Prevention is the best cure for banana viruses

RIU

Validated RNRRS Output.

Smallholder growers in the Philippines and Uganda can now recognise virus infections in their banana plants. Simply spotting viruses early and pulling out the infected plants, then making sure new plants are healthy, helps double yields. The banana bunchy top and banana streak viruses devastate banana crops across South Asia and the Pacific. Now they are spreading in southern Africa. No varieties resistant to either virus have been found and, because chemicals don't work against viruses, prevention is the best option. Growers in Davao-Mindanao, in the Philippines, and in Rakai, Masaka and Ntungamo, Uganda, found that just by removing infected plants they reduce damage and prevent spread of the viruses. They also now make sure that they plant healthy plantlets, produced by low-cost tissue culture.

Project Ref: **CPP75:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

Document Contents:

Description

CPP75

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Philippines, Uganda,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Increasing yield and sustainability of banana production by small-scale growers through use of improved crop management practices to control the spread and reduce the effect of banana virus diseases

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Crop Protection Programme

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

Main Projects

R7529 (1999 to 2003) Management Strategies for Banana Streak Virus: Epidemiology, Vector Studies & Control in East African Highland Bananas (A0926)
R8342 (2003 to 2005) Promotion of improved IPM practices for banana diseases and pests in Uganda (CABI)
R7478 (1999 to 2001) Management strategies for banana streak virus: variation of BSV in Uganda as an adjunct to diagnosis and epidemiology (JIC)
ZA0292 (1999 to 1999) Preparation and publication of a comic-book on banana bunchy top control (A0821)
R6579 (1996 to 1998) Identification, vector relationships and control of virus and bacterial diseases of banana (A0507)
R6202 (1994 to 1997) Banana Virus epidemiology in the Philippines (X0285)

Earlier/linked Projects:

R5234 (1992 to 1994) Identification and Detection of Virus Diseases of Banana (A0217)
R6093 (1994 to 1996) Studies on the Molecular Basis for Pathogenicity in Vascular Bacterial Pathogens of Banana & Plantain (A0365)
R6006cb/R6007cb (1994 to 1996) Detection & Characterisation of Fungi Causing Fusarium Wilt & Sigatoka Leaf Spots of Banana (F0055/F0056)
R6692 (1996 to 1997) Novel techniques of fungi causing Fusarium wilt & Sigatoka leaf spots of banana (X0345)
ZA0160 (1996 to 1997) NRI booklet: PCR techniques for the detection of banana leaf spot pathogens. (A0628)
R7248 (1998 to 1999) Analysis of a host specificity gene in vascular bacterial pathogens for banana and plantain (A0793)
E0009 (1997 to 2000) Molecular and pathogenic diversity of the Mycosphaerella species causing Black Sigatoka.
R7466c (2000 to 2003) Farmer participatory testing of banana IPM options for sustainable banana production in eastern Africa (INIBAP)
R7488 (1999 to 2000) Study of factors affecting the uptake and adoption of outputs of crop protection

research in banana cropping system in Uganda
R7567(2000 to 2003) Integrated management of banana diseases in Uganda
R7972 (2001 to 2004) Integrated management of the banana weevil in Uganda
C1808 (2004 to 2005) Confirmation of *Mycosphaerella fijiensis* (Black Sigatoka) infection in samples of French plantain from Trinidad.
R8437 (2005) Assessing the impact of the banana bacterial wilt, *Xanthomonas campestris* pv. *musacearum* on household livelihoods in East Africa

Institutional Partners – Main Projects

Lead Institute The **Natural Resources Institute**, University of Greenwich, Central Avenue, Chatham Maritime, Kent ME4 4TB UK
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Mr Richard Lamboll [e-mail: r.i.lamboll@gre.ac.uk]

Partner **Bureau of Plant Industries**, Davao National Crops Research & Development Center, Bago Oshiro, Davao, Philippines
Contact Dr Lorna Herradura [e-mail: lorna_herradura@yahoo.com]

