Cost-benefit and feasibility analysis for establishing a foot and mouth disease free zone in Rukwa region in Tanzania

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ACRONYMS

AU-IBAR	African Union – Interafrican Bureau for Animal Resources
BIP	Border inspection post
BQ	Black Quarters
BVI	Botswana Vaccine Institute
CBA	Cost-Benefit Analysis
CBPP	Contagious Bovine Pleuropneumonia
CIDB	Centre for Infectious Diseases and Biotechnology
CIF	Cost Insurance and Freight
DED	District Executive Director
DFZ	Disease Free Zone
DVO	District Veterinary Officer
DC	District Council
DIVA	Differentiation of infected from vaccinated animals
DRC	Democratic Republic of the Congo
DVS	Director of Veterinary Services or Directorate of Veterinary Services
ECF	East Coast Fever
ELISA	Enzyme Linked Immunosorbent Assay
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
FMD_FZ	Foot and Mouth Disease Free Zone
FMD_QV	FMD quadrivalent vaccine
IBRD	International Bank for Reconstruction and Development (The World Bank)
IDA	International Development Association
IFAD	International Fund for Agricultural Development
KEVEVAP	Kenya Veterinary Vaccine Production Unit
LGA	Local government authority
LITS	Livestock Identification and Traceability System
LITU	Livestock Identification and Traceability Unit
LSD	Lumpy Skin Disease
MALF	Ministry of Agriculture, Livestock and Fisheries
MC	Municipality Council
MLFD	Ministry of Livestock and Fisheries Development
MRA	Mixed arid/semi-arid systems
MRH	Mixed humid/sub-humid systems
MRT	Mixed, Temperate/Tropical highlands
NARCO	National Ranching Company Ltd
NGO	Non-governmental organisation
OIE	World Organisation for Animal Health
PACE	Pan African Control of Epizootics (Programme)
PCP	Progressive Control Pathways
PPG	Project Preparation Grant
PCR	Polymerase Chain Reaction
RC	Regional commissioner
RAS	Regional Administrative Secretary
RVC	Royal Veterinary College
SAAFI	Sumbawanga Agricultural and Animal Food Industries Limited

SADC	Southern African Development Community
SAT	Southern African Type
SBA DC	Sumbawanga District Council
SBA MC	Sumbawanga Municipal Council
SHDDP	Southern Highlands Dairy Development Project
SPS	Sanitary and Phytosanitary Measures
STDF	Standards and Trade Development Facility
SUA	Sokoine University of Agriculture
SWZ	South Western Zone
TADAT	Dairy Trust
TAHC	Terrestrial Animal Health Code
TAMPA	Tanzania Milk Processors Associations
TAMPRODA	Tanzania Milk Producers association
TAS	Tanzanian Shillings
TBS	Tanzania Bureau of Standards
TBT	Technical Barriers to Trade
TDDP	Tanga Dairy Development Project
TFDA	Tanzania Food and Drugs Authority
TIB	Tanzania Investment Bank
TMB	Tanzanian Meat Board
TPL	Tanganyika Packers Limited
TVLA	Tanzania Veterinary Laboratory Authority
WHO	World Health Organization
USAID	United States Agency for International Development
ZVC	Zonal Veterinary Centre

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EXECUTIVE SUMMARY

This report reflects the findings and recommendations following fieldwork and analysis under the Project Preparation Grant (PPG), entitled "Benefit-Cost Analysis for Establishing a Foot and Mouth Disease (FMD) Free Zone in Tanzania" (STDF/PPG/516), funded by the Standards and Trade Development Facility (STDF). The Department of Veterinary Services, in the **Ministry of Livestock and Fisheries Development** (MLFD), requested this PPG, which was approved by the STDF Working Group in October 2015. The Royal Veterinary College (RVC) was contracted to implement the PPG, in close collaboration with the Department of Veterinary Services and other concerned stakeholders in Tanzania.

The MLFD selected the **Rukwa region in southwestern Tanzania** to pilot the establishment of a **foot-and-mouth disease (FMD) free zone**. The aim of the PPG was to estimate the costs and benefits of establishing an FMD-free zone in Tanzania and recommend potential follow-up actions to guide policy makers on the economic merits of such a large investment.

Foot-and-mouth disease is perceived as a very high impact disease in Tanzania. The disease can cause serious production losses and bar the trade of live animals, beef and other animal products due to imposed bans. The Rukwa region was selected by the Department of Veterinary Services because of its geographical location, being well demarcated on a plateau and surrounded by natural barriers, notably Lake Tanganyika on the southwest, Lake Rukwa in the northeast and the Katavi national park in the northwest. Its natural resources and climate provide good livestock production potential and the area is supported by good infrastructure of communication and road networks, processing and marketing facilities, livestock multiplication units and existing cattle ranches.

The Rukwa region is populated by farmers who predominantly practise extensive agro-pastoral production, keeping mainly indigenous zebu cattle, sheep and goats and fewer pigs and chickens. Crop production is the predominant economic activity. Cattle have an important role in cultivation as a source of draft power and manure, but are primarily kept as a store of wealth and social capital. They are mainly sold to meet expenses, which may include school fees, food and clothing purchases, or capital for building. This pattern is observed even in very large herds. Cattle are therefore not seen as a way of wealth creation/economic activity through sales but rather a store of capital. The absence of “animal harvesting” to build a cash store and a culture of banking cash, further exacerbates this practice. Semi intensive production systems are found at the more commercial beef ranches of Kalambo, which is a National Ranching Company (NARCO) Ranch, and Nkundi, which is a Sumbawanga Agricultural and Animal Food Industries Limited (SAAFI) ranch.

Rukwa region has several active primary cattle markets. In addition, there is a border market in Kathete ward, which formed over recent time due to the high demand from two modern abattoirs in neighbouring Zambia. Official estimates of legal cross-border cattle movements were reported as 422 cattle per month, a seven-fold increase since the opening of the abattoirs. Statistics of unofficial or illegal cross border movements are unknown but expected to be high given the open border and the costs of official movement permits and export fees. In general, live cattle exports from across Tanzania are trekked to Burundi, Rwanda, Uganda, DRC, Zambia, Malawi and Mozambique.

Apart from small slaughter slabs in Rukwa there is only one abattoir owned by SAAFI, which opened in 2007 but was at a standstill during our visit in September 2016 and still not operating in August

2017 when this report was finalised (plant closed since early 2016). It sourced cattle from local ranches and supplied Tanzanian city markets and regional and overseas international markets. All stakeholders suggested that the revival of this abattoir was an essential part in upgrading the beef value chain in Rukwa region. Existing beef export channels reported by the Tanzanian Meat Board (TMB) include gulf countries of Dubai, Oman, Iraq and Kuwait and boneless beef to Vietnam. The TMB described a strong future potential demand for beef exports to the Middle East and Egypt.

Small scale livestock keepers in Rukwa region perceived FMD outbreaks to have less impact than other diseases (e.g. Contagious Bovine Pleuropneumonia, CBPP; East Coast Fever) because of low mortalities, little loss of traction and although a drop in milk production was noted, milk was only for household use and not for sale. If the government were not supplying vaccines, farmers did not see the value in purchasing them privately. The larger ranches by contrast recognised losses in production (live weight) and calf mortalities but still referred to CBPP as their main concern. **They described FMD vaccines as expensive and difficult to access.**

The proposed FMD control plan is to create disease free populations in the ranches and then expand to the whole zone with a supportive surveillance system. The cost-benefit analysis included estimation of the disease for agro-pastoralists, pastoralists and ranch farmers, the outbreak control costs, costs of vaccination and supportive surveillance, and the benefits from avoiding disease costs. The results were analysed to show the benefit that would be required through income generated from export trade to break even. **The marginal gain in income derived from export would need to be USD 28.59 million to match the negative Net Present Value of the same amount.** In other words, a 53% increase in price for export quality hindquarter cuts would be needed before any positive gains would be made on the investment.

Although a Livestock Identification and Traceability System (LITS) exists elsewhere in Tanzania, it is not yet in use in Rukwa. It has been criticised as being complicated and will require fine-tuning to make it more practical and easier to use. To date, funding pressures have been the critical barrier and public private partnerships are being discussed to share costs of training, implementation and ongoing support.

Vaccines are sourced from the two main producers, namely the Botswana Vaccine Institute (BVI) and the Kenya Vaccine Production Unit (KeVeVAP). For diagnostics, only the Tanzania Veterinary Laboratories Authority (TVLA) has a Centre for Infectious Diseases and Biotechnology (CIDB) in Dar es Salaam, which deals with diagnosis of viral diseases. It has OIE status for FMD diagnosis and is the recommended laboratory for diagnoses and surveillance in this programme. It also has the capacity to offer training to field staff in the proper methods for collecting, preserving and shipping of samples to the Dar es Salaam laboratories.

Tanzania has had two previous attempts to control FMD in the past; the ongoing effort is the third one (it started in 2000). Lessons learned that are applicable to this project include: 1. To give valid estimates of benefits, sound data on FMD impacts within relevant livestock production systems is needed; 2. Deciding to implement a control programme should be based on more than just demonstration of technical capacity and cost-effectiveness; for example, the programme requires the support of a dedicated champion and continuity of institutions throughout; 3. A programme associated export abattoir and defined export premium market are required to provide incentives for

control; and 4. Agreement is required as to which control policy is most suited and which control principles are to be incorporated.

The report concludes that the proposed FMD programme is unlikely to be cost-effective, primarily due to the lack of market opportunities, the uncertainty of SAAFI's future involvement in the in-country value addition and the low off-take / need-based selling of cattle and the perceived low impact of FMD by farmers. Porous borders and challenges in livestock identification and movement control will also complicate substantially control efforts – in particular in the absence of fencing. The reliable supply of effective vaccines is a pre-requisite for control but is currently uncertain. There is also a background of land use issues between pastoralists, agro-pastoralists and wildlife adding to the challenges.

In light of these challenges and the outcome of the analysis, it may be worth exploring the option of Commodity Based Trade and a value chain approach to producing FMD safe deboned beef from an endemic area. However, this option has similar requirements and would therefore require substantial investments too, namely a LITS, a deliverable and sustained vaccination and surveillance programme, enforced movement control measures, the availability of an export market, and investment in infrastructure (abattoirs and deboning processing plants) so that export requirements can be met. Hence, the challenges to be addressed would be similar to those of a FMD control programme. Among the countries in the region, Namibia has managed successfully to produce CBT beef for export, based on an OIE endorsed FMD control programme with government subsidised vaccination and a nationwide compulsory LITS.

Recommendations include addressing major data gaps and a refinement of the national control plan with particular reference to the surveillance strategy. Leaders and champions of the programme are needed to facilitate progress. **The existing ranches should be a starting point; they have made larger investments into production and management and have better finished cattle and higher off-take rates.** Research to understand better acceptable incentives for farmers to increase off-take rates is recommended. Mobile banking opportunities should be explored as part of this research. The LITS is a foundation to FMD control and must be logistically refined with public private partnerships and promoted. Markets must to be explored and developed to provide stable opportunities for suppliers. Institutional capacity building is needed to improve disease management and surveillance to identify hotspots for FMD emergence, and to include other diseases to improve synergies. With regards export opportunities, it needs to be borne in mind that high-end export markets are also increasingly imposing additional standards, requirements and preferences concerning animal welfare, organic production, drug residue testing and food safety, making access even more difficult even with successful FMD control. It is therefore critical that the export markets and likely returns are explored before investment is made in high cost control programmes.

1 INTRODUCTION

1.1 Background

Tanzania has abundant natural resources including widespread rangelands, which support one of Africa's largest wildlife populations and in turn provides substantial tourist revenue to the state. These rangelands also support livestock populations that contribute 7.4% to the country's GDP with an annual growth rate of 2.2%[1]. Livestock sector growth is mainly due to an increase in livestock numbers rather than productivity gains. Even though half of the households keep livestock and 70% of poor rural populations depend on livestock for their income and livelihoods [1], the sector is severely constrained by low livestock reproductive rates, high mortality, lack of market opportunities, low yielding breeds, poor management structures, and high disease prevalence.

Foot-and-mouth disease is perceived to have a very high disease impact in Tanzania. The disease causes production losses, particularly in dairy cattle, affecting large and small-scale dairy producers. In addition, it can bar the trade of live animals, beef and other animal products due to imposed bans. Household surveys conducted recently as part of a study in Northern Tanzania indicate that FMD is a problem for many farmers [2]. According to Perry and Rich [3], FMD is ranked third (after gastro-intestinal helminths and neonatal mortality syndrome) amongst animal diseases having the greatest impact on overall poverty levels.

Economic losses attributable to FMD in Tanzania include losses through quarantine, export market loss, milk losses, weight losses, breeding losses (due to longer calving intervals, sterility, abortions), loss of traction power, and deaths particularly among calves but also among the mature exotic cattle [4].

Sere and Steinfeld [5] developed a global classification system for livestock production, with four production categories: landless systems (typically found in peri-urban settings), livestock/rangeland-based systems (areas with minimal cropping, often corresponding to pastoral systems), mixed rain fed systems (mostly rain fed cropping combined with livestock, i.e. agropastoral systems), and mixed irrigated systems (significant proportion of cropping uses irrigation and is interspersed with livestock). In Tanzania, the mixed irrigated systems cover less than 1% of the surface land area. About one third of the agricultural area in Tanzania is under grasslands supporting (agro-) pastoral livestock production, but the most common production system is **mixed rainfed crop-livestock systems**, covering just over 50% of the land (Figure 1). Bovine densities are highest in the mixed arid/semi-arid (MRA) and humid/sub-humid (MRH) systems as well as in urban areas. The lowest bovine densities are found in rangeland humid/sub-humid (LGH) systems.

Tanzania has the third largest livestock population in Africa after Ethiopia and Sudan. The **livestock population** as of October 2010 (census data) included 21 million cattle, 15.2 million goats, 5.7 million sheep, 1.6 million pigs, and 42.7 million chickens [1]. The regions of Shinyanga (>3m) and Singida (>2m) had the highest number of cattle, followed by Mwanza, Arusha, Mara, Manyara, and Mbeya (all

[1] Statistics from the NBS National Accounts May 2015

>1.5m) [1]. At the household level, livestock keeping is important and an integral part of agriculture based livelihoods for a significant proportion of the Tanzania population.

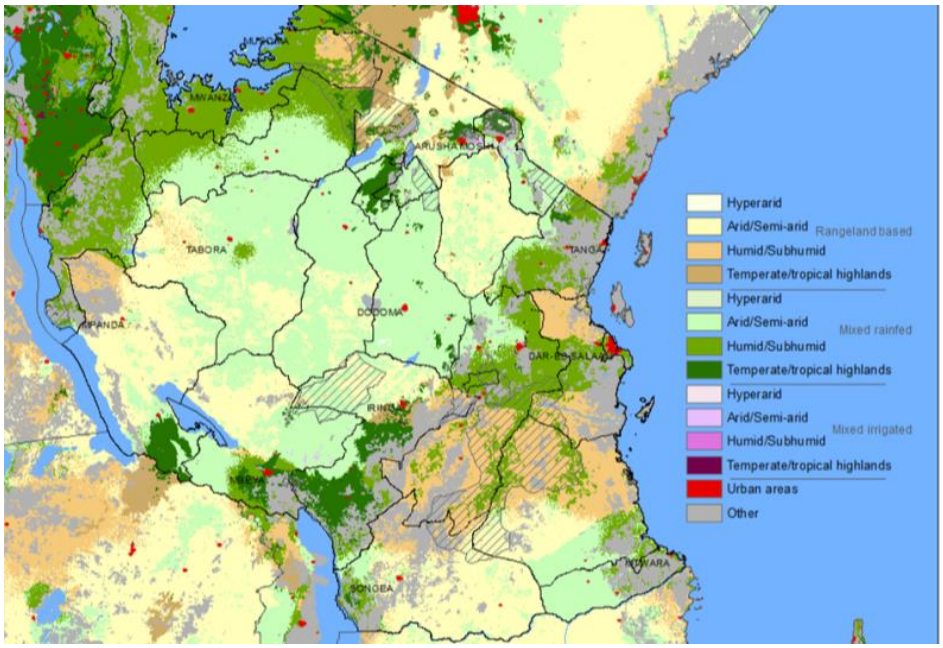

Figure 1. Distribution of production systems in Tanzania. Source: [6]**.**

Human population densities derived from data of the Global Rural-Urban Mapping Project (GRUMP) for the year 2000 show that in the rangeland areas the lowest population densities prevail (mean 10.1-11.3 people/km^2; SD +/- 4.2-4.9), while densities increase in the mixed systems (32.7-52.0 people/km^2, SD +/- 31.8-44.1) (Figure 2). The World Bank's 2015 report "Tanzania's Mainland Poverty" [7] stated that in 2012 approximately 70% of Tanzanians lived in poverty (defined as less than $2 per person per day), and over 80% of the poor and extreme poor lived in rural areas. More than half of these rural poor depend on subsistence agriculture for their livelihoods.

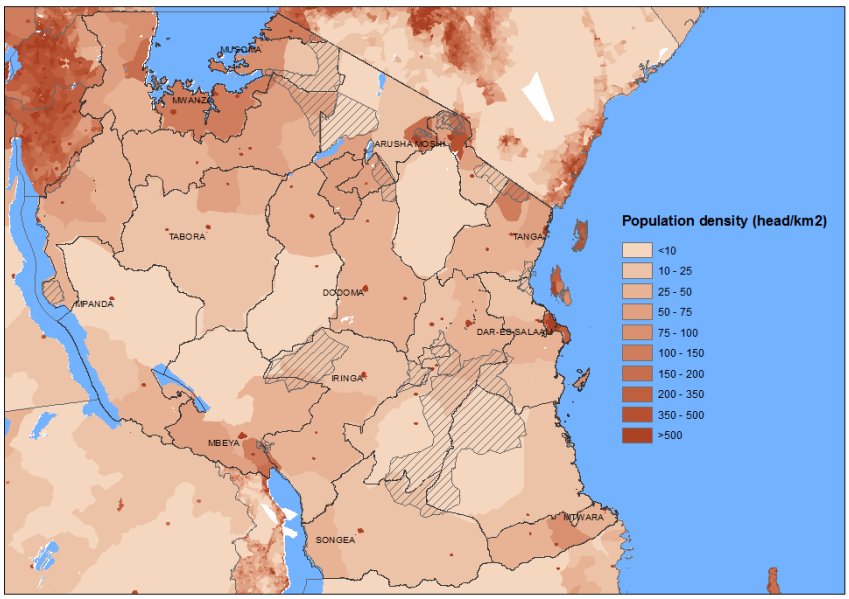

Figure 2. Distribution of human population density in Tanzania. Source: [6]

Rukwa region in south western Tanzania was selected by the Ministry of Livestock and Fisheries Development (MLFD) to pilot test the establishment of a FMD free zone in Tanzania. The following selection criteria were applied:

(a) Geographical location: the area is well demarcated from other areas by natural barriers which are formed by the Lake Tanganyika on the south west, Lake Rukwa in the north east and the Katavi national park in the north-west. These natural barriers can be strengthened by electric fences, if necessary. The border with Zambia to the south is a shared international border between Tanzania and Zambia;

(b) Potential for livestock production: The area has indigenous animals of good genetic merit (Ufipa zebu), suitable climatic conditions, adequate rain, and fertile land;

(c) Infrastructure for livestock production: The area has existing ranches and livestock multiplication units, processing plants and marketing facilities, roads, and communication networks;

(d) Public/private partnership: The area has large commercial ranches belonging to the national ranching company (NARCO) with established management systems.

1.2 Aim and objectives

In October 2015, the STDF Working Group approved a project preparation grant (PPG) entitled *"Benefit-Cost Analysis for Establishing a Foot and Mouth Disease (FMD) Free Zone in Tanzania"*. The PPG was requested by the Department of Veterinary Services in the Ministry of Livestock and Fisheries Development and supported by various government stakeholders.[2] The Royal Veterinary College (RVC) was contracted to implement the PPG, in close collaboration with the Department of Veterinary Services and other concerned stakeholders in Tanzania.

The **aim** of the PPG was to estimate the costs and benefits of establishing an FMD-free zone in Tanzania and recommend potential follow-up actions to guide policy makers on the economic merits of such a large investment. Depending on the findings and recommendations of the analysis, further steps may be initiated to secure funding to establish the said zone or any alternative intervention that may be recommended.

The analysis was to be based on consultations with relevant stakeholders (government, private sector, development partners, donors, etc.) and aimed to include a **systematic examination** of the following:

i. Target livestock products and markets to determine demand and trade benefits of the establishment of an FMD-free zone including both regional and other international markets as well as trade-related constraints beyond FMD.
ii. The environmental impact of this FMD-free zone from a conservation and tourism point of view (e.g. game-proof fencing).
iii. Livestock population, productivity level, potential access to markets, access to slaughterhouses and processing plants of the proposed zone.
iv. Human resource needs and infrastructural requirements related to upfront and ongoing costs for the establishment and maintenance of the FMD-free zone.

[2] Including the Ministry of Livestock and Fisheries Development, Rukwa Regional Commissioner's office (Zonal Veterinary Centre) in Sumbawanga, the Tanzania Meat Board, and the Tanzania Veterinary Laboratory Agency.

v. Experiences from other African countries such as Uganda, Botswana and Namibia regarding the establishment and maintenance of FMD-free zones.
vi. Whether alternative investments in relation to FMD management may be worth focusing on.

1.3 Study approach

Part 1: Following an initial conceptualisation of the study plan, a scoping visit was held in Tanzania from the 9th to the 22nd of September 2016 to gain an overview of the geographic, livestock, human population, socio-economic, disease, infrastructure, and service characteristics of Rukwa region by means of semi-structured interviews. Moreover, a range of stakeholders from the Ministry of Agriculture, Livestock and Fisheries (MALF) were consulted and statistics and data were collated on the characteristics above. This scoping study provided important information to inform the structure of the cost-benefit analysis (CBA). The list of people met is available in Appendix 1.

Part 2: In a second step, the plan for the analysis was updated taking into account the findings from the scoping visit. Primary and secondary data collection and analysis were conducted by the national and international consultants. Further stakeholder interviews were conducted in Tanzania by the national consultant (Appendix 1). Representatives from the MALF updated the national control plan taking into account points discussed during the scoping study. Cost-benefit analysis models were developed in @Risk for Excel to estimate the different costs of implementing a disease free zone and the resulting benefits. The models were populated with input data.

Part 3: In a second visit to Tanzania in March 2017, the progress with the analysis was discussed and data gaps were addressed by visiting and interviewing further stakeholders. Following this, the analyses were completed, the results interpreted and discussed and a full draft report put together for reviewing and revising.

Part 4: A study tour to Zambia was conducted in July 2017. Zambia was chosen because of the joint neighbouring country issues of cross-border disease control and their history of attempting a FMD Disease Free Zone. The tour included a day in Lusaka to meet the Zambian Chief Veterinary Officer and the coordinator of the Disease Control Unit, and to visit the laboratory facilities at the Central Veterinary Research Institute in Balmoral, 20 km to the southwest of Lusaka. This was followed by a day in Mbala in the Northern Province (20 km from the border crossing of Kasesya) to visit the District Veterinary Officer and staff, the Zambeef abattoir and to review planned locations of veterinary quarantine and loading ramps on the Zambian side of the border. The Tanzanian side of the border crossing was also visited for the Zambian Veterinary staff to hold discussions with the Tanzanian Veterinary inspector at the border (Appendix 1).

Part 5: Following the study tour, the findings were integrated into the report for reviewing and revising among collaborators in preparation of a final report.

2 RUKWA REGION CHARACTERISATION

2.1 Geographical description

The Rukwa region is one of 25 regions in Tanzania located in the South Western part of Tanzania. It was established in 1974, when parts of Mbeya and Tabora Regions were demarcated to form a new region. Because of the creation of Katavi region, the remaining land area in Rukwa region now covers an area of 27,765 km^2, of which 21,160 km^2 is land area, and the remaining 6,605 km^2 are water areas [8]. It is located in the Southwest of the country bordered by the regions Katavi in the North/Northeast and Mbeya in the Southeast (Figure 3). Lake Tanganyika separates it from the Democratic Republic of Congo (DRC). The Rukwa region's land border with Zambia spans a distance of approximately 120 km. There is one national park (Katavi National Park) and three game reserves, namely (1) Luafi Game Reserve, (2) Rukwa Game Reserve, and (3) Uwanda Game Reserve. The highest point of the region is at Malonje in the Ufipa plateau at 2,461 meters above sea level and the lowest point is Lake Tanganyika at 773 meters above sea level [8]. A more detailed map can be found in Appendix 2.

Figure 3. The 25 regions in Tanzania and neighbouring countries. Rukwa region is in the Southwest of the country. Downloaded from www.mapsoftheworld.com.

2.2 Administrative units

2.2.1 ADMINISTRATIVE INSTITUTIONS IN TANZANIA

The government in Tanzania is divided into two arms, namely the central government and local government (Figure 4). The central government is made up of the presidency and sectoral ministries such as the Ministry for Regional and Local Government placed in the office of the president and the Ministry of Agriculture, Livestock and Fisheries. For administrative purposes the country is divided into about 30 regions each headed by a Regional Commissioner (RC) assisted by the Regional Administrative Secretary who heads the Regional Secretariat composed of experts in different technical and economic fields.

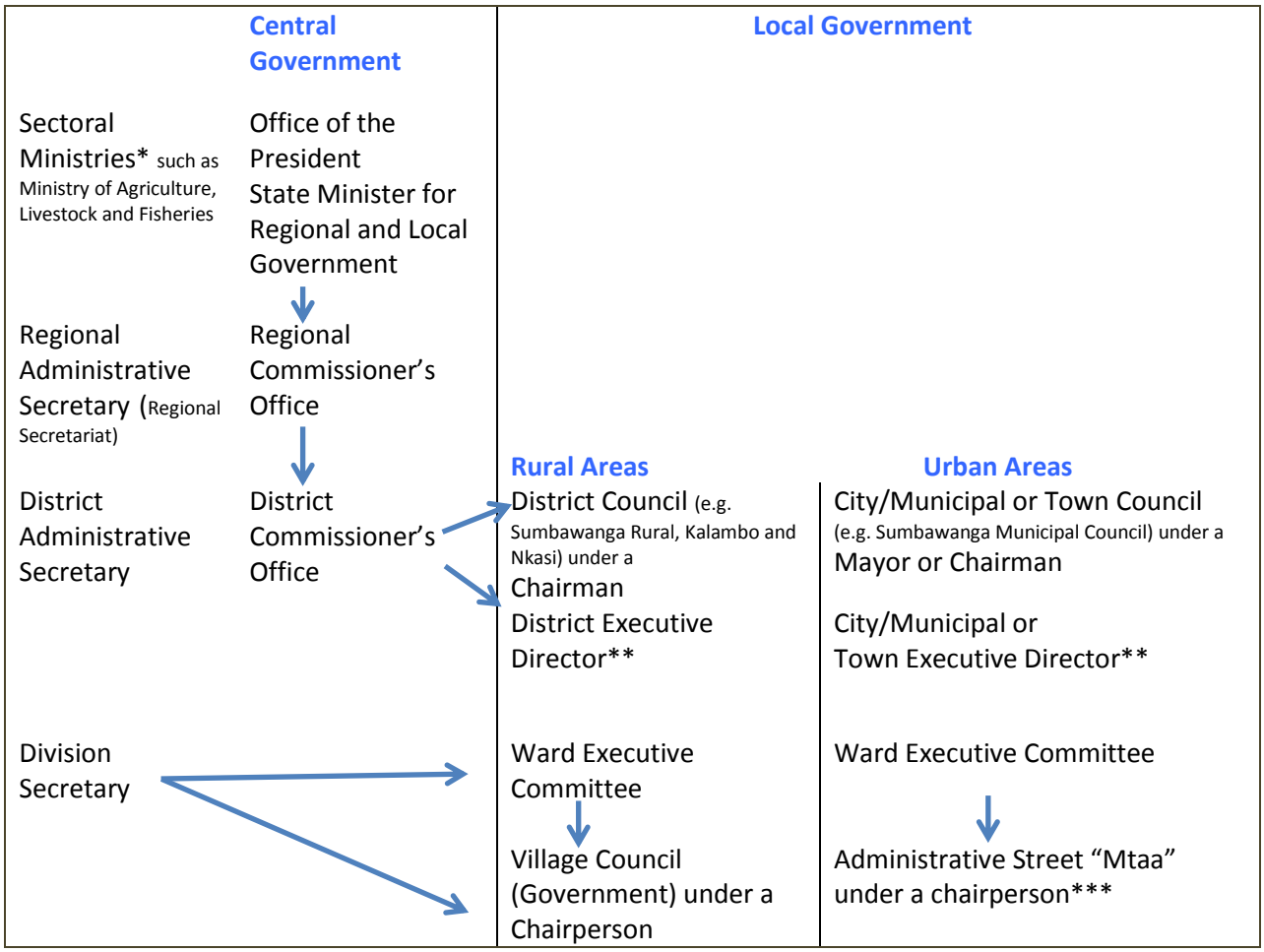

Figure 4. Overview of administrative units in Tanzania and their linkages

* The Zonal Veterinary Centre, Sumbawanga (for Rukwa and Katavi Regions) is an arm of the Ministry of Agriculture, Livestock and Fisheries
** Secretary of council meetings and council accounting officer
*** "Mtaa" in urban areas has a similar status to that of the villages in the rural areas

Each region is further divided into districts under the District Commissioner who represents the presidency at that level and reports to the RC. The District Commissioner is backed up by a District Administrative Officer. In each district, there are the local government authorities (LGA), which are

responsible primarily for development work. The district council is vested with powers to steer development under its elected Chairperson and an ex official secretary who is the District Executive Director. The latter is also the accounting officer for the council. In urban areas, instead of the district council there may be a City, Municipal, or Town council each headed by a mayor or town council chairperson and again an executive director serves as the secretary and accounting officer of the council.

