IMPACT ASSESSMENT OF BANANA BACTERIAL WILT DISEASE ON HOUSEHOLD FOOD SECURITY AND INCOME IN KAGERA REGION, TANZANIA

BY

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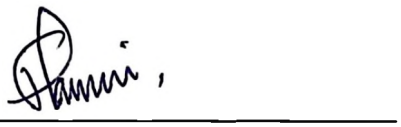
ABSTRACT

This study was conducted in six villages in Muleba and Misenyi districts in Kagera region to assess the impact of banana bacterial wilt disease on household food security and income. The sample of six (6) villages composed of four villages affected with banana bacterial wilt disease and two villages without disease were selected for this study using purposive and random sampling technique respectively. Simple random sampling technique was employed to select 20 affected households and 15 not affected households from each affected village. Also 30 households were randomly selected from not affected villages making a total of 200 households. A structured questionnaire was used to collect data from the sample households. Data were coded, entered and analysed using the Statistical Package for Social Sciences (SPSS) version 11.5 and Excel computer programs. Comparison of means was done using independent t-test to verify if there were any differences in the variables between households with and without the disease. Results on banana yield reveals that, there were significant differences in mean yields of banana between affected and unaffected households in all sampled villages with the exception of Ngando village, meaning they were food insecure. Further more all affected household in sampled villages with the exception of Ngando village had an average income below the poverty line meaning they had low income. Majority of the affected households planted different crops in the uprooted areas; most planted crops are maize 32.8% and maize intercropped with cassava 22.5% while those who have no alternative crop to plant were 21.3% households. Most of the affected households were engaged into labour selling (42.5%) to different agricultural enterprises. From these findings

it is recommended that deliberate efforts should be made to assist creating awareness and preventive measures so as to contain the disease within the affected villages and reducing the spread to the unaffected villages/ households.

DECLARATION

I, Filbert Yona Kavia do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work and it has not been or concurrently being submitted for a higher degree award in any other University.



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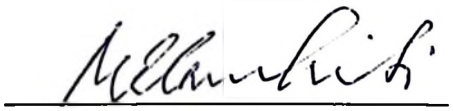
The above declaration is confirmed



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DEDICATION

This dissertation is dedicated to my parents Mr. Yona Lulamso Kavia and Mrs. Edith Masika Kimaro for laying the foundation of my education, to my wife, the late Jacqueline Mwangwa and my son Yona

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LIST OF ABBREVIATIONS

AE	Adult Equivalent
DEC	Dietary Energy Consumption
DFID	Department of International Development
FAO	Food and Agriculture Organisation of the United Nations
FAO-WHO-UNU	Food and Agricultural Organisation- World Health Organisation-United Nations University
FGD	Focused Group Discussions
GDP	Gross Domestic Product
HBS	Household Budget Survey
HFS	Household Food Security
MAFS	Ministry of Agriculture and Food Security
MOAC	Ministry of Agriculture and Cooperatives
NBS	National Bureau of Statistics.
SNAL	Sokoine National Agriculture Library
SPSS	Statistical Package for Social Sciences
TFNC	Tanzania Food and Nutrition Centre
UNICEF	United Nations International Children Education Fund
URT	United Republic of Tanzania
USAID	United State Agency for International Development
WB	World Bank
WHO	World Health Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Banana crop is one of the important staple foods in the humid tropics (INIBAP, 2002). Tanzania is the second banana producer in East Africa after Uganda and seventh in the world (www.agr.kuleuven.ac.be/DTP/TRO/Tanzania/banpj.htm, 12/06/2007). In Tanzania, about 350 000 ha of bananas are cultivated and production level is about 2.6 million metric tonnes per year (MOAC, 2000). Kagera region is one of the major producing areas along Lake Victoria that stretch from the northeast portion of the lake through central and western Uganda., with an estimated annual banana production of 1.26 million metric tons on 187,000 ha (Mbwana, 2005).

Other banana producing areas in Tanzania are the highlands of Kilimanjaro, Arusha and Tanga in the Northern Zone, Mbeya, Ruvuma and Iringa in the Southern Highlands Zone, Coast and Morogoro in the Eastern Zone and Zanzibar Islands. In 2001 banana production by regions of Tanzania, the Northern Zone has the highest banana production followed by Lake Zone and Southern Zone (Table 1).

Despite its good banana production, Kagera region has production constraints like increased pressure of pests and diseases, poor soil fertility, poor agronomic practices, high prices of inputs, inadequate extension and research services, poor farm input distribution and lack of credit (Mgenzi *et al.*, 1999).

Table 1: Banana production in each region of Tanzania 2001

Region	Tons ('000)	Productivity T/Ha	Area ('000) Ha	Rank
Kilimanjaro	1383.8	10.5	131.6	1
Kagera	1150.0	8.3	137.7	2
Mbeya	434.6	9.6	45.2	3
Kigoma	258.3	8.3	31.2	4
Arusha	232.5	10.1	23.0	5
Tanga	113.5	8.7	13.0	6
Mwanza	69.1	7.3	9.4	7
Morogoro	26.1	8.7	3.0	8
Rukwa	18.4	9.2	2.0	9
Mtwara	17.0	7.7	2.2	10
Tabora	13.5	8.4	1.6	11
Ruvuma	9.2	9.2	1.0	12
Coast/DSM	7.0	8.7	0.8	13
Lindi	6.6	8.2	0.8	14
Iringa	1.8	12.0	0.2	15
Mara	1.7	12.0	0.1	16
Dodoma	1.6	8.0	0.2	17
Singida	0.8	8.0	0.1	18
Shinyanga	0.5	4.3	0.1	19
Total		9.3 (Ave.)	403.2	-

Further more banana is a staple food for about 90 percent of the total population of Kagera region (Mbwana *et al.*, 1997, Mgenzi *et al.*, 2006) and a staple food to 20 – 30 percent of the total population in the country (Mbwana, 2005). Since the crop is harvested throughout the year, it ensures food and income security particularly at household level. For the past 10 to 15 years, its contribution to household income has been increasing significantly whilst contributions of traditional cash crops such as coffee and tea grown in the same farming systems have been decreasing (Nkuba *et al.*, 2002).

Tanzania is one of the countries in sub- Sahara Africa where food insecurity is a threatening problem that needs to be addressed urgently (URT, 2001). According to

URT (2000) currents estimates are around 42% of Tanzania's household's population has households with expenditures that are insufficient to obtain enough food to meet nutritional requirements.

Efforts of Tanzanian government to improve food security include to assure basic food security for the nation, to improve national standards of nutrition by increasing output, quality and availability of food commodities, to increase food crops production through productivity and area expansion, to introduce and develop new technologies which increase the productivity of labour and land, and improve crop processing technologies (URT, 1997). Nevertheless, the situation is still worse in Tanzania's agriculture does not depend only on poor tools, rainfall but also pest and diseases.

1.2 Problem statement

Until 1980s, people in the banana- based farming systems of Kagera region were relatively better off in terms of living standards compared to other areas in Tanzania (UNICEF, 1985; Nkuba *et al.,* 2003). This was attributed to good income from the sale of coffee, and food stability from banana production. But during the 1990s, the economic status of people in Kagera region dropped considerably and in 1999, Kagera was the region with the lowest per capita GDP of TSh. 149,828 compared to the highest per capita GDP of TSh. 554, 287 for Da es Salaam region (NBS, 2003).

In the region agriculture is the dominant preoccupation of the region's inhabitants. About 90 percent of the economically active population depends on crops, livestock

and fishing for subsistence and income (NBS, 2003). Major food crops grown are bananas, beans, maize, cassava, sweet potatoes, yams and sorghum. Banana is by far the most widely grown food crop in the area, covering about 27.64 percent and fallowed by 19.62 percent cassava of the total land (554,650 Ha) under crops in Kagera (NBS, 2003).

Table 2: Area (ha) under crop production district wise, in the region (1996–2002)

Crop type	Bukoba	Muleba	B'mulo	Ngara	Karagwe	Total	% of total
	Hectares						
Food crop:							
Bananas	47 830	36 807	1 870	25 549	41 289	153 345	27.64
Maize	11 490	4 440	25 445	4 347	25 523	71 245	12.85
Sorghum	-	-	8 675	3 056	2 500	14 231	2.57
Sweet potatoes	15 970	6 060	13 647	151	6 961	42 669	7.69
Cassava	15 551	15 401	33 570	9 524	34 763	108 809	19.62
Paddy	-	-	1 826	-	-	1 826	0.33
Beans	21 560	8 631	16 795	5 786	32 856	85 628	15.44
R/potatoes	-	-	-	-	361	361	0.01
Total (food)	112 401	71 339	101 829	48 292	144 254	478 115	86.20
Cash crop:							
Coffee	31 434	19 374	617	762	15 895	68 082	12.27
Tea	1 129	133	-	-	-	1 262	0.23
Cotton	-	-	7 191	-	-	7 191	1.30
Total (cash)	32 563	19 507	7 808	762	15 895	76 535	13.80
Grand total	**144 964**	**90 846**	**109 637**	**49 054**	**160 149**	**554 650**	**100.00**

Source: Regional Commissioner's Office, Bukoba, (2003).

The trend of food production between 1996/97 to 2001/02 in the Region shows that bananas production accounted for about 60 percent followed by cassava 17 percent. Karagwe District contributed about 45 percent of the regional banana production, followed by Bukoba District 23 percent, Muleba 20 percent, Ngara 11 percent and Biharamulo 1 percent (NBS, 2003).

Table 3: Estimated production ("000" metric tons) of major food crops Kagera region 1996/97 – 200/01.

Crop	Year					5 years average	% of total
	1996/97	1997/98	1998/99	1999/00	2000/01		
Bananas	902. 57	885.34	925.56	941. 51	945.00	920.00	60.1
Maize	74.80	76.50	71.90	72.70	80.60	75.30	4.9
Sorghum	9.40	8.10	9.20	9.70	9.80	9.24	0.6
Sweet potatoes	151.30	204.60	243.30	184.15	192.90	195.25	12.8
Cassava	326.35	256.10	244.80	258.65	246.50	266.48	17.4
Paddy	0.89	1.09	0.79	0.72	1.08	0.91	0.1
Beans	53.20	65.30	68.30	54.77	55.80	59.47	3.9
Round potatoes	4.00	3.40	3.56	3.60	3.50	3.61	0.2
Total	**1522.51**	**1500.43**	**1567.41**	**1525.80**	**1535.18**	**1530.26**	**100.0**

Source: Regional Commissioner's Office, Bukoba, (2003).

The decline of banana contribution to food and income to households, without cash revenue from coffee, has, caused one third of total households in Kagera region be food insecure and more than more than 50% of income of households from agriculture and non- agriculture activities to be used for food consumption (Eric, 2005). Many studies have been conducted in African countries including Tanzania to assess food insecurity and how people responded to severe crises and famine. Ashimogo *et al.* (1988), Wagao, (1991), Kavishe and Mushi, (1993), Ashimogo, (1995), Makundi, (1996), Mngondo *et al.* (1996), Ishengoma, (1998), Huysman *et al.* (1999) and Novati (2005) reported occurrence of food deficits in various parts of Tanzania. These studies revealed various effects of seasonal food problems to health and productivity of rural households. Furthermore the proportion of households in the rural areas of Tanzania that suffer from food insufficiently is as high as 77% (TFNC, 1992), and the number of households that are food insecure has been rising year after year (Kavishe, 1993).

Despite efforts made by the government and other development practitioners to address the country's economic and social problems since independence in 1961, nearly one half and a quarter of all Tanzanians living in rural areas today are considered to be basically poor and food insecure, respectively (Household Budget Survey, 2000).

1.3 Justification

The outbreak of banana bacterial wilt disease in early 2006 in Kagera region threatens banana production, district wise the total banana mats infested and uprooted were 80 000 mats (80h) in Muleba, 6000 mats (6ha) in Bukoba, 15 000 mats (15ha) in Biharamulo and 45 000 mats (45ha) Karagwe districts (Mgenzi *at el.*, 2006). According to Mgenzi *at el.* (2006) total of 146 600 banana mats have been uprooted (app.147 ha of bananas) in Kagera Region. This situation necessitates the undertaking of this study to assess the region's food security status after the occurrence of banana bacterial wilt disease.

The research findings will provide valuable guidance on the current status of the disease as well as food security in the study area, and will assist researchers in developing new technology in favour of the affected households.

1.4 Research objectives

1.4.1 General objective

To assess the effects of Banana Bacterial Wilt disease on income and food security of households in the region

1.4.2 Specific objectives

(i) To assess banana productivity trend before and after the outbreak of the disease between affected and not affected households

(ii) To analyse the impact of the disease on households food security.

(iii) To analyse the impact of the disease on households income.

(iv) To study the coping strategies adopted by households affected by the disease

1.5 Hypotheses

1.5.1 Null hypothesis (Ho)

(i) Banana productivity trend before and after the outbreak of the disease is not statistically significant between affected and unaffected households.

(ii) Household income situation between affected and not affected households does not differ significantly.

(iii) The food security situation between affected and not affected households does not differ significantly

(iv) There are no any copping strategies adopted by households affected by the disease.

1.5.2 Alternative hypothesis (H1)

(i) Banana productivity trend before and after the outbreak of the disease is statistically different between affected and unaffected households.

(ii) The income levels between affected and not affected household differ significantly.

(iii) The food security situation between affected and not affected households differ significantly.

(iv) There are several copping strategies adopted by households after by outbreak.

1.6 Conceptual framework

The conceptual framework is a narrative outline presentation of variables to be studied and hypothetical relationship between and among the variables. Agrios, (2005) defined epidemiology as study of disease in the populations, and they believe that frequency of occurrence of disease in the population is governed by the interactions of large number of factors or determinants. A determinant is any factor or variable that can affect the frequency at which a disease occurs in the population and further can be classified as being either intrinsic or extrinsic in nature (Putt, 1987).

Intrinsic determinants are physical or physiological characteristic of the disease agent which further can be categorized into living agents such as bacteria, viruses, protozoa etc and Non living agent, such as water, toxic substances, nutrients etc. (Agrios, 2005).

