DISEASE, VULNERABILITY AND LIVELIHOODS ON THE TANZANIA-UGANDA INTERFACE ECOSYSTEM TO THE WEST OF LAKE VICTORIA

Diagnostic Survey of north-western Tanzania

Edited by Gabriel Rugalema and Kirsten Mathieson

Food and Agriculture Organization of the United Nations

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Lake Zone Agricultural Research and Development Institute

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Gabriel Rugalema and **Kirsten Mathieson**
Rome, February 2009

FOREWORD

Agriculture based livelihoods entail the interdependence between crops, livestock and human labour. Throughout human history, diseases and agriculture have been inextricably linked. Yet most often research and programming addressing the impact of diseases on agriculture and rural livelihoods take a narrow disciplinary view, failing to recognize that diseases – whether human, animal or plant – often co-occur and that livelihood systems are vulnerable to multiple disease threats. The research reported in this paper seeks to challenge this established tradition and is built on the premise that the analysis of diseases, livelihood vulnerability and food security should be grounded in the context of interactions and co-occurrence of diseases. As the concept of "one health" implies, animal, plant and human health are mutually dependent and interact on various levels. Thus, it is the concomitant nature of diseases and their combined impact that poses a threat to rural livelihoods.

In light of the marked increase in emerging and re-emerging infectious diseases (EIDs) – including those of plants, animals and humans – in the last four decades, and in response to the expressed needs of member countries, FAO has been at the forefront of work to generate knowledge on EIDs and their socio-economic impacts on rural populations in order to support relevant policy and programmatic responses at country level. It is against this background that FAO, in collaboration with Kachwekano Zonal Agricultural Research Institute (Uganda) and Maruku Zonal Agricultural Research Institute (Tanzania) and with funding from the Norwegian Government, developed a pilot programme to identify and measure the combined effects of EIDs in the Uganda-Tanzania interface ecosystem west of Lake Victoria. The project had two phases. Phase one was basically a research study to generate evidence of co-occurring diseases and their impacts on rural livelihoods while phase two focused on the development of a participatory disease surveillance network.

This report presents and discusses findings obtained by the research study conducted under the first phase of the project. The findings reveal a high prevalence of crop, livestock and human diseases in the area and their co-occurrence in both space and time. It is clear that plant and animal diseases are threatening local crop and livestock production, a situation which is further affected by human diseases and resultant declines in labour availability. The report seeks to explain this high burden of disease and discusses the impact on food security, as well as proposing various responses.

In terms of recommendations, the report highlights the need for a paradigm shift. Disciplinary boundaries must be transcended in order to effectively and adequately address the actual magnitude of the disease burden and its implications. The remaining knowledge gaps on the combined burden of disease in the study area, and

the impact on livelihoods, need to be filled. The report argues that further research on disease dynamics is equally needed to enhance awareness among households and policy makers. Enhanced capacity is also necessary to put in place an effective disease response system. Finally, due to the linkages between crop, livestock and human health, and the transboundary nature of many diseases, the study recommends intensified collaboration between disciplines and also across the shared Tanzania-Uganda border.

Both at FAO and at field level this project has been a product of interdisciplinary work. At FAO, the project was designed and implemented collaboratively between the Department of Agriculture and Consumer Protection and the Social and Economic Development Department. At field level, the research team was comprised of crop, livestock and human health experts. For many people in the field, this was the first time that different sectors had come together to discuss a common problem. We hope this initiative will encourage agencies working on agriculture and those working on health to intensify their collaboration. It is worth repeating that among agrarian societies agriculture and food security are the foundations of health and health is the foundation of agricultural productivity and food security.

We would like to underline the need for a technical and policy platform that brings together crop protection, veterinary and human medical sectors. One sector alone cannot sufficiently address these complex challenges hence a multi-sectoral, multi-disciplinary approach cannot be overemphasized. Such an approach is not only cost-effective but addresses real life problems as experienced by rural communities.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACMV	African Cassava Mosaic Virus
AIDS	Acquired Immunodeficiency Syndrome
ANC	Antenatal Care
ARI	Acute Respiratory Infection
BARNESA	Banana Research Network for East and Southern Africa
BFW	Banana Fusarium Wilt
BXW	Banana Xanthomonas Wilt
CBPP	Contagious Bovine Pleuropneumonia
CGM	Cassava Green Mite
CMD	Cassava Mosaic Disease
CR	Coffee Rust
CWD	Coffee Wilt Disease
DALDO	District Agriculture and Livestock Development Officer
DRC	Democratic Republic of Congo
EAC	East African Community
EACMV	East African Cassava Mosaic Virus
EACM-UgV	East African Cassava Mosaic Virus – Uganda Variant
ECF	East Coast Fever
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
HIV	Human Immunodeficiency Virus
KII	Key Informant Interview
MDG	Millennium Development Goal
NCD	Newcastle Disease
NGO	Non-governmental Organization
PPLO	Pleuropneumonia-like Organism
RMO	Regional Medical Officer
RNA	Ribonucleic Acid
SARS	Severe Acute Respiratory Syndrome
SPVD	Sweet Potato Virus Disease
STI	Sexually Transmitted Infection
TSh	Tanzanian Shillings
UN	United Nations
US$	US Dollars
UTI	Urinary Tract Infection
VTC	Voluntary Testing and Counselling

EXECUTIVE SUMMARY

Diseases have shaped human history and they have influenced the course and speed of social development. The emergence and re-emergence of pests and infectious diseases over the last four decades is a worldwide trend, though with greater effects in developing than developed countries (Knols and Takken, 2008). Some 250 emerging infectious diseases have been identified, of which three-quarters are zoonotic (Wilcox and Ellis, 2006). In rural areas of developing countries where livelihoods are largely dependent on agriculture and human labour is the main factor of production, high incidence of human, livestock or crop diseases constitutes one of the major factors of food insecurity at individual, household and community level. In real life, rural societies are simultaneously confronted with diseases that affect crops, livestock and human health. Thus all these diseases are of agriculture and food security importance. However, measures to control and prevent diseases of agricultural importance often fragmentary - focusing on single disease or pest in isolation without recourse to the overall disease context. It turns out that control of one disease often does not lead to overall reduction of disease burden or their impact on agriculture, food and nutrition security.

This study is the first of its kind in its attempt to examine the combined burden of disease and hence the impact of diseases on food security on the Uganda-Tanzania interface ecosystem west of Lake Victoria. In the last four decades or so, the study area has experienced emergence and re-emergence of various types of disease including the outbreak of HIV in the early 1980s, resurgence of malaria and tuberculosis in the human population in the 1990s. Among livestock, contagious bovine pleuropneumonia (CBPP) and foot and mouth disease have not only become persistent but more destructive in terms of morbidity and mortality of livestock. In respect to crops, the three most important crops – banana, coffee and cassava have all been severely affected by a variety of diseases. How big is the problem of diseases and to what extent do they pose risk to lives and livelihoods of the local people in the study area? To answer this question, FAO, with funding from the Government of Norway, collaborated with Maruku Zonal Agricultural Research and Development Institute to assess the magnitude and dynamics of diseases and their combined impact on food security and livelihoods. The specific objectives of the study were:

- To identify important mechanisms of disease transmission in the study area;
- To explore to what extent these diseases constitute potential and actual biosecurity problems, and possible implications for food security;
- To understand how various groups of people and institutions perceive disease-related biosecurity problems;

- To identify and analyse available capacity (human, logistical, financial, material and institutional) for effective detection, identification, monitoring and control of diseases at local, district, national and regional (East African Community – EAC) levels.

Fieldwork was carried out in north-western Tanzania, particularly in the districts of Bukoba, Muleba, Missenyi and Karagwe. The study sites are spread across different agro-ecological zones and farming systems, thus allowing to capture agro-ecological differences and environmental effects on pest and disease prevalence. The study used a variety of qualitative and quantitative data collection methods - household survey, community meetings, key informant interviews and focus group discussions.

The findings of the study reveal that diseases are rampant in the study area. Many have been there for a long time. Others, such as AIDS among humans, cassava mosaic virus and banana xanthomonas wilt among cassava and bananas respectively, are new but they are widespread throughout the major agro-ecological zones. Findings of the study reveal the following:

- Major crop diseases in the study area include: banana fusarium wilt, banana xanthomonas wilt, cassava mosaic disease and coffee wilt disease. Banana weevils and nematodes are widespread and important pests of banana.
- In the case of livestock, the major disease problems include: East coast fever, Foot and mouth disease and contagious bovine pleuropneumonia.
- Malaria, dysentery/typhoid, sexually transmitted infections, AIDS, acute respiratory infection and intestinal worms are the main health problems in the human population.
- These diseases (and pests) co-occur in space and time and so at any given time communities in the study area are grappling with more than one disease or pest problem.
- Impact of one disease has a knock on effect on the impact of another or other diseases.
- Diseases are sustained by a wide range of factors including agricultural practices, sanitary practises, population mobility, ecological conditions, ignorance and suspicion smallholder farmers have on government-led disease control measures, lack of human and financial resources as well as weak institutional capacity.
- Lack of data on the trends, overall burden of disease and combined impact of diseases in the study area limits the extent to which the real social and economic cost of diseases could be discerned. As a result disease control and impact mitigation is not seen as a priority part of the local development agenda.
- Despite the fact that a wide range of diseases co-occur, there is little professional collaboration between veterinary, human health and crop protection experts.

The findings of the present study show that rural communities in the study area are faced with concurrent disease problems among humans, crops and livestock which have critical implications for social and economic development in this particular area as well as others in similar circumstances. The recognition that diseases are a barrier to agricultural development and food security should be influence decision on poli-

cies and programmes geared at improving agricultural productivity. However, human societies and the agro-ecological systems in which they eke a living are dynamic, so are the diseases that attack humans, crops and livestock. Thus, successful interventions would require good knowledge of the interactions between diseases, types and trends of pathogens and impact diseases, social drivers of diseases and the implications of weather and climatic variables not only on diseases but also on crops and livestock on which humans derive their livelihoods. A paradigm shift too is required in terms conceptualising and responding to diseases in the complex social, ecological and epidemiological context in which they occur. It is apparent that the isolationist, sectoral approach may not the best methodology in dealing with complex disease problems as experienced in the study area.

This study found that the weakest link in the quest for prevention and control of diseases in the study area is the severely limited institutional capacity in human health, veterinary or plant protection. At community and district level, capacity for disease surveillance, diagnosis, data processing and reporting, and responding to disease emergencies is severely limited by lack of human resources, equipment and infrastructure. However, the need and importance of building capacity or strengthening it where it already exists need no further emphasis. The basic message though is that institutional capacity could be further strengthened through inter-sectoral collaboration since such a strategy not only makes sense in terms of addressing the complex real life issues discussed in this report, it is also fundamental in lowering operational costs and improving efficiency and effectiveness of interventions.

CHAPTER ONE: INTRODUCTION

1

The study was undertaken to identify and analyse the burden of disease and pest problems in the Tanzania and Uganda interface ecosystem west of Lake Victoria. Diseases are a social problem as much as they are a biological problem. Nowhere is this more clearly illustrated than in developing countries where the high burden of infectious disease is a major stumbling block to social and economic development (Diamond, 2002). Although analyses on the linkages between smallholder agriculture and ill-health (due to diseases) have become common since the 1970s (Belcher *et al.*, 1975) most of the analyses have focused on the impact of one disease regardless of the prevailing multiple disease context.

The aim of this study was to look at the co-occurrence and interactions between diseases and the food security implication for households in the study area. This chapter begins with a brief theoretical overview in which a conceptual framework is laid out.

1.1 BACKGROUND AND RATIONALE OF THE STUDY

Despite emerging evidence concerning emerging and re-emerging infectious diseases (and pests in the case of crops), there has not been (sufficient) analysis of the combined burden of animal, human and crop diseases on livelihoods of smallholder farmers. Analyses that exist are strictly along disciplinary/sectoral lines and we argue that such an approach is insufficient to reveal the true extent of the disease burden and its implications for rural livelihoods.

The overall objective of this study was to examine the burden of transboundary diseases and pests within the districts along the Tanzania and Uganda interface ecosystem to the west of Lake Victoria. In carrying out this study, our main goal was to contribute to a better understanding of the burden of diseases and pests on food security as well as to generate ideas for policy and programmes.

Specific objectives of the study:

i) To identify significant mechanisms of disease transmission and spread in the study area;

ii) To explore to what extent these diseases and pests constitute potential and actual threats to food security and rural livelihoods;

iii) To understand how various groups of people and institutions perceive disease and pest related problems;

iv) To identify and analyse available capacity (human, logistical, financial, material and institutional) for effective detection, identification, monitoring and control of diseases and pests at local, district, national and regional (East African Community – EAC) levels.

1.2 CONCEPTUAL CONTEXT: AN OVERVIEW

Diseases can be conceptualised as products of **evolution** (of a pathogen, vector or host), **ecology** (the environment in which a particular disease thrives) and **culture** (the human environment and institution arrangements that aid and abet the transmission and spread of that particular disease). Any significant change in the elements just mentioned would change the threshold of a disease in a particular environment. Figure 1.1 is a simplified schema depicting interactions between the main elements that determine disease distribution, persistence and severity.

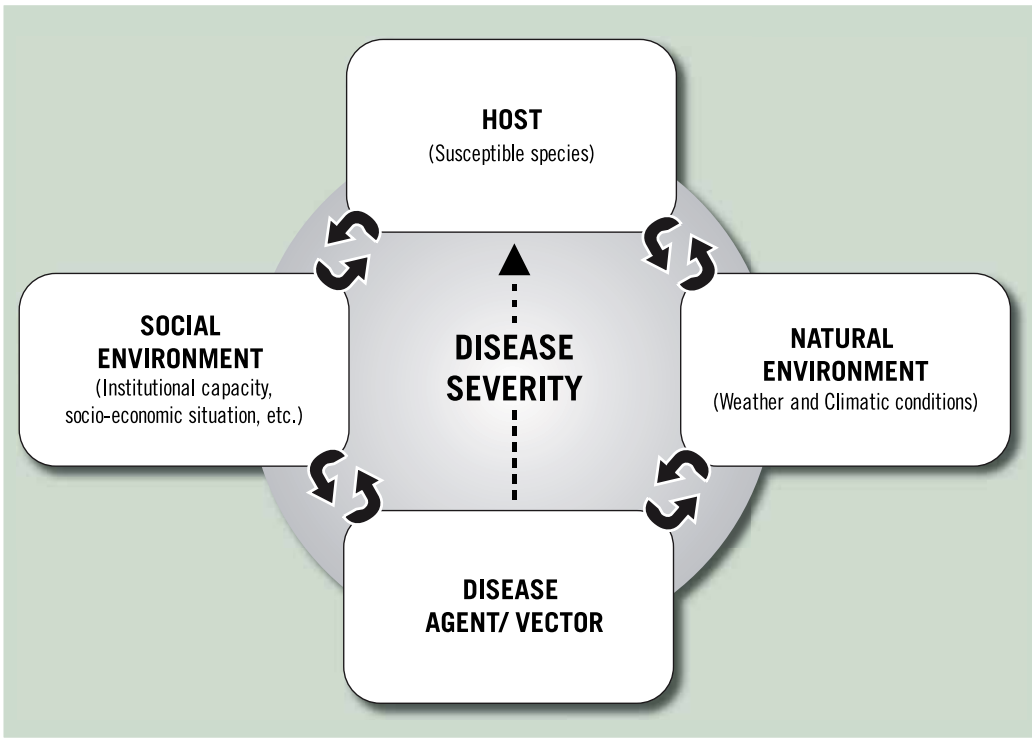

Figure 1.1 Interaction between disease causing organism, host and the environment

In real life there are many germs, several vectors and various hosts. In the context of a rural farming society where livelihood is derived mostly from agriculture (crop and animal production) there are direct interactions between the health of crops and that of livestock. However, since such production systems are mostly dependent on human labour, any major health problem among people in the productive age bracket would impact agricultural production (Baier, 1997; Rau, 2006). There is thus a complex interdependency between health of humans, livestock and crops and therefore significant ill-health in one sub-sector, be it crops, humans or livestock would be detrimental to the other sectors.

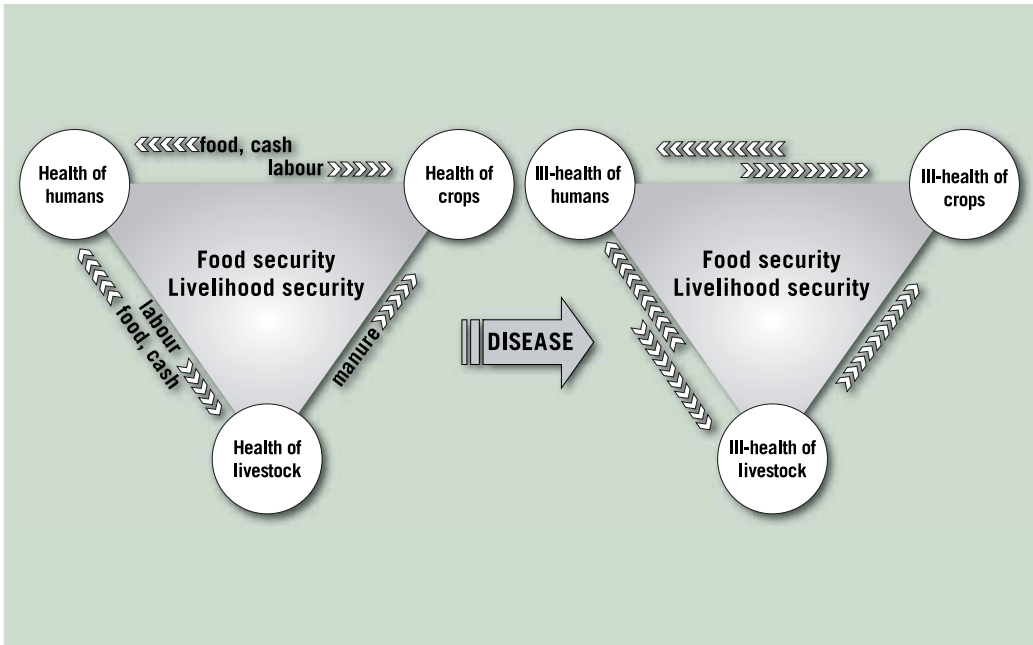

Figure 1.2 Interdependence of human, crop and livestock health

This study argues that poor agricultural productivity, and food, nutrition and livelihood insecurity in agricultural-based rural societies result from the high burden of disease and particularly the interaction at impact level, where the impact of one disease or a group of them has a strong knock-on-effect on the others (figure 1.2). Given that diseases also co-occur in space and time there is need to analyse their impact in a broader context rather than one disease in isolation.

The focus of this study was on the socio-economic burden of disease. Our analysis is largely focused on the impact of diseases in terms of food security and rural livelihoods. Very little is said about the pathogens and their pathogenicity, nor do we delve into the details of susceptibility of various species. Also, little is said on the ecology of the area and some discussion of climatic conditions is alluded to. As already indicated, these are key elements in explaining disease distribution and we would welcome good analysis on them in the future.

1.3 DISEASES AND PESTS IN THE STUDY AREA: A BRIEF OVERVIEW

This study reveals that the burden of disease and pests in the study area is quite high. The following tables provide a brief overview of the disease and pest burden in this area and identified by this study. The tables provide a quick outlook and are intended to show the variety of disease and/or pest problems in the study area. Further analysis of the impact of these problems on food security is undertaken in subsequent chapters.

Table 1.1 Crop diseases and pests

	Fungal	Viral	Nematode	Bacterial	Other
Banana	Banana fusarium wilt, Black sigatoka			Banana bacterial wilt	Banana weevil,
Coffee	Coffee wilt disease, Leaf rust				Coffee mealybug, tailed caterpillar, Coffee berry borer
Cassava		East African cassava mosaic virus			
Sweet potato		Sweet potato mosaic disease			

Table 1.2 Livestock diseases

	Fungal	Viral	Helminths	Bacterial	Other
Cattle		Foot and mouth disease	Worms	Contagious bovine pleuropneumonia	East Coast fever (tick-borne)
Goats		Foot and mouth disease	Worms		
Sheep		Foot and mouth disease	Worms		
Pigs			Worms		
Chickens and ducks		Newcastle disease	Worms, Coccidiosis		

Table 1.3 Human diseases

	Viral	Helminths	Bacterial	Other
Adults	Respiratory tract infections, AIDS	Worms	Dysentery, Tuberculosis, Typhoid, Syphilis	Malaria, Cough, Jiggers, Bilharzia, Tooth decay
Children	Respiratory tract infections, Measles	Worms	Dysentery, Tuberculosis, Typhoid	Malaria, Cough, Jiggers, Bilharzia, Tooth decay

1.4 METHODOLOGY

As stated earlier, research sites were selected based on one main criterion, namely that they are part of the Tanzania-Uganda interface ecosystem to the west of Lake Victoria. Being part of the same ecosystem implies same if not similar livelihood systems, similar or comparable systems of cropping and livestock keeping and a shared culture.