Collaborator **INIBAP-AP**, c/o IRRI, Khush Hall, College, Laguna 4031 Philippines Tel/Fax. (63) 49-536-0532;
Contact Dr Gus Molina [e-mail a.molina@cgiar.org]

Partner **Uganda National Banana Research Programme**, Kawanda Agricultural Research Institute, Kampala, Uganda
Contacts Dr Wilberforce Tushemereirwe [e-mail: tush@kari.go.ug]
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Contact Dr James Legg [e-mail: j.legg@cgiar.org]

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Partner **John Innes Centre**, Norwich Research Park, Colney Norwich NR4 7UH UK
Contact Prof Roger Hull, [e-mail: roger.hull@bbsrc.ac.uk]

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Contact Dr Mike Rutherford [e-mail: m.rutherford@cabi.org]

4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? ***(max. 400 words)****. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Banana bunchy top caused by ***Banana bunchy top virus*** (**BBTV**) is the most devastating virus **disease** of banana and is present across all of south Asia and the Pacific and is currently spreading in Southern Africa. It is spread by the banana aphid (***Pentalonia nigronervosa***) and through **infected planting material**. ***Banana streak virus*** (**BSV**) is probably present in all banana-growing regions of the World, but is generally slower than BBTV to cause severe damage with initial symptoms often being confused for other problems. BSV is transmitted by several mealybug species and through infected planting material. No good **resistance** has been identified in **Musa germplasm** to either virus, and chemical treatments are not an option for viruses, so disease management has to be based on avoidance by preventing disease spread and removing sources of infection.

The projects identified **sustainable** methods of **managing** both the diseases in **small-holder** banana plantations and the outputs comprise:

- Knowledge/information on the **dynamics** of the **spread** of BBTV in smallholder plantations (of the popular local variety '**Lakatan**') in the Philippines and of the spread of BSV in **East African Highland Bananas** in **Uganda.**
- **Lessons learnt** about how Filipino and Ugandan small-hold growers perceive diseases and other banana production constraints, and the factors that affect the uptake/adoption of new crop management practices.
- **Diagnostic tests** for testing mother plants for BBTV and BSV so that only **"clean" material** is multiplied (by **tissue culture**) for planting out.
- I**ntegrated crop management (ICM) practices** based on smallholders being assisted to learn the causes of the virus diseases and how they are spread so that they understand the importance of **good crop hygiene**, including the early recognition and removal (**roguing**) of diseased plants and the replanting with **"clean" plantlets** in preventing the **perpetuation** and spread of the diseases.
-

These outputs have converged with those of other projects to conclude that under small-holder banana production systems, it is necessary to adopt an integrated approach to crop management addressing all pests and diseases, and **soil fertility**. For this, the growers have to be able to identify the signs of the constraint and be aware of the **threshold** levels where it becomes necessary to remove diseased plants and replant with healthy plantlets. They also need the **incentives to adopt** this approach, including an **affordable** source of virus-tested "clean" planting material of the varieties they desire.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
	X		*X*		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

Main commodity**: Bananas** and **Plantains**, including **East African Highland bananas**

There are lessons learnt about how resource-poor farmers perceive virus diseases and the general principles of how to detect/diagnose and control them, taking account of these perceptions and some generic constraints to adoption of such systems, that could be applied to other perennial or vegetatively propagated crops. Developing systems for increasing the supply and use of "clean" planting materials either for replanting where diseased plants have been rogued out or for planting new fields is potentially applicable to all the vegetatively propagated food crops (e.g. yams, cassava, sweet potato, cocoyam, Solanum potato) and tree crops (e.g. citrus, cocoa).

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
	X	*X*	*X*	*X*		*X*	

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
X			*X*			

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

All the CPP projects on banana, particularly those focussed on East Africa, were operating as an effective cluster since early in the RNRRS. This allowed the sharing of resources and lessons learnt, and engendered a more holistic approach to the care of the crop to be adopted; necessary to improve banana productivity and sustainability.