Extrinsic determinants of disease are important in the epidemiology in that, they can have effects on the host and agent interaction. They include climate, soils and Human. Climate is made up of different factor such as heat, cold, rainfall, wind, humidity etc which can act as disease agent on their own right, either individual or in combinations. Also can affect the ability of the disease agent, or host to survive in the environment.

Lack of balance nutrients in the soil can be the direct cause of the disease, or can stress the host and thus increase plant susceptibility to infection and disease from other sources. Also soil can have an effect on the ability of agent to survive in the environment, such as water logging and PH. (Eden- Green, 2004).

Climate and soil interact in the variety of ways which affect the environment of the host, agent and are involved in the transmission of disease, thus determine the type and extent of disease transmission. (Brandt *et al.*, 1997; Gnanamanickam *et al.*, 1999).

Human create conditions favourable for survival and can alter the determinants of the diseases present in that environment and changes in determinants of the disease present in that environment. The changes in determinants will favour diseases to be detrimental to others, and thus changes in systems and methods of production that will results in changes in the relative importance of the diseases present. (Putt, 1987, 1988).

The consequence of the interaction among the determinant, host and cause agent is reflected in the production system which can lead to low production and copping strategies against low production (Figure 1).

The low production situation affects food security and income of the affected households (Eden- Green, 2004; Agrios, 2005).

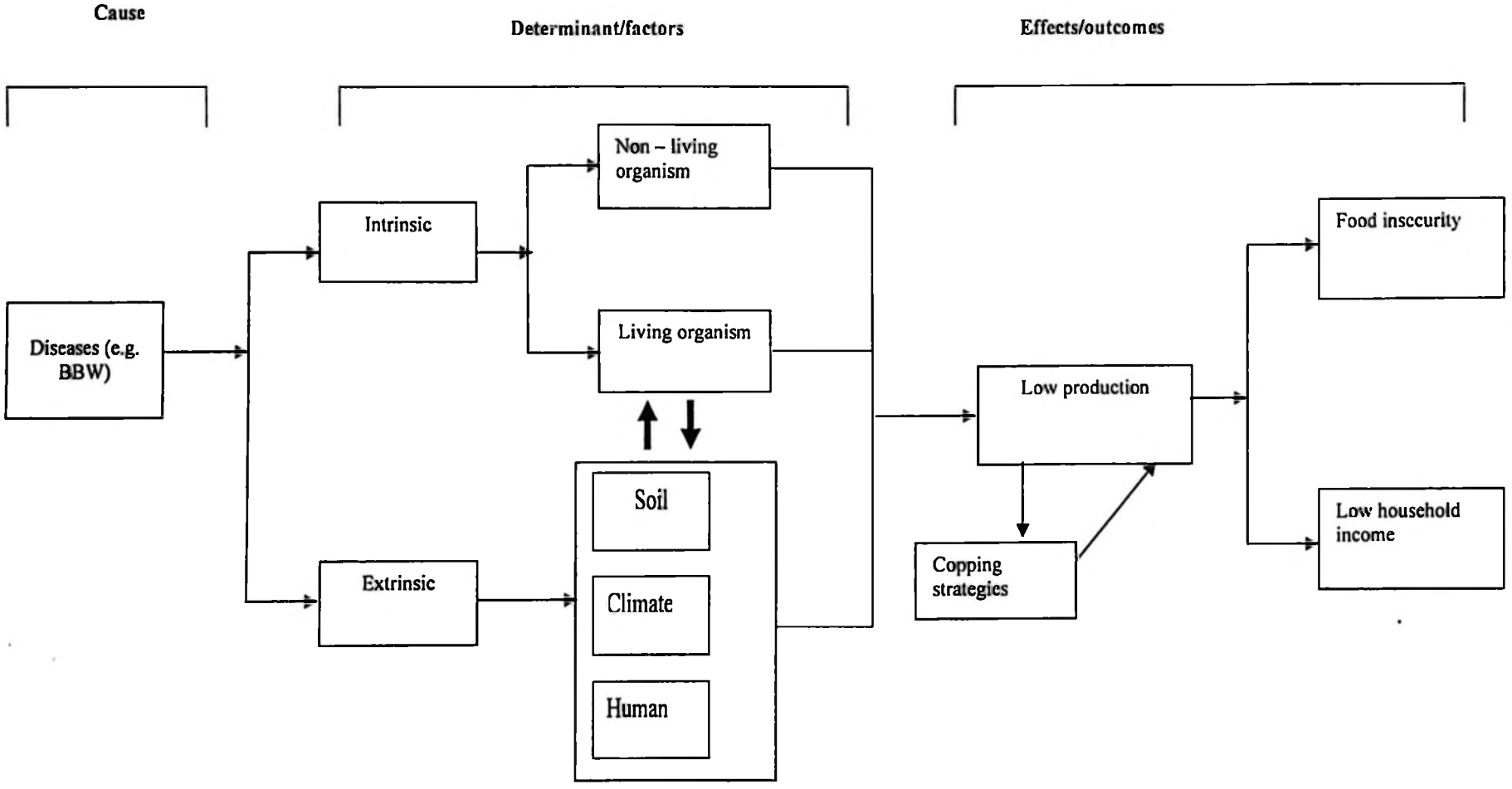

Figure 1: Conceptual framework

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definitions of concepts

Food security

Food security is defined as situation in which all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2001). Food security depends on the availability, accessibility, adequacy and acceptability. The most frequently used definition is probably the one by the World Bank (1986), "access by all people at all times for enough food for an active, healthy life." Other definitions include one by FAO/WHO (1992), which defined food security as "the ability of the household to secure, either from own production or through purchases adequate food for meeting the dietary needs of its members". This study adopts the definition stated by FAO/WHO (1992).

Adult equivalent units (AEU)

The number of household members adjusted for a composition (by sex and age) and nutrient requirements so that all the members are equivalent to adults (Collier *et al.*, 1990, World Bank, 1993). The number is normally smaller than the household size and even smaller in households with more children, females and the old since these need fewer nutrients than adults, men and relatively younger people, respectively.

Household

It is a social group which resides in the same place, shares the same meals, and makes joint or coordinated decisions over resources allocation and income pooling (Ellis, 1993:Ch.1 as cited by Ellis, 2000). This study defines household as total number of all members in the house as a unit.

Impact assessment

DfID (2001) defines impact assessment as the process of identifying the anticipated or actual impacts of a development intervention on social and economic factors which the intervention is designed to affect or may inadvertently affect.

According to Anandajayasekeram and Martella (1996), the term impact assessment is defined as a special form of evaluation which measures the intended and unintended changes of an intervention or technology. Similarly Baker (2000) and Prennushi, *et al.*, (2000) defined impact assessment as an assessment of the extent to which interventions or programmes cause changes in the well-being of target populations, such as individuals, households, organisations, communities, or other identifiable units to which interventions are directed in social programmes. All these definitions emphasize measurement of the direct and indirect effects of the project on the targeted beneficiaries. The study adopts the definition of Baker & Prennushi.

Banana mat

Banana mat is defined as a banana mother plant and all of its plantlets (Svetlana, 2005).

2.2 Importance of banana in Tanzania

The importance of banana as a food crop in Tanzania varies from place to place. In the high rainfall highlands of Kagera, Kilimanjaro and Arusha, banana is a principal carbohydrate source (Sekiku, 2005). However, other regions also use banana as food, but to a much lesser extent. Overall about 30% of the people in rural Tanzania principally derive their carbohydrates from bananas with annual per-capita consumption in the range of 28-500 kg. (Sekiku, 2005).

Bananas are used for brewing two famous local brews, Lubisi and Mbege in Kagera and Kilimanjaro respectively which is used as source of income in households. The leaves and leaf sheaths are put to various uses including: thatching houses, feeding animals, making domestic ornamental objects, packing materials and as well as plates (Mbwana, 2005).

Throughout the year round fruiting habit makes banana a very reliable food and income source for the banana dependant communities. On steep highland slopes, the crop is important for minimizing soil erosion through its root system and the mulch it provides from dried leaves and pseudo-stems (Mgenzi, and Mbwana 1999).

Further more banana is considered as an indirect supporter of coffee production in Tanzania, not only as a continuous food source to the coffee growers, but for windbreaks and shade to young coffee trees (Nkuba *et al.*, 2003).

2.3 Banana growing areas

Kagera region forms part of the banana growing areas along Lake Victoria that stretch from the northeast portion of the lake through central and western Uganda. Farmers in this region grow many of the same banana types (genomic groups and clone sets) and similar cultivars (clones), and similar cultivars (clones), though with different local names (Mbwana, 2005). The other production areas in Tanzania are the highlands of Kilimanjaro, Arusha and Tanga in the Northern Zone, Mbeya, Ruvuma and Iringa in the Southern Highlands Zone, Coast and Morogoro in the Eastern Zone and Zanzibar Islands (Mbwana, 2005).

2.4 Banana production

From 1992/93 to 2000/04, the total cultivated area under bananas ranged from 0.25 to 0.35 million ha, equivalent to 2.5 to 3.5 percent of the total cultivated land area in Tanzania. (Sekiku, 2005) Over the same period, national average banana yields were from 2.4 to 3.5 tons per ha and production ranged from 0.7 to 2.6 million metric tons per year, depending on weather conditions (Nkuba, 2007). Based on production records the banana crop ranks third after maize and cassava crops (Nkuba *et al.*, 2003).

The total estimated annual production of bananas in Kagera region is 1.26 metric tons on 187 000 ha, which is equivalent to 6.81 tons per ha (Mbwana *et al.*, 1997, Sekiku, 2005). The attainable yields recorded by research at on-farm and on-station trials range from 25 to 40 tons per ha, while the actual yields obtained by farmers ranges from 6 to 10 tons per ha (Mbwana, *et al.*, 1997).

2.5 Banana production constraints

The major banana production constraints faced by farmers in Tanzania include increased pressure of pests and diseases, declining soil fertility and poor agronomic practices (Ndile *et al.*, 1999). The major pests and diseases of bananas found in Tanzania are banana weevils (*Cosmopolites sordidus*), nematodes (different species), Black Sigatoka (*Mycosphaerella fijiensis*) and Fusarium Wilt (*Fusarium oxysporum cv cubence*) (Mgenzi and Mbwan, 1999).

Banana-based farming systems receive high levels of rainfall, which contribute to leaching of soil nutrients (Baijukya and Steenhuijsen, 1999). Large amounts of soil nutrients are removed through the harvested fruit bunches, especially if bunches are sold and taken away (Baijukya and Steenhuijsen, 1999). Lack of nutrient replenishment in turn leads to declining banana productivity, this is due to producer prices are too low to justify the use of chemical fertilizer in banana production. The situation is made exacerbated by inadequate extension and research services, poor farm input distribution systems, high prices of inputs, and lack of credit, for either farmers or traders (Ndile *et al.*, 1999; Mgenzi, and Mbwana, 1999).

Further more many producers and traders have no information about prevailing prices in markets within and outside the country, further more banana bunches are bulky in nature and perishable, farmers often have little alternative but to sell bananas at "throw away" prices (Nkuba, *et al.*, 2002).

According to Nkuba *et al.* (2002) processing technology could support product differentiation, eliminating at least some of these problems. However, processing of bananas into products with longer shelf life products such as dried bananas, banana flour, banana biscuit and breads is not well developed in the country. Only an estimated 5 percent of all banana production is processed (Mbwana *et al.*, 1997).

2.6 Banana bacterial wilt

In 2001, a banana bacterial wilt disease (hereinafter referred to as Banana *Xanthomonas* Wilt- BXW) was detected for the first time in central Uganda (Tushemereirwe *et al.*, 2001).

The disease previously known only from *Ensete* in Ethiopia, it developed within just three years of its discovery in central Uganda into a full-blown epidemic, spreading throughout the eastern, central and north-western districts of the country (Eden-Green, 2004). Beyond Uganda, other outbreaks were also confirmed in the North Kivu region of the Democratic Republic of Congo (2004) and in Rwanda (2005). The disease is poised to spread into Tanzania, Burundi, Kenya and other neighboring countries. The causal agent of the disease was identified as *Xanthomonas campestris* pv. *Musacearum* and relatively little research has been carried out specifically on this pathogen and the damages it causes in banana (Mgenzi and Kavia, 2006).

According to Yirgou and Bradbury (1974), BBW Task Force (2003), Eden-Green, (2004) long distance transmission of the disease is aided through: (a) farm tools such

as machetes, pangas and pruning knives. Contaminated tools transmit the bacteria through injuries on roots and aerial parts when farming, (b) movement of infected plant materials (suckers, bunches, leaves), (c) contamination of body parts (hands and feet), (d) insects as they look for nectar in flowers, (e) animals as they browse from infected to clean plants, (f) water when it moves around infected soil, and (g) rain splash and wind, Rain is believed to aggravate the spread of the disease within a plantation during the rainy season.

The disease is transmitted by insects like sting less bees, wasps and ants from one banana stand to the other, but this is more of a localized spread once the disease breaks out in a specific area. Transmission over long distances, however, is believed to be largely due to human activities such as movement of diseased plants, plant parts or contaminated stands (BBW Task Force, 2000).

The disease has been found to be very destructive with incidence of 70-80% in many plantations per year. The pathogen destroys the banana fruits and is known to result in almost total loss of production (Tripathi *et al.*, 2004) The economic impact of the disease is further manifested in its ability to reduce yield of banana due to smaller and lighter bunches and poor fruit filling (BBW Task Force, 2003).

External symptoms of the disease are clear on plants parts the maiden sucker stage and recently flowered plants. The major manifestations of the disease are yellowing and complete wilting of the plant starting with the most peripheral leaves, as with

fusarium wilt. However, unlike fusarium, which does not affect East African cultivars, this bacterium affects all banana types (Tushemereirwe *et al.*, 2003)

The fruits exhibited discoloration of the pulp when they are sectioned. After wilting, the leaves tend to drop and the plant eventually stops growing and dies. Secretion of bacterial ooze can also be seen on leaves. Such secretions are absent in the case of fusarium wilt and can be used to distinguish the two diseases on cultivars that are also affected by fusarium wilt (Tushemereirwe *et al.*, 2003).