Field work was undertaken by a team led by researchers from Maruku Local Agriculture Research and Development Institute. It was conducted in four districts of Kagera Region, namely Bukoba, Muleba, Missenyi and Karagwe. Muleba District was included as a special area which, although being far from the border, has been highly impacted by crop diseases, mainly Banana Xanthomonas Wilt (BXW), Cassava Mosaic Disease (CMD), HIV, and has some of the worst malaria cases in the region (Yanda *et al.*, 2005). Within each district, one or two Wards[1] were selected for in-depth investigation (Table 1.4 and 1.5). The following activities were undertaken:

i) Quantitative information was collected through:

- Formal interviews were conducted with 12-16 households in each village (representing 10-12 percent of the households in the village) for which structured questionnaires were used. It was originally conceived to interview 12 households per village, however, in some villages additional farmers were requested to provide information, leading to an unequal number of interviewed households per village. These interviews were conducted to obtain standardised information on a number of household characteristics. Care was taken to ensure that in each village female headed households were not left out of the study. In total, the questionnaire was administered to a sample of 204 respondents drawn from seven wards in four districts (Table 1.4) of which 68 were female headed households.

ii) Qualitative information was collected through:

- 157 interviews with key informants (Ward and village leaders, as well as renowned farmers), both in groups and individually, using a standard checklist, plus a visual appraisal of livestock and crops.
- Focus group discussions with three to four farmers and livestock herder groups per village, using a standard checklist. The groups were composed of 10-30 farmers (including men, women and youth). Throughout the study, discussions were carried out with a total of 65 groups, involving 1 305 people. A gender-sensitive analytical framework was used throughout the entire study. The effects of biosecurity issues, diseases, coping strategies, perceptions and so on were analysed from a gender perspective (i.e. looking at differential impacts on men/women, boys/girls).
- Besides key informant interviews and focus group discussion, the study team carried out transect walks in all of the villages. During the transect walks, which followed more or less a straight line from the centre to the periphery of the village, information was obtained on, among others, types of crops and livestock, their management, presence and/or absence of diseases, soil, household land holdings, houses and their condition, the presence and/or absence of latrines, garbage disposal methods, and quality of water used at home and for livestock.

[1] The Ward is the lowest planning level within the Government structure. It can be composed of two or more villages depending on the population of the villages.

In-depth Interviews were conducted with various institutions (e.g. government, research, NGO's, etc.) at village, Ward and District levels to identify the capacity of various institutions to address biosecurity threats. In addition, a comprehensive meeting was held with technical staff from agriculture and livestock, health and community development departments.

Table 1.4 Study sites in Tanzania by district, agro-ecological zone, ward and village

District	Ecological zone	Ward	Village	Sample Households
Bukoba	High rainfall	Kaagya	Katangalala	14
			Mushozi	13
Muleba	High rainfall	Izigo	Izigo	17
			Kabale	15
	Low rainfall	Kasharunga	Kasharunga	12
			Kiteme	12
Missenyi	Medium rainfall	Kanyigo	Kikukwe	14
			Bweyunge	12
	Low rainfall	Nsunga	Byamutemba	15
			Byeju	14
Karagwe	Medium rainfall	Murongo	Murongo	17
			Nyamihaga	18
	Low rainfall	Kihanga	Kishoju	14
			Kihanga	14
Total				***204***

Table 1.5 Characteristics of study sites

Ward	Important characteristics
Kaagya	This site is historically the oldest settlement in the region. It is highly populated and is faced with declining land productivity due to low soil fertility and endemic pests and diseases of coffee and banana. High banana disease prevalence has led to complete extinction of indigenous banana varieties in the ward. Partly due to a famous fish landing site, mobility of people from different places in East and Central Africa is high and is said to contribute to high incidences of AIDS in the area. The extermination of banana due to diseases and pests has led to a high level of malnutrition among children and adults in Kaagya.
Izigo	This ward is seriously affected by banana wilt diseases, banana weevils and nematodes, coffee wilt disease and cassava mosaic disease. It has high incidences of malaria and it is a staging post for migration to some of the main islands in Lake Victoria.
Kasharunga	This site is a cattle corridor with a high burden of livestock diseases, notably foot and mouth disease, contagious bovine pleuropneumonia and east coast fever.
Kanyigo	This site is contiguous to the Uganda border. Many households in the area depend on remittances from younger people working outside the area. The first three cases of AIDS in Tanzania were identified in Kanyigo ward. It is also considered a hotspot for many crop diseases such as banana Xanthomonas wilt (BXW), coffee wilt and cassava mosaic diseases.
Nsunga	This site forms a piece of the Tanzania-Uganda border. It is predominantly a pastoral area and cattle diseases are said to be widespread. Pastoralists move up and down the international border in search of pasture or to escape strict measures of disease control.
Murongo	Murongo ward is also sited on the Tanzania-Uganda border. The site experiences high levels of movements of people, livestock and other types of goods traded on both sides of the border.
Kihanga	Similar to Nsunga, the area is predominantly pastoral. It has experienced high level of conflict between cultivators and livestock keepers. Diseases of humans and livestock are said to be common.

1.5 SITUATING NORTH-WESTERN TANZANIA

Kagera Region, with an area of 28 510 km^2, is located in the northwest corner of Tanzania at approximately 30 ^{0} 5 "-32 ^{0} E and 1 ^{0}-3 ^{0} S. It borders Uganda, Rwanda and Burundi. The region supports a population of 1.8 million people, 90 percent of whom live in rural areas. The rural economy is heavily reliant on agriculture and 85 percent of people are involved in farming.

Three major agro-ecological zones can be distinguished based on local geology, soils and the amount of rainfall received per year (Baijukya and Folmer, 1999). Table 1.6 summarises the major characteristics of these zones. Annual rainfall ranges from 750 mm in the lowland plains to over 2000 mm along the shores of Lake Victoria. Rainfall occurs in a bimodal pattern with the long rains lasting from late February to May/June, followed by the short rains from late September to early December, providing a long growing period of about 200 days. Soil parent materials range from extensive sandstone, quartzite and gneissic formations to alluvial and colluvial materials in the marshes and wetlands. The main soil types are consequently Ferralsols, Acrisols, Luvisols, Gleysols and Planosols (FAO, 1990). Most of these soils are highly weathered and leached, resulting in inherent poor fertility.

Table 1.6 Characteristics of major agro-ecological zones of Kagera Region

Characteristic	Agro-ecological Zone		
	High rainfall	***Medium rainfall***	***Low rainfall***
Mean annual rainfall (mm)	Ranges from 1 500 to over 2 000	Ranges from 1 000 to 1 500	Ranges from 750 to 800
Geological materials	Sandstone and shales	Largely shales, admixtures of quartz and quartizic sandstone	Unconsolidated sedimentary deposits
Soils	Highly weathered and leached, sandy clay to sandy clay loam, poor in available plant nutrients	Highly weathered but moderately leached with low available plant nutrients	Young soils containing sufficient amounts of plant nutrients
Land form	Hilly to gently undulating uplands with long stony slopes to the sores of Lake Victoria	Hilly with steep, straight, long and smooth to stony convex slopes	Mixture of wide and narrow colluvial valleys and flat low level countryside
Farming system	Mixed agro-forestry, crops (intercropping of perennial bananas and coffee, and annuals dominated by cassava, maize, sweet potatoes and beans) and livestock	Predominantly perennial banana and coffee, in addition to annuals in pure strands (cassava, maize, field peas, beans and round potatoes)	Livestock based (largely transhumance), annual cropping dominated by cassava and beans. The zone is designated as a migration area for people from other zones and outside Kagera Region
Human population density per square kilometre of cultivated inhabited land	430-510	350-420	less than 250
Major economic activities	Predominantly agriculture, in addition to fishing and related trade activities. Livestock keeping limited to a few households.	Predominantly agriculture and related trade activities.	Predominantly livestock keeping, limited farming and related trade activities.

Overall, the land use system in the study area can be broadly classified into two main types, with several further sub-types according to management intensity and biological diversity:

i) Perennial banana-based farming system, including coffee, root crops, tubers, crops, cereals and various agro-forestry trees. This type of land use is characteristic of high and medium rainfall zones.

ii) Pastoral system, characterized by transhumance/free range grazing of livestock but with some degree of integrated crop cultivation of crops, tubers and grain legumes.

Banana-based Farming System

Many experts have described the historical and cultural background of the banana-based farming system of Kagera Region, which is distinct from other forms of crop production (Rald and Rald, 1975; Rugalema, *et al*., 1994; Maruo, 2002). The Bantu people practised slash and burn shifting cultivation and grew finger millet (*Eleusine coracana*), yams (*Dioscorea sp*) and Coleus (*Coleus spp*) for approximately two millennia. In the 16th century the Nilo-Hamitic pastoralists arrived in contemporary Kagera Region from the lower Nile Valley and brought with them cattle. The two groups mixed and formed a new society, now called the *Haya.* The Haya exploited manure with careful management and built up a perennial culture of banana plants on highly weathered soils. At the end of the 19th century Rinderpest disease killed 90 percent of cattle in the region and since then the number has continued to dwindle due to various epidemics. Nowadays, replenishment of fertility in banana fields depends mainly on grass brought in from the surrounding grasslands and only partly on manure (Baijukya and Steenhuijsen Piters, 1998). This situation, together with human population growth since the 1920s (Milne, 1938), has put pressure on farming and the region has been experiencing a decline in the degree of food security for over two decades.

The Haya classify land use into two main categories: *kibanja* and *rweya*. The *kibanja* is the archetype of Bahaya rootedness and prosperity. In the *kibanja* farmers grow banana, which is interplanted with coffee (mainly *Coffea canephora*), maize (*Zea mays*), *Phaseolus* beans, and root and tuber crops. A farmer's life is anchored in the *kibanja*, where he/she erects a family home. The *kibanja* also serves as a final resting place for deceased family members. A group of *kibanja* comprises an aggregate of homesteads which form a village community (*ekyaro*). Milne (1938) described this aggregate as 'an island of fertility in the sea of infertile grassland'.

Rweya is the savanna type grassland used mainly for grazing cattle. It also serves as a source of grass for mulching, thatching, carpeting and other essential uses. *Rweya* is also a site where crops (notably cassava – *Manhot esculenta*, Bambara nuts – *Vigna subterranea* and yams – *Dioscorea sp*) are planted. Thus Rweya and Kibanja are interdependent and central to the livelihoods and food security of the local people.

The Pastoral System

The pastoral system, which is believed to have existed in parts of Kagera Region since the 16th century (Rald and Rald, 1975) and partly collapsed due to Rindepest disease in the 19th century, somewhat re-emerged in the region in the late 1950s following the arrival of *Hima* pastoralists from Rwanda (Friedrich, 1968). The system slowly expanded in the early 1960s with the further arrival of *Bahima* and *Banyankole* from south-west Uganda in search of pastures and water for their livestock. Kagera Region has ample grazing land and relatively good quality pastures. In this pastoral system, pastoralist households own between 100 and 800 heads of cattle. The Ankole breed is the dominant cattle kept by pastoralists. Settlements are temporal, made of wooden poles and grass, and are situated at some distance from permanent villages. Very little crop production is undertaken and thus the major outputs from this system are milk and the occasional sale of cattle as a means of obtaining cash to purchase food and other necessities for which cash is required. According to Omolo *et al*. (1999), the pastoral system has stagnated, largely due to recurrent outbreaks of epizootic diseases.

1.6 SUMMARY

As described in the foregoing sections, the area we chose for this study is known for having a high burden of disease and pests. Some diseases are a century old, some are new. What is not known is the extent of the disease burden, trends and dynamics, and impacts on food security. This report is the first attempt to unravel the complex relationships and linkages between various diseases and their combined effect on food security. This analysis is important for policy and programming in the region. As demonstrated later in this report, high burden of pests and diseases is one important driver of food insecurity and poverty in the study area. It is noteworthy that this high burden straddles the international border between Tanzania and Uganda, implying that the problem is transboundary[2] and therefore needs internal collaboration in addressing it. To appreciate the transboundary dimensions of the diseases, this report should be read in conjunction with the Uganda country report.

2 Transboundary diseases are defined as: "those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires co-operation between several countries" (FAO, 1997). In the context of this study, the transboundary aspects of diseases refers to the commonality of these problems across the Tanzania-Uganda border.

CHAPTER TWO: CROP PESTS AND DISEASES

2

Declining productivity of the banana-based farming systems of Kagera Region has been the subject of a number of investigations (Rald and Rald, 1975; FSR, 1990; Rugalema *et al*., 1994; Bosch *et al*., 1996; Baijukya, 2004). Although there are insufficient statistics to quantify losses due to crop pests and diseases, it is evident that the increase in occurrence in recent years is a contributing factor to the decline in crop production (Mbwana and Rukazambuga, 1998) and thus pronounced food insecurity. Another pertinent cause of the systems declining productivity has been identified as soil fertility decline (Moberg, 1972; Baijukya, 2004), partly due to declined herd sizes, and hence manure, due to decimation by various cattle diseases.

This chapter identifies the major crop pests and diseases in Kagera Region, particularly in the districts bordering Uganda. The focus is given to pests and diseases affecting bananas, coffee and cassava, due to these crops' high social, cultural and economic value in the study communities. For each pest/disease identified, we attempt to provide a brief historical account of its spread and distribution in the study area. Also, we look at how a particular disease is perceived by the community and its impact on crops. Finally, we turn to control measures for diseases and analyse institutional capacity for effective control of the disease.

2.1 IMPORTANT CROP PESTS AND DISEASES IN KAGERA REGION

As mentioned in the preceding chapter, farmers in the study area grow a range of crops that vary both across and within the major agro-ecological zones. At the level of the individual farm unit, farmers diversify extensively, typically growing five or more crops (Rugalema *et al*., 1994). The major crops and their associated pests and diseases, as identified by farmers during the present study, are summarised in Table 2.1. The list of diseases identified by farmers during the study is similar to what has been reported by different experts (Mgenzi *et al*., 2005; Maliyatabu, 2007; Sato and Ndyetabula, 2006). The study team observed other diseases that are important even though these did not feature in the farmers' list of important diseases. Such diseases include coffee rust (CR), coffee blister, cassava green mite (CGM) and sweet potato virus disease (SPVD). Farmers did not consider these diseases to be among the most important as they are masked by more problematic diseases, namely Cassava mosaic disease, Coffee fusarium wilt and Banana Xanthomonas wilt.

Table 2.1 Farmer reported pests and diseases of major crops in Kagera Region

Crop	Pest	Freq	Percent (n=158)
Cassava			**n = 158**
	CMD	158	100
Banana			**n = 153**
	BXW	22	14
	Fusarium wilt	39	25
	Black sigatoka	14	9
	Banana weevil	94	61
	Nematodes	33	22
Coffee			**n = 103**
	Coffee wilt	6	6
	Rust	4	4
	Berry borer	11	11
	Tailed caterpillar	6	6
Maize			**n = 91**
	Leaf rust	7	8
	Stock borer	3	3
	Maize streak	7	8
Beans			**n = 70**
	Nematodes	19	27
	Beetles	4	6

2.2 DISEASES AND PESTS OF BANANA

The study area has often been referred to as "banana culture" or "banana land". The crop is the major staple food for over two million inhabitants in the study area (Bureau of statistics, 2006). Kagera Region produces more than one-third of the total banana production in the country, which in 2006 was estimated at 2.2 million tonnes. Banana dominates the diet of the Bahaya, the autochthonous people of Kagera Region. In this region, 70 percent of households grow bananas and an estimated 2.3 million people depend to a large extent on bananas for their daily source of carbohydrates (Bureau of statistics, 2006). Nonetheless, banana production is on low-input system, practiced on small holdings averaging 0.5 ha per farming household (Bosch and Shwagala, 1994). In this area, bananas also provide a source of cash income for farmers as excess production, if any, is sold on the market. Bananas also have ecological functions such as protection of the soil against erosion and leaching (due to both massive root systems and aerial leaf cover).

In the last thirty years or so, banana production in the study area has been declining. Field data shows that in Kagera Region, average yield of bananas has declined from 18 tonnes/ha in the 1960s to less than 6 tonnes/ha in 2000 (Walker *et al.*, 1984; Sikora *et al.*, 1989; Mgenzi *et al.*, 2005), with pests and diseases being the major causal factor for this decline. Other factors have contributed to this situation however. These include lack of suitable land for expansion of banana cultivation, declining fertility, declining holding size and impact of human and/or livestock diseases in the decline of banana production as pointed out by Ruthernberg, 1986; Kjekshus, 1996; Rugalema, 1999; among others.

The types of banana grown in Kagera Region, in order of their importance are: East African highland bananas (AAA-EAHB), composed of cooking and brewing types[3]; other brewing types (AB, ABB); other cooking types (ABB); dessert bananas (AAA, AAB); and plantains (AAB) (Karamura and Mgenzi, 2004). Often, farmers grow bananas in highly complex cultivar mixtures.

During the study respondents were asked to mention the most important diseases and pests of the banana crop. This list is presented in Figure 2.1. Of the pest problems, banana weevils were the most frequently mentioned followed by nematodes. In terms of diseases, the list and order of importance is as follows: banana fusarium wilt (BFW), banana xanthomonas wilt (BXW) and black sigatoka (Panama diseases). Although nematodes are too small to be seen by the naked eye, farmers were able to describe the pest by the type of damage it causes, which includes root necrosis and the toppling of banana plants. From this description we inferred that they are referring to root-rot nematodes. Interestingly, the ranking of banana diseases by farmers is in line with findings of other similar surveys conducted in the region (e.g. Mgenzi *et al.*, 2005), as well as with the field observations made by the study team and other studies cited earlier in this report.

3 According to Stover and Simonds (1987), edible bananas have their origins in two wide species – *Musa acuminate* (A) and *Musa balbisiana* (B).The system of classification of bananas is thus based on relative contributions (genomic constitutions) of the two parent species.

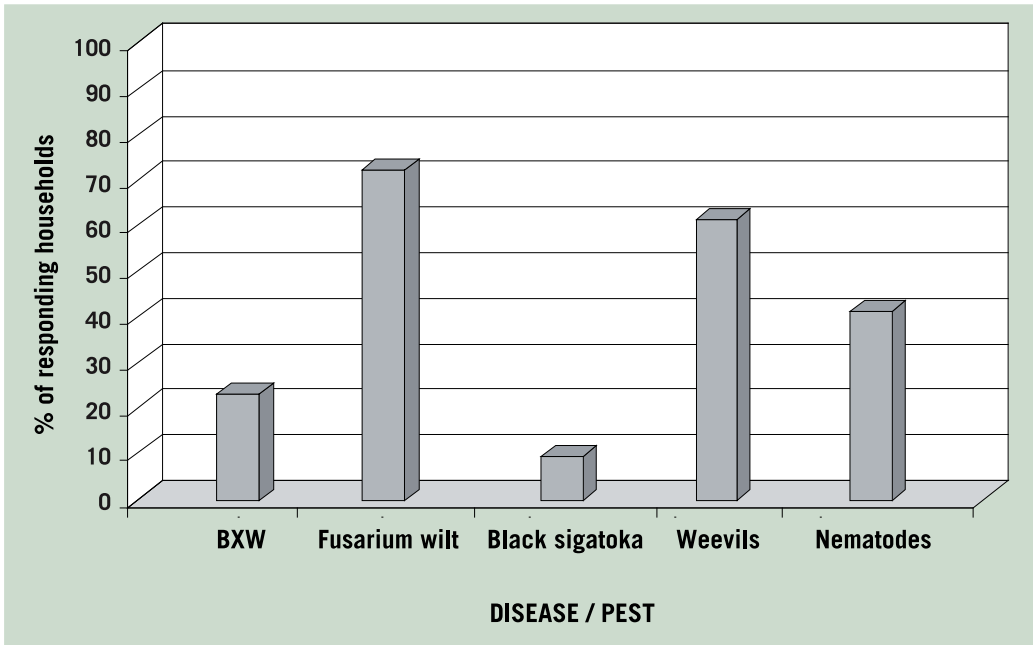

Figure 2.1 Relative importance of banana pests and diseases in Kagera Region (as reported by farmers)

Figure 2.2 below shows the distribution of banana pests and diseases in the different agro-ecological zones covered by the study, as reported by farmers. Banana fusarium wilt and banana xanthomonas wilt were more frequently mentioned in high rainfall zones. This observation is also supported by a technical surveillance report on BXW, which indicated higher prevalence of BXW in high rainfall zones as opposed to medium and low rainfall areas (Mgenzi, *et al.*, 2007).

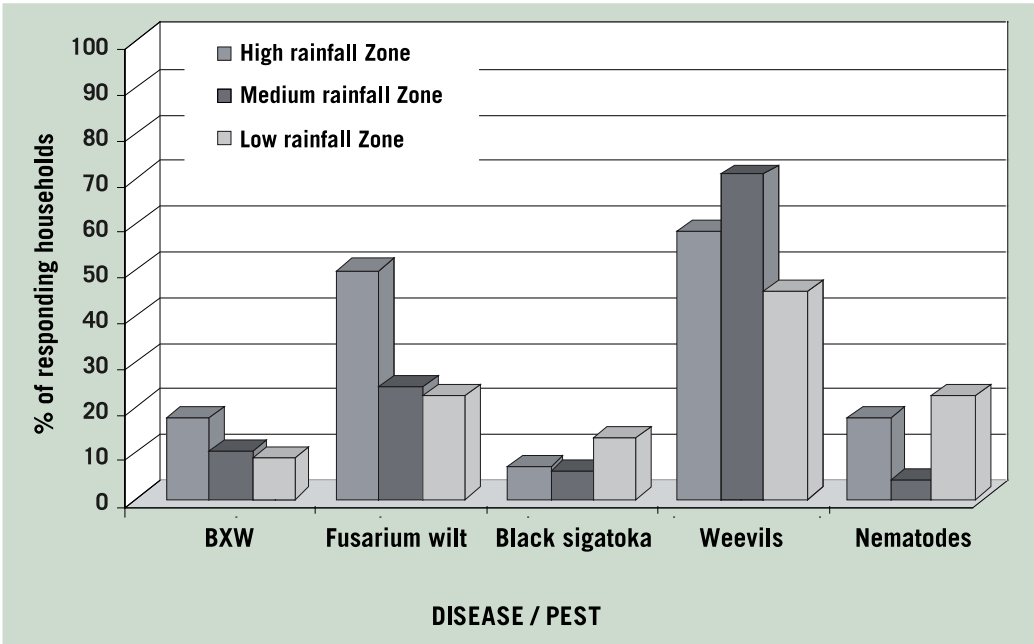

Figure 2.2 Relative importance of major banana pests and diseases in different agro-ecological zones of Kagera Region (as reported by farmers)

Banana Fusarium Wilt (BFW)

Banana fusarium wilt is caused by a soil fungus – *Fusarium oxysporum* f.sp. *cubense*. It is locally known as *Panama* disease and was first recorded in Tanzania in Kaagya Ward, Kagera Region in the mid 1970s (Mbwana and Rukazambuga, 1998). The disease is widely distributed throughout all banana growing areas of Tanzania, though is considered most destructive in Kagera Region (Ibid). BFW exclusively attacks sweet banana cultivars, including Gros Michel – AAA, *kainja* (Pisang awak – ABB), and *kanana* and *kishubi* (Ney Poovan – AB) (Tushemereirwe *et al*., 2004). During the present study it was noted that in some areas, such as Nsunga Ward, entire plots of susceptible varieties have been wiped out.

