disease (FMD), locally known as *Kalusu /Ruhaha*. This was an extremely acute and highly contagious disease affecting cloven-foot animals, including cattle, sheep, goats and pigs. The disease is endemic in most parts of East Africa (Vosloo *et al*., 2005). In the two districts, more than 30% of farmers indicated that they had experienced foot and mouth disease among their livestock mainly cattle. The disease was mostly spread through direct contact between animals (Vosloo *et al*., 2005). Epidemiological studies have shown that transmission can also be air-borne (viral spores could be carried by wind up to 100 km) provided other optimal conditions such as humidity. Infection spread through the animal's milk and the survival of the disease in the tissue of animals slaughtered for meat have also been reported (Robertson, 1976).

Farmers reported that they were aware of how the disease is spread. They were also very certain about the seasonal occurrence of the disease mentioning that it erupts mainly during the dry season. Frequently, dry seasons are characterized by acute shortages of good pastures and water which make cattle keepers wander with their animals in search for water and pasture (FAO, 2009). Hundreds of animals congregate in the few available green patches of land commonly around permanent sources of water or pools of brackish water. Sometimes this source is shared with human beings, as a source of water for drinking, bathing, washing clothes and dishes.

The other factor which farmers mentioned that spreads foot and mouth disease was livestock markets. When animals are taken to the market, they are driven there in a large group even though the farmer's desire is to sell only a few animals. At the markets, different herds would mix freely. The unsold animals are taken back home and often they bring new diseases with them.

According to the district Veterinary Officers, foot and mouth disease was controlled in the areas through vaccinations and quarantines. These measures, however, had not been applied at a level necessary to limit transmission and maintain the disease especially in Rakai. The veterinary officer in Rakai district (Kakuuto sub-county) reported that less than 50 percent of the cattle in the region are vaccinated annually.

During focus group discussions some cattle keepers stated that they do not vaccinate their animals against FMD because of the ineffectiveness of the vaccines used. This is possible because as pointed out by Vosloo *et al.* (2005), foot and mouth disease in East Africa occurs in six serotypes, namely: O, A, C and SAT types 1, 2 and 3, thus complicating the epidemiology and the effectiveness of vaccinations against FMD. Furthermore, it was frequently mentioned by the farmers that lack of effectiveness of vaccination measures was due to the high cost of vaccines and delayed or irregular vaccination regimes.

Farmers who paid for vaccination stated that it cost them approximately UGX 500 (USD 0.25) per animal. However, quite a number complained about the high cost of vaccination, especially the owners of large herds. As a result, they tended to hide some of the animals to avoid them from being vaccinated and brought them back after the vaccination campaign was over. This supports findings of FAO (2009) that farmers with large herds of cattle hid some of their animals to avoid being vaccinated by moving them across the border into Uganda or Rwanda and brought them back after the vaccination campaign was over.

An additional dimension was the livestock-wildlife interaction in areas where game reserves were located. For example in Lake Mburo National park, some FMD serotypes had been isolated in wild animals. In this context, there could have been active recombination between the FMD viruses carried by livestock and those that were carried by wild animals.

4.3 Benefits and costs of controlling TADs

The total costs of TADs control per animal per year were obtained by adding the annual cost of the drugs, annual cost of administering drugs and annual vaccination costs. The number of times drugs were administered differs for the different types of drugs as recommended by the manufacturers and was mainly determined by the disease (tick) infestation in the area. The study focused on the spray products (acaricides) used in Uganda (Table 4.7). Given that the study area was vulnerable to TADs, the number of treatments was based on the rates recommended for such areas. The number of treatments and dose /dilution of the chemical in turn determined the quantity of the drug administered per animal per year. The dose for the spray chemical had two aspects, the dilution factor and the amount of diluted chemical administered per animal.

Table 4.7: Recommended application rates for sprays against ticks

Spray	Packaging (mls)	Dose/ dilution	No. of treatments per year	Quantity of chemical administered per animal per year (mls)
Decatix	50	1 ml/ L of water	22	50
Renegade	100	1 ml/ L of water	40	100
Cooperthion	100	1 ml/ L of water	40	100

Number of treatments based on high tick challenge.
Source: Agro-vet shops

The total cost of application for the different insecticide sprays was obtained by multiplying the number of packets of sprays per animal per year by the cost per packet (Table 4.8). The number of packets per animal per year was derived from the quantity applied per animal per year divided by the packaging for a given spray.

Table 4.8: Cost of application for different insecticide spray products

Spray	Quantity applied per animal per year (mls)	Packaging (mls)	Equivalent no. of packets	Cost per packet (UGX)	Total cost per head of cattle (UGX)
Decatix	50	10	5	2,500	12,500
Renegade	100	250	0.4	21,000	8,400
Cooperthion	100	200	0.5	6,000	3,000

Source: Agro-vet shops

The annual cost of spray was derived from multiplying the cost of spray per animal per treatment by the number of treatments per animal per year (Table 4.9). Price was the average of the market prices for the year 2011, as obtained from several agro-vet shops.

Table 4.9: Derived costs of sprays (UGX) per animal per year

Spray	Cost of spray per treatment	No. of treatments per year	Cost of spray per year
Decatix	568	22	12,500
Renegade	210	40	8,400
Cooperthion	75	40	3,000

Source: Agro-vet shops

In addition to purchasing insecticides, farmers incurred costs of administering treatment. The major costs considered here were mainly the labor costs and the cost of treatment. The annual labor costs were derived basing on the market price of labor at the time of the survey. Labor was needed for pumping the chemical, spraying the animals and fetching of water (water was assumed to be obtained free of charge in rural areas). In terms of man power, farmers reported that 10 people were required to carry out treatment of a herd of 1,000 cattle, with an average wage rate of UGX 3,000 per day for rural areas (based on survey data) and an average of 30 spray treatments per year. The total cost of labor per year per cattle was estimated to be UGX 900. Farmers reported that they incurred an average cost of UGX 20,000 on only treating each affected animal annually.

According to the district veterinary officers in Rakai and Ntungamo districts, the cost price per FMD dose was about five united states dollars excluding transport and cold-chain costs (USD 1 = UGX 2,500)[1]. However, each farmer was asked to contribute only UGX 500 (USD 0.25) per head of cattle vaccinated as cost sharing. This compares remarkably well to the price of the commercial FMD vaccine of USD 1.00 by (FAO, 1997).