Districts are further divided into Divisions made up of a number of Wards to which several villages are found and in urban areas one finds administrative areas called “mtaa” usually made up of one or more streets. All these lower levels have governments under chairpersons and executive officers. At all levels, experts in animal production, marketing and animal health are employed and serve under the executive officers in local government and the administrative secretaries in central government.

2.2.2 RUKWA REGION ADMINISTRATION

Rukwa Region is divided into three **districts**, namely Kalambo, Nkasi and Sumbawanga with four **Local Government Authorities** (LGA), namely Sumbawanga Municipal Council (SBA MC), Sumbawanga District Council (SBA DC), Kalambo District Council and Nkasi District Council (Figure 5). The four councils are divided into 16 divisions, 64 wards and 318 villages [8].

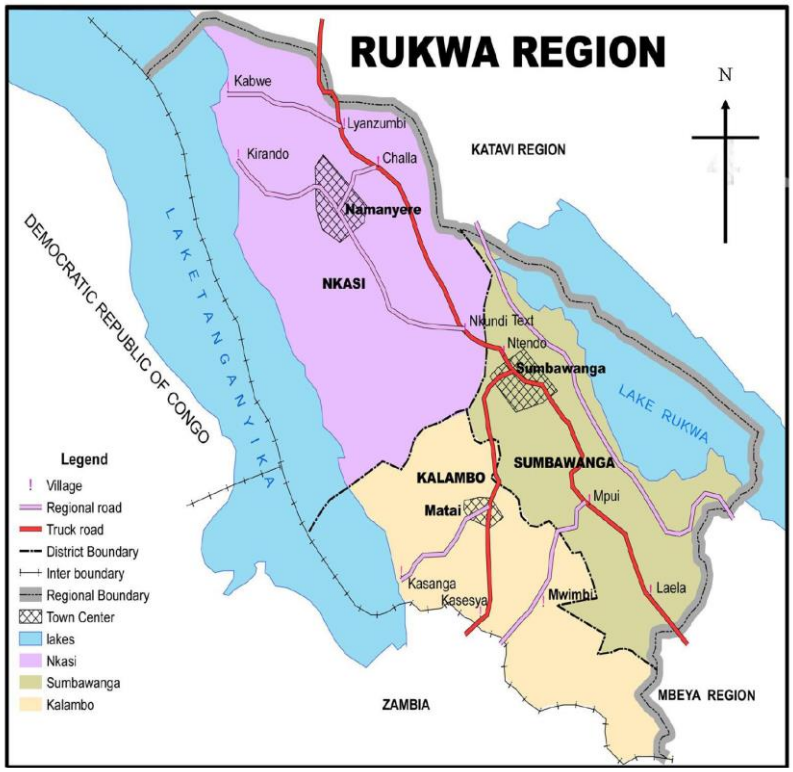

Figure 5. Map of Rukwa region and its three districts Nkasi, Kalambo and Sumbawanga. Source: [8]

2.2.3 SOUTH WESTERN ZONE

For the purpose of disease control, Tanzania is divided into seven zones, each of which comprise of more than one administrative region and each zone is served by one Zonal Veterinary Centre (ZVC). The FMD Free Zone is proposed to be established in the South Western Zone (SWZ) encompassing

Rukwa and Katavi regions served by the Zonal Veterinary Centre Sumbawanga (Figure 6). Being newly established, the ZVC does not have a corresponding Tanzania Veterinary Laboratory Authority (TVLA) Station and it is instead served by the TVLA station in Iringa located together with the Southern Highland ZVC. For the purpose of FMD diagnosis, the samples collected by the ZVC Sumbawanga will have to be shipped to the TVLA's Dar es Salaam Centre for Infectious Diseases and Biotechnology (CIDB), which deals with diagnosis of viral diseases. Biological samples for (FMD) testing could also be sent to Sokoine University of Agriculture laboratories if there was not sufficient capacity at the TVLA. The ZVCs operate under the Director of Veterinary Services, MALF. The ministry gives technical advice to regional and local governments. TVLA on the other hand is a semi-autonomous agency of the MALF.

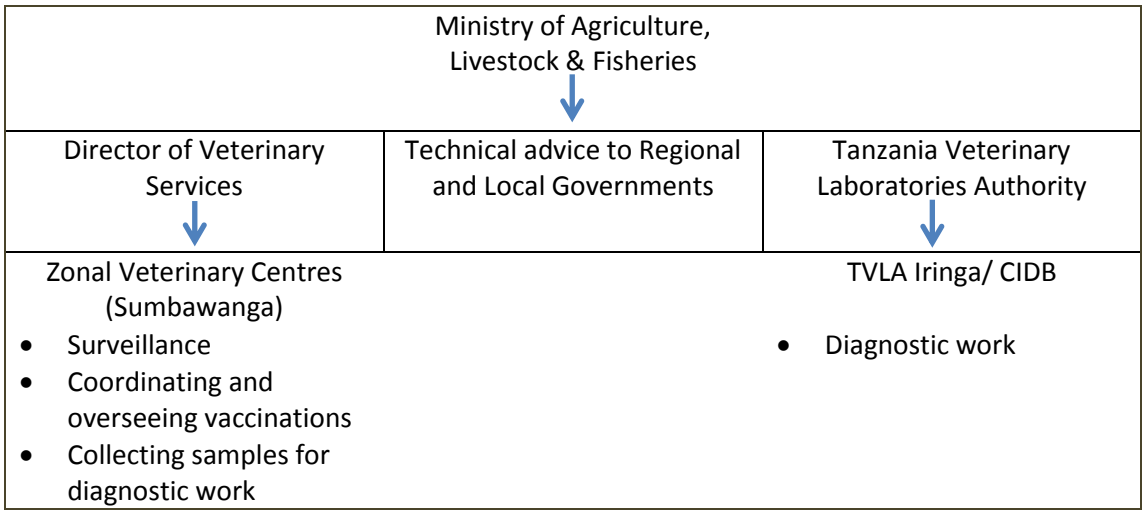

Figure 6. Overview of the administrative units for disease control in Rukwa region.

2.3 Livestock and human demography

2.3.1 LIVESTOCK POPULATION

Based on data from the Regional Commissioner's Office, the total number of livestock in Rukwa region in 2013/14 was 1.4 million (Table 1), of which almost half a million were bovines [8].

Table 1. Livestock population in Rukwa region, by local government authority. Source: [8]

Council	Cattle	Goats	Sheep	Donkeys	Pigs	Rabbits	Chicken	Ducks	Guinea fowls
Nkasi	142,853	85,609	29,028	1,568	4,210	1,615	216,883	17,460	1,845
SBA DC	189,420	71,666	12,899	3,804	24,158	350	174,903	22,410	4,990
SBA MC	39,632	18,908	1,189	1,605	11,839	2,550	102,112	5,525	588
KALAMBO DC	74,841	27,125	2,752	1,061	16,850	609	100,892	3,385	4,316
Total	*446,646*	*203,308*	*45,868*	*8,038*	*57,057*	*5,124*	*594,790*	*48,780*	*11,739*

Officials in Nkasi district reported that the number of cattle decreased substantially over the past decade, namely from 200,000 in 1999 to 145,000 in 2010 and 107,000 in 2015 (latest census), a marked difference to the figures reported above. It was not possible to ascertain, which figures were the most accurate. Explanations provided for the decrease in cattle numbers by local farmers and livestock officers were that a) farmers move to other regions in the search of land and grazing; b) there is an increased awareness that fewer cattle, but of higher quality should be kept; and c) due to an increase in crop production, less land is available for livestock.

2.3.2 HUMAN POPULATION

The human population in Rukwa region was estimated to be 1.1 million in 2014 (Table 2), with an estimated population density of 47 inhabitants per km^2 of land area [8]. The major languages spoken in this region include Swahili, Fipa, Mambwe, Lungu and Nyamwanga. Fipa people represent the predominant ethnic group (85 to 90%). Other ethnicities include the Sukuma in the lowlands (Lake Rukwa basin), as well as Nyakuysa and Ndali. The average household size among all districts was 5.0.

Table 2. Land area and human population in Rukwa region. Source: [8]

	Land area			Population				
District (LGA)	**Total area km^2**	**Land area**	**Water area**	**Census 2012**	**2012 population density**	**2014 projection**	**2014 population density**	**% increase 2012-2014**
SBA MC	1,329	1,329	0	209,793	158	224,736	169	4.1
SBA DS	8,871	8,203	668	305,846	37	327,630	40	3.3
Kalambo DC	4,441	3,937	504	207,700	53	222,493	57	3.1
Nkasi DC	13,124	9,375	3,749	281,200	30	301,228	32	3.5
Total	*27,765*	*22,844*	*4,921*	*1,004,539*	*44*	*1,076,087*	*47*	*3.5*

The number of households practising agro-pastoralism were a total of 212,120; broken down by local government authority as follows [9]:

- Sumbawanga rural: 55,812
- Sumbawanga urban: 61,169
- Nkasi: 45,360
- Kalambo: 49,779

2.3.3 LIVESTOCK PRODUCTION SYSTEMS

Rukwa region is characterised by a predominantly **extensive agro-pastoral production** system practised by the majority of residents, who keep indigenous zebu cattle, sheep, goats and some other livestock (pigs and chickens). Crop production is the predominant economic activity. Cattle have an important role in cultivation as a source of draft power and manure. Since the 1990s, many agro-pastoralists from the Lake Victoria area in the North West (mainly the Sukuma tribe) have migrated into the South West in search of pasture and water for their animals. Where they have managed to acquire land, they have settled and continue to practice agro-pastoralism cultivating both food and cash crops like maize, rice and cotton.

There are few remaining “pure pastoralists”, which include nomadic Maasai migrating from the North. The cattle kept in Rukwa region depend on (communal) grazing and there is no additional feeding even in large herds. After harvest, some of the crop land/stubble fields can be used for grazing of the animals based on agreements (and sometimes payments) with the land owners.

The number of animals per household among livestock-keeping households [9] are presented in Table 3 below.

Table 3. Number of households keeping cattle at different scales in Rukwa region. Source: [9]

District	Small-scale [1 to 10 cattle]	%	Medium-scale [11 to 49 cattle]	%	Large scale [50 and more cattle]	%
Sumbawanga municipality	7423	22.4	620	12.7	17	1.3
Sumbawanga rural	11746	35.4	1898	38.9	448	34.0
Kalambo	9722	29.3	1333	27.2	276	21.0
Nkasi	4264	12.9	1045	21.3	575	43.7
Total	*33155*	*100*	*4896*	*100*	*1316*	*100*

There are differences in livestock numbers kept in the lowlands and the highlands, indicating slightly different practices:

- The following local classification applies for the agro-pastoralist system in the highlands in **Sumbawanga** rural (Source: SWZ, Kaini Kamwela):
    - Small cattle holders: Up to 15 cattle per household
    - Medium holders: 16 to 200 cattle per household
    - Large cattle holders: >200 cattle per household
- The following local classification applies for the agro-pastoralist system in the highlands in **Sumbawanga** municipality (based on statistics RAS):
    - Small cattle holders: 1 to 10 cattle per household
    - Medium cattle holders: 11 to 49 cattle per household
    - Large cattle holders: ≥50 cattle per household
- The following local classification applies for the agro-pastoralist system in the lowlands in **Southern Rift Valley** (source: livestock extension officer Kilyamatundu):
    - Small cattle holders: Up to 15 cattle per household – 20%
    - Medium holders: 16 to 200 cattle per household – 70%
    - Large cattle holders: > 200 cattle per household – 10%
    - Very large cattle holders: ≥ 4000 cattle per household – 3 households (negligible)
- The following local classification applies for the agro-pastoralist system in **Nkasi district** (source: district council)
    - Small cattle holders: 1 to 10 cattle per household – 4266/5884 (73%)
    - Medium holders: 11 to 49 cattle per household – 1069/5884 (18%)
    - Large cattle holders: 50 to 1,000 cattle per household – 549/5884 (9%).

In most agro-pastoralist households, cattle off-take rates (the proportion of cattle sold or slaughtered for consumption in a year) are low, typically less than 10% [10]. **Cattle are kept as a store of wealth and social capital**. They are mainly sold to meet expenses, which include for example school fees, food and clothing purchases, or capital for building. This pattern is observed even in very large herds. Hence, cattle are not seen as a way of wealth creation/economic activity through sales but rather a store of capital. The absence of "animal harvesting" to build a cash store and a culture of banking cash, further exacerbates this practice. This was corroborated by the owner of a 4,000 head of beef cattle in Kipeta division (Sumbawanga rural), who explained that cattle sales are driven only by the need to cover expenses. In addition to the cattle, the farmer also engages successfully in maize and rice cultivation. The farmer keeps a constant crop harvest stockpile to cover three years consumption and any surplus is sold for cash. If large sums of money are needed (e.g. to build a house), the farmer tends

to sell cattle. On average, the farmer sells 240 of the 4,000 cattle per year (off-take rate of 6%). Similarly, in Nkasi, a group of producers described that even households with larger herds would be engaging in crop production and only a few (three to four) animals sold to meet cash expenses. The practice of livestock keeping for commercial purposes was not totally absent, but reportedly involved less than 1% of all farmers, who by contrast may sell up to 300 animals per year with off-take rates ranging from 14-38% on commercial ranches [11].

Semi intensive production systems were found at the beef ranches of Kalambo, which is a National Ranching Company (NARCO) ranch, and Nkundi, which is a Sumbawanga Agricultural and Animal Food Industries Limited (SAAFI) ranch (see below).

- **Kalambo ranch** is a ranch operated by the National Ranching Company, which is a subsidiary of the government; it was established in 1974. It has 67,000 hectares of land divided into 14 blocks. Block 9 has a total of 23,526 hectares of land and is managed by the ranch management. The remaining 13 blocks have 43,640 hectares of 2,000 to 4,000 hectares rented to other producers (the block producers), which keep beef cattle for fattening based on grazing. Kalambo ranch has 660 cattle, 146 sheep, and 15 horses. They have a total of 22 workers including manager, accountant, clerk, secretary, security, landlord, animal handlers and herdmen. Nowadays, the ranch is a self-financing enterprise[3] and suffers finance problems. They diversify to keep the ranch in business through selling milk, keeping 500 bee hives, planting 500 acres of wheat and 501 acres of maize and peas, and cutting trees to sell wood. They keep Boran cattle as well as Boran-Friesian mix, grade 2 cattle and sell two year-olds at 350 to 400 kg liveweight with a reported off-take rate of 38% [11]. The Regional Livestock Advisor for Rukwa region advises a carrying capacity of one livestock unit per 4 hectares (the Ministry advises 3 to 8). Based on one livestock unit per 4 ha carrying capacity, there could be 6,000 cattle on the Kalambo ranch land (full grazing). The current number of animals in the producers' blocks are as follows: the biggest one has ≥1500 cattle (Block 13); the smallest one has 764 (Block 2). There is a total of 11,761 cattle in all blocks, which makes an average of 905 heads per block. There are reported difficulties of farmers in selling their produce.
- **Nkundi ranch**, owned by SAAFI, keeps about 714 beef cattle on 16,800 acres. The ranch started in 2004 as a government farm and was used as a livestock multiplication unit, breeding heifers to sell to farmers. Nowadays it belongs to SAAFI. Currently they have 2 technical staff (with diplomas in animal health) and 15 other workers (1 headman, 8 herdsmen, 6 security personnel because of cattle theft). They have Boran bulls that they cross breed with zebu. The 714 cattle are split into four herds. They also have 43 goats and one sheep. The owner is also using part of the ranch for growing maize seeds and wheat. The ranch occasionally buys from some of the block owners for fattening and selling. In 2016, they lost 73 animals between June and July due to pneumonia (calves) and tick-borne diseases. The herd structure consists of 74 calves, 14 breeding bulls, 18 young bulls for stocking and slaughter, 25 castrated bulls for fattening or draught, whilst the remaining animals include the breeding cows and heifers. At one time they were reportedly producing 300 calves per year but these numbers have reduced recently.

[3] In the past, these ranches would get government funding, but are now expected to be a financially independent and autonomously managed enterprise.

Feedlotting (the keeping and fattening of cattle in pens with zero grazing and feeding of prepared rations) is practised very rarely in Rukwa region. In Nkasi district, feedlotting operations were present in the past, but have decreased drastically, because of the lack of market channels ("There is nowhere for these animals to sell").

In urban areas semi intensive zero grazing is practised by progressive smallholder dairy farmers keeping two to three animals on average for milk production. Milk is sold raw to the available urban populations.

2.3.4 CATTLE BREEDS

The agro-pastoralists commonly keep the Ufipa zebu cattle, an animal that has suitable characteristics for beef production due to its size and morphological conformation. Growth rates are often under-utilised due to limited grazing offered. They are hardy animals that do relatively better under conditions of drought. Often the bulls are castrated for traction because of their big frame. Another prevalent breed in use is the Sukuma zebu, which is another sub-type of the Tanzania short-horn zebu. Others of lesser importance are crosses of local breeds with Friesians and Ayshire. Few Boran, Brahman, St. Gertrude, Simmental and Ankole cattle are also found.

2.3.5 DESCRIPTION OF CROP PRODUCTION

The main **staple foods** are maize, rice and beans with exception of some parts along Lake Tanganyika and Rukwa where cassava and rice are the main source of food. Other common food crops include groundnuts, finger millet, potatoes, sorghum, wheat and sugarcane [8].

The following average **market crop prices** were found in the region in 2014/2015 (Source: Regional administration):

- Maize: TSh 240 per kg min (farm gate) to TSh 500 per kg max (market)
- Rice: TSh 1,100 per kg min (farm gate) to TSh 1,700 per kg max (market)
- Beans: TSh 1,000 per kg average
- Sweet potatoes: TSh 250 per kg min (farm gate) to TSh 500 per kg max (market)
- Groundnuts: TSh 2,000 per kg average
- No prices/market information were available for Cassava, sunflowers and sugarcane.

2.3.6 LAND USE

Since 1995, there is a policy in Tanzania to regulate land use all over the country; the National Land Policy stipulated that **public land be vested to the President as a trustee on behalf of all citizens**. The purpose was to use land productively and in line with principles of sustainable development. If for example investors are interested to occupy land, they have to pay appropriate compensation to people whose rights of occupancy and use are revoked. Public land in Tanzania falls into the following categories: a) general land; b) village land, and c) reserved land with a right to occupy land according to land Act (1999) with a granted right of occupancy or a derivative right [8].

In Rukwa region, the implementation of the policy is based on agreements between crop farmers and landless livestock keepers coming in from the North (once they settle, they commonly become agro-pastoralists). The village and ward leaders enforce the land policy on behalf of the local population.

The district commissioner is in charge of security matters, but veterinary and livestock staff have the right to inspect livestock movement permits. However, the village and ward executives have the legal power to refuse animals moving in based on land and water capacity. Livestock keepers need to seek approval to move the animals into the area.

Despite these mechanisms, the issue of limited land availability is a major concern and conflicts stemming from requests for land for crop production, livestock grazing, hunting, game reserves, conservation and national parks are a very frequent problem.

Kipeta ward in the Southern Rift Valley reported to have 4,000 households of which 1,000 keep livestock with a total livestock population of approximately 40,000 cattle, 10,000 goats, and 5,000 sheep. The influx of Sukuma livestock keepers in the past (mainly in 1974 after a major drought caused people to move in with groups of 200 to 300 animals) revolutionised both livestock keeping and cultivating practices in the area. Further influx appears to be well-regulated using the system mentioned above. However, in 2016 there was an extraordinary influx of about 10,000 livestock, which had been removed from the Rukwa game reserve.

3 INFRASTRUCTURE INCLUDING MARKETS AND MARKETING CHANNELS

3.1 Primary cattle markets

Rukwa has 12 official primary cattle markets, namely

- **Nkasi**: Isunta, Ntalamila, Ntuchi
- **Sumbawanga rural**: Kipeta division: Kilyamatundu and Ilemba; Mtowisa division: Muze and Mtowisa; Laela division: Laela.
- **Sumbawanga municipality**: Sumbawanga
- **Kalambo**: Mkowe, Mtula and Kasesya

Kilyamatundu is the biggest primary market in Sumbawanga rural, taking place on the 1st and the 14th of each month. The market has a fenced area where dealing takes place. Upon purchase and leaving the market, the market fee and movement permit fee must be paid. The animals mainly come from neighbouring villages in the same ward (distance of 10-50km) and exceptionally from Nkasi district (200km). The animals usually go to Mbeya, Tunduma, Chunya and Usangu predominantly to be slaughtered (all these places have slaughterhouses); on rare occasions some are taken to Songea and Mbinga. They are commonly purchased by traders from the outside who also own butcheries. After purchase the most common form of moving is by trekking with distances of up to 250km, on average 200km. Sometimes, animals are trekked part of the way and then shipped.

Seasonal patterns are as follows:

- During the dry season, the prices for 60% of the cattle are TSh 500,000 to 700,000, for the rest between TSh 350,000 and 500,000. On average, 600 cattle gather in the market and about 500 are sold.
- During the rainy season the prices drop, because the roads are bad, local rivers get flooded thereby impeding passage, and buyers have less money. The most common price is TSh 400,000, whereas the lowest is TSh 200,000. The number of animals also drops to 350 per market day.

Over the past decade, the market has seen an increase in animal numbers traded and the number of market days was increased from one to two to accommodate higher demand. The changes are said to be driven by an increase in the human population combined with a higher per capita demand of meat in Tanzania. Consequently, the local cattle population has increased, mainly through local breeding, as there is a policy in place that restricts movements from the North into the area (see above).

In **Muze primary market,** the authorities created a new one-way, fixed structure for the cattle trading, consisting of a waiting area (open space), concrete holding pens, a bidding area and a ramp for truck loading. However, most animals are trekked from the market and not trucked; these animals exit the concrete market structure through a separate door. There are two market days on the 11th and 25th of each month where approximately 300 animals gather and 200 are sold. Market prices are on average TSh 600,000 to 700,000 for large cattle and TSh 400,000 for small cattle.

In **Nkasi** district, there are three primary markets, namely in Isumta (on the 2nd and 16th of each month) in Namanyere ward, Ntuchi (on the 12th of each month) in Isale ward and Ntalamila (on the 27th of each month) in Myula ward. During these four market days in each month, a total of 2,600 cattle are

presented and about 1,300 to 1,400 are sold. Prices are TSh 1,200,000 for large cattle (30% of all cattle), 700,000 to 900,000 for medium sized cattle (40% of all cattle) and TSh 180,000 to 210,000 for small cattle (30% of all cattle). Some breeding animals of the meat breeds like St. Gertrude, Simmental or Boran are sometimes marketed and in exceptional cases and can fetch TSh 2 to 3 million. The source of animals for these markets are from local villages and from Majimoto market (Katavi Region) and Mtowisa (infrequent). Animals are trekked outside the district for slaughter, namely to Sumbawanga slaughter slab, to Zambia via Kasesya border market, and Kalambo. Moreover, they are sold to slaughter places outside the region (commonly trucked), namely Mbeya city, Tukuyu, Songea (Ruvuma) and Dar es Salaam. Chinese traders also buy animals to take them to Dodoma for slaughter and export in the Chinese abattoirs. In Dodoma, there is another export abattoir, which is a tripartite operation between government and private stakeholders. Trade with the Democratic Republic of Congo was described to be infrequent and relates mainly to goats.

There is a primary market called **Mtula** about 16-20 km from Kasesya along the border, which takes place on the 14th day of each month. Primary markets are not usually located close to the border and it has been suggested by the MALF to move the market or to stop the sale of live animals and their products.

3.2 Border market and border inspection post

Rukwa does not have a secondary market, but operates the border market Kasesya. This market is situated in the Ward Kathete, which has five villages in an area of up to 50km^2. The villages are Kathete (sub-village is Kasesya), Kaluko, Ngoma, Safu, and Jengeni. This market has formed "organically" over the past years as a reaction to the high demand for cattle from neighbouring Zambia. On the Zambian side, two modern abattoirs have been built to serve their national market, namely "Zambeef" abattoir (re-opened in April 2016) and "Dayow Beef" abattoir (opened in July 2016), which have a combined capacity of 200 cattle/day. See also the section below "Study tour to Zambia".

Kasesya market takes place on the 4th, 5th, and 6th of each month. Approximately 150 cattle gather over the three days at the market, of which about 120 cattle are sold, the rest are "going back", while others remain in the area, grazing and waiting for orders from Zambia. There is no grading system in place, because the Zambian abattoirs pay farmers based on carcass weight: TSh 4,000 to 4,500 per kg. There used to be no payments for offals, hides, skins, heads, or trotters, but the situation seems to be changing due to the new competition between the two neighbouring abattoirs and high demand for cattle. The average market value of beef cattle was estimated by local extension officers to be TSh 600,000.

The majority of animals are trekked to the Zambian abattoirs, of which some legally pass the nearby border inspection post (BIP) and acquire both the movement certificate/health certificate for export as well as paying export fees (TSh 20,000 per bovine animal). The number of cattle moved legally in this manner was estimated by BIP staff to be on average 422 per month. This number has gone up substantially from past movements of about 60 animals per month with the opening of the two abattoirs.

However, border officials reported that a lot of animals are traded informally outside of the official market, partly because the construction of the new market is not completed. In these cases, many

farmers leave the market with their cattle and cross the border illegally at night thereby avoiding the movement permit and export fees. Patrolling the border by BIP staff was reported by border officials to be near impossible due to the low number of personnel (three police officers), very long national borders, lack of firearms and lack of transport.

The SWZ veterinary centre supervises the ongoing creation of an official border market with fixed structures and strategies to curb illegal movements.

These include (Figure 7):

- Fenced area to control movement into/out of market area
- One way system that connects pre-sale pens, the selling area, post-sale pens and the loading area. This will allow keeping animals overnight and transporting them the next day.
- Animals to be moved across border only on trucks (already a legal requirement, but it is not enforced)
- Some form of identification system to differentiate local livestock (from the ward) from the livestock moving in from other areas. The suggestion was made to engage local ward people to collaborate to identify the “foreign” animals, because the frequent movements as well as mixing with ward cattle during grazing and watering puts the local animals at increased risk of disease.

Figure 7. The holding pens and bidding area for the new official Kasesya border market (under development during visit in autumn 2016)

Apart from cattle, there are no significant movement of other species or products. However, the pig sector on the Zambian side is growing, which could lead to demand for pigs in the future.

3.3 Market and movement fees

The following fees apply

- To move cattle within district: TSh 1,000/head
- To move cattle to another district in the region: TSh 1,500/head
- To move cattle to another region in Tanzania: TSh 2,500/head
- To move cattle to another country: TSh 20,000/head
- To bring cattle to a primary or secondary market: TSh 5,000/head.

For the primary markets, the fee is collected by the district council and should be invested to improve and maintain the market infrastructure and services. For the secondary and border markets, the fee is paid to the MALF, which is in charge of investing into the border market.

3.4 Slaughter facilities and dynamics

There are some small slaughter slabs in Rukwa region, but no slaughterhouse. Sumbawanga municipality has a slaughter slab where they slaughter about 20 cattle per month for local consumption.

There is a modern abattoir owned by SAAFI, which is described in detail here. The information is based on interviews conducted in September 2016 during the field visit.

