

## **CROP PROTECTION PROGRAMME**

**Project Title: Assessing the Impact of the Banana Bacterial Wilt,  
*Xanthomonas campestris* pv. *musacearum* (BXW),  
on Household Livelihoods in East Africa**

**R No (ZA No): R8437 (ZA0661)**

## **FINAL TECHNICAL REPORT**

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Project Leader: Dr Eldad B. Karamura

Project Leader's institution:  
International Network for the Improvement of Banana and Plantain  
(a network of the International Plant Genetic Resources Institute, IPGRI)

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## Abbreviations and acronyms

<b>BXW</b>	Banana <i>Xanthomonas</i> Wilt
<b>DFID-CPP</b>	Department for International Development - Crop Protection Programme (United Kingdom)
<b>EG Consulting</b>	Eden-Green Consulting
<b>FGD</b>	Focus Group Discussions
<b>GoU</b>	Government of Uganda
<b>Foodnet</b>	IITA/ASARECA Post-harvest Network
<b>IFPRI</b>	International Food Policy Research Institute
<b>IITA</b>	International Institute of Tropical Agriculture
<b>INIBAP</b>	International Network for the Improvement of Banana and Plantain
<b>MAAIF</b>	Ministry of Agriculture, Animal Industry and Fisheries
<b>MS Excel</b>	Microsoft Excel Programme
<b><i>MusaLit</i></b>	<i>Musa</i> Literature database
<b>NAADS</b>	National Agricultural Advisory Services
<b>NARO</b>	National Agricultural Research Organisation
<b>NGO</b>	Non-Governmental Organisation
<b>NIDA</b>	Nkoola Institutional Development Associates
<b>PDC</b>	Participatory Development Communication
<b>R&amp;D</b>	Research and Development
<b>REDIMA</b>	<i>Musa</i> Documentation and Information Network for Africa
<b>SPSS</b>	Statistical Programme for Social Scientists
<b>UBOS</b>	Uganda Bureau of Statistics
<b>UgSh</b>	Uganda Shilling
<b>UNHS</b>	Uganda National Household Survey

## Executive Summary

The overall objective of this study was to carry out an assessment of the impacts of Banana *Xanthomonas* Wilt (BXW) – caused by bacterium *Xanthomonas campestris* pv. *musacearum* – on affected banana-growing communities in Uganda, in order to provide a sound foundation for strategic planning, at a national and regional level, for controlling the spread of the disease and mitigating the impacts on banana producers. The research strategy was based on household- and community-level surveys, using focus group discussions and individual interviews, cross-checked wherever possible with researcher observations, to gather perceptions of BXW impacts. Surveys were focused in four districts which offered contrasting scenarios of banana production and BXW history: Mukono and Kayunga districts, which grow mainly beer (Kayinja) and dessert (Sukali Ndiizi) bananas and where BXW has been established for some time; Sironko district with both Matooke (green cooking) bananas and a mix of beer and dessert bananas, partly affected with BXW; and Luwero district, also with a mix of banana types, but first affected by BXW only at the time of the study. Within these districts, sampled communities were stratified according to whether or not they had benefited from BXW-awareness campaigns.

Data were collected on perceived changes since 2001 in banana production and processing, land and labour allocation, and livelihoods strategies, as well as the reasons for all these changes and the use of coping strategies. Farmers were also questioned on their knowledge of BXW diagnostics, their knowledge and use of management strategies, and sources of such information and technologies. After analysis, the data from the study area were combined with data on BXW incidence and banana production in other districts to project likely losses at a national level.

Results documented severe falls in production of all types of banana in areas where the disease was well established, with the greatest impacts on beer and dessert bananas and equally serious implications for the production of Matooke; farmers were reducing the land area under banana, reducing their consumption of cooking banana, adopting other crops or livestock and switching to processing of other agricultural products in order to cope with the situation imposed by the disease. Almost all farmers were aware of at least some BXW symptoms and at least one management tactic but very few understood and applied all four recommended practices. Those farmers who applied at least three tactics were able to mitigate the effects of the disease, underlining the value and importance of an intensified extension effort.

Projections suggest that, in the absence of resolute action, cumulative losses of banana production could mount to over US\$4 billion by 2010, emphasizing the need for an investment of resources commensurate with the scale of the BXW threat.

## Background

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 pathogen enters the vascular system of the plant destroying the fruit bunches and eventually killing the entire plant. The spread of the disease threatens the livelihoods of millions of people who depend on banana as a food and income source in the Great Lakes Region of Central Africa – an area that boasts of the highest *per capita* consumption of banana in the world. Previously known only from *Ensete* in Ethiopia, the disease 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. 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 neighbouring countries.

The causal agent of the disease was identified as *Xanthomonas campestris* pv. *musacearum* and, although relatively little research has been carried out specifically on this pathogen and the disease it causes in banana, a growing body of evidence suggested similarities to bacterial wilt diseases of banana encountered in Latin America and Asia, especially *moko* and *bugtok*, caused by the bacterium *Ralstonia solanacearum*. By analogy with these diseases it has been proposed (and largely borne out by subsequent experience) that the spread of the disease can be halted and its impact mitigated by adoption of crop management strategies – in particular, removal of male flower buds to reduce insect transmission of the disease, and strict sanitation on the farm to avoid transmission on contaminated tools and crop residues. However, these measures imply extensive farmer education based on the biology and epidemiology of the disease, as they need to be applied rigorously over large areas.

The Uganda government has concentrated its resources on developing and disseminating such control strategies for the disease, involving some research to validate control strategies but mainly focusing on sensitising banana-producing communities and other stakeholders to the risks, and educating banana producers on the disease and options for its management. Unfortunately, the recommended control measures are labour-intensive and/or require resource inputs and changes in cultural practices that are difficult for farmers to implement. As a result the disease has continued to advance and the limited resources available for control within the national lead organizations, especially the National Agricultural Research Organization (NARO) and the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), have become thinly stretched. Although there were alarming anecdotal reports that some 90% of the stools in a banana plot could become infected within a year of the first appearance of disease and that yields could be reduced to 10-20% of pre-disease levels, there was a paucity of reliable information not only on the distribution and incidence of the disease but also on the likely impact the disease will have on the communities – largely rural and poor – that depend on banana. This has made mobilizing resources to address the disease outbreak particularly difficult.

The objective of this study was to carry out a thorough and objective assessment of the impacts of BXW on affected communities in order to provide a rational basis for decision-making on how to invest resources and to lay the foundation for sound strategic planning, at a national and regional level.

## **Project Purpose**

The purpose of the project was to quantify the impacts of BXW on affected communities and thus provide a rational basis for decision making and sound strategic planning in mounting an appropriate response to the disease epidemic, within the broader goal of promoting pro-poor strategies that improve the yield and quality of bananas and so contribute to improved livelihoods in sustainable agricultural systems.

## **Research Activities**

### **Overview of project activities**

The project was designed to provide a comprehensive and reliable set of information on disease impacts (social and economic), and likely outcomes of the BXW epidemic (along the production-consumption chain); these results would then be passed on to appropriate parties to facilitate national and regional policy-making, planning and mobilization of resources to deal with the problem, including prioritisation of research and development activities. All-inclusive stakeholder approaches were aimed at maximizing the use of available resources, while strengthening institutional partnerships to tackle this and similar future challenges in sustainable agricultural development

These expectations were formalised in the following two outputs and related activities:

#### **1. Socio-economic impact of BXW on rural communities in Uganda assessed**

- 1.1 Literature review
- 1.2 Sample selection of study sub-counties, communities, and households.
- 1.3 Development and pre-testing of survey tools for impact assessment (IA), including the household questionnaire, checklists for key focus group discussions as well as key informant interviews and protocols for physical validation in the fields.
- 1.4 Field data collection
  - 1.4.1 Orientation of field data collection enumerators
  - 1.4.2 Administering the individual household interviews impact of BXW in benchmark sites in four districts of Uganda
  - 1.4.3 Conducting focus group discussions
  - 1.4.4 Physical validation of disease prevalence in the sample fields/farms
- 1.5 Data entry and analysis.
  - 1.5.1 Analyse data at the household level in study districts. Use available secondary data on severity and coverage of the disease to quantify impact of the disease in the sample districts.
  - 1.5.2 Use findings and secondary data on banana production in various districts to project impact in other districts as well as the country at large.
- 1.6 Preparation of draft report
- 1.7 Incorporation of comments, write and distribute final report

#### **2.0 Key stakeholders in the banana sector informed of the extent of impact of BXW on livelihoods**

- 2.1 One-day national level feedback and validation workshop
- 2.2 Refinement and preparation of final report incorporating comments and recommendations from the feedback and validation workshop

- 2.3 Preparation of policy briefs tailored to special interest groups, including government policy makers, donor agencies and national and regional research systems prepared and shared with the respective agencies.
- 2.4 Conduct of targeted dissemination events including preparation of newspaper articles, radio and or TV talk shows to contribute to NARO/MAAIF public awareness effort.

The project research strategy was based on comparing stratified random samples from households in communities that had been exposed to BXW for different lengths of time, and which grow a range of different types of banana and had, or had not, been exposed to extension efforts focused on BXW in the form of Participatory Development Communication (PDC) activities conducted by NARO/MAAIF. Projections of impacts to the national level would then be carried out using econometric models, based on existing data from NARO/MAAIF on disease spread and banana production.

Project sites were selected based on the following scenarios:

- i) **Mukono** and **Kayunga** districts, as major banana-growing areas with more emphasis on beer (Kayinja) and dessert (Sukali Ndiizi) bananas than on green-cooking (Matooke) bananas, with heavy BXW infection well established and experience of NARO/MAAIF sensitization activities: sub-counties of Kimenyedde (Mukono), Nazigo (Kayunga) had already benefited from PDC activities while Ntunda (Mukono), Kayunga (Kayunga) sub-counties have not.
- ii) **Sironko** district, as a major banana growing area with nearly 50:50 balance between green-cooking bananas on one hand and beer and dessert bananas on the other, with BXW well-established but thus far very limited NARO/MAAIF sensitization; Buwalasi (Sironko) sub-county has been exposed to PDC activities while Bukigarabho (Sironko) has not.
- iii) **Masaka** district in southwestern Uganda, was initially considered for the study, as a major production area for green-cooking banana, supplying markets in Kampala, Entebbe and Jinja, but at the time of project initiation, the district had not yet been affected by BXW (or major extension efforts). Thus Masaka was dropped and the role was left to Sironko.
- iv) During the pre-testing stage it was realised that it would not be possible to find sites in Mukono and Kayunga districts that had been affected by the disease for less than 6 months; it was therefore decided to include **Luwero** district where the disease had just been discovered.

## **Implementation of project activities**

The implementation of the project began with intensive consultations among the leading project partners – especially NIDA (field sampling), IFPRI (economic modelling), Makerere University (statistics and modelling), EG consulting (BXW pathology and technical support) and INIBAP (banana production systems and project management) – to refine the project research strategy and to obtain clear insights (especially with NARO and MAAIF) about the dynamics of the problem, including efforts so far discharged for containment, control and awareness creation.

### **1. Socio-economic impact of BXW on rural communities in Uganda assessed**

Available published and ‘grey’ literature was assembled by project staff through on-line searches and direct solicitation. Many references were made available globally through *MusaLit*, INIBAP’s on-line searchable database of banana citations.

Districts were chosen, based on the scenarios explained in the previous section; sub-counties and villages were randomly selected and households were also selected on a stratified random

basis, in consultation with locally based staff of MAAIF, non-governmental organizations (NGOs) and local authorities. A total sample size of 340 households was adopted.

A reconnaissance survey was conducted to enable the research team to set the ground for data collection. Prior to embarking on the field data collection, a 3-day orientation of the field data collection team was undertaken. The tools were pre-tested with at least 5 individual households in Goma sub-county of Mukono district. Sub-teams of 2 enumerators carried out interviews. Each team member was given an opportunity to lead the discussion while the other recorded the responses. Supervisors stayed with the sub-teams in the course of the interviews, noting questions that were not easy for the interviewees to grasp, as well as those questions that were wrongly interpreted by the interviewers. During the pre-testing exercise, the team observed and discussed symptoms of the disease in order to enable them to validate physical presence of BXW in banana gardens. Results of the pre-testing exercise were discussed in a one-day meeting. The salient features unearthed during the pre-testing exercise and the post pre-test meetings were used to further refine the tools and produce the final impact assessment tools used in the study.

The data collection phase involved orientation of data collection teams by training and pre-testing of study tools, field data collection (focus group discussions and individual household interviews) and debriefing.

The data management phase involved reviewing and cleaning the raw data questionnaires, coding of the questionnaires and responses, designing data entry spreadsheet, data entry, data cleaning and analysis. The data were managed using SPSS for Windows version 12 and converted to MS Excel format for econometric analysis. Further details of the econometric analysis carried out are provided in the Outputs section of this report.

This report was prepared on the basis of submissions by project partners to the national level feedback and evaluation workshop (see below) on 20<sup>th</sup> December 2005 and submitted to the Department for International Development's Crop Protection Programme (DFID-CPP) on the project completion date. Further input from partners to validate the data will be required before these can be captured for dissemination under Output 2.