Farmers reported three common insecticide sprays which they used most. Since all insecticides sprays were purchased at different prices, the average cost of the three was computed and it is what was used in the study. Therefore, the average total annual cost of control by spraying (with different insecticide sprays) computed in this study was UGX 8,867 (USD 3.6) per animal. This is comparable to the figure estimated by Mukhebi and Perry (1993) in their study on the economic implications of the control of east coast fever in eastern, central and southern Africa where annual costs of acaricides ranged from USD 2 to USD 20 per animal to farmers who were financially responsible for the purchase of these drugs.

1. USD 1 = UGX 2,500 [average exchange rate for July, 2011][1]

Table 4.10: The annual costs per animal for the control of TADs (UGX)

Spray/ treatment	Annual cost of spray per animal	Annual cost of admin. Drugs per animal	Total annual cost of spraying	Average total annual cost of spraying	Total annual TADs control costs per animal
Decatix	12,500	900	13,400	8,867	29,367
Renegade	8,400	900	9,300		
Cooperthion	3,000	900	3,900		
Annual vaccination cost				500	
Annual treatment cost				20,000	

For all the farmers in the sample, their cattle were sprayed, vaccinated and treated for TADs control at an average cost of UGX 29,367 per animal annually (Table 4.10). The computed costs were compared with the benefits of transboundary animal disease control. Avoided losses due to Foot and Mouth Disease and East Coast Fever control were estimated as the difference between the value of output produced without disease and that produced with presence of disease in a given year. Total avoided losses due to FMD vaccination were estimated at 35% higher from beef and 76% from milk than if TADs were not controlled. The avoided physical losses were assigned appropriate economic values based on the average annual farm gate prices of the respective products. For the 176 farmers in the sample, the total annual avoided losses per animal per farmer were 64% higher if TADs were controlled than if they were not controlled.

Table 4.11: Annual avoided Losses due to Foot and mouth disease and East coast fever in Ntungamo and Rakai districts

				Value of output ('000 UGX)		
Product	**With TADs**	**No TADs**	**Avoided losses**	**With TADs**	**No TADs**	**Avoided losses**
Weight per live animal (Kg)	182	223	41	728	1,115	387
Quantity of Milk (L)	2,040	8,880	6,840	714	2,930	2,216
Total				**1,442**	**4,045**	**2,603**
Value Per animal						**41.3**

Since the average number of cattle owned per farmer was 63 animals, the average avoided losses (benefits) per animal per year were UGX 41,300 (USD 16.5) (Table 4.11). In other words, controlling TADs would yield benefits amounting to UGX 41,300 (USD 16.5) per animal annually. These findings are comparable to those of Singh *et al*. (2007) where the benefits derived by livestock owners as a result of vaccinating their animals against FMD were USD 9.87-14.76 per animal per lactation, while the cost incurred by a farmer to treat FMD affected buffaloes was USD 19.49 per animal (Mahajan and Rautmare, 2005).

The standard indicator of benefit cost ratio (BCR) was used as a measure of the value of TADs (FMD and ECF) control. The benefit cost ratio of TADs control was 1.41. The calculated benefit cost ratio indicates that TADs (FMD and ECF) control was economically profitable for the two districts. The benefit cost ratio of 1.4 implies that each Uganda shilling invested in TADs control yielded a return of UGX 1.4. This ratio indicates that TADs control yielded higher benefits compared to costs. This therefore suggests that the null hypothesis that the net benefits of controlling TADs were significantly different from zero could not be rejected.

4.4 Willingness to pay (WTP) for TADs control in Ntungamo and Rakai districts

This study also investigated the factors that influenced willingness to pay for transboundary animal disease control. A number of socio-demographic and socio-economic factors including farmer's characteristics such as age, education level, annual income, and household size, distance from the border, and type of cattle kept influenced willingness to pay for TADs control. A slightly higher willingness to pay for TADs control was expected because animal husbandry is a profitable venture (Tambi *et al.*, 1999) as the animals and their products are sold by farmers to buy other basic needs especially food. Each of the animals has a specified value that is considered as an asset among farmers. In addition, Nenghanjwa (2005) reported that livestock is the mainstay of the pastoral people providing food security in harsh conditions under which they live and is one of the few assets available to the poor to bring them successfully to the cash economy.

4.4.1 Bidding price and reasons for unwillingness to pay for TADs control

How much a person is willing to pay depends on the perceived economic value and on the utility of the good (Breidert, 2005). If a person believes that there is no alternative offering, the highest amount of money he or she is willing to pay equals the utility of the good and is the reservation price. The majority of the farmers (60%) were prepared to pay for TADs control through contributing towards vaccination. Results show that bidding price ranged from UGX 500 to 25,000. Thirty percent of the farmers were willing to pay UGX 500 to 4,500 and only 3.4%were willing to pay UGX 15,000 to 19,500 (Table 4.12). The results are comparable to those of Mwaura *et al*. (2010) that about 35% and 40% of the farmers were respectively willing to pay an average of UGX 3,400 and 3,700 for extension services in crop and animal husbandry.

Table 4.12: Amount farmers were willing to pay for TADs control in Ntungamo and Rakai districts

Amount (UGX)	Percent of farmers (n = 108)
500 – 4,500	29.6
5,000 – 9,500	17.6
10,000 – 14,500	26.1
15,000 – 19,500	3.4
20,000 – 25,000	23.3
500	Median
5276	Mean
8110	Standard deviation

Due to the inequalities that existed among farmers, there were wide variations in the amounts they were willing to pay as predicted by the standard deviation of UGX 8,110 (Table 4.12). Generally, the median indicates that majority of the farmers were willing to pay a small amount of money (UGX ≤500) to control TADs due to low income (Table 4.12). The mean willingness to pay was UGX 5,276 while the median was UGX 500 (Table 4.12). The median is very far from the mean implying that there were usually high and low bids among farmers in the study area.

The socio-economic characteristics of the farmers who bid below and above the median bid are shown in Tables 4.13 and 4.14. Variables with statistical significance were farmer's annual income and marital status. As expected, farmer's annual income was significant at 1%, with farmers who were willing to pay above the median bid having more income than those who were bidding below the median (Table 4.13). This is because those who bid above the median had higher disposable income and therefore were willing to pay a higher price. These findings are consistent with those of Tessendorf (2007) on estimating the willingness to pay for restoring indigenous vegetation at selected sites in South Africa.