SAAFI started operating in May 2007 and has the facilities to perform the following activities:

- Slaughtering in a modern abattoir with a capacity of 150 animals per shift (max 2 shifts per day, i.e. 300 animals) with chilling and freezing facilities and cold chain capacity (including transport) (Figure 8). The facility could operate for a maximum 273 days per year (closed for Sundays, public holidays and annual repairs and maintenance). SAAFI staff reported that the capacity could accommodate a 5% increase in throughput i.e. 15 cattle a day.
- Processing facility to produce 'prime cuts', carcasses and sausages
- Rendering plant for by-products to provide inputs for feed, soap, candle production, etc.
- SAAFI ranch (as described above)

Figure 8. The slaughter line and transport trucks at SAAFI abattoir

SAAFI operations started production in 2007 and the plant was fully operational in 2008 using the majority of the capacity and employing about 350 people. For most of 2016 (including during our visit in September 2016), the abattoir was at a standstill[4]. The market for the factory's products had included Dar es Salaam (Namanga shop delivered to from 2009 to 2011), mining companies of Buzwagi (from 2012 to 2014, 20 tons per month), countries bordering the region (Zambia and DRC), Comoros islands and the Gulf countries. Deals discussed with Egypt in 2008 failed. A further export deal was agreed with Oman in 2008, but only one delivery was made.

[4] At the time of writing the report in August 2017, the situation was reported to be unchanged

To resume operations in a profitable and market-orientated way, SAAFI abattoir needs running capital do to essential repairs, buy cattle, and run the business. In past years, SAAFI often did not pay farmers for the cattle they purchased and/or had long delays, as the examples below illustrate.

Kalambo ranch used to supply cattle to SAAFI, but is owed a total of TSh 600 m in outstanding payments. This lack of payment by SAAFI had a substantial knock-on effect on Kalambo operations, which reported to be struggling financially. The matter has been reported to the Regional Commissioner so that a solution can be found. Kalambo ranch cannot be given further credit by the Tanzania Investment Bank (TIB) or any other bank because they are no longer considered to be worthy of credit. Consequently, the farm started selling animals to traders from other regions (who often own butcheries). It was reported by ranch staff that these traders push the prices down and refuse to pay more than TSh 400k per cattle (even for a large animal) and there seems to be some price collusion going on, as Kalambo ranch is perceived to be desperate. Due to the low prices, more animals need to be sold to pay the workers and keep the operations going, which has led to a decrease in herd size. The ranch manager is considering opening their own NARCO butchery to cut out the traders and gain a higher income from the animals slaughtered. They have their own slaughter slab and slaughter man on the ranch and they sell the beef carcasses, not the live animals.

The adjacent block farmers (commonly called progressive farmers) sell to individual brokers and traders including Zambian traders. In Zambia, they are paid in the local currency (Kwacha), which can lead to exchange losses or gains depending on the fluctuations in exchange rates. Because the block farmed animals are usually of good condition and weight, these farmers would welcome scales in primary and secondary markets to be able to sell the animals based on measured live weight and get more accurate payment for them. The block farmers in 2012 achieved TSh 1,700 per kg live weight; in 2016 the price was between TSh 2,500 to 2,700 per kg live weight. These block farmers would be a suitable source for good quality animals in a commercial abattoir like SAAFI.

Similarly, producers in Nkasi district used to sell to SAAFI in the past, but stopped doing so at the end of 2015, because of serious delays in payments. SAAFI was buying about 20-30 animals per month when operations were working well. Producers said that they would be happy to start selling to SAAFI again if the conditions improved and payment was reliable. They also said that Kasesya border market needs to be improved, i.e. to have incentives and structures that prevent Zambian traders to dictate the terms, follow the right procedures, protect farmers, and to have inspections. Farmers mentioned that hybrid animals (i.e. exotic and indigenous crossbred/improved animal) did not sell well, as they are too expensive and there are no buyers. In Nkasi district, it was estimated that about three to five of 20 improved animals sent to the market may be sold.

3.5 Meat exports

Information and statistics shared by the Livestock Production Department of MALF and the Tanzanian Meat Board (TMB) showed that several **export channels for beef** are in place and further markets have been identified:

Export channels in 2016 were reported to be the following (Figure 9):

- Burundi, DRC, Comoros, Zambia, Malawi, Mozambique, Rwanda, Uganda, Kenya: mostly live cattle, often through trekking

- United Arab Emirates, Oman, Iraq and Kuwait: chilled beef, chilled mutton (some problems with Dubai, as the meat is considered to be too tough)
- Vietnam: boneless beef and boneless donkey meat

Figure 9. Export destinations as reported by Tanzanian Meat Board and Department of Livestock Production

An FAO report on the red meat value chain [12] could not quantify, but described the movement of livestock across borders as “substantial”. Prices in neighbouring countries were reportedly often considerably higher, with Kenya’s export industry drawing stock from its neighbouring countries including Tanzania. Kenya, together with Uganda reportedly drew the bulk of trans-border live animal movements, even from as far as the Southern Highlands, with less cattle going to Rwanda, Burundi, DRC and Zambia.

The TMB is in conversation with **potential buyers** from China to open trade channels into that market. Given their sanitary requirements, future exports to China would be boneless meat (at least whilst there are no disease free zones in place). A lot of potential is also described for the Central African market (Rwanda, DRC, etc.), which could be strengthened by the expansion and modernisation (upgrading to standard gauge) of a railway line from Tanzania to Rwanda and DRC (the line currently ends in Tanzania). A lot of potential was also described for future trade deals with Egypt, and the Middle East who do not stipulate sanitary requirements, but were described to want halal, chilled meat that is firm, but not tough and does not show any colour changes.

Commonly, potential buyers approach the TMB, which then enters into negotiations with the interested parties. However, for trade deals to be implemented successfully, the TMB depends on stable and reliable supply chains that can deliver the quantities required. Moreover, several people mentioned that it would be important to have more value addition in the country and export animal products instead of exporting live animals.

An analysis of data sourced from UN COMTRADE on reported Tanzanian Beef exports shows marked variations year on year in totals exported and the importing partners (Table 4).

Table 4. Tanzanian Beef exports as reported for 2010-2015. Data provided by TMB/MALF.

Year	Importing partner	Beef	Net weight (kg)	Trade Value (US$)
2010	Vietnam	Frozen	15,000	2,891
	Total	Frozen	15,000	2,891
2011	*Total*		0	0
2012	Oman	Fresh or Chilled	2,500	3,557
		Frozen	3,200	3,557
	Other (Asia and NES)	Frozen	100	325
	Singapore	Frozen	300	1,016
	South Africa	Frozen	110	1,518
	United Arab Emirates	Fresh or Chilled	7,333	8,731
		Frozen	28,856	69,763
	Zambia	Fresh or Chilled	125,000	314,809
	Totals	Fresh or Chilled	134,833	327,097
		Frozen	32,566	76,179
2013	Germany	Frozen	720	202
	United Arab Emirates	Frozen	1,845	1,509
	Total	Frozen	2,565	1,711
2014	Kenya	Fresh or Chilled	4,925	30,551
	Mozambique	Frozen	20,000	26,468
	Oman	Fresh or Chilled	1,338	2,673
	United Arab Emirates	Fresh or Chilled	5,988	11,977
		Frozen	2,300	1,984
	Totals	Fresh or Chilled	12,251	45,200
		Frozen	22,300	28,452
2015	Mozambique	Frozen	30,004	41,713
	Total	Frozen	30,004	41,713

All stakeholders consulted agreed that the **revival of SAAFI operations** was critical for the successful disease management and upgrading of the beef value chain in Rukwa region, because the positive effects of disease control are limited if there are no market opportunities to sell the cattle. They declared excellent potential to establish a reliable supply chain in the region given the conditions described and the infrastructure established by SAAFI. While SAAFI is privately owned, there was a **tripartite agreement** established between TIB, NARCO and SAAFI in 2014 to promote the operations in the following manner: 1) The TIB gave a credit to Kalambo ranch (NARCO) for buying and fattening of cattle; and 2) the TIB gave a credit to SAAFI for construction and running of the abattoir. Moreover, the government through the Bank of Tanzania acted as a guarantor for the loan TIB gained from a foreign bank. Because SAAFI could not pay their debts and defaulted, the government had to pay the outstanding amount. Currently there is strong interest from several ministries under their plans to promote industry-based growth to re-vive SAAFI operations and agree on a model for better and more sustainable management. One of the options under consideration is to create a share-holding structure. All negotiations are dependent on the support by the owner of SAAFI.

3.6 Institutions to support beef production and trade

3.6.1 TANZANIA MEAT BOARD

Representatives from the TMB provided the following overview: The TMB is a semi-autonomous institution that forms a public private partnership of half government, half private industry (producers, abattoirs, processing facilities, etc). It was established in 2006 by law under the Meat Industry Act 2006 with the main objective to restructure the meat industry for production of quality and safe meat. It has 13 staff members and 10 board members (directors). The four key roles are:

- Promote the development of the meat industry
- Organise stakeholders
- Organise markets
- Advocacy and representation of stakeholders

Members pay a registration fee, but there is no regular membership fee afterwards (e.g. annual fee) nor do the private stakeholders provide financial support for the TMB. However, they need to cover their own costs when attending a training event. The stakeholders operate as individuals in the TMB and are usually not organised in cooperatives or similar organisations. The TMB management would like to see people organised in associations and coordinate supply themselves according to the demand (e.g. if a weekly supply of 5,000 tons is needed to Egypt, stakeholders should have a system that can guarantee such supply). There is no experience with contract systems. Because previous cooperatives did not work well, there is a lot of scepticism. However, the TMB managed to establish three associations:

- Livestock producers (>2,000 members)
- Livestock and meat traders (>2,000 members)
- Processors (few members, approximately 10)

One key TMB activity is to provide training and build capacity so that the associations can get organised and coordinate constant supply as needed.

3.6.2 AN EXAMPLE OF A PRODUCER COOPERATIVE IN RUKWA REGION

In Nkasi district, a producer cooperative called “Umoja wa wafugaji wa n’gombe wilaya ya Nkasi” (i.e. “Association of cattle keepers in Nkasi district”, registration number 1889) was visited. It was established in 2012 with 67 founding members and had more than 240 members in 2016. Their purpose is to

- Bring together beef cattle keepers
- Control movement of livestock from outside areas
- Reduce conflicts between livestock keepers and crop producers
- Encourage sending children to school
- Practice modern farming
- Look for markets outside the country

For a member’s fee, the following activities are implemented: information on and resolution of conflicts; farm visits and advice; and collaboration with extension officers (who often lack means, in

particular transport) who are also invited to meetings. For the control of livestock movements, the cooperative gathers information and then passes this on to the field officer who is supposed to take action and can provide advice to the people coming in. Moving into a new area is not illegal (if the paperwork is in order, i.e. a movement permit is necessary), but conversation with livestock keepers can help to find a satisfactory situation for all and avoid conflicts over land use.

3.6.3 BANKING

The TIB has supported SAAFI in Rukwa region, but the TMB reports that it is increasingly more difficult to get loans from TIB. Therefore, they are in negotiations with the agricultural bank to find solutions for investment in livestock production and marketing.

Most producers are used to a cash-based system, where "delay" or rather non-imminent payments are not acceptable. Moreover, many firms have very low running capital. To encourage farmers to increase their off-take rates and operate a more commercial system, opportunities need to be created that allow farmers to manage the new income generated (which would not be stored any longer in the standing herd). Past initiatives proved to be successful; for example in Morogoro producers were trained about harvesting of cattle, diversifying production, and investment opportunities for the income generated. Opportunities could also arise by using loan-based intermediaries and/or mobile phone based banking. The latter has revolutions banking opportunities in recent years in Tanzania, as it provides access to financial services, allows paying bills 24 hours a day, securely save money electronically instead of in cash, and access financial services like insurance and social security. These mechanisms offer opportunities for traders or processors to get credit and pay farmers on time.

3.7 Cattle movements

Statistics shared by the SWZ veterinary centre showed the following movements from primary or secondary markets (Table 5):

Table 5. Cattle movements recorded by the SWZ veterinary centre in Rukwa region between Sep 2015 and Aug 2016

District	Within district	Outside district	Outside region	Total
Sumbawanga rural	4240 (38%)	697 (6%)	6384 (56%)	11,355
Nkasi	1748 (21%)	4280 (52%)	2222 (27%)	8,250
Sumbawanga municipality	4 (<1%)	57 (5%)	1005 (94%)	3,231
Kalambo	Not recorded			

For Nkasi, the animals moving out of the district included 727 cattle moved to Kasesya, 52 to Ilemba, 6 to Kilyamatundu, 16 to Muze, 23 to Mtowisa, 319 to Laela.

The following movements of cattle to areas outside the region (but within Tanzania) were observed: 729 cattle from Muze, 45 from Ilemba, 4727 from Kilyamatundu, 389 from Laela, and 287 from Mtowisa. Of these movements, the largest number of cattle went to Mbeya (2,512 bovines) and to Tunduma (1,405 bovines).

3.8 Beef consumption

Data on beef consumption in Tanzania varies dependent on source as presented in Table 6 below; on average it is approximately 4.9 kg/capita/year. Comparable data from OECD were 10.7 kg/capita/year for South Africa, 9.1 for Zambia, 2.5 for Ethiopia and 0.8 for Mozambique. Reliable Tanzanian beef consumption statistics could not be obtained.

Table 6. Beef Consumption in Tanzania in kg/capita/year (2006-2015)

Data Source	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OECD	4.90	4.75	4.67	4.61	3.78	3.92	4.19	4.19	4.14	4.09
FAOSTAT	5.21	4.40	5.19	5.16	5.43	5.67	6.04	6.09	n/a	n/a

4 FMD SITUATION

4.1 Epidemiology

The epidemiology of FMD in East and Southern Africa is complex given that outbreaks involving all serotypes (with the exclusion of Asia-1) namely A, O, C and all three Southern African Territories (SAT 1, 2 &3) have occurred in recent decades. The genetic characterisation of the viruses has been used to create separate pools of serotypes. Pool 4 covers north and East Africa and contains serotypes A, O and SAT 1 & 2. Two FMD cycles exist; one maintained within domestic animals and another in wildlife (most importantly the African Buffalo). African Buffalo maintain the three SAT serotypes, which when passed onto cattle can then be maintained independently in cattle populations. The exact transmission of virus between buffalo and cattle is not fully understood but is thought to occur through close contact and shared grazing and water sources. The circulating viruses in the field have extensive genetic diversity especially the SAT serotypes (including topotypes or geographical serotypes and subtypes). The current inactivated vaccines may reduce clinical signs but often they provide little cross protective immunity. Therefore, surveillance programmes to isolate and identify the locally circulating viruses are critical to provide the basis for development of targeted vaccines. Control programmes should be specific to the local context, both epidemiologically and ecologically.

4.2 FMD outbreaks and prevalence

Picado *et al.* [13] published maps generated from data of countrywide FMD outbreaks for the period 2001-2006. A total of 878 outbreaks were reported from 605 village locations which were mainly located along national borders (particularly with Kenya and Zambia) and the northern and central areas of the country. Similarly, Sinkala *et al.* [14] reported that FMD outbreaks in northern Zambia shared the same serotypes with outbreaks across the border in the Rukwa and Mbeya regions of Tanzania; suggestive of likely trans-border transmission.

Table 7 shows the reported FMD cases in Rukwa region between 2013 and 2017. With the exception of 2014 and 2015, it shows that the animal level prevalence remains largely stable and overall quite low, i.e. <3% throughout. The expected between herd prevalence was estimated at 5% and the within herd incidence rate 20% (data provided by Dr Makungu S. Luka, MALF). Published data on sero-prevalence of FMD in Tanzania and Zambia were not found. By contrast, the sero-prevalence figure for Kenya was reported as 52.5% (1947/3709 samples) [15].

Table 7: FMD reported cases from 2013 to 2017 from the zonal veterinary centre Sumbawanga (Rukwa region); reported cases. DC District Council, MC Municipal Council. Data provided by MALF.

Year	District	At risk	Cases	Species	Production system	Prevalence
2012/2013	Sumbawanga DC	149,593	216	Bovine	Agro pastoral	0.001
	Sumbawanga MC	25,909	37	Bovine	Agro pastoral	0.001
	Kalambo DC	89,683	165	Bovine	Agro pastoral	0.002
	Nkasi DC	116,849	121	Bovine	Agro pastoral	0.001
2013/2014	Sumbawanga DC	149,593	12	Bovine	Agro pastoral	0.0001
	Sumbawanga MC	25,909	31	Bovine	Agro pastoral	0.001
	Kalambo DC	89,683	18	Bovine	Agro pastoral	0.0002
	Nkasi DC	116,849	72	Bovine	Agro pastoral	0.001
2014/2015	Sumbawanga DC	149,593	4,216	Bovine	Agro pastoral	0.028
	Sumbawanga MC	25,909	10	Bovine	Agro pastoral	0.0004
	Kalambo DC	89,683	2,415	Bovine	Agro pastoral	0.027
	Nkasi DC	116,849	2,481	Bovine	Agro pastoral	0.021
2015/2016	Sumbawanga DC	149,593	546	Bovine	Agro pastoral	0.004
	Sumbawanga MC	28,165	164	Bovine	Agro pastoral	0.006
	Kalambo DC	93,865	1,173	Bovine	Agro pastoral	0.012
	Nkasi DC	122,927	2	Bovine	Agro pastoral	0.00002
Feb 2017	Sumbawanga DC	17,284	51	Bovine	Agro pastoral	0.003

4.3 FMD occurrence and impact as perceived by different stakeholders visited

4.3.1 KIPETA, LOWER RIFT VALLEY

The **owner** of a 4,000 head cattle herd (split into various herds managed by his sons) described that there are many contact points between different cattle herds in the ward due to communal grazing practices. FMD vaccination was done for the last time in 2012 by the local government (district). The farmer does not vaccinate for FMD privately. In comparison, Contagious Bovine Pleuropneumonia (CBPP) is vaccinated for every year based on a system where the farmer pays for the vaccine and the district veterinarian offers the service. In general, for anything veterinary related in terms of treatment and similar, the farmer relies on the veterinary extension officers, as he wants to make sure that things are done correctly.

He remembered having had a FMD outbreak in the past. The most striking observation was that the animals could not eat well due to blisters and therefore lost weight/appeared emaciated. Moreover, in some animals, the milk could drop to zero, but this was not perceived to be a major problem, as some of the milk was said to be used for the household and the rest left for calves; milk sales from the herd were considered negligible. The farmer mentioned that FMD outbreaks in the region commonly occur *after* the rainy season.

The **ward marketing officer in charge** said that FMD outbreaks in the area commonly occur in the rainy season from January to February. But in the last eight years, there were also some FMD outbreaks before the rainy season. He considered the FMD related losses for the farmers to be very small for the following reasons:

- No calf deaths observed
- No effect on cultivation, through loss of draught power, as no cultivation is done during this time

- Milk production drops, but as there are no sales, i.e. only household milk consumption, this effect is small

However, the farmers would have some expenditure for palliative treatment. Because animals do not die, farmers may not be very willing to do something about the disease. Officials and farmers described that goats can also get the disease, but that the symptoms were commonly mild.

The situation seems different for **CBPP**, which is perceived to be a major problem and has a high mortality. In August 2016, 6,000 animals were vaccinated for CBPP in Kipeta ward (6,000/40,000 = vaccination coverage 15%). Other diseases of relevance that were described by farmers and officials were **ECF, anaplasmosis, and lumpy skin disease (LSD)**. The local authority vaccinated 400-500 dogs against rabies in Kipeta from January to September 2016. In terms of infrastructure, there is no longer a dip (the only one was swept away in floods), a dam is under construction, and the veterinary centre is described to be poorly equipped. Ticks are controlled by spraying but this may not be effective in large herds.

4.3.2 KALAMBO RANCH, KALAMBO DISTRICT COUNCIL

The ranch manager reported that the ranch itself as well as the surrounding blocks suffered from FMD problems. He reported that without vaccination, they get FMD outbreaks three times a year if there are heavy rains, namely in April-May, July, and September. In years of extraordinarily heavy rainfall, there could even be four outbreaks. The outbreaks were described as having the following characteristics:

- When there is an outbreak, a large number of animals suffer from clinical disease; estimated 40 to 60 out of 200 cattle (20-30%)
- The serotypes involved are not known
- Outbreak duration is 2 weeks; spread through herd is promoted by bringing together animals for salt licking to increase transmission
- Animals lose weight, there is slowed growth
- Milk drops to zero
- Calves deaths: 4 out of 76 (5.3%) calves died. Considered to be major problem
- Secondary infections require palliative treatment for calves (Oxytetracyclin) and sometimes adults. Costs of palliative treatment: adult cattle – TSh 20,000 per head including drugs only (no veterinary fee, as applied by farmer). TSh 10,000 for a calf.
- Abortions are also a substantial problem, but the number of abortions is not known

With vaccination, no FMD outbreaks were observed. The ranch uses a trivalent vaccine that they get from Anicrop Ltd in Arusha, which orders from Zimbabwe and Kenya. Price for FMD vaccine ranged from TSh 4,000 to 5,000 per dose (in comparison the vaccine for Black Quarter, BQ, costs TSh 400 per dose and for CBPP TSh 1000 per dose). The manager said that the vaccine is not easy to access and is expensive and therefore he would appreciate authority support to procure vaccines. He helps and collaborates with the other farmers in the surrounding blocks to order vaccines and drugs.

Further disease challenges mentioned by the farmer were CBPP, BQ, LSD, and tick borne diseases.

4.3.3 NKASI COOPERATIVE, NKASI DISTRICIT

Farmers reportedly did not vaccinate against FMD. They observed the disease during the rainy season, but said that it has not been very common in the last 2 to 3 years. The impact was described as loss of body condition, which was worst in the dry season, and calf, lamb and kids (goats) mortality. They described a strong impact on cultivation, as farmers cannot use cattle draught power to prepare fields.

However, FMD was not deemed to be of major importance. For them, the main problem was CBPP; vaccination for this disease took place in 2012 for the last time. From 2008 to 2011, there were vaccination campaigns by a NGO-led project, but there was no money left after the project ended. The farmers said that the DED collects money from livestock activities, but the 15% of the collections that should go into the livestock fund is not set aside for livestock development activities. Therefore, the district cannot purchase vaccines.

4.3.4 NKUNDI RANCH

The Nkundi ranch manager reported that FMD occurred rarely and if it occurred, it was mainly in March and April. They had their last outbreak in 2014. The losses due to FMD included calf deaths, emaciation of the adult cattle, costs of treatments (palliative and combat secondary bacterial infections). The main disease problems reported were pneumonia in calves during coldest period (Jun to Aug) and BQ. There were no CBPP problems recently, which may be due to the farm vaccinating for CBPP in the past and improving their biosecurity. Moreover, the farm uses more of their own stock for re-stocking, there is less influx from other areas apart from Kalambo. The farm used to be fenced, but the fence was stolen/got broken.

The ranch keeps Boran bulls to cross with zebu. The manager says that the Boran were not very resistant to diseases, got very emaciated when hit by FMD and that the Tanzanian shorthorn is more resistant in comparison. The farm manager relies on the government officers if there is a disease problem to get vaccines, advice and treatment. Their plans are to reach a capacity of 3,000 animals in the farm. They rely on SAAFI for sales and expect the owner to do something to improve the situation.

5 DESCRIPTION OF THE FMD CONTROL PLAN AND COST-BENEFIT ANALYSIS

The Tanzania Development Vision 2025 aspires to commercialise the livestock sector, make it more competitive by producing world class quality animals and products. The Vision is interpreted in the National Livestock Policy (2006) which supports the establishment of a FMD disease free zone in line with international guidelines and the SPS Agreement in which member countries agree to recognise disease free zones as sources of animals and animal products for international markets, subject to risk assessment. The MALF expects that the establishment and maintenance of a disease free zones would promote the availability of safe and quality products like meat and milk for local and export markets and improve earnings of livestock producers and businesses in the value chain by reducing economic losses due to the disease and enhance the performance and efficiency of the national veterinary services [16]. This expectation is based on experiences from other countries: Botswana, Namibia and Swaziland are described to have benefitted economically from their livestock industries after successful establishment of disease free zones without vaccination in their territories and access to higher value export markets [16].

There is a detailed national FMD control plan available elaborated in a workshop organised by MALF in collaboration with key stakeholders ("Strategy For The Control Of Foot And Mouth Disease In Tanzania Mainland 2012/13 – 2017/18"). There is also a strategy available specifically for Rukwa region, which is included in Appendix 3. This document includes background information, justification and an overview of relevant activities, but lacks detail on the activities foreseen. Moreover, the original plan envisaged an area comprised of two districts that formed Rukwa region; the same area has been administratively further divided to include a new district of Kalambo, making Rukwa region to have three districts (Sumbawanga, Nkasi and Kalambo).

Following the scoping study, MALF members under the guidance of Dr Joram Mghwira worked on the details of the national strategy and the surveillance plan and updated the relevant documents.

5.1 Overview of the FMD control approach for Rukwa region

The current plan foresees a staged approach to FMD control to achieve disease free ranches in a first step and then expand the vaccination programme gradually to the whole zone.

In more detail: In the first three years of implementation disease free zone establishment and maintenance; 5 sub district/divisions in Nkasi district will be under surveillance according to this plan.

- Year 1: Implementation of vaccination in Nkundi and Kalambo ranches including all of Nkasi district
- Year 2: Implementation of vaccination expanded to Sumbawanga, both the district and the municipality
- Years 3 to 10: Vaccination of the whole region

The **surveillance plan** intends to support FMD control in the designated ranches by ensuring that all FMD clinical disease and suspect cases are reported for subsequent testing to identify the virus strains involved to inform vaccine matching. The surveillance area will include the rest of the district for easy coordination of activities as well as considering the geographical location of the two ranches and the

need to control FMD by vaccination, which is also intended to show spill over effect of benefits of controlling FMD to traditional livestock keepers in the region.

5.2 Overview of the cost-benefit analysis and feasibility assessment

The cost-benefit analysis (CBA) included the following, namely estimation of

1. FMD disease impact for agro-pastoralist, pastoralist farms and ranches in an endemic situation (baseline)
2. Outbreak control costs
3. Costs of a vaccination campaign
4. Costs of surveillance activities to support the vaccination campaign
5. Avoidance of disease costs and outbreak control costs with the intervention (=benefit)
6. Comparison of costs and benefits in a cost-benefit analysis.
7. Comparison of results with the benefit that could be generated from trade income

Spreadsheet models were developed in Microsoft Excel with Palisade @Risk software for simulation modelling. All prices used were in Tanzanian Shillings (TSh); 1 USD = 2235 TSh at the time of analysis. The time frame chosen for the analysis was 2017 to 2026. All future costs and benefits were translated into present values by multiplying the costs or benefits by the discount factor $1/(1 + r)^t$, where **r** = 3% was the selected discount rate (in line with other cost-benefit analyses for animal disease in production animals) and **t** = the time in years.
Finally, the feasibility of the intervention and surveillance programme was analysed descriptively. The establishment of a traceability and animal identification system was not included in the costs, as such a system is already required by law and after pilot testing ready to be rolled out more widely (see feasibility section).

5.3 Estimation of disease costs

5.3.1 METHODS

The monetary benefit comprised avoided production losses and avoided expenditures for palliative treatment (E_{PT}). The **production losses** included losses due to mortality (L_M), abortion (L_A), reduced milk yield (L_{RMY}), reduced weight gain (L_W) and loss of traction in agro-pastoralist systems (L_T) and were calculated as outlined below. Losses due to premature culling of young and adult stock as well as prolonged calving interval were considered negligible.

The number of cattle (e.g. number of cows, number of steers) was calculated by multiplying the total number of cattle in a herd by the proportion of the respective group, e.g. *number of total cattle * proportion of calves* (Table 8).

Table 8. Cattle herd demographics used to estimate FMD losses at the herd level

Herd composition	Units	Nota-tion	Small (1 to 10)	Medium (11 to 49)	Large (50 or more)	Nkundi Ranch	Kalambo Ranch	Kalambo Ranch blocks
Total cattle per herd	Heads	N_{CT}	Pert (1,5,10)	Pert (11,30,49)	Gamma (4,12,Shift(80))	714	660	11,761
Proportion of cows	%	P_C	0.50	0.55	0.60	0.68	0.68	0.68
Proportion of bulls	%	P_B	0.03	0.03	0.30	0.02	0.02	0.02
Proportion of oxen for draft	%	P_O	0.20	0.30	0.05	0.04	0.04	0.04
Proportion of steers	%	P_S	0.02	0.05	0.07	0.03	0.03	0.03
Proportion of calves	%	P_{CV}	0.15	0.15	0.15	0.10	0.10	0.10
Proportion of heifers	%	P_H	0.10	0.10	0.10	0.29	0.29	0.29

Physical loss coefficients, market prices and production data used are listed in Table 9. The number of households with cattle is presented in Table 10.