Generally, farmers could point out that Banana fusarium wilt is largely spread from one farm to another through use of infected materials and/or mulching, and the use of contaminated farm tools. Despite the fact that the disease is widespread, and now endemic in Kagera Region, there is no shared opinion about the origin and the drivers of the diseases. During focus group discussions, a variety of ideas were given regarding the origin and spread of the disease. For example, farmers in Mushozi village, claimed that BFW originated from Uganda and that it was introduced to the area by farmers who imported planting materials of the banana cultivar Gros Michael in the early 1970s. Whether this story is authentic or not, it reveals two aspects about farmers' perception of pests and diseases which will feature repeatedly in this report. The first is that farmers are not utterly unaware of the diseases and the nature of damage. Actually, we found that they know better than we expected. The second aspect pertains to assigning diseases and pests to foreign origin. That diseases might originate from a foreign country is neither new nor something to be disputed. Modern epidemiology has shown time and again that diseases respect no international boundaries. However, it is also possible that by claiming that the diseases comes from a foreign country, farmers are trying avoid any blame or responsibility for the spread of the disease or indeed to indicate that since they have no control of the situation in a foreign country (where a certain disease is reputed to be coming from), there is nothing they can do to prevent the disease from attacking their farms.

We also found that farmers relate the outbreak and severity of Banana fusarium wilt to prevailing weather conditions. In Byamutemba and Byeju villages, respondents associated the disease with prolonged dry spells which hit the area in the mid 1980s. They claimed that once the disease was established, it never left the area. Agronomic research findings have come up with similar observations showing that the symptoms of BFW are more expressed during the dry season when soil moisture is low (Mgenzi, 2001, unpublished).

An important question at this point is, if Banana fusarium wilt is such a big problem, are the farmers in the study area trying to control it? This question was posed to the respondents both in the questionnaire survey and in the focus group discussions. What emerges is a complex picture. While a few farmers adhere to recommended measures[4], many of them do not. The study team noted several diseased banana mats which were left standing in the farms or even when mats are uprooted, they are not properly disposed of. In any case, uprooting was done by only a few farmers and

4 The scientifically recommended methods to control BFW include: uprooting of the infected banana stools and chopping the materials into pieces; disinfecting farm tools after their use on infected plantations/banana mats; and the planting of disease free materials and/or disease resistant cultivars.

Plate 1 Typical banana fusarium wilt (BFW) symptoms at late stage

the main reason was that there is simply not enough labour to cut and dispose of the dead mats[5]. Farmers prefer to do this task once or twice per year just to remove the old/dead mats and prepare the farm for a new planting season. While this practice may have worked well in the pre-BFW days, it is now a risky practice. Leaving diseased mats in the farm for a long time maintains the innoculum *in situ* and guarantees further spread of the disease. Previous studies in Honduras and elsewhere have indicated that susceptible clones cannot be successfully replanted in an infested site for up to 30 years due to the long-term survival of *F. oxysporum* f. sp. *cubense* in soil and weed species (Stover and Simonds, 1987). In some instances, we were informed that farmers tend to re-plant susceptible cultivars (e.g. Gros Michel, *Kanana* and *Kayinja*) because of their high market value as well as their favourable brewing qualities as compared to non-susceptible varieties. Thus, the disease is sustained within the farming system through the non-removal of diseased plants as well as replanting of susceptible varieties. Farmers and scientists recognise that the disease is now endemic in the area with sporadic outbreak into epidemic proportions.

The recent trend though is that farmers are switching to resistant cultivars, such as tall Cavendish "Mtwishe"; FHIA 17, 23 and 25; and Yangambi Km 5. According to Kikulwe *et al.* (2007), between 1997 and 2002 about 1.5 million banana suckers of various resistant cultivars (mentioned above) were given to farmers in Kagera Region. There are no records for the period 2002 and 2007 but anecdotal evidence shows that adoption of resistant cultivars has increased.

5 The issue of availability of labour is a complicated one. In some households, particularly those affected by AIDS or headed by elderly people, lack of labour is a reality. In other households, invoking lack of labour may be a short-hand for not wanting to allocate labour to this particular task. Very little is known about the relationship between ill-health and labour availability/allocation in rural farming households and it certainly is an area for further research.

Banana Weevils

Banana weevils have long been regarded as one of the biggest constraints to banana production around the world (Treverrow *et al.*, 1992). In Kagera Region, they have been considered a major threat to bananas since they were first detected in 1939 in Mutukula village, which lies on the border with Uganda (Hyden, 1969). According to Mbwana and Rukazambuga (1998), by 1996 banana weevils had spread all over Kagera Region.

The majority of respondents were not certain about the origin of banana weevils. A few farmers claimed that weevils arrived with the sunflower crop which was introduced in the area in the early 1970s. Sunflower never really took off as a commercial crop. It is therefore arguable that sunflower could have contributed significantly to the banana weevil problem that is evident today. In most cases, farmers were not able to differentiate between damage caused by weevils and the damage caused by nematodes as these two pests co-exist. As observed by Sikora *et al.* (1989), nematode damage often works in tandem with weevil damage.

Like many pests, banana weevils have extended their ecological range. While the problem is much older in the high rainfall zones as well as low rainfall ones, farmers in the medium rainfall zone, particularly in Murongo Ward, perceived the problem to be a more recent occurrence. This implies that the weevils have only recently become established in these areas either due to climate change, weevil's mobility or through anthropogenic factors such as human mobility, coupled with introduction of planting materials.

Studies on susceptibility of banana cultivars to weevil damage have indicated that bananas of the AAA-East African highland group, which are dominant in the region, are most attractive to weevils, and their corms are less resistant to weevil damage as compared to other banana cultivars (Simon, 1994). Due to increased weevil damage to local banana cultivars (African highland bananas), particularly in Bukoba District, farmers are gradually replacing these indigenous varieties with exotic types. A worrisome development though pertains to the extension of ecological range of weevils which means that sooner or later the entire region may be facing a significant threat from the weevils.

Plate 2 Banana weevil (*Cosmopolites sordidus*) and eggs on a banana corm

At farm holding level, severity of damage was found to vary between farms. Field observations by the research team revealed that poorly tended farms have higher incidence of weevil damage. Studies have also indicated a pest-soil fertility correlation in which weevil damage is high in bananas growing in soil with low fertility, for example in farm holdings belonging to households that do not apply cattle manure (Rugalema, 1991; Bosch *et al*., 1996). In addition to soil fertility, it was observed that more weevil damage occurs on farms with poor sanitation, namely farms not weeded, banana plants not de-trashed, and where banana densities are higher than recommended. In most cases these are farms owned by households with labour shortages, usually due to prolonged illness of household members, death due to human diseases, and migration in search of off-farm employment. Such households are likely to be headed either by young women (either widowed or unmarried) or the elderly.

Mechanical weevil trapping is a well known control method. Approximately 80 percent of interviewees (mainly male farmers) have some knowledge about how to trap weevils. However, during the present study only two farmers were found to be practicing this method. Studies by Bosch *et al.* (1996) have shown that poor timing of trapping, laboriousness, and the sometimes inefficiency of traps due to the presence of heavy mulch in banana fields are among the reasons why farmers do not employ this practice. The use of insecticides (notably Furadan) has been reported to reduce weevil damage, however, this method is reportedly expensive, chemicals are available erratically and farmers are less keen to use them. No farmer reported any use of agro-chemicals for weevil control.

Another weevil control method is a mixture of cattle urine, tobacco, ash and local herbs (*Targetes minuta* and *Vernonia amygdalina*), which is applied around the banana stool. *Targetes minuta* can be used as a repellent, though it is also recommended as a fallow crop to eradicate nematodes (Mbwana and Rukazambuga, 1998). During the present study, none of the farmers were found to be using this mixture for the control of weevils.

Banana Xanthomonas Wilt (BXW)

Banana Xanthomonas Wilt (BXW), caused by the bacterium *Xanthomonas campestris* pv. Musacearum, is considered the most serious threat ever faced by banana growers in tropical regions. Until 2001, BXW had only been reported in Ethiopia, where it attacked both *Musa* (banana and plantains) and *Ensete* sp. (Karamura, 2006). In September 2001 an outbreak of BXW was reported in Uganda and in early 2004 the disease was spotted in the eastern part of the Democratic Republic of Congo. The disease was first recorded in Tanzania in January 2006 in Kabale village, Muleba District, however, the situation has since changed significantly and within one year it has spread to most parts of Kagera Region (see Figure 2.3).

Whether the disease hit this region in 2006 or before, is hard to tell. Anecdotal evidence from the village purported to be the first one to be attacked by the disease shows however that the disease actually went unnoticed by the authorities for some months (see Box 2.1).

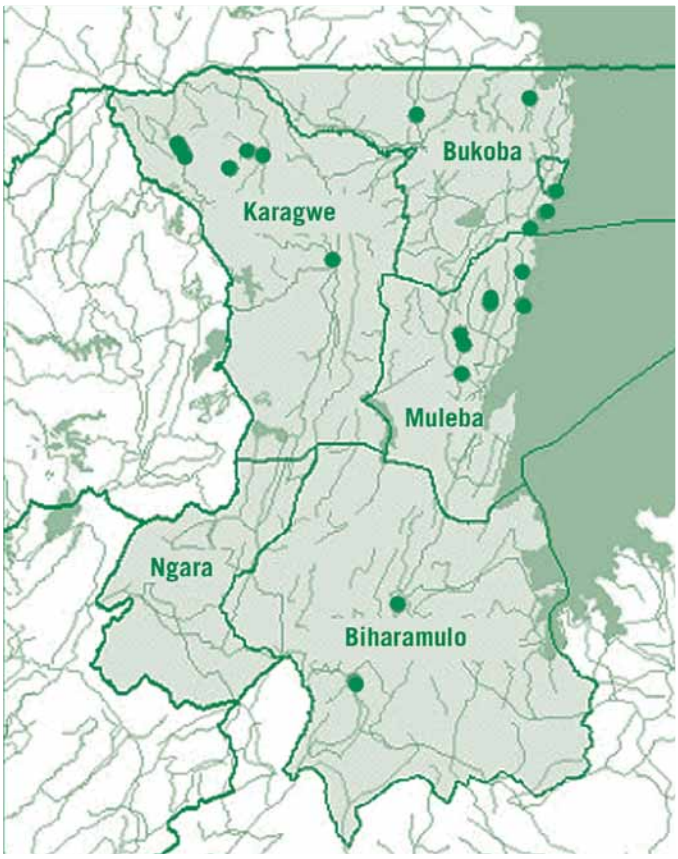

Figure 2.3 Distribution and spread of BXW in Kagera Region as of March 2007

communication between villages and government at district level are not functioning very well. We will come back to this point later. Second, human resources in terms of government extension workers are scarce and thinly spread, which means that there is little contact between farmers and extensions workers as well as between extension workers and their principals at district level. As highlighted elsewhere in this report, this capacity problem is contributing to the endemicity of this and a variety of other diseases.

The speedy spread of Banana Xanthomonas wilt in the study area has been remarkable. As shown in Table 2.2, the disease had affected virtually all the districts in the region.

This kind of account was repeatedly mentioned by respondents in respect to this and other diseases. The long time lag between what the farmers say was the first outbreak and the official date of the outbreak given by government, reveals something to worry about in disease prevention and control. First, it seems that the lines of

Box 2.1
Experience of one of the first farmers to be hit by BXW

One day during the month of August 2005 my daughter reported a ripe bunch of bananas in the plantation. Surprisingly the reported bunch appeared mature just two months after it had flowered, which is abnormal. In any case we harvested the bunch but found that the fingers were hard and blackish inside and emitted a very strong odour. We did not understand what kind of disease had caused this problem, but thought that possibly Cassava Mosaic Disease had now started to affect Bananas. By September the disease had spread to about 20 other mats on the plantation.

I decided to report the disease to the village Government, but the village chairman asked me to report it to extension staff. At that time there was no extension staff available as the officer responsible for our Ward had gone to Mwanza for further studies. Fortunately, extension staff from an NGO (KADETFU) was visiting our village and I gave the officer the report, which was then taken to the District Office.

In mid December 2005 I was visited by extension officers from the district headquarters who told me that the disease was Banana Xanthomonas Wilt.

It was not until 26 January 2006 when I was visited by group consisting of the District Commissioner, District extension officers and researchers, who ordered that we uproot the whole banana plantation. By then more than three-quarters of my plantation had been affected and the disease could be seen in neighbouring plantations.

Table 2.2 Extent of spread of BXW in Kagera Region as of March 2007

District	Ward	Village	Date of record	Total banana corms affected
Muleba	Magata	Magata	March 2006	1091
		Katanga	March 2006	3
	Kibanga	Bumiro	January 2006	19,621
		Kibanga	March 2006	13,960
	Izigo	Izigo	January 2006	5,108
		Kabale	January 2006	3,832
	Kagoma	Nsisha	February 2006	34
	Kashasha	Rwagati	May 2006	199
		Ihangiro	May 2006	138
		Rubya	May 2006	236
	Mububda	Nyakashenyi	March 2006	56
	Kyebitembe	Kagasha	March 2006	31
Bukoba	Maruku	Maruku	February 2006	58
	Kanyangereko	Bulinda	February 2006	20
		Butahyaibega	December 2006	8
	Izimbya	Mugajwale	January 2007	67
Missenyi	Kanyigo	Byeyunge	September 2006	134
	Nsunga	Ngando	January 2007	56
		Byamutemba	January 2007	43
Karagwe	Isingiro	Ishaka	April 2006	5
		Ibale	April 2006	23
	Kaisho	Nyabishenge	April 2006	1
		Rutunguru	June 2006	16
	Kamuli	Kitwe	April 2006	60
		Nyakatuntu	November 2006	12
	Bugene	Bugene	May 2006	15
Biharamulo	Lusahunga	Lusahunga	April 2006	120
		Nyarubungo	May 2006	183

In the study area, BXW is locally called "*the cholera of bananas*" due to the speed with which it spreads and kills infected plants. In these aspects, BXW resembles human cholera, the farmers noted. BXW kill banana plants through a systemic attack of the entire plant (leaves, stem, corm and root) leading to sudden wilting of the plant (see Plate 3a). Leaves turn yellow, wilt and slowly droop. The vascular system of the plant is severely damaged. The bracts of the male bud begin to wilt and rot but they remain attached to the plant. Corms of affected plants may survive long for the new suckers emerge to emerge but although the suckers may initially appear healthy they usually become infected by the mother plant, rarely surviving until the flowering stage (Plate 3b).

Plate 3a Plate 3b

Near complete loss of crop due to BXW (Plate 3a) and typical symptoms on a young banana plant (Plate 3b). Courtesy: G. Rugalema

During interviews it was revealed that the majority of farmers in communities hitherto not affected by BXW have little or no information about the disease despite an intensive multimedia campaign mounted by the government since the outbreak of the diseases. Farmers in communities affected by BXW mentioned that the disease originated from Uganda, though they did not know how it reached their area. Again, the foreign origin of a disease was alluded to. Although various possible mechanisms for the spread of the disease were mentioned, it is obvious that quite a lot of farmers have no clear idea about the disease. One development worth a mention is that following the outbreak of BXW in the Democratic Republic of Congo, Uganda, Rwanda and Ethiopia, a regional strategy to control the disease has been developed (Karamura et al. 2006). The strategy is coordinated by the Banana Research Network for East and Southern Africa (BARNESA). The strategy envisage the involvement of international, regional, national and local level actors to develop, implement and coordinate research and extension interventions to support in the prevention and control of BXW. Whether the strategy has been operationalised and to what extent it has been successful was beyond the objectives of this study. However, it is an issue that deserves attention because the success or failure of BXW strategy might determine the fate of millions of households dependent on banana.

At district level measures for control of BXW have included mainly sensitization and awareness campaigns and the imposition of quarantine measures (i.e. prohibiting the import of banana fruits and planting materials from affected areas). However, observations by the research team reveal movement of banana bunches and other related materials between villages and districts was going on undeterred by the quarantine. When we asked farmers why this is the case, the most frequently cited reason were that they needed to bring bananas to the market in order to generate income from sales of banana. Not surprising, the price of banana went up during this period thus enticing farmers to break the quarantine. In any case, the enforcement of the quarantine by the authorities was, if anything, very weak.

At the farm level recommended methods for the control of BXW include uprooting of affected banana mats and burying or burning them; removing male buds to mi-

nimise the spread of the disease by insects and birds; and heat treatment or use of chemicals to disinfect farm tools. Also, farmers are advised not to use planting materials from infected farms. In BXW affected villages, special task forces have been established in order to mobilise communities to assist in uprooting infected bananas, especially for households with labour shortages. It was noted, however, that despite all these efforts recommended measures are not always fully followed. As depicted in Plate 4, our research team saw a number of piles of dead banana plants on which young suckers were sprouting. A closer look at these suckers indicated that they are themselves diseased. This certainly is part of the cycle through which the disease is sustained in the banana ecosystem. The reliance on labour intensive disease control method, though inevitable, but must be carefully assessed given that no all household can marshal the required labour to uproot diseased plants. As already mentioned the situation might be complicate among households whose labour have been either been affected by diseases such as AIDS (a major cause of mortality in the study area), migration and ageing. In some households all of these factors may be at play resulting into severe labour shortages for productive activities. This discussion shows that shortage of labour, regardless of the cause, increases vulnerability to crop diseases not only among households with labour shortages but also for the rest of the households in the community.

Plate 4 Pile of uprooted BXW affected bananas (note the emerging seedlings which are themselves infected)

Effects of Banana Pests and Diseases on Livelihoods in the Study Area

The preceding discussion has shown the extent of the burden of banana diseases and pests. Needless to say, the burden is very high. The question is: how is the high prevalence of banana pests and diseases affecting the communities in the study areas? This section attempts to answer that question. We show that as a result of pests and diseases and therefore reduced crop yields, food insecurity and malnutrition are on the increase and so is the loss of income from banana. Loss of biodiversity is highlighted and results from cultivars being exterminated by pests and diseases. Pest and disease related crop failures do not only affect yields and income but they also affect soil quality. Death of plants exposes soils to weather elements resulting into soil degradation (hardening, erosion) and consequently forcing farmers to expand of farming into fragile lands (Baijukya, 2004).

Although by the time of this study BXW had affected only a small proportion of banana growers in Kagera Region, it has shown to be a severe disease resulting into loss of entire banana plantations. The disease was first seen in Kagera in mid-2006 and it had caused a loss of about 80 000 banana mats by March 2007. This is equivalent to 80 hectares of banana or loss of bunches worth about US$ 4 million in one year alone.

Besides BXW which is rather recent, banana fusarium wilt (BFW) is now almost endemic in the region. In the high rainfall zone the disease is most widely known for damage it causes to the banana cultivar Gros Michel. Prior to the 1990s, the banana export trade in the area was based almost entirely on the susceptible cultivar Gros Michel. According to one expert opinion, it is roughly estimated that in Bukoba District alone, 6 000 mats (equivalent to six hectares) of this cultivar have been lost each year since 1985 (Mgenzi, personal communication). These mats could produce at least 18 000 bunches per year, worth about US$8 per bunch. Thus estimated direct losses due to the impact of BFW on Gros Michel over the past one year amounts to about US$144,000. This yield loss is an estimate for only one variety of bananas. The disease attacks many varieties and the effect is not confine in Bukoba district. Unfortunately, nobody has analysed the economic cost of crop disease on staple crops such as banana. In any case, a loss of $144,000/year from one disease is significant and when added to the loss emanating from other diseases it becomes obvious that the economic cost is even higher.

In the medium and low rainfall zones BFW is most widely known for the damage it causes to the *Kisubi* and *Kanana* banana cultivars. These are imported cultivars and are used in brewing. In most villages of these zones, these banana varieties have nearly become extinct, subsequently reducing the volume of local brew produced and the income generated from its sale. Some studies (Nkuba *et al.,* 2002) have highlighted similar findings, particularly for women farmers who are largely involved in brewing activities. A lack of effective BFW control measures could result in the extinction of susceptible banana varieties and subsequently reduce banana diversity. By the mid-1990s the banana export trade in Bukoba District was forced to resort to the resistant cultivars of FHIA 17 and FHIA 21 (Nkuba *et al.,* 2002). These resistant cultivars continue to perform well in most parts of Kagera Region and remain the clones upon which the trade of dessert bananas from Kagera Region is now based.

Although all farmers interviewed during the survey mentioned that weevil damage decreases their banana yield, it was difficult for them to estimate the extent of the loss, largely due to the complex nature of weevil damage to the banana plant. During focus group discussions in Kaagya, Kanyigo and Izigo Wards, farmers claimed that weevils cause reductions in bunch size. Some plants also die prematurely before becoming a bunch. Similarly, experts have been unable to establish yield loss resulting from banana weevils in Kagera Region and elsewhere in East Africa. Yield reductions of up to 50 percent were estimated by Walker *et al.* (1984), although it is known that for some cultivars weevil damage could lead to up to 70 percent yield loss. In Kaagya and Kanyigo Wards, farmers attributed the continuing disappearance of indigenous banana cultivars (African highland bananas-AAA) to weevil damage, an observation supported by several expert studies (e.g. Mbwana and Rukazambuga, 1998). The disappearance of cultivars leads to a reduction of cultivar types.

One of the responses to the continued onslaught of banana diseases and pests is the dependency on cassava. The next section discusses problems facing the cassava crop.