Table 4.13: Continuous socio-demographic and socio-economic characteristics of farmers above and below the median willingness to pay for TADs control

Variable	Bid above median (n = 71)		Bid below median (n = 69)		t - value	Sig. level
	Mean	Std. Dev.	Mean	Std. Dev.		
Farmer's age (years)	47.97	13.87	49.28	12.99	0.57	0.57
Farmer's income ('000 UGX)	13,000	12,000	5,500	7,071.78	-2.88	0.005
Household size (number)	9.41	3.66	10.16	4.41	1.09	0.274
Farmer's experience (years)	24.68	12.57	26.38	11.94	0.82	0.413
Number of cattle	59.45	46.29	71.74	84.28	1.07	0.29
Farmer's education (years)	6.10	5.09	4.90	4.09	-1.53	0.127

Significant differences at 5% also exist between marital status of those willing to pay a price that was above the median and those whose willingness to pay price was less than the median bid (Table 4.14). There were more married farmers not willing to pay a price that was above the median (91%) than those willing to pay a price that was greater than the median (85%). As noted earlier, married persons had larger demand on the available resources hence less willing to pay for TADs control. Those who were married had a lower willingness to pay for TADs control because they had greater demand on the limited available resources (Pokou *et al*., 2010).

Table 4.14: Categorical socio-demographic and socio-economic characteristics of farmers above and below the median willingness to pay for TADs control

Variable		% Total (n = 140)	% Bid above median (n = 71)	% Bid below median (n = 69)	Chi-Square	Sig. level
Sex of farmer	Male	95.0	97.2	92.8	0.27	0.21
	Female	5.0	2.8	7.2		
Marital status of farmer	Married	87.9	84.5	91.3	8.69	0.03
	Separated /divorced	2.1	0.0	4.3		
	Single	6.4	11.3	1.4		
	Widowed	3.6	4.2	2.9		
Farmer's main occupation	Farming	93.6	94.4	92.8	1.04	0.59
	Business	5.7	5.6	5.8		
	Employment	0.7	0.0	1.4		
Cattle type kept by farmer	Local cattle only	30.0	26.8	33.3	0.72	0.46
	Some improved cattle	70.0	73.2	66.7		

Although majority of the farmers (60%) were willing to pay for TADs control, some farmers were not willing to pay anything to control TADs. Those not willing to pay said it was costly, others said it was a government’s responsibility to carryout vaccination in case there were TADs outbreaks (Table 4.15). The other reason for not willing to pay for TADs control was inability to afford the levy. These findings are similar to those in a study by Tessendorf (2007) on estimating the willingness to pay for restoring indigenous vegetation at selected sites in South Africa.

Table 4.15: Reasons for not willing to pay for TADs control

Reason	**Percent of farmers (n = 68)**
Costly	42.7
Government’s responsibility	57.4
Total	100.0

4.4.2 Factors influencing farmers’ willingness to pay for TADs control

To determine the factors that influenced farmers’ willingness to pay for TADs control, a Logit regression model was used. Results of the model are presented in Table 4.15.

Table 4.16: Logit model estimates of factors influencing farmers’ willingness to Pay for TADs control

Willingness to pay (Dependent variable)	Coefficient	P-Value	Odds ratio	Marginal effect
Household size	-0. 112	0.019	0.894	-0.025
Farmer’s age squared	0.0001	0.672	1.000	0.000
Farmer’s education level	-0.046	0.342	0.955	-0.010
Number of cattle owned	-0.007	0.059	0.994	-0.002
Cattle type	-0.339	0.507	0.712	-0.075
Farmer’s experience	-0.027	0.439	0.974	-0.006
Distance from market	0.043	0.124	1.043	0.009
Distance from border	0.007	0.608	1.007	0.002
Farmer’s annual income	0.531	0.023	1.701	0.120
Husbandry system	-0.139	0.793	0.870	-0.032
Location of water source	0.649	0.201	1.914	0.148

Mode of grazing	0.002	0.996	1.002	0.000
Cost of vaccination	-0.001	0.135	0.999	-0.000
Currently paying for vaccination	0.961	0.042	2.614	0.211
Training on disease control	1.332	0.012	3.788	0.263
Bidding price	-0.00003	0.131	0.999	-0.000
constant	-5.967	0.090		
Logistic regression		Number of observations = 168		
		LR chi2(16) = 44.83		
		Prob > chi2 = 0.0001		
Log likelihood = -89.701025		Pseudo R2 = 0.1999		

Table 4.17: Classification table (goodness of fit tests)

	TRUE		
Classification	D	~D	Total
+	96	1	97
-	7	65	72
Total	103	66	169
	Correctly Classified		95. 3%

Variables that were significant were; household size, number of animals owned, farmer’s annual income, payment for vaccination and training on animal disease control.

The coefficient of farmer’s annual income was positive and significant at 5%. This suggests that the odds of willingness to pay for TADs control increases by a factor of 1.7 when farmer’s annual income increases by one unit. The marginal effect of 0.120 suggests that for a unit increase in farmer’s annual income, the odds of paying for TADs control increases by about 12%. This is because the more disposable income one has, the less budget constraints they face.

Therefore, as expected, TADs control services were viewed as a normal good. Thus, farmers' willingness to pay for these services increased with increasing farmers' annual income. This is in line with the findings by Tessendorf (2007) who found that higher incomes increased the willingness to pay for restoring indigenous vegetation in South Africa. The finding is also consistent with those of past studies that indicate that income level of individuals increases their consumption behaviour especially the demand for credence attributes such as environmental friendliness, safety, hygiene and ethics involved in the production and marketing process (Regmi and Gehlhar, 2005; Ngigi *et al*., 2010).

The number of cattle owned by the farmer was negatively related to willingness to pay for TADs control and significant at 10%. Contrary to what was expected, owning many animals reduced the probability of farmers' willingness to contribute towards TADs control and / or seeking treatment for their cattle. The odds of willingness to pay for TADs control decreases by a factor of 0.99 when the number of cattle owned by the farmer is increased by one unit. The marginal effect of -0.002 suggests that for every unit increase in the number of cattle owned, the log odds of paying for TADs control decreases by about 0.2%. This is plausible as the farmers reported that the more animals they owned, the more costly the animal health services were and therefore a lower probability of paying for TADs control. According to the farmers, veterinary services were very expensive. On the other hand, farmers with fewer animals had a higher probability of paying for TADs control because they were risk averse and they feared losing even the few animals they had. This result supports that by Koma (2003) who found that herders' willingness to seek for animal health services dropped with increasing expected financial cost of the services because at high costs the services became less attractive and difficult to attain.