The importance of the clustering has been:

- to be able to quickly diagnose what constraints are affecting the crop in a particular area (diagnostic tools outputs from R5234, R6006/7, ZA0160, E0009, R7478)
- have sufficient understanding of how the different pest and disease constraints are spread and affect the plants such that integrated management practices can be developed (Disease characterisation and understanding and impact assessment in R8437/R8484 [BXW], R7972 [banana weevil] R6580 [nematode

bio-control])

- to understand the socio-cultural environment growers are working under and how they perceive the crop and the constraints sufficiently well to be able to work with them, or instil in them the ability, to adapt management practices appropriate to the local conditions (Factors affecting adoption in R7488, R7567, R8342).
- To be able to link demand with supply of agricultural information (R8429, R8281)
- To be able to evaluate alternative methods of providing information/training to farmers and extension workers such as experiential learning approaches and tools [e.g. Farmer Field Schools(R8457)]

(NB DFID/ODA have spent over £5M on banana research alone over the last 16 years – see Table 4)

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

The main outputs of the projects described are the research findings about the two virus diseases and approaches to controlling them, gained through laboratory and field experiments. The understanding of smallholder perceptions of banana diseases and the factors affecting uptake/adoption of alternative control practices were obtained through semi-structured surveys/interviews with small-hold growers in the Davao/ Mindanao area of the Philippines and in Rakai, Masaka and Ntungamo in Uganda.

Research on BBTV was carried out through collaboration between research partners from the Bureau of Plant Industries (Davao, Mindanao, Philippines), and the Natural Resources Institute (UK), with some support from the INIBAP-AP office and the Queensland Department of Primary Industries, Australia (for diagnostic tools). The BBTV projects did not have the resources and did not continue for long enough to have the specific outputs validated by end users or other intermediary organizations.

Research on BSV was carried out through collaboration between research partners at the Ugandan National Banana Research Programme and NRI, with additional input from John Innes Centre (UK) and IITA (Nigeria and Uganda).

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Knowledge on the dynamics of the spread of BBTV was validated through three experiments in small-scale

banana producers' plantations in Davao over 2.5 years. The recommended practice of early identification and roguing of BBTV-infected plants was validated by studying the incidence of BBTV in a portion of a small commercial plantation where the practice was standard. The results obtained were considered sufficiently rigorous to be published in a peer-reviewed journal [Smith MC, Holt J, Kenyon L, Foot C (1998) Quantitative epidemiology of Banana Bunchy Top Virus Disease and its control. *Plant Pathology* **47**, 177-187.]. The perceptions and understanding of small-scale banana growers in Mindanao of diseases of banana, focussing on BBTV, and the recommended control practices were assessed through a semi-structured survey and focus group discussions with over 100 growers in the Davao area of Mindanao (in 1997).

Replicated on-station field trials in Kawanda and Mbarara over 3 cropping cycles (mother and two ratoons) demonstrated that using improved crop management could increase the useable yield obtained from BSV-infected plants by up to 2x. Replicated screenhouse experiments and field trials in Rakai and Ntungamo confirmed that there is active spread of BSV and this is probably by mealybugs. Observation of 30 small-scale growers' fields in Ntungamo in 2001-2002 revealed that where growers adopted more of the recommended crop management practices, severity of BSV was generally less, resulting in greater yields. Surveys involving individual growers and focus-group discussions in Ntungamo, Masaka and Rakai in 2001-2002 revealed that most farmers were unaware of the cause of BSV disease symptoms and so did not understand the rationale behind the crop management practices being recommended to control the spread and impact of the disease. The research was of sufficient quality to warrant the award of two PhDs [Kubiriba J (2005) Epidemiology of Banana Streak Virus (BSV) in East African Highland Bananas (AAA-EA). PhD thesis, University of Greenwich, pp217. and Murekezi C (2006) Effects of banana steak virus and crop management on growth and yield of east African highland bananas (Musa spp., AAA-EA). University of Reading].

Current Situation

C. Current situation

12. ***How and by whom*** *are the outputs currently being used? Please give a brief description* ***(max. 250 words****).*

The projects/outputs described in this proforma were relatively up-stream research and so any promotion of the outputs took place after the end of the projects and there is no direct evidence from the projects of the specific outputs being used.