2.3 DISEASES AND PESTS OF CASSAVA

Cassava (*Manihot esculenta*) is grown in all districts of Kagera Region, though it is most depended upon in the low rainfall zone where soil moisture constrains the production of banana and cereals (Baijukya and Folmer, 1999). This crop has gained importance due to the continued decline in banana production, in addition to the fact that it has a relatively good ability to tolerate drought and significant yields are realized even when grown in marginal soils, which occurs in most parts of the region. Cassava is expected to become even more important as human populations in this part of the world and pressure on land continue to increase. Available data indicates that land under cassava production in the study area increased from less than 20 000 ha in the 1980s to over 40 000 ha in 2002 (Bureau of Statistics, 2006). However, cassava production in Kagera is said to be declining, from 15 metric tonnes per hectare in the1980s to less than 6 tonnes per hectare in 2005, largely attributable to the deleterious effects of pests and diseases (Sato and Ndyetabula, 2006).

Cassava Mosaic Disease (CMD)

In the study area, Cassava Mosaic Disease (CMD) is considered to be the most important disease of cassava and responsible for decreasing cassava yields. Although the research team identified other cassava diseases, such as cassava bacterial blight, our respondents emphasized that the most serious problem is CMD, which is virtually a problem in all farm holdings that grow cassava. As shown in figure 2.4, CMD is pretty widespread throughout the three agro-ecological zones with the low rainfall zones having a slightly higher prevalence.

Cassava Mosaic Disease was first reported in the Usambara Mountains of Tanzania more than a century ago (Warburg, 1894), however, it was not a production limiting problem until the late 1980s when for the first time it was reported as an epidemic in Uganda (Thresh and Otim-Nape, 1994). The epidemic eventually spread into north-

western Tanzania in 1998. The first cases of CMD were recorded at Kyaka, on the Tanzania-Uganda border. By 2005, the disease had spread all over Kagera Region (Sato and Ndyetabula, 2006).

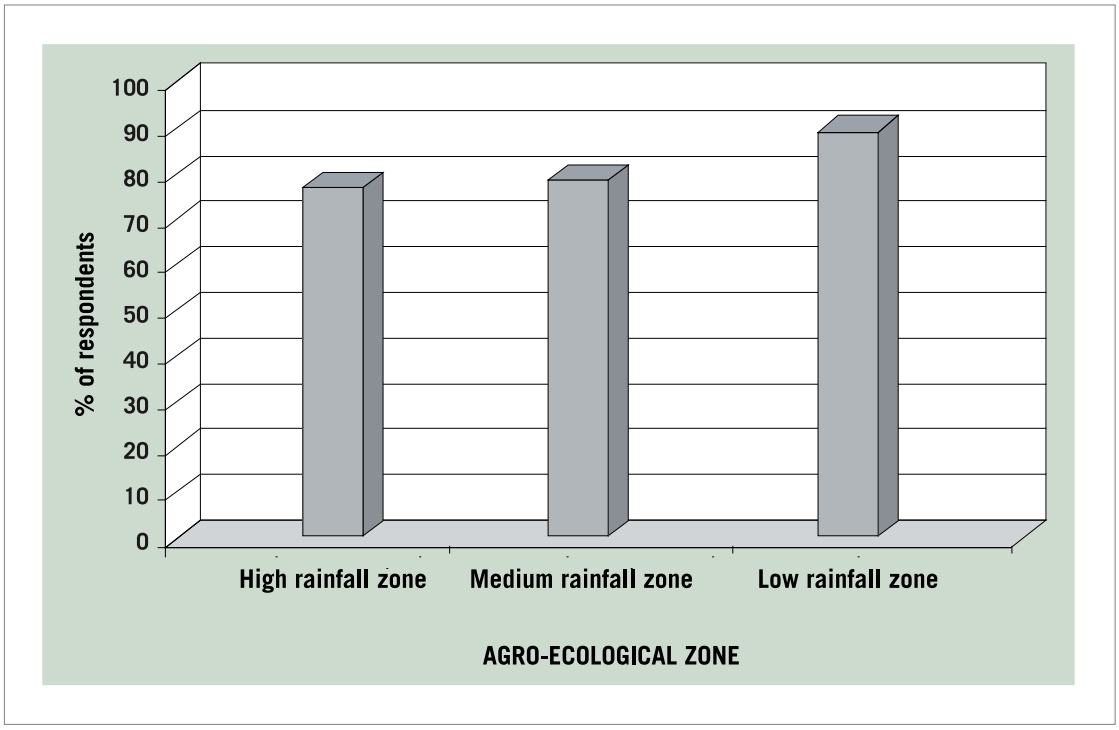

Figure 2.4 Importance of CMD in different agro-ecological zones of Kagera Region

Cassava Mosaic Disease is not a simple disease but rather a syndrome consisting of a number of viral recombinants with varying severity, as shown in table 2.3.

Table 2.3 Recombinants and Severity of CMD

Recombinant	*Severity*
ACMV	+
EACMV	+
EACMV-Ug	++
EACMV-Ug + ACMV	++++

Source: *FAO, 2006*

Cassava Mosaic Disease is widely distributed in the Lake Victoria basin, as depicted in figure 2.5. Due to natural and anthropogenic factors, the disease is sustained and spread into new areas all the time. Respondent farmers were of the opinion that the disease is becoming endemic.

As for the origin of the disease, there were mixed perceptions among respondent farmers. As shown in figure 2.6, there is a broad spectrum of ideas regarding the origin of CMD. Communities closer to the Tanzania-Uganda border claimed that the disease originated in Uganda, although they could not specify how it spread into Tanzania. Communities further away from the border claimed that the disease originated from neighbouring districts.

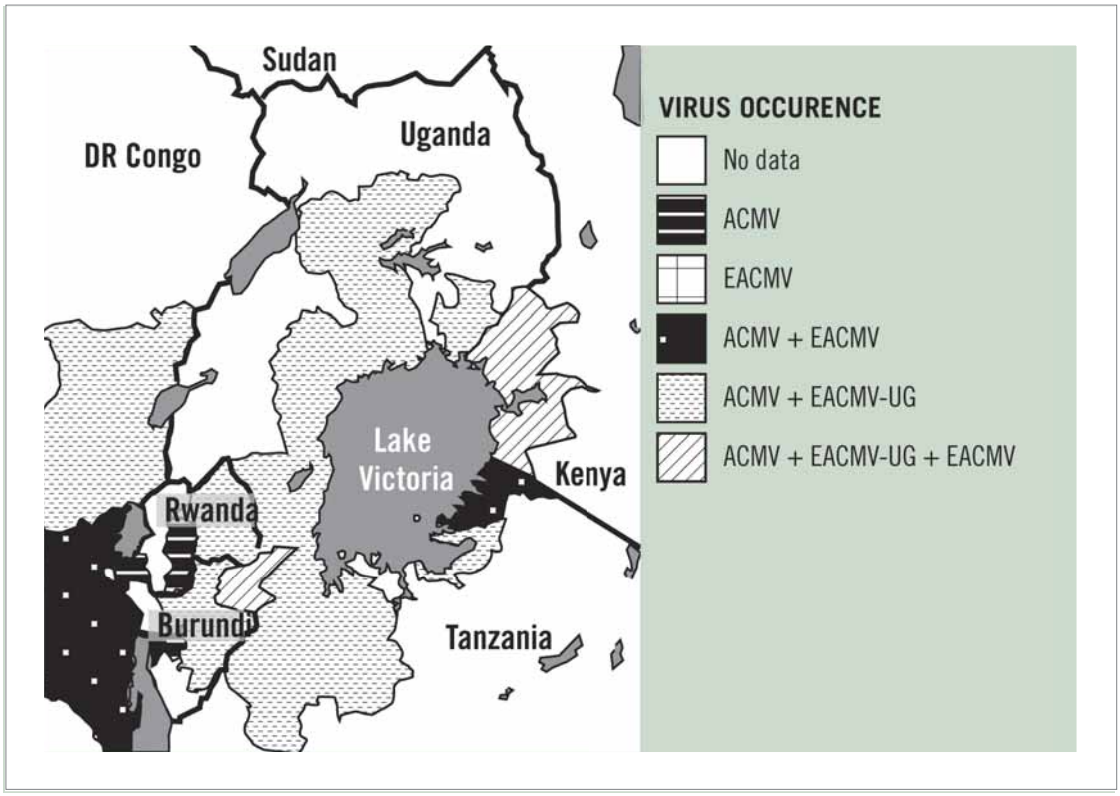

Figure 2.5 Map of CMD distribution in countries surrounding Lake Victoria (2004)

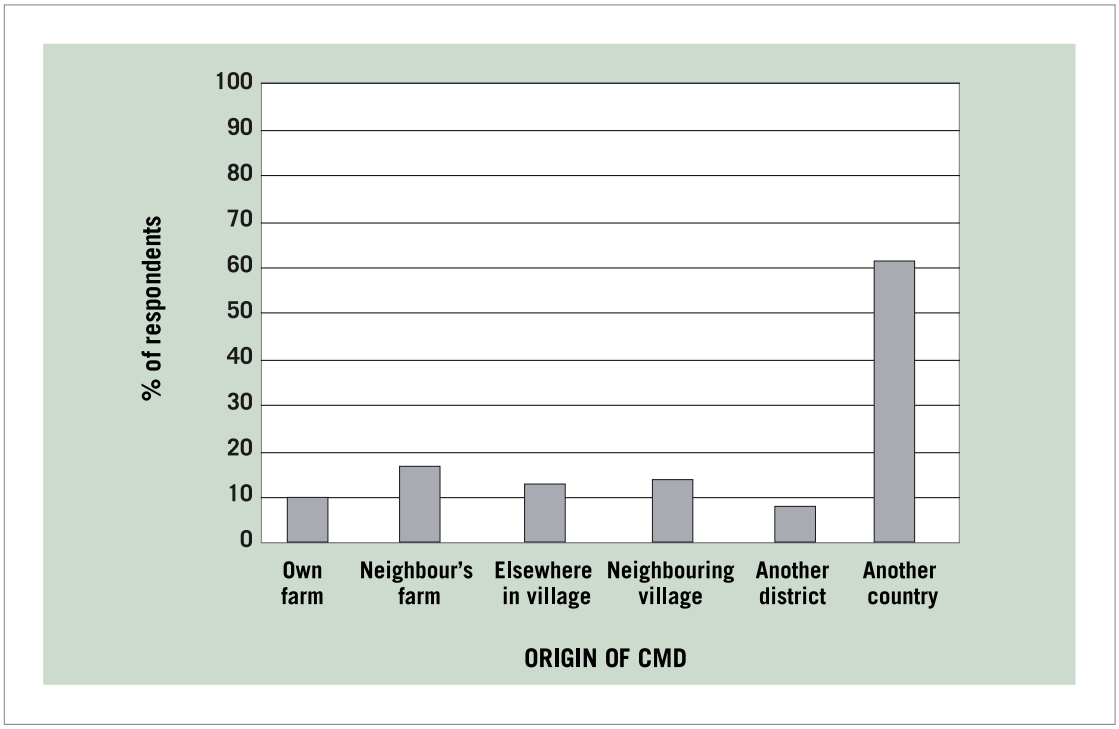

Figure 2.6 Farmers' perceptions about the origin of CMD

About 44 percent of our respondents reported to have first seen the disease on either their neighbours' farms or on farms in neighbouring villages. A small proportion (10 percent) of households, primarily in Izigo Ward, mentioned having first seen symptoms of CMD on cassava plants on their own farms. These were typically young farmers who had inherited farms that were already infested with CMD.

Effects of CMD on yields

Cassava Mosaic Disease leads to declines in yields and some affected cassava plants may yield nothing at all. Reduction can range from 10 to 100 percent. If heavy infestation occurs before tuber formation, the loss is always high – over 80 percent. If infestation occurs after tuber formation, the yield reduction is typically low – below 50 percent (for comparison see plate 5a and 5b).

Since excess production is always marketed, decline in yields leads to a loss of income for affected farmers. Reduced yields also result in food instability. Cassava's value has always been in its dependability as it yields well in poor soils and can stay in the soil for a long time. CMD, however, is changing this situation and the value of cassava in food stability is diminishing. Poor taste is also an effect of CMD as affected plants have "bad" tasting tubers.

Plate 5a Plate 5b

Healthy cassava plant and plant affected by cassava mosaic disease (CMV-UgV-variant)

2.4 DISEASES AND PESTS OF COFFEE

Coffee is the principal cash crop in Kagera Region. This region is the second largest coffee producer in Tanzania after Mbeya Region (Bureau of statistics, 2006). Coffee provides an important source of income for over 94 000 households. However, coffee farmers are currently dealing with multiple production constraints. These constraints include pests and diseases, in addition to quality problems due to poor processing and markets, which all lead to higher production costs and/or lower coffee prices. Recently the coffee industry in the region has also been challenged by the increased spread of Coffee Wilt Disease (CWD).

Coffee Wilt Disease (CWD)

Coffee Wilt Disease (CWD), also referred to as *Tracheomycosis* or vascular wilt disease, is caused by the fungus *Fusarium xylarioides.* This disease was first observed in 1927 in Central African Republic on *Coffea excelsa* and the pathogen was later identified in the Democratic Republic of Congo (DRC, formerly Zaire) in 1948 (Kranz and Mogk, 1973). The disease has since arisen sporadically in various parts of Africa, attacking *Coffea excelsa* in Cameroon, *Coffea canephora* (Robusta coffee) in Ivory Coast as well as *Coffea arabica* (Arabic coffee) in Ethiopia (Adugna *et al.*, 2005). In the last decade the disease has become more virulent, sweeping across the Congo into Uganda and on to Rwanda and Tanzania, notably in Kagera Region.

In Tanzania, CWD was first recorded in 1997 in Kagera Region, particularly in Minziro Ward and later in the same year in Kanyigo and Bugabo Wards (Kaiza and Steenhuijsen Piters, 1997). All these wards are on the Tanzania-Uganda border. The disease has since spread to Bukoba, Muleba, Missenyi and Karagwe Districts. The most susceptible variety seems to be robusta coffee (*Coffea canephora).*

The first signs of CWD include the yellowing, folding and inward curling of leaves, which consequently dry up and turn brown in colour. The leaves eventually drop off,

Plate 6 Coffee tree affected by coffee wilt disease

leaving the infected tree completely bare and remaining branches may turn black or black/brown in colour. These symptoms, also known as 'dieback', often start on the branches on one side of the tree though rapidly spread across the whole tree.

As shown in figure 2.7, surveyed farmers had mixed notions regarding the origin and spread of CWD. Approximately 70 percent of farmers believe that CWD originated from Uganda and reached their farms through the introduction of planting materials and sacks brought by coffee traders from the neighbouring country. Others thought that the disease originated from their neighbours' farms, as that is where they first saw the symptoms, or to have come from elsewhere within their village.

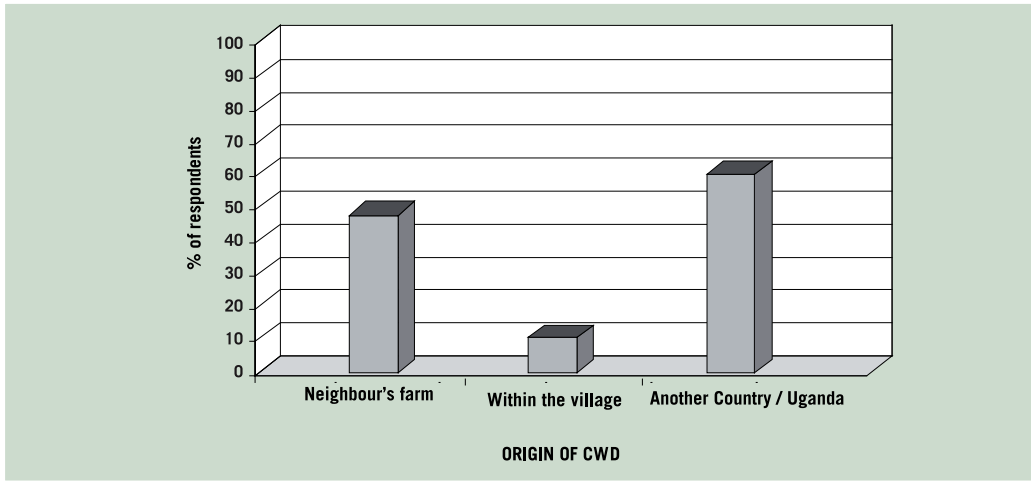

Figure 2.7 Farmer perceptions of the origin of CWD on their farms

The spread of CWD in Kagera Region has been highly varied. Available data on disease prevalence is compiled on a district basis, thus making it difficult to correlate findings to ecological factors. Figure 2.8 shows the extent of the prevalence of CMD in three of our study districts (Bukoba, Muleba and Karagwe). However, during the present study, the disease was observed to be more prevalent on coffee farms established in areas that are cleared off natural forests (e.g. in Kanyigo and Murongo Wards). Farmers mentioned that new cases of the disease appear during the dry season when there is limited moisture. Such conditions are favourable for the fungus *Fusarium xylarioides* growth and reproduction (Adugna *et al*., 2005). Within the same area the destruction of plants by the disease was also noted to differ between farms. More severe infestation was observed on well tended farms, indicating that the pathogens may have been spread during farm operations and probably through contaminated tools.

CWD continues to spread despite control measures instituted by the Government of Tanzania, of which quarantine is the most important. It was stated during focus group discussions that movement of coffee from Kanyigo, Nsunga and Murongo Wards to neighbouring Uganda is going on unabated despite the fact that these wards are under CWD quarantine. Coffee is smuggled into Uganda by middlemen who move from house to house, village to village collecting coffee. The quarantines are not observed and its enforcement is almost non-existent.

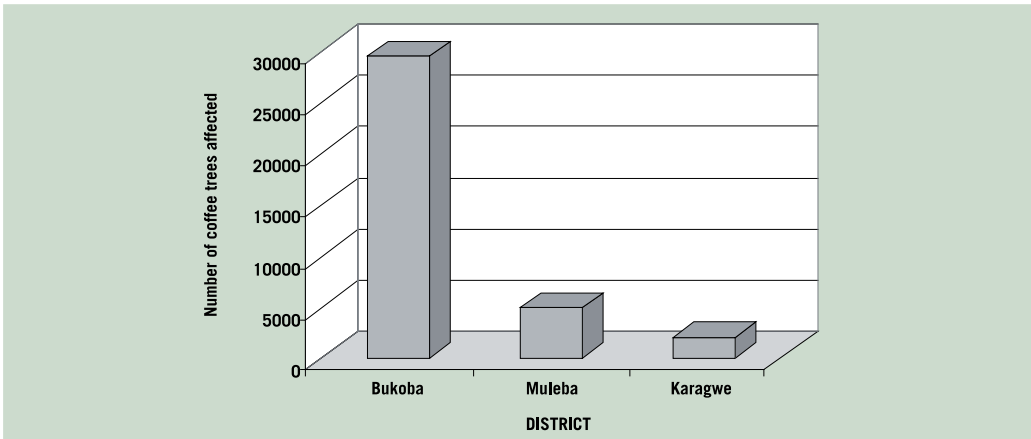

Figure 2.8 Magnitude of CWD in affected districts of Kagera Region (Maliyatabu, 2006)

At the household level, knowledge about the control of CWD was limited to households that have experienced the diseases because they have been contacted by the extension staff. Although these farmers were aware of the problem and have been educated about the control measures for CWD, only about one in ten indicated that he/she complies with recommended control measures (See figure 2.9). For example, despite expert recommendation that coffee trees that die from the disease should be uprooted and burned, they are often left standing until cut down for use as firewood. Farmers argued that it does not make sense to uproot and burn the affected trees. As of the respondents put it, "*...I cannot dare to just uproot and burn the trees... I have lost coffee, why should I also loose firewood?"*

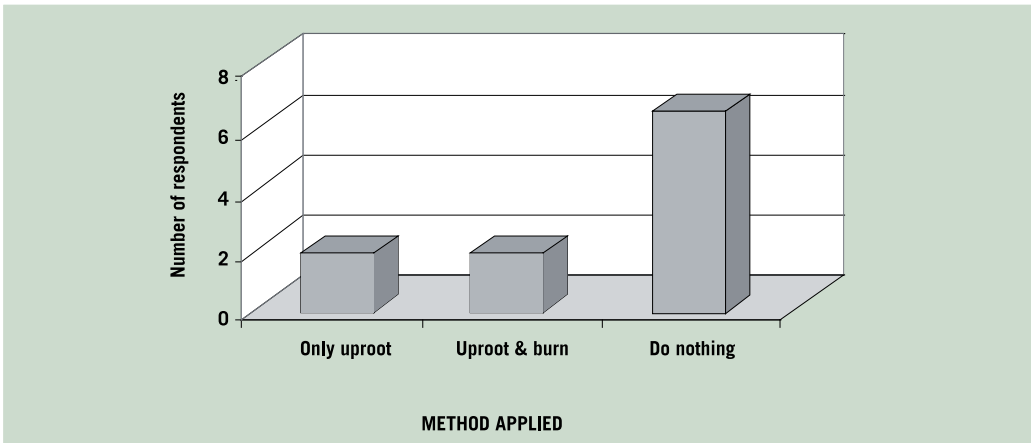

Figure 2.9 Relative application of uprooting and burning (n=8)

Farmers also argued that uprooting the diseased coffee plants is laborious and costly. The labour for uprooting one coffee tree is estimated at TSh 2000 (US$ 2). Few are prepared to pay this amount of money, as they put it, "*just to please extension workers and the government*". There are no reliable estimates of coffee crop losses due to CWD but the disease is very widespread in the region and it is highly destructive. One estimate by Maliyatabu (2007) indicates that about 40 000 coffee trees have been affected by CWD in the last ten years or so resulting into losses amounting to thousands of dollars.

2.5 IMPLICATIONS OF CROP PESTS AND DISEASES

The above discussion has revealed the extent to which crop diseases and pests threaten crop production and hence food security in the study area. There are several ways in which diseases and pests affect crop production but primarily their effects is through reduced yields whose knock on effects include diminished food availability, access and utilization.