## **2. Key stakeholders informed of the extent of BXW impacts**

The national stakeholder briefing workshop was initially planned for July but had to be delayed at the request of the project partners to allow more time for data analysis; a three-month no-cost extension to the project period was granted by DFID-CPP management. The meeting was then set up for the last week of October but was delayed at the request of Ugandan Government representatives, who requested more time to gain familiarity with the results before these were made public; a further no-cost extension was granted by DFID-CPP management.

The one-day national consultative workshop was finally convened in Kampala on 20<sup>th</sup> December, 2005. Thirty participants represented NGOs, public- and private-sector organisations, international agricultural research centres, policy makers, development partners and farmers' organisations. The workshop was chaired by the Chairperson of the National Technical Committee on Banana Bacterial Wilt and was officially opened by the Director General, NARO, on behalf of the Chair, National Steering Committee on Banana Bacterial Wilt. The workshop itself opened with presentations on workshop objectives, and background information (INIBAP) as well as on the progress of Uganda's effort to combat the disease (NARO). Study findings (essentially as detailed in the Outputs section of this report) were then presented to the meeting by project consortium scientists and discussed. In the final session, participants agreed on workshop recommendations and the way forward.

Full details of the participants, presentations, discussions, conclusions and recommendations are available in the workshop report (see Annex 1). A final version, with inputs from workshop participants, will be circulated during the first part of 2006.

A recommendation of the workshop reinforced the need for project partners to capture the results of the study in the form of project briefs in a form suitable for use by stakeholders at various levels in the research and development process. This activity will be completed during the first quarter of 2006.

Due to the delay in the national stakeholder briefing workshop and the desire of the Ugandan authorities to gain familiarity with the results before they were publicized, the planned public awareness activities could not be completed before the completion date of the project. These activities will be completed by the project partners during the first quarter of 2006.

## Outputs

### Output 1: Socio-economic impact of BXW assessed

#### A. Household impacts

##### A.1 Household demographic characteristics

Information was elicited on the composition, sex, age, and main occupation of household members. Only one member of each household was designated as the household head. Results indicate that roughly 20% of the household heads were women while 80% were men. The proportion of female-headed households in the study is slightly lower than the 24% in rural areas cited in the 2002/03 Uganda National Household Survey (UNHS) but conforms to the general trend of declining proportions of female-headed households in rural areas since 1999/2000. Mean age was about 50 years and was not statistically different across districts. Average household size stood at 6 persons, with almost equal numbers of males and females. The estimate is slightly higher than the national average of 5.3 persons in rural households (UBOS, 2002). Average household size was highest in Luwero (7.6 persons), followed by Kayunga (6.6 persons) while Mukono and Sironko each registered 5.6 persons. Farming is the main occupation for the majority (84%) of the household heads in the study districts and farming was the main source of income. This is in line with national estimates which indicate that 85% of the population live in the rural areas depending directly or indirectly on agriculture for their livelihoods (GoU, 2004). Over 70% of the sampled households derived their incomes mainly from farming in Mukono and Luwero districts but in Kayunga and Sironko households reported obtaining more income from off-farm activities (Table A.1).

Table A.1: Mean household demographic characteristics, by district.

Variables	Districts				Mean
	Mukono	Kayunga	Sironko	Luwero	
Age of household head	54.9	49.9	49.6	47.8	50.3
House hold size	5.6	6.6	5.6	7.6	6.2
No of females	3.0	3.0	2.9	3.9	3.2
No of males	2.6	3.6	2.7	3.7	3.0
Farm income (UgSh)	573576	342301	195406	992335	557943
Off-farm income (UgSh)	288653	107255	371509	709914	433479
Other income (UgSh)	41405	107254	30308	43558	46205
Total income (UgSh)	835 569	790 854	586 303	1 730 076	1003 519
Household head					
Male (%)	79.1	80.7	80.5	82.1	80.5
Female (%)	20.9	19.3	19.5	17.9	19.5

Variables	Districts				
	Mukono	Kayunga	Sironko	Luwero	Mean
Types of occupation					
None (%)	5.5	0	1.6	0	2.3
Farming (%)	84.1	87.0	78.4	89.6	84.3
Civil service (%)	1.0	3.0	3.9	0.9	2.0
Privately employed(%)	5.2	4.3	2.3	4.5	4.1
Self-employment (%)	4.3	5.8	13.8	5.0	7.3

## **A.2. Housing conditions of the respondents**

Summary findings on the housing conditions of sampled households are presented in Table A.2. The majority of respondents had houses with sizes ranging from 300 to 600 ft<sup>2</sup> with an average of 4 rooms. Exterior walls of most houses in Sironko and Mukono were made of mud and wattle compared to baked bricks in Luwero and Kayunga. Houses mostly had earthen floors, though in Sironko they were also smeared with cow dung; the majority were roofed with iron sheets across all districts.

Table A.2: % of surveyed households with given housing characteristics by district

Variables	Districts				
	Mukono	Kayunga	Sironko	Luwero	Overall
	Mean				
Number of rooms	3.3	3.9	3.1	3.8	3.8
	Percentages				
<i>House size (ft<sup>2</sup>)</i>					
<200	35.51	12.60	31.62	13.83	24.92
200-399	26.91	36.45	38.33	29.51	31.91
400-599	14.21	21.28	17.13	34.32	21.33
600-799	15.22	12.99	7.82	15.91	13.07
800-999	0.98	5.74	0.54	2.70	1.86
>999	10.17	10.94	4.57	3.73	6.91
<i>Materials for exterior walls</i>					
Papyrus and grass	0	1.86	0	0.99	0.48
Mud and wattle	62.90	30.10	85.00	33.19	57.35
Un-baked bricks	4.17	0	0	4.33	2.57
Baked bricks	28.57	65.03	12.77	59.75	36.71
Concrete blocks	4.36	3.01	0.47	1.73	2.39
Iron sheets	0	0	1.76	0	0.50
<i>Types of floor</i>					
Earth	68.64	50.25	45.84	49.77	54.98
Cow dung	9.94	3.26	45.17	6.36	18.17
Brick/stone	0.44	6.22	5.29	4.25	3.50
Cement	20.98	38.75	3.70	39.61	23.18
Cement and tiles	0	1.53	0	0	0.17
<i>Types of roofing materials</i>					
Banana leaves	0	3.39	15.31	0	4.71
Papyrus/grass	17.19	5.73	0	0.69	6.53
Tins	0	0	1.76	0	0.50
Iron sheets	82.81	90.88	82.93	99.31	88.27

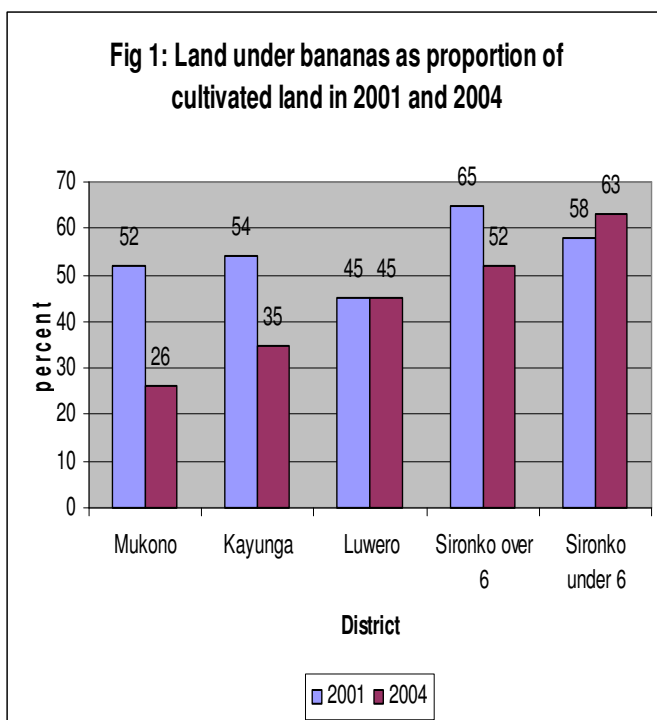
### **A.3 Farm size and utilization**

Results indicate that land holdings were larger in Luwero district with a mean area of 9.5 acres, compared to Sironko with less than 2 acres. However only 48% of Luwero's total acreage was under crop production, as compared to over 90% in Sironko district. Land utilisation was over 80% in Mukono, compared to 63% in Kayunga. Total land under cultivation ranged from 0 acres up to 26.5 acres, with households on average cultivating 3 acres at the time of the first outbreaks (2001) and in the year prior to the survey (2004) (Table A.3a). Results showed no statistically significant difference in land ownership and utilisation between 2001 and 2004 by district.

Overall, land under banana has reduced over the last four years from a mean of 1.53 acres to 1.17 acres, accounting for about 51% of total land under cultivation in 2001 and only 39.6% of land under cultivation in 2004. The decline in land devoted to banana production was only recorded in areas where BXW has been in evidence for over six months, decreasing from 1.49 acres under banana (accounting for 55% of cultivated land) in 2001, to 0.85 acres under banana (accounting for 33% of cultivated land) in 2004. Variations exist by district and production system (Table A.3a). The reduction is greater in the predominantly Kayinja-producing areas of Kayunga and Mukono than in the predominantly Matooke-producing district of Sironko.

Table A.3a: Farm size and banana production 2001 and 2004 by district

District	Land allocation for	2001	2004
		Mean (acres)	Mean (acres)
All districts	Cultivated land	2.98	2.95
	Land under Banana	1.53	1.17
All districts - over 6 month of BXW	Land under cultivation	2.7	2.6
	Land under Banana	1.49	.85
All districts under 6 month of BXW	Land under cultivation	3.4	3.4
	Land under Banana	1.59	1.6
Mukono	Cultivated land	2.97	2.87
	Land under Banana	1.55	0.75
Kayunga	Cultivated land	2.88	2.70
	Land under Banana	1.55	0.95
Sironko	Cultivated land	1.57	1.59
	Land under Banana	0.98	0.91
Sironko under 6 month	Cultivated land	1.25	1.28
	Land under Banana	0.73	0.81
Sironko over 6 month	Cultivated land	1.94	1.95
	Land under Banana	1.27	1.02
Luwero	Cultivated land	4.52	4.56
	Land under Banana	2.05	2.05
Mukono PDC	Land under cultivation	3.01	2.73
	Land under Banana	1.48	0.61
Mukono non-PDC	Land under cultivation	2.95	3.4
	Land under Banana	1.81	1.21
Kayunga PDC	Land under cultivation	2.36	2.28
	Land under Banana	1.14	0.78
Kayunga non-PDC	Land under cultivation	3.44	3.14
	Land under Banana	1.98	1.12
Luwero PDC	Land under cultivation	3.65	3.66
	Land under Banana	1.66	1.69
Luwero non-PDC	Land under cultivation	5.50	5.57
	Land under Banana	2.45	2.42

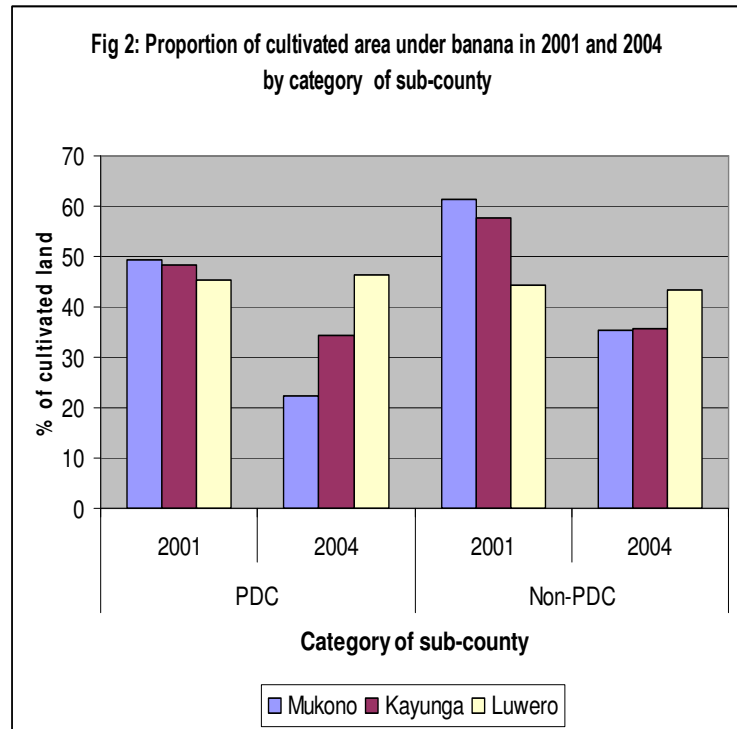


Banana acreage as a proportion of the total cultivated area decreased sharply between 2001 and 2004 in those areas of Sironko where BXW had been present for over 6 months (13%). No decrease in land under bananas was recorded in areas where BXW has been present for less than six months. Data disaggregated by district indicates that the proportion of cultivated land under banana remained at same level in Luwero (45%) and increased slightly in those parts of Sironko where BXW had been for less than 6 month (Fig 1) at the time of study. The results suggest that BXW has contributed to the reduction in cultivated land devoted to banana production over the last four years.