The internal symptoms of the disease include a pale yellow discoloration in the cross section of the corm of most affected plants. When the pseudo stems of affected flowered plants are sectioned, discoloration is much more apparent in the central stalk that carries the bunch than in the outer leaf sheaths. A lot of liquid can be observed to ooze from the sectioned stems of affected plants, and on leaving the sectioned tissues overnight, the ooze changes into a slimy Liquid.

2.7 Food security

Food security can be addressed at global, national, regional, community, household and individual levels. Ultimately, however, food security refers to individuals in a household (WFP, 1998).There are many indicators used to measure levels of food security example: meals/day, change in diet, percentage of spent in total income on food and changes in adult anthropometry (FS, 2002).

The World Bank defines food security as access by all people at all times to enough food for an active and healthy life, a definition, which has been widely accepted (World Bank, 1986). This definition encompasses two elements: (1) food supply and (2) the access or the ability of households to acquire food, either through their own production or through purchase. Although increased food production alone does not ensure food security for all people, it is an important component of food security. In general, food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (USAID, 1992).

2.8 Income

Income is one of the important aspects of food security due to the facts that it assists in buying food stuffs particularly during the food deficit. Lack of insufficient income can hinder one's ability to afford buying food, rendering him/her to be food insecure. Income is even more important to rural people who are engaged in activities other than farming, for example fishing, labour selling etc as well as to urban people who depend solely to income obtained, for buying all kind of food stuffs (Novati, 2005).

2.9 Assessment studies of banana bacterial wilt disease

According to Eden- Green, (2004) one of the most susceptible cultivars in Uganda ' Pisang awak' locally known as ' Kayinja' , is widely grown for production of banana beer" that is a source of income for many households. Many households also obtain cash income from selling 'Kayinja' leaves that are used in preparation of food

(Eden- Green, 2004). Households are reluctant to destroy ' Kayinja' even if the plants are infested and it's very difficult to persuade households to destroy diseased mats since occasionally a diseased mat may still produce a normal bunch (Agrios, 2005).

According to Karumula *et al.* (2006), banana bacterial wilt disease causes banana yield loss of about 30-52% at different level of pre-infection; this has caused a reduction in the amount of banana harvested by households which has impacted livelihoods negatively. This effect leads many households switch to other crops while others abandon banana cultivation. Alternative food sources such as sweet potato and cassava have been provided to households in badly affected areas by NGOs (Karumula, 2006). While some farmers have adopted alternative crops, other still prefer banana as the staple (Tushemererwa and Opolot, 2005).

The impact of banana bacterial wilt on banana production in East Africa is not full determined (Karumula *et al.*, 2006). Although the economic loss of the disease on the welfare of the households and the economy of the countries is not well documented, an economic analysis of the disease has to be based on findings from central Uganda, where the disease occurred first and is widely spread, and possible to forecast the economic impact of banana bacterial wilt disease pandemic in other areas by extrapolating the observations made in this region (Tushemererwa and Opolot, 2005).

CHAPTER THREE

3.0 METHODOLOGY

3.1 The research area

The research was conducted in Kagera region. The Region was purposively selected because the first outbreak of banana bacterial wilt disease was observed there. Two districts were purposively selected Muleba and Misenyi districts because they were the most serious affected districts compared to other districts in the region.

3.1 Location of the study area

Kagera region is situated in the north-western corner of Tanzania, on the Western shores of Lake Victoria. It lies just below the Equator between latitudes 10^0 0.5' and 20^0 45' South and between longitudes 30^0 25' to 32^0 40' East of Greenwich. The region borders Uganda in the North, Rwanda and Burundi in the West, and in the South, Kigoma, Shinyanga and Mwanza regions. The total area of Kagera region is estimated to be 39 258 square kilometres, with 1.85 million hectares of arable land. The area under water is 28 513 square kilometres. Until June 2007 Kagera region was sub-divided into six administrative districts namely: Biharamulo, Bukoba Rural, Bukoba Urban, Muleba, Chato, Misenye, Karagwe and Ngara (Nkuba, 2007).

3.2 Research design

Non-experimental design was employed whereby a cross-sectional research design was conducted. The design was chosen because it is suitable for the study in which data for single year are considered which was the case of this research (Cooksey and Lokuji, 1995 cited by Novati, 2005).

Regarding the affected villages Muleba and Misenyi districts, villages were purposive selected as per literature (Mgenzi and Kavia, 2006). Key informants included Maruku agricultural research institute and District agricultural and livestock development offices in Muleba and Misenyi.

In collaboration with the above key informants, in Muleba district, Kabale and Ibumilo villages were purposive selected as affected villages and Katoke village were random selected from the list of villages in the district as not affected village (Control Village). While in Misenyi district Ngando and Bweyunge were purposively selected villages that were affected by the disease, while Kasambya was randomly selected from the district list of villages not affected (Control village).

Thereafter simple random selection was done, where twenty affected households and fifteen not affected households were selected from each affected villages, giving thirty five households per affected village. This makes one hundred and forty households in total in the affected villages. Lastly thirty households were randomly selected in each of the unaffected villages making a total of sixty households. According to Bailey, (1994) who argues that regardless of the population size, a sample or sub-sample of 30 households is the bare minimum; this adhered to the study sample of 200 households.

3.3 Sources of data

3.3.1 Primary data collection

A questionnaire was used to interview respondents to get both qualitative and quantitative data. Discussion with Focus Group Discussion using a checklist was

used to get in-depth understanding of the banana bacterial wilt to income and food security.

3.3.2 Secondary data collection

Secondary data such as background information, yields, etc, was extracted from relevant reports and other documentary materials available in Muleba and Misenyi districts, Institutions such as Sokoine National Agricultural Library (SNAL) in Morogoro, Tanzania, and Maruku Research Institutes in Bukoba, Tanzania.

3.4 Data analysis

Data collected from primary sources were coded, entered and analysed using the Statistical Package for Social Sciences version 11.5 (SPSS) and Excel computer programs. Both qualitative and quantitative analyses were carried out, qualitative analyses produced frequency distribution, percentages and cross tabulations. Comparison of means using independent t – test was used to check for any differences in the variables between affected and not affected households.

Methods of data analysis in food security were borrowed from tools and techniques of dietary energy consumption developed by FAO/WHO/UNU expert consultation group, Seshamani (1981: 9), Ashimogo (1995), and Novati (2005). While methods of analysing income data were borrowed from tools and technique of Deaton and Muellbauer's approach, Collier (1990), as explained in chapter 4

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 An overview

In this chapter, the results of study are presented and discussed in line with study objectives. Data presentation and discussion is divided into six sections: Section one presents calculation of major variables, section two analyses the socio- demographic characteristics of respondents, section three discusses the trends of banana productivity before and after outbreak of disease, section four discusses the dependent variable food security and its independent variables, while section five analyses dependent variable income and its independent variables results, and finally section six discusses coping strategies adopted by affected households.

4.2 Calculation of major variables

4.2.1 Trend of banana productivity

The effect of the disease in banana production was measured by comparing the banana productivity in the affected and not affected households before and after outbreak of the disease. Production was recorded in bunches (Total consumed, sold, and given to relatives) and then converted into Kilogramme. The conventions were obtained by measuring separately the weight of cooking banana (Indigenous one) and of income generating banana (The improved one) in each village of study, this was done prior to the survey and during the open market of the respective village, to simplify getting the intended bunches. The samples were obtained by randomly selection of ten household farms in each village of study. Further more two bunches of cooking banana and two bunches of income generation types were randomly

selected making a total of four bunches in each household farm, and finally forty bunches per village. The selected bunches were weighed using hanging scale, finally the average weight of bunches in each village were obtained. Then the average weight used to convert banana bunches into kg in respectively village. The following average weights were obtained in each village, in Muleba district: Kabale village (1 bunch = 13kgs), Ibumilo village (1 bunch = 15kgs, and Katoke village 1 bunch = 28kgs, While in Misenyi district, Ngando village 1bunch = 12.65kgs), Bweyunge village (1 bunch = 14kgs) and Kasambya village (1 bunch = 22kgs). This difference in average weights was due to whether and farm management practiced in different villages. Excel software were used to convent number of bunches into kilogram in each household.

The productivity trend was measured in affected and not affected households before and after the outbreak of disease by comparing yield (Kg/acre). The results were compared with the potential yield in each district under the study because banana production is influenced by other factors than the disease, for example farm management. The gap was the effect of the disease and was tested by independent sample t –test by assuming equality of means to justify the differences.

4.2.2 Food security analysis

Determination of dietary energy consumption

The information of frequency and types of food (Kg) eaten by each household was collected and converted to dietary energy consumption basing on calorie intake estimation based on nutrient content of each food, adjusted for edible portion (Ashimogo, 1995).

Food availability was in turn, measured by the daily dietary energy and protein intake levels, and adjusted for household size, age and gender composition as recommended by FAO/WHO/UNU expert consultation group (FAO-WHO-UNU (1985) cited by Ashimogo 1995,). Household differs in size and those children, women and old people need fewer nutrients than adult men, (Collier *et al.*, 1990: World Bank, 1993) therefore household size will be converted to adult equivalent units. According to Seshamani (1981:9) cited by Ashimogo (1995) and Novati (2005), in Tanzania foods other than cereals contribute about 20% of energy in diet and 80% from cereals. Convention based on maize equivalent energy content of other non-maize carbohydrate foodstuffs was used in this study where staple food is banana (Table 4).

Table 4: Food energy values (FEV)

Commodity	Kcal/Kg
Cereals:	
Maize	3570
Wheat	3320
Rice	3630
Sorghum	3450
Millet	3410
Non-cereals:	
Cassava, flour	3550
Cassava, dried	3180
Cassava, fresh	1490
Sweet potatoes, fresh	1210
Cooking Bananas	1530

Source: FAO and SADC

The average daily calorie requirement for a moderately active adult per day is 2780kcal/AE/day (FAO-WHO-UNU (1985) cited by Ashimogo 1995). According to the World Health Organization (WHO), a safe minimum daily intake should be

2,280 Kcal/day, which was the benchmark for food security in this study. To obtain such Kilocalories, an adult has to consume 568grams of maize per day, which is equivalent to 207.3 kg of maize or cassava or any grain expressed in maize equivalents per year (Ashimogo, 1995).Therefore, the following equation was used to get dietary energy consumption:

X = Grains actually consumed per AE per day (Kg) X 2,280Kcal per AE per day/0.568kg.

Where:

X = Dietary energy consumption.

2,280Kcal/AE/day = Minimum grain equivalent consumed per day

If it is assumed that 30% of the grain (maize or rice) are lost during processing and cooking (West *et al.*, 1988), then the amount of grain (maize and Rice) consumed in household was multiplied by 70% to get actually amount of grain consumed per day (Kg). Then the above formula was used to calculate the Dietary Energy Consumption (DEC).The amount of dietary energy consumed that was obtained in the above formula was multiplied by 80% in order to cater for 20% of energy consumed in food other than grains. In order to quantify the differences in food security levels between affected and unaffected households, a t-test was run to find if they were significantly different between food insecure and secure households.

4.2.3 Income analysis

Expression of variable values per adult equivalent

Information on different sources of income in each household was collected by asking the head of household to mention different sources of income for his/her household per year. In case of banana respondents were asked to provide estimates of their banana production in 2007. Total banana production for any given household comprised the quantity consumed in the home, the quantity sold and the quantity given out to relatives and friends or for social functions (if any). To get a more realistic estimate, the information was solicited on a monthly or peak basis, thereby allowing the household head to reflect on a shorter period than an entire year. Then it was converted to adult equivalent basing on the following recommendation;

In the analysis of household food security, standardisation or scaling is necessary in order to account for differences in household size and age. Since adult equivalent scales for Tanzania have not been estimated for any one who may need to use them, in this study they were estimated following Collier *et al.*, (1990) procedure in their study in Tanzania. The two step procedures were done by combining nutritional requirement approach and Deaton and Muellbauer's approach, using the figures in Table 4 and 5. In the first step each household member was assigned an appropriate adult equivalent unit, and all the weights for all the members of household were summed up to get household sizes in adult equivalent units (AEU).This step was done to adjust for household composition owing to the fact that children, women and old people need less nutrients than adults, men and young people respectively

Collier *et al.*, (1990). In second step was important to take into account economies of scale since large household need less resource per person due to sharing some facilities. Dietary energy consumed by each household was divided by its own adjusted adult equivalent units (AAEU) to get corresponding values of DEC per adult equivalent. In order to quantify the differences in income levels between affected and unaffected households independent sample t-test was used to justify the difference.

Table 5: Equivalent scales for adjusting aggregate household size

Age category (years)	Sex based in adult equivalent scales		Household size*	Economies of scale
	Male	Female		
0 to 2	0.40	0.40	0 to 2	1.000
3 to 4	0.48	0.48	2 to 3	0.946
5 to 6	0.56	0.56	3 to 4	0.897
7 to 8	0.64	0.64	4 to 5	0.851
9 to 10	0.76	0.76	5 to 6	0.807
11 to 12	0.80	0.88	6 to7	0.778
13 to 14	1.00	1.00	7 to 8	0.757
15 to 18	1.20	1.00	8 to 9	0.741
19 to 59	1.00	0.88	9 to 10	0.729
60+	0.88	0.72	10+	0.719

Source: Richards *et al.*, (2003)

* Measured in number of age and gender-weighted, adult equivalent units.

Example

In order to find the adult equivalent total annual income of household number one of the research in the Table 6 below, given the following composition and a total annual income of Tshs 221,750 for the whole household, the following procedure was used.

Table 6: Example: Total annual income of household member

Household members	Sex (Male/Female)	Age	Individual No.
a) Household head	Male	45	1
b) Wife	Female	43	2
c) Children: 1.	Male	23	3
2.	Male	17	4
3.	Female	15	5
4.	Female	13	6
5.	Female	12	7
6.	Male	2	8
Total -	-	-	8

First step: Finding adult equivalent units using Table 5 and 6 statistics

Adult equivalent units (AEU) $=1.00_{(1)} + 0.88_{(2)} + 1.00_{(3)} + 1.20_{(4)} + 1.00_{(5)} + 1.00_{(6)} + 0.88_{(7)} + 0.40_{(8)} = 7.36$ AEU

Second step: Adjusting the adult equivalent units for economies of scale

Adjusted adult equivalent units (AAEU) are equal to the number of adult equivalent units' times the average cost factor. The adult equivalent unit (AEU) is, 7.36. The average cost factor corresponding to eight AEU is 0.741.