Crop failures due to disease and attack also reduce households' income. Evidence shows that income loss could be significant. For example, a farmer in one of the surveyed villages, reported a loss amounting to TSh 3 million (US$ 3 000) due to severe banana fusarium wilt of Gros Michel banana crop. In another village, a farmer reported losing TSh 2 million following a Coffee Wilt Disease that killed some 6 000 of his coffee trees. These few cases show that upstream as well as downstream impacts of disease-induced crop failures is significant and may have profound consequences on the survival of poor households. Respondents clearly pointed out that loss of crops reduces households' access to other necessities. The situation is often made worse when quarantines are imposed as a tool for disease control. The unintended consequence though is that of restricted supply which leads to abrupt price increases. We believe the economic cost of crop diseases is much higher than stated here and we welcome further research on this aspect, not only for the sake of improved knowledge but more important for informing disease control policies and programmes.

It is noteworthy that effects of crop diseases are not uniformly distributed. The impacts vary across households within same agro-ecology but also across different and agro-ecologies. High rainfall zones, for example, generally face a higher incidence of crop disease (Figure 2.2.). Of critical importance though is the variation of impact across households. In the study area, subsistence crops namely banana and cassava, are typically female crops. In the face of pests and diseases, women have to work longer hours either to expand acreage or earn cash from casual labour or both. It was also revealed that women get involved in activities such as brewing and petty trade in order to earn income for family and personal use. It was often pointed out during the interviews that as a final resort, women too are migrating from rural areas into urban areas, fish landing sites, or islands of Lake Victoria because agriculture is increasingly made difficult by the onslaught of diseases on crops.

Men on the other hand are more affected by diseases that affect cash crops (e.g. coffee). Often the argument was made that the decline of coffee production in the study area has resulted in underemployment for men. Consequently men are migrating in search of work (often to fish landing sites along Lake Victoria) and getting more dependent on casual labour. These new migration sites were often referred to as "dangerous spots" in terms of high prevalence of diseases, particularly STDs.

Crop diseases have impacts beyond households. At the district level for example, resources have to be shifted from planned activities to containment of a disease outbreak. Extension workers, as well as other technical and political staff, are often mobilized and sent to affected areas. Diseases have become an emergency phenomenon. Accordingly, funds are diverted to cover these emergency expenses. Resources are needed in terms of equipment, procurement of new planting materials and procurement and distribution of relief food. For example, when BXW broke-out

in Muleba district in the course of this study, the district had to re-allocate some TSh 3.5 million from the development budget to respond to the outbreak of the disease. The impact of crop diseases also include the temporary loss of taxes and levies as crop markets are closed as a result of quarantines.

CHAPTER THREE: LIVESTOCK DISEASES

3

Livestock form an integral part of the social, cultural and economic livelihoods of people in the study area. Livestock are a source of manure for crop farming and provide nourishment in the form of meat, milk, milk products and eggs. Also, livestock are an important source of household income, which is then used to access essential goods and services such as clothes, health care, shelter and education.

This chapter analyses findings regarding the major diseases affecting livestock in the study area. It delves into the prevalence and distribution of diseases as well as effects on livelihoods as perceived by surveyed communities.

3.1 LIVESTOCK KEEPING IN KAGERA REGION

The type, number and distribution of livestock kept in Kagera Region are an outcome of ecological and cultural factors (Omolo *et al.*, 1999). Higher populations of indigenous cattle (dominated by Ankole), goats, sheep and chicken are recorded in the low rainfall zone, which is characterized by abundant pastures and favourable climatic conditions for livestock keeping. In the high and medium rainfall zones, however, much smaller herds of indigenous livestock are kept – mainly a mixture of short horn Zebu and Ankole (Roeleveld and Wella, 1994).

Throughout the study area privatization of grazing land is gathering pace and the change in land tenure is likely to have significant implications for animal husbandry practices. This situation is leading to serious conflicts between pastoralists and cultivators in some of the districts notably Muleba and Karagwe Districts, a potential threat to community stability. In the more densely populated high rainfall zone, there

Table 3.1 Percentage of households keeping livestock (by agro-ecological zone)

Type of livestock	Agro-ecological zone		
	High rainfall (n=87)	***Medium rainfall (n=53)***	***Low rainfall (n=64)***
Cattle	24.1	47.2	53.1
Goats	24.1	34.0	60.9
Sheep	1.1	13.2	14.1
Pigs	18.4	1.9	-
Chicken	24.1	18.9	46.9

is progressive fencing and pen construction, allowing rich farmers to graze their animals in confined areas. In this process, poor households are left out because of lack capital to invest in fencing and pen construction (Baijukya, 2004)[6]. As an alternative, poor farmers in this zone are turning to piggery and zero-grazed dairy goats. The more the animals are confined within the farm, the higher the interaction between them and human beings, and the higher the likelihood of cross infection particularly of zoonotic diseases and helminths. Indeed, as discussed in the subsequent sections this seems to be the case.

Table 3.1 shows the most important livestock species listed in the order of importance. As already mentioned, piggery is increasingly becoming an important enterprise particularly in pasture scarce, highly populated lake littoral zones.

3.2 MAJOR DISEASES OF LIVESTOCK

The most common livestock diseases, as identified by livestock keepers during this study, are summarized in Table 3.2. It is interesting to note that severity of different livestock diseases varies between agro-ecological zones. As for Cattle, the most important form of livestock, the frequently mentioned disease problems were: East Coast Fever, Contagious Bovine Pleuropneumonia, Foot and Mouth Disease and worms.

Table 3.2 Major livestock diseases (by type and agro-ecological zone)

Livestock type	Disease	High rainfall zone %	Medium rainfall zone %	Low rainfall zone %
Cattle	ECF	71.4	52.0	41.2
	CBPP	19.0	48.0	17.6
	Worms	52.4	28.0	47.1
	FMD	14.3	88.0	82.4
Goats	Worms	71.4	44.4	61.5
	FMD	9.5	61.1	53.9
Chicken / ducks	Worms	71.4	70.0	63.3
	Coccidiosis	9.5	10.0	30.0
	New castle	9.5	-	26.7

East Coast Fever (ECF)

East Coast Fever (ECF) is a non-contagious, febrile disease accounting for the greatest loss of cattle in Kagera Region and throughout Tanzania. Reports by the Kagera Region Veterinary Officer indicate that ECF occurs in the region in both enzootic and epizootic forms and is characterized by high mortality rates. The present study found that more than two-thirds of cattle keeps in the study area consider ECF[7] the most common and serious disease of cattle.

6 In both Tanzania and Uganda what was once communal land is now increasingly being privatised and fenced off or planted with trees to exclude trespassers and casual users. The implications of this trend to the property rights and livelihoods of the poorer sections of society (poor households which include majority of female headed households, etc) deserve both policy and research attention.

7 Locally know as *Amashuyu*

The ECF pathogen - *Theileria parva* - is transmitted by brown ear ticks (*Rhipicephalus appendiculatus).* During the survey, respondents reported that they are aware that the disease is spread by ticks, that it affects cattle of all ages and that it leads to mortality if infected animals are not treated at an early stage. Since the 1950s dipping has been almost the sole method employed for tick control in the study area. However, in the intervening years, problems of dip maintenance, availability of chemicals, lack of veterinary officers to attend the dips, etc; has led into disuse of many of the dips. For example, our study established that there are 60 dips in Bukoba District of which only six are operational. Spray races and hand spray pumps are also used but only by a few relatively rich farmers.

Livestock farmers periodically burn pastures, particularly communal grazing land to control the tick populations. Although this method kills off ticks, it does not kill those that are already on the animals and so it provides only a temporary respite. It is also a controversial method given that the Government of Tanzania is against bush burning, arguing that it is bad for the natural environment. In any case, it is obvious that effective control of ticks is necessary for the control of the disease but this will require a combination of methods rather than reliance on one method, whether based on chemicals, physical removal of ticks from animals, or burning of grass to destroy the ticks and their habitats.

Foot and Mouth Disease (FMD)

Foot and mouth disease (FMD), locally known as *ebinwanwa*, is an extremely acute and highly contagious disease affecting cloven-foot animals, including cattle, sheep, goats and pigs. The disease is endemic in most parts of East Africa (Vosloo *et al*., 2005). Farmers indicated that the disease has possibly always been there but some of the old people claimed that the first outbreaks of the disease happened in the 1940s. As shown in Table 3.2, FMD is a big problem in low and medium rainfall zones of the region. In these agro-ecological zones, more than 80% percent of respondents indicated that they have experienced FMD among their livestock primarily cattle.

The disease is primarily spread through direct contact between animals (Vosloo *et al*., 2005). Epidemiological studies have shown that transmission can also be air-borne (viral spores could be carried by wind up to 100 km) provided other optimal conditions such as humidity. Infection spread through the animal's milk and the survival of the disease in the tissue of animals slaughtered for meat have also been reported (Robertson, 1976).

Interviews with farmers revealed that most livestock keepers are aware how the disease is spread. Respondents were also very certain about the seasonal occurrence of the disease mentioning that it erupts during the dry season. Frequently, dry seasons are characterized by acute shortages of good pastures and water which make cattle keepers wander with their animals in search of water and pasture. Hundreds, if not thousands, of animals congregate in the few available green patches of land commonly around permanent sources of water. In the absence of a permanent source of water, animals are forced to drink from pools of brackish water and sometimes this

source is shared with human beings, as a source of drinking water and for bathing, washing clothes and dishes, etcetera (See Plate 7).

The other aspect mentioned by our interviews as a factor that spreads FMD is livestock markets. When animals are taken to the market, they are driven there in a large group even though the farmer's desire is to sell only a few animals. At the markets, different herds would mingle freely. Once a desired number of beasts has been sold, the rest are driven home and often they bring new diseases with them, so observed the respondents. Some of the reasons for the spread of FMD offered by our respondents, are quoted in Box 3.1.

According to the Kagera Region Veterinary Officer, FMD is controlled in the area through vaccinations and restrictions on the movement of animals. These measures, however, have not been applied at a level of intensity necessary to curtail transmission and maintain the disease. The Officer reported that less than 50 percent of the cattle in the region are vaccinated annually. During focus group discussions some cattle keepers stated that they do not vaccinate their animals against FMD because of the ineffectiveness of the vaccines used. This is a real possibility. As pointed out by Vosloo *et al.* (2005), FMD in East Africa occurs in six serotypes, namely: O, A, C and SAT types 1, 2 and 3, thus complicating the epidemiology and the effectiveness of vaccinations against FMD. An additional dimension is the livestock-wildlife interaction. In areas where game reserves are located for example; Kagera National Park, Kimisi Game Reserve, Rumanyika Game Reserve, Burigi Game Reserve, Minziro Forest Reserve and Ibanda Game Reserve, some FMD serotypes have been isolated in wild animals. In this context, there might be active recombination between the FMD viruses carried by livestock and those that are carried by wild animals.

Again, it was frequently mentioned that lack of effectiveness of vaccination measures are due to the high cost of vaccines and late or erratic vaccination regimes. Although

Plate 7 Humans and livestock sharing a watering point. Courtesy: G. Rugalema

the exact cost of vaccinating one cattle could not be established, farmers stated that they have to contribute about TSh 1,500 (US$1.50) per cattle. Cattle keepers claimed that the cost is high, particularly for owners of large herd. As a result, they hide some of the animals to avoid being vaccinated by moving the beasts across the border into Uganda or Rwanda and bringing them back after the vaccination campaign is over. One question, however, is whether the cost is really that high or whether farmers have other priorities on which to spend the money. As demonstrated by the findings of this study (see respective chapters on crops diseases and human diseases), farm households are faced with many disease problems. So in an environment characterised by the presence of many production limiting and life threatening diseases, farmers are faced with dilemma on whether to spend money on livestock health, human health or crop protection. We have offered preliminary analysis of these issues but certainly further research is needed on these real life issues.

Box 3.1
A respondent's views on the spread of FMD in the area

According to the respondents, "…the disease is spreading faster and it has become endemic in the area because of many cattle sharing communal grazing land and watering points; sharing livestock markets within districts and across the Uganda border; the use of common routes by animals in search of water and pastures; and cultural practices of our people of exchanging live animals and their products as gifts between families."

Contagious Bovine Pleuropneumonia (CBPP)

Contagious bovine pleuropneumonia (CBPP) is a contagious bacterial disease caused by *Mycoplasma mycoides* subsp. *mycoides*. It afflicts the lungs of some huffed animals such as cattle, buffalo, and yaks. Others such as sheep and goats are resistant to the disease. It is widespread in Africa and in other regions of the world, particularly in the semi-arid, sub-humid and arid zones of tropical Africa (Masiga *et al*., 1998).

According to available records, CBPP first appeared in Tanzania in 1916 and was thought to have been eradicated in 1964 (Kusiluka and Sudi, 2003). It is suspected that the disease was re-introduced into Tanzania from Kenya in the early 1990s. It first appeared in the northern region of Arusha in 1990 and it quickly spread rapidly to Mara Region, through unrestricted movements between the two regions. It was not until November 1992 that an outbreak of CBPP occurred in Kagera Region. The source of this infection is thought to be southern Uganda (Msami *et al*., 2003). In Tanzania, the affected area now stretches roughly between latitudes 1° and 9° South and longitudes 30° and 37° East. In other words, the disease has spread virtually throughout the whole country.

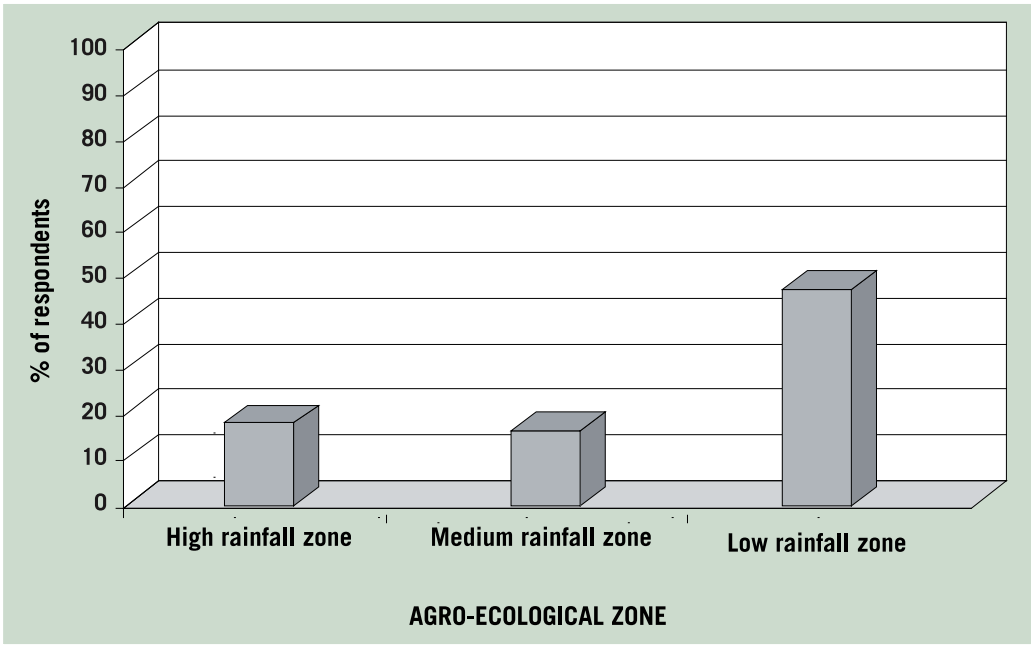

Figure 3.1 Distribution of CBPP in Kagera Region

According to the National Livestock Epidemiological Unit in Tanzania (URT, 2002), CBPP is ranked number four in terms of total cattle morbidity and number one in terms of mortality. During the present study CBPP was most frequently reported by livestock keepers in the low rainfall zones and less so in the high and medium rainfall zones (Figure 3.1). During interviews, pastoralists in the semi arid villages of Nsunga, Kihanga, Kasharunga and Murongo Wards ranked CBPP first in terms of mortality of their cattle.

CBPP is typically controlled through restrictions on cattle movements, quarantines, identification and elimination of carriers and the creation of an overall high level of immunity through intensive vaccination campaigns. Records kept by the Kagera Region Veterinary Officer indicate that the current policy in the region is to vaccinate all cattle twice a year when severe outbreaks occur and once a year thereafter. Consequently, an emergency vaccination campaign against CBPP has been implemented since 1998 (KALIDEP, 2000), and quarantines have been imposed wherever there is an outbreak. Due to the absence of readily available data on the cattle population in the region and the number of cattle vaccinated, it was difficult to conclusively assess the success of vaccination campaigns.

Data obtained from the Bukoba District Livestock Office indicate that since the year 2000, CBPP outbreaks in Kagera Region have been severe, thus requiring vaccinations to be given twice a year. An examination of the available data (Table 3.3), however, indicates an irregular frequency of vaccinations and that the number of campaigns undertaken annually is below the prescribed level.

Table 3.3 Performance and success of CBPP vaccination campaigns in Bukoba District (2000-2005)

Year	Number of cattle expected to be vaccinated	Number of cattle vaccinated	Number of vaccination campaigns per year	Success (%)
2000	29,280	-	2	-
2001	63,861	61,859	1	97
2002	65,283	62,382	1	96
2003	-	0	0	0
2004	77,655	73,083	1	94
2005	78,315	-	1	-

Source: *DALDO's Office, Bukoba*

During focus group discussions in all surveyed districts, livestock keepers mentioned having vaccinated some of their cattle against CBPP and treating clinically infected animals with antibiotics. There was no mention of any traditional control measures for CBPP. Cattle keepers claimed that antibiotics and vaccines are not very effective as some cattle have died following CBPP vaccinations. These observations were corroborated by expert opinion. Njau (2003) reported that vaccines against CBPP currently in use do not confer long-term immunity, generally lasting only 2-3 months. Discussions with District Livestock Officers revealed that the major obstacles to the eradication of CBPP in Kagera Region are difficulties in controlling cattle movements as well as in enforcing quarantines and slaughter practices. Other obstacles include lack of field testing equipment for diagnosis and the relatively short duration of post-vaccination immunity. Whether the breakdown of the immunity conferred by vaccination in a short time is due to bacterial resistance or the quality of the drugs, is a question that needs further analysis.

Intestinal Worms

Although internal helminths (worms) are strictly speaking, not diseases, but they produce disease-like conditions, they contribute to co-morbidity, and their economic consequences on livestock (prolonged illness, poor productivity, mortality) are similar to those caused by diseases such as the ones discussed above. Intestinal worms were reported as endemic and severe throughout the study districts. The issue of internal worms is therefore discussed here because respondents in the study area considered it an important problem not only for livestock but also for human health. Respondents mainly attributed the presence of worms to poor hygiene in cattle and goat pens and contaminated soil and water. During focus group discussions, most livestock farmers stated that they use local herbs to control intestinal worms. The most common herb used is *Vernonia amygdalina* (locally known as *mubilizi*). The main issue though is that the high burden of worm infestation in livestock is reflected in equally high worm infestation among humans (see chapter 4). This is a clear sign that some types of worms infest both livestock and humans, contributing to (severe) morbidity in both.

3.3 IMPACT OF LIVESTOCK DISEASES

The economic impact of livestock diseases is difficult to establish due to a lack of proper records by farmers and government authorities responsible for the livestock sector. There are nonetheless some clear indications of the impact of livestock diseases on individual livestock keepers and the Government. In 2003, for example, direct cost incurred by the Government as a result of animal mortality, vaccination campaigns and surveillance of CBPP was estimated at US$11 million (Msami *et al.*, 2003).

Data from the Bukoba District Livestock Office (Figure 3.2) indicates that between 2000 and 2005 nearly US$20 000 was spent on the CBPP vaccination programme excluding the cost of procuring vaccines. The drop in expenditure in 2003 is attributed to low budget allocations to the livestock sector, which is a recurrent problem. It is worth noting that even the funds allocated for livestock disease prevention and control are but a small part of the financial resources required to do a good job.

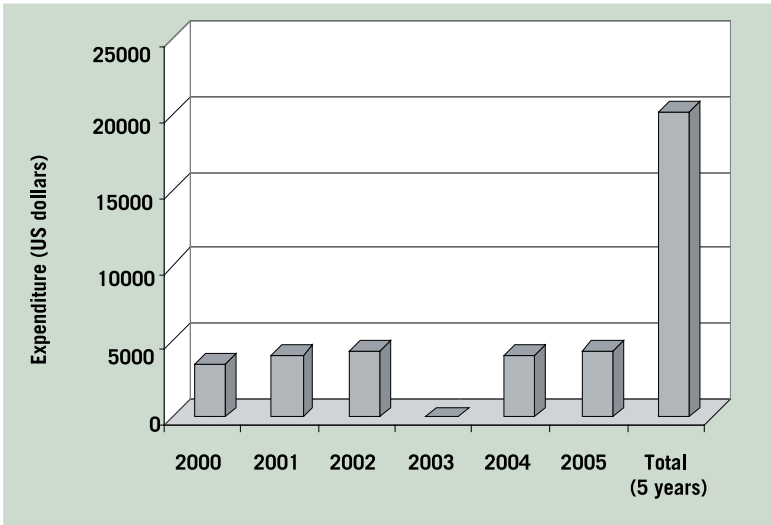

Figure 3.2
Expenditure on CBPP vaccination programme in Bukoba district excluding the actual cost of vaccines

Focus group discussions and household interviews reveal that the impacts of livestock diseases are significant. Our respondents indicate that the most important impacts of livestock diseases at the household level are reduced income (from the sale of livestock and livestock products) and a decline in the quantity of livestock. These have direct implications for food security in terms of availability and access. Many of the household-level impacts resulting from livestock diseases overlap with those of crop diseases, namely declines in income and food availability, and the subsequent effects these losses have on food and nutrition security and the ability of households to access services. In summary, the impacts of livestock diseases as perceived by farmers include:

- Loss of household income from livestock sales (i.e. sick animals cannot be sold or fetch a small price). Farmers saw this effect in terms of inability to afford health care and other services necessary for the short and long term survival of the household unit.
- Shortage of manure for use in crop production (due to death or prolonged morbidity of beasts) and hence low crop production which leads to food scarcity.
- Diversion of household income for the treatment of livestock diseases.