Table A.3b: Land under bananas as proportion of total cultivated land by district

District	% Bananas to cultivated area		% Change in proportion land under bananas between 2001 and 2004
	2001	2004	
Mukono	52	26	-26
Kayunga	54	35	-19
Sironko over 6	65	52	-13
Sironko under 6	58	63	+5
Luwero	45	45	0
Total sample	51	40	-11
Total over 6 month	55	33	-23
Total under 6 month	47	47	0
Mukono PDC	49.2	22.3	-27
Mukono non PDC	61.4	35.6	-26
Kayunga PDC	48.3	34.2	-14
Kayunga non PDC	57.6	35.6	-22
Luwero PDC	45.5	46.2	-0.7
Luwero non-PDC	44.5	43.4	+1.1

When data were analysed according to the time that BXW had been present and whether or not PDC activities had been carried out (Table A.3b), there was no significant difference in cultivated land between 2001 and 2004. Where BXW has been present for less than 6 months there was no change in land under bananas as a proportion of total cultivated land in the non PDC areas while in PDC areas there was a roughly 1% increase in proportion of land under bananas. Overall, where BXW has been for more than 6 months, the banana acreage decreased in PDC areas by 24% compared to 20% in the non-PDC areas.



In both Mukono, and Kayunga (representing predominantly Kayinja areas, exposed to BXW for more than 6 months) and Luwero (representing a predominantly Kayinja area exposed to BXW for less than 6 months), data were compared on the basis of whether PDC activities had been carried out or not (Figure 2). In both PDC and non-PDC areas, the proportion of cultivated land devoted to banana production was relatively constant in Luwero but fell in Mukono and Kayunga from higher than the Luwero level in 2001 to lower than the Luwero level in 2004 (Figure 2). It seems reasonable to conclude that the declines observed in Kayunga and Mukono are attributable to the establishment of BXW.

In Mukono there was a 26.9% reduction in the proportion of cultivated land under banana between 2001 and 2004 in the PDC sub-county and a 25.9% reduction in the non-PDC sub-county; in Kayunga, the corresponding figures were 14.1% for the PDC sub-county and 21.9% for the non-PDC sub-county. Results for Luwero indicate negligible differences between the PDC and non-PDC sub-counties. The data suggest that in the areas where the disease is well established, the PDC activities have not so far been successful in mitigating the reduction in banana cultivation. Other innovative approaches may be needed to significantly reduce the effects of the disease.

### A.3.1. Major crops grown in the years 2001 and 2004

The change in the crop enterprises engaged in by farmers between 2001 and 2004 was considered as an indicator of the impact of BXW on farm production. Results in Table A.3c indicate that banana was the dominant crop grown in 2001, having been cited as the most important crop by 88% of the respondents in all four districts; it was followed a distant second and third by cassava and maize/beans, which were cited as the most important crop on the farm by 40% and 34% of the sampled respondents respectively. About 33% of respondents grew sweet potatoes as their first choice, with Luwero reporting 54%, Mukono, 47%, Kayunga, 23% and Sironko only 1%. Coffee was also ranked first by 33% of the respondents overall, with Sironko leading with 52%, followed by Mukono with 32%, Kayunga with 28% and Luwero having the lowest, at 15%.

By 2004 the proportion of farmers who reported banana as the most important crop on their farms had slightly decreased to 83% overall. District disaggregated data reveal that the decrease is more pronounced in Mukono and Kayunga where 95% and 78% of the respondents cited banana as the most dominant crop in 2001, falling to 80% and 73%, respectively, in 2004. This contrasts with Luwero and Sironko which were essentially unchanged (97% and 73% in 2001; 98% and 74% in 2004).

Overall, about 5% of the respondents reported shifting their emphasis from banana to other crops between 2001 and 2004. The major shifts away from banana growing were reported in Mukono (15%) and Kayunga (5%). These changes can probably be attributed to the outbreak of BXW disease over the same period. However it is widely believed among the farmers that once it is demonstrated that the disease can be controlled most of these farmers currently abandoning banana cultivation will revert back to their traditional crop.

Maize and beans appear to have gained prominence, as reflected by a 10% increase (from 34% in 2001 to 44% in 2004) in farmers citing these crops as the most important crops on their farms. Coffee more-or-less retained the same position over the four-year period, being ranked first by 32% of the respondents overall in 2004, with Sironko reporting 49%, Mukono, 33%, Kayunga 23% and Luwero having the lowest, 18%. Cassava was ranked first by 40% of the respondents in 2004, similar to the figure for 2001. However, in Mukono there was a reduction in the importance of cassava growing, from 58% to 36%, while in Kayunga there was a gain, from 39% to 60%. Similar increases for cassava were reported in Sironko, from 11% in 2001 to 33% in 2004. Trends for other crops were not clear.

Table A.3c: Major crops grown in 2001 and 2004 according to percentage ranked as 1

Crop	Major crops grown 2001-Ranked 1					Major crops grown 2004-Ranked 1				
	Mukono	Kayunga	Sironko	Luwero	Mean	Mukono	Kayunga	Sironko	Luwero	Mean
Banana	95.1	77.9	73.6	96.7	87.5	79.9	72.7	75.4	98.3	82.8
Maize	26.2	40.9	18.9	57.5	34.3	43.3	45.5	24.2	64.6	43.9
Beans	22.3	31.8	18.7	64.7	33.9	30.7	46.5	36.6	65.8	43.7
Coffee	31.9	28.0	52.2	15.4	32.7	32.5	23.4	48.7	18.0	32.1
Tomato	9.5	5.2	2.7	12.3	7.9	12.9	8.2	3.5	10.1	9.0
Groundnuts	3.5	6.5	5.4	21.1	9.2	12.4	4.6	6.7	18.3	11.5
Sweet potato	47.4	22.7	1.1	54.2	33.4	59.2	47.2	1.1	53.5	39.8
Cassava	57.5	39.3	11.3	47.7	39.7	35.6	60.0	33.1	26.9	40.1

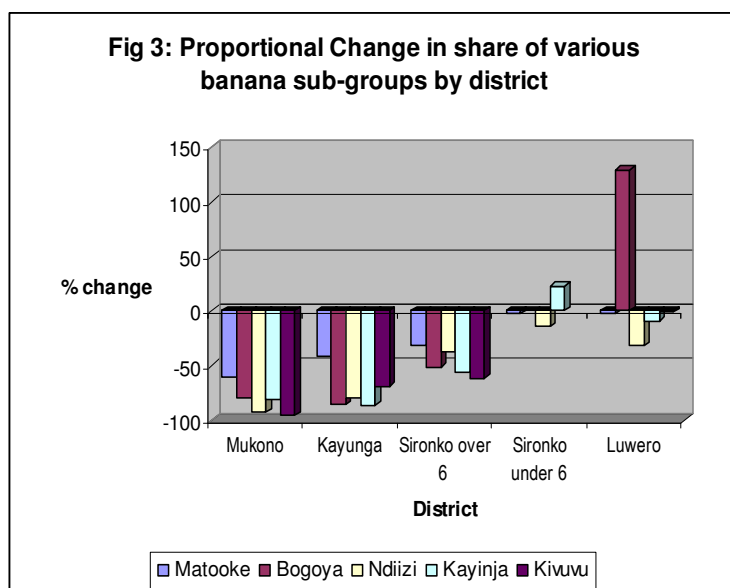
#### **A.4. Proportion of banana types grown in 2001 and 2004**

The change in the proportion of various banana types was considered as an indicator of the banana types most hit by BXW (Table A.4a and Figure 3). The disease has been observed to follow different modes of infection for different banana cultivar subgroups and farming systems. Thus for the Kayinja-based banana systems of Central Uganda, where management is less intensive, the main mode of disease transmission is by insects (Blomme, *et al*, 2005), while in Matooke-based systems, where farmer management is very intense, the main mode of transmission is through human activities via field tools. In 2001, Matooke, closely followed by Kayinja, was the dominant banana type in Mukono and Kayunga districts; these two types were at the same level in Luwero while in Sironko Matooke was by far the dominant type. Ndiizi was the third most common type across all study districts while Bogoya was fourth, except in Mukono where Kivuvu came in fourth place.

The results by variety mainly follow the general trend in banana as a proportion of major crops, with sharp declines between 2001 and 2004 in Mukono, Kayunga and parts of Sironko with BXW for over 6 months, while most varieties held their own in Luwero and those parts of Sironko only recently affected by the disease. In the longer-affected areas, all five kinds of banana recorded major declines.

Table A.4a: % Change in deployment of main banana types by district

Banana sub-group	Percent change by district				
	Mukono	Kayunga	Sironko over 6 mnths	Sironko under 6 mnths	Luwero
Matooke	-60	-41	-31	-3	-3
Bogoya	-79	-86	-51	0	129
Ndiizi	-93	-80	-37	-15	-32
Kayinja	-81	-86	-56	23	-9
Kivuvu	-96	-69	-61		-1



#### A.4.1 Perceptions on susceptibility of various banana types

##### A.4.1.1 Comparative rate of destruction of various banana types by BXW

The project conducted 19 Focus Group Discussions (FGDs) across the study area to gain a better understanding of perceptions of various issues at the community level. Among the issues investigated were perceptions of the comparative rate of destruction of the various banana types attributed to BXW. Across districts and irrespective of how long BXW had been present in an area, three banana types – Kayinja, Ndiizi and Kivuvu – were overwhelmingly rated as very vulnerable to the BXW disease by all communities. These results were consistent with evidence on the ground, as well as perceptions from key informant interviews and individual household interviews.

Regarding the susceptibility of the Matooke sub-group, none of the communities regarded the rate of destruction of these bananas as high. Overall, all FGDs in Kayunga, the majority in Mukono and Luwero and half in Sironko, considered that the rate of destruction of Matooke was medium. In the entire sample, only three communities, Wanjeyo and Kiyiribwa (Mukono) and Buwadada (Sironko) claimed that the rate of destruction was low for Matooke. Three communities in the Luwero sample were silent on the issue for they were, at the time of the study, disease-free. This result is not surprising because all the sites that rated Matooke to be at less risk from BXW than the other sub-groups are in the less intensively managed Kayinja-based banana systems where the dominant transmission mode is by insects. Other observations (data not available for this report) made in the southwestern Uganda where the Matooke-based cropping system is intensively managed and the disease transmission is by field tools, the rate of infection is reportedly high and comparable with insect transmission in the Kayinja-based systems.

Next in vulnerability, according to the FGDs, is Bogoya. Two communities in Kayunga (Nazigo HQ and Njalebirese) rated its susceptibility as high. Surprisingly, no community in Mukono rated it so, though this may be due to its limited presence in the district. Kitanswa (Luwero) also rated destruction of Bogoya as high. Wanjeyo and Kiyiribwa (Mukono), Bukigarabo and Buwadada (Sironko) and Sembwa (Luwero) assessed the rate of destruction of Bogoya as medium. The remaining three communities in Mukono and Kayunga rated it low. No village in Sironko and Luwero rated it low. Overall, there does not seem to be a consensus on the rate at which Bogoya is destroyed by BXW. In Kayunga, for instance, two groups contended the rate was high while the other three said it was low.

Most of the communities appear to think that the rate of destruction of Gonja is medium. This view emerged from two communities in Mukono and one each from Kayunga, Sironko and Luwero. One community in Kayunga rated it high and one community each from Mukono and Luwero, two from Kayunga and other communities in Sironko rated it low.

Lowest in susceptibility, according to the FGDs, is the East African Highland beer banana type. This finding however should be qualified by the observation that this type of banana is not as widely grown as other types in the study area.

#### A.4.1.2 Farmers' ranking of varieties susceptibility to BXW

To cross-check views from FGDs and key informants, individual households were requested to assign ranks to the banana types they had cultivated or had had on their farms prior to BXW attack. Findings from the individual households (Table A.4b) seem to confirm findings from FGDs. Farmers ranked Kayinja, Ndiizi, Kivuvu as the varieties most susceptible to BXW and Matooke as the least. The awareness of the susceptibility of cultivar types to BXW varied from district to district, from the highest awareness in Mukono, via Kayunga and Luwero to the lowest in Sironko. Knowledge imparted by PDC activities appeared to have had a considerable effect on the responses. The same cultivars were ranked second and third, with percentage weights in the way they are ordered altering slightly. Matooke was ranked first by about 5% of the respondents, second by 18%, third by 16%. Kayinja was ranked first by 29% of the respondents, second by 13% and third by 3%. Ndiizi was ranked first by 14%, second by 14% and third by 11%. Bogoya was ranked first by 2% and second by 3% of the respondents and third by 4%. Kivuvu was ranked first by 7% and second by 9% of the respondents and third by 3%. Other cultivars were given very small weight in the ranking.