Then, AAEU = 7.36 X 0.741 = 5.45, Since the annual total income for the whole household is 221,750/=, the total annual income per adult equivalent is Tsh 221,750/= /5.45, which is equal to Tshs 40,688/= The procedure was done for each of 200 households of the research to get various values per adult's equivalent units, which was compared to adult equivalent per day which is 259/= as documented in the Household budget survey report of 2000/01 (NBS, 2002).

4.3 Socio-demographics of respondents

Information was elicited on the composition, sex, age, marital status, education household size and main occupation of household members. Only one member of each household was designated as the household head.

4.3.1 Sex of the household heads

A household being headed by female or male may influence income, food security and productivity within the household (Novati, 2005). Most of Female head of household are those that are headed by widows who have lost their spouses and they are normally characterized by not only a burden of dependants (Mostly grand children) but also with low income. Usually, each household tends to be food insecure because they are poor and they can not work properly in the fields as well as doing non farm activities to earn money. The proportions of male-headed households (MHHs) and female- headed households (FHHs) interviewed are presented in Figure 2.

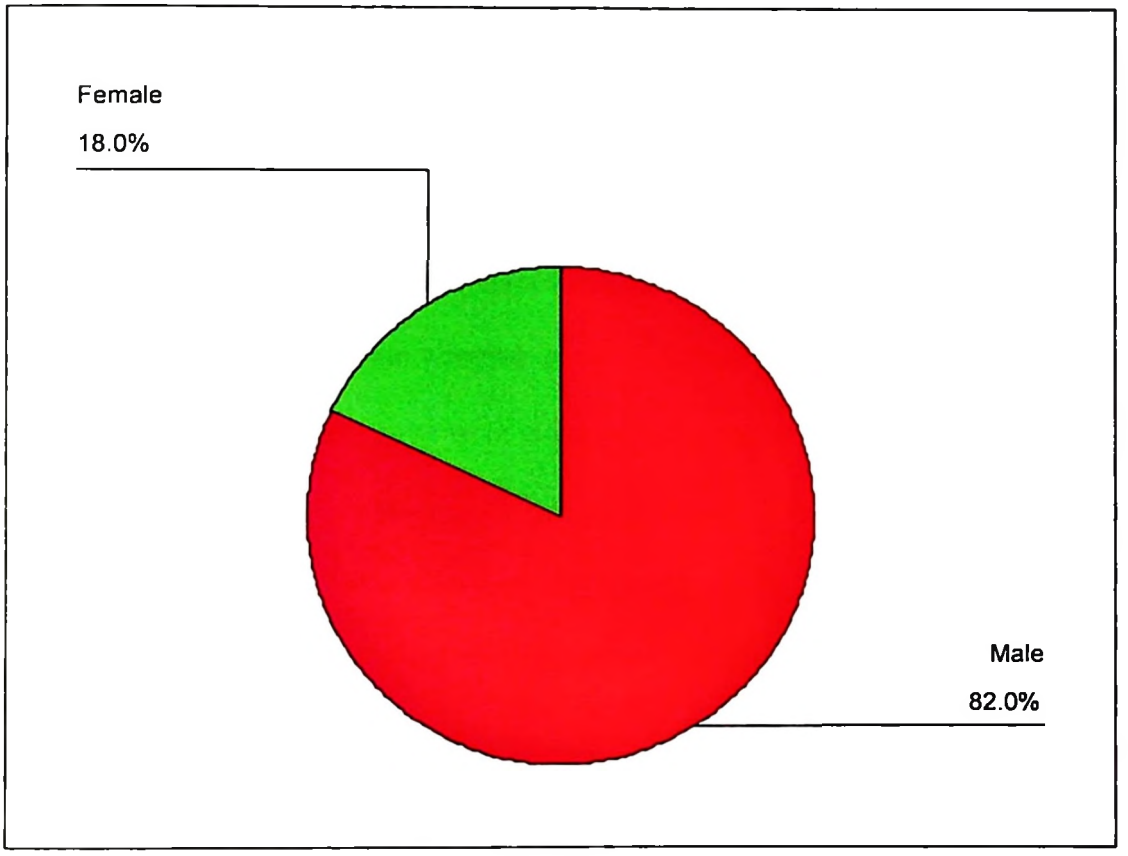

Figure 2: Kagera region: Sex of heads of households (n=200).

Among the surveyed households, female headed households (FHHs) were 18%, while male headed households (MHHs) were 82%. According to Novati (2005), FHHs among smallholder farm households in Tanzania are almost 30%. In the study done by Tanzania Demographic and Health survey (TDHS) in 1996 results shows that rural areas female head 21.3% of households (Minja, 2007).But World Bank (1993), cited by Novati, (2005), reports that in rural Tanzania FHHs are only 5.8%. The above contradictory information implies that the number of FHHs in this study area may have been either over or under presented. The percentage of interviewed FHHs (18%) was almost the average of the percentages reported by other researchers, as seen above.

4.3.2 Marital status of household head

Married couples are likely to be more productive than single one due to labour reinforcement (synergy) in accomplishing farm and non farm activities, hence the former are more likely to be in a food secure situation (Novati, 2005). Households with widowed, separated and divorced household heads are normally characterized by more dependants than married ones (Minja, 2007). Most of the widowed households in the study area were old and had a burden of dependants who were mostly their grand children (Figure 3). This category of dependants normally cannot participate in either agricultural production or in income generating activities, resulting into a food insecure situation in households with many dependants. The result shows that 78.5% of the interviewed households were married.

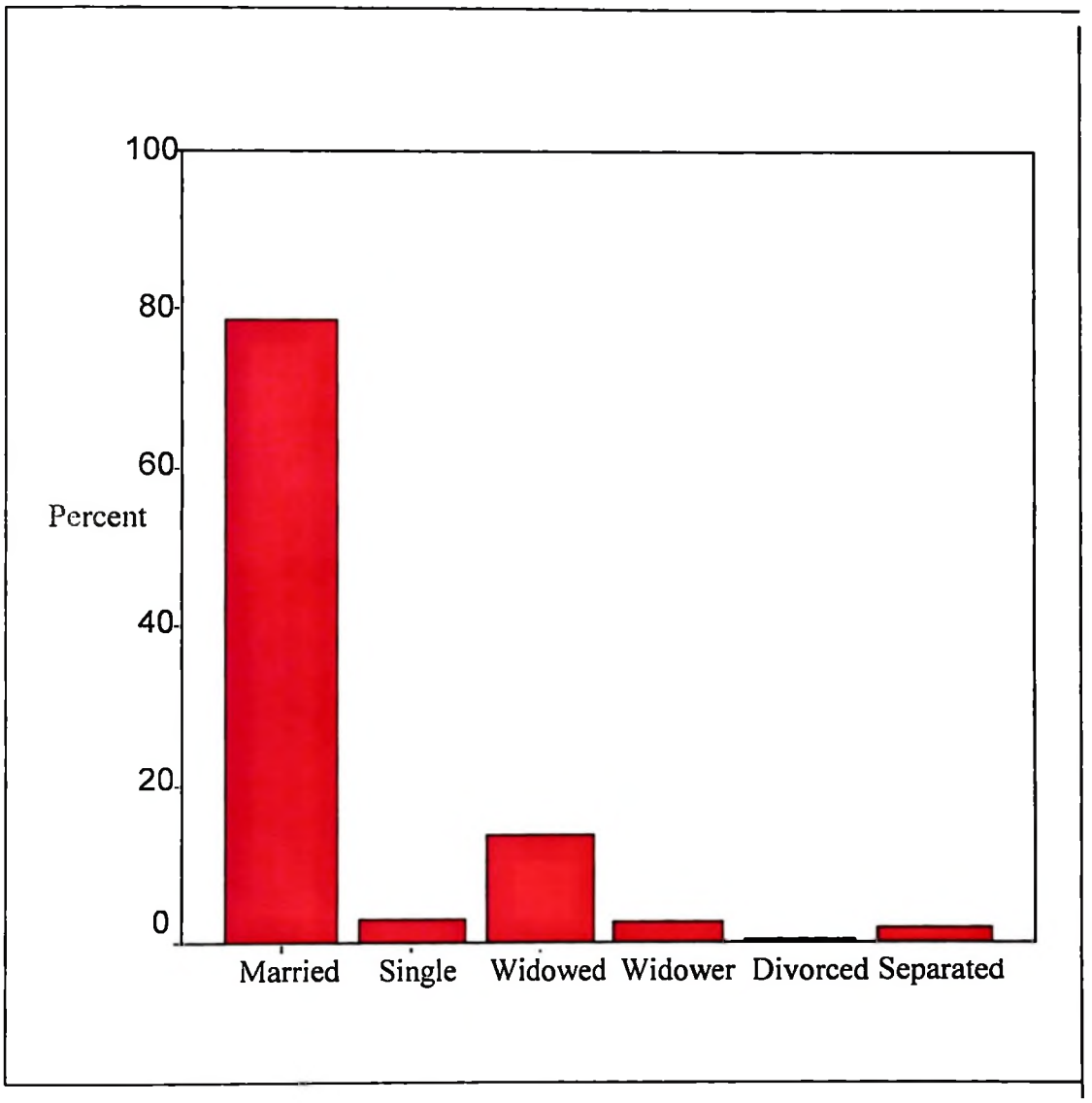

Figure 3 : Kagera region: Marital status of heads of households.

4.2.3 Main occupations of household heads

The findings indicate that 94.5% of respondents were involved in crop production (Table 7). This implies that land is scarce to the people living in Kagera and is very important resource for their livelihoods. This is due to the fact that the majority depends on agriculture, for food as well as income, for example they produce banana as food as well as cash crop and sell coffee for income generation.

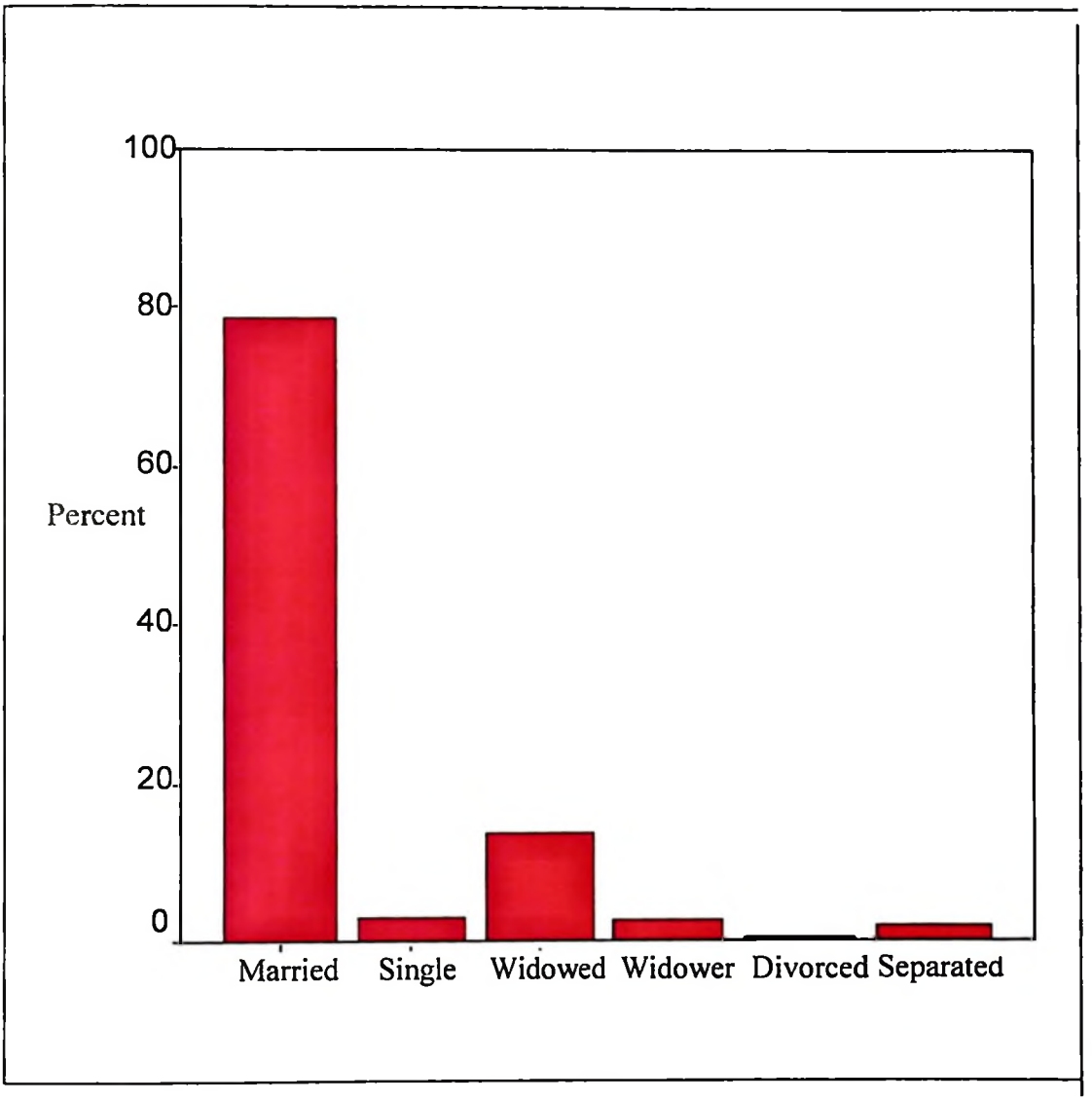

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Table 7: Kagera region: Occupation of heads of households (n=200)

Occupation of head of household	Number of head of household	Percent (%)
Farming crops	189	94.5
Fishing	1	0.5
Employment	10	5.0
Total	200	100.0

4.3.4 Age – sex composition of household members

Age has influence on productivity as well as on food consumption. Age of the household head influences decision making and provision of labour itself (Minja, 2007). There is difference in food consumption among household members (Collier *et al.*, 1990). Moreover, energy requirement among household members differ (Minja, 2007). For example, children need less food than adults and females need less food than male (Collier *et al.*, 1990). Furthermore, children, women and old people need less nutrients than adult, men, women and young people respectively (Collier *et al.*, 1990; World Bank, 1986; and 1993). Therefore, age composition of household members was considered to be an important factor in this study. Ages of household heads were treated on individual basis, the highest age of head of household was 86 years and the lowest was 22 years , with big number of household heads (29.5%) having ages between 41 -50 years. Table 8 Shows that a greater proportional of household head aged over 64 years are men.