Outputs related to BBTV are being promoted and used in the INIBAP-AP coordinated project: "*Collaborative banana research, development and extension for improved cropping systems*". This is promoting the tissue-culture production of virus-tested banana by public-private partnerships for sale at relatively low cost to small-holder banana growers in Luzon (Philippines) so they can counter the recent BBTV epidemic and revitalize their production of the locally preferred variety "Lakatan". (details in table of annex).

The outputs specific to BSV appear only to be being used by/promoted by the *Uganda National Banana Research Programme* through the development of training materials (e.g. http://www.banana.go.ug/downloads/bsv_fact_sheet.pd) and conducting training (e.g. in the Benchmark sites programme). There is also an

unconfirmed suggestion that KARI-Kenya is attempting to get BSV diagnostic tools working for testing mother plants prior to tissue culture.

The less disease-specific approach of improving the supply of "clean" tissue-cultured banana plantlets (of both local varieties and some of the improved hybrids – e.g. some of the FHIA varieties) to small-holder banana growers to enable them to establish new "healthy" plantations is being promoted and used by several partnerships:

- Maendeleo Agricultural Technology Fund (MATF) – Diffusion of Banana Tissue Culture Technology to smallholder farmers in Kenya, Tanzania and Uganda (see details in annex).
- INIBAP – Leading or partners in several projects/programmes in sub-Saharan Africa and in South Asia (See table in annex)
- Crop Crisis Control Project (C3P), an 18-month initiative to intensify, and bring coordination to, the fight against Cassava mosaic virus disease (CMD) and **Banana *Xanthomonas Wilt*** (BXW) in six countries of Central and East Africa. Part of the strategy here is to improve the supply of clean planting material by promoting the multiplication in disease-free nurseries (macro-propagation units) of plants from areas where BXW is not present or from plants that have escaped the disease (and thus may show some resistance/ tolerance to the disease). Some of the nurseries are planted with tissue-culture-derived plantlets.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

BBTV-specific outputs – INIBAP programme in Luzon, Philippines.

BSV-specific outputs – Uganda (and possibly in Kenya?) some farmer training at benchmark sites, but appears not to be being widely promoted or used on the ground. BSV, unlike BXW is a slow, insidious problem whose impact on yield is not necessarily immediately dramatic, as it depends on the interaction of many crop management variables. Policy-makers, scientists (NARO) and technical advisors (including NAADS) are currently focused on the more visible and faster-acting BXW.

More general banana Integrated Crop Management projects:

- See Table 2 in annex
- Crop Crisis Control Project (C3P) – Burundi, Democratic Republic of Congo (DRC), Kenya, Rwanda, Tanzania, and Uganda.
- Maendeleo Agricultural Technology Fund (MATF) - Kenya, Tanzania and Uganda.
- INIBAP – projects in all banana growing countries of sub-Saharan Africa and Asia. (See tables in annex)

*14. **What** is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words)**.*

BBTV – INIBAP Luzon. Approximately 400,000 plantlets (sufficient to replant about 20,000ha) of the locally preferred variety "Lakatan" were sold by Lapanday (A commercial banana grower-exporter in the Philippines) in 2005 alone. Also, 77 500 tissue-cultured planting materials of the different introduced and local cultivars were distributed to farmers (groups) in Luzon in 2005 and over 150 farmers/groups were trained in crop management

practices to manage BBTV.

BSV – No information on scale of current use of BSV-specific outputs.

C3P – Currently focussed on BXW, but interventions to make available clean banana planting material are relevant to BBTV and BSV control (as well as to nematode and fungal diseases). Aims that 300 farmers per targeted district in Uganda and 300 farmers in each of other 5 countries receive and plant 40 clean suckers (produced on local macro-propagation units).

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

The organisations listed above in questions 12-14 have been instrumental in successfully promoting the outputs. Table 2 in the annex also lists these organizations/networks as well as several other that have had or potentially could have a role in promoting aspects of banana Integrated crop management (ICM).

