A STUDY OF THE ECONOMIC AND POLITICAL DRIVERS OF FOOT-AND-MOUTH DISEASE CONTROL IN TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FORTHE DEGREE OF MASTER OF SCIENCE IN EPIDEMIOLOGY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

The Livestock sector plays a vital role in the economies of many developing countries. It provides food, income, employment and possibly foreign exchange. Consumption and trade of livestock and livestock products in developing countries is rapidly growing however, animal diseases have a permanent threat to livestock keepersand major economic implications both through public and private costs of outbreaks. An example of such diseases is transboundary animal diseases (TADs). One of the significant TADs in Tanzania, foot-and-mouth disease (FMD), isendemic and a major threat to livestock production. The disease impacts and incentives for its control are likely to vary across stakeholders affected by this disease, but these aspects have been poorly characterized in Tanzania. To address these gaps this study investigated political, economic and social drivers of FMD control in Tanzania across different sectors so as to provide the evidence which would support decision making in the control of the disease. The study used collection and analysis of both quantitative and qualitative data. It revealed that FMD caused a standardized milk loss of 2.67 litres per cow per day withan average price of milk per liter per day estimated at Tsh868.75.Therefore, direct losses due to reduced milk yield were estimated at Tsh2319 and an average indirect loss due to control cost was estimated at Tsh2344 per animal per day. The study further identified vaccination as the most important prevention strategy, however, there is need to predict the pattern in which local circulating virus strains occur and develop vaccines relevant to these circulating strains.Identified priority areas of action include better communication mechanisms for better dialogue amongst stakeholders concerned with FMD control and involvement of livestock keepers in national dialogue. Overall,traditional farmers expressed a keen interest in continuing to be involved in research effortswith researchers to develop joint

agendas for FMD control. In Tanzania, there is currently still some debate amongst national stakeholders as to whether FMD should be considered a private or public good.

DECLARATION

I **GLORIA NDHLOVU,** do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor concurrently being submitted for a higher degree award in any other institution.

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DEDICATION

I dedicate this work to my family, my first and eternal love, whose support got me to where I am now. To my mother, I would not have gotten this far without your unwavering faith in me, your constant support and prayers; to my father, thank you for the advice and believing in me at all times; to my husband, we make a great team my love and I am ever grateful for your support and encouragement during my MScprogrammedespite spending months away from home; and lastly but certainly not the least, to my brothers, what can I say, you are all awesome and I am inspired to do my best because of you guys.

"I CAN DO ALL THINGS THROUGH CHRIST WHO STRENGTHENS ME" Philippians 4:13

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LIST OF ABBREVIATIONS

DVO	District Veterinary Officer
DVS	Directorate of Veterinary Services
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
FMDv	Foot and Mouth Disease virus
GDP	Gross Domestic Product
GLM	General Linear Model
MoLFD	Ministry of Livestock and Fisheries Development
NLP	National Livestock Policy
NSGRP	National Strategy for Growth and Reduction of Poverty
OIE	Office International des Epizooties
PCP	Progressive Control Pathway
RAG	Regional Advisory Group
RQDA	R package for Qualitative Data Analysis
SAT	Southern African Territories
TADs	Transboundary Animal Diseases
TFDA	Tanzania Food and Drugs Authority

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Livestock production contribute significantly to the world economy, provide source of household income, food security, draft power for crop cultivation, improved nutrition (meat, milk), manure, raw materials (hides and skins) and bride price (Perry*et al.,*2003; Bonnet *et; al.,*2011). The livestock sector accounts for about 30% of the agricultural GDP in sub-Saharan Africa and nearly 60% of the value of edible livestock products is generated by cattle (AU-IBAR, 2010). Livestock provide a safety net to resource poor farmers and traders along the value chain throughout the developing world (Forman *et al*., 2009). Furthermore, livestock provide a potential pathway out of poverty for rural producers and other actors along the marketing chain where market access exists, constitute a means of investment and perform important networking functions (Perry *et al.,* 2003; Rich and Perry, 2011).

Tanzania has a huge livestock production potential in terms of livestock numbers, variety of species and a rich natural resource base. The latter includes amenities such as abundant land, rangelands and water (rain, underground and surface) and a strategically good geographical location that ensures accessibility to marine, land and air transport, favorable for internal and external trade. The livestock industry in Tanzania contributes 13% to the Agricultural Gross Domestic Product generating 3.8% of the National Gross Domestic Product (Livestock Sector Development Programme, 2011). However, the existing potential is not fully tapped as substantiated by the level of livestock industry contribution to the national economy, foreign exchange earnings and participation in international trade of livestock and livestock products.

The main problems that hinder the development of the livestock industry in Tanzania, as identified by various stakeholders, include animal diseases and the nature of these diseases, poor animal husbandry and management practices, land tenure system that is unfavorable to agro-pastoralism and pastoralism. (Livestock Sector Development Programme, 2011). Amongst these issues, animal diseases are undoubtedly one of the most crucial. Animal diseases constrain the livestock sector and affect livelihoods via their impact on animal health, animal food production, and disease outbreaks significantly constrain the livestock sector throughout the world due to economic impacts and measures taken to mitigate the risk of disease transmission (Perry and Grace, 2009; Rich and Perry, 2011), with implications on food security and poverty alleviation efforts (Heath, 2008). Animal diseases undermine the livestock sector potential and compromise food security that encompasses food self-sufficiency, nutritional and health status of the population, food availability, accessibility and stability of food supply and stocks (Bonnet *et al.,* 2011). Furthermore, animal diseases do not only limit productivity but also reduce the maximum benefits derived by farmers from livestock rearing. Animal diseases cause loss of livelihoods to farmers who are often among the poor people and increase disease control costs through increased vaccination and treatment costs (Rushton, 2009; Webber and Labaste, 2010). Animal diseases cause losses of up to 30% of the annual livestock output in developing countries (Tambi *et al.,* 2006), thus reducing household incomes and yet millennium development goals (MDGs) are increasingly focusing attention on global poverty.

Transboundary animal diseases (TADs) such as FMD are significant animal diseases causing considerable impacts on livelihood. Such are associated with widespread transmission and have no respect for boundaries, they can reach epidemic levels thus increasing the scope of private and public costs of measures taken at individual, collective

and international levels to prevent or control disease outbreaks (Otte *et al.,* 2004). TADs decrease the quantity and quality of livestock products (milk, meat), and limit other uses of livestock such as draft power (Perry *et al.,* 2004), and they further cause reduced cattle productivity (Musemwa *et al.,* 2008).

FMD occurs endemically across most regions of Africa and Asia, affecting 77% of the global livestock population (Rushton*et al.,* 2013). It is one of the most important livestock diseases in the world, posing a threat to national and international economy, and food security. Its effective control and elimination are therefore critical for sustainable livestock and food production. The disease is estimated to cost up to USD $21 billion per year in control which includes substantial costs to poor communities of rural Africa where livestock-keeping families are heavily dependent on livestock for food security and livelihoods (Knight-Jones and Rushton, 2013). Despite the establishment of international frameworks for global control and elimination of FMD (OIE/FAO, 2012), prospects for effective control of endemic FMD in Africa is hampered by a lack of understanding of the epidemiology of the disease. While the situation may be very different across other parts of sub-Saharan Africa, for instance in southern Africa where the use of fencing and other means to strictly control movement of wildlife and livestock and judicious application of vaccines are used as control options(Vosloo*et al.,* 2002), preliminary epidemiological data from Tanzania (Allepuz*et al.,* 2003), including findings from recent Biotechnology and Biological Sciences Research Council (BBSRC)-funded studies, provide little evidence that wildlife-related risk factors have major importance in the epidemiology of FMD in Tanzania.

The first FMD outbreak in Tanzania was reported in 1927. Outbreaks occur in different geographic regions and factors associated with outbreaks in each region are not clearly

known. In Tanzania, it is usually difficult to determine the exact source of FMD outbreaks or to trace the transmission of the disease over time due to poor surveillance and reporting system, lack of comprehensive animal movement records and lack of effective outbreak investigation, therefore, prevention and control is difficult to execute due to lack of effective quarantine in affected areas and type of vaccine used not corresponding with circulating strains (Kasanga *et al.,*2012). However, FMD in Tanzanian livestock is characterized by successive outbreaks of different serotypes (O, A, SAT 1 and SAT 2) (Kasanga *et al.,* 2012), which somewhat appear to be sweeping across the region in a predictable manner. These findings indicate that FMD prevention strategies based on livestock vaccination are likely to beeffective and could be timed in advance of outbreaks by given serotypes.

The presence of FMD in Tanzania creates problems for most livestock owners who are connected to an infected population either geographically or through livestock value chains. Therefore, there is need to emphasize on spending money on disease prevention in order to reduce losses elsewhere substantially(Perry *et al.,* 2003). This brings in the issue of population level control that will reflect the benefits to individual livestock owners.

1.2 Problem Statement and Justification

Livestock play an important role in the livelihoods of pastoral and agro-pastoral communities in Tanzania. FMD is increasingly recognized as a key threat to livestock production in Tanzania and sub-Saharan Africa generally. Economic losses, due to trade restrictions and decreased livestock production may be attributed to many factors including the complex epidemiology of the disease, and a lack of policy agendas focusing on FMD control. Yet, the containment of the disease would maximize the full potential of the livestock industry in sub-Saharan Africa.

The findings of this study will determine the economic impacts of FMD in key sectors in Tanzania and further help understand the drivers of FMD control, from an economic and political perspective to encourage population level control and contribute to control policy formulation. A demonstration of the impacts of the disease combined with the country's large potential for local market access and export of livestock and livestock productswould make investment in FMD control an economically rational consideration. Reducing the burden of FMD and therefore increasing the local value of livestock assets would have beneficial consequences on national and local-level economies, as well as creating opportunities for international market access.

1.3 Research Objectives

1.3.1 Main objective

To determine the political, economic and social drivers of FMD control in Tanzania so as to provide the evidence which would support decision making in the control of the disease

1.3.2 Specific objectives

i. To assess the economic impacts of FMD on commercial-level livestock keepers;
ii. To understand current approaches towards FMD control in Tanzania at both national and local levels;
iii. To determine incentives of FMD prevention and control at both national and local levels;
iv. To determine the barriers/challenges to FMD prevention and control and potential solutions to these barriers, that can move the FMD control agenda further.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The Livestock Sector in Tanzania

Livestock farming is one of the major agricultural activities in the country contributing towards achieving development goals of the National Growth and Reduction of Poverty (NSGRP). The livestock industry contribution to the Agricultural Gross Domestic Product is about 13% generating 3.8% of the National Gross Domestic Product in 2010. Overall the livestock industry has an important role to play in building a strong national economy. Besides contributing significantly to the GDP, livestock are also vital in food security, creation of assets and employment, trade earning foreign exchange, reduction of vulnerability and poverty, industrialization as well as providing a more equitable form of ownership than land. (National Livestock Policy, 2006).

Livestock production in Tanzania includes traditional and commercial firm production systems. The former is further divided into agro-pastoral, pastoral and mixed farming sub-systems while the latter comprises large scale enterprises and smallholder units (Kivaria, 2003). The traditional sector is the most dominant, accounting for over 95% of cattle. A number of initiatives in Tanzania well reflect the importance of the livestock sector in the national economy, for example the Tanzania Development Vision of 2025 which aims at achieving a high quality livelihood for its people; attain good governance through the rule of law and develop a strong and competitive economy, NSGRP which is committed to the Millennium Development Goals (MDGs) as internationally agreed targets for reducing poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women by 2015, and the National Livestock Policy (NLP) of 2006 which aims to develop a competitive and more efficient livestock industry that contributes to the improvement of

the well-being of the people whose principal occupation and livelihood is based on livestock.