Household size had a negative coefficient and was significant at 5%. When household size is increased by one person, the odds of willingness to pay for TADs control decreases by a factor of 0.9. The marginal effect of -0.025 implies that for a unit increase in household size, the log odds of paying for TADs control reduces by about 2.5%. The probability of paying for TADs control was therefore lower for farmers with a relatively large number of people in their households. This was expected because a large number of people in the household constrains the budget and makes it difficult to meet household demands. Pokou *et al*. (2010) confirmed this as they noted that larger households have greater demand on available money and hence less willing to contribute money and more willing to contribute labour to the diseases control campaign.

If a farmer was already paying for vaccination dummy was positive and significant at 5%. The odds of willingness to pay for TADs control increases by a factor of 2.6 if the farmer is already paying for vaccination. These farmers had perhaps already recognised the importance of having a healthy herd through disease and vector control. Therefore, the probability of their willingness to pay for TADs control was higher than that of farmers who were not paying for vaccination. This is in line with FAO (2010) that vaccination stops disease from spreading.

Training in control of livestock diseases dummy positively influenced willingness to pay for TADs control and was significant at 5%. Thus, if the farmer has attained some training on disease control, the odds of willingness to pay for TADs control increases by a factor of 3.8. Trained farmers tend to be more conversant with improved animal husbandry methods and generally recognise the importance of having a healthy herd through disease and vector control. For such farmers, the willingness to pay for animal health services was higher compared to those who had not been trained on control of livestock diseases. Similarly, Koma (2003) in a study on

Africa's changing markets for health and veterinary services observed that during training farmers learn basic information on common livestock diseases and their control, and management techniques such as bovine castration and deworming. The author further noted that after training, farmers were more likely to request the assistance of veterinary livestock technicians hence more willing to pay for disease control.

Although farmers' age, distance from the border, distance from the market, location of water source and mode of grazing were not significant, they had a positive relationship with willingness to pay for TADs control (Table 4.16). Variables such as farmer's education, type of cattle kept, farmer's experience, animal husbandry system, cost of vaccination and the bidding price were also not significant and had a negative relationship with willingness to pay for TADs control.

Age of the farmer positively affects farmers' willingness to pay for TADs control. A unit increase in farmer's age increases the odds of willingness to pay for TADs control by a factor of 1.0. As farmers get older, they learn more about the importance of maintaining a healthy herd through intensive spraying and vaccination of their animals and as such their willingness to pay for TADs control was higher than that of young farmers. The eagerness for information coupled by the socio-economic characteristics of the older farmers increased their probability to pay for improved animal health services. These results are comparable with those of Goldsmith *et al*. (2004) that older people were likely to have more avenues for information and have more disposable income than the young farmers. Goldsmith *et al*. (2004) noted that the young unprofessional people initially engage in agriculture as an economic activity and after acquiring capital they shift to business while pursuing commercialization of their farming activities.

Contrary to what was expected, type of cattle kept by the farmer had a negative but non significant influence on farmers' willingness to pay for TADs control. The probability of paying for TADs control was lower among farmers with improved breeds than those with local breeds only. The odds of willingness to pay for TADs control decreases by a factor of 0.7 when the farmer owns some improved cattle than locals only. The marginal effect of -0.075 suggests that when a farmer owns some improved cattle, the log odds of paying for TADs control decreases by about 7.5%. This could be attributed to the communal grazing complexities where a farmer might unintentionally end-up with improved breeds as a result of his/her cattle (local) mating with the exotic bulls of other farmers usually of a relatively high socio-economic status (Randela *et al*., 2000). In addition, farmers with more disease tolerant cattle in their herds spend less on drugs and are likely to hold positive cash balances (Pokou *et al*., 2010) hence more willing to pay for disease control.

As predicted, the bidding price had a negative influence on willingness to pay for TADs control. For every unit increase in the bidding price, the odds of willingness to pay for TADs control reduces by a factor of 0.99. Since it is a measure of affordability, a higher bidding price constrains the budget and limits money available to meet other household needs. This is consistent with the demand theory that the higher the price, the less the quantity demanded of that good (Nicholson, 2005).

Farming experience had a negative but non significant influence on willingness to pay for TADs control. This implies that the odds of paying for TADs control reduces by a factor of 0.97 when farming experience increases by one unit. These farmers tend to use their own knowledge in livestock keeping rather than seeking other information sources hence a lower probability of paying for TADs control. Farmers who had spent so many years in keeping livestock were traditionally not used to the payment of rising prices and were characterised by the dependency syndrome (Randela *et al*., 2000)..

Contrary to what was predicted, the coefficient of farmer's education level was negative. This suggests that increasing level of education by one year reduces the odds of paying for TADs control by about a factor of 0.96. This is because educated people are involved in civil service or in other non-agricultural businesses. The results are in line with those of Muhereza (2005) that high levels of education promote increased off-farm activities resulting to less adoption of intensive practices in Ugandan agriculture. This contradicts Pokou *et al*. (2010) that household members with formal education and /or knowledge of disease symptoms are capable of identifying animal diseases as a major cause of mortality, thus have favourable pre-disposition for higher levels of resources contribution to disease control.

Although not significant, livestock husbandry system had a negative relationship with farmers' willingness to pay for TADs control. The odds of willingness to pay for TADs control decreases by a factor of 0.9 when the farmer practiced fenced grazing than herding. Results showed that the probability of paying for TADs control was lower among farmers practicing fenced grazing than herding. This could be because those practicing fenced grazing thought fencing would stop their animals from mixing with those from other farms hence protecting them from getting TADs. On the contrary, Pokou *et al*. (2010) observed that herding exposes livestock to higher risks of catching disease, therefore, herders were likely to spend more on preventive drugs than those who practiced fenced grazing hence a higher willingness to pay for TADs control.

Location of the water source dummy had a positive influence on farmers' willingness to pay for TADs control. The odds of willingness to pay for TADs control increases by a factor of 0.9 when farmers own water sources on their farms than when they use communal watering points or valley dams. This could be because farmers who maintained water sources on their farms were risk averse. Therefore, they recognised the importance of maintaining a healthy herd through intensive spraying and vaccination of their animals and as such had a higher willingness to pay for TADs control. The probability of willingness to pay for TADs control was low for farmers using communal watering points because they feared that having paid, their animals would get re-infected hence no need to pay (FAO and OIE, 2010).

Mode of grazing different animals although not significant had a positive influence on willingness to pay for TADs control. The odds of willingness to pay for TADs control increases by a factor of 1.0 when farmers graze their animals (cattle, sheep and goats) together than if they graze them separately. Farmers who practiced mixed grazing were at high risks in situations of high disease incidence thus a higher probability of paying for paying for TADs control. Similarly, (Pokou *et al*., 2010) reported that farmers practicing mixed grazing had a higher willingness to pay for disease control because they were scared that different animals might catch disease and spread it to the rest.