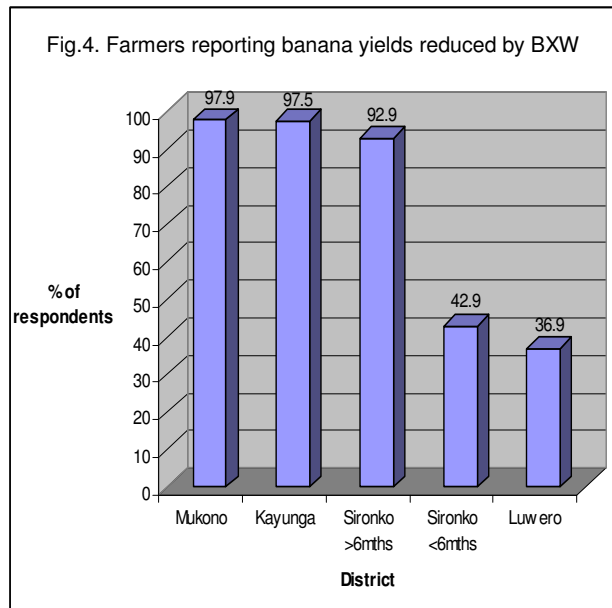
Table A.4b. Farmers' ranking of most susceptible banana to BXW by district

Cultivar sub-groups	% of responses by district				Overall sample
	Mukono	Kayunga	Sironko	Luwero	
Kayinja	66.6	51.6	21.0	29.8	41.9
Ndiizi	36.6	26.8	34.7	10.2	27.8
Matooke	24.6	31.3	20.7	17.5	22.4
Kivuvu	24.2	41.3	10.4	3.6	16.6
Bogoya	5.1	3.3	12.0	0	5.4

## A.5. Impact of BXW on banana yields

### A.5.1 Perceptions of impact of BXW on banana yield

Farmers were asked whether they had observed any changes in yield that is directly attributable to BXW. Results from individual farmers as well as FGDs suggest that in the majority of cases, farmers believed that BXW had led to reduced banana yield on their farms. Participants in FGDs especially in areas where the disease had been present for more than a year asserted that BXW has greatly reduced banana yields in their communities. Over 90% of the farmers in Mukono, Kayunga and part of Sironko district where the disease has existed for more than 6 months believed this to be the case (Figure 4).



FGDs in areas where BXW is already well established were more likely to report yields decreasing a lot, compared to their counterparts in areas where the disease had newly arrived (Figure 5a). In the longer-affected areas, the great majority of FGDs (over 80%) noted that yield had reduced ‘a lot’ in the case of Kayinja and Ndiizi and a ‘a little’ or ‘a lot’ in the case of Matooke or Bogoya.

Overall 89%, 81%, 78% and 47% of FGDs reported yield reduction due to BXW to be high for Kayinja, Ndiizi, Matooke and Bogoya respectively. Figures 5b and 5c present findings from individual surveys which underline the views expressed by FGDs, especially in case of Kayinja.

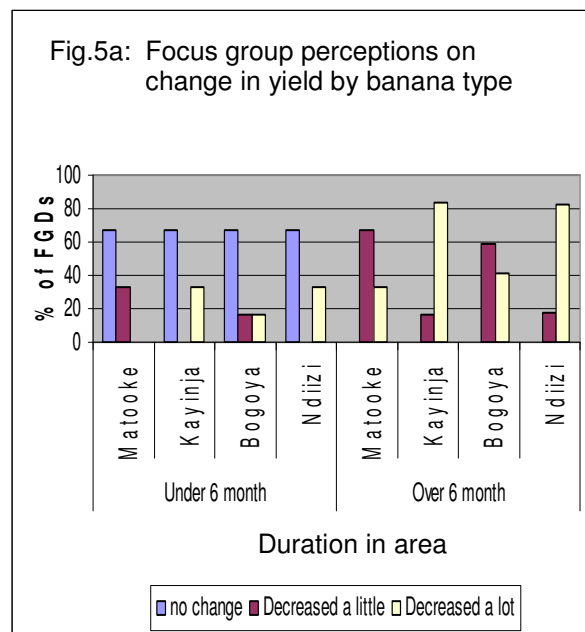


Fig.5b: Perceptions on magnitude of reduction in production for Kayinja

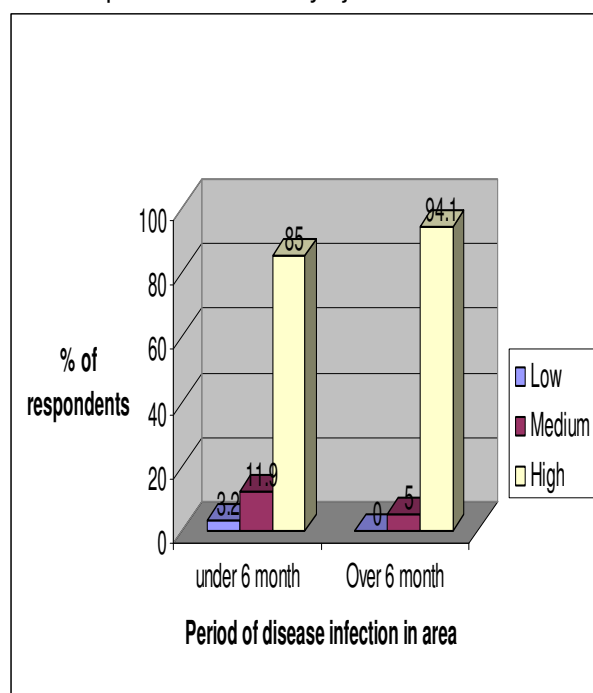
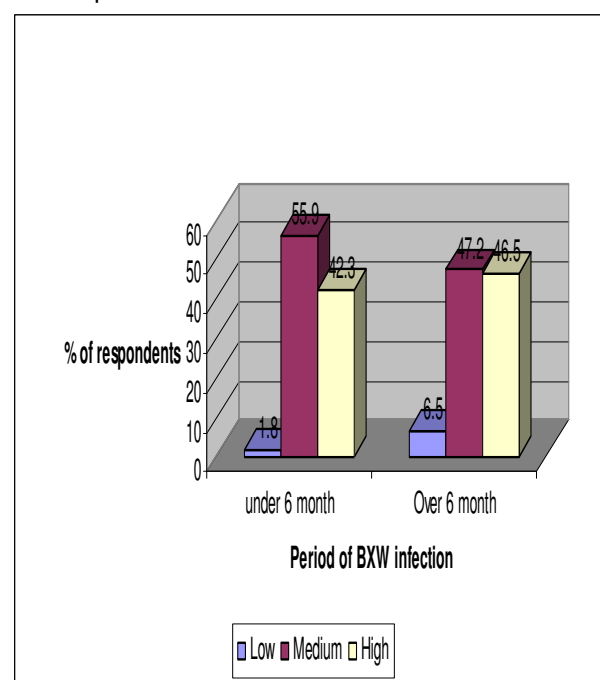


Fig.5c: Perceptions on magnitude of reduction in production of EAH Matooke



### A.5.2 Effect of BXW on banana production

To cross-check farmers' perceptions of the extent of reduction in banana yields, respondents were asked to provide estimates of their banana production in 2001 and 2004. Total banana production for any given household comprised the quantity consumed in the home, the quantity sold (if any) 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. Banana production in 2001 was treated as the benchmark for the sampled households. Comparing production in 2004 with the benchmark year enabled the team to establish the perceived change. The estimated production of the various banana types in 2004 was expressed as a fraction of that in 2001, then subtracted from 1 and multiplied by 100 to obtain the perceived percentage change.

Results indicate that across districts and banana types, farmers reported production to have declined over the past four years. The sharpest reduction was reported for Kayinja, followed by Kivuvu, Ndiizi, Bogoya and Matooke in descending order (Table A.5a). Across all banana types, much more severe reductions were reported in areas affected by BXW for more than 6 months than in areas where the disease had more recently arrived.

Table A.5a: Percentage change in banana production between 2001 & 2004 by district

Cultivars Sub-groups	District					Total sample		
	Mukono	Kayunga	Sironko over 6	Sironko under 6	Luwero	Overall sample	Overall over 6	Overall under 6
Matooke	-79.76	-86.92	-78.09	-36.04	-24.95	-60.43	-81.86	-27.12
Bogoya	-95.68	-82.23	-91.84	-4.09	+67.76	-81.98	-90.03	-13.72
Ndiizi	-98.31	-96.3	-86.62	-70.49	-61.82	-92.3	-96.04	-67.52
Kayinja	-96.00	-95.00	-95.00	-73.00	-55.00	-81.84	-96.00	-55.00
Kivuvu	-94.70	-91.43	-98.30		-21.56	-93.58	-94.50	-21.56
Gonja	-100.00	-93.30				-57.45	-93.31	-53.59

The most severe changes were reported for Kayinja, Matooke, Kivuvu and Bogoya in Mukono and Kayunga districts and the least severe in Luwero and Sironko districts.

### *A.5.3 Perceived reasons for the change in production of bananas*

Farmers were asked to give reasons for changes in production between 2001 and 2004. The great majority of respondents, especially where the disease was well established (97% in Kayunga, 92% in Mukono, 65% in Sironko) attributed the change in production to BXW (Table A.5b). A decrease in the area under banana was the second most commonly cited reason for reduced production, especially in Mukono (59% of respondents) and Kayunga (49%). Less than 15% attributed the reduction to poor weather, although this view was more prevalent (cited by 33% of the respondents) in Luwero where BXW has only recently arrived. About 16% reported that production had declined due to poor management, a perception that was more widely held in Luwero, Mukono and Kayunga districts than in Sironko district. Other diseases were also more likely to be cited as the cause in the areas more recently affected by BXW. Poor soil fertility was not widely cited as the reason for reduced production. Overall, these results strongly confirm that most farmers perceive BXW as the main cause of reduced banana production over the last four years.

Table A.5b: Responses (%) of reasons for change in production by district

Reasons for change	Districts				Mean
	Mukono	Kayunga	Sironko	Luwero	
Presence of BXW	96.9	92.0	64.9	34.9	70.4
Prolonged dry spells	6.2	6.8	13.4	32.8	15.6
Poor management	17.2	11.2	6.3	27.4	16.2
Decrease of banana acreage	58.9	49.5	2.9	9.4	28.5
Other diseases & pests	5.5	3.3	11.6	18.4	10.5
Poor soil fertility	4.3	7.5	4.9	6.4	5.4

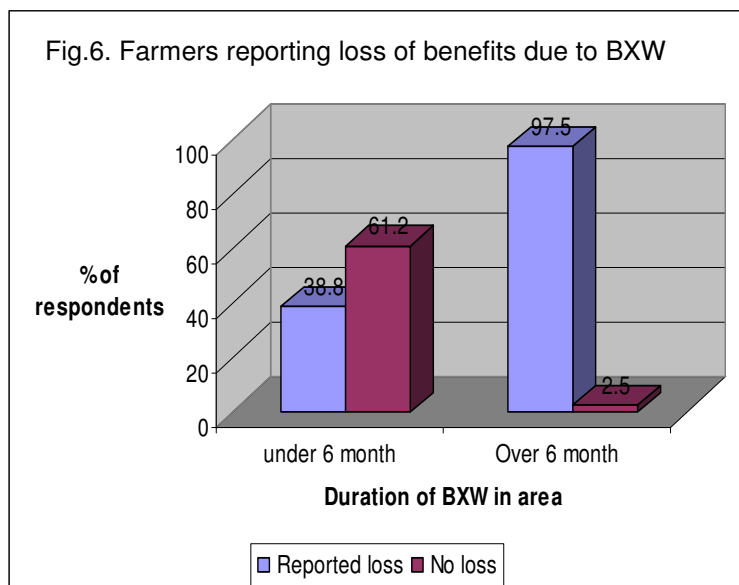
## **A.6. Impact on Rural Livelihoods**

### *A.6.1 Livelihood strategies*

Focus group participants were asked to enumerate livelihood strategies at the time of the study and four years ago, as well to cite reasons for the changes if any. Findings from areas with a longer history of BXW infection indicate that the relative importance of bananas as a means of making a living has greatly declined. Closely linked to this is the reduction in trade in banana products (beer, Matooke, juice) which had a negative impact on the livelihoods of households that relied on activities such as brewing local wine, roadside selling of juice, banana vending, and the sale of pancakes. In all cases, the relative importance of brewing as an activity has gone down and this was attributed to the reduced availability of Kayinja. FGD participants noted that most households have greatly reduced or ceased their home consumption of Matooke, resorting to the sale of labour to raise cash to buy food and bridge the gap in household income left by banana. People who were predominantly labourers in banana fields were reported to have migrated to other areas as opportunities to find work was greatly reduced in the BXW-affected villages.

Findings from individual household surveys seem to confirm views expressed in the FGDs as 72% of the sampled respondents acknowledge having lost some benefit due to BXW disease. Variations exist in the proportion of households acknowledging loss of benefits due to the disease, depending on the period the disease has been in the area. Virtually all (97.5%) of the sampled households in areas where the BXW has existed for over a year reported having lost

benefits compared to 39% in areas where the disease has arrived more recently (Figure 6). Findings from FGDs indicated that lost benefits are in form of losses of food, income from sale of various banana products, sources of employment for casual labourers, processors and marketing intermediaries. Households have attempted to cope with the effects of the disease in various ways depending on their position in the banana production-consumption chain.



#### A6.1.1. Producers

Focus group participants noted that availability of Matooke, Kivuvu, Ndiizi and Bogoya 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 people. They considered that cutting down entire banana fields due to BXW increases the risk of food shortages to everybody in the

village. As a coping strategy, people have resorted to selling labour to get money to buy food. In addition some households have 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 have declined in some instances to zero. Despite the increase in prices, income from Matooke has fallen due to reduced yields and increased food thefts. Food thefts have increased as people target the Matooke that they can sell at high prices. The transport cost of bringing Matooke from distant producers has led to prices rising. Consumption of *posho* (maize meal) has increased. A community that never used to sell or buy Matooke in clusters/hands (as opposed to whole bunches) now does so.

Findings from individual household survey on bunch sales appear to confirm findings from FGDs. Results revealed significant differences in average number of bunch sales for all cultivars in 2004, between households with BXW and those without the disease (Table A.6a and Figure 7). Farmers' sales of their own bananas was lower by 72%, 64% and 42% for EAH Matooke, Kayinja and Ndiizi in BXW infected households compared to those without the disease.