Tanzania has a large population of animals including 18.5 million cattle, 13.2million goats, 3 million sheep, and 1million pigs according to the Tanzania Agriculture Livestock Census 2007/08 (National Bureau of Statistics, 2014) [Fig. 1].

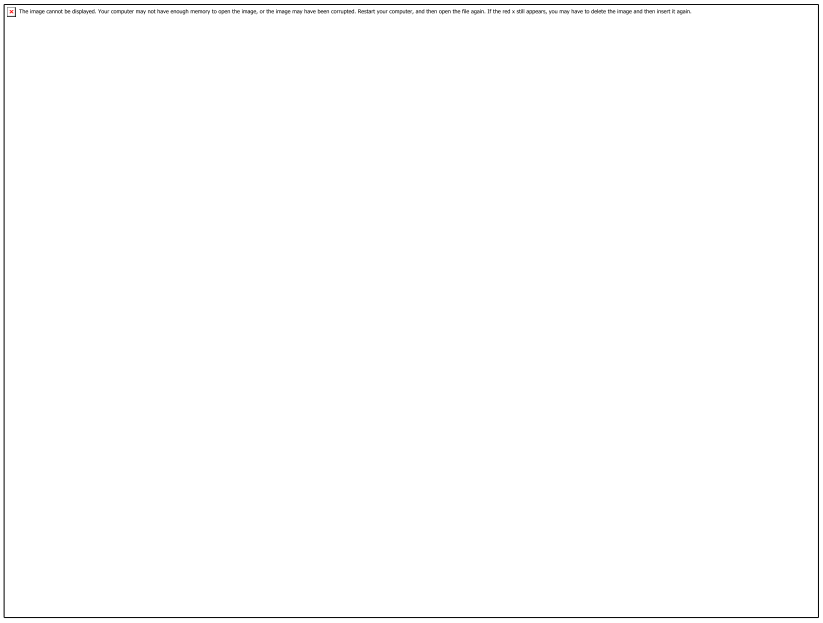

Figure 1: Proportion of different species dominating domestic livestock in Tanzania

A major constraint to livestock production includes livestock diseases such as TADs. TADs may cause economic losses when they deter farmers from investing in better inputs such as better breeds and compel them to adopt less profitable risk management strategies such as less productive indigenous breeds to minimize disease impacts (Swallow, 2012). An outbreak of a TAD such as FMD can cause nearly a 31.8% drop in beef export as a result of animal health implications and production losses (Otieno *et al.,* 2008). It further reduces milk yield, increases probability of mastitis, abortions, perinatal mortality, lameness in draft animals which reduces their ability to work, loss of body weight in

growing animals due to reduced feed intake resulting from FMD lesions and premature culling of animals from intensive production systems that recover from FMD as a result of permanent foot, udder or thyroid damage (James and Rushton, 2009, Rushton, 2009). The majority of production losses due to FMD are attributed to reduced weight and milk yield reduced growth rates and imposed trade restrictions constraining export of animals and animal products to lucrative markets (Kumar *et al.,* 2012).

National, regional and international cooperation is necessary in the control of FMD through an enhanced system of early warning, early detection, tracing along the value chain, proper zoo-sanitary measures and coordination and harmonization of control strategies within and across borders. Successful control of TADs is a major indicator of functional and effective veterinary service delivery such that even challenging diseases such as FMD can be easily controlled (Kivaria, 2003).

The presence of FMD poses a significant threat towards the improvement of meat and dairy industries in Tanzania (Knight-Jones, Rushton, 2013). FMD is one of the priority animal diseases earmarked for control and subsequent eradication in Tanzania (Livestock Sector Development Strategy, 2011).

2.2Etiology and Transmission

Foot-and-mouth disease virus (FMDV; family *Picornaviridae*, genus: *Aphthovirus*) exists as seven serotypes (O, A, C, Asia 1, Southern African Territories 1–3 [SAT 1–3]) and causes a highly contagious disease of ruminants and swine (Kasanga *et al.,* 2011). All domestic and wild cloven-hoofed animals are susceptible, including cattle, pigs, sheep, goats, and buffalo. Transmission of the virus primarily occurs via direct contact. Animals exposed to the virus will typically develop clinical signs within two to five days.

Incubation period of FMDv is 2–14 days. FMD is generally not fatal in livestock, though mortality in animals less than one year of age is significantly more probable; however, the FMD morbidity rates approach 100%. The main impact of FMD on infected livestock is reduced productivity.

2.3Clinical Signs and Treatment

The severity of clinical signs varies with the strain of virus, exposure dose, age and breed of animal/host species, and degree of host immunity. Signs can range from mild or in apparent to severe and include vesicles or blisters on the tongue, dental pad, gums, cheek, hard and soft palate, lips, nostrils, muzzle, coronary bands, teats, udder, snout of pigs, corium of dewclaws and interdigital spaces. At postmortem, erosions may be visible on rumen pillars as well as gray or yellow streaking in the heart from degeneration and necrosis of the myocardium in young animals of all species, 'tiger heart'(OIE fact sheet, 2009).

In endemic countries, prevention and control is through vaccination, strict animal movement control and quarantine measures, while in FMD free countries, prevention and control is by slaughter of infected, recovered, and in contact animals, cleaning and disinfection of premises and all infected material and proper disposal of carcasses and contaminated animal products. No treatment for the disease is available apart from antibiotics to prevent secondary bacterial infection. Recovery in uncomplicated cases is usually about two weeks.

2.4Epidemiology of FMD in Tanzania

FMD is endemic in Tanzania; however, the overall clinical-prevalence is low at about 3% (Kivaria, 2003). Although the spatial distribution of serotypes has not been fully studied,

current evidence indicates that the serotypes detected in Tanzania up to date are four, including A, O, SAT 1 and SAT 2 (Kasanga *et al.,* 2012) and that there seems to be a temporal pattern linked to their occurrence. There is no evidence of a seasonal pattern to the disease but according to livestock keepers, it has shown that it is more common during the dry season and this may be attributed to the close congregation of animals at watering points and grazing areas at those times (Kivaria, 2003).

There is no evidence of the role of wildlife in FMD transmission in Tanzania; however, it is known that wildlife particularly the African buffalo (*Syncerus caffer*) maintain certain FMDV serotypes (SAT) in southern Africa (Vosloo *et al.,* 2002).

2.5 Influence of FMD on Trade

FMD poses a major challenge because of its unique characteristics and epidemiology in Tanzania, and the weight it has been given by the international community as a non-tariff barrier in livestock trade (Mdetele *et al.,* 2014). The disease is logistically difficult and very costly to eradicate in endemic countries. For this reason, developed countries that have managed to eradicate the disease are reluctant to import livestock and livestock products from developing countries that still have the disease. However, recently change of international regulations which open up movement/ market opportunities for livestock and livestock products from FMD-endemic countries were adopted at an OIE World Assembly in Paris. A new policy was adopted allowing for flexibility for FMD-endemic countries which means poorest livestock farmers are no longer excluded from global beef markets and environmentally devastating veterinary fencing is no longer the only option for managing FMD in Southern Africa (OIE Terrestrial Animal Health Code, 2015).

2.6 Economic Impact of FMD

FMD causes economic losses due to reduced milk yield, loss of body condition and reduced growth rate that may persist after recovery as well as mastitis, abortions in female animals, lameness and loss of young animals through deaths. Besides causing direct losses to livestock economy, it also causes indirect losses in terms of severe trade restrictions, impacts which may prove to be higher than direct losses (Mlangwa, 1983). Therefore, FMD contributes considerably to the low performance of the livestock sector and partially to the GDP, thereby, threatening employment opportunities particularly of the traditional sector who depend on livestock for their livelihood. More effort is needed to control FMD so as to utilize the livestock resource more productively in order to reduce poverty among livestock dependent communities.

In pastoral livestock keeping communities, livestock also plays an important role in social matters. Sustainable livelihood of livestock keepers on livestock production provides an increased household income and employment such that it discourages indiscriminate rural urban migration (Lembo *et al.,* 2012).

FMD is considered an economically devastating disease because of the magnitude of the economic harm it can cause to individual livestock keepers and local communities (Randolph *et al.,* 2002). Previously, the immediate economic impact of FMD on livestock in Tanzania was not obvious it could not be measured solely in monetary terms, as livestock are deep-seated in the everyday lives of many rural Tanzanians (Kivaria, 2003).Constraints such as a lack of priority and no resources allocated to FMD control are a major drawback, therefore, demonstrating the economic importance of FMD is expected to improve awareness as to where losses are being incurred and were resource allocation can therefore, be improved (Perry *et al.,* 2002). Knowledge is required about rural

economies in various regions of Tanzania. Control strategies usually depend on the composition of the rural economy.

Knowledge about the different livestock sectors in different regions is important for understanding the consequences of an FMD outbreak to the nation, region and district. FMD outbreaks pose significant threats to livestock sectors throughout Tanzania, both from the standpoint of the economic impacts of the disease itself and the measures taken to mitigate the risk of disease occurrence. These impacts are multidimensional and not always well understood, thereby, complicating effective policy response. An important gap in animal health economics is the explicit incorporation of approaches and incentives, challenges/barriers and their solutions in impact analyses that will highlight the interactions of disease with its socio-economic and institutional setting. In 1997, consultants from the Food and Agriculture Organization of the United Nations (FAO) undertook a technical assessment mission to Laos, Vietnam and Cambodia with the aim of enhancing capabilities for FMD control and assisting in control strategy formulation. As part of the report of this mission, economic impact assessment studies were performed. The impact assessments carried out by the FAO consultants attempted to focus on the different production systems of the region. Three main systems were singled out for the analysis: the village cattle and buffalo in Laos, the smallholder dairy sector in southern Vietnam, and the smallholder commercial pig sector common to much of the region. Data were gathered when possible at the farm level through interviews by the consultants and from secondary sources. The results illustrated the contrasting impacts of FMD control in different production systems. In the cattle/buffalo system, the calculated average return to FMD control per head ranged from USD $0.2 to USD $0.5 depending on FMD incidence (of between 0.1 and 0.3). In smallholder dairy systems, the picture was quite different. The calculations demonstrated that benefits of USD $9-USD $29 per cow would be achieved

through FMD control (with FMD incidences of 0.1-0.3 respectively), resulting in an increase of 7%-24% in the gross margin per cow.

Economic losses are likely to affect different sectors in different ways, for example, most impacts on individual farmers may result from failure of beef animals to put on weight and loss of milk in dairy cows. At national level, losses may be due to rigorously applied heavy expenditure on diagnostic services, vaccinationprogrammes, restriction zones, movement control surveillance, quarantine, etc. (Pendall *et al.,* 2007).

2.7FMD Control in Tanzania

Methods advocated for FMD control in the country are vaccinations, animal movement control and quarantine (Kivaria, 2003). Vaccination is likely to be key factor in the control of FMD in Tanzania. Admittedly, implementing these measures has not been easy due to commercially available vaccines not easily accessible and vaccines tailored to the locally circulating strains do not exist, poor fragmented chain of command and difficulties experienced in enforcing control of livestock movement. Voluntary vaccinations are occasionally done among a few livestock keepers butwith the majority, vaccinations are rarely done and in most cases the disease is just left to run its course due to low mortalities experienced (Mdetela *et al.,* 2014). Great emphasis should be placed on the important role played by communities in reporting outbreaks in order to generate samples for virus typing and vaccine selection production purposes (Picado *et al.,* 2011).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1Study Area and Duration

The study was conductedin Northern Tanzania, Morogoro region and Pwani region. Northern Tanzania was selected for its representation of the two main traditional farming systems; pastoral and agro-pastoral and the existence of well-established research infrastructure through projects that have investigated FMD over the past four years. The study was done in four districts in Northern Tanzania, namely Serengeti,Ngorongoro, Simanjiro and Monduli.