Table 8: Kagera region: Age – Sex composition of members of household (n=200)

Age group	Men	Women	Total
21-30	13(6.5)	0(0.0)	13(6.5)
31-40	37(18.5)	3(1.5)	40(20.0)
41-50	44(22)	15(7.5)	59(29.5)
51-60	23(11.5)	6(3.0)	29(14.5)
61-70	25(12.5)	8(4.0)	33(16.5)
71-80	17(8.5)	4(2.0)	21(10.5)
>81	5(2.5)	0(0.0)	5(2.5)
Total	164(84)	36(18.0)	200(100.0)

4.3.5 Level of education of household heads

A person with higher education level is expected to have more knowledge than a counterpart with lower education (Novati, 2005). Normally, through formal education one gets more knowledge and skills that can enhanced ones ability to effectively produce, get higher returns and make one to be food secure (Regnar *et al.*, 2002).. Furthermore, farmer's education is very important for their ability to efficiently utilize the advice and information offered by the extension service and development agency (Regnar *et al.*, 2002).

The levels of household head were obtained by asking respondent to state the level of education attained as opposed to informal learning. The results show that (74.5%) of respondents had primary school education and 9% had secondary education, and 3. % had more than secondary education. However, 13.5% of respondents had not attended school at all (Table 9). It is impressive that 86% of respondents had some formal education that could enable them to read leaflets of newly introduced technologies and hence be able to use them. Nevertheless, it is important that the illiterate group be given special attention when information is being disseminated.

Table 9: Level of education of household head (n = 200)

Level of education of head of household	Number of head of household	Percent
No education	27	13.5
Primary education	149	74.5
Secondary education	18	9.0
Collage education	6	3.0
Total	**200**	**100.0**

4.3.6 Household size of surveyed households

Taking into account that the size of household may affect food security situation within a household, the number of household member were recorded. The results in Table 10 show that average household size among the surveyed household in Muleba and Misenyi districts was 7.1 and 5.4 respectively. This figure differs from the official census of household size of Muleba and Misenyi districts of 4.9 and 4.4 respectively (URT, 2003). The reason for the discrepancy is the fact that rural households normally have bigger household size than urban ones, whereas the official census household size of 4.9 and 4.4 includes also urban households whose size are normally smaller.

Table 10: Kagera region: Household size of surveyed households (n = 200)

District	Mean	N	Std. Deviation	% of Total N
Muleba	7.1600	100	3.2058	48.3
Misenyi	5.7200	100	3.0387	51.7
Total	6.4400	200	3.1981	100.0

4.2.7 Land ownership

Results show that Ngando village in Misenyi district is leading with households possessing an average of 6 acres each with standard deviation of 10; this means that

there is a great variation in land sizes in the village, while those from Bweyunge village in the same district had the least of about 3 acres (Table 11). Large land size per household explains the availability of one of the main factors of agriculture production; it offers possibility that those having more land adopt of more exotic and novel technologies as compared to those having less. But land productivity is affected by technology involved in farming and soil fertility (Manyong *et al.*, 2008)

Table 11: Mean land sizes (acres) ownership by surveyed villages in Muleba and Misenyi

Items	Name of village						
	Kabale	Ibumilo	Katoke	Ngando	Bweyunge	Kasambya	Total
N	35	35	30	35	35	30	200.0
Mean land sizes (acre)	3.6	3.4	4.3	6.3	3.2	5.0	4.3
Std deviation	2.6	3.4	5.5	10.6	3.6	4.0	5.7

4.4 Trend of banana production

The first objective of the study was to investigate the trend of banana production in the affected and not affected households before and after the outbreak of the disease. The respondents were asked to mention the amount of banana bunches harvested from 2005 to 2007 with their respectively area planted. Also general information of total land owned, land under cultivation and tenure type were asked.

4.4.1 Proportional area under banana to total area under cultivation

4.4.1.1 Area under banana production

Under banana/ coffee based farming system, banana is intercropped with coffee in a land use locally known as *Kibanja*, *Kibanja* is permanent field for cultivation of banana. Area under banana was obtained by counting the number of banana mats then was converted to area using the on farm spacing in surveyed villages. Result in Table 12 show that, the average acres dominated by households were 1.3 acres. These results coincide with that of Svetlana *et al.*, 2005 on use of banana hybrid cultivars in Kagera in 2005 which shows that banana/coffee farming system in Kagera is dominated by smallholders farmers with an average farm size ranging from 1.25 to 3.75 acres.

Table 12: Area under banana (acres) cultivation (n=200)

Village surveyed	Mean	Number of households	Std. Deviation
Kabale	1.10	35	.78202
Ibumilo	1.00	35	.94163
Katoke	1.20	30	.73968
Ngando	1.40	35	1.23860
Bweyunge	1.30	35	.95387
Kasambya	1.70	30	1.39345
Total	**1.30**	**200**	**1.04435**

4.4.1.2 Area under banana as proportion of total cultivated area by village

Generally more than sixty percent of land under cultivation was located for banana production (Table 13), although allocation of land for banana production differs among the surveyed villages. Results shows that households in Bweyunge village in Misenyi district located more than 90% of total cultivated land for banana production. Meanwhile Ngando village in the same district locate less than fifty

percent for banana cultivation. This implies that, households in the village not only depend on banana for food and income generation, they also depend on other crops like maize.

Furthermore results indicate that on average households who are not affected with the disease in the same villages locate more proportional of land for banana production (71%) compared to affected households (64%). This is probably because the uprooted areas in affected households were planted with other crops rather than banana as a control measure.

Table 13: Kagera region: Area under banana as proportion of total cultivated area by village wise

Item	Name of village							Household situation		
	Kabale	Ibumilo	Katoke	Ngando	Bweyunge	Kasambya	Total	Unaffected	Afected	Total
Household	35	35	30	35	35	30	200	120	80	200
Proportion	0.60	0.70	0.60	0.43	0.94	0.81	0.68	0.71	0.64	0.68
Std deviation	27.4	41.3	24.5	27.3	94.3	92.9	60.8	72.3	37.5	60.8

4 4.2 Banana yield trend in affected and unaffected households

Households were asked whether they had observed any changes in yield that is directly caused by disease. Results from individual farmers as well as Focus Group Discussion (FGDs) suggest that majority of the farmers believed that BBWD had led to the reduced banana yield on their farms.

Head of households were asked to provide estimates of their banana production in 2005, 2006 and 2007. Total banana production for any given household comprised the quantity consumed in the home, the quantity sold and the quantity given out to relatives and friends or for social functions. To get a more realistic estimate, the information was solicited on a monthly or peak basis, thereby allowing the farmer to reflect on a shorter period than an entire year.

There after bunches were converted to kilogram (kgs) using the conventional weights addressed in section 4.2. Finally the banana productions were converted to yields.. Then comparison was done between affected villages and not affected village (control) in respective district, that is in Muleba the affected villages Kabale and Ibumilo were compared with control village Katoke while in Misenyi district Ngando and Bweyunge villages were compared with control Kasambya. Using independent t-test for equality means at 95% confidence interval ($P<0.05$) results in Table 14 reveals that, there was significant difference in yield between affected and control villages in year 2006 and 2007. Meanwhile yields in 2005 were not statistically different between the affected villages and control village because in that year disease outbreak was not reported.

Table 14: Kagera region: Banana average yields comparison between affected villages and not affected villages in different years

Village comparison	Year	N	Mean	Std deviation	T test for equality means		
					t	Df	Sig (2-tailed)
Kabale	2005	35	2672	4258	-0.925	63	0.359
Katoke		30	3550	3218			
Kabale	2006	35	855	759	-5.432	63	0.000***
Katoke		30	4418	3797			
Kabale	2007	35	1008	828	-6.552	63	0.000***
Katoke		30	4191	2734			
Ibumilo	2005	35	2132	1922	-2.193	63	0.320
Katoke		30	3550	3218			
Ibumilo	2006	35	766	766	-5.612	63	0.000***
Katoke		30	4417	4417			
Ibumilo	2007	35	1017	812	-6.547	63	0.000***
Katoke		30	4191	2734			
Ngando	2005	35	1265	963	-2.068	63	0.430
Kasambya		30	1872	1391			
Ngando	2006	35	1087	809	-2.588	63	0.012**
Kasambya		30	1751	1239			
Ngando	2007	30	1677	1748	-1.172	63	0.246
Kasambya		35	2273	2342			
Bweyunge	2005	35	1588	667	-1.073	63	0.287
Kasambya		30	1872	1391			
Bweyunge	2006	35	1321	753	-1.716	63	0.091*
Kasambya		30	1751	1239			
Bweyunge	2007	35	1209	854	-2.503	63	0.015**
Kasambya		30	2273	2342			

Notes: ***, **, and * indicate statistically significant at the 1 percent, 5 percent, and 10 percent levels, respectively, in the difference of means of affected and unaffected households in affected villages. Mean number was calculated only for affected villages households.

According to Mbwana, (2005) the average potential yield of banana in Muleba and Misenyi districts were 10 tons/ha (4 tons/acre) and 6tons/ha (2.4tons/acre) respectively (Table 15). The results are the same as that of control villages in the same districts which shows average yield of 4.3 tons/acre and 2.2 tons/acre during the period of disease (2006 & 2007). This implies that the difference in yield in affected villages was the impact of the banana bacterial wilt disease.

Table 15: Kagera region: Potential banana production

Districts	Yield in hectors	Yield in acres
Bukoba	10tons/ha	4tons/acre
Muleba	10tons/ha	4tons/acres
Karagwe	27tons/ha	10.8tons/acre
Misenyi	6tons/ha	2.4tons/acre
Biharamulo	5tons/ha	2tons/acre
Ngara	12tons/ha	4.8tons/acre

Source: Mgenzi and Mbwana 2005

There after independent sample t test for equality means was used to compare banana average yields between affected (715kg/acre) and unaffected (2241kg/acre) in year 2006, and affected (779 kg/acre) and not affected (2530 kg/acre) in 2007. Results showed that, there was significantly a difference in mean yield between affected and not affected households in years at 95% confidence interval ($p<0.05$) (Table 16). This implies that the disease had an impact on yields of banana between the affected and not affected households.

Table 16: Kagera region: Banana average yields between affected and not affected households

Household category	Year	N	Mean	T – test for equality means		
				T	Df	Sig.(2-tailed)
Not affected	2006	120	2241	5.548	198	0.000***
Affected		80	715			
Not affected		120	2530	6.760	198	0.000***
Affected	2007	80	779			

Note*** indicate statistical difference at one percent level

4.5 Food security

Food security is dependent variable in this research. It was defined as dietary energy consumption per adult equivalent. There are many indicators of food insecurity, for example the proportion of population who are unable to get two meals a day (URT, 1999). That indicator and others that have not been mentioned are just proxy indicators of food security, but the actual indicator of food security is dietary energy consumption (URT, 1999).

4.5.1 Number of meals consumed by adult members and children

Respondents were asked to mention the number of meals that adult members as well as under five children members of households had per day, in both affected villages (Kabale, Ibumilo, Ngando and Bweyunge) and unaffected villages (Katoke and Kasambya). Results show that within the affected villages only in Kabale village where more than half of the adult members surveyed had at least 2 meals per day 19 (54.3%), but the remaining affected villages less than half of adult members of respondent eat at least two meals per day, that is Ibumilo 14 (40%), Ngando 13(37.1%) and Bweyunge 12 (34.3%). The possible explanation as to why more than fifty percent of adult members at Kabale village differ from other affected villages is that many respondents in Kabale had free seeds of maize and cassava planting materials from Ministry of agriculture, food security and co operatives, and being close to the Lake Victoria had alternatives for food and income from fishing. Furthermore more than fifty percent of adult members of respondent surveyed in unaffected villages had three meals per day, Katoke 20 (66.7%) and Kasambya 26

(86.7%) this is because these villages were not affected with banana bacterial wilt diseases so they are had more food compared to the affected villages (Table 17).

Table 17: Kagera region: Number of meals consumed by adults per day (n=200)

No of meals	Households in surveyed villages						Total
	Kabale	Ibumilo	Katoke	Ngando	Bweyunge	Kasambya	
1.00	1(2.9)	5(14.3)	0(0.0)	4(11.4)	6(17.1)	0(0.0)	16(8.0)
2.00	19(54.3)	14(40.0)	8(26.7)	13(37.1)	12(34.3)	4(13.3)	70(35.0)
3.00	15(42.9)	15(42.9)	20(66.7)	18(51.4)	17(48.6)	26(86.7)	111(55.5)
4.00	0(0.0)	1(2.9)	2(6.7)	0(0.0)	0(0.0)	0(0.0)	3(1.5)
Total	35 (100.0)	35(100.0)	30(100.0)	35(100.0)	35(100.0)	30(100.0)	200(100.0)

Results in Table 18 shows that, only Bweyunge village has more than fifty percent of children members that had at least three meals per day 23 (76.7).But the remaining children members of affected villages had less than fifty percent of children who had three meals per day. But for household in the unaffected villages more than fifty percent of children had 3 meals per day, Katoke 63.3% and Kasambya 76.7%. That means that they had more meals than children in the affected villages.