CHAPTER FOUR: HUMAN DISEASES

4

Human health is probably the most important determinant of labour availability and productivity. This is more so in rural areas of developing countries where agriculture productivity is almost solely dependent on human labour. Ill-health caused by infectious and non-infectious diseases among humans constitute a major stumbling block to poverty alleviation simply because they directly impact on labour availability and productivity. This chapter analyses the effects of major human diseases on food security in the study area. It discusses mechanisms of disease spread and the burden faced by rural households.

4.1 HUMAN DISEASE PREVALENCE IN KAGERA REGION

We set out to identify the most important human diseases as perceived by local people in the study area and to analyse their effects on food security. Findings show that prevalence of human diseases among the surveyed households is high as clearly indicated in Table 4.1. Malaria was identified as endemic and common and was considered the most important disease by over 96 percent of respondents. This is followed by acute respiratory infection, which in most cases is characterized by severe cough, flu and cold like conditions (locally referred to as chest ailments - *Olufuba*). Other important human diseases in the study area include intestinal worms, dysentery/typhoid, sexual transmitted infections (including AIDS), tuberculosis and measles. The main human diseases identified during household surveys to a large extent corroborate Regional disease records. The top ten disease conditions and top most diseases responsible for human deaths in Kagera Region are shown in Table 4.2. The table differentiates between diseases that are merely prevalent and those that are mostly responsible for (pre-mature) death. Notwithstanding some slight differences, the two tables are comparable. By and large, the data clearly reveals that malaria remains the most important health problem across the study area.

Table 4.1 Most important human diseases identified by respondents in the study area

Disease	Frequency	% of respondents
Malaria	196	96.1
Acute respiratory infections*	109	53.4
Intestinal worms	59	28.9
Dysentery/typhoid	28	13.7
Sexual transmitted infection (STI)	11	5.4
AIDS	9	4.4
Tuberculosis	6	2.9
Measles	2	1.0

*Includes cough, flu, asthma and pneumonia

Table 4.2 Most important human diseases (Kagera Region)

Ten most important human diseases		Ten most important diseases causing human mortality	
1	Malaria	**1**	Malaria
2	Acute respiratory infection (ARI)	**2**	HIV and AIDS
3	Diarrhoea	**3**	Tuberculosis
4	Pneumonia	**4**	Anemia
5	Anemia	**5**	Pneumonia
6	Worms	**6**	Cardiovascular diseases
7	Surgical conditions (including tumours)	**7**	Acute Respiratory Infection (ARI)
8	Urinary Tract Infection (UTI)	**8**	Pelvic diseases
9	HIV and AIDS	**9**	Diabetes
10	Pregnancy related problems	**10**	Meningitis

Source: *Tubeti, 2007.*

Malaria

Malaria is a vector-borne disease caused by protozoan species: *plasmodium falciparum* and *plasmodium vivax*. It is transmitted by female Anopheles mosquitoes. Interviews conducted during the study reveal that Malaria has been a problem for a long time. Some farmers claimed that malaria became a big problem in the early 1940s following the introduction of maize in the region. If this is the case, then the association between Malaria and maize farming needs a closer attention. Interestingly, some research (Kebede *et al.*, 2005) indicates that there is a significant relationship between the incidence of malaria and cultivation of maize. These researchers have ascribed this link to the nutrition provided to malaria-transmitting mosquitoes by the pollen of the maize crop.

Our respondents strongly argued that Malaria is an increasing problem in the study area. This is due to a favourable climate, abundance of water in river valleys and permanent vegetation cover. Also, they pointed out that deforestation in the last 30 years has meant that mosquitoes have moved from forests to nearby villages. This coupled with the decline of livestock (on which mosquitoes would preferably feed) is said to have further exposed the human population to malaria bearing mosquitoes.

Throughout the study area malaria is perceived as endemic, with the exception of the highlands of Karagwe and Muleba Districts where epidemic cases of malaria have been reported only in the past few years, attributed to prolonged rainy seasons and warmer temperatures conducive for mosquito breeding. According to Kagera Region Medical Office, the overall number of malaria cases in the region increased sharply following the El Niño rains of 1997, reaching its peak in 2004. Worryingly, malaria continues to spread in the highlands of Karagwe and Muleba Districts. Data collected in the course of our study suggest a small but steady decline in malaria cases in the region, particularly among children under the age of five. The increased use of treated mosquito bed nets is certainly the main factor behind this trend. In addition to increased use of treated bed nets, it was also revealed that pregnant women are using anti-malaria drugs more than before.

In most villages in the high and low rainfall zones, community members stated that malaria transmission occurs throughout the year though peaks occur at the end of the rainy seasons and at the beginning of the dry season (between February and March and also between June and July) and that is probably why malaria is locally known as '*endwala y'omushana'*, literally the disease that comes during the sunny (dry) season. A clear pattern of malaria seasonality is shown by the data collected from the Karagwe District Medical Office (Figure 4.1 – absolute cases reported and Figure 4.2 – as a percent of the total population of the district).

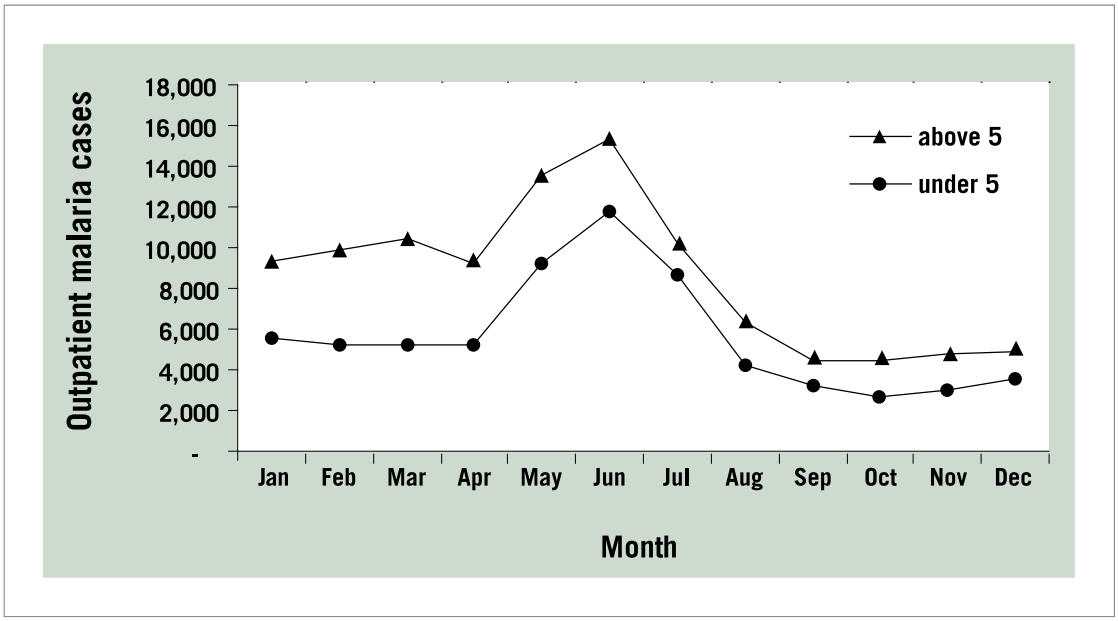

Figure 4.1 Seasonality of malaria patients under and above five years of Age, Karagwe District (2006)

Source: *Karagwe District Medical Office*

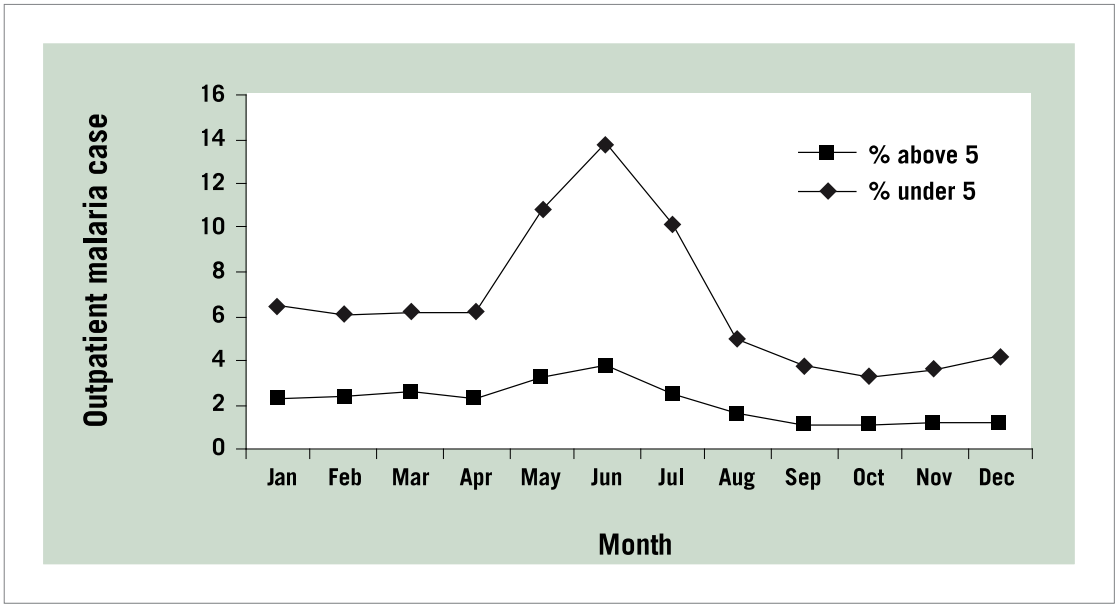

Figure 4.2 Outpatient malaria cases as % of total population in Karagwe District (2006)

Source: *Karagwe District Medical Office*

Of all the diseases, malaria continues to be the main cause of morbidity and mortality in Kagera Region, particularly in infants and children under the age of five (Tubeti, 2007). In the present study, it was found that during the five years prior to the study, 55 percent of deaths in surveyed households were reportedly due to malaria. Although records show that the number of deaths due to malaria is decreasing (Figure 4.3), our respondents feel that the number is still very high.

In discussing the impact of malaria on households, respondents emphasised that malaria's most important effect is unpredictable illnesses and loss of human life, particularly among children. Illness is seen as disruptive in terms of re-allocation of labour from productive to treatment-seeking activities. Time and income spent in seeking treatment constitute a direct loss to the household and so does the occasional death caused by the disease.

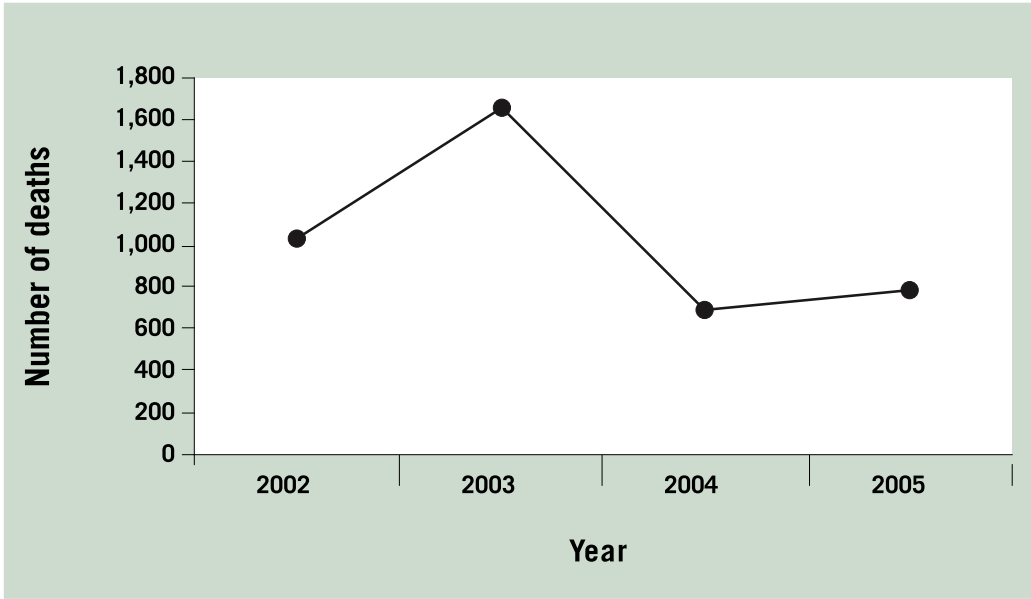

Figure 4.3 Number of deaths due to malaria, Kagera Region (2002-2005)

Source: *Tubeti, 2007*

AIDS

The first three cases of AIDS in Tanzania were identified in Bukoba District, Kagera Region in 1983, in a village on the Tanzania-Uganda border (Killewo *et al.*, 1998). By 1986, Kagera Region had 322 reported cases out of a total 404 cases in Tanzania. From 1983 to 2004 the number of registered cases in the region rose to 12 234. A recent survey (TACAIDS/NBS/ORC, 2005) has estimated a regional HIV prevalence rate 3.7 percent, showing a significant decline from the peak level of 24 percent in 1987. In most communities, the problem of AIDS was reported to be stable or declining. Morbidity and mortality have declined too.

Although the prevalence of HIV has declined over the last ten years or so, when it was at its peak, the AIDS epidemic caused a lot of illness and deaths in the study

area. Even to date it is still ranked number two among the diseases responsible for high levels of mortality (Table 4.2). Of interest is the way local communities have perceived AIDS since its outbreak. Initially, the disease was called *Juliana*, a popular textile fabric which, in the 1970s, was the most sought out textile article and was only available through cross-border smuggling between Uganda and Tanzania. Smugglers were among the first people to be affected by AIDS and so the disease was seen as an affliction of Juliana traders. As the disease spread into the general population its perception by the people as a disease of a select group of people changed too. It is now called *endwara yaitu*, meaning 'our disease' – a disease that afflicts all. It was reported during some of the focus group discussions that all types of households, both in urban and rural areas, have in one way or the other experienced the effects of HIV and AIDS. When asked about the effects of AIDS on households and other levels of society, respondents highlighted a number of effects which are listed in Table 4.3.

Table 4.3 Main impacts of AIDS as mentioned by community members

Household/Community Level	Government Level
• Losses within the labour force • Loss of household assets (including land) • Increased number of orphans • Increased community burden to care for the sick and orphans • Increased household expenditures to care for the sick • Mistrust among families	• Increased government expenditure on health care provision • Increased government burden to care for orphans

At the household level, interviews revealed that the disease creates fear, mistrust and loss of hope for the future. Moreover, due to prolonged illness associated with the disease, some households are forced to sell family assets (e.g. radios, land and livestock) in order to meet costs associated with taking care of patients. AIDS significantly contributes to a loss of skilled labour in all study districts, including teachers, nurses, doctors, extension staff and other professionals. The exact number of professionals lost per sector could not be ascertained, however, respondents indicated that a number of professionals have died due to HIV related illnesses.

Intestinal Worms

The problem of intestinal worms was consistently mentioned by villagers, health workers and medical doctors as one of the most important health problems in the region. As discussed in the previous chapter, it is also one of the major health problems of livestock. There is no doubt that worms are highly endemic in the study area and they are sustained by poor sanitary practices, particularly inappropriate use of toilet facilities as well as unprotected working with the soil and handling of livestock excreta. The high burden of worm infestation is worrisome given that these internal parasites are known for depressing immunity and recent studies indicate that high prevalence of HIV and other diseases in the study area may be explained, at least in part, by the high prevalence of these internal parasites (Stillwaggon, 2006). It would seem obvious that the control of these parasites may be key to controlling or even lessening the morbidity and mortality effects of other diseases.

4.2 GEOGRAPHICAL DIFFERENCES AND SEASONALITY OF DISEASE PREVALENCE

We have already mentioned that data from household interviews do not show major ecological differences in the reported incidence and prevalence of human diseases (Table 4.4). However, caution must be taken in interpreting this kind of data because it is based on people's perception rather than a carefully designed epidemiological study. What one can safely say, therefore, is that these diseases are widely distributed across the study area with some notable variations in the distribution of some of the diseases. However, data obtained from the Regional Medical Office of Health and other available evidence (Yanda *et al*., 2005) indicate that some Wards, for example Nshamba (Muleba District) and Bushangaro (Karagwe District), have higher than average prevalence of Malaria and are ecologically considered as "hotspots" for the disease.

Table 4.4 Major human diseases in the last five years by agro-ecological zone (% of responding households)

Disease	Agro-Ecological Zone		
	High rainfall (n=87)	***Medium rainfall (n=53)***	***Low rainfall (n=64)***
Malaria	97.7	96.2	93.8
ARI	51.7	60.4	50.0
Intestinal worms	32.2	28.3	25.0
Dysentery	17.2	15.1	14.1
AIDS	4.3	2.4	2.3
STI	9.2	-	4.7
Measles	1.1	1.9	-

STI=Sexual Transmitted Infection; ARI=Acute Respiratory Infection

Diseases such as malaria, dysentery, typhoid and acute respiratory infections are seasonal but many others occur throughout the year. For example, malaria cases were reported to occur at the end of the rainy seasons (in the months of January and February and then June and July). According to the Muleba District Medical Officer of Health, these months tend to be warm and humid, creating an environment conducive for mosquito breeding. Dysentery and typhoid cases are higher during the dry season when most households do not have access to clean and safe water. Acute respiratory infections occur during the rainy season when the air is cooler and damp.

4.3 HOUSEHOLD IMPACTS OF HUMAN DISEASES

As discussed at the beginning of this chapter, agricultural production in the study area is primarily dependent on human labour. Likewise, human labour is largely determined by human health. Our study revealed that agricultural production is affected by human diseases, which inhibit labour availability and output. This has knock-on-effects on food security, mainly in terms of access and availability.

Diseases lead to illness and death within households. Study findings show that in the face of human illness, labour is re-distributed from productive activities towards disease prevention and treatment, as well as caretaking responsibilities. The latter involves the responsibility of caring for both those who are sick and children who have been orphaned. In some case there is a complete loss of labour as disease leads to death. Time and income spent on these activities has impacts on food security as households have less income to access food and less labour to produce it.

Other household impacts of human diseases relate to the economic burden as households may have to sell assets to meet medical expenses and are faced with funeral related expenses for family members. In addition to these economic costs, households also face added pressure on their already scarce household resources. People who are ill may have particular or enhanced food and nutrition requirements. Also, as a result of disease, there is an increase in the number of dependents in households, particularly orphans. These factors have the propensity to increase a household's poverty level and enhance food insecurity.

The study also revealed that human diseases interact with each other in such a way that increases the morbidity and mortality effects of diseases. Crop and livestock diseases also indirectly interact with human health (for the latter, also directly – e.g. zoonoses and intestinal worms). This is particularly an issue in terms of reduced food production as a result of crop and livestock diseases, which affects household food availability and has serious implications for people who are ill and have increased food and nutritional requirements.

CHAPTER FIVE: EXPLAINING THE HIGH BURDEN OF DISEASE

5

The present study was undertaken to examine the human, crop and livestock diseases in the Tanzania-Uganda interface ecosystem to the West of Lake Victoria. We set out to identify diseases prevalent in this area and to investigate the mechanisms for their spread and sustenance. The overall aim of this study was to assess the socio-economic burden of diseases that attack crops, livestock and people. Of particular interest was the combined impact of these diseases on food security and livelihoods. This chapter looks at some of the key factors that contribute to the high burden of disease in the study area. Key to understanding the effects of diseases on society is to examine the factors that (a) lead to a disease or pest's arrival in a new environment; (b) help a disease/pest to establish itself; (c) help in the spread of the disease or pest in the (new) environment; and (d) institutional capacity to prevent and control diseases. Much of the discussion in this chapter dwells on factors related to items a-d above.

5.1 DRIVERS OF PESTS AND DISEASES

The Social and Physical Architecture of the Local Farming System(s)

By and large, the productivity and sustenance of the local farming systems is built on the interdependence between humans, livestock, crop plants and rangelands. The central element in this web of interrelationships is the human being who has to harness the system for his/her livelihood. Looked at this way, it is possible to point out some salient factors that make it possible for diseases and pests to establish themselves and spread in the environment. Such factors include: (i) the physical architecture of the farming system; (ii) the constant interaction between human beings and livestock; and (iii) the role played by both livestock and crops in maintaining networks of mutual insurance and traditional social support.

In terms of the physical architecture of the farming system, particularly in the high and medium rainfall zones, farm holdings are characterised by a variety of crop plants as well as other useful plants in a single, if tiny plot of land. According to our respondents, having many plants ensures that plant diseases and pests have many alternative hosts, thus making their eradication difficult. It was also pointed out that the *Kibanja* micro-climate (humid, shady, constant temperature) provides a good environment for microbes and insects (such as mosquitoes) to thrive. For example, the use of banana leaves as mulching material is said to help in the breeding of mosquitoes because the leaves trap small water pools which if not drained become breeding sites. Also, the use of grass from the *rweya* for mulching the *kibanja* ensures that wild bugs are brought into the *kibanja* and certainly closer to the human population.

We have already alluded to the social value attached to livestock (particularly cattle) in the study area. One manifestation of this is the close physical proximity between

humans and livestock. During the study, it was observed that small livestock such as chicken often share sleeping quarters with human beings. Although cattle have separate housing, the distance between the human house and cattle pen is really very small. In any case, cattle keepers interact with their livestock on a daily basis during chores related to milking, removal of manure from the kraal, and herding. In this study the close proximity between humans and livestock was linked to the spread of worms between humans and livestock. Worms, however, are but one of the problems that result from human-livestock interaction. Other studies have concluded that the close proximity between humans and livestock is one of the major drivers of zoonotic emerging infectious diseases (WHO, 2006).

Crops and livestock play an important role in the human life cycle in the study area. Not only do they provide food – a source of nourishment – but they are also used in rituals and in cementing relationships. This social role spans all important phases of the human life cycle – birth, marriage, death. For example, it was pointed out that the exchange of livestock and crops at events such as weddings contribute to the unregulated movement of these items and it is in some way responsible for the spread of diseases and pests. The fact that there are many types of social events that require the exchange of gifts – in terms of plants, harvested crops, livestock or livestock products – makes it possible for diseases to be unwittingly introduced and spread within and between communities.