Morogoro and Pwani regionsare traditionally not livestock keeping areas, although a large number of cattle, sheep and goats are kept by traditional pastoral tribes like the Masaai, Sukuma and Barbaigs who move across these areas in search of pasture. However, although new to the regions, commercial livestock production is starting to emerge and include; national ranches, government training institute farms and a few privately owned farms rearing dairy animals.These regions were selected as a representation of commercial livestock production. The study was done in 7 districts within these regions which included Bagamoyo, Kibaha, Kisarawe, for Pwani Region and Kilosa, Morogoro rural, Morogoro municipal, Mvomero for Morogoro Region. This study was conducted between January and June 2015.

3.2 Study Design

This study used mixed methodsspecifically the sequential explanatory designcharacterized by collection and analysis of both quantitative and qualitative data.The qualitative results in such a design would assist in explaining the findings of a quantitative study(Ivankova *et*

al., 2006); however, in this studythe qualitative aspect was used to help better understand the drivers of FMD and its control.The quantitative study was conducted using questionnaires administered to commercial farms. This data was used to make estimates ofboth direct and indirect economic losses. The qualitative study was conducted using community level group discussions to identify available approaches, incentives, barriers, and solutions related to FMD surveillance and prevention in the Tanzanian context, expert interviews and policy level group discussionsof key national level stakeholders.

3.3 Study Approach

This study involved three main approaches:

3.3.1 Structured questionnaires

Structured questionnaires (Appendix 1)were administered in Morogoro and Pwani regions and targeted commercial-level livestock keepers to assess the socio-economic impacts of FMD on commercial-level livestock keepers. Written informed consent was obtained prior to administering the questionnaire (Appendix 2).

3.3.2 Community-level group discussions

These were held in Serengeti, Loliondo, Simanjiro and Monduli and were attended by pastoralist and agro-pastoralist livestock owners, as well as district veterinary authorities, livestock field officers and FMD scientists. Each workshop had an average of 30 participants. The aims of the group discussions were to understand current approaches towards FMD control in Tanzania, determine incentives of FMD prevention and control, and further determine the barriers/challenges to FMD prevention and control and potential solutions to these barriers, which can move the FMD control agenda further (Appendix 3).

3.3.3An institutional assessment and analysis

This was done through;

3.3.3.1 Expert interviews: - of national level key stakeholders (MoLFD, Dar es Salaam) and private sector key stakeholders to understand current approaches towards FMD control and determine incentives of FMD prevention and control. Characteristics such as knowledge of FMD, interests related to FMD control, position for or against formulation of FMD policy, potential alliances with other stakeholders, and ability to effect this policy (through their power and leadership) were analyzed in order to clarify interests, perspectives and motives among different stakeholders (Appendix 4); and

3.3.3.2 Policy level group discussions: - which was held in Morogoro was attended by 23 national stakeholders in the different livestock systems and leading government authorities responsible for FMD control in Tanzania. This provided an opportunity to understand broader issues related to other sectors other than the traditional sector, as well as broader insights into the policy arena. This data was used as an additional data collection tool to expert interview.

3.4Sample Size

3.4.1Structured questionnaires: This used non-probability purposive sampling method because of scarcity of commercial farms in Morogoro and Pwani regions, a total sample size of 46 households was identified and all were included in the study. The unit of analysis was commercial farms defined in this study as large scale enterprises and smallholder units because of their involvement in milk trade. These households were also selected according to willingness of livestock owners to cooperate or physical accessibility of the households.

3.4.2Community level group discussions*:*This also used non-probability purposive sampling. Each grouphad varying numbers of participants in each area but with an average of 30 participants per area. These participants were further split into various smaller working groups of 6 individuals each on average, to allow for individual participation.The group characteristics included adult males and females who were heads of households. The unit of analysis was pastoralists and agro-pastoralists who are representative of the target population.

3.4.3Key Informants*:*This too used non-probability purposive sampling.

3.4.3.1 Expert Interviews:- The number of key informants interviewed was based on availability of government representatives and included a representation of stakeholders from the Ministry of Livestock and Fisheries Development, including the focal person for FMD, officers responsible for food standards, animal identification and traceability, export, epidemiologists, FAO country office representative, FMD contact persons at central veterinary laboratory and selected district veterinary officers. A total of 11 were available and interviewed accordingly. The unit of analysis was key national level and private sector stakeholders with known or demonstrable experience and expertise in FMD control in Tanzania, in order to elicit their views and provide evidence for the validity for FMD control in Tanzania.

3.4.3.2 Policy level group discussion: -This group had 23 participants from the FMD stakeholder workshop, who were further split into various smaller working groups of 8 individuals each, to allow for individual participation. The unit of analysis was key national level and private sector stakeholders with known or demonstrable experience and expertise in FMD control in Tanzania, in order to elicit their views and provide evidence for the validity for FMD control in Tanzania.

3.5Data Collection

3.5.1 Structured questionnaires

A cross-sectional study was undertaken in two regions of Tanzania namely Morogoro and Pwani, which involved seven districts. Datawas collected using a questionnaire that was administered by interview to each farm/household. English was used to construct these questionnaires; however, flexibility for translations existed and was done byan assistant fluent in both English and Swahili. This reduced the possibility of change in meaning of the questions during translation. The questionnaire was also pre-tested among livestock keepers around Morogoro municipal, prior to its actual administration.

The questionnaire was constructed using questions that mostly consisted of closed and very few open-ended questions to establish perspectives. Type of data covered by the questionnaire included general information, farm/household demographics, type of production system, details of livestock production, farm/household characteristics, crop related production, livestock summary, livestock related production, acquired livestock, sold livestock, consumed livestock, livestock product produced and sold, livestock morbidity and mortality, veterinary services receive or sought, FMD vaccinations and farmers' willingness to vaccinate, history of FMD in the herd, recent FMD outbreaks in the herd, production losses due to FMD outbreaks and other FMD treatments and its cost (Appendix 2).

3.5.2 Community level group discussions

Each smaller working group was asked to discuss FMD prevention and reporting strategies within their community, including: available approaches to the community; the incentives for FMD reporting/prevention from their perspective in these communities; the current barriers to better FMD reporting/prevention; options available to address these

barriers; and the stakeholders who would need to be involved and could help implement the devised plan. Data was collected using corporate Ketso24 kits) for each of the groups allowing for individual participation within smaller groups. Ketso is hands-on kit for creative engagement, with colorful shapes to capture and display people's ideas. Participants write their ideas and comments on re-usable, color-coded 'leaves'. Every participant was given a pen and leaves, so everyone can develop and add their ideas. Each participant was given a chance to give personal viewsby writing down or drawing an idea on a ‘leaf’. A Swahili speaking moderator was assigned to each working group to help lead the discussions as well as help participants to progressively movefromtaskto task.Plate 1 shows some of the community-level participants in their respective working groups.

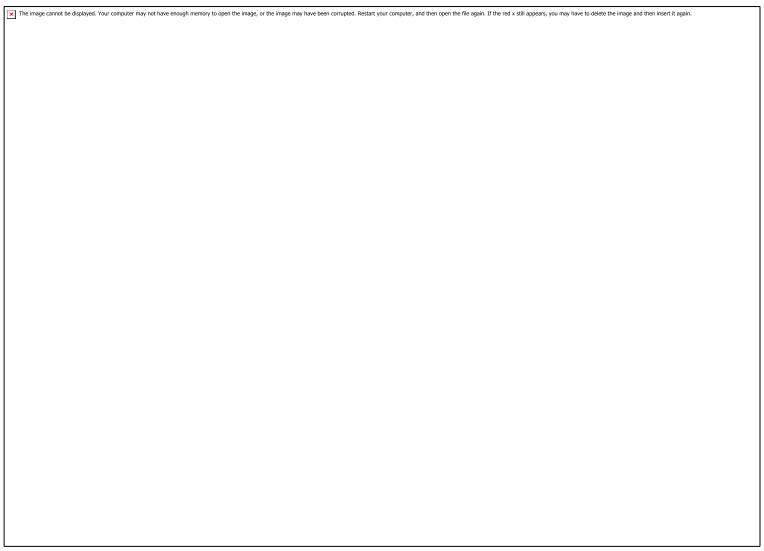

Plate 1: **Community level participants**

3.5.3 Expert Interviews

In-depth interviews were conducted in English through voice recordings. Stakeholders involved included representation from the Ministry of Livestock and Fisheries Development, including the focal person for FMD, officers responsible for food standards,

animal identification and traceability, export, epidemiologists, FAO country office representative, FMD contact persons at central veterinary laboratory and selected district veterinary officers to enable an in-depth examination of the policy environment in which veterinary services operate as well as FMD-related policy issues.

The type of data collected during these interviews was under the following themes; legislative frameworks available which are relevant to FMD; FMD surveillance from local- and central-level authorities and FMD diagnosis; Response to FMD outbreaks i.e. epidemiological tracing and investigation of outbreaks and response capacity of governing institutions for FMD control; General FMD control measures currently used, barriers and drivers of FMD control in Tanzania; FMD vaccination in Tanzania; and border control measures against FMD for import and export (Appendix 4).

3.5.4 Policy level group discussions

The group discussions were held in Morogoro as an additional data collection tool to the expert interviews. It brought together a wide range of national stakeholders in the different livestock sector together with leading government authorities responsible for FMD control in Tanzania. This was an extremely open and interactive process. It moved into a series of four sessions, each session addressing the workshop objectives. The order of the objectives was adjusted to enable the assembled participants to first look to the future, and discuss and characterize the major benefits to be achieved from better FMD control, or even FMD freedom. The group discussions then moved through the objectives to finish with the key actions necessary by different stakeholder groups to achieve the envisioned benefits. Each session was conducted through four separate working groups of participants. Each group generally contained a moderator and amixture of national stakeholders, smallholder pastoralist or agro-pastoralist, commercial dairy, wildlife,

academia and other livestock system representatives. Data was collected using corporate Ketso24 kits for each of the four groups, allowing the teams to progressively move from task to task.Plate 2 shows some of the policy-level participants in a working group.

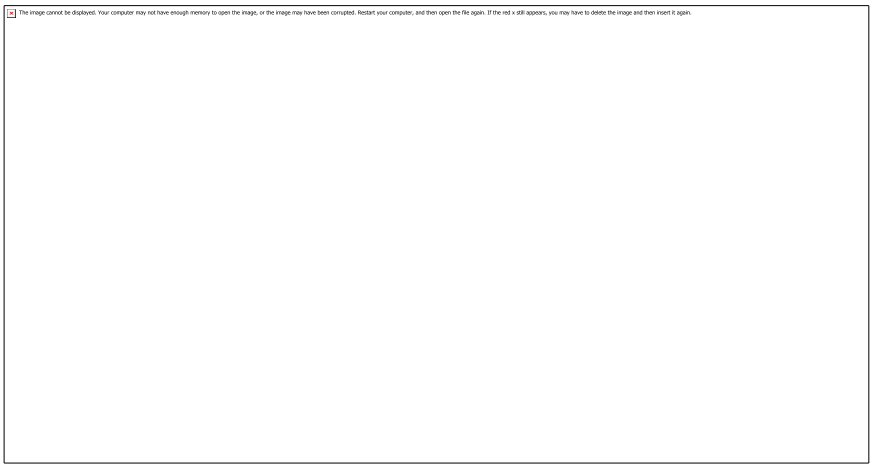

Plate 2: Policy level participants

3.6 Entry of Questionnaire Data

Questionnaire data was entered into an excel template created prior. One excel spreadsheet was used for each questionnaire and with each excel file, a unique identifier was given. This excel file was then turned into an SQL database putting the data together in a way that it was easy to analyze.

3.7Data Analysis

To address specific objective 1; to assess the socio-economic impacts of FMD on commercial livestock keepers, quantitative dataobtained from structured questionnaires wereanalyzed using R statistical package version 3.2.1.