The following equations were used to estimate disease costs:

$$L_M = N_{CV} \cdot Mt_{\mathrm{YS}} \cdot AV_{\mathrm{CV}} + N_H \cdot Mt_{\mathrm{YS}} \cdot AV_H$$

Where N_{CV} stands for the number of calves, N_H for the number of heifers, Mt_{YS} for the extra mortality rate due to FMD in young stock, AV for live animal value for calves (CV) and heifers (H), respectively.

$$L_A = (N_C + N_H) \cdot P_P \cdot Mb \cdot AR \cdot CA$$

Where N_C stands for the number of cows, N_H for the number of heifers, P_P for proportion of cows and heifers that are pregnant, *Mb* for morbidity, *AR* for the extra abortion rate due to FMD (in clinically ill, pregnant animals), and *CA* for costs per abortion.

$$L_{RMY} = N_C \cdot P_L \cdot Mb \cdot (P_{MLA} \cdot N_{MLA} \cdot RMY_A + P_{MLC} \cdot N_{MLC} \cdot RMY_C) \cdot MY \cdot MP$$

Where N_C stands for the number of cows, P_L the proportion of cows in lactation, *Mb* for morbidity, P_{MLA} and P_{MLC} for the proportion of cows affected with milk loss during acute (A) and chronic (C) FMD, N_{MLA} and N_{MLC} for the number of days of milk loss, *RMY* for the rate of reduced milk yield, *MY* for average daily milk yield, and *MP* for the market price per litre milk.

$$L_W = (N_C + N_B) \cdot Mb \cdot RWL \cdot VM$$

Where N_C stands for the number of cows, N_B for the number of bulls, *Mb* for morbidity, *RWL* for the rate of weight loss assuming that the reduced weight gain would only be partly compensated in the long term, and *VM* for the value of the meat lost.

$$L_T = (N_O \cdot Mb)/2 \cdot P_{OP} \cdot WTL \cdot RRI \cdot IC$$

Where N_O stands for the number of oxen, *Mb* for morbidity, P_{OP} for the probability of an outbreak during planting season, *WTL* for the oxen working time lost in days due to FMD, N_{DP} the number of days work in planting season, *RRI* for the rate of reduced income per day from crop due to late planting, and *IC* for the value of the total income from crop production, which is based on a

combination of what is frequently grown in Rukwa region, namely maize and rice and typical farm sizes (areas under crop).

$$E_{PT} = N_A \cdot Mb \cdot VTR_A \cdot EV_A + N_Y \cdot Mb \cdot VTR_Y \cdot EV_Y$$

Variable *N* stands for the number of cattle, *Mb* for morbidity, *VTR* for the proportion of clinically ill cattle getting treatment, and *EV* for the expenditures for the veterinary treatment for adult stock (A) and young stock (Y), respectively.

Table 9. Input variables used to estimate FMD production losses and expenditures

Variable	Unit	Notation	Small farm (1-10 cattle)	Medium farm (11-49 cattle)	Large farm (≥50 cattle)	Ranches	Derived from
Morbidity							
Proportion of animals clinically affected (morbidity)	%	Mb	0.20	0.20	0.20	0.20	Official statistics
Duration of clinical symptoms in days	d	D_O	Pert(7,20,90)	Pert(7,20,90)	Pert(7,20,90)	Pert(7,20,90)	[17], [18] and expert opinion
Decrease in milk yield							
Proportion of cows in lactation, %	%	P_L	0.40	0.40	0.40	0.40	[19]
Proportion of clinically ill, lactating cows affected with milk loss	%	P_{MLA}	0.92	0.57	0.22	0.22	[17], [18] and expert opinion
Number of days of acute FMD milk loss	d	N_{MLA}	Pert (7,29,90)	Pert (7,26,63)	Pert (7,23,35)	Pert (7,23,35)	[18], [20]
Reduced milk yield per affected cow and day of clinical illness	%	RMY_A	Pert (0.077,0.54,1)	Pert (0.077,0.54,1)	Pert (0.077,0.54,1)	Pert (0.077,0.54,1)	[20] and expert opinion
Proportion of acute FMD cases that develop chronic FMD	%	P_{CFMD}	0.13	0.13	0.13	0.13	[20]
Number of days of chronic FMD affecting lactation	d	N_{MLC}	Pert (61,116,458)	Pert (61,116,321)	Pert (61,116,183)	Pert (61,116,183)	[20]
Reduced milk yield per affected cow, chronic FMD	%	RMY_C	0.832	0.832	0.832	0.832	[20]
Average milk yield per cow and year	l	MY	Pert (365,424,986)	Pert (365,424,986)	Pert (365,424,986)	Pert (365,424,986)	[20], [21]
Milk price per litre milk	TSh	MP	1,000	1,000	1,000	1,000	Pers. comm. J. Mghwira
Mortality and premature culling							
Young stock mortality, acute FMD	%	MT_Y	0.08	0.05	0.03	0.03	[17], [18]
Adult stock mortality, acute FMD	%	MT_A	0.00	0.00	0.00	0.00	Expert opinion
Value calf	TSh	V_{CV}	Pert (200k, 300k,400k)	Pert (200k, 300k,400k)	Pert (200k, 300k,400k)	Pert (200k, 300k,400k)	Assumption
Market value large cattle (bulls, oxen) per head	TSh	MV_{LC}	1,100,000	1,100,000	1,100,000	1,100,000	Scoping study, expert opinion
Market value medium cattle (cows, small bulls or oxen) per head	TSh	MV_{MC}	600,000	600,000	600,000	600,000	Scoping study, expert opinion

Market value small animals (small cows, heifers, young bulls) per head	TSh	MV_{SC}	400,000	400,000	400,000	400,000	Scoping study, expert opinion
Reproductive disorders							
Proportion of cows and heifers pregnant	%	P_P	0.3	0.3	0.3	0.3	[19]
Abortion rate in clinically ill, pregnant cows	%	AR	0.08	0.08	0.08	0.08	[22]
Cost per abortion	TSH	CA	Calf value plus treatment costs (assumed to be the same as for FMD ill animals getting veterinary treatment)				Assumption
Reduced growth							
Weight loss during outbreak	kg	wl	23	23	23	23	[23]
Ratio liveweight to slaughterweight * proportion of lost weight not regained	n/a	rw	0.13	0.13	0.13	0.13	Assumption
Rate of weight loss	%	RWL	3.07	3.07	3.07	3.07	Calculated
Value per kg of beef meat	TSh	VM	6500	6500	6500	6500	Scoping study, expert opinion
Loss of draft power							
Land area ploughed by ox pair per day	Ha	AP	0.2	0.2	n/a	n/a	[24]
Land area under crop, input variable	Ha	AC	0.5	2			Derived from [24], [25]
Average number of days worked on own farm, 1 planting season	d	N_{DP}	8	8	n/a	n/a	Derived from [24]
Rate of reduced income per day from crop due to late planting	%	RRI	0.01357	0.01357	n/a	n/a	Derived from [26]
Value of average rice crop per Ha	TSh	VRC	5,735,740	5,735,740	n/a	n/a	Ratin.net and [25]
Value of average maize crop per Ha	TSh	VMC	2,581,965	2,581,965	n/a	n/a	[25]
Time oxen cannot be used for traction due to FMD outbreak	days	DTL	Pert(7,25,84)	Pert(7,25,84)	n/a	n/a	[17], [18]
Oxen working time lost in days due to FMD	days	WTL	8	8	n/a	n/a	Assumption[1]
Probability of outbreak during planting season	n/a	P_{OP}	0.16	0.16	0.16	0.16	Assumption[2]
Average income from crop	TSh	IC	2,079,426	8,317,705	n/a	n/a	Assuming 50% rice, 50% maize
Veterinary treatment rate							
% of clinically ill young stock getting vet treatment	%	VTR_Y	0.2	0.3	0.4	0.4	Assumption
% of clinically ill young stock getting vet treatment	%	VTR_A	0.1	0.15	0.2	0.2	Assumption
Expenditures of veterinary treatment per clinical FMD case adult stock	TSh	EV_Y	20,000	20,000	20,000	20,000	Expert opinion

Expenditures of veterinary treatment per clinical FMD case young stock	TSh	EV_A	10,000	10,000	10,000	10,000	Expert opinion
Vaccination							
Proportion of animals vaccinated preventatively	%	PVP	0	0	0	0	Expert opinion and scoping visit
Private share	%	PVP_{PR}	0	0	0	0	Expert opinion and scoping visit
Public share	%	PVP_{PU}	0	0	0	0	Expert opinion and scoping visit
Number of vaccine doses per year	doses	DV	3	3	3	3	

[1] This reflects the average number of working days during planting season. Oxen will be unfit to work for longer, but they are not needed for that many days

[2] One planting season per year in study area. Duration of outbreak is 20 days. 20days/365 *number of outbreaks per year (assumed to be three).

The losses and expenditures were added up to estimate the total disease costs per farm type or ranch. This figure was then multiplied by the number of cattle holding households in the area (Table 10), the reported between herd prevalence (5%) and a correction factor for underreporting of 2 to estimate the total disease impact for the region.

Table 10. Number of cattle keeping households in Rukwa region. MC = municipal council, DC = district council

Number of households with cattle	Unit	Notation	Small (1 to 10)	Medium (11 to 49)	Large (50 or more)
Sumbawanga MC	HH	H_{SBCMC}	7423	620	17
Sumbawanga DC	HH	H_{SBCDC}	11746	1898	448
Kalambo DC	HH	H_K	9722	1333	276
Nkasi DC	HH	H_N	4264	1045	575
Total	*HH*	H_T	*33155*	*4896*	*1316*

5.3.2 ESTIMATED FMD DISEASE COSTS IN RUKWA REGION

Table 11 summarises the total FMD diseases costs (losses and expenditures) for different types of animal holdings as well as the total disease costs for the baseline (endemic situation) extrapolated to Rukwa region using a between-herd prevalence of 5%, an underreporting correction factor of 2 and two outbreaks per year for the ranches. This adds up to total disease costs of TSh 711 m per year for Rukwa region.

Table 11. Estimated FMD disease cost for different types of holdings used

Disease cost	Unit	Small farm (1-10 cattle)	Medium farm (11-49 cattle)	Large farm (≥50 cattle)	Nkundi Ranch	Kalambo Ranch	Kalambo Ranch blocks
Loss due to mortality young stock	TSh	33,363	132,600	173,400	2,677,500	2,475,000	44,103,750
Loss due to mortality adult stock	TSh	0	0	0	0	0	0
Loss due to increased abortions	TSh	4,608	29,952	86,016	1,058,304	978,264	17,432,372
Loss due to prolonged calving interval	TSh	0	0	0	0	0	0
Loss due to reduced milk yield acute FMD	TSh	3,347	12,271	12,188	122,392	113,136	2,016,046
Loss due to reduced milk yield chronic FMD	TSh	2,870	18,943	55,106	553,352	511,502	9,114,804
Loss due to reduced milk yield	TSh	6,217	31,214	67,294	675,744	624,637	11,130,850
Loss due to reduced weight gain	TSh	10,565	69,368	200,928	2,063,677	1,987,390	36,836,940
Loss due to impact on traction	TSh	3,711	55,663	0	0	0	0
Veterinary treatment expenditures clinically affected animals	TSh	2,000	18,000	64,000	656,000	606,387	10,805,625
Total disease cost per herd affected	**TSh**	**60,463**	**336,796**	**591,638**	**7,131,228**	**6,671,682**	**120,309,542**
	USD	27	152	266	3,209	3,002	54,139
Total disease cost per head	**TSh**	**12,093**	**11,227**	**7,395**	**9,988**	**10,109**	**10,230**
	USD	5	5	3	4	5	5
Total costs for all affected farms	**TSh**	**200,466,042**	**164,895,483**	**77,859,564**	**14,262,455**	**13,343,364**	**240,619,084**
	USD	90,210	74,203	35,037	6,418	6,005	108,279

5.4 FMD vaccination activities and their costs

5.4.1 NUMBER OF VACCINES AND STAFF NEEDED

To vaccinate the whole zone against FMD with the aim of elimination of disease, there will need to be vaccines for all cattle, sheep, goats, and pigs. Data received from the officers in Nkasi districts for 2016 listed 107,000 cattle, 14,445 Sheep and 30,475 goats; a marked difference to the figures reported officially. Veterinary officials in Nkasi district reported that the number of cattle went down substantially over the past decade, namely from 200,000 in 1999 to 145,000 in 2010 and 107,000 in 2015 (latest census). Explanations provided for this effect by local farmers and livestock officers were that a) farmers move to other regions in the search of land and grazing; b) there is an increased awareness that fewer cattle, but of higher quality should be kept; and c) due to an increase in crop production, less land is available for livestock. Given the discrepancy in figures obtained, it was assumed that the actual livestock numbers may lie between the official statistics and the data shared by officers in the district and the following correction factors were applied to the official statistics:

0.87 for cattle, 0.68 for goats, 0.75 for sheep and 0.77 for pigs. A yearly livestock population increase of 3% was assumed taking into account a decrease in mortality and increase in fertility with control. This resulted in the following input figures (Table 12):

Table 12. Number of animals to be vaccinated in Rukwa region. 2015 data used as baseline with an annual population increase modelled of 3%.

	Nkasi district	Kalambo district	Sumbawanga district	Sumbawanga municipality
Total number of goats	58,214	18,445	48,733	12,857
Total number of sheep	21,771	2,064	9,674	1,034
Total number of cattle	124,282	65,112	164,795	34,480
Total number of pigs	3,228	12,918	18,521	9,077
Total number of animals	*207,495*	*98,539*	*241,724*	*57,448*

Cattle will need 2 to 3 doses per year, because of a relatively short duration of protective immunity; only one is needed for sheep, goats and pigs. The vaccination will take place in teams of 5-6 people, namely 1 driver, 1 leader/coordinator, plus 3 or 4 vaccinators. Based on information gathered during the scoping visit, it was assumed that their salaries will be paid already, i.e. that they will be employed by government or the local authority and be assigned to this task (instead of other duties). It is assumed that vaccination teams will be constituted from local government staff supervised by the respective DVO. Data on staffing at the local government level (district) is given in Table 13.

Table 13: Current number of livestock officers and staff members from the four districts capable of forming the FMD vaccination teams.

Designation	District			
	Sumbawanga District	**Sumbawanga Municipality**	**Kalambo District**	**Nkasi District**
Livestock Officers	7	3	3	4
Livestock Field Officers	23	19	15	10
Total	*30*	*22*	*18*	*14*

To ensure effective implementation, 4 to 5 vaccination teams will need to operate per district, working 5 days per week. Given the staff numbers in Table 13, the possible numbers of vaccination teams could be: 4 for Sumbawanga DC, 4 for Sumbawanga MC, 3 for Kalambo DC and 3 for Nkasi DC (estimate by Dr KM Kamwela, Senior Veterinary Officer, MALF, ZVC), equalling to a total of 14 vaccination teams. It is estimated that a team can vaccinate 500 animals per day, which gives a maximum of 20,000 animals per month or 123,000 heads per year with 246 working days per year.

The current staffing seems adequate for the vaccination programme but none of the four district/municipality councils have a DVO in place. These would have to be recruited / seconded from other regions to give confidence to the operations of the FMD_FZ. While the salaries of staff are paid (i.e. staffing would be absorbed within existing structures and duties), DSA will apply as follows: veterinary officer TSh 80k, field staff TSh 60k, and driver TSh 50k. The DSA costs for a team of five as described above operating on 246 working days would cost TSh 76.26 m per year.

5.4.2 PROCUREMENT OF VACCINES FOR RUKWA REGION AND STORAGE

The common practice for vaccine procurement is to place an order through private suppliers. In the case of the FMD_FZ it is proposed that the vaccine be ordered by CIF Dar es Salaam and then the

Directorate of Veterinary Services in Dar es Salaam takes charge of the delivery of the vaccine to the ZVC in Sumbawanga. This will ensure that the vaccines are maintained properly and stored by the directorate itself in its cold chain facilities in Dar es Salaam. The vaccines will then be delivered to the ZVC in Sumbawanga where they will be stored and later distributed to the vaccination teams as and when required.

To handle the anticipated volume of vaccines the centre in Sumbawanga would need to invest in cold chain facilities, as estimated in Table 14.

Table 14. Cold chain facilities requirements for FMD_FZ

District/Office	Refrigerator	Deep freezer	Vaccine carriers	Ice packs
Sumbawanga DC	0	0	4	16
Sumbawanga MC	0	0	4	16
Kalambo	1	1	4	16
Nkasi	1	1	4	16
ZVC Sumbawanga	3	3	12	48

The ZVC Sumbawanga would also store vaccines for the Sumbawanga Municipality and District Councils. A standby generator would be required to maintain the cold chain in case of anticipated power outage. Prices found using an internet search (www.jumia.co.tz) were as follows: Commercial deep freezer, 258 litres: TSh 750k; refrigerator TSh 500k, cool box TSh 100k, ice pack TSh 20k.

5.4.3 VACCINE PRICES

From Alpha Vet Arusha it was learned that they would charge TSh 400,000 for the quadrivalent vaccine (SAT 1 and 2, Type O and A) manufactured in Kenya for a 300 ml bottle containing 100 cattle doses delivered to Dar es Salaam, i.e. TSh 4,000 per dose. Vaccination is recommended every 4 to 6 months to maximise protection.

The Botswana Vaccine Institute would charge approximately USD 13.54 per 100 doses (i.e. USD 0.135 per dose) for CBPP as the Cost Insurance and Freight (CIF) price (i.e. landing price) for Dar es Salaam. For the quadrivalent FMD vaccine, the landing price in Dar es Salaam is about USD 2.52 per dose (=TSh 5,600 per dose).

Some vaccinations took place in one of the ranches we visited, namely the Kalambo Ranch with CBPP vaccines costing about TSh 1,000 per vaccinated animal and FMD_QV (O, A, SAT 1 and 2) between TSh 4,000 and 5,000 per dose. The vaccines were obtained from or ordered through Anicorp Arusha.

The input used for the vaccine price per dose was the average of the price information received from the three sources above for the quadrivalent vaccine (TSh 4,700) assuming that the government would distribute vaccines at the landing price. For sheep, goats and pigs, it was assumed that the price per dose would be a third of the cattle price, i.e. TSh 1,567.

5.4.4 VEHICLES NEEDED

Each team will have a car provided by the authorities. It is assumed that existing cars can be used for this purpose. For vaccine distribution and sample collection two **4 Wheel Drive Landcruiser** vehicles would be required to be stationed at the Centre in Sumbawanga. The two cars will operate from ZVC Sumbawanga whereby one car will be used for shipment of supplies to ZVC and subsequent

distribution to the districts. This includes field materials for surveillance and vaccination (vaccines, cool boxes, ice packs, etc). The second car will be used for coordination and supervision of both surveillance and vaccination and for facilitation during communication and training sessions with field staff, livestock keepers and the general public.

The following figures were used to estimate vehicle costs during the vaccination campaign (based on pers. comm. Dr Joram Mghwira and Dr Michael Madege, MALF). The average amount of fuel needed will be 50 litre per day and car to move locally; price per litre is TSh 2,000. Further, there will be car maintenance, service (2 times per year @ TSh 1m) and new sets of tyres (3 times per year @ TSh 500k per set) to pay. Summing up all costs for a total of 246 field days, the total vehicle costs per team and year will be TSh 28.1 m.

5.4.5 MATERIALS/CONSUMABLES

The vaccinated cattle will need to be identified using a special livestock marker, which usually lasts up to two months in cattle, sheep and goats. For pigs, that marker may last slightly less long due to their roaming and dust/mud-bathing behaviour. An alternative to the marker would be to use a water-based special paint with brush, which holds better than sprays. Brush would be the preferred option with purchasing tins of paint of 4 kg, which would translate to TSh 30,000 for 500 animals.

For the application of the vaccines, needles and syringes would need to be purchased. An automatic syringe costs TSh 65,000, which could be used by somebody experienced up to a month without breaking, i.e. an application of 10,000 doses maximum; an inexperienced person would vaccinate 5,000 animals before breaking the syringe (average value used as input, i.e. 7,500 animals vaccinated). It is assumed that one needle will be used for 50 animals, as FMD – unlike CBPP – does not cause reactions. The price for a dozen needles is TSh 7,200 (pers. comm. Dr Michael Madege), i.e. TSh 600 per needle.

5.4.6 ESTIMATION OF TOTAL VACCINATION COSTS

The total vaccination costs were estimated based on the number of injections needed in the animal population (Table 15). The number of doses as illustrated in the table was estimated by multiplying the number of animals in the district by species times the number of doses needed per year. The number of teams needed was estimated by dividing the total number of injections needed by the capacity of vaccination per team (expressed in the number of animals that can be vaccinated).

Table 15. Number of FMD doses / applications and teams needed for the vaccination campaign

Number of	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Doses needed Nkasi DC	469,741	483,833	498,348	513,299	528,698	544,558	560,895	577,722	595,054	612,905
Doses needed Kalambo DC	0	0	249,975	257,474	265,198	273,154	281,349	289,789	298,483	307,437
Doses needed SBA DC	0	606,108	624,291	643,019	662,310	682,179	702,645	723,724	745,436	767,799
Doses needed SBA MC	0	140,525	144,741	149,083	153,556	158,162	162,907	167,794	172,828	178,013
Teams needed	4	10	12	13	13	13	14	14	15	15

The number of doses were multiplied by the prices for vaccines, needles, syringes, and consumables as described above. The number of teams needed per year were multiplied by the cost for vehicle and DSA per team. Finally, the total costs were estimated by summing up all cost items and discounting them with a discount rate of 3%.

5.4.7 ESTIMATED VACCINATION COSTS

Table 16 illustrates the total estimated costs for the vaccination campaign in Rukwa region for the years 2017 to 2026 assuming a vaccination coverage of 100%. Taking into account the population to be vaccinated, this translates into approximately TSh 5,000 per animal vaccinated on average (across all species).

Table 16. Total estimated costs for the vaccination campaign in Rukwa region in million TSh and USD.

Vaccination costs		**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Vaccines	TSh m	1939	5144	6359	6550	6746	6949	7157	7372	7593	7821
Consumables	TSh m	53	116	141	145	150	154	158	163	168	173
DSA for all teams	TSh m	291	763	941	969	998	1028	1059	1091	1123	1157
Vehicle/transport	TSh m	107	281	347	357	368	379	390	402	414	426
Total vaccination costs (undiscounted)	**TSh m**	**2391**	**6304**	**7788**	**8021**	**8262**	**8509**	**8765**	**9027**	**9298**	**9577**
	USD m	1.08	2.84	3.50	3.61	3.72	3.83	3.94	4.06	4.18	4.31
Total vaccination costs (discounted)	**TSh m**	**2391**	**6120**	**7341**	**7341**	**7340**	**7340**	**7340**	**7340**	**7340**	**7340**
	USD m	1.08	2.75	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30

5.5 Estimation of outbreak investigation costs

Upon detection of a suspect FMD case, the veterinary field officer, the farmer, or the DVO will report the case to the ZVC from where it will be reported to the central epidemiological unit. Following reporting, two officers from the ZVC will go to the farm to investigate, which includes the following: clinical examination or post-mortem if animal is dead and collection of biological samples. These samples are then normally sent to the TVLA in Dar es Salaam either directly or through the TVLA in Iringa; there is also the possibility for the samples to be sent to the TVLA in Mpwapwa, Dodoma or the laboratory at SUA if there are problems with the preferred option. The laboratory will be contacted in advance by telephone so that the staff is aware and to avoid delays in processing of the samples. All laboratories are known to produce answers in a quick and reliable manner; the duration varies from two days to two weeks. The estimated shipping costs to the laboratory are TSh 10,000 per package.

The laboratories use antigen ELISA tests for virus identification. Any positive results will be communicated to the DVS in a weekly reporting.

The results will also be sent to the DVO for further action. The following activities apply:

- If block affected (on ranch), the affected block will not be vaccinated (as already infected), but all neighbouring blocks will be vaccinated.
- If an agro-pastoralist village will be affected, the affected sub-village will not be vaccinated, but all other sub-villages will be vaccinated.

It is important to note that experienced people are able to make a clinical diagnosis with good confidence. The laboratory diagnosis helps to know which serotypes are involved, which enables

targeted vaccination with the appropriate vaccine. Due to the time it takes for shipping and analysis, the index farm/herd may already be in the recovery stage, i.e. when lesions are already advanced/healing. However, the outbreak control measures will still be critical to avoid further spread.

If a village or sub-village is affected, then there will be a movement ban implemented at the ward level upon suspicion of disease and continued if a suspect case is confirmed positive. If the ward is affected, then the movement ban will be at the district level. The epidemiological unit is the village. Commonly, the movement ban lasts for about one month. During the duration of the outbreak, DVOs go to the ward or district regularly to check for clinical signs and to make sure that the movement ban is complied with. Nonetheless, it has been described that some producers sneak out to sell their cattle at markets. During the time of the movement ban, the purchasing power of the affected villages is reduced. The ban is lifted once no further clinical cases have been observed.

To estimate the outbreak control costs, it was assumed that for an average outbreak all the animals in a village (consisting of several sub-villages) would be vaccinated. Rukwa region has a total of 318 villages, which – on average – translates to a total of 2,000 FMD susceptible animals per village. This translates to a vaccination cost of TSh 10m. Adding to this, the costs for sample taking and initial clinical examination of an estimated TSh 200,000 for personnel, consumables and fuel plus TSh 10,000 for shipping and laboratory testing of the submission (TSh 10,000 each) gives an approximate outbreak control cost of TSh 10.22 m per outbreak. The total outbreak costs per year were calculated by multiplying this by the number of detected outbreaks in an endemic situation, i.e. 6 – a figure derived from data published previously [27]. For the intervention scenario, it was assumed that the number of outbreaks with successful vaccination would be zero.

5.6 Surveillance approach and design

According to the (draft) national control plan, disease reporting based on passive surveillance in combination with active surveillance in all susceptible livestock will be carried out in the proposed area with the aim to detect active disease or infection. Active surveillance in African Buffalo will be established in existing wildlife ecosystems in close proximity to the proposed area to detect and monitor FMD spill over from wildlife to livestock and vice versa. Various information communication technologies and software (Digital Pen Technology, mobile phone, online) will be applied during active and passive surveillance methodologies to improve the quality and timeliness of surveillance data and information.

The approach to surveillance was guided by the endemic status of FMD in the targeted semi intensive commercial beef production ranches in Nkasi district; the agro-pastoral livestock production system practised by traditional livestock keeper in the Nkasi district whereby the majority of local domestic animals kept are susceptible to FMD (cattle, pigs, sheep and goats); and the surrounding game protected areas in Sumbawanga and Kalambo districts and neighbouring Katavi region where a number of FMD susceptible wildlife species including the buffalo are found in large numbers. It relies on laws governing animal disease and veterinary practices, in particular the Animal Disease Act 2003 and Veterinary Act section 14, 15(1,2,3(c)), 16 (1 (a,b)), which provides the foundation for disease reporting.