Distance from the nearest livestock market also had a positive but non significant coefficient. For each kilometre away from the nearest livestock market, the odds of paying for TADs control increases by a factor of 1.0. Farmers near livestock markets had a lower probability to pay for TADs control because they were scared that even if they paid, their animals would get re-infected from the untreated animals that are brought to the market. One of the factors that spread TADs was livestock markets where different herds would mix freely (FAO, 2009). This made it easy for different diseases to spread even to those farms which were near the market.

Although not significant, distance from the closest border had a positive relationship with willingness to pay for TADs control. The odds ratio of 1.007 suggests that the odds of paying for TADs control increased by a factor of 1.0 for each kilometre away from the nearest border. The probability of paying for TADs control was lower among farmers at the border because they feared that having paid, their animals would get re-infected from the untreated animals especially from the other country hence no need to pay. At the border different animals would mix freely making it easy for TADs to spread to those farms which are near the border. In addition, there is spread of vectors which do not respect political boundaries especially if the other country does not control these diseases. This is comparable to FAO (2009) that disease could be carried by wind up to 100km provided optimal conditions such as humidity. The variable was not significant perhaps because of lack of sensitization of the farmers about their involvement in TADs control.

Cost of vaccination had a negative and non significant coefficient. This implies that the odds of willingness to pay for TADs control reduces by a factor of 0.99 when the cost of vaccination is increased by one unit. This was expected because a higher vaccination cost constrains the budget and limits money available to meet other domestic needs hence lowering the probability of paying for TADs control. Higher costs of vaccination also make the service less attractive and difficult to attain. This is in line with Koma *et al*. (2003) that the propensity to seek for veterinary services in Uganda dropped as the expected cost of the services rose making the services less attractive and difficult to attain.

The classification table shows the goodness of fit for the Willingness to pay model (Table 4.16). In this case, the model prediction was compared with the observed outcomes. It shows that the value 1 was assigned to 97 observations. For 96 observations, this corresponds to the true value but for 1 of the observations it does not. The value 0 was assigned to 72 observations which were correct for 65 of those observations. In total the model correctly classified 95.3% of the observations.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the findings and Conclusions

The study focused on assessing the socio-economic effects of transboundary animal diseases and farmers' willingness to pay for the control of these diseases. The specific objectives were: to characterise agro-pastoralists in Ntungamo and Rakai districts; to evaluate the farm level benefits and costs associated with the control of TADs and to determine the factors influencing farmers' willingness to pay for TADs control. The sample consisted of 176 farmers from Ntungamo and Rakai districts. Data were collected using pretested questionnaires and analysed using SPSS and STATA. Analytical tools used included descriptive statistics, Cost Benefit Analysis (CBA) and Logit models.

The study findings showed that spraying and vaccination were the most commonly used methods of TADs control. The cost of spraying per animal was estimated at UGX 8,867 while that of vaccination was UGX 500 per animal per year. Using the cost benefit analysis, it was estimated that the total annual avoided losses per animal per farmer were 64% higher if TADs were controlled than if they were not controlled. Analysis of the factors affecting farmers' willingness to pay for TADs control showed that whereas high income earning farmers had a higher probability of paying for TADs control, low income earning farmers reported a lower probability to do so. The challenge is compromising with these farmers to agree on how to manage disease.

Although 60% of the farmers were willing to pay for TADs control, majority of those willing to pay had a bidding price of UGX 500 for Vaccination. The median willingness to pay for TADs control of UGX 500 could be primarily because most of the farmers did not have enough income to pay for those services. This was proven to be correct in the analysis of the factors affecting the willingness to pay for TADs control where results showed that the probability of paying for TADs control increased with increasing farmers' annual income. Therefore, given that 60% of the farmers were willing to pay for the control of TADs, it could be pointed out that TADs control in Ntungamo and Rakai districts is economically viable.

5.2 Recommendations

The economic effects of TADs are mitigated through measures aimed at control, containment, or eradication. Controlling TADs involves agro-pastoralists in a community committing themselves to individually looking after their cattle well by spraying to protect them against ticks and other biting insects and through vaccination. This has clear private benefits that accrue to farmers. However, the challenge is how to make sure that a sufficiently large number of farmers pay for TADs control. This can be achieved with government involvement in the following ways.

Farmers' annual income plays a major role in willingness to pay because it determines the ease with which farmers gain access to veterinary services for their cattle. Farmers should therefore be encouraged to pay for TADs control because it is from the healthy animals that reasonable annual income is realised. Farmers' income can be improved by providing credit to farmers at reasonable interest rates.

Results indicated that the more the animals owned, the less the probability of paying for TADs control because it was costly. Therefore, veterinary services particularly vaccination should be subsidised to encourage farmers' willingness to pay for TADs control.

There is need to encourage farmers to rear a reasonable and quality number of animals which they are able to provide good veterinary services for and thus able to manage in case of TADs outbreaks. Farmers should also be sensitised about the importance of their payment towards TADs control as this boosts their output and hence their profits. Increasing production or herd size is important because some farm management strategies do incorporate some additional production when possible to serve as a buffer against losses.

Results showed that farmers who had attained some training on animal disease control and those who were already paying for vaccination had a positive influence on farmers' willingness to pay for TADs control. Therefore, in order to promote this, veterinary services delivery should be improved by making veterinary services more accessible to farmers. This will help in sensitizing the agro-pastoralists on sustainable livestock management practices in order to improve output from their animals. This will improve information flow and create awareness among farmers about the need to contribute towards TADs control.

There is also a need to implement the foot and mouth disease scientifically planned prophylactic vaccination campaign and mass awareness programme through intensive extension education programmes for livestock owners and veterinary officers. Farmers need to be trained on how to recognise the clinical signs and tasked to report suspicious cases so as to increase public awareness of diseases which call for vigorous efforts among the farmers regarding the vaccination of animals against those diseases.

Agricultural information relating to TADs control has some elements of a public good. In order to enhance willingness to pay for TADs control, the government should develop systematic information dissemination systems relating to disease incidence, the types of control options available, where to obtain them and how to obtain them. Such a move would help solve problems of information asymmetry and bounded rationality thereby increasing adopting of TADs control measures. Information dissemination can be in form of regular radio programmes in different languages and simplified reading materials. This approach has worked well for malaria control campaigns using insecticide treated mosquito nets (Mugasi, 2009).