Population Movement

Another key factor linked by our respondents to the spread of diseases and pests in the study area is population mobility. The Lake Victoria basin is known for the intensive movement of people within and between different agro-ecological zones, and across national borders[8]. In the period between 1940 and 1970, population movements in the study area were driven by the search for employment as well as for new land for farming. The latter case was probably the most dominant and it is still evident today. Many such migrants bring their livestock and planting materials to the new areas. It is not surprising that the geographical spread of banana production has been matched by the outbreaks of banana diseases and pests in the newly settled areas (Bosch *et al.,* 1996). As described in the chapter on human diseases, trade-induced movements have been linked to the spread of AIDS. Given that traders export and import many crop and animals products, other diseases too may have spread by trade only that the links remain obscure. Anecdotal evidence from a Tanzanian village that was the first to be hit by Banana bacterial wilt, suggest that its introduction from Uganda is trade related. As transport infrastructure become better and modern (exemplified by the newly constructed Kampala - Bukoba highway). Fast movement of people and other good through surface and water transport would require a robust disease control system. As experience from South East Asia has shown, infrastructure development, particularly roads, can facilitate spread of pest and diseases (Kenmore et al, 2005).

Between the 1970s and the 1990s, the area experienced intense armed conflicts in countries such as Uganda, Rwanda, Burundi and Zaire (now the Democratic Republic of Congo). These conflicts led to millions of internally displaced persons and

8 For a thorough review of literature on this area of study see Bosch et al., 1989.

refugees. Many such people moved with their livestock or a few seeds for planting. Many other such objects were introduced as part of the emergency relief. Opinion gathered during the study pointed to the fact that massive population movement due to armed conflicts could be responsible, at least in part, for intensification of some of the disease and pest problems.

Other significant forms of population movement which are said to contribute to the spread of diseases relate to the fisheries sector and pastoralism. Fisherfolk are mostly itinerant, moving from one fish landing site to another and carrying with them crops and animals either for food or for trade. Pastoralists mainly move within and across country borders in search of pastures and water, but also, as already pointed out, running away from conflicts and avoiding quarantine or other disease control measures, such as vaccines. The resultant movement of crops and livestock (and their products) contribute to the spread of disease in these new areas.

Livelihood insecurity, for which the high disease burden discussed in this report is partly responsible, has led to new forces of migration. People are migrating from villages to fish landing sites, border towns, and hitherto scantly inhabited islands in Lake Victoria in search of alternative livelihood options. Not only does this form of migration contribute to the spread of disease in newly settled areas, but people who have migrated are also vulnerable to new diseases. These areas have increasingly become disease "hotspots" (particularly for cholera, malaria, HIV, STIs and skin diseases), largely attributable to intense interactions of people brought about by economic activities carried out to supplement the shrinking agricultural economy.

Plate 8 A fish landing site – Lake Victoria shore

5.2 WEAK INSTITUTIONAL CAPACITY

The current study revealed clear gaps in disease management systems in the study area. This is characterized by weak capacity to identify, diagnose, monitor, report and respond to diseases affecting crops, livestock and humans, as well as the absence of field testing technology. The main underlying causes of these shortcomings include a lack of human and financial resources in disease control systems, inadequate infrastructure and the absence of laboratories, health facilities and equipment. Furthermore, information channels for disease reporting and response are characterized by a lack of coordination both within and between departments. Due to district level deficits, there is a heavy reliance on external assistance to identify, analyse and finance disease threats, which resultantly makes it difficult to plan ahead.

It was also evident during our study that there is a lack of border security in terms of inability to create barriers to disease entry from foreign countries. Given the free movement of humans and livestock and other goods across the common borders of Tanzania, Uganda and Rwanda, it is no wonder that diseases identified in this study are common in the other two countries as well.

Another aspect of weak institutional capacity in the study area is the lack of knowledge and preparedness of community members to respond to disease outbreaks. The study revealed that community members in the study area hold a variety of ideas, some of which are misconceptions, about prevalence, impact and control methods of particular diseases and pests. There are myths and misconceptions about origins of particular diseases, with many people for instance attributing disease outbreak to foreign events, foreigners, or supernatural interventions. This complex perceptual environment is not conducive for disease prevention and control. It also engenders mistrust between different population groups and most importantly between farmers and the authorities.

5.3 SEARCHING FOR THE ELUSIVE MAGIC BULLET

In crops, use of plants bred to genetically resist diseases or pests is one of the most effective approaches to disease management. Once resistant crops are identified or bred, genetic resistance is a surely low cost method for disease control. However, developing resistant varieties and breeds takes time to yield results, often after diseases have already had significant impacts on communities or the pathogen has already mutated to the extent that genetic resistance breaks down sooner or later. This study found that, in the case of Cassava Mosaic Disease, resistant cultivars are being distributed to farmers as the only means through which one can raise cassava and harvest something. Yet, our respondents pointed out that some of the supposedly CMD resistant cassava cultivars distributed in response to the onslaught of viral disease, soon succumb to the virus. This is not an isolated case as it was mentioned in many study sites. Also, livestock farmers claimed that some of the vaccines used against CBPP have short prophylactic life (a claim corroborated by local veterinarians) and thus some of the vaccinated animals get infected shortly thereafter. These experiences show that reliance on only one method of disease control may not be the best idea, particularly when responding to such a complex problem as Cassava Mosaic disease. More ominously is that when such failures are frequent and wide-

spread, they would, as already mentioned in previous chapters, reinforce mistrust and apprehension of authorities by the farmers.

5.4 THE LABOUR ISSUE

One of the recurring themes in the foregoing discussion is that of lack of labour for disease control activities particularly in relation to crop diseases for which uprooting of diseased material is required. The deleterious impact of the lack of labour on farm productivity and household well being in African agricultural-dependent societies has been well document through several micro-level farm studies (Ruthenberg, 1968; Cleave, 1974; Kamuzora, 1980; Kamuzora, 1998 among others). Studies consistently show less poverty among households with higher proportions of members in the productive age, that is, 15 years and above (Kamuzora 2001). In the context of the study area, lack of labour results from several factors mainly the high levels of morbidity (and mortality) due to diseases such as AIDS, malaria, acute respiratory infections (see Table 4.2) as well as migration within and outside the region. This shortage of labour at household level has a knock on effects on crop and livestock disease prevention and control. There is no doubt that disease prevention and control policies and programmes have to seriously take into consideration the labour issue without which many households can't respond to disease control programmes let alone programmes aimed at poverty alleviation in general.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6

6.1 CONCLUSION

The present study shows clear interactions between the health of crops, livestock and humans. In the study area, diseases that affect humans, crops and livestock have direct impacts on food security and rural livelihoods, as discussed in chapters 2-4 of this report. According to the widely used definition, food security is a situation when all people, at all times, have physical, social and economic access to sufficient, safe, nutritious and culturally acceptable food for an active and healthy life. The four dimensions of food security are: food availability, food access, food utilization and food stability. Our findings clearly reveal that plant and animal diseases are threatening crop and livestock production in the study area. Human diseases further aggravate the situation through the multiple impacts of human disease on households. The discussion below dwells on the combined effects of diseases on the four dimensions of food security as revealed by this study.

Food Availability

For most rural agrarian societies, food availability is a function of household production (the food that is produced on own farm and mainly through use of household labour) and purchase from the market. This study has revealed that disease whether be of crops, livestock or humans, have direct impact on food availability (a more detailed discussion is presented in chapters 2, 3 and 4 of this report). Findings show that in general disease cause production failure. Yields of crops are reduced through direct effects of disease on crops, loss of manure due to cattle diseases, soil degradation due to loss of soil cover, loss of varieties and cultivars (biodiversity), and low labour productivity (due to illness/death of people). All these upstream impacts consequently have more down stream impacts. Decline in food availability certainly leads to malnutrition and other related conditions such as anaemia (which are widespread in the study area, see Table 4.2), chronic food insecurity and poverty ratchets. In some of the study sites, respondents reported high yield losses due to crop disease but one of the extreme cases that shows how diseases can threaten food security is to be found in Bugabo division, Kagera region, Tanzania where some of the local banana cultivars have been wiped out by diseases and the crop is no longer a dependable staple.

Food Access

Even though many rural households produce their own food, even in the best of seasons food produced in small-scale holdings such as the ones in the study area is never sufficient to meet the subsistence needs. Often, households have to buy food and other nourishments (meat, fish, etc) form the market using incomes generated through sale of farm produce or wage labour. To the extent that diseases adversely affect household income, they affect the ability of households to access food from the market. This report has shown (i) how yield loss due to disease attack on food

and cash crops leads to reduced income. For instance, the significant and sustained loss of the banana cultivar Gros Michel – upon which much of the banana export trade in the study area is based – has caused considerable loss of income. Similarly production and sale of coffee, a key cash crop in the area, is being threatened by disease and has resulted in sizeable income losses for farmers. These represent a few examples of losses of income incurred due to crop diseases. It was clear from our respondents that these losses undermine the ability of households to access food. The loss of income due to crop diseases is exacerbated by the impact of diseases on livestock production. Not only that sick animals don't fetch high price, but diseases lead to livestock mortality effectively reducing the size and quality of the herd. In addition, quarantines imposed on the movement of both crops and livestock disrupts and distorts markets and farmers were very bitter about the adverse effects of quarantines on household incomes. On top of all this, human diseases not only restrict sick people from producing saleable surplus but also from wage income. Many studies have also shown that human diseases lead to loss of household capital as livestock and other assets are disposed of to generate income for treatment.

Food Utilization

In the context of diseases, food utilization largely concerns the issue of food safety and acceptability. Heavy use of pesticides and veterinary drugs in response to the emergence and high prevalence of pests and diseases can contaminate water sources and the rest of the environment. While no such analyses have been conducted in the area, it does not diminish the (potential of) the problem. Critically though is the suitability and acceptability of food produced. Respondents pointed out that "bad-tasting" CMD-infested cassava tubers have negatively affected the utilization of this crop for food consumption. The study also revealed that in response to pest and disease threats, alternative disease-resistant crops are being planted. It was explained that many such varieties lack some key desired attributes, including storability, taste and cooking qualities.

Food Stability

Food stability refers to the reliability of food supply (without seasonal or periodic perturbations) so that households have food throughout the year. In rural agrarian communities, incidences of disease, however minor, have been observed to have considerable impacts on the stability of food supply (Richards, 1986). Our study revealed several such impacts. For example, within a year BXW had spread throughout the whole region, killing infected plants within a short period of time. Statistics taken between March and May 2006 indicate that within those three short months BXW killed about 50 000 bananas, equal to a loss of the same amount of bunches, which could have otherwise been used for food or sold for income. The speed and severity of this disease has led to acute shocks to banana production and consequently contributed to food instability in the area. A disease such as BXW or cassava mosaic virus that affects plants all throughout the year regardless of the season contributes to perennial food instability. However, this is not the only challenge facing farmers. Probably more acute is the seasonal food insecurity caused by acute seasonal diseases such as FMD among cattle. Among humans, Malaria is similarly correlated

to seasonal patterns, in particular to prolonged rains and warm temperatures and agricultural production suffers during the malaria season (Yanda, *et al.*, 2005). As already discussed, other human diseases, particularly AIDS, whose prolonged morbidity and mortality withdraw human labour from farming and earning income surely have a persistent impact on food stability.

6.2 RECOMMENDATIONS

Diseases of crops, livestock and humans are significantly impacting food security in the study area in terms of availability, access, utilization and stability, as clearly illustrated in the foregoing discussion. Many households are involved in both crop production and livestock rearing; farming activities which are largely dependent on human labour inputs. Households thus face a triple threat to food security as they are confronted with the prevalence of crop, livestock and human diseases. It is clear that impacts are coming from multiple fronts and therefore require a multi-faceted response. In the following sections we propose various recommendations to respond to the high disease burden in the study area, recognizing the concomitant nature of disease impacts.

Need for a paradigm shift from one disease to one health

The present study clearly illustrates the co-occurrence of diseases in the study area. Yet planning and implementation of disease response remains isolated along strictly disciplinary and sectoral lines. There is a need to shift this paradigm and to see health of crops and livestock as directly linked to the health of humans, and vice-versa. There is a need for a technical and policy platform that brings together crop protection, veterinary and human medical sectors. The hitherto sectoral approach to disease control has not worked well as it is often the case of focusing on one disease problem in an environment where there are many interacting disease problems. Broadening the paradigm to one health would bring various sectors together and enable them to share skills, infrastructure and financial resources as well as coordinate their disease control activities. Such an approach is likely to be cost-effective.

Research on interactions between diseases and their micro and macro-economic impacts must be strengthened

This study has at best scratched the surface in terms of generating knowledge on the overall burden of disease in the study area and combined disease impacts on rural livelihoods. There are still many knowledge gaps. Effective control of diseases requires good data conditions and adequate information on factors that facilitate establishment, spread and impact of diseases, such as ecological, demographic (gender, age), socio-economic and infrastructural aspects. Some further areas of research, though not an exhaustive list, include:

- Socio-economic studies to analyse trends and dynamics in risks and vulnerability to diseases of agricultural importance particularly in the context of climate change;
- Epidemiological studies to examine and identify microbial types and sub-types,

their prevalence and distribution in time and space;

- Impact studies to look at effects of disease on productivity, nutrition, knock-on-effects and cost-effectiveness of control measures;
- Analyses of the economic costs of diseases at micro, meso and macro economic levels;
- Ecological studies addressing climate change, clustering of diseases (i.e. why certain diseases are concentrated in certain areas) and links between agricultural practices and diseases;
- Analysis of existing disease surveillance systems, their strengths and weaknesses and the capacity building needs for establishing and maintaining a robust disease management system.

Need for an effective communication, information and education strategy

It is not that local communities are not aware of the diseases and their impacts on their daily lives and livelihoods. The issue is, such awareness is often clouded by myths and wrong perception about origin and risk to particular diseases. These are compelling reasons why a sustained communication campaign against diseases is needed. Creating awareness on diseases, their spread, establishment, and impact on society is essential. A community aware of its problems is more likely to participate in efforts to find solutions for that particular problem. A good communication strategy may help overcome suspicion and mistrust among households and between households and state authorities. To date, communication strategies against diseases are designed by the experts and brought to local communities "to educate them." But as this study has revealed, knowledge, experience and practices of local communities in relation to locally established diseases level are not always "useless" folk knowledge and experience but a powerful and insightful tool that could and should be incorporated into disease control strategies.

This study has not only showed that perception about diseases differ between local communities and experts, but also that in some instances, local communities may have better knowledge about diseases in their localities. This is partly due to lack of good epidemiological surveillance programmes. Those that are in place are dependent on experts rather than active participation of local communities. Thus the input of local stakeholders is needed not only in the design of information materials but most important in the development of disease early warning systems as well as implementation of disease control programmes. This study did not find evidence of any developments seeking to harness inputs from local communities.

Institutional capacity must be strengthened

Strong institutional capacity is critical for disease surveillance and response. This study has revealed that in the study area, the capacity to monitor and respond to diseases is at best very limited. This is due to a combination of factors including lack of skilled human resources and financial resources as well as equipment and general infrastructure for managing human, crop and livestock health. Yet, we think it is feasible to establish rural health stations with the capacity for multiple disease

surveillance and response. These stations should have the ability to superintend disease control measures and be capable of providing front line services and constant follow-up. The rural health station proved a very effective vehicle in the eradication of Malaria in Italy (Snowden 2006). An added advantage is that there is a gamut of communication technologies which can be deployed in disease surveillance and response at a reasonable cost (Measures and Rugalema, 2008).

Necessity of strong international collaboration

Simply stated, disease respects no national boundaries. This point has become clear in this study as well as in the Uganda country study report. It has shown not only that diseases that are common in north-western Tanzania are also common on the Uganda side of the border but more important it has shown that shared ecological and socio-economic conditions, high mobility of humans, animals and crops across the border, and weak capacity to monitor and respond to diseases on both sides of the border are factors that abet the emergency and epidemicity of some of the diseases and endemicity of others. Information channels for disease reporting and response need to be well coordinated and capacity improved. In this context, it is recommended that the neighbouring countries of Tanzania and Uganda should explore key avenues of collaboration for disease surveillance and control. Such avenues could include:

- joint disease surveillance and early warning programmes;
- coordination of disease response programmes (quarantine, vaccination campaigns, etc);
- jointly funded institutions for disease research, surveillance and control;
- joint communication and education campaigns against diseases targeted to mobile populations such as pastoralists;
- regular exchange of information on outbreaks, spread and impact of diseases along the common border;
- integration of disease issues in the regular deliberations of the district-level good neighbouriness committees;
- seeking support of a wider regional body – the East African Community (EAC) to strengthen disease control policies and infrastructure at regional level.

Without a coordinated response to diseases, it is going to be difficult for each individual country to effectively control the many diseases that affect lives and livelihoods in this region. There are many advantages for international collaboration in disease control, not least the potential for lowering the cost of interventions.

BIBLIOGRAPHY

Adugna, G., Hindorf, H., Steiner, U., Niremberg, H.I., Dehne, H.W. & Schellander, K. 2005. Genetic diversity in the coffee wilt pathogenery (Gibbrella xylarisides) populations differentiation by host specialisation and RAPD analysis. *Zeltsschrift für Pflanzenkrankhaiten und Pflanzenschutz.* 112(2): 134-145.

Ainsworth, M., Beegle, K. & Koda, G. 2002. *The impact of adult mortality on primary school enrollment in northwestern Tanzania.* Africa Region Human Development Working Paper Series. Washington, The World Bank.

Anon. 2001. Report of the second meeting of the FAO/OIE/OAU/IAEA Consultative Group on contagious bovine pleuropneumonia (CBPP), Rome, Italy 24-26 October 2000. Rome, FAO.

Baier, E. 1997. The impact of HIV/AIDS on rural households/communities and the need for multisectoral prevention and mitigation strategies to combat the epidemic in rural areas. Rome, FAO.

Baijukya, F.P. & de Steenhuijsen Piters, B. 1998. Nutrient balances and their consequences in the banana-based land use systems of Bukoba District, north west Tanzania. Agric. Ecosyst. & Env., 71(1): 147-158.

Baijukya, F.P. & Folmer, E.C.R. 1999. Agroecological zones of Kagera region. *In* E.C.R. Folmer, C. Schouten & F.P. Baijukya, eds. *Planning the future: Past, present and future perspectives of land use in the Kagera region*, pp. 147-158. Bukoba, Tanzania, Maruku Agricultural Research Institute.

Baijukya, F.P. 2004. *Adapting to change in banana-based farming systems of north-west Tanzania: the potential role of herbaceous legumes*. Wageningen University, Wageningen, The Netherlands. (Ph.D. thesis)

Belcher, D., Wurapa, F.K., Ward, W. & Lourie, I.M. 1975. Guinea Worm in Southern Ghana: Its Epidemiology and Impact on Agricultural Productivity. *Trop. Med. Hyg.,* 24(2): 243-249.

Blomme, G., Gold, E., Karamura, E., eds. 2005. Farmer-participatory testing of integrated pest management options for sustainable banana production in Eastern Africa. Proceedings of the workshop on farmer-participatory testing of IPM options for sustainable banana production in Eastern Africa, held in Seeta, Uganda, 8-9 Dec 2003. Montpellier, France, The International Network for the Improvement of Banana and Plantain.

Bosch, C., Bantje, H. & Maganga, F. 1989. *Annotated Bibliography of Kagera Region*. Tanzania/Netherlands Farming Systems Research Project. Working Paper No. 2. Bukoba, Tanzania, Maruku Research Institute, Mwanza, Tanzania, Ukiriguru Research Institute and Amsterdam, Royal Tropical Institute.

Bosch, Ch. H & Shwagala, D.H. 1994. *Kibanja size and coffee production in Bukoba District*. Farming Systems Research Programme, Field Note No. 39. Bukoba, Tanzania, Lake Zone ARI-Maruku.

Bosch, C., Lorkeers, A., Ndile, M.R. & Sentozi, E. 1996. *Diagnostic Survey: Constraints to Banana Productivity in Bukoba and Muleba Districts, Kagera Region, Tanzania*. Tanzania/Netherlands Farming Systems Research Project. Working Paper No. 8. Bukoba, Tanzania, ARI Maruku and Amsterdam, Royal Tropical Institute.

Brownlie, J., Peckham, C., Waage, J., Woolhouse, M., Lyall, C., Meagher, L., Tait, J., Baylis, M. & Nicoll, A. 2006. Foresight. Infectious Diseases: preparing for the future. Future Threats. London, Office of Science and Innovation.

Buddenhagen, I. 2006. Managing banana bacterial wilts in Latin America. *In* E. Karamura, N. Osiru, G. Blomme, C. Lusty & C. Picq, eds. *Developing a regional strategy to address the outbreak of banana Xanthomonas wilt in East and Central Africa,* pp.23-25. Proceedings of the banana Xanthomonas wilt regional preparedness and strategy development workshop, held in Kampala, Uganda, 14-18 February 2005. Montpellier, France, International Network for the Improvement of Banana and Plantain.

Cleave, J.H. 1974. African Farmers : Labour Use in the Development of Smallholder Agriculture. Praeger Publishers, New York.

Colon, L. 1984. *Contribution á l'étude de la résistance variétale du manioc* (Manhot esculenta *Crantz*) *vis-à-vis de la mosáique africaine du manioc*, Etude realisée dans le cadre du programme ORSTOM. Etude de la mosaïque africaine du manioc. Abidjan, Côte d'Ivoire, ORSTOM.

Cropking. 1986. Banana weevil borer control using Lorsban 50 EC. *Agric-Tropic.*, 93. Queensland, Australia.

DeSalle, R. 1999. Evolution, Ecology and Culture. *In* R. DeSalle, ed. *Epidemic: The world of infectious disease*, pp.7-11. New York, USA, The New York Press.

Diamond, J. 2002. Evolution, consequences and future of plant and animal domestication (Review article). *Nature,* 418: 700-707.