According to MALF, the objectives of surveillance are to:

i. **Demonstrate the presence or absence** of clinical disease or infection, detect as early as possible the FMD emergence in new areas or zones**, determine and/or monitor circulating serotypes and topotypes**, and **delineate the distribution and occurrence** of the disease or infection;
ii. **Identify circulating virus and characterise specific strains** to enable rapid detection of novel FMD viruses or strains in populations of susceptible species and map their distribution to inform response options;
iii. **Improve understanding of the ecology of circulating viruses** and assess rate of natural evolutionary drift in viruses in given ecosystems and establish the role of livestock in the spread and emergence of FMD virus in wildlife populations,
iv. **Contribute data for evaluation of economic impacts of FMD** on livestock populations, opportunity cost of FMDV presence, and assessment of the effect of FMD presence on trade of live animals and livestock commodities with various other endemic and non-endemic areas;
v. Provide **data for use in risk analysis** and for targeted interventions;
vi. **Monitor and measure success of interventions**;
vii. **Collect information for mapping of endemic and "hotspot" areas** to assist with disease control planning and trade negotiations.
viii. **Establish a database** to support FMD control policy.
ix. Surveillance will also be used to **determine herd immunity after vaccination**

The surveillance area will include the ranches as well as the rest of the district for easy coordination of activities as well as considering the geographical location of the two ranches and the need to control FMD by vaccination, which is also intended to show spill over effect of benefits of controlling FMD to traditional livestock keepers in the region

The surveillance will require:

1. Livestock owners (including Kalambo and Nkundi ranches), traders, slaughter house, clinicians, zoosanitary inspectors, livestock market masters and game rangers to recognise the disease symptoms/syndrome and notify the private or public veterinary practitioner in the nearby locality
2. Private and public para veterinarian (extension officers) to conduct a clinical examination, record disease and epidemiological data related to the disease and disseminate the record to the DVO.
3. DVO to receive and enter reports submitted by field staff working in villages, wards and divisions into the database, send them to ZVC and also plan and implement passive surveillance.
4. ZVCs and regional Veterinary office (under Regional Secretariat) to receive and validate information sent by the DVO and plan for surveillance together with the Zonal Veterinary Laboratory.
5. Epidemiology Unit and the Centre for Infectious Disease and Biotechnology (under TVLA) to receive, collate data and disseminate information to interested stakeholder including SADC, AU-IBAR and OIE and plan for surveillance and diagnosis/testing of samples received at the Centre for Infectious diseases

Passive surveillance data will be collected by five surveillance posts at each division in the district on a weekly basis reporting absence or presence of the disease. Surveillance posts can include abattoirs, livestock markets, quarantine station holding grounds, check points, and village/ward/division livestock offices. Any field veterinary personnel have a duty to record and report all disease event they encounter during their daily official routines as part of passive disease surveillance.

In the event where no clinical case has been identified during a period of one year, blood samples will be collected for detection of circulating antibody. The ZVC in collaboration with the ZVL will be responsible for this activity. Colleagues from the MALF estimated that a total of 25 samples will need to be collected at areas around the surveillance posts, summing up to a total of 125 samples per year assuming an expected within herd prevalence of 20%, (epi-tool calculation). Other samples for virus detection will be collected in the event of new outbreaks, which are defined as cases observed after an interval of over six months with no clinical cases within an identified locality.

5.6.1 PERFORMANCE STANDARDS OF THE SURVEILLANCE PLAN

In the first three years of implementation of the vaccination programme, five sub district/divisions in Nkasi district will be under surveillance according to this plan. The district is comprised of 28 administrative wards and 105 villages. Five compulsory reporting posts will be established at each division to link the surveillance system within the district to the national surveillance system. Other districts of Rukwa region will be included in the surveillance system at a later stage.

Activities include:

- Disease reporting by livestock owners and other non-vet animal health professionals
- Surveillance posts reporting regularly absence or presence of FMD cases
- DVO receiving and entering data to database
- DVO planning for surveillance – emergence reports in event of suspected cases, outbreak investigation
- ZVC and Zonal Laboratory data validation and sending to central epidemiology unit
- ZVC and Zonal Laboratory surveillance
- CIDB/CVL sample testing and communication to stakeholders
- Epidemiology unit surveillance plan, database maintenance, risk identification and risk assessment

5.6.2 ADMINISTRATIVE PREPARATIONS FOR SURVEILLANCE

Veterinary authorities at the district and zonal level will be responsible for ensuring that necessary preparations are done to facilitate the smooth implementation of the surveillance plan. The following activities are foreseen:

- Sensitise, create awareness and train livestock value chain actors, including producers (both farmers and pastoralists), middle men, traders and transporters, slaughter house attendants on disease recognition and reporting (using convenient methods such as syndromic manual, mobile phones, digital pen and paper, etc).

- Train field veterinary personnel (public and private) on FMD recognition and reporting, use of appropriate standardised case definitions, a well-organised reporting system, and a good animal health data management system, e.g. ARIS 2, mobile phones and digital pens.
- Equip veterinary services with necessary logistical materials and provide adequate technical staff to undertake investigation of reported FMD cases. The veterinary services itself should be equipped, at appropriate administrative levels, with necessary sample collection equipment, disease reporting tools and materials including standardised reporting formats, mobile phones, digital pens, etc.

There will be a basic diagnostic facility in SWZ veterinary centre in Sumbawanga equipped as part of the national livestock disease control activities that will have ELISA, microscope, freezers, computers, cool boxes, sample equipment, needles, syringes, test tubes. Any further equipment not available and necessary for the FMD surveillance and control programme, will need to be purchased.

5.6.3 ESTIMATION OF SURVEILLANCE COSTS

Activity 1 – Sensitise, create awareness and train livestock value chain actors

The passive surveillance activities will continue in the same way as described for the section outbreak investigation and the same costs will apply. However, they will be complemented by a campaign to raise awareness and train stakeholders in disease recognition and reporting. This will be achieved in the form of training events to be conducted at the district headquarters. Each year, 80 people will be trained per district per year with four (i.e. quarterly) training events (16 training events for the region). Table 17 list the inputs used to estimate the costs for these training events. The total amount per training was calculated by multiplying the number of trainees and trainers by the DSA for the days attended and travelled plus the consumables for each trainee; one training event was estimated to cost TSh 3.38 m. Each year, the same number of training events will be conducted to maintain awareness and avoid intervention and surveillance fatigue.

Table 17. Inputs used to estimate the surveillance awareness and FMD recognition training costs. DC=district council, MC=municipal council.

Variable	Unit	Value	Description
Number of trainers	trainers	3	Trainers: subject matters specialists; animal health, production, marketing, etc. from the district teams
Number of trainees per training	trainees	20	8-10 farmers, 2 traders, 2 community animal health workers, 5 processors/retailers
Number of training days	days	2	Two full days of training
Number of travel days	days	1	Half a day each before/after workshop
Daily subsistence allowance trainers	TSh	30,000	Reflects the location of the training, i.e. district headquarters
Daily subsistence allowance trainees	TSh	50,000	DSA 30k plus their bus fare twice (10k max per bus fare)
Number of trainings per year	trainings	16	Training every quarter, four locations (3x DC, 1x MC)
Cost of consumables for training per trainee	TSh	10,000	Pictorials, manuals, flipchart, videos, brochures and leaflets

Another activity to make stakeholders aware of the intervention, raise awareness of FMD impact and gain their support will be to use local radio and share information through the village extension officer. One team per council will be deployed for this task with one driver and two communications officers.

The DSA will be TSh 80k for communications leader, TSh 60k for communications assistant, and 50k for the driver. The car will be provided by the authority with the same running costs as for the vaccination teams. The village leaders will get TSh 10k DSA (two needed per village) for their support. The team will spend one day per ward twice a year, i.e. 64 wards in all of Rukwa region times two = 128 days. The total cost for this awareness raising per year will be TSh 40.9 m.

There will also be 10 information posters per village (total 318 villages) to hang up in public places like shops, schools, church, etc. Their design and printing will cost TSh 2,000 per poster. Further, there will be radio messaging of TSh 60,000 per short announcement of 30 seconds (one daily foreseen), and TSh 550,000 for longer ones of 30 min (one monthly foreseen). These dissemination activities will accrue a yearly cost of TSh 29.1 m.

Activity 2 - Train field veterinary personnel (public and private) on FMD recognition and reporting

To support effective surveillance, training for field veterinary personnel and DVOs will be offered twice per year on reporting, sample collection, data quality and robustness, and disease recognition at the regional level. The training will be conducted centrally in Sumbawanga. Each training event will host up to 15 people to ensure that each officer can attend the training once per year. Trainers will be the regional veterinary officer and three additional relevant staff members from the headquarters and the ZVO.

The DSA for the trainees will be 90k on average, min 80k, max 100k. The DSA for the trainers from the regional headquarters and ZVO will receive half this amount, as the training will take place in Sumbawanga. The duration of the training will be 3 days with 1 day of travelling; the bus fare will be a maximum of TSh 10,000. Per person, TSh 10,000 will be needed to purchase flipcharts, notebooks, writing materials, pens, handouts. Moreover, an overhead projector will need to be hired @ TSh 50k per day.

Table 18 summarises the inputs used to estimate the costs for these training events. The total amount per training was calculated by multiplying the number of trainees and trainers by the DSA for the days attended and travelled plus the consumables for each trainee plus the costs for projector hire. Each year, the same number of training events will be conducted to maintain and promote surveillance capacity. These training days will amount to a total of TSh 10.38 m per year.

Table 18. Inputs used to estimate the training costs for veterinary officials

Variable	Unit	Value
Number of trainers	trainers	4
Number of trainees per training	trainees	15
Number of training days	days	3
Number of travel days	days	1
Price for bus fare for two journeys	TSh	20,000
Daily subsistence allowance trainers	TSh	45,000
Daily subsistence allowance trainees	TSh	90,000
Number of trainings per year	trainings	2
Cost of equipment for training per trainee	TSh	10,000
Projector hire per day	TSh	50,000

Activity 3: Equip veterinary services with necessary logistical materials and provide adequate technical support

Diligent and prompt investigation of reported, suspect FMD cases will be a critical surveillance activity during the vaccination campaign. Therefore, veterinary services in Rukwa region need to be equipped, at appropriate administrative levels, with necessary sample collection equipment, disease reporting tools and materials including standardised reporting formats, mobile phones, cars, etc. Five surveillance stations will need to be established to coordinate and conduct relevant surveillance activities and support vaccination efforts. For these stations, new equipment will be needed as described in Table 19. The total equipment costs were calculated by multiplying the number of items needed over the years by their costs.

Table 19. Inputs used to estimate the equipment costs for the surveillance stations

Variable	Unit	Value	Number needed
Price mobile phone	TSh	500,000	One per station, replacement needed every two years
Average price data airtime per year	TSh	240,000	One package per station every year
Price of power bank	TSh	150,000	One per station, replacement needed every two years
Price computer, scanner, external drive	TSh	4,400,000	8 sets in total distributed over the 10 years to replace old items
Price 4 Wheel Drive Car	TSh	80,000,000	One per station, initial investment, no replacement needed
Service and tyres costs per year	TSh	3,500,000	One unit per station and year

For active surveillance, each station will collect 25 blood samples from FMD susceptible animals and send them to the laboratory services for testing. It is assumed that all these animals can be sampled in a day and that the costs will include the following: Fuel for car, driver, one coordinator, two veterinary field officers, sample materials (vacu tube @TSh 500, plastic holder @TSh 100, needle @TSh 350, vial for serum @TSh 1,000). All samples would be pooled and shipped to the CIBD in one delivery at a cost of TSh 1,600,000. The CIBD has capacity for antigen detection and antibody detection based on ELISA for serotypes A, O, and SAT 1, 2 and 3. Five submissions are commonly pooled into one sample which costs TSh 44,000 to test. Molecular typing using PCR is also possible, which costs TSh 60,000 per pooled sample.

The analysis of the data, risk analysis, and report writing will be handled centrally as part of the standard work of the people employed by the veterinary service; i.e. there will not be any extra costs for these activities.

5.6.4 TOTAL SURVEILLANCE COSTS

Table 20 illustrates the total estimated costs for the surveillance activities in Rukwa region for the years 2017 to 2026.

Table 20. Total estimated costs for the surveillance (surv) activities in Rukwa region in million TSh and USD.

Total costs (undiscounted) for		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Training of stakeholders	TSh m	54	54	54	54	54	54	54	54	54	54
Village communication visits	TSh m	41	41	41	41	41	41	41	41	41	41
Radio and poster messaging	TSh m	24	24	24	24	24	24	24	24	24	24
Training of officials	TSh m	10	10	10	10	10	10	10	10	10	10
Equipment	TSh m	413	10	4	1	4	10	13	1	4	1
Sampling and testing surv.	TSh m	6	6	6	6	6	6	6	6	6	6
Total surveillance costs (undiscounted)	**TSh m**	**554**	**151**	**145**	**142**	**145**	**151**	**154**	**142**	**145**	**142**
	USD m	0.249	0.068	0.065	0.064	0.065	0.068	0.069	0.064	0.065	0.064
Total costs (discounted)	**TSh m**	**554**	**146**	**137**	**130**	**129**	**130**	**129**	**115**	**115**	**109**
	USD m	0.249	0.066	0.062	0.058	0.058	0.059	0.058	0.052	0.052	0.049

5.7 Sanitary measures

There will be check points for movement control throughout the duration of the intervention, the total number is predicted to be 10. The check points will be supported by police patrols to avoid illegal movements of animals; these police officers will be seconded from the police force. The costs of a check point will include: two livestock officers with a salary of TSh 450,000 per month, i.e. 5.4 m per officer. The station will be equipped with phones, electricity, computer and furniture at a cost of TSh 20 m. The green border controls with police will take place twice per week with four people (two police officers @ TSh 60k for DSA, two livestock officers @ TSh 60k for DSA) and one driver (TSh 50k DSA) plus fuel 50l @TSh 2,000 per litre. Hence, each station will cost a total of TSh 71.36 m per year.

5.8 Comparison of costs and benefits

5.8.1 BASIC EQUATIONS

The Benefit:Cost Ratio (BCR), i.e. the ratio between the sum of the present value of benefits (B) and the sum of the present value of costs (C), was calculated using the following equation (t=time in years; r=discount rate)

$$BCR = \sum \frac{B_t}{(1+r)^t} / \sum \frac{C_t}{(1+r)^t}$$

The Net Present Value (NPV) which represents the difference between the sum of the present value of the benefits (B) and the sum of the present value of costs (C), was calculated using the following equation (t=time in years; r=discount rate)

$$NPV = \sum \frac{B_t}{(1+r)^t} - \sum \frac{C_t}{(1+r)^t}$$

The differences between the cumulative benefits and costs of each technical strategy were used to estimate the breakeven points of each strategy.

The costs included the costs for the intervention, surveillance and sanitary measures as described above, whereas the benefits included the disease costs avoided and the outbreak costs avoided due to the intervention. To estimate the disease costs avoided, it was assumed that the between herd prevalence would be 3.5% in the first year of intervention, 2% in the second year of intervention, 0.5% in the third year of intervention and 0% from Year 4 onwards. In a next step, this value was compared to potential gains related to trade (see details below).

5.8.2 BENEFIT COST RATIO AND NET PRESENT VALUE

Table 21 shows the total undiscounted and discounted costs and benefits, the benefit cost ratio and net present value. The net present value is negative and the benefit-cost ratio is below one showing that the intervention costs are larger than the benefits (i.e. the disease costs and outbreak costs avoided). For the intervention campaign to be economically acceptable, the trade revenues and intangible benefits (e.g. reputation; better animal welfare) created from this programme will need to be at least of a value of TSh 63,500 m (USD 28.59 m).

Table 21. Mean total undiscounted and discounted costs and benefits (in million TSh), the benefit cost ratio and net present value (median and 90% central range)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Total intervention costs undiscounted	3673	7206	8695	8929	9179	9439	9706	9967	10252	10541
Total intervention costs discounted	3673	6996	8196	8172	8155	8142	8128	8104	8093	8079
Total benefits undiscounted	216	504	659	843	843	843	843	843	843	843
Total benefits discounted	216	489	621	771	749	727	706	685	665	646
Benefit cost ratio	Median 0.09; 90% central range 0.07 to 0.11									
Net present value	In million TSh: Median -63,500; 90% central range -73.500 to -54.800 In million USD: Median -28.59; 90% central range -33.07 to -24.66									

5.9 Sensitivity analysis

The impact of the most uncertain input values on the outputs was assessed using sensitivity analysis in the software Palisade @Risk for Excel. The impact of uncertain input values on the outputs was assessed using the software's in-built sensitivity analysis tool, which performed multivariate stepwise regression for values sampled from the defined distributions to calculate beta regression coefficients. The model was run with 10,000 iterations.

Apart from the uncertain inputs listed in Table 8 and Table 9, the following uncertain inputs were included (in brackets the distribution type and values): Herd off-take rate (Pert 0.06, 0.08, 0.1), annual rate of livestock population increase (Pert 0, 0.03, 0.06), number of outbreaks per year (Pert 4.8, 6, 7.2), price of vaccine dose per head of cattle (Pert 4000, 4700, 5600), between herd prevalence (Pert 0.03, 0.05, 0.06), and the correction factor for underreporting (Pert 1.6, 2, 2.4).

Sensitivity analyses showed that the rate of yearly livestock population increase and the price of the vaccine had the largest negative impact on the net present value. The number of cattle per farm, the correction factor for underreporting and the between her prevalence had positive regression

coefficients between 0.02 and 0.10 (Figure 10. The effect that selected input variables have on the output “Net Present value” expressed as beta regression coefficients.Figure 10). All other stochastic input variables had regression coefficients <0.02.

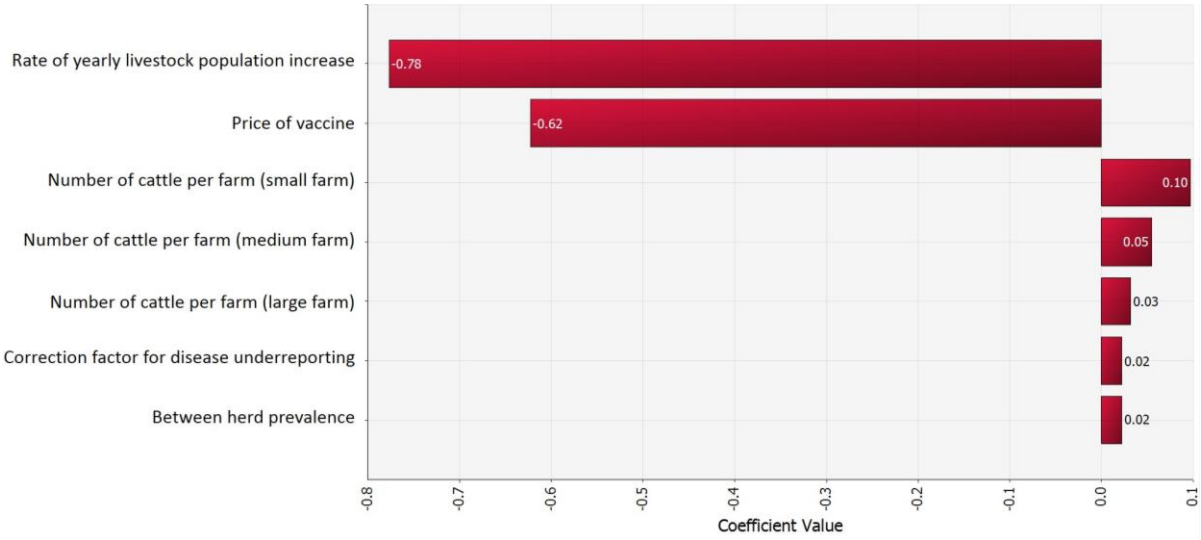

Figure 10. The effect that selected input variables have on the output “Net Present value” expressed as beta regression coefficients.

5.10 Benefits to be realised from increased trade

The cost-benefit analysis indicates that a sum of TSh 63,500 m or USD 28.59 m (Table 21) would be required as marginal gains from export income just to meet the costs of this control programme (including surveillance costs) – or in other words for the programme to break-even. The cattle population of Rukwa was estimated at approximately 400,000 at the baseline with an assumed population increase of 3% per year, which would translate to an average of 460,000 animals per year over a ten year time period. With an off-take rate of 0.08, this regional herd would produce 36,800 cattle for slaughter/year or 368,000 over the ten year period. The marginal increase required from exported meat/animal is therefore calculated as USD 28.59 m ÷ 368,000 cattle = USD 78 per animal. Current sale prices for medium size cattle are shown in Table 9 as TSh 600,000 (USD 270) but were reported as low as TSh 400,000 (USD 180). An average live weight of 375 kg/animal with an assumed dressing out percentage of 53% will produce a carcase weight of 199 kg. Export cuts from hindquarters typically represent 25% of the carcase weight, yielding 50 kg. Current prices per kg beef meat from Table 9 are TSh 6,500 or USD 2.93. The total price required from export cuts would be (USD 78 ÷ 50) + USD 2.93 = **USD 4.49 /kg** to meet costs. In other words, a 53% increase in price for export quality hindquarter cuts would be needed before any positive gains would be made on the investment.

6 FEASIBILITY CONSIDERATIONS

In this section, factors essential for the successful implementation of an FMD control programme are discussed. They include a description and discussion of the establishment of the Tanzanian Livestock Identification and Traceability System (LITS) including pilot testing and plans for the future as well as information on the structure and the capacity of the veterinary services including human resources, supply chains, and diagnostics.

6.1 Animal identification, registration and traceability

The success of a disease control programme relies heavily on the ability to have information on the identity of animals and animal (related) premises as well as the provenance and destination of animals and their products. The World Organisation for Animal Health (OIE) stipulates in its Terrestrial Animal Health Code that animal identification and traceability *"may significantly improve the effectiveness of activities such as: the management of disease outbreaks and food safety incidents, vaccination programmes, herd /flock husbandry, zoning/compartmentalisation, surveillance, early response and notification systems, animal movement controls, inspection, certification, fair practices in trade and the utilisation of veterinary drugs, feed and pesticides at farm level"*.

Being aware of the importance of these tools, Tanzania has been implementing relevant measures to establish a Livestock Identification and Traceability System (LITS). The officer in charge of the LITS unit had also served in Rukwa region for a number of years. He confirmed that there is appropriate legislation and regulations to guide both registration and traceability in the proposed FMD_FZ, namely the Livestock Identification and Traceability Act of 2010 #12 or CAP 184 and the secondary regulations of 2011, which were gazetted in GN 362 of October 28, 2011. The office of the Vice President has directed through the Prime Minister that all cattle in the country should be identifiable. The Act also foresees the identification of other livestock, but in a first phase, cattle are prioritised. Wider rolling out to other species may be prioritised based on demand.

The LITS has been piloted in three districts (Muheza, Bagamoyo, Kibaha urban and rural), a database is in place and ready to be established in other districts, but funding has been the main limiting factor. The "Dairy Genetic Gain Project" funded the implementation of the system in six regions (Arusha, Kilimanjaro, Tanga, Iringa, Njombe and Mbeya). It is reported that a directive from the Prime Minister has been given to Regional Commissioners to roll out the LITS across the country but funding remains the bottleneck (personal communication Dr Kagaruki of Tanzanian LITS).

In the beginning of the pilot testing, branding was used, which consisted of three letters for country, district and village, but there was not individual animal identification (only group identification); a problem addressed by the move towards ear-tagging[5]. Branding was supposed to alleviate tensions around cattle movement, as people can see where the cattle are coming from (in particular whole herds). However, experience in the pilot areas revealed that pastoralists are not in favour of their animals being branded; in particular the Maasai had strong reservations and the Barbaig showed some

[5] Technologies available include ear tags, or ear tags with rumen bolus. Ear tags with an electronic part, for example the Combo Ear-tag from France with a microchip and a visual part sell at 1.5 Euros a piece before tax.

reservation. The Sukuma, who tend to be agropastoralists, did not object to identification during the pilot testing phase, but were not willing to bear the full cost of identification.

The LITS uses GIS information and has a component for vaccination data. Other data include village data, farm or premise data linked to owners. The registration of birth of calves is linked to the cow/sire. Registration of events includes movement in or off the premise/farm, termination notification (e.g. death, slaughter), export etc. The data are recorded in Excel forms.

To date, the system has not yet been rolled out to Rukwa region. There are plans for regional implementation of the animal registration and traceability system (pers. comm. Dr Mrutu, Principal Livestock Officer) in line with the legislative requirements. A question under discussion is the cost sharing between private and public stakeholders. Experience from pilot sites demonstrated that farmers may be willing to make a (small) contribution towards branding and/or ear-tagging; the costs are on average approximately TSh 1,000/branding and TSh 2,500/tagging. The contribution of the public sector could be training of extension officers, awareness raising, sensitisation and central logistics with farmers covering the actual branding or tagging. The MALF intends to provide financial support for training and campaigning in Rukwa region in 2017. It is expected by the government that in Rukwa region the campaign will be well received, because of the large number of agro-pastoralists who are commonly favourable towards animal identification. To avoid potential suspicion and resistance building against identification, it is planned to start with the more willing stakeholders before extending more widely.

It is estimated that the section would need to get a minimum of four extra staff to operate adequately and these would require the continued support of the ministry's IT staff. At this minimum level of staffing, the unit will have the capacity to establish and oversee the system as long as funding is made available. The required staff could potentially be transferred from other sections (administratively). The location of the Livestock Identification and Traceability Unit (LITU) needs to be revisited. It is currently part of extension (Research, Extension and Training directorate) but given the responsibilities and requirements of the epidemiology unit it would make sense to merge this unit with the epidemiology unit in the Directorate of Veterinary Services. Not only is the epidemiology unit a major user and beneficiary of a functional LITS, but it is in the interest of the epidemiology unit to ensure that the LITS is fully functional and operating efficiently. Currently, the reporting pathway operates with hardcopies from the field, which are then shared with the district, where they are entered into the computer and then uploaded to the LITS database. The epidemiology unit and the LITU would naturally share resources and in the same way as it currently responds to local and international reporting responsibilities it could respond to the requirements of other interested parties (stakeholders) in the ministry and outside. A similar recommendation has been made in the 2009 OIE PVS report [28]. Concerns have been expressed about the workability of the Tanzanian LITS; although very thorough it appears to be cumbersome, the logistical detail still needs to be developed, and the system linked to the current paper-based movement permit system.

Lack of funding has limited progress and the officer in charge for LITU warned that funding will be required in the long-term to sustain the system once operational. Different funding streams may be considered from interested stakeholders, e.g. private-public partnerships, industry or government support.

6.2 Capacity and infrastructure of the regional veterinary services

This section provides an assessment of the existing infrastructure and capacity in relation to the planned activities. Key informants interviewed were officers in charge of the various activities under review and one very recently retired officer.

6.2.1 BASIC STRUCTURE OF VETERINARY SERVICES IN TANZANIA

The Veterinary Services in Tanzania are divided into the Public Veterinary Services provided by the directorate of Veterinary Services under the Director of Veterinary Services within the MALF. The DVS has at his disposal the **Zonal Veterinary Centres** responsible for surveillance, disease investigation and control. There is also the Tanzania Veterinary Laboratory Authority responsible for diagnostic work and production of biologicals - also arranged with zonal laboratories at the periphery and the TVLA headquarters (including the Central veterinary Laboratory and the Centre for Infectious Diseases and Biotechnology - CIDB) at the centre.

6.2.2 SURVEILLANCE AND VACCINATION MONITORING

For the FMD_FZ programme, surveillance activities will be the responsibility of the Veterinary Centre in Sumbawanga whereas field vaccination will be carried out by vaccination teams under the District Veterinary Officers. It was estimated that the following staff would be required to carry out the surveillance and vaccination monitoring activities in an appropriate manner (Table 22). The requirements and numbers were estimated by the officer in charge at the Zonal Veterinary Centre and discussed with the authors.

Table 22: Requirements of Staff at Zonal Veterinary Centre (ZVC), Sumbawanga, Tanzania. Estimates provided by Zonal Veterinary Centre and discussed with staff from the Ministry of Agriculture Livestock and Fisheries.

S/N	Office	Requirements	Number required	Present staff
1	ZVC Headquarters	Principal Veterinary Officer (Officer In charge)	1	1
		Senior Veterinary Officer (Disease Surveillance)	1	0
		Veterinary Officer (Zoosanitary)	1	1
		SUB-TOTAL (A)	**3**	**2**
2	Laboratory	Principal Livestock Officer	1	1
		Livestock Officers	1	0
		Livestock Field Officer	2	0
3	Border posts (4)	Livestock Field Officers	8	2
4	Quarantine Stations (4)	Livestock Field Officers	4	0
5	Holding ground	Livestock officer	1	0
		SUB-TOTAL (B)	**17**	**3**
6	Administration	Accountant	1	0
		Office secretary	1	0
		Office attendant	1	0
		Driver	1	0
		Security guard	2	0
		SUB-TOTAL (C)	**6**	**0**
	TOTAL		**26**	**5**

The 21 additional people required for staffing in the ZVC during the FMD control programme could be mobilised from within the government services if required.

6.2.3 PREVIOUS MASS VACCINATION EXPERIENCE

In the 1990s there was mass vaccination for CBPP, based on a rollback plan which gradually covered all regions starting from the South and moving North going through all the zones using 3 m doses per year vaccinating all cattle from 6 months of age. The target vaccination coverage was 100%. Three doses were needed per animal with a vaccination schedule of 3 times in 18 months. In every region, there were dedicated vaccination teams. The government provided the vaccines, the DSA allowances for teams were covered by local government, and there was some cost recovery in some regions from farmers.

6.2.4 VACCINE SUPPLY CHAINS AND VACCINE PRICES

Key informants consulted to collate this information were three government officers, an import and a distribution agent. Moreover, the Botswana Vaccine Institute was consulted and public reports retrieved from the internet were reviewed.