In addition, the government should put in place measures that would enhance the availability and affordability of veterinary inputs in rural areas. For example, some of the money allocated to agricultural programmes should specifically target farmers in TADs affected areas. The government should promote private-public partnerships for example by working with the relevant government departments and farmer organisations plus Non Government Organisations (NGOs) in the respective locations to extend veterinary services to remote rural areas. The farmer (non-state) organisations include producers' association such as Uganda National Farmers Federation (UNFF), NGOs such as the heifer project, Send a Cow and cooperatives, which provide public animal health service. The role of the government should be to provide an enabling environment through provision of appropriate incentives for the private providers of animal health services to operate in rural areas. For example, by waiving of local trading tax for agro-veterinary dealers and provision of affordable loans to the private sector players involved in the provision of veterinary health care. The government should also put in place a regulatory framework to ensure quality control.

Given the inverse relationship between number of animals owned and willingness to Pay for TADs control, there is need to encourage farmers to rear a reasonable and quality number of animals which they are able to provide good veterinary services for and thus able to manage in case of TADs outbreaks. Farmers should not merely keep large herds of animals which they cannot manage well in case of calamities.

Furthermore, the negative effect that household size had on willingness to pay for TADs control highlights how essential it is for farmers to practice family planning. There is need for households to adopt family planning programs hence improving their livelihood.

Other alternatives for farmers to reduce the impact of disease include: Increasing or adapting agricultural production. Farmers are well aware of the potential of disease to harm their efforts. Among the options are choices of where to locate, especially if they are pastoralists. Farmers can also choose production techniques and species or breeds that are more resistant to diseases and other risks. Diversification of output so that periodic damage to one product can be buffered by production of other products that are not afflicted by the same problems is another approach to reduce the effect of disease. Thus farmers in certain areas engage in mixed farming systems of crops and livestock to spread the risk of infrequent and uncertain disease incursions.

5.3 Areas for further research

This study aimed at assessing the economic analysis of TADs control in Ntungamo and Rakai districts. It thus paves way for further research in other aspects such as the role of collective action in TADs control, and the various transaction costs incurred by the farmers in accessing input markets.

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APPENDIX

APPENDIX 1

Questionnaire on economic analysis of transboundary animal disease control in Ntungamo and Rakai districts

Strict confidentiality is to be given to information given in this interview

SECTION 0: IDENTIFICATION

District ……………………….. Sub-County …………………… Parish ………………..
Village ………………………….. Farmer's name ………….... Telephone………….......
Interviewer ……………………… Date …………………………………………..

SECTION 1: SOCIO-DEMOGRAPHIC DATA

1. How many are you in the household?……………………
2. What is the current composition of your household?
   (1) Children under 12 years……… (2) 12-17 years………… (3) Adults (≥ 17 years)…………
3. How many people in your household are involved in livestock?
   (1) Children under 12 years……… (2) 12-17 years……… (3) Adults (≥ 17 years)…………

Description/ Relationship	Age (Years)	Education level	Sex		Marital status (1 = Married 2 = Separated / divorced 3 = Single 4 = Widow /widower)	Main occupation (1 = Farming 2 = Business 3 = Other (specify)……….)
			M	F		
Household head						
Spouse 1						
Spouse 2						

SECTION 2: FARM CHARACTERISTICS AND PRODUCTION

4. How much land do you have access to?..
5. How much of this land do you use for farming?...
6. Who owns the land? (1) Husband (2) Wife (3) Hired (4) Other (specify)....................
7. What are the types and numbers of livestock on the farm?
   (1) Cattle……… (2) Goats……… (3) Sheep………… (4) Others (specify)…………………
8. What are the numbers of each breed of cattle? (1) Exotic…… (2) Cross breed….. (3) Local....
9. When did you start rearing cattle?..............................
10. What is the major source of animals on the farm?
    (1) Born on the farm (2) Bought from breeders (3) Bought from the market
11. Did you introduce new animals on the farm last year? (1) Yes (2) No
12. If yes, what is the number of new animals brought in the herd?

Type of animal	No. brought	Source
Cattle		

Goats		
Sheep		
Others (specify)		

13. Who makes management decisions for cattle ……… and goats ……?
(1) Husband (2) Wife (3) Both husband and wife (4) Children (5) Other (specify)…………
14. Which enterprises do you have?

	Crops	***Animals***
1	Maize	*Dairy Cow(s)*
2	Beans	*Goats*
3	Bananas	*Sheep*
4	Potatoes	*poultry*
5	Cassava	*Piggery*
6	Tomatoes	*Rabbits*
7	Fruits	*Ducks*
8	Vegetables	*Other (Specify)*
9	Other (Specify)	

15. Where do you put the output from the above enterprises?
(1) Sold (2) Consumed (3) Both (4) other (specify)…
16. If sold, give reason for selling.
(1) To be able to afford other basic household needs (2) Perishability of output
(3) Lack of enough space for storing the output (4) Others (specify) ……………………..
17. What livestock husbandry system do you use?
(1) Zero grazing (2) Tethering (3) Herding (4) Ranching (5) Other (specify)…..

18. What is the major source of labor for your livestock? (1) Hired (2) Family (3) Both
19. What is the primary source of water for your animals?
(1) On farm (2) Communal watering point (valley dams (3) Other (specify) …..

20. What is the major source of feed for the animals? (1) On Farm (2) Communal grazing (3) Other ……….
21. If you have more than one type of livestock, how do you graze them? (1) Together (2) Separately (3) Other (specify) …………
22. What are the major causes of animal deaths on the farm?

Disease	Calves	Cows	Bulls
ECF			
FMD			
CBPP			
Others (Specify)			

23. Please list the animal diseases affecting your household and rank them.

Livestock diseases (first fill in those cited by respondent, then probe)	Rank (1 = Most serious 2 = Serious 3 = Least serious)
1. East coast fever 2. Foot and mouth disease 3. CBPP 4. Others (specify)…	

24. Are there TADs in your village? (1)Yes (2) No
25. Please list the TADs that are common in your area.
(1) East coast fever (2) Foot and mouth disease (3) CBPP (4) Others (specify)………

26. How are these TADs likely to affect your livelihood?

	Effect
Human health	
Animal health	
Annual productivity	
Others (specify)	