Calculations for quantitative data

Deductions of results were done in two steps.

3.7.1Paired t-test

An inferential statistical test, paired t test, was used to determine whether there is a statistically significant difference between the means in two independent groups i.e. milk yield before outbreaks and milk yield after outbreaks. The hypotheses concern a new variable M_d, (true difference in means).

$M_d = M_1 - M_2$;

Where;

M_1 is milk yield before outbreak and M_2 is milk yield after outbreaks. Therefore, this was calculated based on the following hypothesis;

Null Hypothesis: H0: true difference in means is equal to 0 ($M_d = 0$)

Tests were considered significant at $P \leq 0.05$.

Descriptive statistics (measures of central tendency) was used to calculate the means of various variables. Paired t-test was utilized for comparison of the average milk yield pre- and post- FMD outbreaks, to evaluate whether the means for the two groups were significantly different from each other. Statistical confidence level was set at 95% and $P \leq 0.05$ was set for significance.

3.7.2Economic impact estimation

Impact of disease is an important estimation to guide where to apply resources to animal health and needs to be strengthened through examining the marginal costs and benefits of applying disease control measures. For example if money is spent on disease control, the intention is to reduce the direct losses due to losses in animal and herd productivity. This study applied the disease impact framework to make estimates of the direct and indirect economic losses due to FMD. The following losses were used as representative to estimate direct and indirect losses respectively;

Direct losses estimated- Milk yield reduction

$$LY = (M_b - M_a) * D * P \quad \text{[Equation 1]}$$

Where;

LY = Losses due to reduced milk yield

M_b = Milk yield at before FMD outbreak (Lts/day)

M_a = Milk yield at after FMD outbreak (Lts/day)

D = Duration of infection in in-milk animals (mths)

P = Price / liter of milk (Tsh.)

Indirect losses estimated- Treatment costs

$$LT = (CP * N) \quad \text{[Equation 2]}$$

Where;

LT = Losses due to treatment costs

CP = Cost of professional treatment (Tsh), N = No. of animals treated

Therefore, a summation of equation 1 and equation 2 gave the total economic losses/animal/outbreak in TSH.

The formulae below calculated the amount of milk lost per cow per day, standardized milk loss, and incorporated into a general linear model as a response variable.

$$\text{Standardized milk loss} = \frac{\text{Total milk yield(b)}}{\text{Total lactating cows(b)}} - \frac{\text{Total milk yield(a)}}{\text{Total lactating cows(a)}}$$

Response (standardized milk loss) and explanatory variables (milk produced per cow per day, treatment, vaccination, duration of outbreak in months and grazing pattern) were incorporated into a General Linear Model(Appendix 5) to determine if there were any linear relationship among response variable and explanatory variables. A correlation coefficient (r) was also calculated. In this analysis, statistical confidence level was set at

95% and $P \leq 0.05$ was set for significance. This model was used to account for any variations.

3.7.3 Qualitative data

To address specific objective 2, 3 and 4; to understand current approaches towards FMD control in Tanzania at both national and local levels: to determine incentives of FMD prevention and control at both government and local levels: to determine the barriers/challenges to FMD prevention and control and potential solutions to these barriers, that can move the FMD control agenda further: data collected on color coded leaves were summarized into a simple word template/table using Corporate Ketso24 software to record the key ideas and perspectives from workshops. Whiledata collected from voice recordings from expert interviews was transcribed and subjected to content/thematic analysis which provides “rich and detailed”, yet complex account of data; and summarized using the RQDA package of R statistical package version 3.2.1.

CHAPTER FOUR

4.0 RESULTS

4.1 Structured Questionnaires

4.1.1 Comparison of herd-level population means

The reported herd level mean of milk yield before an FMD outbreak was 296.25litres, while during an outbreak it was 202.05litres. The difference between the sample mean milk yield before outbreaks and during outbreakswas 94.2litres. A paired-samples t-test was conducted to compare the two sample means. There was a significant difference in the means pre- and post- outbreaks; $t = 5.4034$, $p = 3.484^{-0.6}$, $P< 0.05$. These results therefore suggest that FMD outbreaks really do have an effect on milk yield. Specifically, the results suggest that when FMD outbreaks occur, the amount of liters produced per day decreases significantly.

4.1.2 Economic impact of FMD

The study findings showed that FMD caused an average direct loss of 2.67litres per cow per day (Table 1). The average price of milk per liter per day was estimated at Tsh868.75, with economic losses due to reduced milk yield because of FMD estimated at Tsh2319.56 per cow per day.

Table 1: Direct economic losses due to milk loss per cow

Parameter	Mean	Range
Daily milk yield before an FMD outbreak (Lts)	6.51	0-20
Daily milk yield during an FMD outbreak (Lts)	4.18	0-19
Duration of FMD illness (months)	0.8	0-2
Quantity of milk lost per day (Lts)	2.67	-12.4–15
Price/lt (Tsh)	868.75	400-1300
Economic loss due to production losses/day (Tsh)	2319.56	
Economic loss due to production losses/outbreak (Tsh)	56442.63 [a]	

The study further showed that the average indirect economic loss due to cost of treatment per animal was estimated at Tsh2344 per animal for an outbreak lasting 0.8 of a month. Furthermore, the total economic cost per cow per outbreak was further estimated at Tsh58 786.63 (Table 2).

Table 2: Indirect economic losses due to treatment costs per outbreak

Parameter	Mean	Range
Number of animals affected	51	0-363
Number of animals treated	51	0-363
Economic losses due to treatment costs/animal (Tsh)	2344[b]	
Total economic losses/animal/outbreak (Tsh)	**58786.63 [a+b]**	

The standardized milk loss average was calculated at 2.67litres. However, there was considerable variability about this average and therefore, possible explanatory variables, which could have accounted for this variation, were explored.

Table 3: Factors that may affect variability in milk yield during FMD outbreaks

Response variable	Explanatory variable	Category	Proportion of respondents	Tvalue	P value
Standardised milk loss	Vaccination	Y	60.8	0.388	0.7001
		N	39.2		
	Duration of outbreak (months)	0	39.1	0.038	0.970
		1	41.3		
		2	19.6		
	Grazing pattern	Zero	8.8	-0.220	0.8224
		Private	30.4		
		Communal	60.8		
	Treatment	Y	32.6	-0.235	0.815
		N	67.4		
	Milk yield/cow/day	Proportion loss	25.2	4.261	1.29^{-4}

Response and explanatory variables were incorporated into a model (GLM). Statistical confidence level was set at 95% and $P \leq 0.05$ was set for significance. The explanatory variables investigated, include vaccination, duration of outbreaks, treatment and grazing pattern were not statistically significantly different from zero ($P>0.05$). However, milk yield per cow per day before outbreaks was statistically significant ($P<0.05$) and may account for the variations in the standardized milk loss (Table 3).

Arelationship between standardized milk loss and milk yield/cow/day in liters before outbreaks (Fig. 2)had a correlation coefficient (r) of0.5686; p = 3.7e-05 ($P<0.05$). This shows a moderately positive correlation between the two variables showing that the greater the productivity, the greater the loss when there is an outbreak.

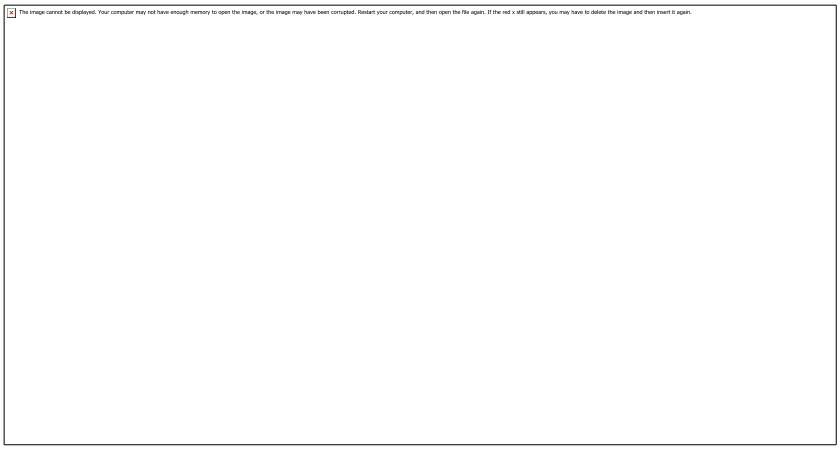

Figure 2: Relationship between standardized milk loss and Milk yield/cow/day (lts) before outbreaks

4.2 Percent of Commercial Farms Willing to Pay for Vaccinations

The proportion of farmers willing to pay for effective vaccines was 89.1%, 0.9%was unsure and 10% were less prepared to incur costs due to the nature of the disease i.e. low mortality rates. These proportions are indicated in Figure 3.

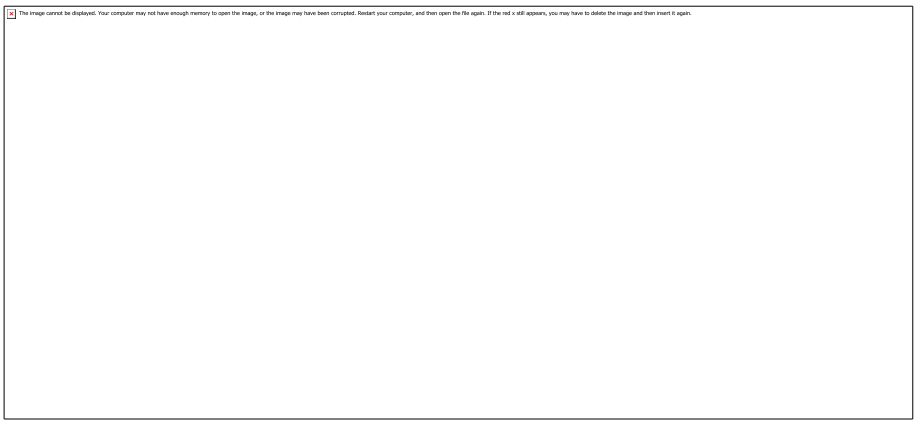

Figure 3: Percent of commercial farms willing to pay for vaccination

4.3 Community based Group Discussions

Common themes were identified in these interactive group sessions in relation to FMD prevention and reporting by participants selected to attend these group discussions in Serengeti, Ngorongoro, Simanjiro and Monduli (Appendix 3).

Summary of ideas and perspectives identified during community based group discussions is indicated in Table 4.

Table 4: Common ideas identified by community level participants in northern Tanzania related to FMD prevention and reporting

Foot-and-Mouth Disease Control in Tanzania	
FMD Prevention	
Current approaches working • Vaccination • Avoid mixing herds • Avoid buying sick animals • Cleaning environments after outbreaks • Sensitization programmes about the disease	Incentives • Reduce mortalities • Source of income • Source of nutrition • Improve animal health and productivity • Increased value of animals
Barriers • Lack of vaccines • Lack of resources • Political interference • Uncontrolled animal movements • Insufficient grazing land	Solutions to these barriers • Develop effective vaccines • Proper resource allocation • Fight corruption • Set up quarantine stations • Proper land use and management plans.
FMD Reporting	
Current approaches working • Sharing information among livestock owners • Report to village leaders • Report to Livestock field officers • Report to District veterinary officer • Use of mass media to report	Incentives for FMD reporting • Avoid further spread • Avoid mortalities and reduced productivity • Protect local markets • To develop effective control strategies • Early rapid response to contain disease
Barriers to FMD reporting • Lack of qualified personnel • Lack of diagnostic facilities • Weak chain of communication • Lack of resources • Ineffective vaccines • Lack of interest to report because of the nature of the disease	Solutions to these barriers • Employ more field officers • Improve diagnostic facilities • Improve reporting chain of command • Allocate more resources to field officers • Increase awareness of importance of reporting

Table 5 further summarizes major points that emerged from discussions on vaccination challenges faced by traditional livestock keepers from the study areas.