The control of FMD in Tanzania is influenced greatly by the livestock production system in question linked to the purpose of keeping livestock. Dairy farmers are worst hit by FMD and are willing to vaccinate their stock since production losses are usually high [3]. Similarly, commercial beef ranchers are also willing to vaccinate as for example found in Kalambo Ranch, Rukwa. However, most traditional farmers and even veterinarians are doubtful about the economic benefits of FMD vaccination and do not vaccinate their animals in practice ([4], [29] and field trip respondents). Consequently, vaccination is left to the individual farmers and the private sector. As such, the market for FMD vaccines is thin on both the supply and demand side, with demand peaks occurring during outbreaks.

Supply side: In connection with FMD vaccines, six private distribution companies were mentioned by three respondents (two ministry officials and one import and distribution agent): (1) Rhone Meraux, Dar es Salaam, (2) Multi-vet Farm Tanzania Ltd, Dar es Salaam, (3) Anicop Tanzania Ltd Arusha, (4) Alpha Tanzania ltd, Arusha, (5) Bajuta Drug Company, and (6) Farmer Centre Dar es Salaam. Given the very low demand for these vaccines, the companies would only import on demand. These companies have the capacity to import the vaccines if asked to do so. Government requirements when they arise, would normally be met through tendering and competitive bidding by those who have the capacity including the required cold chain.

Most vaccines are not registered for use/sale in Tanzania given the low demand. If one requires such vaccines then justification for imports can be made in an application to get an importation permit to the TFDA through the DVS. The end user works in consultation with a distribution/import company of his/her choice. In ordering a vaccine one very important element to take into account are the cold chain services required- the question is who would supply them at which point along the delivery path. The agents will normally be responsible up to the point of delivery and the Ministry / project will be responsible for the rest of the pathway. All six companies mentioned above offer bespoke services.

Sources of Vaccines: FMD vaccines may be obtained from Kenya, Botswana, South Africa and on some international markets. The two main producers in the region are the Botswana Vaccine Institute (BVI)

and the Kenya Veterinary Vaccine Production Unit (KeVeVAP), which both manufacture FMD as well as CBPP vaccines. For a large project contractual arrangements have to be made to procure the required quantities in a timely manner – the mechanism of choice would most likely be a public tendering process. Importers do not keep large amounts of vaccines. It is worth noting that some importing agents have special relationships with certain source companies.

Vaccines Botswana Vaccine Institute (BVI): Aftovax™ is an inactivated vaccine against FMD in ruminants. It is composed of the antigen which is inactivated FMD virus containing any type of 5 serotypes appropriate to the region, namely **Types SAT 1, SAT 2, SAT 3, O, A** and a mixture of aluminium hydroxide and saponin as adjuvants. The vaccine can be used in the vaccination of cattle, buffalo, sheep and goats against FMD. The other vaccine from BVI on the market is Aftovaxpur™, which is a purified inactivated vaccine against FMD in ruminants with the same adjuvants and use as Aftovax™.

The purified FMD vaccine is for emergency use and permits differentiation of infected from vaccinated animals (DIVA); it provides a suitable alternative to mass slaughter in FMD eradication to sustain trade. The vaccination schedule foresees the following:

- *Initial vaccination*: two injections, 3 to 4 weeks apart, starting at two weeks of age for young animals from unvaccinated dams or 2.5 months of age for young animals from vaccinated dams. In case of an epidemic the first injection should be given to all animals as early as 2 weeks of age.
- *Boosters:* to be given every 4-6 months depending on the risk and in accordance with local legislation. Once opened bottles of vaccines should be used within 24 hours provided they have been stored between +2°C and 8°C. Bottles usually come in sizes of 100 ml and 300 ml. In general, cattle should get 3 ml doses and sheep and goats 1ml doses, respectively.

Kenya Veterinary Vaccines Production Institute (KeVeVaPI) produces an inactivated FMD vaccine called FOTIVAX™, which is very similar to that produced by the BVI in 100 ml containers. The usual blend of FOTIVAX™ contains **FMD strains A, O, SAT1 and SAT2** with aluminium hydroxide gel and saponin adjuvants. KeVeVaPI recommends the following dosage and administration: Administer to animals of all ages via subcutaneous injection at the rate of 3 ml per animal for cattle and 2 ml per animal in pigs, sheep, and goats. Revaccination should be carried out every 6 months or for better protection every 4 months. However, there are question marks related to the ability of KeVEVAPU to produce high quality vaccines, as captured in the following quotation: “In general, the vaccine production facilities at KEVEVAPI are regarded to be obsolete, and hence need to be revamped. This has been acknowledged; hence, the GoK (Government of Kenya) is looking for funds to undertake the required changes” [30].

Information on the effectiveness on the vaccines produced by BVI and KeVeVAPI could not be obtained.

6.2.5 DIAGNOSTICS

In the current set up, diagnostic work is done by the Tanzania Veterinary Laboratories Authority (TVLA) with their headquarters in Dar es Salaam. For the purpose of FMD diagnosis the samples collected by The Zonal Veterinary Centre Sumbawanga will have to be shipped to TVLA’s Dar es Salaam CIBD, which deals with diagnosis of viral diseases. Although the Southern Highland Veterinary Centre in Iringa has

the capacity to carry out FMD ELISA serology, the technician is about to retire (with no replacement currently planned). Furthermore, only the centre in Dar es Salaam has OIE recognised status for FMD diagnosis and it has higher biosecurity standards. For these reasons it is recommended by TVLA that the project works with the Dar es Salaam centre directly. Samples would be collected by the veterinarians and livestock officers in Rukwa and the samples would then be sent to Dar es Salaam. The CIBD has capacity for both antigen detection based serotyping using ELISA for serotypes A, O, and SAT 1, 2 and 3. The laboratory employs one graduate technologist assisted by three technicians. The facilities are up to date and there is enough capacity for serology and molecular biology.

The CIDB has three sections, namely a cell and tissue culture section, a serology section and a molecular diagnosis section with a total of seven staff members. Currently the staff are not working to their full capacity. At full utilisation they would be able to process about 500 samples by ELISA testing about every three working days without additional staff.

For epidemiosurveillance work the CIBD conducts FMD antibody detection by serotyping against structural protein (which does not differentiate between vaccinated and un-vaccinated). For CBPP samples can be sent to the Bacteriology Laboratory at the Central Veterinary Laboratory, which is part of the TVLA, where the diagnostic analyses would be performed. Cold chain would be required to transport the samples; for this cool boxes (disposable or otherwise) similar to those used to preserve vaccines could be used. Past experience showed that if properly handled and packed the samples will be of good quality with at least 95% of samples capable of yielding positive results (if positive). For antigen detection reliability may decrease to between 90-95%.

The CIBD also have the capacity to train field staff in proper methods for collecting, preserving and shipping samples to the TVLA Dar es Salaam laboratories.

7 HISTORICAL CONSIDERATIONS

Since the 1960s, there have been three structured plans in Tanzania to control FMD and/or establish a disease free zone, but none of them was implemented successfully. These were analysed to learn key lessons to inform better future control plans. Information was gathered through unstructured interviews with former senior veterinary officers involved in the efforts at the time who are now retired. The interviews were conducted at their residencies or at "Temeke Veterinari" in the offices of the Director of Veterinary Services. Other sources of information were publications from the World Bank available online as well as a documents shared by the DVS's office. Following the interviews and study of relevant documents, follow-up telephone discussions were made to clarify remaining questions.

7.1 Description of the three structured attempts at FMD control in Tanzania from 1960 to 2000

7.1.1 THE FIRST STRUCTURED EFFORT TO ESTABLISH A FOOT AND MOUTH DISEASE FREE ZONE 1960-1980

Efforts to establish a disease free zone in Tanzania are well documented. A cost benefit analysis was conducted in 1972 and a loan application for combined Dairy Development Phase 1 and Animal Health projects was made to the International Bank for Reconstruction and Development (IBRD) in 1974. The applicants were the Ministry of Agriculture in association with the Tanzania Rural Development Bank. One of the projects was to establish a pilot FMD disease Free Zone (FMD_FZ) in South Western Tanzania. Three regions were targeted (Mbeya, Iringa and Rukwa), the economic rate of return for the FMD_FZ component was quite high at 30% costing some TSh 17.36 m (USD 7.8 m). The IDA credit was TSh 13.01 m (USD 5.8 m) and government contribution was set at TSh 4.34 m (USD 1.94 m).

Implementation was to be led by the Ministry of Agriculture under the then Director of Livestock Development under whom a section to coordinate the project was to be established. The work was to be financed through the Ministry's annual budget and reimbursement was to be claimed through the Project Management Unit. The project was to be implemented by veterinary staff in the regions assisted by additional staff recruited for the purpose. An export abattoir being set up in Mbeya was to serve the three region DFZ.

None of the three former high ranking veterinary officers was in a position to say why the disease free zone did not materialise but they recalled that the Dairy Project was funded and probably some of the funds were used in capacity development (e.g. four epidemiologists were trained in Reading University). A former Regional Veterinary Officer in the mid-1970s was - like the three officers - certain that the dairy component was funded but suspected that the animal health component especially the FMD_FZ was not funded otherwise he would have been involved in its implementation as Mbeya featured prominently in the proposal.

An internal document of the World Bank reveals that the FMD_FZ pilot though technically sound was not funded on two main grounds, namely 1) the anticipated benefits were unlikely to materialise due

to the uncertainty in the timing of the Mbeya slaughter house construction[6], supplies of cattle for export and the requirement of a DFZ by Zambia[7]; and 2) data on impact of FMD in traditional herds was inadequate and the impact of FMD was considered minor by livestock officers and farmers alike [31]. Abattoir construction was stalled and the structure remains unfinished.

Historically the 1972-74 work was the first structured effort to do an economic appraisal of establishing a FMD_FZ in the Southern Highlands of Tanzania. It was revealed that in the late 1960s a white farmer who owned the now defunct Malanje Ranch Farm in Rukwa had a small abattoir and used to send carcases to the Zambian Copperbelt towns. A veterinarian was requested to be stationed in Sumbawanga to conduct the required meat inspection. When the topography of the area was investigated, it was revealed that the Ufipa Plateau was geographically and physically isolated by Lake Tanganyika in the west and the Zambian Border that was void of livestock. On the eastern front, there was the escarpment that in the north turned westwards and is called the Liamba la Mfipa separating the plateau from Katavi National Park. Buffaloes in the park were thus cut off from the plateau physically and different climates (hot in the national park but cold in the plateau). These facts gave rise to the idea of an FMD_FZ in the plateau.

7.1.2 THE SECOND STRUCTURED EFFORT TO ESTABLISH A FMD FREE ZONE 1981-82

In 1981/82 a separate Ministry of Livestock Development was formed and one of the respondents (a former senior veterinary official) developed another structured effort to establish a FMD_FZ which was to be established in the Eastern Zone with the Tanganyika Packers Abattoir in Dar es Salaam serving as the export abattoir. Cattle were to come from the Lake Zone by train and then be held in a holding zone in the Coast Region separated by a fence from the Disease Free Zone (Figure 11). In the holding grounds, animals would be vaccinated and after six months be moved into the DFZ. Initially in the DFZ vaccination would take place for the first three years and upon attainment of disease free status the animals would be transported to TPL in Dar es Salaam. A fence was to be constructed between the DFZ and the rest of Dar es Salaam to prevent animals getting to the abattoir from other places or from the DFZ without proper movement control. All of Dar es Salaam was to be part of the disease free zone. The EU was the targeted market. A full cost benefit analysis was done and the main strategies included fencing and vaccination. The proposal was submitted to the Ministry of Finance and the desk officer was very supportive, but was later transferred to another post and the proposal stalled for lack of a champion in the Ministry for Finance. The responsible official in the Ministry of Livestock Development was also later transferred to another post and the second structured effort was discontinued. Documentation for the second effort could not be retrieved.

[6] Construction started in the 1970s and halted before the structure was completed. Two other slaughterhouses were also met the same fate, namely Shinyanga and Mwanza, which all started to be constructed around the same time

[7] This is likely due to the expectation that a DFZ or DFC (Disease Free Compartment) would go a long way to reduce the risk of FMD incursions from Tanzania

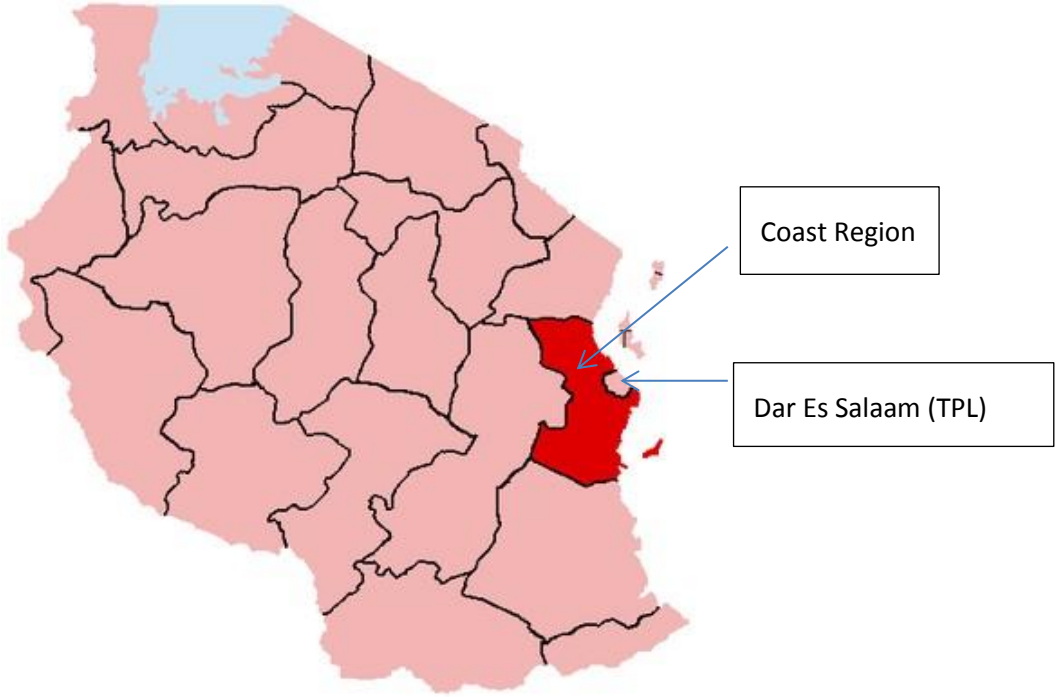

Figure 11. A map of Tanzania showing the location of the proposed FMD-FZ in 1981

7.1.3 THE THIRD STRUCTURED EFFORT 2000

Achieving eradication of Rinderpest in Tanzania with the assistance of the Pan African Control of Epizootics (PACE) programme created awareness and room to shift the focus of animal health control efforts once again on FMD control in the country and also regional efforts were initiated against FMD in the SADC region. Efforts started in 2000 in the country and are ongoing. By that time, the use of fencing had lost much favour (Mtei personal communication 2016) and OIE has developed other practical control measures (see Section 8 below) such as compartmentalisation, commodity based trade and Progressive Control Pathways (PCP). These strategies may be combined - in particular disease control efforts - but where there are standards for PCP and Commodity based Trade and Compartmentalisation there is none for DFZ.

Two consecutive budget reports (2015 and 2016) by the Minister responsible for livestock mentioned two different approaches, the first one was focusing on a DFZ in Rukwa Region, where as the second one had emphasis on FMD_Compartments in the former national commercial ranches (NARCO) probably indicating policy shifts. The Minister, in the 2017/18 budget speech, also referred to the work of this PPG as a collaboration with the WTO for a CBA and feasibility study of creating a disease free zone in Rukwa region.

7.2 Key lessons to be learned from the historical perspective

Some of the key lessons from past FMD control attempts are summarised below:

1. Sound data on the impact of FMD in the relevant livestock production systems is paramount to the estimation of benefits.

2. Demonstration of technical possibilities and cost-effectiveness is not enough to take a decision on implementation of a programme; for example one or more champion(s) and institutional continuity and support are required to follow through the process
3. Each attempt required an associated export abattoir and export premium market to provide the incentives for control.
4. There is a need to have a clear and agreed policy as to what is needed-a DFZ or DC and what other control principles may be incorporated.

8 ALTERNATIVES TO CREATING A DISEASE-FREE ZONE

The WTO SPS Agreement encourages Members to base their sanitary and phytosanitary measures on international standards, guidelines or recommendations, which includes the OIE's standards for animal health. The OIE Terrestrial Animal Health Code (the Terrestrial Code) sets out standards for the improvement of animal health and welfare and veterinary public health worldwide, including through standards for safe international trade in terrestrial animals and their products. The health measures in the Terrestrial Code should be used by the Veterinary Authorities of importing and exporting countries to provide for early detection, reporting and control agents that are pathogenic to animals or humans, and to prevent their transfer via international trade in animals and animal products, while avoiding unjustified sanitary barriers to trade. With respect to FMD, Chapter 8.8 sets out the terms of defining and classifying countries or zones according to their disease status. It also provides recommendations for importation of animals and their products from countries within the various classifications. The FMD progressive control pathway, created by the FAO, aims to assist countries to achieve a Free-of-FMD status. However, more recently the OIE has recognised the difficulty some countries have in achieving progress along this pathway (particularly those in sub Saharan Africa). Various animal health experts exerted pressure on the OIE to consider a non-geographical approach to FMD in relation to trade, with particular reference to the southern African region where African Buffalo are recognised as carriers of the SAT 1, 2 and 3 serotypes.

The OIE now makes provision in the TAHC (See Box 1 below: Chapter 8.8, Article 22) which includes the concept of commodity based trade (CBT) [32], [33]. It provides a system to ensure safety of the animal product irrespective of the disease status of the country of origin as an alternative to creating a disease free-zone, which arguably puts a lot of emphasis on animal health management, disease control and welfare and wildlife impact considerations.

BOX 1: OIE TAHC 8.8.22

Veterinary Authorities should require the presentation of an *international veterinary certificate* attesting that the entire consignment of *meat*:

1. comes from animals which:

a. have remained, for at least three months prior to *slaughter*, in a *zone* of the *exporting country* where cattle and water buffaloes are regularly vaccinated against FMD and where an *official control programme* is in operation;

b. have been vaccinated at least twice with the last *vaccination* not more than six months, unless protective immunity has been demonstrated for more than six months, and not less than one month prior to *slaughter*;

c. were kept for the past 30 days in an *establishment*, and that FMD has not occurred within a 10 kilometre radius of the *establishment* during that period, or the *establishment* is a *quarantine station*;

d. have been transported, in a *vehicle* which was cleansed and disinfected before the cattle and water buffaloes were loaded, directly from the *establishment* of origin or *quarantine station* to the approved *slaughterhouse/abattoir* without coming into contact with other animals which do not fulfil the required conditions for export;

e. have been slaughtered in an approved *slaughterhouse/abattoir*:

   i. which is officially designated for export;

   ii. in which no FMD has been detected during the period between the last *disinfection* carried out before *slaughter* and the shipment for export has been dispatched;

f. have been subjected to ante- and post-mortem inspections within 24 hours before and after *slaughter* with no evidence of FMD;

2. comes from deboned carcasses:

a. from which the major lymphatic nodes have been removed;

b. which, prior to deboning, have been submitted to maturation at a temperature greater than + 2°C for a minimum period of 24 hours following *slaughter* and in which the pH value was less than 6.0 when tested in the middle of both the longissimus dorsi muscle.

8.1 Fundamentals of Commodity Based trade

The production of CBT beef for export from an FMD endemic area must be supported by a solid foundation based on the following key points:

1. Regular and sustained vaccination, permanent individual animal identification and enforced movement control measures must form part of an official FMD control programme, which in turn requires solid national economic stability and sustained investment in veterinary services staff, vaccines and logistical capability.
2. A market must exist or be developed that accepts and has a demand for CBT beef.
3. Production systems must exist or be developed to produce beef to meet export market requirements e.g. quantity, consistent supply, quality, meeting other non-CBT standards (welfare, grass fed, organic etc.)
4. CBT is not an FMD control measure but a condition for safe trade.

Producing beef from an endemic but vaccinated area using the CBT pathway, may be acknowledged as safe by some but, as yet, it has struggled to gain widespread acceptance even between Southern African Development community (SADC) member countries. The reasons for this are unclear but may be due to political and competitive reasons.

9 STUDY TOUR TO ZAMBIA

9.1 Background

Zambia is a landlocked Southern African country and lies to the southwest of Tanzania, bordering Tanzania's Rukwa region with its Northern Province. In addition, it is bordered by the DRC in the North, Malawi to the east, Mozambique to the southeast, Zimbabwe and Namibia to the south and Angola to the east (Figure 12). Zambia covers 752,614 km^2 with most of the land mass consisting of a high plateau of savannah country and undulating plains lying between 900-1500m above sea level.

Figure 12. Zambia's provinces and neighbouring countries

Zambia has a human population of approximately 17 million and a cattle population of 5 million. Zambia has a shortage of beef and consequently live imports of cattle, both legal and illegal, occur across the borders primarily with Tanzania in the north and Namibia and Botswana in the southwest. Both these areas are considered points of FMD entry into the country (Figure 13). FMD is then spread by illegal movement of cattle and maintained and exacerbated by the presence of buffalo within the country [34].

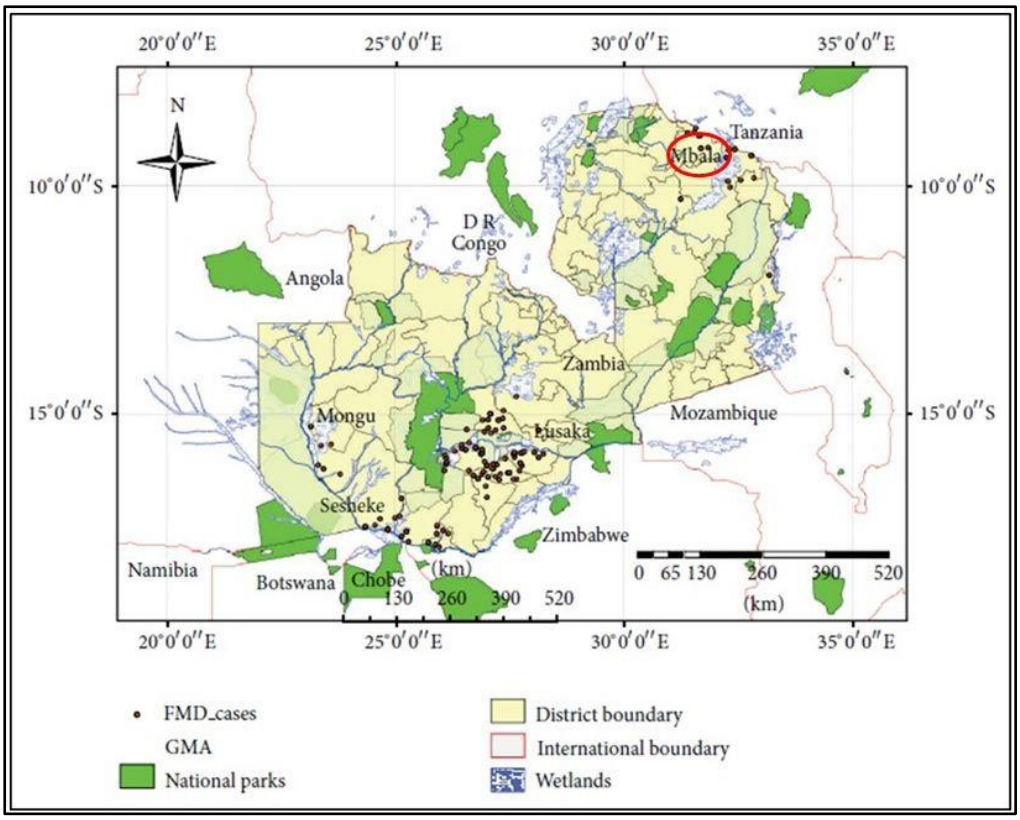

Figure 13. Distribution of FMD cases in Zambia, indicating Mbala district in the Northern Province [34]

9.2 Zambia's FMD control experiences

Currently FMD (and CBPP) vaccination in Zambia are seen as a public good and costs are borne by government, however consideration is being given to the idea of commercial farmers in high risk area contributing to the costs. About 600,000 to 700,000 cattle are vaccinated twice a year (May/June and Nov/Dec) using the BVI Aftovax™ (SAT 1 & 2) vaccine (USD 2/dose purchase cost) in these high risk zones. FMD vaccination programmes are concentrated in the South, West and East of the country (Central, Western, Southern and Lusaka Provinces where the largest cattle populations reside, whilst the border area of Northern Province appears to take lower priority).

Cattle in Mbala district in the Northern Province were reportedly last vaccinated in 2015 due to funding constraints. There was no FMD outbreak in Mbala region in 2016 despite no vaccination, however an outbreak has occurred in April 2017. Cattle are identified with local zonal brands and village brand marks but not as individuals and there is no compulsory LITS in place. Movement permits for cattle within Zambia are issued by local veterinary offices and a further police clearance certificate is also required for movements between districts and between provinces. The movement of carcases also requires a permit.

9.3 Zambia's experience with establishing a FMD Disease Free Zone (DFZ)

After a roundtable meeting with the World Bank, IFAD, FAO, the Netherlands, USAID, the EU, AU-IBAR, Land 'O Lakes and Heifer International and a lot of political will the creation of a DFZ was attempted in Zambia in (2009 – 2013) with the aim to improve export opportunities. The planned location of the

zone included parts or all of the Central, Lusaka and Copperbelt provinces. The project started before a CBA was done. The subsequent CBA , conducted on behalf of the Department of Fisheries and Livestock, Zambia by ICON-INSTITUT Public Sector GmbH, in consortium with PAN Livestock and Jules van Lancker [35] concluded that the project was not cost effective. The creation of a DFZ was based on the experiences in Namibia, Botswana and South Africa, which rely on heavy duty buffalo/game fencing to separate cattle subpopulations. The CBA concluded that the costs of the fencing would require a cattle population of 5 million within the zone (the equivalent of the whole country's cattle population) to meet costs. In addition, the issues of National Parks (with buffalo) within the zone and the costs of surveillance of the buffalo were also considerations. As a result, the World Bank could not support the full costs of the project. It was also recognised that there was an inadequate supply of beef to meet local demand and that the focus on exports should be dropped. Instead, the project was used to support FMD control measures in the same area and improving provision of beef to the local market. Currently Zambia is also considering the option of CBT beef production within compartments.

The question of creating a DFZ in Tanzania without fencing was discussed with the Zambian CVO. The Zambian veterinary team, using the Zambia CBA report, argued that the Tanzanian plan to rely on natural geographical boundaries and to create a DFZ without fencing the entire area, was not possible. They argued that it has never been accomplished elsewhere in Africa and that the OIE would not certify it. The point was also raised that the creation of a DFZ is aimed at fetching higher prices for the resident cattle. This would attract illegal movements of cattle from outside the zone, (which was another reason for the fencing) and would also require stringent policing of movement and ownership, which would depend on an effective LITS.

9.4 The Mbala District and Kasesya border in Zambia; Zambeef abattoir

The Mbala disitrict in the Northern Province (adjacent to the Rukwa region in Tanzania) together with the Nakonde district form the border with Tanzania. The Mbala district is home to approximately 213,000 people and 21,863 cattle; the latter are primarily oxen for draught power. Local ethic groups include the Lungu and Mambwe who occupy land on both sides of the border, often having family and land on either side. The Mambwe are the main cattle keeping group here. The main ethnic group in the Northern Province are the Bemba who are mainly crop producers, producing maize, beans and sweet potatoes. Herd sizes were reported to be as small as only two oxen (just for draught power) or up to 7-12 per household. As a consequence, there is a poor supply of beef locally. In contrast, there are local mining companies in the Northern province (and across the border in DRC) adding to a local demand for beef as well as a demand from the higher populated nearby provinces of Copperbelt and Lusaka. The low supply and high demand draws cattle across the border to Mbala town's two abattoirs, Zambeef and Dayow.