Table A.6a: Average number of bunch sales by households with and without BXW in 2004

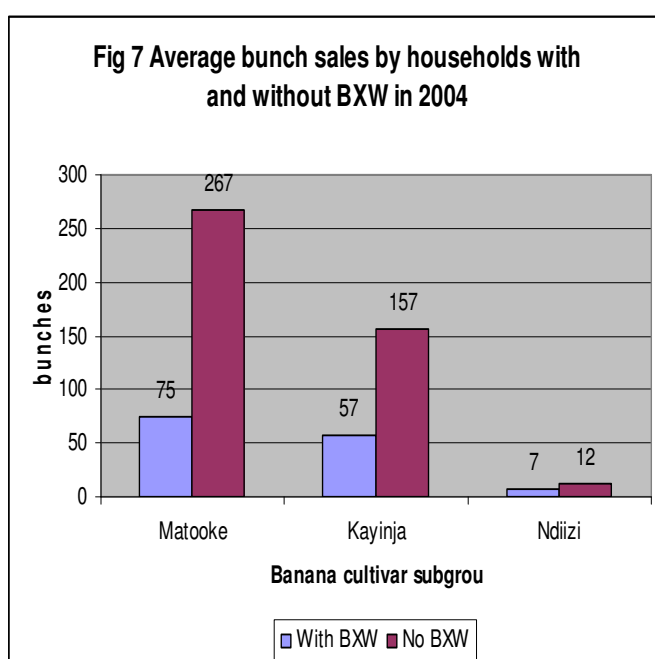
Cultivar sub group	With BXW	No BXW	t test statistic
Matooke	75	267	174
Bogoya	1.66	1.97	3.42
Ndiizi	7	12	30
Kayinja	57	157	115
Kivuvu	0.44	1.93	15.28

Table A.6b: Value of banana production in 2001 and 2004 by district

Type	Mukono	Kayunga	Sironko > 6mths	Sironko < 6mths	Luwero
<b>Value of production in 2001 (UgSh)</b>					
Matooke	1 352 452	2 910 593	1 554 784	864 919	1 789 748
Bogoya	63 238	108 882	152 626	39 676	47 020
Ndiizi	260 238	246 530	114 858	86 954	87 249
Kayinja	543 859	351 902	139 282	65 101	445 001
<b>Value of production in 2004 (UgSh)</b>					
Matooke	273 726	380 809	340 721	553 208	1 343 210
Bogoya	2 731	19 345	12 453	38 051	78 883
Ndiizi	4 401	9 124	13 070	25 660	33 312
Kayinja	19 050	18 903	6 050	18 347	205 440

Table A.6c: Absolute and percentage change in value of banana production between 2001 and 2004

	Mukono	Kayunga	Sironko > 6mths	Sironko < 6mths	Luwero
<b>Absolute change in value of production (UgSh)</b>					
Matooke	-1 078 726	-2 529 783	-1 214 063	-311 711	-446 538
Bogoya	-60 507	-89 537	-140 173	-1 624	31 862
Ndiizi	-255 837	-237 406	-101 788	-61 294	-53 937
Kivuvu	-44 530	-85 083	-97 832	0	-4 813
Kayinja	-524 810	-332 999	-133 231	-46 754	-239 561
<b>Percentage change in value of production %</b>					
Matooke	-79.76	-86.92	-78.09	-36.04	-24.95
Bogoya	-95.68	-82.23	-91.84	-4.09	67.76
Ndiizi	-98.31	-96.30	-88.62	-70.49	-61.82
Kivuvu	-94.70	-91.43	-98.30	0	-21.56
Kayinja	-96.49	-94.63	-95.66	-71.82	-53.83



Findings from individual households on the value of production in 2001 and 2004 (at 2004 prices) depicted in tables A.6b and A.6c also support the views of the focus groups. On average, Matooke-producing households in Mukono, Kayunga and Sironko (over 6 month) have lost annual income from Matooke equivalent to 1.1, 2.5 and 1.2 million Uganda shillings while farmers in Luwero and Sironko (under 6 month) lost 0.4 and 0.3 million shillings. The findings reveal that where BXW has existed for over 6 month, incomes have declined by over 80% for the various banana types.

At the production level, households have tried to cope with the effects of BXW in various ways. From FGDs, it was evident that these communities had substantially reduced the acreage under various banana types. Either the reduction was a result of a conscious effort to move into crops and products that were considered safer than banana; or it was due to the direct impact of the disease, without a corresponding coping strategy by those affected. In the former case, there was a corresponding increase in the acreage under production of other crops as the banana acreage dwindled. In the group discussions, communities reported a growing trend of households diversifying into other areas of crop production. The crops mentioned were mainly maize and cassava. However, other crops like sweet potatoes, beans, groundnuts, Irish potatoes, pineapples, sorghum, and vanilla were also cited as some of the crops households have taken up. Livestock farming has also been adopted but on a rather small scale.

Where the move out of bananas was not an intentional coping strategy, the loss in banana acreage did not generate an equivalent increase in land under other crops. This is attributed to households taking too long to accept that BXW was not going to go away quickly. In some instances, adaptive mechanisms were based on non-farming activities such as riding *bodabodas*, brick-making, retail/petty/produce trading and charcoal production. The implications for land-use are not yet clear but in some cases (such as charcoal production) changes could be noticeably harmful to the natural resource base. Where livestock farming gained in relative importance, land previously under bananas was converted into pasture for the animals.

In the most heavily affected districts, farmers appear to have taken bananas for granted as a source of livelihoods and were in general having great difficulty in adjusting to the situation and finding alternatives. On the other hand, in Mukono and Kayunga, those who were quick to seize opportunities created by BXW were selling pick-up loads of pineapples.

#### A.6.1.2. Processors and post-harvest handlers

In all communities in Mukono, Kayunga, and Sironko where BXW has existed for over six months, FGDs revealed that relative importance of brewing local wine, distilling waragi, pancake and juice making as means of making a living had declined over the last four years. Key informants confirmed this and indicated that most brewing households had gone out of business.

#### **Case history on the impact of BXW on income from brewing**

Ssalongo Emmanuel from Kiyiribwa LC1 in Kimenyedde sub-county revealed that he used to process an estimated 292 jerrycans (of approximately 20 litres capacity) of local brew (24 per month) in 2001 but by 2004 he had lost his *kayinja* field and *kayinja* sources and was getting virtually no income from brewing. With each jerry can fetching, this farmer lost an equivalent of UgSh 1,168,000/=

Table A.6d gives estimates of the value of brewing based on average production levels for *kayinja* in 2001 and 2004. As can be seen, losses of income from brewing in the districts where the disease has been for more than 6 months are more than 90% and even in the districts where the disease has existed for less than six months the losses are very substantial.

Overall the reduction in incomes was impacting negatively on the other livelihood assets. In the interviews people indicated that they were having difficulties in meeting their needs (health, educating children, and recreation), maintaining and improving their household infrastructure, adding to their productive assets, and maintaining their social fabric.

Table A.6d: Change in average estimated revenue from brewing in 2001 and 2004 by district

District	Average Revenue from Brewing (UgSh)		Change in brewing income between 2001 and 2004	% change in income
	2001	2004		
Mukono	674 533	23 627	-650 907	-96.5
Kayunga	687 560	36 933	-650 627	-94.6
Sironko over 6	274 707	11 933	-262 773	-95.7
Sironko under 6	128 400	36 187	-92 213	-71.8
Luwero	622 880	287 560	-335 320	-53.8

Production of local *waragi* (distilled spirit) and banana beer has been greatly curtailed due to decimation of the raw material. Increasingly, producers of these local beverages are resorting to alternatives made from maize and millet. Production of *malwa* or *kwete* (cereal-based beers) is on the increase. Where possible, *waragi* is distilled from molasses but this raw material may be relatively expensive, if it has to be transported from a distance. In some places, even millet for *kwete* has to be bought. However, the number of beverage producers finding alternative raw materials is much less than those who were previously in the business of brewing or distilling banana-based products. As an alternative source of income, some have resorted to buying local brew or *waragi* as finished products from other areas for resale in the village. In many cases, processing equipment has been sold off or used to feed and water livestock; in other cases it has simply been abandoned.

The number of people who engage in frying pancakes and extracting juice for sale is also falling and the production of these by-products has gone down tremendously. In the short term, a few producers of pancakes have taken on cassava chips. A number of factors are however making this change in strategy difficult. High on the list is the fact that the new raw materials are not readily available from local sources (and are therefore costly to obtain). Secondly the vendors have had to contend with the need to change consumer preferences.

There was evidence from the FGDs and key informant interviews that the livelihood strategies of the traders and transporters were changing. This included:

- a growing tendency for traders who used to buy Matooke in bunches from the farm gate to get the same from Matooke markets;
- petty traders who were selling bunches are now selling clusters and hands as a response to the decline in purchasing power of the local consumers due to the increased price of bunches;
- some banana traders have become traders of other available crops like maize, cassava, potatoes or pineapples.;
- there are traders and transporters who have dropped out of the business completely;
- roadside stalls that used to sell juice, pancakes, Ndiizi and Bogoya bananas have either wound up or transformed their services to other edibles like cassava chips.

#### A.6.1.3. Labourers

Findings from individual household interviews on trends in allocation of labour to bananas and other crops in the face of the BXW outbreak revealed a relatively higher proportion of households acknowledging reduced labour allocation to banana compared to increasing labour to other crops (Table A.6e). Results indicate 67% of the sampled households acknowledge a net decrease in labour allocation to bananas, compared to 55% who cite increased labour allocation to other crops. While there were variations between the districts, the results indicate that there was a net decrease in labour allocation to bananas - much more so in the areas where the disease had existed for more than six months.

Respondents were asked to give reasons for the change in labour allocation. Reasons given included decreased area under banana production, increased area under other crops and reduced income from bananas to enable hiring in of labour (Table A.6f). This effect was felt relatively more in Mukono and Kayunga, to a lesser extent in Sironko, and a much less extent in Luwero. The results also show that family labour previously allocated to bananas had shifted to other crops. Overall, therefore, the findings from the individual households suggest that BXW had led to loss of employment in agriculture despite efforts to shift labour from bananas to other agricultural crops.

Table A.6e: Trends in allocation of labour to bananas compared to other crops in the wake of BXW.

Labour allocation	% Change in sampled households by district					Total sample >6mnths	Total sample <6mnths
	Mukono	Kayunga	Sironko >6mnths	Sironko <6mnths	Luwero		
Enterprise							
Banana	-76.9	-50.9	-54.4	-3.6	-16.2	-66.7	-12
Other crops	54.5	46.4	61.8	38	33.5	54.6	35

Table A.6f: Reasons for change in labour allocation by district

Reason	% Citing reason by district				Mean
	Mukono	Kayunga	Sironko	Luwero	
Increase in area under other crops	29.1	15.6	24.8	4.8	19.7
Decrease in area under banana	15.4	22.0	18.7	9.7	15.5
Decrease in income from banana products	43.5	16.1	15.5	7.9	22.8
Increase tasks due to BXW	7.3	10.2	5.6	2.2	5.7

FGDs revealed that people who were predominantly labourers in banana fields had drifted out of the communities. The study did not track the alternative employment opportunities that they had migrated to. It can however be assumed that, at the very least, during the time that they were seeking new opportunities they faced the negative social and human consequences of being unemployed and without income.

BXW has also influenced the way labour in some communities was paid. Four years ago, men providing labour in banana plantations were often paid in kind. Large-scale banana farmers would brew their own local beer and serve this to the workers at the end of the day. On the other hand, women providing similar services would be paid with the equivalent in physical bunches of Matooke for consumption or sale. Labour for carrying fruit down the slopes to loading points in the valleys was also typically paid in kind. These practices have been drastically reduced and, if work is available at all, the tendency is for labour to be paid in cash.

#### A.6.1.4 Consumers

The scarcity of bananas has sharply increased their price, for instance from UgSh 500 per bunch to UgSh 5000. As a result, consumers have resorted to buying fingers or hands of bananas, instead of whole bunches. Similarly, *waragi* distilled from purchased ingredients, such as molasses, is more expensive (the price has reportedly doubled from UgSh 10,000 for a 20-litre jerry-can in 2001 to UgSh 20,000 in 2004) and of lower quality.

### *A.6.2 Impact of BXW on sustainable management of the natural resource base*

The banana crop has positive linkages and interactions with soil water and fertility management, and livestock production. In the FGDs, the following advantages associated with banana cultivation were no longer available with the advent of BXW.