Table 5: Vaccination challenges identified during community-level group discussions according to district

Serengeti	Ngorongoro	Simanjiro	Monduli
Ineffective vaccines	No vaccine available locally	4 serotypes and no vaccine for all	No working vaccine
Lack of willingness to vaccinate	Lack of willingness to vaccinate	Lack of willingness to vaccinate	Willing to vaccinate but cost too high
No treatment	No treatment available	Traditional treatment available	No treatment available
No government vaccination policy	Neglected disease by government	Government not help to vaccinate	No government vaccination
No compensation for losses	No compensation	No compensation	No compensation
Livestock-wildlife interaction	Livestock-wildlife interaction	Livestock-wildlife interaction	Livestock-wildlife interaction
Lack of proper handling of vaccines	No handling facilities for vaccines	Lack of proper handling of vaccines	Lack of proper handling of vaccines

Furthermore, data collected during community level workshops also identified factors leading to non-compliance to vaccinate animals against FMD;

- Low prioritization given to FMD by the government;
- Lack of political will;
- High cost of vaccines which are currently not subsidized by government;
- Vaccines are ineffective because they are not tailored to circulating serotypes;
- No timely response when there is an outbreak;
- No procedures available to monitor/limit animal movements;
- No treatment available for the disease.

4.4 Expert Interview Data

Common themes were identified during interviews involving key informants and key findings are outlined below.

4.4.1 Existing legislations and documents

A number of documents were identified by key informants to have been produced by the government that are relevant to livestock development issues and FMD control:

a) National Livestock Policy (2006);
b) Animal Diseases Act No. 203 and Regulations (2007);
c) Veterinary ActNo. 16 (2003);
d) Livestock Identification, Registration and Traceability Act (2010);
e) NationalFMD Control and Eradication strategy: - this document is being developed.

However, several participants further indicated that there is currently no specific policy targeting FMD and its control in Tanzania and stakeholders at national level are more broadly driving current policy development of livestock diseases as an entity rather than a single disease. However, these legislations are basically used to operationalize the National Livestock Policy

4.4.2 FMD surveillance and diagnosis

Reporting and notification of FMD cases is regulated by the national law andthere are defined penalties stipulated in case of non-compliance, however, these laws are not adequately enforced. “The role of this legislative framework in FMD control is basically to promote early reporting of the disease…” (MoLFD- interview).Reporting mechanisms related to FMD outbreaks are outlined in these legislations and livestock owners, by law,

are required to report outbreaks. The chain of reporting outlined by respondents is shown in Figure4.

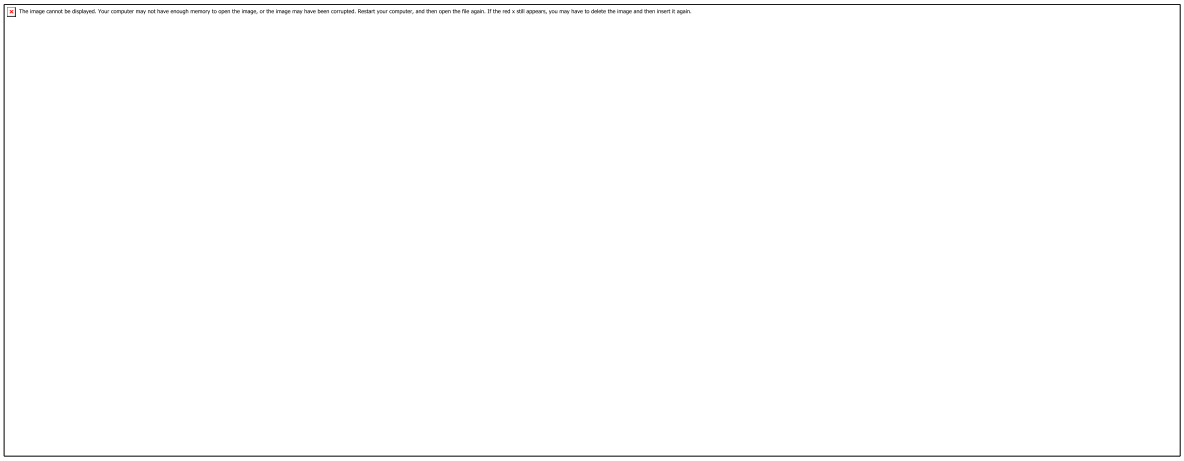

Figure 4: Reporting mechanisms for FMD and other diseases as stipulated by the MoLDF in Tanzania

Forms for reporting disease events are available at the district veterinary office. An online template is also available for this purpose. In case of outbreaks, mechanisms are in place to restrictanimal movements and impose quarantine at local level. The epidemiology unit at central level is responsible for notification to international organizations.

“In case of a disease event being reported, clinical examination of suspected cases is performed by the district veterinary officers and livestock field officers. Samples are collected at district level and sent to zonal veterinary centers and ultimately to central veterinary laboratory....” (TVLA- interview). However, these mechanisms are constrained in some cases because of geographical barriers such as bad road networks, at district level, a lack of appropriate equipment or laboratories not equipped to handle samples. Poor chain of command, logistical issues and poor/weak network coverage are also responsible forpoor regional- and government-level mechanisms and processes linking central- and local-level structures. This was corroborated by several district level officials who

indicated that “poor infrastructure and diagnostic facilities make our work very difficult to communicate with HQ….” (DVO- interview).Currently there are minimal efforts by policy makers to encourage early reporting of the disease apart from educational activities such as agricultural shows, disease atlas (guides for extension workers), meetings/seminars, posters and pamphlets to sensitize about the disease which are limited efforts by the ministry.

Outbreaks are countrywide as pointed out by several national level informants. For example, at the time of these interviews, 52 FMD outbreaks had been reported countrywide by 16 districts between January and March 2015, however, under-reporting is considered likely. No appropriate measures are available to be taken in affected districts. According to national officials setting up quarantine, which sometimes fail due to political interference; and restricting animal movement, which also poses a challenge because of the nature of traditional farming systems, particularly in the pastoral communities are in some parts imposed. However, this was disregarded by district level informants who indicated that quarantine does not exist for FMD as there is no infrastructure or manpower to support that. Others further stated that, politicians make their work difficult when they decide to use political power to make phone calls and jump imposed quarantine.

Despite FMD being considered a public good globally, in Tanzania, there is still some debate as to whether to consider it a public or private good and currently the country has no compensation scheme for affected livestock keepers which could account for a limited willingness to report outbreaks. “It would be great if authorities would respond to outbreaks as soon as reported because they don’t come after reporting so we don’t report…” (Traditional sector- policy workshop)

Common factors identified by several interviewed participants leading to poor reporting of FMD outbreaks were:

a) Poor communication mechanisms connecting farmers with government level officers;
b) No compensation scheme for losses due to FMD during outbreaks;
c) Late or no response to reports;
d) No control programmes available at local level;
e) Low mortality caused by the disease, and therefore affected communities consider reporting meaningless.

With regard to surveillance it was found that current surveillance mechanisms for FMD were only passive. Control of the disease is challenging given that there are different serotypes responsible for the disease in Tanzania. However, respondents in research indicated that, "Research outputs on where the different serotypes occur in Tanzania are slowly beginning to become available…" (Researcher- interview).

Some information on national FMD status is available from research that has been going on in Tanzania. Other data available include the livestock census data (2012) and production-level data (MoLFD basic data booklet). A regional meeting to develop the road map for FMD control in East Africa was held in Kigali, Rwanda in October 2014 and a Regional Advisory Group (RAG) was established.

4.4.3 Response to FMD outbreaks

According to national level respondents, epidemiological tracing and investigation of outbreaks to determine suspected sources of introduction and transmission routes of FMD are still very poor. These investigations are very difficult to conduct due to uncontrolled animal movements across the country mainly due to unorganized farming systems of the

pastoralist communities who are predominant in the country. It was noted that the governmenthad previously tried to establish a traceability system for risk based surveillance which is still operational but has stalled because of such farming systems. Poor chain of command, political interference and no clear description of roles and responsibilities of professionals at central government, local government, and other relevant agencies/organizations in case of outbreaks are also the major drawbacks in achieving thorough outbreak investigation. This was agreed by several interview participants at district level. However, other respondents stated that, there is no response to FMD when it happens, field officers either respond late or never respond at all, excuses relating to logistics are given.

Concerning restriction zones, national level stakeholders stated that Tanzania does not currently have any restriction zones. There were previous efforts to establish one in Southern highlands in Rukwa because of its natural barriers, which made it suitable for this purpose, however, this attempt failed because the area became easily accessible to pastoralists who are non-compliant to movement restriction efforts.There are no zoning and/or compartmentalization structures in place in Tanzania. “FMD status in Tanzania is currently based on the type of circulating strains rather than FMD freedom…” (Researcher- interview).

4.4.4 General FMD control measures

The Progressive Control Pathway for Foot and Mouth Disease (PCP-FMD) has been developed by FAO to assist and facilitate countries where FMD is still endemic to progressively reduce the impact of FMD and the load of FMD virus. The PCP-FMD has been adopted by FAO as a working tool in the design of FMD country (and some regional) control programs, and following appropriate consultation it has become a joint FAO/OIE

tool. The PCP-FMD is expected to form the backbone of the Global FAO/OIE Strategy for the Control of FMD that is under development. The PCP-FMD in Tanzania is being used as a framework, but at the same time customized to fit the Tanzanian context.

There was some concern among district level respondents about some government efforts in the control of Contagious Bovine Pleuropneumonia (CBPP) and other diseases prioritized in contrastto efforts from government for FMD control, and most argued that the problem of FMD is bigger than that of CBPP or other prioritized diseases. “It is very important for the government to allocate resources to better manage FMD…” (DVO-interview).Othersargued as to why priority should be given to a disease with low mortality, “Why should money be wasted on a disease that doesn’t kill? Too much unnecessary noise is made about this disease…” (DVO- interview). However, others stated thatin Tanzania, a clear distinction needs to be made between diseases that are treated as private or public goods; others further argued that FMD control should bedefinitely considered a public good. “The government should meet us half way; the losses we suffer are very bad…” (Dairy sector- interview). Nevertheless, others argued that given the inadequacies of government programmes in Tanzania, FMD control should be a shared responsibility between the government and livestock-owning communities.

Currently there is no information on operational aspects of programs for the control of FMD in susceptible species such as livestock or wildlife in Tanzania. This is because there are no funds allocated for such programs. Others argued that there is need for government to allocate funds for control programmes soon. However, others disagreed and argued that even if funds were made available, programs may not be successful due to lack of established infrastructure and properly working chains of commands for active surveillance. “There isa need to first set up systems and infrastructure before the issue of

funding for control programmes can even be addressed…" (MoLFD-interview).Respondents from the Meat and Dairy boards further indicated that in Tanzania, particularly, stakeholders concerned with FMD control are mostly commercial farmers with an interest in trade as well as livestock professionals and researchers.

4.4.5 Barriers to FMD control at the National Level

The wildlife sector indicated that epidemiological barriers to FMD control can be attributed to wildlife-livestock interactionsduring grazing and at waterholes because most of these lie adjacent to protected areas and this was strongly agreed on by both the FAO and MoLFD respondents. All sectors agreed on potential practical interventions in the Tanzanian setup being vaccination, strict movement control and quarantine, however, such interventions may not be effective due to none compliance by pastoralists, who may move into protected areas. Apart from non-compliance, the degree of enforcement by national stakeholders should also be considered. Table 6 summarizes the common barriers identified by workshop and expert interview participants.