In recognition of the cross border residence of the local ethnic groups, an arrangement was reached between SADC countries, during the SADC-TADS Project of 2009-2013, that no import/export permits (issued at regional offices) would be required for movement of cattle across the border, if originating within a 20km zone running along either side of the border. Instead, local movement permits (issued by the local Kasesya district DVO office in Tanzania at the cost of TSh 20,000) were agreed to be accepted by Zambian border officers. This however appears to have become very relaxed from the Zambian side of the border. On market days in Kasesya (across the border in Tanzania), cattle are

scouted for by agents of Zambeef. They are issued Zambian movement permits and police clearance certificates (50 ZMW for each, for up to 50 head of cattle). They are trekked approximately 1.5 km to a temporary loading ramp just inside Zambia, without passing through the official border crossing. They are then loaded onto Zambeef trucks and taken directly to the Zambeef abattoir and payment is based on ungraded dressed carcase weight. A new veterinary quarantine station and loading ramp is in the process of being built 300m from the temporary ramp (Figure 14).

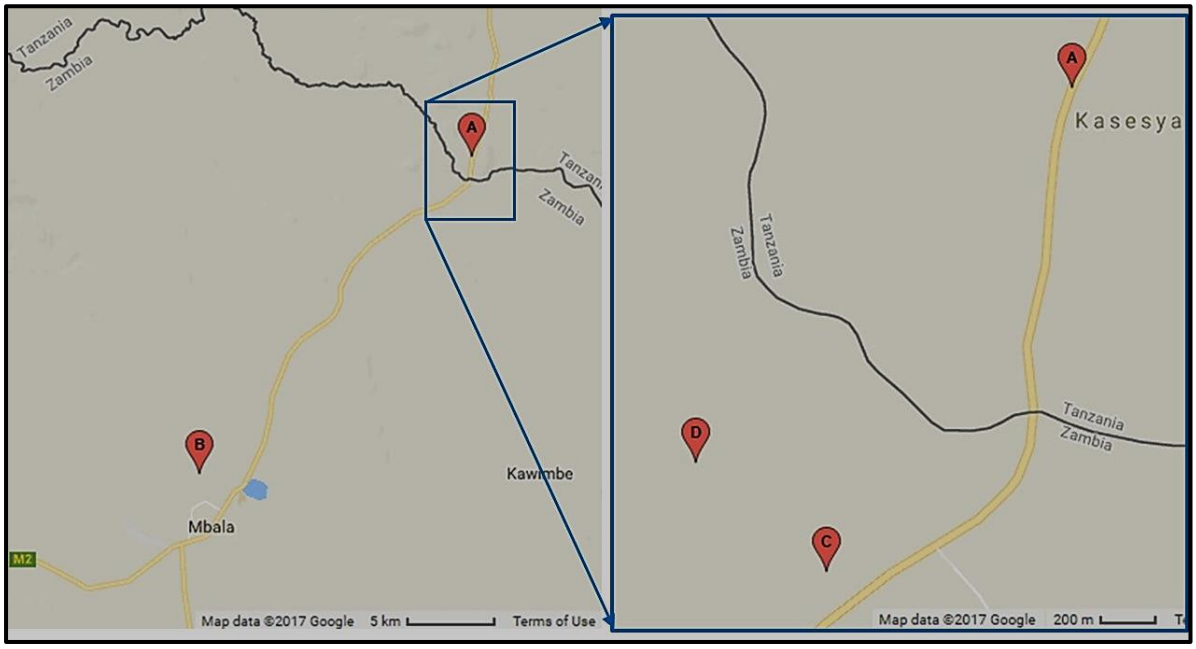

Figure 14. Map of border area around Mbala town in Zambia. Key: A- Kasesya market in Tanzania, B- Zambeef abattoir, Mbala, C- Temporary loading ramp for Zambeef trucks, D- Proposed site of new veterinary quarantine station and loading ramp

This procurement process by Zambeef is in agreement with the Zambian veterinary officers on the strict terms that all cattle accessing the country this way are slaughtered within 24 hours and are either dressed as carcases or incinerated. The cattle will also undergo an ante- and post-mortem examination at the abattoir to check for FMD. However, it became clear on questioning that the local movement permits were not being checked to identify the actual origin of the cattle and an invalid assumption was made that they were originating from within the 20km zone.

Zambeef abattoir slaughters on average 80 cattle a day with a capacity of 150. The low supply and high demand means local prices per kg (ungraded carcase weight) offered by Zambeef abattoir are currently around ZMW 19 (USD 2.13)/kg but have been as high as ZMW 22 (USD 2.47). The issue was raised about Tanzanian farmers being dissatisfied with receiving prices based on dressed carcases weights with nothing for the 5th quarter (skin, offal, head, hooves, blood etc.). The option of receiving payment for the latter or buying on the basis of liveweight were raised. Zambeef advised that they have alternative buying models and that these concerns would be raised in discussions at the office headquarters.

Beyond this “official” route of movement direct to the abattoir, the Zambian Veterinary officers were aware of a significant illegal movement of cattle into Zambia, often in trucks at night or by trekking. These were either slaughtered at informal slaughter poles near Mbala, or some went further to

Kasama (Mbala to Kasama: 170km) or deeper and were sold for slaughter or as live animals. This illegal movement was understood to be exacerbated by the higher prices achievable in Zambia (even via unofficial means), the high cost of the Tanzania movement permit (recently increased from TSh 5,000 to 20,000), the relatively high cost of Zambian movement and police clearance certificates for small number of cattle and the closure of SAAFI abattoir (reducing the options for sale in Tanzania).

Several issues were raised by the Tanzanian and Zambian veterinary services. The Tanzanians were insistent that all cattle should move through the official (road) border crossing. This would ensure that the local veterinary officer at the border could check the Tanzania local movement permits and ensure that Tanzanian cattle were originating from the Kasesya area. In addition, Zambeef agents should only source cattle being sold at the market at Kasesya and not other cattle that had congregated outside. The Zambeef agents should check and only accept cattle with a local movement permit bearing a stamp from Kasesya DVO. This would reduce risk of FMD spreading within Tanzania (with cattle being moved long distances in search of the Zambeef agents) and across the border into Zambia. In addition, income from permits and market fees would be maintained and support local veterinary services in Tanzania. The Tanzanian border officials also confirmed that Zambeef vehicles could cross freely into Tanzania to load cattle directly at the market. These cattle would then be offloaded at new quarantine and loading facilities being built just across the border before transport to the abattoirs. Some consideration was given to having a synchronised, joint vaccination programme for the area on either side of the border given the common demography on both sides. The Zambians reported that this was done previously with Angola on the Western Province border and they would consider the same in conjunction with Tanzania. Official meetings between the two countries CVO are to be arranged imminently to discuss cross border disease control issues further.

10 DISCUSSION AND RECOMMENDATIONS

10.1 Discussion

The cost-benefit analysis of the outlined elimination programme for FMD in the Rukwa region shows that substantial benefits from export trade would be needed to cover the costs accruing from the intervention. The export trade is currently small scale and is mainly regional live animal export, whilst the future potential to export beef to higher value markets is still questionable for the reasons stated below.

Export trade will be dependent on:

1. *A steady and reliable supply to fulfil contractual quotas*: The cultural significance of herd size and subsequent low off-take rate of communal farmers, agro-pastoralist and pastoralists is a common issue not just in Tanzania [36]. Culturally sensitive potential incentives to increase off-take would need to discussed and understood at a community level.
2. *Stability in the beef value chain:* The previous experience surrounding the collapse of key stakeholders (e.g. SAAFI) may make others reticent to join and invest in the programme.
3. *Reliable and established market structures:* SAAFI fulfilled this role in the past but would need significant investment and co-operation of partners or shareholders to restart and regain its potential.
4. *Value addition in Tanzania*: The potential to increase revenue from exports is currently being lost through the export of live animal and value addition occurring outside the country. Once again, SAAFI fulfilled this role through provision of slaughter, butchery and processing services.
5. *The success of the campaign:* The establishment of a disease free zone will require technical capacity development and ongoing concerted investment of human capital and equipment. The investment to drive this will require funding and support from central government, regional officials and public-private partnerships. Vaccination costs could be recovered (partly) from farmers, although non-commercial farmers may not see the value in vaccination, since production losses for them are typically low (scoping study and [37]).

The analysis provided estimates of production losses and expenditures for palliative care of about USD 5 per head. This estimate is comparable with figures published for Ethiopia [18] and a little bit higher than published figures for endemic situations in Latin America [38]. The benefits calculated do not include some wider potential benefits such as the capacity of animal health extension services, with resultant improved animal health and welfare that could expand on the back of the FMD related training nor non-market benefits such as international reputation. The benefits were found to be relatively low because of the FMD situation in the region and the moderate disease effects and reactions to disease described in agro-pastoralist production systems. Consequently, the benefits to be realised from trade would need to be considerable with a price increase of more than 50% (excluding inflation) for the programme to break even. Other benefits not included, would be the reduction in losses from FMD in other livestock species as a result of the control programme in cattle. This was not included as field officers reported losses in sheep, goats and pigs to be negligible.

The calculation of costs for the programme did not include the costs for the LITS, as this programme is a national legal requirement and needs to be rolled independently of any disease specific control programmes. The expenditures for vaccination were found to be a major cost factor (and the price of the vaccine an important influencing factor) due to the necessity to vaccinate susceptible animal populations in a large geographic area and the respective resource needs. Co-benefits could be created by using vaccination efforts to target more important diseases as perceived by farmers e.g. CBPP. The real costs for staffing of the vaccination programme are likely to be even higher, since in some cases it may not be possible that the necessary staff from the veterinary service can be allocated to other tasks in the service (as currently assumed by the authorities that this will be the case) and new people will need to be recruited with an impact on costs (i.e. salaries). On the other hand, costs for the vaccination efforts may have been overestimated in the analysis as these are based on 100% coverage. It is possible that a lower coverage rate would be as successful to control FMD outbreaks and may be reduced further in time, during the prevention stages. There are no figures available on the lowest possible coverage rates still capable of achieving FMD freedom. Estimates of these reductions would require further inputs from the MALF epidemiology and modelling team and would enhance the accuracy of the analysis. Epidemiological data and modelling outputs on outbreak hotspots, outbreak frequency and the impact of the vaccination programme would allow to make more precise efficiency predictions.

Moreover, further costs for surveillance will accrue once the disease gets reduced in the population and surveillance efforts need to be increase to demonstrate freedom from disease. The current sample size calculation provided by the authorities is done for an endemic situation with a 20% within herd prevalence. This figure likely underestimates the costs as with decreasing prevalence more efforts will need to be put into surveillance designs to increase the detection probability. Moreover, the details for buffalo surveillance (i.e. the basis for the cost calculation) were not provided and therefore not included. The calculations were done for the quadrivalent vaccine on the market (with the prices reported above), which does not allow to differentiate between previous infections or antibodies from vaccination. The use of a marker vaccine for immunological differentiation of infected from vaccinated animals (DIVA vaccine) such as the newly launched Purified Oil Based FMD inactivated vaccine from KEVEVAPI, would allow making this difference. However, the cost of this purified vaccine is USD 615 for 100 doses, which is three time the price of the standard vaccine. This would increase the costs of the campaign substantially and it is therefore recommended to pursue alternative approaches of surveillance instead, e.g. surveillance based on antigen testing.

The report and analysis have faced several challenges primarily relating to a lack of reliable data and data gaps. Methods to acquire data included a review of literature and available government statistics, data accumulated from expert opinions, the scoping visit and study tour, professional judgement, assumptions and sensitivity analysis.

Due to sharing and accessibility issues, data were difficult to extract and when available often showed vast discrepancies. For some data points, no data were available. Underreporting of FMD cases appeared to be a major issue with anecdotal evidence estimating underreporting at over 50%. Reported data suggested a low incidence but farmers, perceiving it as a low impact disease due to its low mortality, may be less likely to report cases. Indeed, it can be argued from the farmers' perspective, that FMD control measures (movement bans) during outbreaks have a greater impact on

their livelihoods than the disease itself. Farmers will need positive incentives to report outbreaks for FMD control programmes to succeed.

Similarly, contradictory information was received regarding animal population data with some data sources describing increases in livestock populations over the past decade and other (official) data sources reporting decreases for the same populations. Because the size of the livestock population to be vaccinated is a highly influential factor in this analysis, it is recommended to implement activities that allow determining the actual size of these populations and their dynamics over time. This is particularly important when making predictions about future population sizes and considering potential benefits that may be derived from reduced herd sizes and lower carrying capacity if off-take and commercialisation of livestock keeping is encouraged. With the establishment of the LITS in Rukwa region, such data could be generated over time with good precision.

Given the epidemiology of FMD and wildlife in Africa, there is a need to include a One Health or EcoHealth element, which considers FMD at the livestock/ wildlife interface and the competition for natural resource use. Currently, the programme does not have the involvement of the Ministry of Natural Resources and Tourism and this should be encouraged. Wildlife conservation officials are mainly concerned about livestock encroachment into conservation areas and the LITS should help them to identify offending livestock keepers. Wildlife and African buffalo have not been given much attention by the national FMD control programme and appear to be of less concern in the geography of Rukwa; livestock are concentrated on the cooler Ufipa plateau and buffalo favour the warmer lowlands around Lake Rukwa and the two are divided by an escarpment.

Transhumance is recognised as a major driver in the spread of FMD and the control of livestock movement is debatably the main challenge in FMD eradication programmes [34]. The success of this programme therefore is heavily dependent on the LITS, which in turn will facilitate the monitoring and control of movement and the enforcement of movement bans during outbreaks. The Rukwa region however shares an international border with Zambia, which is not fenced and the capacity to patrol and monitor illegal livestock movement is currently lacking. Zambia has two abattoirs close to the border which attract livestock sales from Tanzania. Zambian colleagues consulted during the study tour expressed doubts about the feasibility of vaccination for FMD control without fencing. Any attempts at fencing would increase drastically the investment and operational costs and is in direct contradiction of the Tanzanian “no-fence” policy. Because of the geographic features of Rukwa region, innovative approaches may be tested here that make use of the natural barriers: Given the steep ascent, it appears to be very difficult to trek livestock from the lowlands to the plateau. Studies would need to be conducted to identify which paths were used in (attempted) past crossings and more stringent policing could be used in such areas complemented by border patrols in the lowlands.

Consideration should also be given to the effect of increased off-take and sales for export on the national market. To maximise gains from export, the higher priced, top quality cuts are typically selected. The remaining lower cost cuts could potentially flood the local market and reduce local prices. Whilst this may suit consumers, it may reduce returns for farmers using the local market to sell ungraded meat. In parallel, there may be a shortage in supply of higher quality cuts for the more discerning consumers in urban centres, driving prices up.

As described above, export markets usually demand a steady supply to fulfil quotas or contracts. The marketing system will have to identify risk sensitive issues and potential new risks, which may affect

the stability of the supply chain. Potential issues include price fluctuations (between different markets), droughts and other disease outbreaks affecting off-take rates. Meat derived from the FMD_DF zone cattle would need a fraud-proof labelling system to maintain trust in the safety of the product.

Previous attempts at creating a FMD disease free zone have shown that a local champion is needed to back the project and maintain momentum. Given that Dr Mghwira retired as Assistant Director of Veterinary Services in 2017, his successor will be required to take an active role in this programme and contribute to preserving the institutional memory and the work done thus far.

The control of FMD in developing countries is often modelled on success stories from eradication programmes in developed countries. These include high levels of sustained investment and the returns are made through export trade. The latter is often backed by large livestock production systems and processing companies with sufficient clout to negotiate international trade deals. High-end export markets are also increasingly imposing additional standards, requirements and preferences concerning animal welfare, organic production, drug residue testing and food safety, making access even more difficult even with successful FMD control. It is therefore critical that the export markets and likely returns are explored before investment is made in high investment control programmes. It is also argued that even if similar high investment in FMD control is successful, it will ultimately benefit the large companies with little trickle down of benefits to improve livelihoods of small-scale, poor livestock keepers. As suggested by Maree et al [39] control programmes for FMD in Africa should rather be tailored to the individual country or region's specific and often unique challenges, including the livestock production and marketing systems and the epidemiological, ecological, socio-economic and governance issues that challenge effective control of FMD.

In summary, the following key challenges relevant to successful disease control and associated promotion of beef to internal and external markets can be described:

- *Negative net present value.* The campaign to establish a FMD disease free zone in Rukwa region is unlikely to be cost-effective due to high costs, low benefits resulting from production losses and uncertain trade benefits
- *Lack of market opportunities / channels at all levels combined with a feeling of powerlessness.* Given that some abattoirs report that they do not get enough quality animals, there may be an issue of a non-working / lack of market information system
- *Value addition outside country (particularly Zambia).* Many people recommend that efforts are put in place to create value in the country and export the products to increase export revenue.
- *SAAFI management.* A critical stakeholder in Rukwa that has the potential to contribute to the creation of stable and resilient supply chains that serve a high end market if the management can be sorted out and agreements defined.
- *Disease awareness and farmer support.* FMD is not perceived to be a major problem by farmers, which may impact on their willingness to support a vaccination campaign. Consequently, it will be important to think about effective communication campaigns.
- *Need-based selling of cattle.* There is a culture of selling animals based on need. To avoid farmer keeping larger herds with successful disease control and not releasing them onto the market, there should be training events that allow farmers to learn about other options of investment, banking, loans and similar.

- *Porous internal and external borders, livestock movements (incl. illegal movements).* A major concern mentioned by many stakeholders. Successful controlling of movements will need a multi-intervention package that also makes use of farmers' knowledge and their networks and successful implementation of the LITS.
- *Availability of vaccines.* The establishment of reliable supply chain will be pre-requisite for FMD control with vaccination.
- Challenges related to livestock wildlife interface and land use.

In light of these challenges and the outcome of the CBA, it may be worth considering other options. The option of Commodity Based Trade and a value chain approach to producing FMD safe deboned beef from an endemic area could be explored [40]. This alternative, non-geographical approach to FMD control and the production of FMD safe beef for export, so called commodity based trade (CBT) beef is outlined in Article 8.8.22 of the TAHC. However, this option has similar requirements, namely a LITS, a deliverable and sustained vaccination and surveillance programme, enforced movement control measures, the availability of an export market, and investment in infrastructure (abattoirs and deboning processing plants) so that export requirements can be met. On the other hand, it is advocated as a more "conservation friendly" approach to FMD control and livestock production and faces less pressure in terms of operational costs, need for region-wide disease awareness and support from the whole farming community. It has also been agreed by SADC members as an acceptable regional standard for trade with reference to FMD and would open possibilities for regional and potentially overseas export markets. Consequently, it is a promising option to generate export revenues if the conditions above can be met (e.g. focusing on ranches in combination with a reliable export abattoir), but it is important to acknowledge that commodity-based trade is not a FMD control measure, but a condition for safe trade. Because of the requirements for CBT, several of the recommendations for FMD control will also be applicable to CBT (although at a different scale) and therefore require equally careful consideration and planning. The case of Namibia, which has managed successfully to produce CBT beef for export, based on an OIE endorsed FMD control programme with government subsidised vaccination and a nationwide compulsory LITS, highlights the importance of the underlying infrastructure and capacity.

Based on the above considerations, the following recommendations are made to the Tanzanian animal health authorities and their associated networks. These recommendations are also important for donors who may wish to support all or some of these activities with the view to create improved animal health capacity in Tanzania:

1) *Refine the existing national FMD control plan and reconnect with the FAO's Progressive Control Pathway (PCP):* Tanzania gained Stage 2 status on the FAO's Progressive Control Pathway (pers. comm. J. Mghwira), but has failed to implement the required next steps. Moreover, some parts of the existing plan require more detail (e.g. sections on surveillance) and will benefit from updating also taking into account findings from this work. For the plans for Rukwa region a staged approach is recommended to first tackle the ranches and surroundings and in a second step expand to neighbouring districts and finally the whole region. In the absence of fencing it is important to come up with innovative approaches to reduce the risk of introduction of disease from the outside. This may include studies to establish where the hotspots are for FMD emergence and introduction and elaboration of a risk-based surveillance and control approach.

2) *Identify champions who can assume leadership and initiate next steps and make them happen:* Past (failed) FMD control efforts have shown that the programme requires the support of a dedicated champion and continuity of institutions. Given the retirement of Dr Joram Mghwira, an important player in the last structured effort of FMD control in Tanzania (since 2000), it is recommended to think about continuity and institutional memory. One approach could be to establish a dedicated FMD control steering committee with stakeholders from relevant institutions.
3) *Conduct research into understanding the offtake rates and incentivising farmers:* Any control programme to improve ruminant livestock health and increase the associated meat supply to local and international markets will need to take into decision-making in agro-pastoralist and pastoralist systems, in particular the culture of keeping cattle as social capital and selling animals based on need. If off-take rates from herds are to be increased, the implications of such behaviour on the population, market dynamics and the livelihood of producers and their families need to be researched carefully. Linked to this is research that looks into the culture of doing cash-based transactions and the scope for benefitting from the mobile phone revolution and its mobile banking, payment and insurance services.
4) *Create stable market opportunities, connect demand and supply across different stakeholders in the system*: Currently, there seems to be a disconnect nationally across stakeholders in the beef food systems with suppliers describing a lack of market opportunities and sellers describing unstable supply chains. In combination with Point 3 above it should be possible to identify suitable approaches that will allow linking the different points in the system, e.g. with contract systems with immediate mobile phone payments. With a more stable system of supply, it will be possible for the TMB and companies in the meat industry to realise (further) contracts with overseas buyers. For Rukwa region it will be particularly important to consider reviving SAAFI operations or find more competitive business agreements with the Zambian meat industry operating near the border.
5) *Enable the rolling out of LITS:* A functioning LITS is a pre-requisite for any FMD as well as other animal disease control programmes. There is strong legal and technical foundation for the LITS, but the rolling out has been hindered by funding bottlenecks. Given the importance of the LITS and its recognition by all authorities; it is recommended that long-term funding of the system is generated/sought and its implementation promoted. This will not only facilitate disease control, but also provide detailed data on population dynamics (and thereby help addressing important data gaps), help with disease surveillance, land use management, conservation, and outbreak investigation, among others.
6) *Promote private public partnerships:* The establishment of a disease free zone including rolling out of the LITS and the creation and maintenance of private public partnerships will require capacity development and ongoing concerted investment of human capital and equipment. It is recommended to explore public-private partnerships to bring together convergent interests and secure long-term funding. Functioning models of such partnerships already exist in the Tanzanian food systems, such as the Tanzania Meat Board that is half publicly, half privately operated. The public-private partnership model has evolved to include new types of partners and new areas. Hence, apart from business models based on cooperation with the private industry, it may be worthwhile to consider the involvement of non-profit organisations (e.g. charities, NGOs) that have an interest in longer-term issues and local capacity building.

7) *Include other diseases in control efforts, use synergies:* To increase cost-effectiveness of a FMD control programme, it will make sense to use the ongoing activities, training and capacity building to tackle other diseases like CBPP at the same time and thereby generate co-benefits and efficiency in resource use.

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12 APPENDIX 1 – SUMMARY OF SCOPING VISIT

Itinerary for Consultations FMD Free Zone Tanzania September, 9-22, 2016 Tanzania

Date	Serial No	Name	Position	Location
10 .09. 2016	1	Dr Joram Mghwira	Assistant Director of Veterinary Services	Dar es Salaam (Colloseum Hotel)
12.09.2016	2	Dr S. Nong'ona	Officer in charge Iringa Zonal Veterinary Centre	Mbeya (Mbeya Eatery)
	3	Dr KM Kamwela	Officer in charge Zonal Veterinary Centre, Sumbawanga	Sumbawanga
		Mr. Protas Reshola	Principal Livestock Officer, Zonal Veterinary Centre Sumbawanga	
13.09.2016	4	Mr. Godfrey Haule	Internal Auditor & Ag. Regional Administrative Officer, Sumbawanga Region	Sumbawanga (Office of the Regional Administrative Secretary)
		Dr. KM Kamwela	Officer in charge Zonal Veterinary Centre, Sumbawanga	
		Mr. Protas Reshola	Principal Livestock Officer, Zonal Veterinary Centre Sumbawanga	
		Mr. Ngassa Mussa J	Regional Livestock Officer	
		Dr. Henry Kisinga	Veterinarian, Zonal Veterinary Centre	
		Mr. Respich A. Maengo	Livestock Officer, Regional Secretariat	
13.09.2016	5	Dr. KM Kamwela	Officer in charge Zonal Veterinary Centre, Sumbawanga	Sumbawanga (Zonal Veterinary Office)
		Mr. Protas Reshola	Principal Livestock Officer, Zonal Veterinary Centre Sumbawanga	
		Mr. Ngassa Mussa J	Regional Livestock Officer	
		Dr. Henry Kisinga	Veterinarian, Zonal Veterinary Centre	
		Mr. Respich A. Maengo	Livestock Officer, Regional Secretariat	
13.09.2016	6	Mr. J. Kitindi	SAAFI Factory Manager	Sumbawanga (SAAFI Abattoir)
		Dr. KM Kamwela	As above	
		Mr. Protas Reshola		
		Mr. Respich A. Maengo		
13.09.2016	7	Mr. Richard Kiwale	Officer In-charge Migration	Kasesya Border Post (Kalambo District)
		Mr. Moses Kanigwa	Migration Officer	
		Mr. Charles Chacha	Customs Officer In-charge	
		Mr. Gasper Ngonyani	Quarantine Inspector, Ministry of Agriculture	
		Mr. Godfrey Joel	Police Officer	
		Mr. Fedson M. Pius	Livestock Field Officer, Katete Ward	
		Mr. Alex Mrema	Principal Livestock Officer (Marketing)	
14.09.2016	8	Mr. Kisinza Kulwa	Large Scale Agro-pastoralists	Kilyamatundu Village (Sumbawanga Rural)
14.09.2016	9	Mr. Clemence Kiwonde	Ward Marketing Officer in charge	Kilyamatundu
		Mr. Bruno Mwanyeta	Agricultural Officer	
15.09.2016	10	Hon. Saidi M. Mtanda	Nkasi District Commissioner	Namanyere
15.09.2016	11	Mr. Francis Mapunda	District Engineer & Acting district Executive Director, Nkasi	Namanyere
15.09.2016	12	Mr. Reuben Y Kapongo	District Livestock Development Officer	Namanyere (Livestock Office)
		Mr Brighton Kililikmbi	Livestock Field Officer	
		Mr. Sabakhtan S Mlay	Principal Livestock Field Officer	
		Mr. Mashishanga Salum	Agro-pastoralist & Member Nkasi Livestock Cooperative	
		Mr. Msamakweli Msalaba	Agro-pastoralist and Chair, Nkasi Livestock Cooperative	
		Dr. KM Kamwela	As above	
		Mr. Protas Reshola		
		Mr. Respich A. Maengo		

15.09.2016	13	Mr. Luiza Mutayabarwa	Kalambo Ranch Manager	Kalambo Ranch
		Mr. Hamidu Magesha	Chairman, Kalambo Ranch Block Owners	
16.09.2016	14	Mr. Ngasa J Mussa	Regional Livestock Officer	Sumbawanga
		Mr. Sapience Rugaimukamu	Agricultural Officer	(Regional Officers)
		Mr. Kassim S Shekilango	Agricultural Officer	
		Dr. KM Kamwela	As above	
		Mr. Protas Reshola		
		Mr. Respich A. Maengo		
			Ranch Manager	Nkundi Ranch
17.09.2016	15	Prof. Esron Karimuribo	Professor, Veterinary Medicine	SUA, Morogoro
		Prof. Kim Kayunze	Professor, Development Studies	
		Ms. Janeth George	MSc Post Graduate	
19.09.2016	16	Dr Makungu S. Luka	Principal Veterinary Officer, Epidemiology	Dar es Salaam Ministry of Agriculture, Livestock and Fisheries
19.09.2016	17	Mr. Aaron PB Luziga	Assistant Director, Livestock Infrastructure Development and Marketing	Dar es Salaam Ministry of Agriculture, Livestock and Fisheries
		Mr. Leonard M. Basil	Livestock Marketing Officer	
20.09.2016	18	Dr. Mary SH Mashingo	Permanent Secretary-Livestock Ministry of Agriculture, Livestock and Fisheries	Dar es Salaam
20.09.2016	19	Mr. Susan M. Kiango	Registrar Tanzania Meat Board	Dar es Salaam
		Mr. Nicholai Chiweka	Marketing Research Officer Tanzania Meat Board	Dar es Salaam
20.09.2016	20	Mr. Nelson Kilongozi	Registrar Tanzania Dairy Board	Dar es Salaam
21.09.2016	22	Dr Mary Mashingo	PS Livestock MALF	
		Dr. Omolo JD	Assistant Director	
		Dr. Bundala AS	PVO	
		Dr. Bakuname CN	PVO	
		Dr. Justine A Assenga	PVO	
		Dr. Tinuga DK	Epidemiologist	
		Mr. Kitosi N	Deputy Director Research and Training	
		Mr. Kajeri Gillah	DP-LITA	
		Dr. Siha Mdemu	Researcher CVL (TVLA)	
		Dr. Makungu L. Selemani	Epidemiologist	
		Dr. Makondo E Zachariah	Researcher TVLA	
		Dr. Mohamed Mwajuma	Veterinary Officer, Zonal Veterinary Centre Dar es Salaam	
		Dr. Mkama Mathias	Veterinary Research Officer	
		Mr. Lyimo HC	Head, Legal Unit	
		Mr. Pangani Richard A	Planning Officer	
		Ms. Leocadia K Mkira	Lanning Officer	
		Dr Joram Mghwira	Assistant Director, Tran	
		Mr. Kingu, PM	Assistant Director Policy	
		Mr. Matembo SIR	Principal Tsetse Officer	
		Ms. Ungelle M Angelina	Human Resource Officer	

Throughout the field work the team was accompanied and assisted by Dr Joram Mghwira, Assistant Director for Transboundary Animal Disease and Zoosanitary. In Rukwa Dr. K M Kamwela, RA Maengo and Mr. P. Reshola accompanied the team.