- Banana leaves and sheaths from pseudo-stems are used as mulching material and manure in banana fields as well as mulching other crops, especially vegetables.
- Intercropping with fodder shrubs (such as *Calliandra*) and grasses (such as Napier grass) is possible and is practiced especially in Sironko.
- As well as checking water run-off, these intercrops are an important source of livestock feed and allow maximum utilisation of the available land.
- Banana peels, pseudostems and leaves were cited as vital feeds for cattle and goats especially during long dry spells when natural pastures are scarce.
- Residues from the brewing process were cited as feed for pigs and poultry while remnants of the grass used to squeeze the ripe bananas in the process of producing juice and brewing are used as compost after they decompose

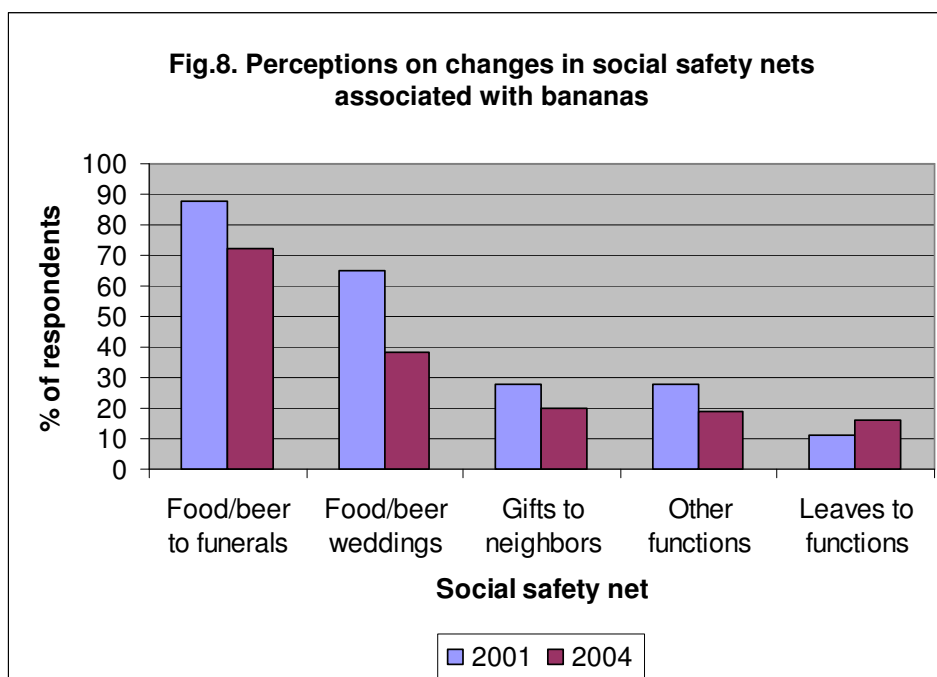
Across the board at the community level, findings show that in places which had had BXW for more than 6 months, the majority of communities were, in 2001, feeding livestock with banana stems. With the advent of BXW, FGD participants noted that no part of the diseased plant is useful and can only be left to decompose. It was alleged that livestock detest BXW-infected banana materials, presumably because of the bad smell. Compost from peels and residues of the brewing process was no longer available. The other crops that the farmers had diversified into – especially maize and beans – do not easily lend themselves to intercropping with fodder species. In contrast, in Luwero and Sironko where BXW had been for less than 6 months, these adverse changes in banana/livestock/soil interactions were not apparent. These developments could have dire consequences both on conservation of the natural resource base and the nutrition of communities. Some of the options (such as brick-making and charcoal-burning) that some of the people were adopting in the face of the BXW challenge pose a direct threat to sound natural resource management and conservation.

### *A.6.3 Impact on social safety nets*

Social safety nets are mechanisms that mitigate the effects of poverty and other risks, temporary or longer-term, on vulnerable households. These risks can be at either a household level (such as illness, disability or death, and unemployment), community- or regionally-based (such as floods or famine) or nationwide (such as drought, global financial risks, or shifts in terms of trade). The adverse effects of these risks will be far more damaging to the poor. For poor people, lost income may force them to sell their land, their livestock or their tools, send their children to work rather than to school, or eat less. These drastic measures may help families survive from day to day, but they will make it that much harder for these families to escape poverty in the future. A variety of informal safety nets address these risks, such as when family members in different households support each other through hard times with cash, food, or labour. Such exchanges, however, depend on social cohesion and social capital. And there is evidence that the BXW epidemic is eroding the social capital of banana-producing households.

One indicator of social capital is the ability of households to contribute products to community functions. FGDs in areas that have had BXW for more than 1 year reported that, in 2001, households in 12 communities were contributing Matooke, beer and juice at funerals; however, by 2004, only 5 groups said households were still meeting such social obligations.

In addition, many households have resorted to contributing banana leaves, instead of bunches, due to the reduction in banana production attributable to BXW (Figure 8). Such an erosion of social capital increases vulnerability of households (especially poor households) and communities as it reduces their capacity to respond to shocks.



## **A.7. Awareness and use of BXW technical interventions**

### *A.7.1 Knowledge of BXW symptoms and technical Interventions*

Since the outbreak of BXW in 2001, concerted efforts have been made to create awareness on the symptoms of BXW as well equipping farmers with knowledge of technical interventions to use, should the disease strike. MAAIF, NARO, and IITA, in collaboration with other development partners, districts local government and NGOs, have spearheaded the awareness campaigns through posters, documentary films, seminars, discussions in strategic public places (such as markets}, newspaper inserts, calendars, and radio broadcasts. Individual farmers as well as focus groups were asked to provide information on their knowledge of BXW symptoms as well as technical interventions to combat the disease.

Table A.7a: Response (%) with knowledge of BXW symptoms by district

Knowledge on BXW Symptoms	Districts				Mean
	Mukono	Kayunga	Sironko	Luwero	
Aware of symptoms	100	97.7	89.9	83.1	92.3
Premature uneven ripening/rotting of bunches	72.8	90.1	68.7	84.4	76.7
Leaves drooping, lamina turning yellow	79.6	85.6	68.2	63.7	72.7
Male bud wilt, flower wither	68.1	44.0	45.6	45.5	52.9
Premature ripening/rotting of fingers that stop growing	17.2	36.0	19.3	35.9	25.0
Stem emitting pus in 5-15 minutes if cut	17.3	11.4	22.1	20.6	18.9

The surveys reveal that a great majority (92.3%) of farmers reported knowing at least one of the symptoms of BXW with a higher awareness (99.5%) in areas where the disease has been for a long time than in recently affected areas (83%). All respondents in Mukono said they

knew BXW symptoms, 98% in Kayunga, 90% in Sironko and 83% in Luwero (Table A.7a). Premature ripening of bunches was cited most often (by 77%) as a BXW symptom, closely followed by drooping, yellowing and subsequent drying of leaves (73%), while drying of male buds was cited by 53%. Internal staining of fingers, ranging from black to brown and hardening of the pulp, and the cut stem releasing yellow bacterial ooze that appears after 5-15 minutes were the least known symptoms, having been cited by 25% and 19% respectively.

The majority of the interviewed farmers did not know the recommended interventions for management of the disease. Sizeable proportions of the respondents knew modified versions of some of the technical interventions. For instance, they were aware of cutting down the infected stem but not of the need to chop it into pieces and bury it. Similarly, they were aware of the tactic of removing the male bud, but were not aware that this must be snapped off with a forked stick, rather than using a cutting tool (Table A.7b).

When data are analysed by district (Table A.7b) some differences in farmer knowledge emerge. Over 60% of respondents in Kayunga and Sironko districts said that infected stems should be uprooted and left in the fields. Less than 20% said that it was necessary to cut the stem into pieces and bury or burn it, to remove male buds immediately once fruit is formed, or to avoid moving any plant material from infected fields. Other measures mentioned included the use of urine or ash and improved management of banana plantations.

Table A.7b: Response (%) of farmers aware of control interventions by district

Control intervention	Districts				Mean
	Mukono	Kayunga	Sironko	Luwero	
Cut into pieces & bury it	15.0	15.3	14.5	19.5	16.1
Uproot infected stem & leave them	58.1	75.4	63.5	38.7	56.3
Burn/ bury cut material	12.1	8.6	6.8	25.9	14.0
Avoid moving diseased plant materials	3.5	2.4	0	15.5	5.7
Debud male flower soon after fruit formation	20.0	12.8	4.3	32.1	18.1
Sound management of banana fields	4.4	5.0	0.5	6.0	3.8
Use of ash	7.8	10.6	10.6	0.7	7.0
Use of urine	4.6	10.5	4.1	0	3.9

### A.7.2. Measures taken by respondents to control BXW

Tables A.7d and A.7e show farmers' responses on techniques they use in controlling BXW disease. A few respondents in Mukono (12%), Luwero (10%), Kayunga (9%) and Sironko (1%) reported that they abandoned their fields due to BXW attack. Some farmers reported that they uprooted bananas as they reverted to growing other crops. Farmers who had been exposed to PDC activities for a period of one year appeared to have abandoned the fields for lack of confidence in the technology that was advised. Knowledge on cutting down the infected plants seems to have been gained through PDC training.

Many farmers (> 60%) in Kayunga, Mukono and Sironko, but only about 36% in Luwero, cut down infected plants. With PDC 20% more farmers did influence implemented this activity compared to without PDC. Very few (< 2% of respondents) replanted infected fields. Only those who had been exposed to PDC removed male buds by using forked sticks, but even then the adoption rate was low: 8% in Kayunga and 3% in Mukono. A larger proportion reported cutting off the male buds. A small group of farmers reported using ash or urine, or cutting leaves, as one of the tactics used to control BXW.

Table A.7c: Response (%) measures taken up by respondent to control BXW by district.

Measures	Districts				Mean
	Mukono	Kayunga	Sironko	Luwero	
Abandon infected fields	11.6	9.2	0.5	10.4	7.9
Grow other crops	16.6	14.5	4.8	0	8.5
Uproot infected plants	17.2	11.7	12.4	1.4	10.9
Cut down infected plants	68.9	86.3	61.8	36.3	59.9
Remove male buds by forked stick	8.4	3.3	0	0	3.1
Cut male buds	14.7	12.1	7.0	19.2	13.4
Use ash/urine	6.6	12.7	6.3	0	5.4
Cut leaves	2.5	1.6	0	0.5	1.1
Replanted infected fields	0.8	0	0	0.9	0.8

### A.7.3 Source of technical services on BXW.

Farmers reported obtaining technical advice from a diversity of sources – that varied in importance among districts (Table A.7d). About 19% of the respondents in Mukono and 18% in Sironko reported that they received their technical advisory services from MAAIF; a few in Mukono and Luwero said they got it from NAADS and NARO (National Banana Research Programme). About 14% and 15% of the respondents from Mukono and Luwero, respectively, reported that they received technical advice from the BXW task forces. These figures were much lower in Kayunga (7%) and Sironko (3%). A small number in Luwero and Mukono get their advice on BXW technologies through NGOs. Overall, 18% reported that they had received their BXW technologies through mass media, 16% through radio, and a very small number (< 1%) from posters, documentary films and on-farm trials. Seemingly open field days are either non-existent or are ineffective.

Many respondents reported receiving information through other farmers: 19% for both Kayunga and Luwero, but only 7% in Sironko and 6% in Mukono. Sensitisation seminars were relatively important in Luwero (17%), but rather less so in Mukono (12%), in Sironko (6%) and in Kayunga (3%). In Luwero and Kayunga transmission of BXW information was also through home visits (21 and 15%) respectively. About 8% of respondents received advisory information through community meetings.

Table A.7d: Response (%) using information on BXW from specific sources by district

Source	Districts				
	Mukono	Kayunga	Sironko	Luwero	Total sample
Public extension	70	26	48	34	48
Audio & Print media	25	53	42	25	31
Radio	25	35	38	22	29
Fellow farmers	11	29	16	29	20
NGOs	6	2	0	25	10
Marketing agents	0	0	0	2	1
Others	2	6	4	3	3

## **B. Econometric analysis**

### **B.1 Factors contributing to the proportion of banana mats infected by BXW**

An overall review of the figures, from the point of view of an econometric analysis, indicate a number of conclusions. In particular, the extent of disease infection is greater the longer BXW has been on the banana farm and is also positively associated with the extent of the disease infection in the first year of infection. The implied infection rate at the margin is about 11% of banana mats per year.

The results indicate that participatory approaches to alert farmers to the disease are paying off, as the proportion of banana mats infected by the disease between 2001 and 2004 is significantly lower, by about 13%-26%, among households in areas where sensitization has been carried out and more specifically among those that know 3 or all four of the 'ABCC' tactics promoted by the PDC campaign for safe production of bananas.

Farmers' perception of the disease amongst the cultivar sub-groups – Matooke, Bogoya (= Gros Michel), Kayinja, Kivuvu and Sukali Ndiizi – indicate that Matooke cultivars were thought to be significantly less affected than the Bogoya, Kayinja and Ndiizi types, but significantly more than the Kivuvu type. Comparing the Bogoya, Kayinja and Ndiizi types, the disease infection was significantly higher in Bogoya than Kayinja and Ndiizi, which were not significantly different from each other. The proportion of banana mats infected with BXW was significantly lower in Luwero than in the other three districts. This is consistent with the project research strategy that depended, for purposes of comparison, on the more recent arrival of BXW in Luwero. Again the perceived differences between cultivar subgroups in these Kayinja-based banana systems is not surprising given that the overriding mode of transmission here is thought to be by insects and Matooke flowers do not attract as many insect attention as do the Kayinja ones. The situation is expected to be different in intensively managed Matooke-based systems where the mode of transmission is dominated by unsterilized tools. The differences between cultivars were not clear-cut across sites and this could be attributed to the sample size of individual cultivars on farm.

### **B.2 Impact of BXW infection on banana production**

Between 2001 and 2004, the results show that a one percent infection of banana mats by BXW was associated with a total reduction in production of about 0.42%, other factors remaining the same. Using the average infection rate of 32% and holding other variables also at their respective mean values, this estimate translates into a total loss of banana production of 30–52% between 2001 and 2004, or about 10–17% per annum. In terms of production systems, the total loss of banana production amounts to 53–60% in Kayunga (Kayinja-based), 43–60% in Mukono (Kayinja-based), 21–60% in Sironko (Matooke-based) and 14–31% in Luwero (Kayinja-based). The milder losses in Luwero district are consistent with the earlier finding that this district had just been attacked at the time of the study and had the shortest period of exposure to disease.