Table 6:Common barriers identified by participants

Barriers	Description
Economic	Cost of available intervention, Inadequate resources,
Operational	Poor infrastructure, few field officers, poor diagnostic tools
Political	Political interference, lack of political will
Social	Environment/Conservation concerns, uncontrolled movement
Geographical	Poor road networks

Economic barriers- "There is a challenge because of inadequate funding to the epidemiological unit for such programmes due toa lack of political will…" (MoLFD-interview).

Operational barriers- “If the government sets up a budget every year for veterinary service delivery, it will help a lot…” (DVO- interview).

Political barriers-“Political interference of professionals executing their duty by issuance of bribes or calling high level government officials to order juniors to bend rules…”(MoLFD-interview)

Social barriers- “Issues of environmental/conservation concerns are hindered by uncontrolled movement….” (Wildlife sector- Policy workshop)

Geographical barriers- “It is very difficult to reach certain villages because of the bad roads and hills…” (DVO- interview)

Furthermore, it is recognized that the present project modalities for supporting district level activities leads to unequal and non-transparent distribution of resources among districts as well as high transaction costs for both central and local governments. “It is important to note that law enforcement organs are not well informed on laws related to livestock production and disease control…” (DVO- interview), this may result in their general disengagement with livestock development and disease control programs. Therefore, there is poor enforcement of laws from the grassroots to the central level. Overall, it was agreed that the decentralization of veterinary services delivery has opened up opportunities for private participation, which were not available prior to the start of the process.

4.4.6 FMD vaccinations in Tanzania

Agencies/organizations responsible for supervision and approval of FMD vaccine production, usage, and import include The Directorate of Veterinary services (DVS) and the Tanzania Food and Drugs Authority (TFDA).The requirement for FMD control in Tanzania is mandatory vaccination, although this is based entirely on individual efforts.

“We buy our own vaccines and vaccinate ourselves; government will never come to help us…” (Dairy sector- interview). It was further determined that marketing and distribution of vaccines is purely private sector driven. The private sector has more information on the cost of currently available vaccines and price changes with/without outbreaks, but a major drawback is that these agro vet dealers cannot advise or sell vaccines to livestock owners tailored to local circulating strains. “Lack of proper storage and handling facilities for these vaccines is another problem by agro vet shops, people risk buying expired or spoilt vaccines…” (DVO- interview).

It was determined from the commercial dairy sector that FMD has major negative impacts on the dairy sector, including considerable milk losses and sometimes mastitis. The Tanzania Dairy Board advocates for vaccine use, but no vaccines are readily available. The responsibility of the Dairy Board as a regulatory board is concerned with increase in production and quality of products, but control of diseases and vaccines are the responsibility of the veterinary services. The Tanzania Dairy Board comes under the Ministry, and farmers are members of the Board, as are milk processors and other stakeholders in the dairy value chain. The different stakeholders do make their voices heard, but the questions may be difficult to answer.

4.4.7 Border control measures against FMD outbreak

Several sectors indicated that political commitment from the government is vital in the control of FMD, importantly for international trade. Most of the growing markets in the region are domestic or regional within East African markets. Additional export markets to complement these include the United Arab Emirates and the Comorosand these opportunities are expanding. China and Egypt have shown an interest with China already investing in a processing facility in Dodoma. However, some respondents stated that, “It is

difficult to source animals for these markets…" (Tanzania Meat Board- interview), other stakeholders considered that demand for such export opportunities might become considerable. Importantly, export markets can catalyze the investments needed for national markets, and also raise standards and technical expertise more broadly.

Current requirements and quarantine measures for in country movement of FMD susceptible animals and their productsare regulated by health certification and other relevant documentation as well as inspection of live animals or animal products before movement. "More effort needs to be made in relation to livestock movements and their monitoring…." (DVO- interview). In the past a movement permit was needed and the extension officers would inspect animals for signs of disease before they could be moved, this no longer happens due to corruption and uncontrolled movements, and sick animals can be easily moved, haphazard grazing patterns also contributeto this problem.

Trade requirements between Tanzania and other countries are dictated by the exporting country. In case of a suspected or confirmed FMD outbreak in Tanzania, regulations stipulate that there should be notification to the trading partners and the OIE before and after confirmation of FMD cases. Measures taken when an FMD outbreak occurs in neighboring countries include prohibiting movement of livestock and livestock products across borders until 3months after the outbreak has finished. However, this is a challenge due to existing high corruption levels in the country.

4.4.8 Policy level group discussions

The following key points were identified which include poor communication mechanisms for better dialogue amongst and between stakeholders concerned with FMD control, including lack of involvement of livestock owners in the national dialogue. With regard to

prevention, the findings suggest that there is need to identify working control options of which vaccination was considered the most effective overall though dependent on identification of local circulating strains specific to each area. Furthermore, these discussions suggested the need to develop a policy and strategy for FMD vaccination as well as improve accessibility of vaccines to all different traditional livestock keepers.

CHAPTER FIVE

5.0 DISCUSSION

In this study, themean liters of milk produced per cow per day in the absence of FMDV are 6.51litres. This figure falls by an average of 2.67lts/cow/day, (25%) to 4.18lts/cow/day during an outbreak.Similar studies in other countries such as Kenya, Uganda, Ethiopia (Bayiyana *et al*., 2012; Jemberu *et al.,* 2014; Lyons *et al*., 2015) also reported economic losses. For example, a study in Ethiopia found the mean daily milk loss per cow was 1.8 litres (ranging 0–4 liters) and 1.8 litres (ranging 0.5–3 litres) for mixed farming and pastoral system respectively (Jemberu *et al.,* 2014). In Kenya, at the herd level, the average daily yields decreased from around 20 to13kg per cow, representing an average 15% reduction (Lyons *et al.,* 2015). In Tanzania, results of a similar study in the Serengeti ecosystem showed that FMD impacts were observed in losses associated with treatment costs (87.5%), milk productivity (85.0%), draught power (80.0%), livestock market loss (67.5) lower weight gain (60.0%), lower fertility (37.5%), abortion (35.0%), death of animals (25.0%) and vaccine supply cost (2.5%) (Mdetela *et al.,* 2014). This therefore justifies why milk production and treatment were considered as variables in this study. However, those of South and South-east Asia where cattle and buffalo are extensively used in small-holder rice-livestock production have also reported on economic losses due to FMD (Rast *et al*., 2010; Kumar *et al.,* 2012; Young *et al*., 2013). A loss of USD $52.4 per affected head of cattle was reported form Laos (Rast *et al*., 2010) while this reached USD $216.32–370.54 per affected cattle in Southern Cambodia (Young *et al*., 2013). A study in dairy farms in Pakistan reported a milk yield reduction of up to 30% two months after infection compared to the pre-clinical FMD yield (Ferrari *et al*., 2013).

Economic impacts of FMD do not need much emphasis. A number of studies around the world have already shown its importance (Thompson *et al.,* 2002). This can be corroborated by Kivaria (2003), Perry and Grace (2009) who reported that FMD is the most economically damaging trans-boundary livestock disease worldwide and its control would also benefit the poorest livestock keepers. All these observations are therefore, in agreement with the findings of this study.

In this study, the impact of FMD infection on milk yield of dairy cows wasobserved;FMD outbreaks resulted in reduced milk yields in individual herds.This compares with a similar study in Ethiopia (Mazengia *et al.,* 2010), which showed that the average milk yield (g) ahead of 10 days of FMD infection (1182.86±32.13) was found significantly ($P<0.05$) higher than that of the milk yield 10 days after infection (602.86±18.86). Furthermore, it was noted in this study that there is moderate but still significant relationshipbetween proportional milk loss per cow per day and the baseline productivity, such that high production in the absence of FMDV is associated with greater proportional losses in the presence of FMDV, rather surprisingly, none of the other explanatory variables i.e. treatment, vaccination, outbreak size, or grazing pattern seem to relate to either absolute or proportional loss. Lack of relationship between milk loss and vaccination presumably reinforces the impression that the vaccines currently in use in Tanzania are not very effective.FMD has diverse, albeit unmistakable impacts on livestock which contribute in one way or another to the livelihood of the commercial, pastoral and agro-pastoral community (Rich *et al.,* 2009). Controlling FMD in the Tanzanian setting will have positive market and non-market benefits, such as healthier animals, increased meat quantity and quality which could assist in increasing food security, possible additional household income, increased milk production and eventually improved market access.

This may lead to the conclusion that poverty may well be reduced by increased animal health (Perry and Sones, 2007).

Community level group discussion findingsdemonstrate that FMD has important consequences for many livestock-dependent Tanzanian communities despite its low mortality and of greatest concern to pastoralists and agro-pastoralists and was ranked highly by livestock dependent communities. In a study in Zimbabwe by Perry (2003), despite livestock keepers reporting no cases of FMD, as a proxy for FMD, impact of general sickness of cattle found that production losses, mainly in terms of income losses from sales and loss of draught power were the major problems for livestock dependent communities. Livestock owners report at least one FMD outbreak in a year, with some herds suffering from two and a few on zero grazing no outbreaks annually, in similar studies in East Africa, livestock owners consistently rank FMD among the top five most important livestock diseases (Cleaveland *et al.,* 2001; Bedelian *et al*., 2007; Ohaga *et al.,* 2007; Jost *et al*., 2010) with anecdotal evidence for an increasing frequency of outbreaks in pastoral herds and flocks.. Cattle suffer the highest morbidity, especially adult female cattle with considerable impacts on milk production. A loss of traction capacity is also a common problem in traditional systems using these animals for draft power. FMD control in these communities has therefore the potential to reduce vulnerability through increased milk and crop production.

The incentive for FMD control, however, differs significantly and is often weighted against the benefits of controlling other diseases that, unlike FMD, induce high mortality rates among infected livestock populations. Prevention of FMD infection in livestock, including cattle vaccination and movement control, is therefore expected to be an effective approach towards reduction of national- and local-level impacts of disease. In a study by

Paton (2009), a progressive approach is needed that can provide interim benefits along the pathway to final eradication. Research is needed to understand and predict the patterns of viral persistence and emergence and to improve vaccine selection. Better diagnostic methods and especially better vaccines could significantly improve control in both the free and the affected parts of the world. First, improved understanding of circulating viral strains and risk factors provides opportunities for exploring livestock vaccination strategies. For example, growing evidence from both West and East Africa indicates that livestock factors, including cattle movements, are major drivers of endemic FMD (Kivaria, 2003; Bronsvoort *et al.,* 2004; Picado *et al.,* 2011), and that proximity to wildlife-protected areas is not consistently identified as a risk factor for livestock outbreaks (Picado *et al.,* 2011; Lembo *et al.,* 2012). Therefore, work is still required to develop vaccines relevant to local circulating virus strains, and to design appropriate control strategies. Knowledge exchange mechanisms allowing researchers to identify locally-specific prevention approaches likely to be effective in a given setting, and communities to make use of research findings to manage disease risks in their herds are critical for reducing FMD impacts.Similar studies indicated that although pastoralists in East Africa indicate that, after tick-borne diseases, FMD is among the most important of livestock diseases (Cleaveland *et al.,* 2001; Bedelian *et al.,* 2007; Ohaga *et al*., 2007; Jost *et al.,* 2010; Catley *et al.,* 2013; De Garine-Wichatitsky *et al.,* 2013) this may not apply in other regions and other farming systems. Poor vaccination of animals observed during the study show that proper FMD vaccination awareness has not been depicted in the control of the disease. A good reason for most farmers not vaccinating their animals is the optional priorities of individuals in disease management where FMD records low mortalities among other livestock diseases as well as vaccines not working at all.In addressing why there are opposing views among different stakeholders on FMD control, one key element is that the impact of FMD is a function of the production system affected i.e. in

commercial dairy production system, there is high disease impact because the greater the production the greater the losses incurred; in agro-pastoral systems, losses are due to draft power losses whereas in pastoralist systems, there are limited losses as perceived by farmers therefore a lack of incentive to vaccinate. Furthermore, the potential uptake by farmers of control strategies, such as FMD vaccination (although efficacious vaccines and delivery remain elusive) is uncertain.