In connection with the above the team visited and looked at

	Facility Visited	Location
1.13.09.2016	SAAFI Slaughter house	Sumbawanga Municipal
2. 13.09.2016	Kakesya Secondary Market	Kakesya Border Post
3. 14.09.2016	Kilyamtungi Primary Market	Kilyamtungi Village
4. 14.09.2016	Muze Primary Market	Muze Village

Itinerary for Consultations FMD Free Zone Tanzania October, 24-November 17, 2016 Tanzania

SN	Date	Name	Location	Comments
1	24.10.2016	Dr. Julius J. Mwandota	Temeke Veterinari	TVLA FMD Diagnostics
2		Dr. Stanslaus Kagaruki	Temeke Veterinari	Tanzania Livestock Registration and Traceability
3	25.10. 2016	Dr John Omolo	Temeke Veterinari	Assitant Director Veterinary Public Health (including input supplies)
4		Dr. Henry Ruhinguka	Magomeni Travetine	Chief Executive, Multivet Farm Ltd
5	26.10. 2016	Dr Steward Magembe	Bunju-Magereza	Former Assistant Director of Veterinary Services
6		Dr. Bonaventura Mtei	Mikocheni	Former National Epidemiologist
7		Dr. Mohammed Bahari	Yombo-Vituka	Former Director of Research and Extension
8	27.10,2016	Dr. Peter Njau	Temeke Veterinari	Former Assistant Director of Veterinary Services
9	17.11. 2016	Prof. Beda Kessy	SUA	Professor SUA &Former Regional Veterinary Officer Mbeya
10		Dr .Kaini Kamwela	ZVC Sumbawanga	Officer in Charge e-mails and phone consultation

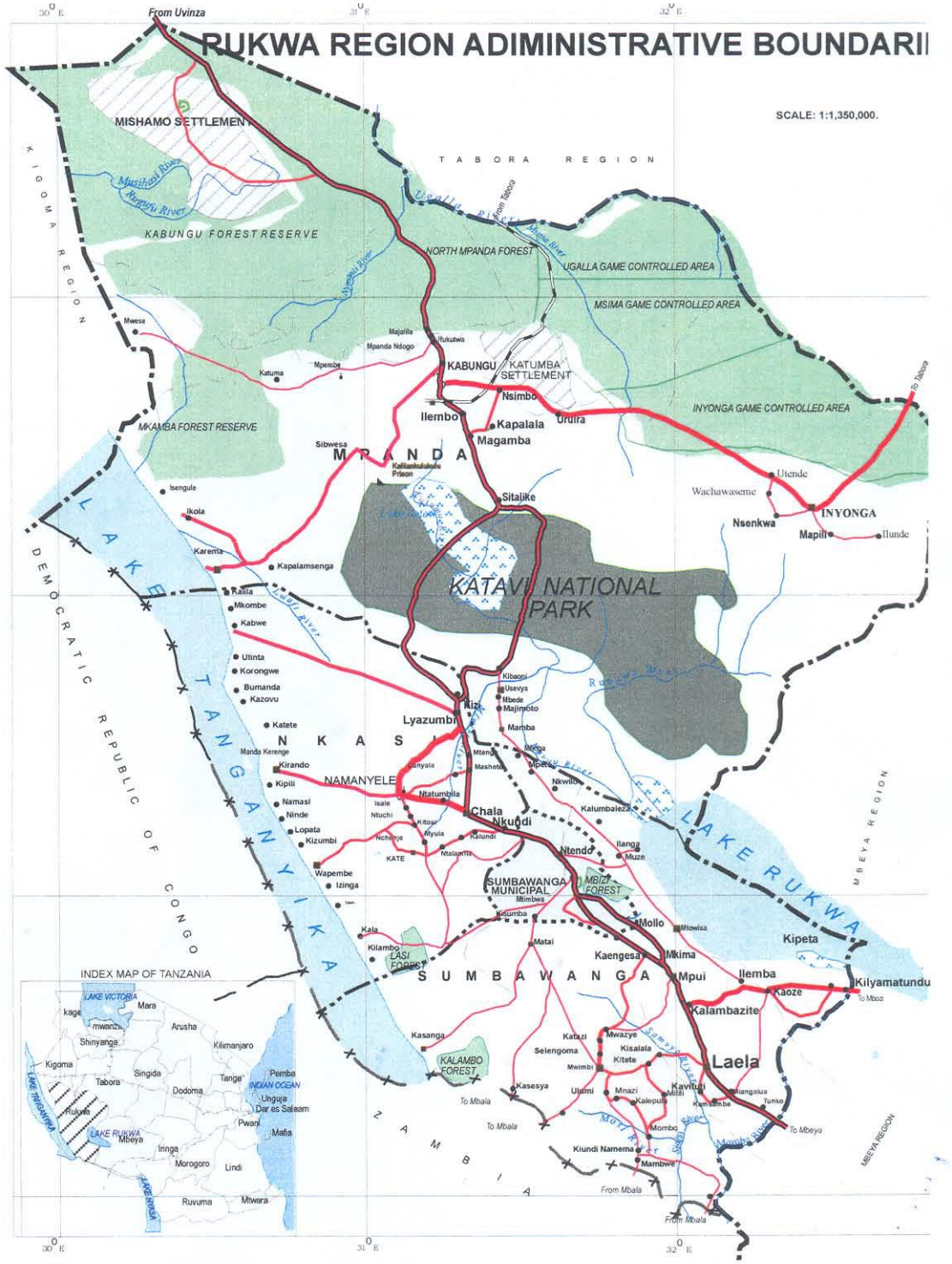
Study Tour 26/07/17 – 28/07/17

Conducted by Dr Michael Madege- PVO- FMD Control MALF HQ Dodoma, Dr Kaini M Kamwella –PVO-Officer Incharge ZVC Sumbawanga, Dr Joram E Mghwira (former AD (TADS & Zoosanitary Inspectorate Services section) of Tanzania Veterinary Services and Kevin Queenan from the Royal Veterinary College. The field trip to Mbala was assisted by Dr Muyeye Mululuma from the Zambian Veterinary Services.

Date	Name	Position	Location
26/07/17	Dr Yona Sinkala	CVO, Zambia	Ministry of Fisheries and Livestock, Lusaka
	Dr Muyeye Mululuma	Co-ordinator of the Disease Control Unit	Ministry of Fisheries and Livestock, Lusaka
28/07/17	Dr Steven Tembo	District Veterinary Officer, Mbala District	District Veterinary Office, Mbala
	Mr Perry Nambe	Livestock Officer	District Veterinary Office, Mbala
	Mr Webster Marambanhaka and Mr Luis Simariwa	Managers at Zambeef abattoir, Mbala	Zambeed abattoir, Mbala

13 APPENDIX 2 – MAP OF RUKWA REGION

Map of Rukwa region



UNITED REPUBLIC OF TANZANIA

MINISTRY OF LIVESTOCK AND FISHERIES DEVELOPMENT

ESTABLISHMENT OF DISEASE FREE ZONE IN TANZANIA

PILOT AREA - THE SOUTHERN HIGHLANDS ZONE

May, 2012

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1.0 BACKGROUND INFORMATION

1.1 INTRODUCTION

The Ministry of livestock and Fisheries Development among other things is charged to facilitate livestock and livestock products to access premium markets both domestic and external markets. In this regards there issues need to be addressed; those include animal diseases control, assured supply of raw materials (quality animals), products processing and distribution channels. The international livestock business regulatory organs (WTO, OIE, etc) provided prerequisites for the products to assess those markets among others to come from diseases free declared areas/compartments.

The Tanzania Development Vision 2025 has the aspiration of making the livestock sub-sector competitive and more efficient to meet world class quality products. The vision was interpreted in National livestock policy (2006). The policy is in supporting of the establishment of the livestock diseases free zone (DFZ) to fulfil the requirement of the WTO which guides the international trade in livestock and livestock products. The DFZ is in line with SPS Agreement where member countries of WTO agree to recognize disease free zones as sources of animals and animal products subject to risk assessment. Tanzania is not participating fully in international trade in Livestock and their products due

to absence of recognised DZF and hence unable to pass risk assessment requirement. The establishment of DFZs will allow Tanzania to regain access to and expand international markets. This will result in commercialization of livestock farming leading to optimal utilization of resources, increase in export revenues due to access to lucrative international and regional meat markets with greater earnings from livestock enterprises, economic development and increased household incomes and food security. It will also result in the increased availability of safe and quality meat for local and international markets with subsequent improved consumer protection and safety and higher prices for the producers.

In southern Africa region (SADC) Botswana, Namibia and South Africa are the only countries that have economically benefitted from their livestock industries after successful implementation of disease free zone concept that enabled the countries to access lucrative EU-beef markets. Once established recognized free zone enable countries to regain their status in case they lose it after disease incursions occur through quickly following the established procedure for achieving freedom again.

Tanzania has earmarked Rukwa and Katavi regions in the southern highlands zone for the initial establishment of the Disease free Zone (DFZs) which later on can expand to cover the Zone. A pilot project for the implementation of this undertaking attempts to detail the profile and potential of the proposed disease free area.

2.0 THE CONCEPT OF DISEASE FREE ZONE (DFZ)

The Tanzania Government, through Tanzania Development Vision 2025 is committed to develop a competitive and more efficient livestock industry that contributes to improvement of the well-being of the people whose principal occupation and livelihoods are based on livestock.

The National Livestock Policy states the main objective of animal health services to be control and or eradication of Trans-boundary Animal Diseases (TADs) in order to sustain the livestock industry and access markets.

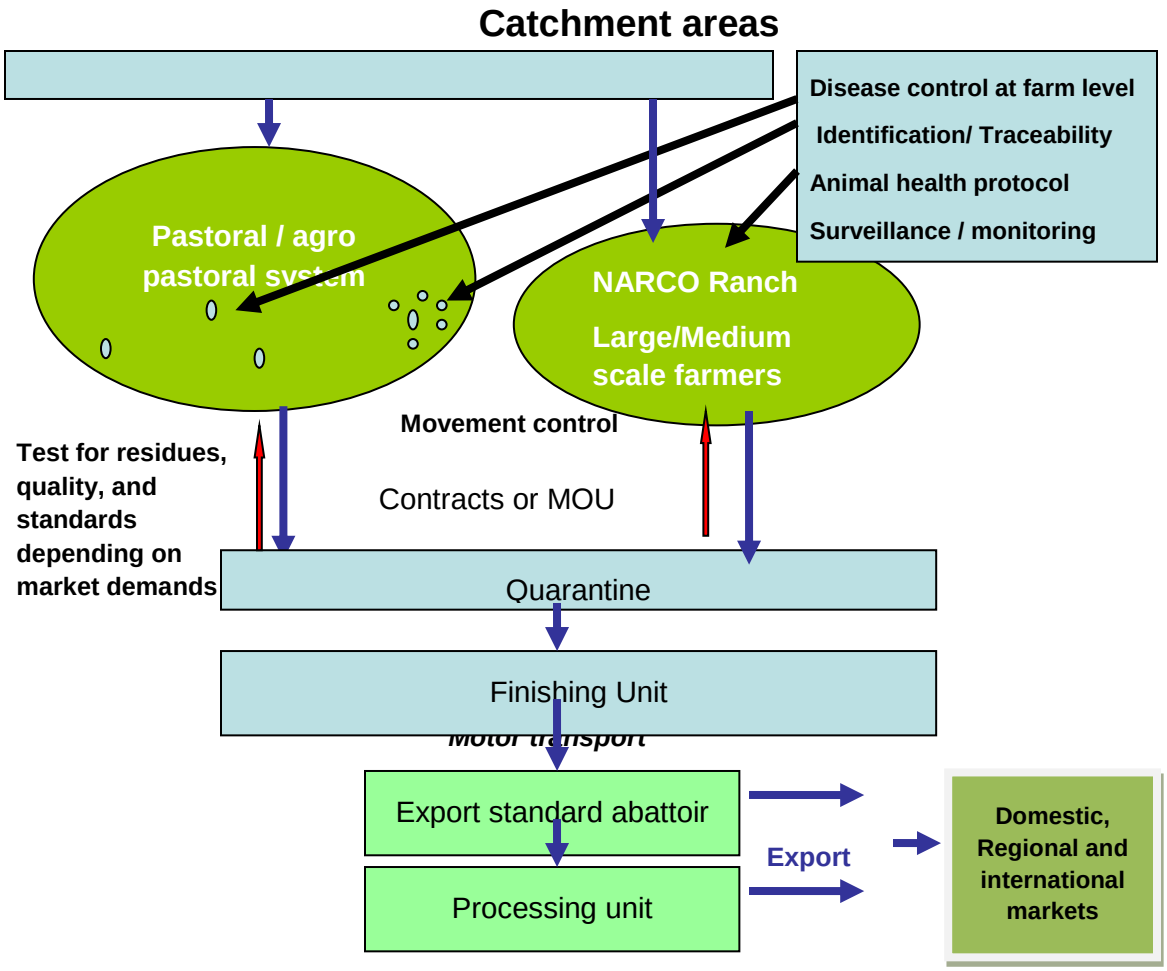
Livestock and livestock products trade is guided by the World Trade Organisation (WTO) Sanitary and Phytosanitary (SPS) Agreements. Under the SPS Agreement, member countries of WTO agree to recognize disease free zones as sources of animals and animal products subject to risk assessment. At the moment Tanzania is not participating fully in international meat trade due to absence of a recognized Disease Free Zone (DFZ) and hence unable to pass risk assessment to access lucrative international meat markets.

The protocol for elimination of the risk of diseases and other sanitary concerns has been established by the standards-setting World Organization for Animal Health (OIE). The objective of disease free zoning measures is to assure countries that diseases, disease-causing organisms, contaminants, toxins and prohibited substances will not be introduced into importing countries through importation of animals and animal products.

The establishment of disease free zones that eventually qualify to be export zones will enable the country to export meat and meat products to regional and international

markets and thus improve earnings of the livestock producers and other players in the value chain. Meat production for export will also contribute to the creation of wealth as well as job and improve the general livelihood for sector players. Potential exists regarding creation of disease free zones using available livestock infrastructure such as export abattoirs, quarantine stations, check points, crushes, dips, dams or bore holes depending on areas under consideration.

Considering trends in livestock migration and their movement and also location of established or conceptual export abattoirs, market access, disease controlled /free zones and the catchment areas are proposed taking into account natural and or artificial physical barriers and administrative boundaries.



3.0 OBJECTIVES

3.1 GENERAL OBJECTIVE

The overall objective of the pilot project is to explore the livestock potentials of Rukwa and Katavi regions in the Southern Highlands and come up with strategies that will improve livestock productivity to attain a more vibrant and profitable domestic and export markets.

3.2 SPECIFIC OBJECTIVES

In order to attain the project objectives the following specific interventions will be implemented at indicated estimate costs:-

- to identify and assign roles and responsibilities of stakeholders in the establishment of disease free zone for accessing markets for livestock and livestock products
- to implement practical livestock identification and registration system to be used in the disease free area
- to implement interventions for livestock disease control and eradication to safeguard animal and public health and contribute to NTBs in export trade
- establishment and strengthening of stakeholder associations
- to develop distribution system for livestock products to improve accessibility to markets
- to establish operational status of existing facilities and infrastructure for livestock development and recommend restablishment or rehabilitation of worn out/outdated facilities
- to take stock of relevant laws and regulations and corresponding infrastructure and train available staff for effective law enforcement

4.0 JUSTIFICATION

4.1 GEOGRAPHICAL LOCATION

Katavi and Rukwa regions are located in the South western part of Tanzania. The two regions occupy an area of 75,240 square kilometres. While 68,635 km^2 are land area, the remaining 6,605 km^2 are covered with water bodies. The area borders with Zambia to the Southwest, the Democratic Republic of Congo (DRC) to the West (across Lake Tanganyika), Kigoma region in the North, Tabora region to the Northeast and Mbeya region to the South east.

The area being proposed for the initial phase of establishing disease free zone is Nkasi and Sumbawanga districts in Rukwa region. The possibility of moving in livestock from other areas is very minimal while inward movements are quite possible. Also, the existence of natural barriers such as Lakes Tanganyika and Rukwa and rivers provides a good boundary for livestock movement thus less risk of moving in diseases and facilitate livestock movement control

Map of Rukwa and Katavi regions showing districts

4.2 DEMOGRAPHIC

The human population of the area was 1,136,354 in 2002 and the estimated number for 2011 was 1,558,200 according to the National Burea of Statistics (NBS).

4.3 CLIMATE

The area has a tropical climate with mean temperatures averaging 13^0C in some places for the months of June and July to 27^0C in the hottest months of October to December. Rainfall has been reliable for many years; it ranges from 800 to 1300 mm per annum.

4.4 ECONOMIC ACTIVITIES

Rukwa and Katavi regions have 1,526,894 ha which are suitable for livestock production which is 22% of the all dry land. The area currently utilised for livestock production is only 1,069,641 ha which is only 70% of the area suitable for livestock keeping. It is estimated that 339,952 ha are tsetse infested which is an equivalent of 5% of the dry land.

If developed by controlling tsetse, pasture improvement and construction of infrastructure like water points and dips the area can carry up to 727,093 cattle or 508,965 Tropical Livestock Units(TLUs) with good livestock distribution without affecting the environment.

The two regions receive good rainfall adequate for pasture and fodder production. The animals are used for draught power which includes ploughing and transportation of farm inputs and produce that make the regions self-sufficient and food secure. Livestock provide meat, milk, eggs and are also a source of cash income. They contribute around 20% to GDP of this area. Katavi and Rukwa have a cattle population of 512,722 with livestock farmers keeping an average of 12 heads of cattle per household.

There are 14 ranches and 3 dairy farm in these regions. The Dairy Farms are at Malonje in Sumbawanga and Nkundi in Nkasi district and Kalambo farm in Kalambo district.

Stakeholders in disease free zone establishment in the area include the many agro pastoralists in the two regions, LGAs, regional administrations, livestock traders and, inputs suppliers, processors of livestock products, CBOs and NGOs, and the central government.

4.5 CROP PRODUCTION

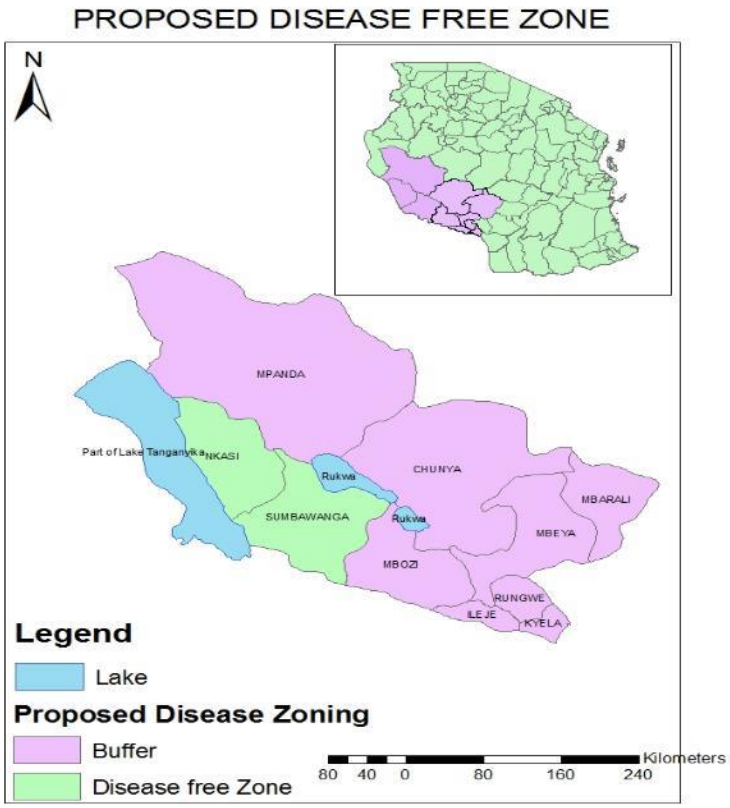
Agriculture in this area, just like in other regions of Tanzania, is dominated by small scale subsistence farming. Approximately 68% of cultivated land is under smallholder operations in which 75% of the tillage is done using animal power. The main cash crops are tobacco, sunflower and groundnuts.

4.6 POLICY AND LEGAL FRAMEWORK.

The establishment of the livestock diseases free zone is in line with National livestock policy and the requirement of the WTO in regards to export of livestock and livestock products. In additional the concept is politically accepted in the region which supports the move of having the DFZ in the area. In a number of occasions the region has requested the support developments in the livestock industry which will lead to establishment of DFZ and increase the value of the products in the market. The Rukwa regional investment profile ranked livestock and products high among important economic activities. This is an indication of the support and further guarantee towards the success of the DFZ programme.

The two regions are under major construction of the communication networks will attract suitable livestock investment and trade. The construction include road networks, Mpanda international airport, Sumbawanga airstrip and the existence of Tabora – Mpanda railway line, Kasanga and Kabwe ports and a number of mobile phone companies like Vodacom, Airtel, Tigo and Zantel.

Establishment of disease free zone aims at controlling diseases that hinder production of good animals and quality animal products and ban markets for animals and their products .Its implementation will be guided by the Animal Disease Act 2003 for matters related to the control and minimizing the disease risk in the target area. Other laws that will by virtue come into effect are those regulating land utilization, movement of stock, inspection of animals and products for quality, and livestock marketing and identification and registration of animals. These include the the Land Act (1999), Veterinary Act (2003), the Meat Industry Act (2006), the Hides ,Skins and Leather Trade Act (2008), the Pasture and Grazing Lands Act,(2010), the Livestock Identification & Traceability Act (2010), and the Animal Welfare Act (2010) etc.



4.7 LIVESTOCK RESOURCE

Establishment of DFZ is in favour of value chain approach which targets to solve trade challenges. In this regard Rukwa and Katavi regions have great potentials in livestock resources which include the Ufipa breed of zebu which has a large body frame and fast growth rate. There are 14 satellite ranches with a total estimate of 14,000 cattle and NARCO ranch with a herd of 1,733.

The regions has also great potentials in terms of livestock feed resources, which comprised of maize, maize bran, rice polishings and bran, wheat bran, groundnuts husks,

Bean straws, and cereal stovers (Maize, Rice, wheat,). In additional the regions receive enough amount of rainfall thus assured availability of pastures though out the year and enough grazing land. In other hand, the investment in place is an added advantage for the regions, among others are meat processing plant “SAAFI”, animal feeds processing plant “Energy Animal Feed Miller” and livestock ranches.

4.8 MARKET POTENTIAL

Investment in livestock will enjoy available market potentials for livestock and livestock products in the two regions. These include the growing local market, emerging southern highland tourist circuit, export markets to East, Southern and Central Africa and the existing and emerging markets in the mining areas.

5.0 ACTION PLAN

The implementation of the action plan will target realization of the specific objectives of establishing DFZ in the designated area. As indicated below

s/n	Objectives	Activities	Outputs	Cost X ,000/=	Responsible Stak.
1	to identify and assign roles and responsibilities of stakeholders in the establishment of disease free zone for accessing markets for livestock and livestock products	Collect information through enquiries from authorities, and by field visits Stakeholder meeting/workshop	Categories and numbers of stakeholders established by 2012/13	25,000	MLFD LGAs Regions NGOs
2	to implement practical livestock identification and registration system for adoption in the disease free area	Training of staff on livestock identification & registration (LIR) Awareness creation for stakeholders Avail tools and equipment for LIR (eartags, brands etc) Institute identification and registration of livestock and livestock owners Operationalise data collection from markets, abattoirs, villages, posts etc	2 LFOs from each of 20 selected LGAs by 2012/13 200 stakeholders sensitised by 2012/13 Nr and type of tools distributed Nr of animals (breed, type,class) identified and registered	27,500 30,000 - -	MLFD LGAs Regions (RS)
3	to implement interventions for livestock disease control and eradication to safeguard animal and public health	Plan and implement active and passive disease surveillance, routine diagnosis, Implement other disease control measures like	Animal diseases controlled /minimized risk of disease	1,000,000	MLFD RS LGAs

	and contribute to NTBs in export trade	dipping, vaccination, tsetse eradication programs, etc Train field staff in the recognition, epidemiology and control of major animal diseases (including TADS)			
4	establishment and strengthening of stakeholder associations	Facilitate and organize formation of stakeholder associations for producers, processors, feedlotters,inputs suppliers etc	Nr of associations formed by 2012/13	50,000	MLFD
5	to asses operational status of existing facilities and infrastructure for livestock health, marketing and recommend reestablishment or rehabilitation of worn out/outdated facilities	Field visit Vertical integration of stakeholders Establishing and rehabilitation of outdated infrastructure	Field visit report Facilities earmarked for rehabilitation or restablishment action Established and rehabilitated facilities by 2013/14	15,000 - 1,500,000	LGA MLFD MCDWG Ushirika
6	list relevant laws and regulations and assess related infrastructure for disease control and train available staff on specific and effective law enforcement in the area	Field visit Training of field staff	Relevant laws identified by 2012/2013 40 Field staff trained on livestock laws enforcement by 2012/2013 Status of infrastructure established and remedial action recommended Nr of field staff trained on law enforcement	5,000 30,000	MLDF LGAs
	Total			**2,682,500**	

6.0 Expected Outputs

It is envisaged that the establishment of a disease free zone will promote the production of livestock and livestock products with a consequent access in profitable domestic and export markets.

The following outputs will be realised:-

1.0 Livestock diseases which contribute to NTBs in international trade controlled and eradicated
2.0 Enhanced productivity of quality livestock products,
3.0 The public safeguarded from infectious and zoonotic diseases and related hazards
4.0 Improved accessibility to quality livestock products/ improve livestock supply chain
5.0 Increased institutional capacity for control of TADs at source
- **5.1** Zonal and district capacity for rapid response enhanced
- **5.2** Capacity for planning for TADs and mitigation in regions and districts improved
- **5.3** Enforcement of laws and regulations related to management of animal movements improved

6.0 Enhanced research and development on TADs
- **6.1** The role of TADs in the transmission and spread of FMD established
- **6.2** The role of buffaloes and other wildlife in the transmission and spread of FMD understood
- **6.3** Vaccines developed
- **6.4** Socio-economic impacts on livelihoods due to FMD assessed
- **6.5** Cost-benefit analysis of scare or TADs outbreak established

7.0 Public awareness and education improved
8.0 Program Management and Coordination achieved
- **8.1** Coordination supported
- **8.2** TADs contingency plans implemented
- **8.3** Monitoring and evaluation undertaken; and
- **8.4** Emergency fund established

9.0 Public – private partnership in provision of veterinary services promoted.

7.0 Conclusion

Export of livestock products to premium markets is hampered by the prevalence of the TADs in the country. In this regards, the investment in disease free zone is not an optional undertaking but a requisite. This requires all facets of the livestock industry to get organized in order to optimise the use of the investment which will involve production of the quality animals, proper processing facilities for production of quality end products that can access competitive domestic and export markets.

Starting in a small area with high probability of success as pilot and later to be replicated and up-scaled to other areas is rational. The selected area for the initial phase is Sumbawanga and Nkasi districts with the rest of Rukwa and Katavi regions being buffer zone. They have features that support the establishment of the DFZ, which include geographical features, natural boundaries, presence of Ufipa breed of the Tanzanian Zebu, a number of commercial beef ranchers and SAAFI meat processing facility among others. The areas is also endowed with presence of game protected area of Katavi National parks and game reserve areas which present challenges for disease control but at same time acting as natural boundary of the targeted area.

Success of the pilot project will offer experience from which future investments in DFZ will draw lessons.