SECTION 3: LIVESTOCK HEALTH AND TRANSACTION COSTS

27. Please give information on the following diseases

Disease	Symptoms (fill in those cited)	No. of cases in H/H herd in recent outbreak	No. of cases in village in recent outbreak	Is disease still a problem? (1.Yes 2. No)
ECF	(1 = Swollen lymph nodes 2 = Fever 3 = Difficult respiration 4 = Loss of appetite)			
FMD	(1 = Inside of the mouth is inflamed 2 = Blisters appear on the tongue, gums and nostrils 3 = Excessive salivation 4 = Blisters between the claws and mammary gland)			
CBPP	(1 = Difficulty in breathing 2 = Sudden onset of high fever 3= Loss of condition 4 = Dead animals produce unclotted blood from all natural openings)			
Others (specify)				

28. Can TADs be controlled? (1) Yes (2) No (3) Don't know

29. If yes, how can TADs be controlled?

Control	Cited Yes/No	If cited, is it used by (Yes/No)	
		Household	Community
Vaccination			
Spraying			
Quarantine			
Others (specify)			

30. How have you been able to treat TADs which have affected your livestock?

Disease	Treatment	Where is treatment obtained?
ECF		
FMD		
CBPP		
Others (specify)		

31. What happens if these diseases are not treated?............................

32. Besides treating these diseases, are there other ways of preventing these diseases?
(1) Yes (2) No

33. If yes, give the ways of preventing these diseases in the table below.

Disease	Prevention method
ECF	
FMD	
CBPP	
Others (specify)	

34. Have you ever applied any of these control/prevention methods? (1) Yes (2) No

35. If no, why have you never applied any TADs control/prevention methods? (1) I do not know any of the control/prevention measures; (2) Control/prevention measures are very expensive (3)control/prevention inputs are not available (4) Others (specify)…………..

36. If yes, please give the following information on the TADs control/prevention methods you have used.

Method	Have you ever used? Yes/No	Year first used	Year last used	Cost/animal	Reasons for stopping use (1 = Cost was too high 2 = Inputs not available 3 = Did not work as expected 4 = Others (specify)……)	Why method has never been used (1 = Never heard about it 2 = Method too expensive 3 = Inputs not available 4 = Others (specify)……)
Vaccination						
Spraying						
Quarantine						
Culling						
Others (specify)						

37. Please also give the following information on the TADs control/prevention methods you have used or heard about.

Method	Vaccination	Spraying	Quarantine	Drugs
Have you ever heard about? (1 = Yes 2 = No)				
Source of information (1 = Neighbour 2 = Veterinary officer 3 = Agro-vet shop 4 = Others (specify)…………..)				
How useful was the information? (1 = Very useful 2 = Useful 3 = Fairly useful 4 = Not useful)				
How easy is it to access such information? (1 = Very easy 2 = Easy 3 = fairly easy 4 = Not easy)				
Are you using this method currently? (1 = Yes 2 = No)				
Are neighbours using the method? (1= Yes 2 = No 3 = Not aware)				
Is there risk of adverse effect? (1= Yes 2 = No 3 = Not aware)				
Rank risk of adverse effect (1 = A minor risk 2 = A risk 3 = A major risk)				
Is there risk of failure to work?(1= Yes 2 = No 3 = Not aware)				
Rank risk of failure to work?(1 = A minor risk 2 = A risk 3 = A major risk)				
Expected benefits (1 = Improved animal health 2 = Improved human health 3 = Increased livestock production 4 = Others (specify)……)				

38. What is the cost of disease control and prevention methods used on your farm?

a) Cost of vaccination

Disease	Vaccination			No. of animals			
	Qty	Frq	Cost	Cattle	Goats	Sheep	Others (Specify)
ECF							
FMD							
CBPP							
Others (Specify)							

b) Cost of spraying

Disease	Spraying			No. of animals			
	Qty	Frq	Cost	Cattle	Goats	Sheep	Others (Specify)
ECF							
FMD							
CBPP							
Others (Specify)							

c) Cost of treatment

Disease	Treatment			No. of animals			
	Qty	Frq	Cost	Cattle	Goats	Sheep	Others (Specify)
ECF							
FMD							
CBPP							
Others (Specify)							

Loss of beef

39. How many animals (cattle) were affected by TADs by category?

Category	No. owned then	No. affected				No. treated but remained weak	No. died
		ECF	FMD	CBPP	Others (Specify)		
Calves							
Heifers							
Adults							
Total							

40. What is the farm gate price of beef today?

Season	Beef yield with TADs outbreak (Kg)	Beef yield without TADs (Kg)	During TADs outbreak (Shs/Kg)	Without TADs (Shs/Kg)
Dry				
Wet				

Loss of milk

41. What is the farm gate price per litre of milk and the milk yield per cow per day in litres?

Season	No. of milking cows in the herd		No. of milking cows which died		During TADs outbreak		Without TADs	
	With TADs	Without TADs	With TADs	Without TADs	Milk yield (ltrs)	Price/ Ltr	Milk yield (ltrs)	Price/ Ltr
Dry								
Wet								

42. What was the case mortality and incidence rate of TADs in calves, immature and adult cattle in the recent TADs incidence?

a. Popn at risk	ECF	FMD	CBPP	Others (Specify)	b. No. affected (ECF)	FMD	CBPP	Others (Specify)	No. dead
Popn of calves at risk									
Popn of immature cattle at risk									
Popn of adult cattle at risk									

43. Is there any livestock market in your area? (1) yes (2) No
44. If yes, how far are you from this market? ………….. Km.
45. How far are you from the border? ………….. Km.
46. Where you visited by an extension agent in the last three months? (1) Yes (2) No
47. What services did you talk about? (1) Livestock management (2) Crop production (3) Others (specify) …........
48. Did you receive any training on the disease control in 2010? (1) Yes (2) No
49. How can control of TADs be improved?
(1) Timely information provision (2) Animal surveillance (3) Research on improved methods of prevention or diagnostics (4) Development of agreed rules and protocols (5) Others (specify) …
50. What coping strategies do you use during TADs outbreak? (1) Vaccination (2) Quarantine (3) Vector control (4) Slaughtering the sick (5) Disinfection (6) Others (speccify) ……
51. What have you done to reduce the spread of TADs in your area?

SECTION 4: WILLINGNESS TO PAY FOR TADs CONTROL

52. Are you currently paying for vaccination of TADs? (1) Yes (2) No
53. TADs have affected animals in your district over the years. If you are not currently paying for control and suppose the government instructs means to control for the outbreaks by vaccinating cattle, would you be willing to pay per animal? (1) 500 (2) 1000 (3) 2000 (4) 5000 (5) 10000 (6) 15000 (7) 20000 (8) 25000
54. If no, why are you not willing to pay? (1) Gov't responsibility (2) Never had any TADs outbreak (3) Too expensive (4) Inputs/drugs not available (5) Other (specify)…………………..
55. How well do you think this community will be willing to pay for disease control if asked to do so? (1)Very well (2) Well (3) Not well
56. How do you rate participation of your village members and the quality of leadership in the following activities?