Table 18: Kagera region: Number of meals consumed by children per day (n=200)

No of meals	Households in surveyed villages						Total
	Kabale	Ibumilo	Katoke	Ngando	Bweyunge	Kasambya	
1.00	7(20.0)	2(5.7)	0(0.0)	2(5.7)	0(0.0)	0(0.0)	11(5.5)
2.00	15(42.9)	20(57.1)	4(13.3)	15(42.9)	12(34.3)	4(13.3)	70(35.0)
3.00	13(37.1)	13(37.1)	19(63.3)	18(51.4)	23(65.7)	23(76.7)	109(54.5)
4.00	0(0.0)	0(0.0)	7(23.3)	0(0.0)	0(0.0)	3(10.0)	10(5.0)
Total	35 (100)	35(100)	30(100)	35(100)	35(100)	30(100.0)	200(100.0)

4.5.2 Average food stuffs consumed per week by household

On how much food stuffs consumed per week, survey results show that respondents and their household members had an average of 40.25kg of banana per week which is the main staple food. Maize is the second with an average of 6.02kg per week in the form of stiff porridge (Ugali).The least of foodstuffs that was consumed by household members was rice and yams with average of 1.56kg and 1.49kg per week,(Table 19).. The plausible explanation for the higher amount of banana consumption was that banana was still the staple food for majority of households because are easily available. Rice is consumed in less volume because it is scarce and expensive.

Table 19: Kagera region: Average food stuffs consumed per week (n=200)

Food Type	Amount eaten (kg)
Banana	40.25
Rice	1.56
Maize (Flour)	6.02
Cassava	5.01
Sweet potato	3.27
Yams	1.49

Respondent were asked to mention and quantify the amount of each foodstuff they ate in a week. Furthermore they were required to mentioned their staple food and number of meals composed of staple food during the week, this was important so that it was ease to compare the amount of staple food consumed in affected households and unaffected household. Table 20 results show that households which are not affected by banana bacterial wilt disease had higher number of banana meals 88 (73.3) fallowed by stiff porridge by 22 (18.3). On the other way households affected by the disease had higher number of meals composed of stiff porridge 43 (54.0) fallowed by banana 21 (26.3). This is probably because of the impact of the disease on banana availability and high prices.

Table 20: Kagera region: Staple food and number of meals composed of staple food for affected and unaffected households members

Household category	Staple food	No of meals composed of staple food			Total
		1-5	6-10	10-15	
Not affected	Banana	3(3.4)	43(48.8)	42(47.8)	88(73.0)
	Stiff porridge(Ugali)	0(0.0)	12(55.0)	10(45.0)	22(18.0)
	Cassava	0(0.0)	0(0.0)	7(100.0)	7(6.0)
	Cssava+ S/P	0(0.0)	2(67.0)	1(33.0)	3(3.0)
	Total	3(2.5)	57(47.5)	60(50%)	120(100.0)
Affected	Banana	0(0.0)	9(43.0)	12(57.0)	21(26.0)
	Stiff porridge (Ugali)	0(0.0)	18(42.0)	25(58.0)	43(54.0)
	Cassava	0(0.0)	5(71.0)	2(29.0)	7(9.0)
	Cassava + S/P	0(0.0)	4(44.0)	5(56.0)	9(11.0)
	Total	0(0.0)	36(45.0)	44(55.0)	80(100.0)

4.5.3 Contribution of banana dietary energy consumption equivalent (DEC) to the total DEC per households

Further analysis was done to verify the contribution of banana to food security of the households surveyed between affected and unaffected households. Table 21 Results showed that only at Ibumilo village that the banana DEC contribution to total DEC of household was an average of half (0.48), while the remaining villages contribute more than sixty percent of DEC to the total DEC of household. Further more the results reveal that the unaffected households banana contribute an average of 0.95 dietary energy consumption to the total dietary energy consumption of household. Contrary to the affected households banana contributes less than fifty percent (0.47) of the total DEC of the households. From the above banana have more than fifty percent contribution to total dietary energy consumption to households.

Table 21: Kagera region: Average banana dietary energy consumption of households

Village	Mean	Number of households	Std deviation
Kabale	0.6680	35	0.4696
Ibumilo	0.4841	35	0.4584
Katoke	0.9376	30	0.5082
Ngando	0.8187	35	0.5216
Bweyunge	0.8109	35	0.4128
Kasambya	0.8943	30	0.3226
Total	0.7616	200	0.4748
Unaffected household	0.9572	120	0.3962
Affected household	0.4682	80	0.4315
Total	0.7616	200	0.4748

4.5.4 Food security and insecurity of surveyed households

Based in the method described in section 3.4.3.1, the result shows that the average dietary energy consumption per adult equivalent per day in the surveyed

households' routine meals was 3030Kcal. That figure is impressive because it is above the safe minimum daily intake that was suggested by WHO i.e. 2280 Kcal/AE/day (Ashimogo, 1995). Furthermore the findings in Table 22 indicate that there is difference in average dietary energy consumption per adult equivalent per day between the affected villages and unaffected villages.

Table 22: Kagera region: Total dietary energy consumption per adult equivalent per day (n=200)

Village	HH category	Mean	N	Std deviation
Kabale	Not affected	2828	15	927.21
	Affected	2322	20	709.78
	Total	2539	35	836.68
Ibumilo	Not affected	3705	15	1739.72
	Affected	1884	20	912.60
	Total	2664	35	1595.93
Katoke	Not affected	4041	30	2058.78
Ngando	Not affected	3032	15	1036.56
	Affected	2556	20	939.77
	Total	2760	35	1101.55
Bweyunge	Not affected	2543	15	721.44
	Affected	2162	20	900.19
	Total	2383	35	1288.62
Kasambya	Not affected	3405	30	1288.62
Total	Not affected	2928	120	1421.59
	Affected	2828	80	927.21
	Total	2322	200	709.78

In Muleba district the affected households in Ibumilo had low dietary energy consumption of 1884 Kcal/AE/Day compared to those of Katoke and Kabale village 4041 and 2322 Kcal/AE/Day respectively. The figure of kabale is impressive because they are above the safe minimum daily intake of 2280Kcal/AE/Day that was suggested by WHO. Also in Misenyi district findings shows Bweyunge had below

safe dietary energy consumption 2162Kcal/AE/Day, while Ngando and Kasambya are above safe dietary energy 2760 and 3405 Kcal/AE/Day respectively.

4.5.5 Estimation of proportional of household's members who are food secure and insecure

One of the objectives was to estimate the proportional members of households that are below the minimum level of dietary consumption per adult equivalent. In this study, house holds which consumed Kilocalories below 2,280Kacl/AE/Day were considered to be food insecure and those who consumed amounts that were equal or more than 2,280 Kacl/AE/Day were considered to be food secure The analysis was based on selecting of affected households in each affected village and compared with non affected households in the control villages of Katoke and Kasambya.

Table 23: Kagera region: Food security and Food insecurity village – wise (n=140)

	Food security		
Village surveyed	Insecure	Secure	Total
Kabale	10(50.0)	10(50.0)	20(100.0)
Ibumilo	15(75.0)	5(25.0)	20(100.0)
Ngando	9(45.0)	11(55.0)	20(100.0)
Kasambya	7(23.3.0)	23(76.7.0)	30(100.0)
Katoke	6(20.0)	24(80.0)	30(100.0)
Total	13(21.0)	47(79.0)	60(100.0)

Results in Table 23 shows that with the exception of Ngando village all households of affected villages had below the minimum level of dietary energy consumption per adult equivalent, i.e. Kabale 10 (50.0%), Ibumilo 15(75.0%) and Bweyunge 12 (60.0%), meaning that they were food insecure while majority of the members of

households in the villages which were not affected i.e. Katoke 24 households (80.0%) and Kasambya 23 households (76.7%) had above the minimum level of dietary energy consumption per adult equivalent, meaning that they are food secure. This implies that the majority of people living in the villages which are not affected with banana bacterial wilt ate the foods that contained calories that were above the recommended minimum level of DEC/AE.

Furthermore food security in affected households was statistically verified by using the independent sample t –test to check whether there was statistical difference in means between food secure and food insecure households (Table 24). Results reveal that there is statistical difference in means between food secure and food insecure households at 95% degrees of freedom.

Table 24: Kagera region: Independent sample t-test for food security in DEC per adult equivalent per day (n=80)

Total DEC per Adult equivalent per Day	Food security status	Households	Mean	t-test for equality of Means		
				T	df	Sig. (2-tailed)
	insecure	44	1636	-11.383	78	.000***
	secure	36	3015			

Notes: *** indicates statistical significance at 1 percent in the difference means between food secure and food insecure households in affected villages. Mean number was calculated only for affected villages households

4.6 Household income

Income is one of the important aspects of food security due to the fact that it enables household's heads to purchase foodstuffs particularly during the period of food

deficit. Lack of insufficient income can hinder one's ability to afford buying food, rendering him/her to be food insecure. Income is even more important to rural people who are engaged in other activities than farming, for example fishing, as well as urban people who depend solely on income obtained, for buying all kinds of foodstuffs.

4.6.1 Main sources of household's income in surveyed villages

It was important to know the main source of household income in the surveyed villages. In order to get this information, head of household were asked to mention the main source of income in the year 2007. Generally the sample showed that banana was the main source of income for many households with high percentage coming from brew banana than cooking banana. Results in Table 25 differ from that documented by Nkuba *et al.*, 2003 which states that banana ranks first as major staple food and second as cash crop, this is probably because of low prices of coffee and banana is harvested throughout the year. Table 24 reveals that about 79 households (39.5%) in surveyed villages mention banana was the main source of income and coffee was the second with 52 households (26%). Furthermore more than fifty percent of the unaffected households of Katoke and Kasambya (control) villages mentioned banana were main source of income. Based on these findings most of households of Muleba and Misenyi districts depend on banana as source of income.

Table 25: Kagera region: Household's main sources of income per year (n=200)

Source	Village Surveyed						Total
	Kabale	Ibumilo	Katoke	Ngando	Bweyunge	Kasambya	
Cook banana	4(11.4)	2(5.7)	7(23.3)	5(14.3)	4(11.4%)	6(20.0)	28(14.0)
Brew banana	7(20.0)	10(28.6)	11(36.7)	6(17.1)	7(20.0)	10(33.3)	51(25.5)
Coffee	12(34.3)	14(40.0)	4(13.3)	8(22.9)	7(20.0)	7(23.3)	52(26.0)
Maize	0(0)	0(0.0)	0(0.0)	6(17.0)	0(0.0)	0(0.0)	6(3.0)
Labour	3(8.6)	3(8.6)	0(0.0)	5(14.3)	4(11.4)	0(0.0)	15(7.5)
Brewing	1(2.9)	1(2.9)	3(10.0)	4(11.4)	4(11.4)	5(16.7)	18(9.0)
Small business	1(2.9)	4(11.4)	1(3.3)	0(0.0)	2(5.7)	1(3.3)	9(4.5)
Salaries	1(2.9)	0(0)	2(6.7)	1(2.9)	1(2.9)	0(0.0)	5(2.5)
Remittance	1(2.9)	1(2.9)	2(6.7)	0(0.0)	5(14.3)	1(3.3)	10(5.0)
Fishing	5(14.3)	0(0.0)	0(0.0)	0(0.0)	1(2.9)	0(0.0)	6(3.0)
Total	35(100)	35(100)	30(100)	35(100)	35(100)	30(100)	200(100)

4.6.2 Proportional of main sources of income to total income of household in adult equivalent per day

Before looking at the impact of Banana into household's income it's important to identify the contribution of each activity per adult equivalent (AE) per day to the total AE income per day of the households. Results in Table 26 reveal that banana was the second potential contributor to household income per AE per day (19.0%) after coffee 44% Furthermore the contribution of banana to total income in AE per day of affected households was less compared to not affected households, 15% and 21% respectively. Also there is substantial increased contribution of non agricultural activities like labour selling, local brewing etc to total income in AE per day in affected households compared to unaffected households. This implies that the affected households shifted to non agricultural activities after decline of income from banana.

Table 26: Kagera region: Contribution of different main sources of income to total income of households in AE/Day

Household		Contribution								
		Banana	Coffee	Maize	Labour	Brewing	Small Business	Salaries	Remittance	Fishing
Unaffected	Mean	.21	.46	0.02	0.10	.1004	.1330	0.05	.1678	0.03
	N	120	120	120	120	120	120	120	120	120.0
Affected	Mean	.15	.40	0.03	.1364	.2116	.1706	0.08	.1939	.1331
	N	80	80	80	80	80	80	80	80	80.0
Total	Mean	.19	.44	0.02	.1134	.1448	.1480	0.06	.1783	0.07

4.6.3 Income per adult equivalent of households

Also respondent were asked to estimate the amount of money they got from different sources of income in twelve month's time (One year) prior to the survey. Generally results show that the average total income obtained from different sources of income was Tshs 570,413/= per year, which is an average of Tshs 1562/= per day for household. The general average total income per adult equivalent per year for the sample was Tshs 96,360/=, with an average of Tsh 264/= per day per adult equivalent (Table 27). This amount is slightly above the basic needs poverty line of Tshs. 259/= per adult equivalent per day documented in the Household Budget Survey report of 2000/2001 (NBS, 2003).

The average income per day per adult equivalent between affected and not affected households in the affected villages was: Kabale Tshs 198/=, Ibumilo Tshs 144/= and Bweyunge Tshs 152/= which were below basic needs poverty line of Tshs 259/= per day per adult equivalent compared to unaffected households in the same villages.

Also the results shows that affected and not affected households in Kabale, Ibumilo and Bweyunge had significant difference in average income per day per adult equivalent ($P<0.05$). However in Ngando village results reveals that there is no significant difference ($P<0.05$) between affected and not affected households. This is probably because the village is very close to Kagera sugar which provides employment in terms of labour for household of the village hence increased their income. More than that the village is located in low rainfall agro ecological zone and have higher average land size (6 acres) owned by households compared to other

villages (Table 10) which is potential for maize production sold to Uganda and hence increase the household income.

Table 27: Kagera region: Household income per adult equivalent per day (Tshs) (n= 140)

Village surveyed	Household category	Mean	N	Std. Deviation	t-test
Kabale	Not affected	340	15	275.71	
	Affected	198	20	112.83	0.040**
	Total	269	35	194.27	
Ibumilo	Not affected	260	15	172.40	
	Affected	144	20	174.36	0.050*
	Total	202	35	173.38	
Ngando	Not affected	502	15	581.15	
	Affected	296	20	234.64	0.150
	Total	399	35	407.89	
Bweyunge	Not affected	269	15	193.86	
	Affected	152	20	90.00	0.052*
	Total	186	35	141.93	
Total	No	330	60	408.86	
	Yes	198	80	170.08	
	Total	264	140	225.50	

Note: **, * indicate statistical difference at 5 percent and at 10 percent levels respectively, in the difference means across affected and not affected households in affected villages.

