CROP PROTECTION PROGRAMME

Promotion of improved IPM practices for banana diseases and pests in Uganda

R8342 (ZA0595)

FINAL TECHNICAL REPORT

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Contents

1. Executive Summary

The primary purpose of this project was to assist the Uganda National Banana Research Program (UNBRP) to promote and disseminate recommended banana crop and resource management technologies to a wide range of stakeholders in Central Uganda who are dependant on the production of bananas for their livelihoods. These technologies include use of improved local and newly introduced improved banana cultivars with tolerance or resistance to major pests and diseases. By utilising a participatory approach a broad range of banana stakeholders, including farmers and representatives of extension services, non-governmental organisations (NGO), community based organisations (CBO), the National Agricultural Advisory Service (NAADS), local councils and national government were presented, by the UNBRP, with improved integrated pest management (IPM) options for banana production in Luwero, Mukono and Kayunga districts of Central Uganda. Based on the relative attributes of the management options, stakeholder communities identified and selected those considered appropriate to their needs. Stakeholders were also identified who were capable and willing to act as intermediaries, or service providers, to communicate knowledge relating to the management options to local communities, thereby promoting their uptake, utilisation and ultimate adoption. Throughout the project a participatory development communication (PDC), rather than a 'top down', approach was employed to help ensure success of the various activities. In each district the project worked through pilot or model sub-counties, parishes and villages within which strong linkages and partnerships were developed and where activities were, and continue to be, coordinated and supervised by community task forces established during the project. In these areas, and indeed beyond, considerable success has already been achieved in promoting management approaches that are now being applied to the benefit of farmers and their associates. Given limited resources, the intention was that the model communities would act as a catalyst for more widespread promotion and adoption of improved management practices.

In the early stages of the project the rapid spread and damaging effects of banana bacterial wilt (BBW, caused by *Xanthomonas campestris* pv. *musacearum*) were becoming apparent in Central Uganda, especially Mukono and Kayunga districts. As a result the UNBRP and other NARES in Uganda, and consequently this project, were compelled to reallocate resources to counteract the disease and to scale out activities from the original focal area, Luwero district. While the project continued to address and promote IPM generally, steps were taken to incorporate and indeed emphasise BBW, by raising awareness of the disease and promoting management practices, such as removal of the male bud from the developing bunch (the terminal part of the flowering axis with male flowers). This is considered to be an effective management practice for banana bacterial diseases elsewhere. In depth research was also completed on transmission of BSV and the effects of management practices on disease development and spread. This work has confirmed that several mealybug species are capable of transmitting the virus in the field and may therefore need to be controlled. Removal of senescing and dead leaves (detrashing) by farmers was found to reduce mealybug populations. BSV was found to have a negative effect on plant growth, but more intensive management practices (e.g. mulching and manuring) counteracted reductions in yield due to the disease. These findings will be of significance in contributing to, and improving, IPM promotional messages being conveyed to growers and other banana stakeholders.

The project has been successful in empowering farming communities in Central Uganda to employ more appropriate IPM practices for banana production. More specifically, these farmers are now in a stronger position to prevent and limit the effects of BBW. Community response has already shown that the benefits of banana production are being more widely realised and that the willingness of farmers to produce bananas not only as food but also as a commercial enterprise is increasing as a result of improved communication and the promotional efforts. These achievements will help to ensure that bananas can be produced in sufficient quantity and of a required standard, that improvements in food security will be attained and that the incomes and livelihoods of those involved in the banana commodity chain, particularly the rural poor (including consumers), will improve.