Community activity	Rank level of participation in (1=Very good 2= Good 3= Fair 4= Poor 5= Very poor)	Rank leadership quality in (5=Very good 4= Good 3= Fair 2= Poor 1= Very poor)
Maintenance of valley dams		
Maintenance of communal grazing areas		
Attendance of village meetings		
Attendance of village seminars		
Community maintenance of roads		
Credit groups		
Self-help projects		
Others (specify)		

SECTION 5: SOCIAL EFFECTS OF TADs

57. What daily activities were affected by last TADs outbreak?

NO.	Activity affected during last TADs outbreak	Type of effect of TADs on the identified activity
1.		
2.		
3.		
4.		
5.		

58. Using the key provided, rank the cattle feeding system(s) used according to percentage of time in 2010.

Grazing (1= Not used at all 2 = less 25% 3 = 25 – 50% 4 = More than 50%)	Cattle		Goats	
Season	Dry season	Rainy season	Dry season	Rainy season
Fenced grazing				
Zero grazing				
Tethering				
Others (specify)…..				

59. Rank the following livestock production constraints

Constraint	Is this a constraint?(1= Yes 2=No)	Rank (1 = Most serious 2 = Serious 3 = Least serious)
Poor market for livestock products		
Shortage of land		
Acquisition of better animal breeds		
Livestock diseases		
Lack of veterinary drugs		
Access to vet. Officer		
Lack of water for animals		
Labour shortage		
Others (specify)………..		

60. Please indicate your household expenditure for 2010?

Item		No. of times services sought	Unit cost (Shs)	Amount (Shs)
Livestock inputs	Drugs			
	Vet services			
	Feed/supplements			
	Others			
Human health	Drugs			
	Medical Services			
	Others			
Labour	Land preparation			
	Sowing			
	Weeding			
	Harvesting			
Marketing	Transport			
Others (specify)				

61. Which of the following best describes your monthly income?

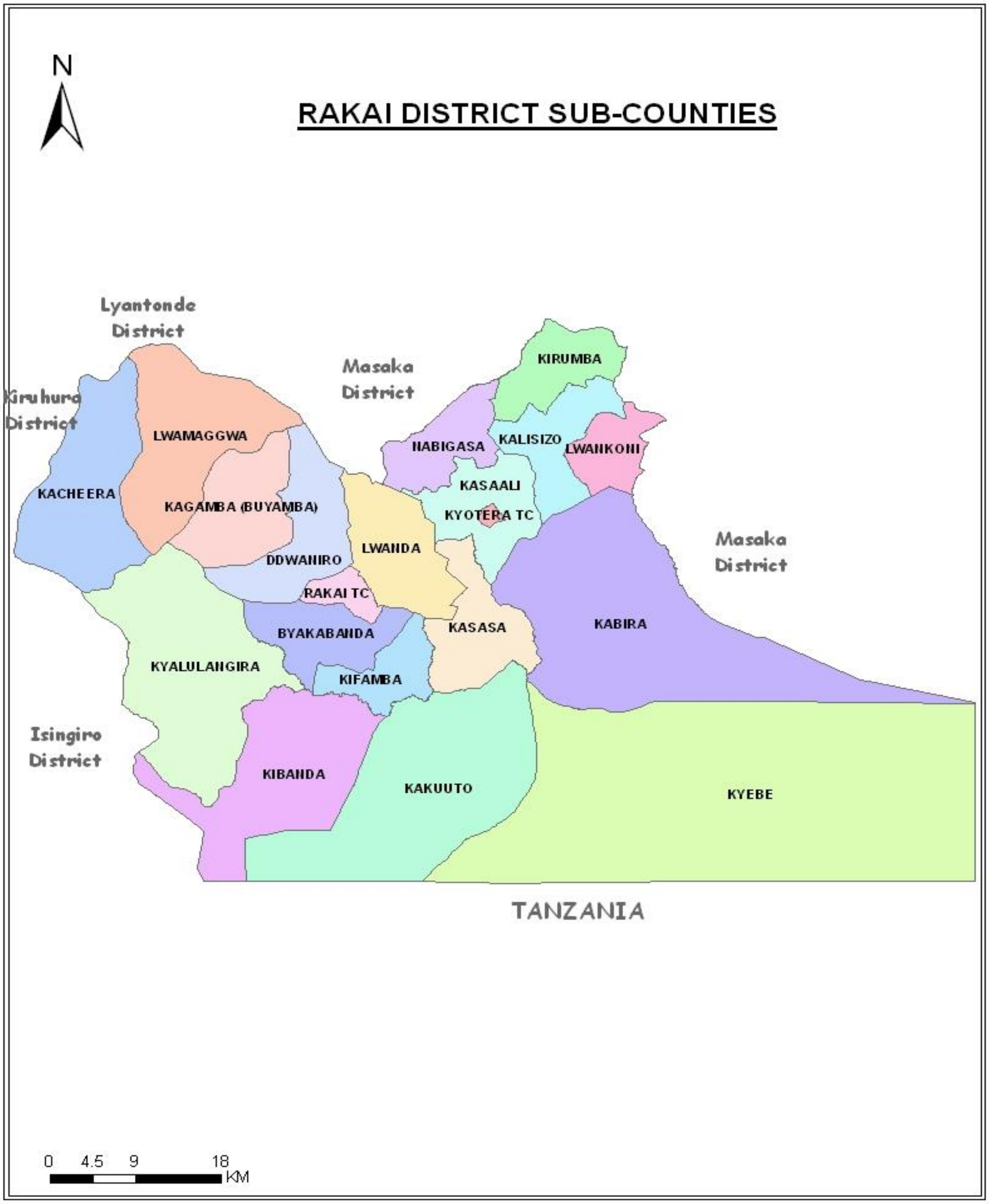
(1)<50000 (2) 51000-100000 (3) 110000-150000 (4) 151000-200000 (5) >200000

62. What were the sources of income for your household in 2010?

Enterprise	Did earn income from? (1)Yes (2)No	What range of income	Rank
Cattle			
Goats			
Sheep			
Pigs			
Poultry			
Crop harvest			
Monthly salary			
Shop			
Remittances			
Other (specify)			

APPENDIX 2

Map of Rakai District



APPENDIX 3

Map of Ntungamo District