4. 6.4 Estimation of number of households below and above income poverty line

The information of household income per adult equivalent per day were grouped for surveyed households below and above the poverty line 249/= Tshs. This was done so that we can compare number of household above and below poverty line in all villages surveyed.

Results in Table 28 show that among the affected villages majority of households were below poverty line, Kabale village had 91.4%, Ibumilo village had 85.7%, Ngando village had 82.9% and Bweyunge village had 85.7%. Furthermore, the findings indicate that there were very few households in un affected villages which were below the poverty line, in Muleba district Katoke village had only 30% and Misenyi districts, Kasambya village had 20%. These results imply that the disease had impact on income of affected households that is why majority of affected households are below poverty line compared to households in the village which are not affected.

Table 28: Kagera region: Number of households above and below poverty line in villages surveyed (n = 200)

Village	Number of households below and above poverty line		Total
	Below	Above	
Kabale	32(91.4)	3(8.6)	35(100.0)
Ibumilo	30(85.7)	5(14.3)	35(100.0)
Katoke	9(30.0)	21(70.0)	30(100.0)
Ngando	29(82.9)	6(17.1)	35(100.0)
Bweyunge	30(85.7)	5(14.3)	35(100.0)
Kasambya	6(20.0)	24(80.0)	30(100.0)
Total	136(68.0)	64(32.0)	200(100.0)

Also affected households in the affected villages was statistically verified by using the independent sample t –test to check whether there is statistical difference between affected households above and below poverty line. Table 29 reveals that 121 households out of 140 affected households in affected villages are below poverty line, and there is statistical difference between number of households below and above poverty line at 95% degrees of freedom.

Table 29: T- test between household below and above poverty line (n=140)

Household Category	Households number	Mean	T test for equality means		
			T	Df	Sig.(2-tailed)
Below poverty line	121	227	-3.859	138	0.00***
Above poverty line	19	471			

Note: *** indicate statistical difference at 1 percent levels, in the difference distributions across affected households in affected villages.

4.7 Copping strategies adopted by households affected by banana bacterial wilt disease

4.7.1 Number of affected banana mats uprooted

According to Focus Group Discussion (FGD), all households considered the disease as a big threat to banana production and feel that they needed collective efforts to eradicate it. Households in collaboration with their leaders and agricultural experts in affected areas formed task forces and worked together to uproot infected mats from one farmers plot to another. When it came to uprooting infected banana mats, some farmers were reluctant until when the community leaders supported by the district commissioners used forces by having such as reluctant households being held at police posts for 24 hours that was when everybody in the infected areas participated fully.

Plate 1: Kagera region: Households in Ibumilo village working jointly on uprooting infested banana mats in one of the affected farm

Information on the number of banana mats uprooted in each affected households were collected from the special forms distributed by extension staff to the affected households heads to record the number of uprooted banana mats. Results in Table 30 show that on average Bweyunge and Ibumilo villages uprooted a big number of banana mats 371 and 367 mats per households respectively, while Ngando village had the least 201 mats per household .In total an average of 22 955 banana mats were uprooted in all affected village, this was equivalent to an average 57 acres for 80 households (0.7 acre/ household) in on-farm spacing of 400 banana mats per acre.

Table 30: Kagera region: Average number of banana mats uprooted in affected areas (n=80)

Village	Mean	Number of households	Std. Deviation	Sum	% of Total Sum
Kabale	208.75	20	234.81883	4175.00	18.2
Ibumilo	366.60	20	322.89747	7332.00	31.9
Ngando	201.05	20	356.69100	4021.00	17.5
Bweyunge	371.35	20	821.17235	7427.00	32.4
Total	286.93	80	487.79248	22955.00	100.0

4.7.2 Crops planted in uprooted areas as copping strategy

Following the disaster, Ministry of Agriculture, Food Security and Cooperatives distributed free seeds of maize and cassava to the affected households to be planted in the uprooted areas. However some of affected households planted sweet potato, tomatoes, yams from their own source, while others do not plant any thing. Further investigation (Figure 4), showed 32.8% of affected households planted maize and maize intercropped with cassava 22.5% households while remaining had no alternative crop to plant 17 household (21.3%) due to scarcity of free maize seeds and cassava planting materials, and late distribution of them during planting season.

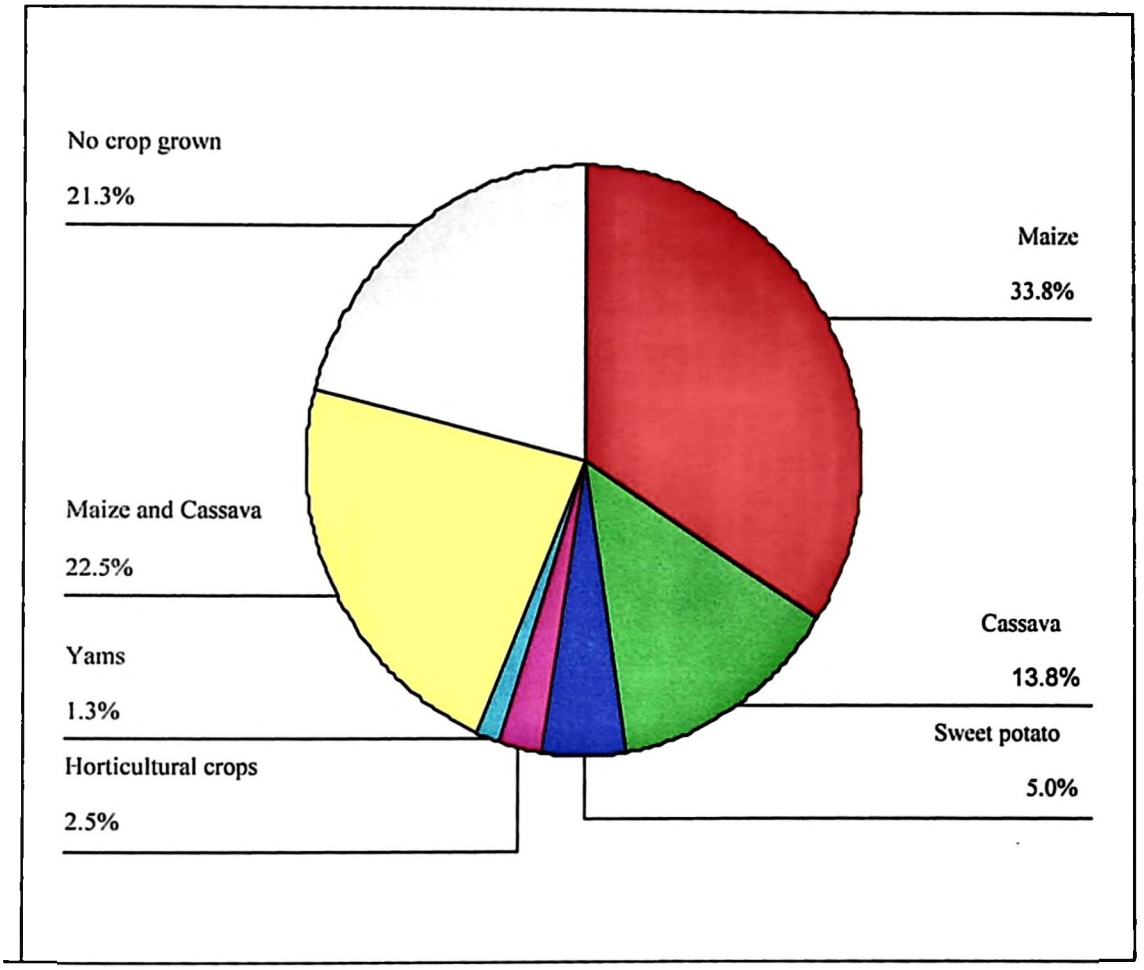

Figure 4: Kagera region: Proportion of crops grown in uprooted areas (n=80).

Table 31 compares the uprooted areas in the affected households by village. The results show, in Kabale village 70% households, intercropped more maize and cassava, while in Ibumilo 40% planted cassava and Ngando village 60% planted maize. Otherwise in Bweyunge village had more households who had nothing to plant this is because the households were not accessed to free maize seeds and cassava planting materials. Few of them planted maize, cassava, sweet potato and yams from their own source.

Plate 2: Kagera region : One of the affected household that planted cassava and maize in uprooted area in Kabale Village.

Table 31: Kagera region: Alternatives crops planted in uprooted areas

Villages	Maize	Cassava	S/potato	Horticultural crops	Yams	Maize & Cassava	No alternative crop	Total
Kabale	3(15.0)	1(5.0)	1(5.0)	0(0.0)	1(5.0)	14(70.0)	0(0.0)	20(100.0)
Ibumilo	7(35.0)	8(40.0)	1(5.0)	1(5.0)	0(0.0)	3(15.0)	0(0.0)	20(100.0)
Ngando	12(60.0)	1(5.0)	1(5.0)	0(0.0)	0(0.0)	2(10.0)	4(20.0)	20(100.0)
Bweyunge	4(20.0)	1(5.0)	1(5.0)	1(5.0)	0(0.0)	0(0.0)	13(65.0)	20(100.0)
Total	26(32.5.0)	11(13.8.0)	4(5.0)	3(4.0)	1(1.3.0)	18(23.0)	17(21.0)	80(100.0)

4.7.3 Non agricultural activities adopted as copping strategies by affected households

Focus group participants' noted that availability of banana for both home consumption and sale had drastically decreased. Bananas have for long been the main staple food for households in the area. Community members believed that if the disease stays and continues to devastate the bananas, hunger will kill many people. They are of the opinion that uprooting entire banana fields due to BBW disease increases the risk of food shortages to everybody in the village. As a coping strategy, people resorted to selling labour, small business, fishing and local brew business to get money to buy food.

In addition some households intensified cultivation of maize to bridge the gap left by reduced production of bananas. The latter may have serious implications to the natural resource base because it means that land will have to be opened seasonally, thereby exposing it to erosion and nutrient loss (in a system where inorganic fertilizers are not in common use); change often leads to a decline in productivity. In addition, farmers may lack the necessary skills and infrastructure for handling the annual crops.

Incomes from the sale of banana products declined in some instances to zero. Despite the increase in prices, income from banana had fallen due to reduced yields and increased thefts. Banana thefts increased as people target the banana of Matooke type that they can sell at high prices. The transport cost of bringing banana of Matooke type from distant producers led to prices increase and consumption of stiff porridge (ugali) increased. A community that never used to sell or buy Matooke in

clusters/hands (as opposed to whole bunches) now does so. Figure 5 shows that majority of the affected households engaged into labour selling (42.5%) in farms of not affected households, in fishing enterprises and in agricultural industries like Kagera sugar.

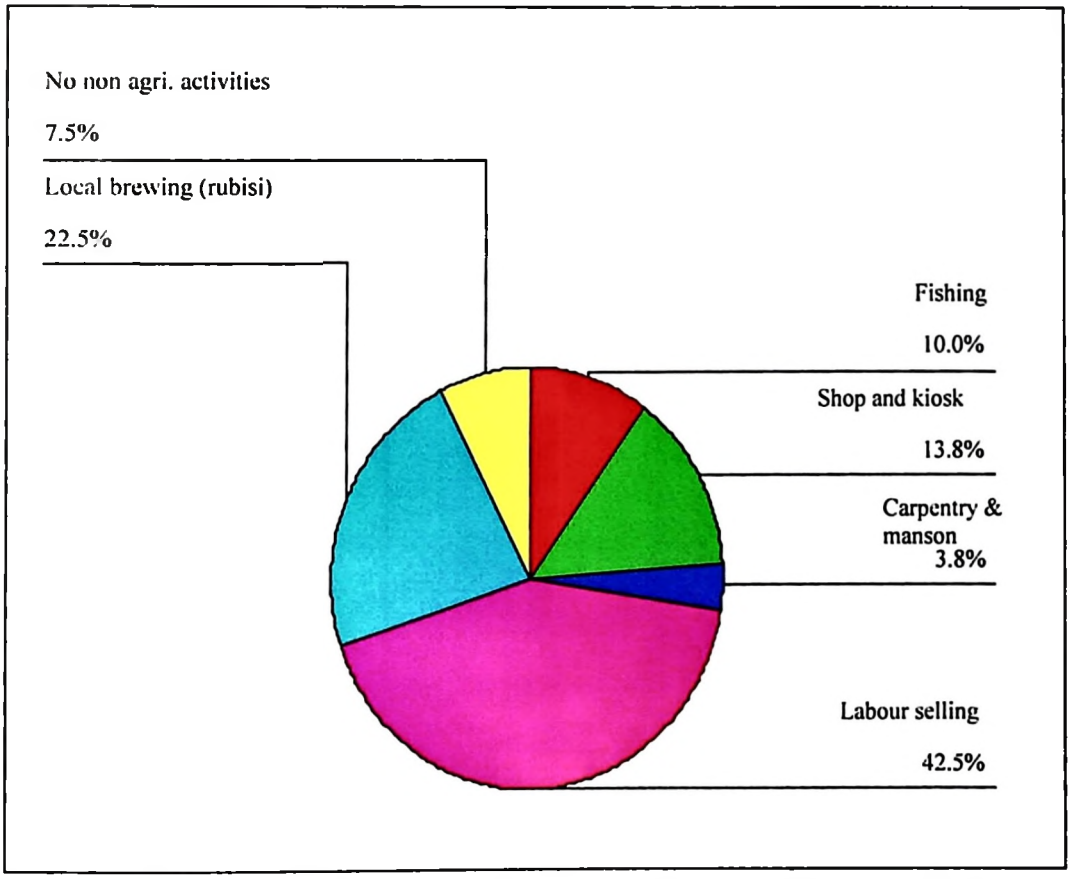

Figure 5: Kagera region: Promotion of non agricultural activities practiced as copping strategy (n=80)

Further more the survey results show that majority of affected households in Kabale, Ibumilo and Ngando depends on labour selling on different activities (Table 32). But the situation is quit different in Bweyunge village where majority of the affected households depend on local brew activities (35%). This is possible because of availability of market of local brew especially *Gongo (Konyagi)* which is local exported to Uganda for purification and standardised to *waragi* the legalised brew.