### **B.3 Models used**

Time series analysis was employed and the model used for projecting the time series banana production data (1981-2001) was the ARIMA model. The ARIMA model used in the analysis was the differenced first-order autoregressive model ARIMA(1,1,0) (Gujarati, 1995), which can be specified as:

$$\hat{Y}_{(t)} - Y_{(t-1)} = \mu + \phi(Y_{(t-1)} - Y_{(t-2)}) \quad \text{or} \quad \hat{Y}_{(t)} = \mu + Y_{(t-1)} + \phi(Y_{(t-1)} - Y_{(t-2)})$$

Thus the estimated ARIMA model for cooking bananas becomes:

$$\hat{Y}_{(t)} = 161,315.392 + Y_{(t-1)} + -0.198 * [(Y_{(t-1)} - Y_{(t-2)})]$$

and the estimated ARIMA model for other bananas becomes:

$$\hat{Y}_{(t)} = 40,328.848 + Y_{(t-1)} + -0.198 * [(Y_{(t-1)} - Y_{(t-2)})]$$

#### **B.4 Assumptions for the Projections**

The assumptions used in applying the models to banana production in Uganda were:

1. In Uganda, 80% of banana production consists of Matooke cooking banana and 20% of production consists of other bananas
2. The disease did not affect banana production prior to 2001, thus this can be used as the baseline for the projections
3. If the disease is unchecked, the disease incidence in Matooke will increase by 8% per annum and by 15% in the other bananas
4. There are interventions that can be used to slow the spread of the disease; and the disease could be slowed by up to 90%, 50% or 10%, depending on the type of intervention or level (intensity) of intervention applied.
5. The price of a kilo of banana is UgSh 280 (Foodnet, Dec 2005)
6. The exchange rate is UgSh 1800 : US\$ 1

Figure 9a: Projection for production of Matooke bananas with various levels of effectiveness of intervention against BXW

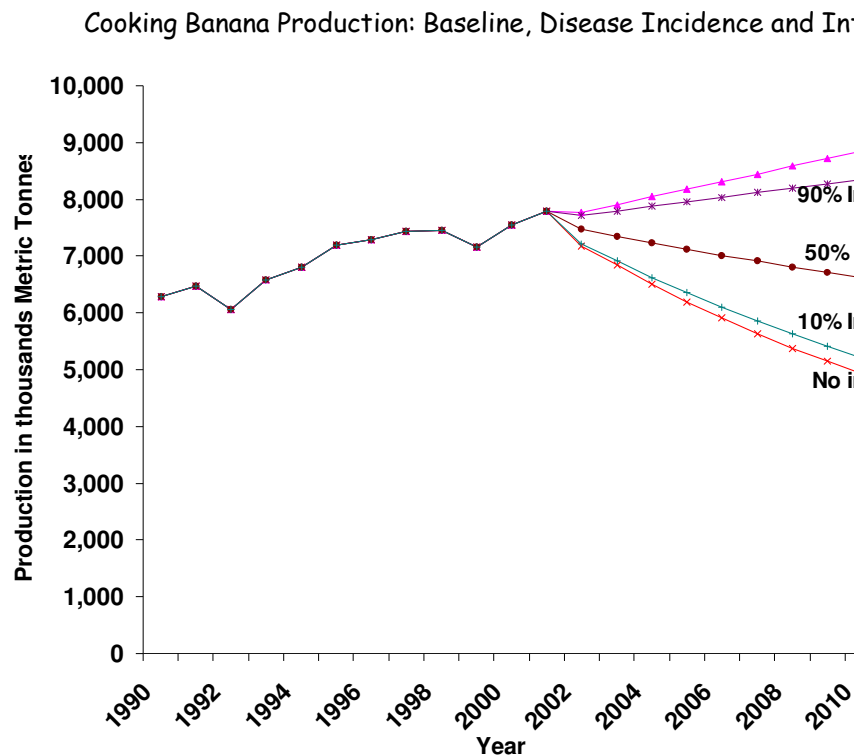


Figure 9b: Projection for production of other (non-Matooke) bananas with various levels of effectiveness of intervention

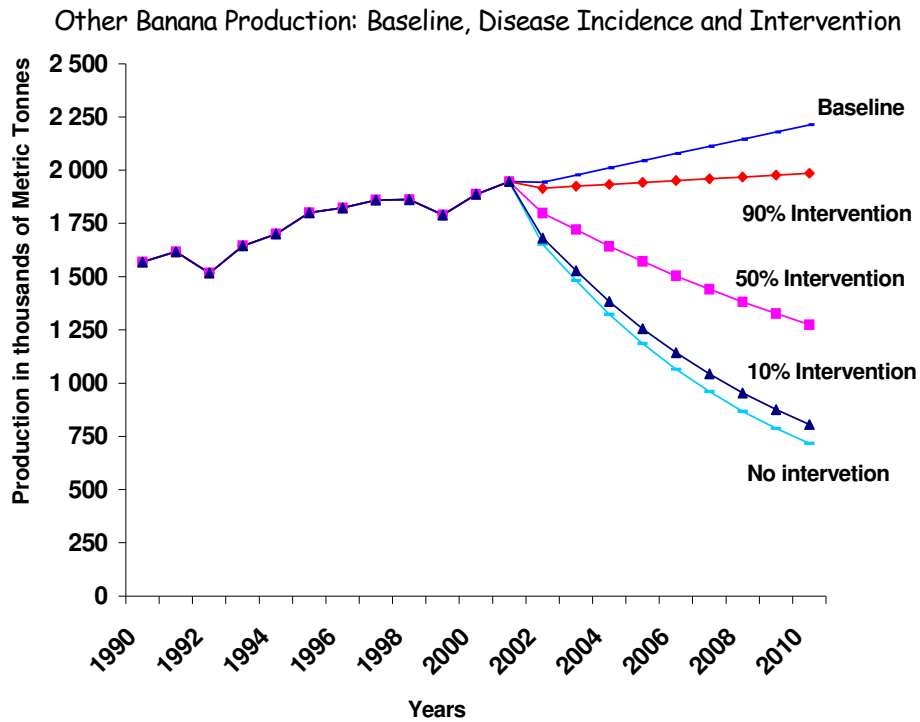


Figure 10a: Projection for change (reduction) in production of Matooke bananas, with various levels of intervention

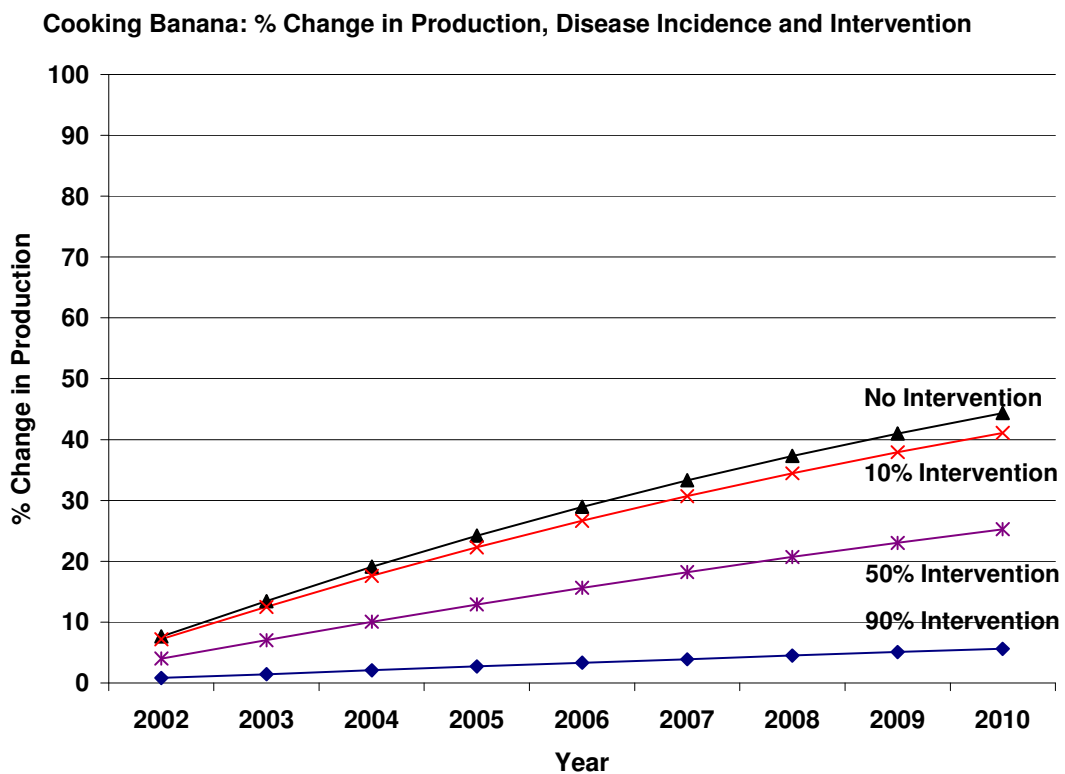


Figure 10b: Projection for change (reduction) in production of non-Matooke bananas, with various levels of intervention

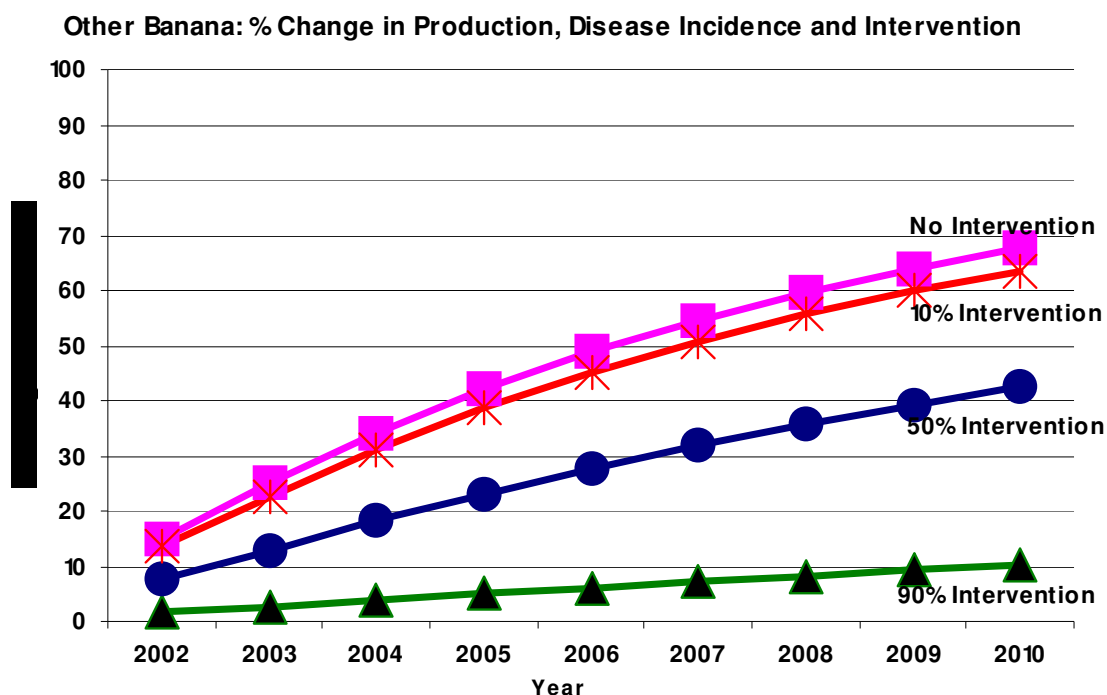


Table B.1: Cooking banana - monetary value lost (/1000), depending on level of intervention

Year		No Intervention	10% Intervention	50% Intervention	90% Intervention
2002	Ugsh	165 798 640	156 720 760	87 067 120	17 413 200
	US\$	92 110	87 067	48 371	9 674
2003	Ugsh	297 442 040	276 089 240	155 618 400	31 570 560
	US\$	165 246	153 383	86 455	17 539
2004	Ugsh	429 843 400	396 437 440	226 453 640	46 555 600
	US\$	238 802	220 243	125 808	25 864
2005	Ugsh	554 530 200	510 654 760	295 530 200	61 560 240
	US\$	308 072	283 697	164 183	34 200
2006	Ugsh	673 662 640	620 488 680	363 685 840	76 742 680
	US\$	374 257	344 716	202 048	42 635
2007	Ugsh	787 291 120	725 933 600	430 798 480	92 070 160
	US\$	437 384	403 296	239 332	51 150
2008	Ugsh	895 847 120	827 307 040	496 933 080	107 548 560
	US\$	497 693	459 615	276 074	59 749
2009	Ugsh	999 658 520	924 844 200	562 116 520	123 175 360
	US\$	555 366	513 802	312 287	68 431
2010	Ugsh	1 099 044 800	1 018 777 200	626 381 560	138 949 440
	US\$	610 580	565 987	347 990	77 194
Total	Ugsh	5 903 118 480	5 457 252 920	3 244 584 840	695 585 800
	US\$	3 279 510	3 031 807	1 802 547	386 437

Table B.2: Cooking banana - monetary value lost (/1000), depending on level of intervention