Overall priority areas of action identified from key informant interviewsand policy level group discussions are improving communication mechanisms and establishment of a unified command structure for better dialogue and reporting respectively amongst and between various stakeholders concerned with FMD control. This includes the involvement of livestock owners in national dialogue.However, in other studies, it was found that African countries that have established zonal FMD freedom have utilized a combination of animal movement control, separation of livestock and wildlife and vaccination of livestock (Vosloo *et al.,* 2003; Brückner *et al.*, 2004).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1Conclusion

In summary, the impact of FMD is poorly characterized in endemic areas. However, this study indicated that there is greater production losses due to reduced milk yields, when outbreaks occur compared to when they do not occur. Prevention of infection in livestock, including cattle vaccination and movement control, is therefore expected to be an effective approach towards reduction of national-and local-level impacts of disease. However, work is still required to develop vaccines relevant to local circulating virus strains, and to design appropriate control strategies. Knowledge exchange mechanisms allowing researchers to identify locally-specific prevention approaches likely to be effective in a given setting, and communities to make use of research findings to manage disease risks in their herds are critical for reducing FMD impacts.

6.2Recommendations

There is a need to develop a policy and strategy for FMD prevention and control to guide on how to control the disease and improve accessibility of vaccines to all different stakeholder groups. Important research areas for Tanzania to address to move the FMD control agenda forward include characterizing circulating strains, production and/or importation of vaccines matching circulating strains and predicting occurrence of outbreaks to guide the selection of appropriate vaccine strains to be used to prevent given outbreaks. Regulations for the control of FMD must be largely dependent on the country's legislation. In order to ensure effective FMD control, vaccination should be subsidized by government to increase demand for vaccination, due to the fact that some livestock keepers believe that the impact of FMD is low in individual herds. Furthermore FMD

vaccinations are public goods characterized by positive externalities, therefore, farmers must be reminded of importance of FMD prevention, as this boosts their output and hence their profits. There is an urgent need for government to devise working protocols for surveillance, monitoring and tracing of outbreak origins and to do this, engaging other relevant stakeholders is strongly recommended. There is a need to rank FMD as a priority disease for control and eradication if Tanzania were to export its livestock and its livestock products. There is also a need to review and finalize the national FMD control plan in line with the Progressive Control Pathway (PCP) developed by the Food and Agriculture Organization (FAO)/World Organization for Animal Health (OIE), (PCP-FMD, FAO/OIE, 2012). There is also a need to carry out follow up studies in Tanzania to ensure that the control scenarios evaluated are as realistic as possible, a sound epidemiological base for the economic impact assessment is essential.

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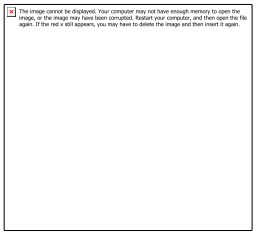
APPENDICES

Appendix 1: Questionnaire



ASSESSMENT OF SOCIO-ECONOMIC IMPACTS OF FOOT-AND-MOUTH DISEASE IN COMMERCIAL FIRM HIGH PRODUCTION SYSTEMS

Name of interviewer…… Date……..……..

1. **General information**

1.1 Location of firm

Region……District……..……..…Ward…….

Village……..…… Sub-village……

Owner/Head of firm……..……

1.2 Respondent details

Respondent ID:……..Gender:…… Age:……..

Ethnicity:

Masai Barbaig Sukuma Others (specify):

Position of the respondent in the household: (if household is part of the firm)

Head of the firm Co-owner Family member

Employee Others (Specify)…….

Position of the respondent in the firm:

Head of the firm Co-owner

Family member Employee Others (Specify)……

2. Firm Household demographics

Does the head of the firm have other households? Yes  No 

If yes, how many? .....

How long has the firm been operational? .....

If moved in last 10 years, where did you move from?.....

Why did you move?.....

3. Type of production system

Livestock only  Livestock and crops  Others, specify……

4. Details of livestock production

Dairy only  Beef only  Dairy and Beef  Others, specify…

5. Firm/Household characteristics

5.1 Firm staff composition:

Staff category	**Number of staff**		
	Females	**Males**	**Total**
Professional			
Technical			
Permanent labourers			
Casual labourers			
Other			

5.2 Firm/household assets

Asset	Number of units	Purchase Price Tsh (if purchased)	Age	Working Y/N
Ox Plough				
Ox Cart				
Vehicle				
Motorbike				
Bicycle				
Tractor				
Automatic milking machinery				
Television				
Radio				
Mobile phone				
Other 1…… 2…… 3…… 4……				

5.3 Staff Housing details

How many staff houses are there on the property? .....

Do any living quarters have a metal roof? Yes  No 

Are any living quarters built of concrete block or brick?

Yes  No 

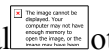
Latrine? indoor  outdoor  none 

Electricity? None  grid  off grid 

if off grid, specify……..

What is your primary water source? Tap  private well  community well  river  pond  other: ……

Energy source used? electricity  gas  kerosene 

cow dung  firewood  charcoal  other?.....

5.4 Firm details

How many buildings are there?.....

Do any buildings have a metal roof? Yes  No 

Are any buildings made of concrete block or brick?

Yes  No 

Electricity? none  grid  off grid 

if off grid, specify……..

What is your primary water source? Borehole  private well 

community well  river  pond  other: ……

5.5 Land use

Land Use	Owned	Rented	Communal
Grazing			
Crops			
Housing			

Crop-related production

Have you harvested any crops in the past farming season?

Yes  No 

Did you have to purchase anything relating to crop production over the past four months? Yes  No 

If yes, how much did you spend in total on crop production expenses in the past four months? TSH……...……..

6. Livestock summary

Number of animals currently at firm / household (Ad > 1yr; Juv 0-1yr):

	Cattle	Goat	Sheep	Pigs	Other …….
Adult	M: F:	M: F:	M: F:	M: F:	
Juvenile					
Total:					

Are your livestock: Zero Grazed  Grazed 

Fed and Grazed  Other? .....

If they are grazed, are they grazed in a communal area with other livestock? Yes  No 

Are they moved from one area to another to be grazed?

Yes  No 

7. Livestock-related Production

7.1. These questions relate to all species (i.e. including chickens, ducks etc). Poultry refers to chickens and ducks together.

What did you use your livestock for in the past four months?

Cattle: Milk  Meat  Draught  Sale 

Other, specify……..…

Goats: Milk  Meat  Sale 

Other, specify…….

Sheep: Milk  Meat  Sale 

Other, specify……

Pigs: Meat  Sale 

Other, specify……

Poultry: Eggs  Meat  Sale 

Other, specify……

8.2 Acquired (purchased) livestock

If you acquired any livestock (all species) in the past four months, please fill in the table below:

	Number	Average price of livestock acquired (or range) (Tsh/head)	Where acquired?	Reason for acquiring?
Cattle				
Goats				
Sheep				
Pigs				
Poultry				
Other				

8.3 Sold livestock

If you sold any livestock (all species) in the past four months, please fill in the table below:

		Number	Average price of livestock sold (or range) (Tsh/head)	Where sold?	Reason for selling?
Cattle	Calf (<12 mths)				
	Adult male (>12 mths)				
	Adult female (>12 mths)				
Goats					
Sheep					
Pigs					
Poultry					
Other					

8.4 Consumed livestock

If you slaughtered any livestock in the past four months, fill in the table below:

Species	Sex	Age (Juv/Ad)	Date	Consumed at home? Y/N	If no, where/what used for?

8.5 Livestock Products produced and sold

If you sold any livestock products in the past four months please fill in the table below:

	Product	Total amount produce /day	Amount sold/ day	Price sold at?	Average no. of animals producing/ day	How sold?[1]	Where sold?[2]
Cattle	Milk (lts/day)						
Goats	Milk (lts/day)						
Sheep	Milk (lts/day)						
Poutry	Eggs/day						
Cattle	Beef (kg/day)						
Other							

1. **P:** with pasteurisation, **WP:** without pasteurisation
2. **M:** market, **CP:** Collection point,

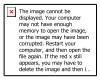
8.6 Did you purchase any of these things over the past four months?

Veterinary services/products	Feed	Supplements	Labour	Other
Yes No	Yes No	Yes No	Yes No	Yes No

Total Cost of these purchases for all livestock in the past four months?

TSH……

9. Livestock morbidity/mortality

9.1 If cattle, sheep or goats died in the past four months, indicate the total number that died: 

Indicate the causes:

Species affected	Date	Common Causes of death (*Disease/Predation/ Drought/Snake bite/Accident/ Others*)

9.2 Were any cattle, sheep or goats sick of disease in the past four months?

Yes  No 

If yes, indicate the total number that got sick: ……..

Fill out the table below:

Species	Date	Signs	Diagnosis if known	Died Y/N

10 Veterinary services received / sought

10.1 Routine veterinary services received/sought:

Vaccination/Immunisation Dipping/spraying

Deworming Others? (Specify)……

10.2 Other vaccinations:

Have you vaccinated any animals for other diseases during the past four months?

Yes No

If YES, fill out the table below vaccinations done:

Vaccination type	When	Vaccine used (if known)	No. cattle	No. sheep	No. goats	No. other species

10.3 FMD vaccination:

Do you vaccinate your animals against FMD? Yes No

If NO, why don't you vaccinate your herd for FMD?.....

If YES how many times do you vaccinate your animal against FMD each year?…

Have you vaccinated any animals for FMD during the past four months?

Yes No

If No, state date of last vaccination. ……..

If YES;

Species	Date of Vaccination	Vaccine Used	Cost of vaccination (TSH/vaccination/animal)
Cattle			
Goats			
Sheep			
Other			

Who vaccinated the animals? Organization Government veterinarian

Private veterinarian Self Other?.....…

If you travelled to obtain vaccination, where did you have to travel to? ……

What is the distance travelled (one way)? : ……..km

Were any government subsidies provided for the vaccination?

Yes No

Was access to the vaccine restricted so that you could not vaccinate as many livestock as desired? Yes No

How did the firm / household pay for the vaccination? Cash Loan in-kind trade Sell livestock Sell other assets

Other? .....…….

Do you know of any FMD control programmes in the area? Yes No

Is FMD vaccine available in your area? Yes No

If it is not, but it became available, would you consider vaccinating your herd at a cost?

Yes No

If so, how much would you be willing to pay for each vaccinated animal?

TSH.....

Do you think that other preventative measures would be;

More helpful  Helpful  Not Helpful  Other:……

If so, which ones? Vaccination  Movement Control 

Quarantine  Other: ……

11. History of foot-and-mouth disease in livestock in the village/herd in the past year

Have you heard of any cases of foot-and-mouth disease in animals in this area during the past year? Yes  No 

Where	Date	Species affected			
		Cattle	Goats	Sheep	Other…….

If YES, please fill in the table below:

Have you had any cases of foot-and-mouth disease in your animals during the past year?

Yes  No 

If YES, fill out the table below and tick which species were affected during each outbreak occurred in the past year:

Outbreak #	Date	Cattle	Sheep	Goats	Other species
1					
2					

12. Recent foot-and-mouth disease outbreak in your herd only

Why do you think that the outbreak occurred?

……

Do you know how FMD spread? Yes  No 

If YES, describe.....

……

Was the outbreak different from other outbreaks you have seen in your herd or flock?

Yes  No 

If Yes, how was it different……

Animals affected in recent outbreak?

Species	Total # of animals affected	Total # of animals that died	Total # of animals that aborted
Cattle			
Goats			
Sheep			
Pigs			
Other			

What did you do when the outbreak occurred in your herd?