Table 32: Kagera region: non agricultural activities practiced by affected households

Village	Non Agricultural activities						Total
	Fishing	Shop and kiosk	Carpentry	Labour	Brewing	No alternative	
Kabale	5(25.0)	2(10.0)	2(10.0)	8(40.0)	3(15.0)	0(0.0)	20(100.0)
Ibumilo	0(0.0)	3(15.0)	0(0.0)	13(65.0)	4(20.0)	0(0.0)	20(100.0)
Ngando	0(0.0)	2(10.0)	0(0.0)	10(50.0)	4(20.0)	4(20.0)	20(100.0)
Bweyunge	3(15.0)	4(20.0)	1(5.0)	3(15.0)	7(35.0)	2(10.0)	20(100.0)
Total	8(10.0)	11(14.0)	3(4.0)	34(43.0)	18(23.0)	6(8.0)	80(100.0)

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This chapter concludes the explanations and discussions made in the preceding chapters. It provides the lessons learnt by households in Kagera about the effect of banana bacterial wilt disease on their food and income, and the likely copping strategies emerged during the outbreak of the disease. Finally recommendations for further interventions are presented.

5.2 Conclusion

5.2.1 Banana production trend

The first objective was to investigate the trend of banana production between the affected households and unaffected households before and after the outbreak of the disease. Results showed that during the disease period in 2006 and 2007, there were significantly differences in mean yields of banana between affected and unaffected households in surveyed villages at 95% confidence interval ($p < 0.05$). But in Ngando village there was also the difference in banana yield between affected and not affected households but the difference was not statistically difference at 95% confidence interval this was probably because the outbreak of the disease in the village was reported latter (September, 2006) compared to other village surveyed.

5.2.2 Food security

The impact of the disease on food security had been observed in all affected villages with the exception of Ngando village. The villages had more than half of households that were below the minimum level of dietary energy consumption per adult

equivalent, i.e. Kabale 10 (50%), Ibumilo 15(75%) and Bweyunge 12 (60%), meaning that they were food insecure. Contrary to not affected villages, findings indicate that the majority of households in the villages are food secure, Katoke 24 households (80%) and Kasambya 23 households (76.7%) are above the minimum level of dietary energy consumption per adult equivalent, which means they are food secure. The food security in affected households was statistically verified by using the independent sample and reveals that there is statistical difference in means between food secure and food insecure households at 95% degrees of freedom.

5.2.3 Household income

Generally the survey results show that banana was the main source of income 79 (39.5%), and the second was coffee 52 (26%) households. Although in adult equivalent per day (AE/day) banana was the second potential contributor to household income (19%) after coffee (44%).

The impact of the disease had been observed in all affected villages with the exemption of Ngando village. The affected villages that had an average income below the poverty line of Tshs 259/=, were Kabale (Tshs 198/=), Ibumilo (Tshs 144/=) and Bweyunge (Tshs 152/=) which households in affected village in Ngando had average income above poverty line (Tshs. 296/=). This is probably because the village is very close to Kagera sugar which provides employment in terms of labour for household of the village hence increasing their income. More than that the village is located in low rainfall agro ecological zone and have higher average land

size (6 acres) owned by households which is potential for maize production and sold in Uganda and hence increase the household income.

5.2.4 Copping strategies of affected households

Fallowing the impact of the disease to banana production most of households found their own copping strategies, like crop diversification and labour selling mainly for food and income generation. Out of the eighty affected households, 32.8% planted maize, 22.5% intercropped maize and cassava, while 21.3% had no alternatively crop due to scarcity of maize seeds and cassava planting materials. Apart from crop diversification other households opted for non agricultural activities like labour selling, brewing, small business and fishing. Majority of households 43% were engaged in labour selling for different agricultural enterprises, and 23% households engaged in local brew business especially rubisi.

5.3 Recommendations

The following recommendations emanate from the major findings of the study.

(i) Household food insecurity in study area was more apparent in households affected by disease who depended largely on banana as their main source of earning income as well as acquiring food. In order to make the affected households' food secure, it is recommended that improved cassava planting materials to be distributed to affected households at subsidies price.

(ii) For the affected villages with an average of large land size like Ngando village, households should be trained on good management of maize production for food security and income generation.

(iii) Unaffected households in all districts should be trained on preventive measures to control the spread of the disease such as cutting of male bud and phytosanitary measures.

(iv) Rouging should be done only for the affected banana mats rather than for the whole field so as to reduce food insecurity within the affected households.

(v) Breeders should plan for breeding resistant varieties to banana bacterial wilt disease.

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APPENDICES

Appendix 1: Questionnaire for affected households

QUESTIONNAIRE FOR IMPACT OF BANANA BACTERIAL WILT (*Xanthomonas campestris pv.Musacearum*) DISEASE ON HOUSEHOLDS FOOD SECURITY AND INCOME IN KAGERA REGION

(QUESTIONNAIRE FOR AFFECTED HOUSEHOLDS/VILLAGES)

A: GENERAL INFORMATION

1. Name of the District.....

2. Agro-ecological zone.....

3. Name of division.....

4. a) Name of the Ward affected with BBW.....

5. a) Name of the village affected with BBW.....

6. a) Name of the household head affected with BW.....

7. Name of Interviewer.....

8. Date of interview.....

B: BACKGROUND VARIABLES

9. Household category
   (a) Rich resource household (b) medium resource household
   (c) Poor resource household

10. Age of head of household (Years).....

11. Level of Education of head of household (Years of schooling).....

12. Sex of household head 1.Male..... 2. Female.....

13. Marital status of household head:
    (1) Married (2) Single (3) Widowed (4) Divorced (5) Separated (6)Widow

14. Main occupation
    (a) Farming crops (b) Livestock keeping (c) Fishing (d) Employment
    (e) off-farm activities (f) Others
    (Specify).....

15. Livestock ownership (Type and number)
    .....
    .....

16. Household Composition

Members of Household		Sex (Male/Female)	Age	Remarks
Household Head	1			
Wife/Wives	1. 2. 3.			
Children	1. 2. 3 4 5 6 7 8 9			
Other member of family	1 2 3 4 5 6			
Total Household size				

C: BANANA BACTERIAL WILT DISEASE VARIABLE

17 a) Did your household own any farmland in 2007?
1 = Yes 2 = No

b) If yes how much did you own in 2007 (acres) .....

c) How many plots do you have.....

d) Did your household rent in land for cultivation in 2007 (acres)
1 = Yes, 2 = No

e) If yes how much was rented in (acres).....

f) Did your household rent out land for cultivation in 2007 (acres)
1 = Yes, 2 = No

g) If yes how much was rented out (acres).....

h) How much of land was used for crop cultivation 2007 (acres).....

i) Crop cultivated and their size

S/N	Crop cultivated	Size (acres)
1	Maize	
2	Cassava	
3	Sweet potatoes	
4	Banana	
5	Coffee	
6	Beans	

18. a) Did your household affected by banana bacterial wilt disease? 1 = Yes, 2 = No
If yes,

b) How many banana stools/ Plants affected .....

c) How many banana stools / plants not affected .....

d) What types of Crops planted in affected/uprooted areas
.....
.....

c) Production trend of banana:

Years	Banana Production in Bunches		
	Total bunches of cooked banana	Total bunches of brewing banana	Total bunches
2005			
2006			
2007			

d) Production Trends of other crops (Bags)

Crop	Year 2006	Years 2007
Maize		
Cassava		
S/potato		
Beans		
Coffee		

19. What are the control measures/ copping strategies practiced for BBW? (Rank them)

.....
.....

20. Reason for preferring the most top one, mention them
    .....
    .....
    .....

21. What are other crops lost during clearing/ uprooting the affected banana stools? Mention them
    .....
    .....
    .....

22. Do you grow any alternative crop after outbreak of BBWD?

    Yes..... No.....

23. If yes mention them
    .....
    .....

24. Do you have any non agricultural activities as alternative of BBWD?

    1 = Yes, 2 = No

If yes mention and rank them.

a).....
b).....
c).....
d).....
e).....

D: INCOME VARIABLE

25. a) What are the major sources of income in your household in 2007 season?

Source of Income	Amount Sold (Bags/Kg)	Money Obtained (Tsh)
Crop sales		
a)Banana for cooking		
b) Banana for brewing		
c) coffee		
d) Beans		
e) Vanilla		
f) Cassava		
g) Other Crops		
Sub total crop		
Livestock Sales		
a)Cattle		
b)Sheep/ goat		
c) Chicken		
Sub- total livestock		
Non Agricultural income		
a) Labour selling		
b)Brewing		
c)Run Business e.g. Shop, kiosk		
d) Salary		
e) Remittances		
f) Fishing		
Subtotal Non Agricultural		
Grand Total		

E: FOOD SECURITY VARIABLE:

26. How many meals do adult members of your household consume per day before BBW outbreak?

    .....

27. How many meals do adult members of your household consume per day after BBW outbreak?

28. How many meals do under five children members of your household consume per day before BBW outbreak?

29. How many meals do under five children members of your household consume per day after BBW outbreak?

30. What is your staple food before BBW?

    .....

31. What is your staple food after BBW outbreak?
.....

32. How many meals compose of staple food per week?
.....

33. What is the composition of your meals during this week?

a) Breakfast.....

b) Lunch.....

c) Dinner.....

34. How much of the following foodstuffs do you consume per week in your household?

Banana..... Bunches

Rice.....kg

Maize..... kg

Cassava.....kg

Round potatoes.....kg

Yams.....kg

Beans..... kg

Others (specify)..... kg

35. Assess the household banana farm quality using the rating instrument below

0 = Very low quality farm
1 = Low quality farm
2 = Medium quality farm
3 = Good quality farm
4 = Very good quality farm

THANK YOU FOR YOUR CO OPERATION

Appendix 2: Questionnaire for not affected households

QUESTIONNAIRE FOR IMPACT OF BANANA BACTERIAL WILT (*Xanthomonas campestris pv.Musacearum*) DISEASE ON HOUSEHOLDS FOOD SECURITY AND INCOME IN KAGERA REGION

(QUESTIONNAIRE FOR NOT AFFECTED HOUSEHOLDS/VILLAGES)
A: GENERAL INFORMATION

1. Name of the District.....
2. Agro-ecological zone.....
3. Name of division.....
4. Name of the Ward .....
5. Name of the village .....
6. Name of head of household.....
7. Name of Interviewer.....
8. Date of interview.....

B: BACKGROUND VARIABLES

9. Household category
   (a) Rich resource household (b) medium resource household (c) Poor resource household
10. Age of head of household (Years).....
11. Level of Education of head of household (Years of schooling).....
12. Sex of household head 1.Male..... 2. Female.....
13. Marital status of household head:
    (1) Married (2) Single (3) Widowed (4) Divorced (5) Separated (6)Widow
14. Main occupation
    (a) Farming crops (b) Livestock keeping (c) Fishing (d) Employment (e) off-farm activities (f) Others (Specify)
15. Livestock ownership (Type and number)
    .....
    .....
    .....

16. Household Composition

Members of Household		Sex (Male/Female)	Age	Remarks
Household Head	1			
Wife/Wives	1. 2. 3.			
Children	1. 2. 3 4 5 6 7 8 9			
Other member of family	1 2 3 4 5 6			
Total Household size				

C: BANANA PRODUCTION

17 a) Did your household own any farmland in 2007?
1 = Yes 2 = No

b) If yes how much did you own in 2007 (acres) .....

c) How many plots do you have.....

d) Did your household rent in land for cultivation in 2007 (acres)
1 = Yes, 2 = No

e) If yes how much was rented in (acres).....

f) Did your household rent out land for cultivation in 2007 (acres)
1 = Yes, 2 = No

g) If yes how much was rented out (acres).....

h) How much of land was used for crop cultivation 2007 (acres).....

i) Crop cultivated and their size

S/N	Crop cultivated	Size (acres)
1	Maize	
2	Cassava	
3	Sweet potatoes	
4	Banana	
5	Coffee	
6	Beans	

18. a) How many banana mats do you have .....

b) Production trend of banana:

Years	Banana Production in Bunches		
	Total bunches of cooked banana	Total bunches of brewing banana	Total bunches
2005			
2006			
2007			

c) Production Trends of other crops (Bags)

Crop	Year 2006	Years 2007
Maize		
Cassava		
S/potato		
Beans		
Coffee		

D: INCOME VARIABLE

25. a) What are the major sources of income in your household in 2007 season?

Source of Income	Amount Sold (Bags/Kg)	Money Obtained (Tsh)
Crop sales		
a)Banana for cooking		
b) Banana for brewing		
c) coffee		
d) Beans		
e) Vanilla		
f) Cassava		
g) Other Crops		
Sub total crop		
Livestock Sales		
a)Cattle		
b)Sheep/ goat		
c) Chicken		
Sub- total livestock		
Non Agricultural income		
a) Labour selling		
b)Brewing		
c)Run Business e.g. Shop, kiosk		
d) Salary		
e) Remittances		
f) Fishing		
Subtotal Non Agricultural		
Grand Total		

E: FOOD SECURITY VARIABLE:

26. How many meals do adult members of your household consume per day
    .....
28. How many meals do under five children members of your household consume per day

30. What is your staple food?
    .....
32. How many meals compose of staple food per week?
    .....
33. What is the composition of your meals during this week?
    a) Breakfast.....
    b) Lunch.....
    c) Dinner.....

34. How much of the following foodstuffs do you consume per week in your household?

Banana..... .....Bunches

Rice.....kg

Maize..... ...kg
Cassava.....kg

Round potatoes.....kg

Yams.....kg

Beans..... .....kg

Others (specify)..... .....kg

35. Assess the household banana farm quality using the rating instrument below

0 = Very low quality farm
1 = Low quality farm
2 = Medium quality farm
3 = Good quality farm
4 = Very good quality farm

THANK YOU FOR YOUR CO OPERATION