Year		No Intervention	10% Intervention	50% Intervention	90% Intervention
2002	Ugsh	81 625 320	73 462 760	40 812 800	8 162 560
	US\$	<i>45 347</i>	<i>40 813</i>	<i>22 674</i>	<i>4 535</i>
2003	Ugsh	138 688 200	125 703 480	71 800 120	14 752 920
	US\$	<i>77 049</i>	<i>69 835</i>	<i>39 889</i>	<i>8 196</i>
2004	Ugsh	192 736 320	175 796 320	102 968 880	21 692 440
	US\$	<i>107 076</i>	<i>97 665</i>	<i>57 205</i>	<i>12 051</i>
2005	Ugsh	240 597 000	220 765 720	132 473 320	28 601 160
	US\$	<i>133 665</i>	<i>122 648</i>	<i>73 596</i>	<i>15 890</i>
2006	Ugsh	283 732 960	261 813 720	160 776 840	35 553 840
	US\$	<i>157 629</i>	<i>145 452</i>	<i>89 320</i>	<i>19 752</i>
2007	Ugsh	322 606 004	299 262 880	187 883 920	42 534 800
	US\$	<i>179 226</i>	<i>166 257</i>	<i>104 380</i>	<i>23 630</i>
2008	Ugsh	357 778 820	333 544 932	213 883 880	49 547 120
	US\$	<i>198 766</i>	<i>185 303</i>	<i>118 824</i>	<i>27 526</i>
2009	Ugsh	389 711 476	365 013 012	238 843 360	56 589 680
	US\$	<i>216 506</i>	<i>202 785</i>	<i>132 691</i>	<i>31 439</i>
2010	Ugsh	418 813 080	393 987 048	262 828 720	63 662 200
	US\$	<i>232 674</i>	<i>218 882</i>	<i>146 016</i>	<i>35 368</i>
Total	Ugsh	2 036 577 704	1 884 336 860	1 173 428 480	264 507 040
	US\$	<i>1 131 432</i>	<i>1 046 854</i>	<i>651 905</i>	<i>146 948</i>

### C. Conclusions and Implications

The farm-level studies and subsequent analyses lead to the following conclusions regarding the impacts of the BXW epidemic in affected areas of Uganda:

- The area under banana has decreased by over 13% and production has declined by 65-80%
- Home consumption of bananas declined from 290 kg to 205 kg/capita
- 5-7 % of farmers have abandoned banana production
- Sales of bunches are 3 times higher from BXW-free households (319 bunches) than from BXW-infected households (103 bunches)
- The advent of BXW leads to the loss of occupational and employment opportunities, reduces social capital and thus weakens community social response systems, thereby increasing vulnerability of households to deeper poverty.

Some farmers and communities are successfully adapting to alternative livelihoods strategies based on other food crops (especially maize and beans), other high-value crops (such as pineapples), livestock rearing or food processing based on other raw materials (such as cassava, millet etc.). However, others are encountering greater difficulties and may need intensive help, either to manage BXW more effectively or to adapt to other crops. It is too early to assess impacts on the natural resource base. However, the switch from perennial bananas to annual row-crops may have potentially serious implications for soil erosion and soil fertility, while some alternative income-generating strategies, especially charcoal burning, have evidently negative impacts on the natural resource base.

On the spread of the disease and projections for further losses, it was concluded that:

- Between 2001 and 2004, about 11% of the total banana mats in the study area became infected with BXW per year, giving a total infection rate of 33%.
- Compared to pre-infection levels, the total loss of banana production due to BXW infection is estimated at 30–52% between 2001 and 2004, or about 10–17% increase per annum over the same period.
- If the disease proceeds unchecked, cumulative losses over the period 2001 to 2010 are estimated at US\$ 4.4 billion, at to-day's prices.

Even if the methods and assumptions of the modelling exercise are subject to criticism and subsequent modification, it is evident that the BXW epidemic represents an enormous problem, threatening massive losses to a country and a region where the economy is still heavily dependent on agriculture in general and on bananas in particular. A more serious investment of resources by governments in the region and international donors, concomitant with the scale of the problem, is called for.

On measures to contain the spread of the disease and mitigate losses, the study suggests that:

- Participatory approaches to raising awareness of the disease and its management are paying off: the proportion of banana mats infected by the disease between 2001 and 2004 was significantly lower, by about 13–26%, among households in areas where the campaigns have been carried out.
- Knowledge and practice by farmers of at least three of the four control methods being promoted (rather than only one or two of them), had a substantial effect in reducing the extent of the disease infection. However, most farmers were only aware of one or two

means of diagnosis and one or two control tactics; moreover, they had only an incomplete understanding of the recommended management tactics, leading to ineffective (or even counter-productive) implementation.

- Although none of the banana types is resistant to the disease, the Matooke cultivars were perceived by farmers to be significantly less affected than the Bogoya, Kayinja and Ndiizi types, but significantly more than the Kivuvu type. Rather than reflecting inherent levels of tolerance or resistance, this may be related more to the mode of transmission of the disease in the different cropping systems – mainly insect transmission in Kayinja-based systems and mainly by human agency, via contaminated tools, in the more intensively managed Matooke-based systems.

Since there are, in principle, effective control measures for BXW and there are examples where farmers have been able to adopt them successfully, it seems worthwhile to learn from these successes and to apply the lessons more widely. Since PDC and other public-awareness campaigns appear to have been only partly successful in transferring key messages to farmers, it may be worthwhile investing in the more intensive, farmer-learning-based participatory approaches that will help farmers to understand the basis of control measures and thus perhaps apply them more rigorously and successfully.

Given the evidence, on the one hand, that multiple management tactics must be applied rigorously to be effective in mitigating losses and, on the other, that the value of the crop and the positive impact on livelihoods would justify this investment, the overall implications of this study appear to be that more investment should be urgently made in knowledge-based participatory extension methods on a larger scale.

## **Output 2: Key stakeholders informed of BXW impacts**

### **A. National-level feedback and validation workshop**

The end-of-project workshop provided an opportunity to share the results of the project with a range of development partners, including representatives of NGOs, public- and private-sector organisations, international agricultural research centres, national policy makers, development partners and farmers' organisations. The results of the study were well received and the project's effort to provide an objective estimate of losses, as a basis for sound decision-making appears to have been widely appreciated.

In a final discussion session, the workshop participants developed the following recommendations:

1. Banana *Xanthomonas* Wilt remains a major threat to the livelihoods of rural communities in Uganda where the crop accounts for 65% of the crop production tonnage and 38% of the land under crops. If left unchecked an annual loss of US\$ 4.0 billion is projected. Thus, the disease could have serious food and income security implications and drastic environment changes in the banana-based farming systems, which in turn could easily translate into social upheavals not only in Uganda but also in other countries threatened by the disease. This makes the epidemic a high-level R&D priority both in the country and the region. There is need for all R&D partners at all levels to take urgent measures to combat the disease. In this regard more resources will be required to effectively combat the disease.
2. Knowledge and practice by farmers of more than three of the four control methods being promoted, rather than one or two of them, had substantial effect in reducing the extent of the disease infection. In planning and executing intervention strategies, it

will be critical to aim at ensuring 90% or higher control efficiency in order to ensure cost-effectiveness of the treatments. In this regard it will be necessary to integrate all the interventions in an all-inclusive stakeholder approach, with special emphasis at the community level. Future campaigns should help educate farmers to understand which of the different methods would be more important against the different modes of infection.

3. The information reported at the workshop is vital for decision making at all levels. As a matter of urgency, a team of scientists drawn from the collaborating institutions on the project should be constituted to prepare technical briefs out of the study results to target different stakeholders at all levels with relevant information that would facilitate/stimulate effective responses to combat the epidemic. In this regard, a one-page summary of the findings with costed activities would assist both policy makers and development partners (donors) to prepare for appropriate financial and technical interventions.
4. This study focused primarily on the impact of the epidemic on the livelihoods of the rural communities that grow and subsist on banana [with some implications for the urban population that depend on the staple]. Another study being carried out by NARO is focused on the evaluation of the effectiveness of the interventions, methods and approaches used in campaigns against the epidemic to bring out what worked well and what needs improvement. The two projects are complementary. The workshop appealed for the speedy completion of the latter study so that long-term intervention strategies could take into account the best-bet practices for up-scaling.
5. In the predominantly Kayinja-based banana systems of Central Uganda, farmers perceived Matooke cultivars as significantly less affected than the Bogoya, Kayinja and Ndiizi types, but significantly more than the Kivuvu type. This may be attributed to the mode of transmission (by insects) in this system where management is not so intense and the risk of transmission by farm tools is lower than in Matooke-based banana systems.
6. While the study focused on the two main systems, Kayinja (ABB)- and Matooke (AAA-EA)-based cropping systems, in terms of national coverage, data was collected largely in the Central Region of Uganda. This generally made it difficult to extrapolate the results reliably to the south-western region of the country whose demographic as well as agro-ecological conditions are different from those of central Uganda. Moreover at the time of the study, the epidemic had not reached the south-western region. Now that it has, the study should be extended to include this heartland of banana production, highest both in production and diversity of banana in the great lakes region of East Africa.
7. The workshop underscored the importance of quality data in the assessing of impacts of projects and programs. It was thus recommended that efforts be made to put in place mechanisms for data collection (cultivar disaggregated), processing and retrieval at national and regional level to ensure effective corrective measures are taken in time.

A report of the workshop is available (E. Karamura, M. Osiru and W. Tinzara. Assessing the impact of banana bacterial wilt, *Xanthomonas campestris* pv. *musacearum*, on livelihoods in Uganda: Report on the National Stakeholder Workshop) and will be widely circulated.

## B. Other dissemination products

So far, the following MS PowerPoint presentations have been made to partners and stakeholder groups:

Authors	Title
September 2005: briefing workshop for partners	
NIDA	Assessing the impact of BXW on livelihoods
December 2005: final project workshop	
INIBAP,NARO,MAAIF, NIDA, Ssemwanga Group, IFPRI	Assessing the Impact of the Banana Bacterial wilt, <i>Xanthomonas campestris</i> pv. <i>musacearum</i> on Household Livelihoods in East Africa
G.Kayobybo, L. Aliguma,	Impacts of BXW on banana farming households
G. Omatia, J. Mugisha	Results from an Econometric Analysis

In addition, the project partners have an obligation under the project, reinforced by the national workshop recommendations, to produce policy briefs tailored to special interest groups, including government policy makers, donor agencies and national and regional research systems. This output will not be achieved by the project completion date but the project partners are committed to delivering and disseminating these outputs with all possible haste. Similarly, more population dissemination materials will be prepared in the form of newspaper articles, radio and/or TV talk shows to contribute to national and regional public awareness efforts.

The project partners also expect to prepare the following as scientific journal publications:

G. Kayobybo *et al.* Assessing the impact of banana bacterial wilt on household livelihoods in Uganda.

J. Mugisha *et al.* An econometric analysis of the impact of banana bacterial wilt on household livelihoods in Uganda.

Community coping mechanisms in response to the banana bacterial wilt challenge in Mukono district. L. Aliguma *et al.* (based on work co-funded by the International Development Research Centre, Canada)

All publications will be made available through INIBAP's on-line *MusaLit* database of banana research publications and through the REDIMA regional information service for banana researchers.

## Contribution of Outputs to Developmental Impact

The results of this study are expected to have a considerable influence on pro-poor development efforts, in Uganda and elsewhere in East and Central Africa. Representatives of a number of influential agencies in Uganda were present at the national end-of-project workshop and the workshop recommendations will also be widely circulated to other organizations that were not represented at the meeting. Costed estimates for various recommended actions have already been requested by representatives of some agencies.

The results of the study not only underlined the importance of the BXW epidemic as a threat to rural livelihoods but also helped to indicate the nature of some of the effective solutions. In particular, the study strongly suggests that improving farmers' access to information and technologies pays off and that, given the appropriate management tools (in terms of

knowledge and research-based technologies), farmers can reduce the effects of the disease on their livelihoods. Moreover, the results emphasize the need for intensive knowledge-based participatory approaches to tackling this disease, enabling farmers to fully gain ownership of the management options, so that they can apply technologies effectively and within their own livelihoods strategies.

The insights provided by this study can also be applied well beyond Uganda, as BXW inevitably spreads through other parts of East and Central Africa where bananas are important to people's livelihoods. INIBAP's networking approach will provide a ready-made uptake pathway for the outputs generated by this project and will help to ensure that these products are also used through specific development mechanisms, such as the Challenge Programme on Sub-Saharan Africa which has chosen the Lake Kivu basin (already partly affected by BXW) as a pilot research-and-development area.

Finally, the study has also indicated where the knowledge base for extension interventions is weak, for instance in understanding how the diversity of banana and other crops can best be managed to mitigate BXW impacts, and so will help to target research investments to where they are most needed in support of pro-poor development efforts.

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## Biometrician's Signature

*The projects named biometrician must sign off the Final Technical Report before it is submitted to CPP. This can either be done by the projects named biometrician signing in the space provided below, or by a letter or email from the named biometrician accompanying the Final Technical Report submitted to CPP. (Please note that NR International reserves the right to retain the final quarter's payment pending NR International's receipt and approval of the Final Technical Report, duly signed by the project's biometrician)*

I confirm that the biometric issues have been adequately addressed in the Final Technical Report:



Signature:

Name (typed): Dr Johnny Mugisha

Position: Senior Lecturer, Makerere University

Date: 27 January 2006