Report to authorities  Treat the affected animals 

Restrict movement  Other actions? .....

Did you do anything to try and stop the disease spreading? Yes  No 

What did you do? Restrict movement  Quarantine 

Slaughter  Other? .....

Did animals which had FMD show any signs after they recovered from the disease?

Yes  No 

If yes, describe: .....

Did cow milk production decrease during the FMD outbreak?

Yes  No  No milking during outbreak 

If yes, how many litres were produced per day during the outbreak? …….

Did goat milk production decrease during the FMD outbreak?

Yes  No  No milking during outbreak 

If yes, how many litres produced per day during the outbreak? …….

If milk production decreased, did you stop selling milk during the outbreak?

Yes  No  No milking during outbreak 

If milk production decreased, did you stop consuming milk during the outbreak?

Yes  No  No milking during outbreak 

If you own working draught animals, did you perceive that FMD affected their

productivity for traction? Yes  No 

Because of FMD did you alter the amount or type of crops you produce?

Yes  No 

Did the FMD outbreak cause you to alter time spent on/off farm work?

Increase  Decrease  Not change 

By how much? ……..

Did you slaughter and consume any animals with FMD? Yes  No 

Did animals die during the outbreak? Yes  No 

If animals died, were they consumed? Yes  No 

If NO, how did you dispose of animals that died because of FMD?

Burn  Bury  Other? …….

How much time did this take?.....

Did FMD affect whether you sold livestock or not? Yes  No 

If YES, why? .....

Did you sell animals during the FMD outbreak? Yes  No 

Did you sell animals exhibiting FMD characteristics? Yes  No 

Did you have to sell any animals because of the outbreak? Yes  No 

How many? …….

Why?.....

If your livestock are grazed, did you alter your routine practises because of the FMD outbreak? Yes  No 

If yes, why?.....

Did you stop moving your animals because of the FMD outbreak?

Yes  No 

If yes, why?.....

13 <u>Other FMD treatments</u>:

Did you treat your animals for FMD during the past outbreak?

Yes  No 

If yes;

Species	Date of Treatment	Treatment used	Cost of treatment (TSH/treatment/animal)
Cattle			
Goats			
Sheep			
Other			

Who treated the animals? Organization  Government veterinarian 

Private Veterinarian  Self  Other:……..

If you travelled to obtain treatment, where was it obtained?.....

What is the distance travelled (one way)? : ……..…..km

Were any government subsidies provided for the treatment?

Yes  No 

Was access to the treatment restricted so that you could not treat as many livestock as desired? Yes  No 

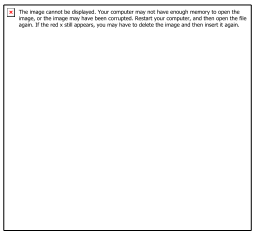
How did the household pay for the treatments?

Cash  Loan  Sell cattle  Other asset 

In-kind trade  Other?……

THANK YOU FOR YOUR COOPERATION

Appendix 2: Consent form



Informed consent agreement for study participants

Title of Study: Socio-economic assessment of foot-and-mouth-disease in high-production systems in Tanzania

Study rationale and aim: We are carrying out research on foot-and-mouth disease in livestock. The aim of this project is to understand the costs of foot-and-mouth disease to farmers. These data are important as they will increase awareness about the implications and productivity losses related to this disease, so to be able to implement control strategies that will reduce these impacts. In order to quantify these losses, we would like to ask you some questions about your household, your income sources and expenditures, including the costs and losses associated with keeping livestock, the health status of your animals, your experience of foot-and-mouth disease in your herd and management practices that you have used to control the disease.

Potential risks: No risks are anticipated in this study except minimal interruption in your time to participate in this survey.

Potential benefits: You and your village will be informed of the broad results obtained and what they mean. We will also discuss with you if there are any actions you might want to take to reduce the impacts of foot-and-mouth disease in your herd. In the end, this study will lead to better control of foot and mouth disease in Tanzania. However, you will not see this benefit during the study.

Compensation: Your participation in this study will be voluntary. However, recommendations will be provided to you regarding ways of containing foot-and-mouth

disease in your herd. Your participation in this study is not compulsory, and you have the right to decline to participate in this study or to not answer any of the questions that we will ask you. There will not be any repercussions on the quality of veterinary care you are receiving from withdrawal from this study.

Data confidentiality: Your answers are completely confidential and your name will not be included in any reports of these results. Your individual answer will not be shared with anyone. In presenting or publishing this study, your household will be represented by a code number, so that any facts about you or your household are kept private.

Contact person in case of emergency: For any emergency cases, please contact……....on +255…….. (phone no.) or through …….(email address).

Participant's information

Village/town name: _____

Village leader (where appropriate): Name _____ Phone no. _____

Study participant: Name _____

Phone no. _____

I hereby give full approval to the researchers of the Sokoine University of Agriculture to conduct this study in my household.

I understand the background and objectives of this research project and I am fully aware of the nature of the research and my role in it.

Signature or thumbprint of participant: _____

Date: _____

Signature of witness:_____ Date:_____

Research team statement

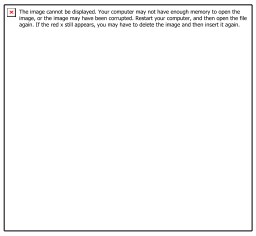
Name of the research officer:_____

Signature: _____

Contact details: _____

I hereby confirm that I have explained the objectives, potential risks, benefits and any compensation of this study to the participants in a language they understand.

Appendix 3: Group Discussion themes



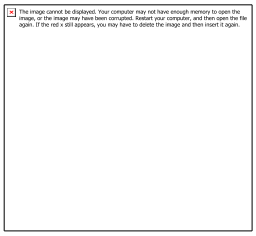
Workshop Information	
Title:	
Date:	
Location:	
Facilitator:	
Host:	
Number of participants:	
Information about participants:	

WORKSHOP RESULTS

<ECONOMIC AND POLITICAL DRIVERS OF FOOT-AND-MOUTH DISEASE CONTROL IN TANZANIA>	
<FMD Prevention>	
Current approaches working	Barriers to FMD Prevention
Solutions to barriers	Incentives for FMD Prevention
	Notes
•	•
<FMD Reporting and Surveillance>	
Current approaches working	Barriers to FMD Prevention
Solutions to barriers	Incentives for FMD Prevention
	Notes
•	•

<u>FMD Vaccination Challenged discussed in groups</u>

Appendix 4: Expert interview themes



INTERVIEWS TO IDENTIFY INSTITUTIONAL PROCESSES RELATED TO FMD SURVEILLANCE AND CONTROL IN TANZANIA (CENTRAL-LEVEL)

A. Legislative frameworks relevant to FMD and official definitions

1) Existing law / regulations on FMD reporting/surveillance, control and contingency planning. Provide a brief outline.
2) Are there any formal definitions for FMD outbreaks and cases in the existing legislative frameworks?
3) Is there a national plan for FMD control in Tanzania? Is this accessible?
4) What are the political drivers of FMD control in Tanzania, who are more broadly driving current policy development in Tanzania?

B. FMD surveillance and diagnosis

1) Is reporting/notification of cases regulated by law and are there any penalties in case of non-compliance?
2) Who is responsible for notification of suspected cases to local- and central-level authorities (e.g. livestock owners, private/government veterinarians/livestock officers)?
3) Who is responsible for clinical examination of suspected cases?
4) How do regional- and government-level structures and processes link with local-level structures?
5) Notified agency/organization - Actions to be taken after receiving initial notification.

6) What efforts are made to encourage early notification (e.g. any compensation scheme for affected farms, strengthening communication with farmers, educational activities etc)?
7) History of FMD outbreak status in the past ten years? Number of notifications received (and number of positive cases, if any)? Date of latest FMD outbreaks?
8) Which laboratories/agencies are responsible for laboratory confirmation of cases or routine screening?
9) Which tests are conducted from detection of suspected cases to confirmation of disease?
10) Are any methods used to distinguish from other vesicular diseases (e.g. vesicular stomatitis, swine vesicular disease)?
11) Information on programs for monitoring of FMD in susceptible species (livestock or wildlife).
12) Are there any active surveillance systems in place? If so who is responsible and what is the sampling methodology, e.g. target population; area; farming category (dairy, fattening, breeding); number of animals to be sampled within the population; method of selection of animals to be sampled; timing and frequency of sampling; and people in charge of taking samples?

C. Response to FMD outbreaks

1) Outline of epidemiological tracing and investigation of outbreaks to determine suspected sources of introduction and transmission routes.
2) Chain of command, roles and responsibilities of national government, local government, and other relevant agencies/organizations in case of outbreaks.
3) Establishment of restriction zones, description of restrictions within zones (movement control etc.) and the requirements to lift these zones.

4) Measures to be taken in the affected districts (e.g. destruction of animals, carcass disposal, cleaning and disinfection).
5) What is the response capacity of governing institutions for FMD control?
6) Definitions of related districts (e.g. epidemiologically related district, high risk district) and measures to be taken in farms within related districts (e.g. destruction of animals, movement restriction, emergency vaccination, targeted surveillance, controlled slaughter).
7) Compensation scheme, if any.

D. General FMD control measures

1) Information on programs for control of FMD in susceptible species (livestock or wildlife) in Tanzania.
2) Are zoning and/or compartmentalization structures in place in Tanzania? For example, are there areas with different FMD status?
3) What are the economic and political drivers of FMD control in Tanzania? (Which stakeholders have an interest in FMD control? What are the economic, political, social incentives for different stakeholders to achieve FMD control? Which stakeholders are driving current policy development in Tanzania?)
4) What are the Epidemiological barriers to FMD control – identify potential interventions, what is the efficacy and effectiveness of different interventions? Economic barriers – what is the cost of available interventions (economic and environmental costs) What are the other operational barriers – e.g. infrastructure and delivery? What are the political and social barriers – e.g. environmental/conservation concerns?
5) Opinions on control methods used

E. FMD vaccination

1) Agencies/organizations responsible for supervision and approval for production, marketing, distribution, usage, and import of FMD vaccine.
2) Vaccination policy for FMD (e.g. mandatory vaccination, emergency vaccination only, vaccination prohibited).
3) Detail information on vaccines stocked by the government for emergency vaccination, if any.
4) Information on cost of vaccines, price changes with/without outbreak

F. Border control measures against FMD

1) Requirements and quarantine measures for the import and export of FMD susceptible animals and their products from and to FMD free country without vaccination (if any), e.g. attachment of the health certificate, inspection of live animals or animal products etc.
2) In case of a suspected or confirmed FMD outbreak in Tanzania, what is the timing for notification to the trading partners (before or after confirmation of FMD cases)?
3) In case of a suspected or confirmed FMD outbreak in Tanzania, what is the timing for notification to the OIE (before or after confirmation of FMD cases)?
4) What measures are taken when an FMD outbreak occurs in neighboring countries?

Appendix 5: General Linear Model

a) glm(formula = SLM ~ Milk.cow.day+Treatment + vaccination_Y.N + Duration_outbreak_mths + grazing_pattern)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-13.2662	-1.1989	0.4274	2.7569	4.5111

Coefficients:

	Estimate	Std. Error	t value	p-value	
(Intercept)	-4.5088	2.2231	-2.028	0.05093	.
TreatmentY	-1.0226	2.9861	-0.342	0.73424	
vaccination_Y.NY	-1.7431	1.5174	-1.149	0.25918	
n_outbreak	-1.1442	1.7005	-0.673	0.50585	
Duration_outbreak_mths	1.7142	1.6141	1.062	0.29617	
grazing_patternprivate	2.7762	1.4589	1.903	0.06607	
grazing_patternzero_grazing	-0.8875	2.3991	-0.370	0.71388	
Milk.cow.day	0.9704	0.2220	4.371	0.000122	***