Eden-Green, S. 2006. Banana bacterial wilts: the global picture. *In* E.B. Karamura, M. Osiru, G. Blomme, C. Lusty & C. Pisq, Eds. *Developing a regional strategy to address the outbreak of banana xanthomonas wilt in East and Central Africa: Proceedings of the Banana xamthomonas wilt regional preparedness and strategy development workshop, held in Kampala, Uganda, 14-18 Feb 2005*, p. 12. Montpellier, France, International Network for the Improvement of Banana and Plantain. 94 pp.

Eshuis, J. & Manschot, P. 1978. *Communicable diseases: a manual for rural health workers*. Nairobi, Kenya, African Medical and Research Foundation.

FAO. 1997. Prevention and control of transboundary animal diseases. FAO animal production and health paper 133. Rome.

FAO. 1988. FAO-UNESCO soil map of the world. Revised legend. *In* FAO. *World Soil Resources Reports, No. 60*, p. 121. Rome, FAO, Paris, UNESCO, Wageningen, Netherlands, International Soil Reference and Information Centre.

FAO. 2003a. *Biosecurity in Food and Agriculture*. Discussion Paper. Committee on Agriculture, 17th Session, Rome.

FAO. 2003b. Proceedings of the FAO-OIE-AU/IBAR-IAEA Consultative Group on Contagious Bovine Pleuropneumonia, Third Meeting, Rome, 12-14 November 2003. Rome, Italy.

FAO. 2006. Cassava Initiative Workshop – Africa Region, Kampala, 6 December 2006. Nairobi, Kenya.

FEWS NET. 2007. *Recent shocks maintain emergency conditions.* Greater Horn of Africa Food Security Update, February 2007. (also available at www.fews.net).

Friedrich, K.H. 1968. Coffee-banana holdings at Bukoba: the reason for stagna-

tion at higher level. *In* H. Ruthemberg, ed. *Smallholder farming and smallholder development in Tanzania: Ten case studies*, pp. 173-212. Munich, Germany, International Food Organisation.

FSR. 1990. *Diagnostic Survey of Bukoba District*. Farming systems research programme, lake zone agricultural research institute Working paper No. 5. Bukoba, Tanzania, ARI Maruku & Amsterdam, Royal Tropical Institute.

Gourlay, R.N. 1964. Antigenicity of *Mycoplasma mycoides* I. Examination of body fluids from cases of contagious bovine pleuropneumonia. *Res. Vet. Sci.,* 5: 473-482.

Haslwimmer, M. 1994. Is HIV/AIDS a threat to livestock production? The example of Rakai, Uganda. *World Animal Review,* 80/81: 92-97. Rome, FAO.

Hargrove, J.W., Omolo, S., Msalilwa, J.S.I. & Fox, B. 2000. Insecticide-treated cattle for tsetse control: the power and the problems. *Med. and Vet. Entom.,* 14(2): 123-130.

Hyden, G. 1969. Political development in rural Tanzania. A west lake study. Nairobi, East African Publishing House.

International Service for National Agricultural Research. 1997. News letter No. 32. IFPRI.

Kagera AIDS Research Project. 2004. Annual Report, 2004. Bukoba, Tanzania, Kagera Region Medical Office.

Kaiza, D. & de Steenhuijsen Piters, C.B. 1997. Coffee management and plant protection problems in Bukoba district. Lake Zone Agriculture and Training Institute Field Note No. 75. Bukoba, Tanzania.

KALIDEP. 2000. Report on the status of control of CBPP disease in Kagera region, Tanzania. Bukoba, Tanzania, Kagera Livestock Development Programme.

Kamuzora, C.L 1980. Constraints to labour time availability in African smallholder agriculture: the case of Bukoba District, Tanzania. Development and Change; 11 (1):

Kamuzora, C.L & Gwalema, S. 1998. Aggravation of Poverty in Rural Bukoba District, Tanzania: labour Constraints, Population Dynamics and AIDS Epidemic. Report submitted to Research for Poverty Alleviation (REPOA), Dar-es-Salaam, Tanzania

Kamuzora, C.L. 2001: Less poverty with higher household size in the eastern and southern Africa region: analysis and implications for the population debate and population policy. Paper presented at the XXIVth IUSSP General Population Conference, Salvador, Brazil 18-24 August, 2001.

Kangire, A., Rutherford, M.A. & Gold, C.S. 2001. Distribution of fusarium wilt and the populations of *fusarium oxysporum f.sp. cubense* on bananas in Uganda. *In* A.B. Molina, N.H. Nik Masdek & K.W. Liew, eds. *Banana fusarium wilt management: towards sustainable cultivation*, pp. 152-161. Proceedings of the international workshop on the Banana Fusarium Wilt Disease, held in Malaysia, 18-20 October 1999. Laguna, Philippines, INIBAP.

Karamura, D. & Mgenzi, B. 2004. On farm conservation of Musa diversity in the great lakes region of East Africa. *Afri. Crop Sci. Journ.*, 12(1): 75-83.

Karamura, E.B. 2006. The banana *Xanthomonus* wilt epidemic. *In* E.B. Karamura, N. Osiru, G. Blomme, C. Lusty & C. Picq, eds. *Developing a regional strategy to address the outbreak of banana xanthomonas wilt in East and Central Africa: Proceedings of the Banana xamthomonas wilt regional preparedness and strategy development workshop, held in Kampala, Uganda, 14-18 Feb 2005*, pp. 7-10. Montpellier,

France, International Network for the Improvement of Banana and Plantain. 94 pp.

Karamura, E.B., Osiru, N., Blomme, G., Lusty, C. & Picq, C, eds. 2006. Developing a regional strategy to address the outbreak of banana xanthomonas wilt in East and Central Africa: Proceedings of the Banana xamthomonas wilt regional preparedness and strategy development workshop, held in Kampala, Uganda, 14-18 Feb 2005. Montpellier, France, International Network for the Improvement of Banana and Plantain.

Kasumba, C. 1998. Livestock diseases and traditional medicine in the bush area Kivu Province, Democratic Republic of Congo. *Afri. Stud. Monographs,* 19(1): 13-33.

Kebede, A., McCann, J.C., Ye-ebiyo, Y. & Kiszewski, A. 2005. New evidence of the effects of agro-ecological change on malaria transmission. *Amer. Journ. Trop. Med Hyg.,* 73(4): 676-680.

Kenmore, P; Slingenberg, J & Rugalema, G. 2005. Anticipating Coincidence: Avian flu, HIV/AIDS, and Coconut leaf beetle on highways in SE Asia. Paper presented at the 19th Session of the Committee on Agriculture (COAG) - Side Event on the Impact of HIV/AIDS on Agriculture and Food Security.

Kikulwe, E.M., Nowakunda, K., Byabachwezi, M.S.R., Nkuba, J.M., Namaganda, J., Talengera, D., Katungi, E., & Tushemereirwe, W.K. 2007. Development and Dissemination of Improved Banana Cultivars and Management Practices in Uganda and Tanzania. *In* M. Smale & W.K. Tushemereirwe, eds. *An Economic Assessment of Banana Genetic Improvement and Innovation in the Lake Victoria Region of Uganda and Tanzania*, pp. 37-48. Washington, IFPRI.

Killewo, J.Z.J., Kwesigabo, G., Comoro, C., Lugalla, J., Mhalu, F.S., Biberfeld, G., Wall, S. & Sandstrom, A. 1998. Acceptability of voluntary HIV testing with counseling in a rural village in Kagera, Tanzania. *AIDS Care*, 10(4): 431-439.

Knols, B.G.J. & Takken, W., Eds. 2007. *Emerging pests and vector-borne diseases in Europe*. Wageningen, The Netherlands, Wageningen Academic Publishers.

Kranz, J. & Mogk, M. 1973. *Gibberella xylarioides* Heim et Saccas on arabica coffee in Ethiopia. *Phytopathologische Zeitschrift,* 78(4): 365-366.

Kusiluka, L.J.M. & Sudi, F.F. 2003. Review of successes and failures of contagious bovine pleuropneumonia control strategies in Tanzania. *Prev. Veter Medic.,* 59: 113-123.

Kusiluka, L.J.M., Karimuribo, E.D., Mdegela, R.H., Luoga, E.J., Munishi, P.K.T., Mlozi, M.R.S. & Kambarage, D.M. 2005. Prevalence and impact of water-borne zoonotic pathogens in water, cattle and humans in selected villages in Dodoma Rural and Bagamoyo districts, Tanzania. *Physics and Chemistry of the Earth,* 30(11-16 SPEC. ISS.): 818-825.

Maliyatabu, N.N. 2007. Coffee research activities in Kagera region. Six-month progress report, June-December 2006. Maruku, Tanzania, Tanzania Coffee Research Institute.

Maruo, S. 2002. Differentiation of subsistence farming patterns among the Haya banana growers in north-western Tanzania. *Afri. Study Monographs*, 23(4): 147-175.

Masiga, W.N., Rossitor, P. & Bessin, R. 1998. Contagious bovine pleuropneumonia. I. Epidemiology: the present situation in Africa and epidemiological trends, Proceedings of the FAO/OIE/OAU CBPP Consultative Group Meeting, FAO, Rome, 5-7 October, 1998.

Mbwambo, H.A., Sudi, F.F., Mkonyi, P.A., Mfinanga, J.M., Mella, E.S. & Ngovi, C.J. 2002. Comparative studies of the efficacy of parvaquone and parvaquone-plus-frusemide in the treatment of *Theileria parva* infection (East Coast fever) in cattle. *Veter. Parasit.*, 108(3): 195-205.

Mbwana, A.S.S. & Rukazambuga, N.D.T.M. 1998. Banana IPM in Tanzania. *In* E.A. Frison, C.S. Gold, E.B. Karamura & A.R. Sikora, eds. *Mobilising IPM for sustainable banana production in Africa*, pp.237-245. Proceedings of the workshop on banana IPM, held in Nelspruit, South Africa, 23-28 November 1998. Montpellier, France, INIBAP.

McCulloch, B., Suda, B.Q.J., Tungaraza, R. & Kalaye, W.J. 1968. *Bull. Epizoot. Dis. Afric.,* 16: 303-326.

Measures, E. & Rugalema, G. 2008. Using mobile telephone technology for disease surveillance and community level: Initial experience, prospects and challenges. Seminar paper presented at Wageningen University and Research Centre, Technology and Agrarian Development Chair Group. 30 June 2008.

Meyen K, 1970. Beef Production in East Africa. Munich, Ifo-Institut für Wirtschaftsforschung Afrika-Studienstelle.

Mgenzi, B. 2001. Report on banana BXW surveillance in Kagera region. Bukoba, Tanzania, ARI Maruku. (unpublished)

Mgenzi, S.R.B., Mkulila, S.I., Blomme, G., Gold, C.S., Ragama, P.E., Karamura, E.B. & Nkuba, J.M. 2005. The effect of pest management practices on banana pests in the Kagera region of Tanzania. *In* G. Blomme, C.S. Gold, & E.B. Karamura, eds. *Farmer-participatory testing of integrated pest management options for sustainable banana production in eastern Africa*, pp. 43-52. Proceedings of the workshop on farmer-participatory testing of IPM options for sustainable banana production in Eastern Africa, held in Seeta, Uganda, 8-9 December 2003. Montpellier, France, INIBAP.

Mgenzi, B., Mkulila, S. & Mohamed, R. 2007. Report on Banana BXW Surveillance in Kagera region. Bukoba, Tanzania, ARI Maruku.

Milne, G. 1938. Essays in applied pedology. III. Bukoba: high and low fertility on a laterised soil. *East Afri. Agric. and For. Journ.,* 4: 13-24.

Möberg, J.P. 1972. Some soil fertility problems in West Lake region of Tanzania, including the effect of different forms of cultivation, on the fertility of some ferralsols. *East Afric. Agric. and For. Journ.,* 39: 35-46.

Msami, H.M., Ponela-Mlelwa, I., Mtei, I.J. & Kapaga, A.M. 2003. Contagious bovine pleruopneumonia in Tanzania: Current status. *Trop. Anim. Heal. Prod.,* 33(2): 21-28.

National Bureau of Statistics Tanzania. 2006. *National sample Census of Agriculture 2003/2003. Small Holder Agriculture.* Vol II. *Crop Sector- National Report*. Dar Es Salaam.

Njau, P. 2003. Contrasting emergency experiences for rinderpest and CBPP in Tanzania. *In:* Report of a Workshop of Chief Veterinary Officers/Directors of Veterinary Services of SADC Member Countries On Transboundary Animal Diseases with special reference to Foot and Mouth Disease and Contagious bovine pleuropneumonia in Southern Africa Pretoria, South Africa 21-22 July 2003.

Njau, B.C. & Mkonyi, P.I. 1981. *In* A.D. Irvin, M.P. Cunningham & A.S. Young, eds. *Advances in the control of Theileriosis*, pp. 215-217. The Hague, Nijhoff.

Nkuba, J.M., Mgenzi, S.R.B., Ishika, M. & Mushongi, C. 2002. Evaluating the marketing opportunities for banana and its products in the principle banana growing countries of ASARECA. Case study of Tanzania. Bukoba, Tanzania, Maruku Agricultural Research and Development Institute.

Omolo, S., Rugambwa, V.K., Masururi, B. & Stanslaus, D. 1999. Livestock production in Kagera region: past, present and future prospects. *In* E.C.R. Former, C. Schouten, & F.P. Baijukya, eds. *Planning the future: Past, present and future perspective of land use in Kagera region*. Bukoba, Tanzania, Maruku Agricultural Research Institute.

Ploetz, R.C. 1990. Population biology of *fusarium oxysporum f.sp. cubense*. *In* R. C. Ploetz, ed. *Fusarium wilt of banana*, pp. 63-79. St. Paul, USA, APS Press.

Ploetz, R.C. & Pegg, K.G. 1997. Fusarium wilt of banana and Wallace's line: was the disease originally restricted to his Indo-Malayan region? *Austral. Plant Pathol.*, 26: 239-249.

Rald, J. & Rald, K. 1975. *Rural organisation in Bukoba district.* Scandinavian Institute of African Studies, Uppsala, Sweden. (Ph.D thesis)

Rau, B. 2006. *Too poor to be sick: linkages between agriculture and health*. FAO HIV/AIDS Programme Working Paper. Rome, FAO.

Research and Analysis Working Group. 2004. *Vulnerability and resilience to poverty in Tanzania: causes, consequences and policy implication*. 2002/2003 Tanzania participatory poverty assessment. Main Report. Dar Es Salaam, Tanzania, Mkuki na Nota Publishers.

Research and Analysis Working Group. 2005. Poverty and human development report 2005. Dar Es Salaam, Tanzania, Mkuki na Nota Publishers.

Richards, P. 1986. *Coping with hunger: Hazard and Experiment in an African Rice-Farming System.* London, Allen and Unwin.

Robertson, A. 1976. *Handbook on animal diseases in the tropics (third edition)*. British Veterinary Association. Oxfordshire, UK, Burgess and Sons, LTS.

Roeleveld, A.C.W. & Wella, E.B. 1994. Informal livestock survey in Bukoba district. Tanzania Netherlands Farming System Research Project, Lake Zone, Workig Paper No. 15. Bukoba, Tanzania, Maruku Agricultural Research Institute.

Rugalema, G.H.R. 1999. *Adult mortality as entitlement Failure: AIDS and the crisis of rural livelihoods in a Tanzanian village*. Institute of Social Studies, The Hague, Netherlands. (Ph.D thesis)

Rugalema, G.H, Okting'ati, A. & Johnsen, F.H. 1994. The homegarden agroforestry system of Bukoba District, north-western Tanzania. *Agrofor. Syst.,* 26: 53-64.

Ruthenberg, H. 1968. Smallholder Farming and Smallholder Development in Tanzania. C. Hurst & Co. London

Rutherford, M., Glozier, J., Buddie, A., Inneson, J., Lea, S. & Flood, J. 2005. Coffee wilt disease. Poster. Engham, UK, CABI Bioscience.

Rweyemamu, M., Musoke, A., Zhang, N. & Shibiao, Y. 2006. Foresight. Infectious diseases: preparing for the future. Cultural and governance influence of the detection, identification and monitoring of infectious diseases of animals. London, Office of Science and Technology.

Sato, J. & Ndyetabula, I. 2006. The status of cassava pests and diseases in the lake and western zones of Tanzania. Bukoba, Tanzania, Lake Zone Agricultural

Research Institute.

Sikora, R.A., Bafokuzara, N.D., Mbwana, A.S.S., Oloo, G.W., Uronu, B. & Sheshu-Reddy, K.V. 1989. *Interrelationship between banana weevil, root lesion nematode and agronomic practices, and their importance for banana decline in the United Republic of Tanzania*. FAO Plant Protection Bulletin No. 37(4): 151-157. Rome.

Simon, S. 1993. La lutte integree contre le charançon noir des bananiers *Cosmopolites sordidus*. Fruits 49(2): 151-162.

Snowden, F.M. 2006.The Conquest of Malaria : Italy 1900-1962. New Haven, Connecticut/London, UK, Yale University Press.

Speijer, P.R., Kajumba, Ch., Lubega, M. & Tumuhaise, R. 1994. Clean planting material trial at farmer fields: nematode infestation rate of hot water treated materials. Working document. Kawanda, Uganda, International Institute of Tropical Agriculture.

Stillwaggon, E. 2006. The ecology of poverty: nutrition, parasites and vulnerability to HIV/AIDS. *In* S.R. Gillespie, Ed. *AIDS, poverty and hunger: Challenges and Responses*, pp. 167-180. Washington, IFPRI.

Stover, R.H. & Simonds, N.W. 1987. Bananas. 3rd Edition, Tropical Agriculture Series. Harlow, England, Longman Scientific and Technical Press.

Tanzania Commission for AIDS (TACAIDS), National Bureau of Statistics (NBS) & ORC Macro. 2005. *Tanzania HIV/AIDS Indicator Survey 2003-04.* Calverton, USA, TACAIDS, NBS & ORC Macro.

Thompson, H., McCandlish, I.A.P. & Wright, N.G. 1976. Experimental respiratory disease in dogs due to Bordetella bronchiseptica. *Res. Vet. Sci*. 20 pp.

Thresh, J.M. & Cooter, J.R. 2005. Strategies for controlling cassava mosaic virus disease in Africa. *Plant Pathol.,* 54: 587-614.

Thresh, J.M. and Otim-Nape, G.W., 1994. Strategies for controlling African cassava mosaic geminivirus. *Adv. Dis. Vector Res*, 10: 215-236.

Treverrow, N. 1985. Banana weevil borer. Agfact H6. AE.1, second edition. New South Wales, Australia, Department of Agriculture. 4 pp.

Treverrow, N., Peasley, D. & Ireland, G. 1992. *Banana weevil borer: a pest management handbook for banana grower*s. Coffs Harbour, Australia, Banana Industry Committee, NSW Agriculture, Horticultural Research Development Corporation. 28 pp.

Tubeti. 2007. Taarifaza sekta ya afya mkoa wa Kagera kwa Mh. Aisha Kigoda (Mb), Naibu Waziri wa Afya na Ustawi wa Jamii wakati wa Ziara Mkoa wa Kagera Tarehe 21 February 2007.

Tushemereirwe, W.K., Kangire, A., Kubiriba, J.Nakyanzi, M. & Gold, C.S. 2004. Diseases threatening banana biodiversity in Uganda. *Afric. Crop Sci. Journ.*, 12(1): 19-26.

Uilenberg, G. 198l. *In* A.D. Irvin, M.P. Cunningham & A.S. Young, eds. *Advances in the Control of Theileriosis*, pp.4-37. The Hague, Martinus Nijhoff.

UNICEF. 2007. Goal: Combat HIV/AIDS, malaria and other diseases via the Internet. In *UNICEF Millennium Development Goals* (available at http://www.unicef.org/mdg/index.html).

URT. 2002. Emergency Animal Disease Surveillance and Control Programme. Dar Es

Salaam, Tanzania, Ministry of Water and Livestock Development.

Vosloo, W., Bastos, A.D.S., Sahle, M., Sangare, O. & Dwarka, R.M. 2005. Virus Topotypes and the role of wildlife in foot and mouth disease in Africa. *In* S.A. Osofsky, S. Cleaveland, W.B. Karesh, M.D. Kock, P.J. Nyhus, L. Starr, & A. Yang, eds. *Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health*, pp. 67-73. Gland, Switzerland and Cambridge, UK, IUCN.

Walker, P.T., Hebbleswaithe, M. & Bridge, J. 1984. *Project for banana pest control and improvement in Tanzania*. EEC report for the Government of Tanzania. London, Tropical Development and Research Institute. 129 pp.

Warburg, O. 1894. Die Kulturpflanzen Usambaras. Mitt Dtsch Schutzgeb 7: 131–200.

Wilcox, B.A. & Ellis, B. 2006. Forests and emerging infectious diseases of humans. *Unasylva 224,* 57: 11-18.

Wilson, M.E. 1995. Travel and the emergence of infectious diseases. *Emerg. Infect. Dis.*, 1(2): 39-46.

World Health Organization. 1996. *Epidemic dysentery fact sheet.* (available at www.who.int/inf-fs/en/fact108.html).

World Health Organization. 2006. *The control of neglected zoonotic diseases: A route to poverty alleviation*. Report of a Joint WHO/DFID-AHP Meeting, with the participation of FAO and OIE. Geneva.

Yanda, P.Z., Kangalawe, R.Y.M, & Sigalla, R.J. 2005. *Climatic and socio-economic influences on malaria and cholera risks in the Lake Victoria region of Tanzania*. AI-ACC Working Paper No. 12. Assessments of Impacts and Adaptations to Climate Change.

Yirgou, D., Bradbury, J.F. 1974. A note of wilt of banana caused by the enset wilt organism, *Xanthomonas musacearum*. *East. Afric. Agric. For. Journ.,* 40: 111-114.

Young, A.S., Purnell, R.E., Payne, R.C., Brown, C.G.D., Kanhai, G.K. 1978. Studies on the transmission and course of infection of a Kenyan strain of Theileria mutans. *Parasitology,* 67: 99-115.

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