The main programmes and platforms that have assisted these broad outputs are:

International banana and plantain network (INIBAP) has had a good coordinating and fund-levering role in both S. Asia and sub-Saharan Africa and includes members from, or has links with practically all of the organizations/ networks listed in Table 2.

INIBAP-Asia-Pacific (Now = BAPNET) has 11 NARS and 2 institutional members in the region at present. One major strand of their work in the region has been in improving the supply of clean planting material; this has been effective in much of S Asia, especially in the Philippines where there are now many small plant tissue-culture enterprises producing plantlets of local varieties at prices small-scale growers can afford.

Banana Research Network for East and Southern Africa (Barnesa) was established by NARS (national agricultural research systems) under the auspices of ASARECA. *MUSACO* (*Réseau Musa pour l'Afrique Centrale et Occidentale*) was formed at the invitation of WECARD (West and Central African Council for Agricultural Research and Development) from 10 NARS along with representatives from the International Institute for Tropical Agriculture (IITA) Nigeria, Centre de recherches régionales sur bananiers et plantains (CRBP) Cameroon and INIBAP. Through these networks INIBAP has coordinated projects covering all of the banana-growing countries of sub-Saharan Africa.

Catholic Relief Services (CRS) and the International Institute of Tropical Agriculture (IITA) coordinate a network of regional associations and agricultural institutes, country-level agricultural research organizations, and local implementing partners for the Crop Crisis Control Project (C3P) covering 6 countries of Eastern and Central Africa.

Philippine Bureau of plant industries
Philippine Bureau of Agricultural Research
NARO/Uganda National Banana Research Programme.
Kenya Agriculture Research Institute.

- Agro Genetic Technologies Ltd (AGT) Uganda – The first (and only?) commercial producer of tissue culture banana plantlets in Uganda supplies plantlets to NARO and other programmes (including some of the above) in the East Africa region.

See question 17 for factors affecting success of promotion/adoption

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Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

Immediate short-term - need to destroy infected plants and to control the spread of the vectors. Plants can be destroyed by application of herbicides but this is probably too expensive for most of the target farmers who should chop down and dig out the infected plants and all associated suckers and chop in small pieces to prevent re-growth. The critical step after plant elimination is replanting with planting material free of the viruses. If plants are eliminated before the diseases have spread widely, then plant cover is only momentarily disrupted on a small scale. However, if the disease has infested large numbers of plants, eradication and replanting with bananas/ plantains or another crop may increase soil erosion.

Long-term - if the control strategies are successful, a perennial banana and plantain cropping system with a diverse mix of varieties to satisfy local markets and consumption patterns will be re-established or conserved. I.e. a return to, or protection of, a cropping system which conserves soil, requires little soil disturbance and uses minimal pesticide.

If the diseases are not controlled and move into new areas then *Musa* will become less productive and farmers will be forced to switch to other crops. In many cases, these are annual crops or root crops with frequent replanting. More soil tillage is required for the frequent replanting of cassava, maize, rice or other such crops. This can be expected to lead to increased erosion and run off. In addition, the biodiversity of *Musa* will be and is threatened; both SE Asia and Central Africa are centres of Musa genetic diversity

For these reasons halting the spread of the diseases is in the long term environmental interests of the banana growing countries.

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

Short-term – destruction of infected plants if done on a large scale could result in increased soil erosion. There is the potential for adverse environmental impact from use of herbicide to kill infected mats and insecticide to prevent spread of vectors from infected mats when they are being destroyed, but since most target farmers are

unable to afford or cannot access these pesticides the risk is minimal.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Bananas are not seasonal so can be harvested at all times of the year. They are also a relatively resilient crop able to withstand short periods of drought or flood. Interventions that help increase the survival and productivity of the crop, and help maintain the *Musa* genetic diversity result in bananas being able to continue to produce in adverse conditions of climate change and other natural disasters.

Annex

Related tables

Click below to view the related information ....

PF_CPP75_Annex.pdf