2. Background

Globally, banana is the fourth most important food crop after rice, wheat and maize. In Uganda, the world's second largest producer, it is the most important food crop in terms of production output, acreage, consumption and priority ranking by stakeholders, with annual production estimated at more than 10 million MT. Over 7 million people in Uganda, including 70% of farmers, rely on the crop as a staple food with estimated annual consumption per capita of 400 kg, the highest rate in the world. The crop, which is cultivated primarily by resource poor, rural farming communities, provides a vital source of income for purchase of other foods, household necessities, childrens' education and medical care. In terms of revenue, banana is the second most important cash crop after coffee, providing 22% of national agricultural revenue. Over the last 50 years there has been a significant decline in banana production in Uganda, as shown by a major shift in production from the previously productive central parts of the country to the south/south-west, where productivity remains high. In these two regions banana production is estimated at 6 and 17 tons/ha, compared with 60 tons/ha attainable on research stations, while longevity of banana plantations has fallen from about 50 years to only 5-10 years in some areas. Many farmers in central Uganda, particularly the young, have abandoned the banana crop after decades of cultivation to seek more lucrative activities, many through migration to urban areas such as Kampala. Even in the west, where production of some banana types (e.g. beer bananas) is increasing, there has been a general decline in productivity.

A programme was established by the UNBRP, in 1989 to reverse the decline in banana productivity. Declining soil fertility and a pest complex, involving banana weevil, parasitic nematodes, fusarium wilt, leaf spots and banana streak virus were identified as major constraints to productivity, with post harvest problems, socio-economic constraints and low genetic diversity also contributing factors. Based on this information, the programme has now moved into a phase of constraint management and identified or developed a number of cultural farming technologies that show potential for alleviating these constraints and, consequently, for increasing production, productivity and yields. These include the use of new, improved cultivars that have good agronomic characteristics and possess resistance or tolerance to leaf spots, fusarium wilt and parasitic nematodes in particular. They also involve improvements in soil and plant nutrition through soil amendments such as manure and mulch, and the use of clean planting material. Since 2000 these have been evaluated and, to some extent, promoted and disseminated through projects R7567, R7529 and R7972 under field conditions at selected benchmark sites. Their relative attributes with respect to minimising losses due to diseases and pests, their acceptability to farmers and their potential for widespread adoption in Ugandan farming systems has already been demonstrated. Based on their specific qualities and those sought after by potential end-users, the primary objective of this project was to take these technologies forward for promotion and dissemination to a broader range of farmers and associated stakeholders as potential beneficiaries and across a much wider geographic area than that encompassed to date.

Banana streak virus (BSV) appears to be becoming an increasingly important constraint to banana production in many countries of the world. As a relatively new disease to Uganda, it has become an emotive issue where it has been called the 'AIDS of banana' in the national press since an epidemic was reported and studied in Rakai District from the mid 1990s. The causes of this epidemic are unclear, but one suggestion was that it was associated with very poor plant husbandry as a result of high incidence of HIV/AIDS in the local human population, which had drastically reduced the labour force able to tend the banana plants. CPP- funded project R7478 (John Innes Centre) confirmed earlier suggestions that BSV is present throughout the banana growing regions of Uganda. Through the use of molecular techniques it was shown that there are at least 12 strains, or pseudospecies, of *Badnavirus* present in Uganda. There appears to be no specific association between any of the virus strains/species and particular clonal groups of *Musa*, geographic regions of the country, or

disease severities. However, from observation in project R7529 it appears that there are significant differences in symptom expression between districts (e.g. Rakai and Ntungamo) that cannot be explained by differences in banana cultivar. Transmission experiments in the screenhouse for project R7529 have indicated that a Ugandan strain of the virus can be transmitted by mealybugs, *Planococcus* sp. and *Dysmicoccus* sp. Results from the project also show that there is natural, vectored spread of the virus in the field in Uganda, but that the rate of spread appears generally slower in Rakai district than in Ntungamo district. It remains unclear whether differences in environment or virus strains can explain the different rates of spread and predominant symptom types observed in different districts. Project R7529 also showed that, in farmers' fields, good crop management has the effect of reducing BSV symptom severity in infected plants, but good management may have less of an effect on yield in plants with severe symptoms than it does on plants with mild symptoms. In controlled field experiments at Kawanda and Mbarara, BSV symptoms were less frequent and less severe in plants grown under optimal compared with minimal crop management. BSV reduced bunch yields at Kawanda by an average of 19% in the mother crop. Nevertheless, improved crop management reduced some of the negative effects of BSV on growth and bunch yield of plants with symptoms. Thus, BSV had a greater (negative) effect on banana yields in Uganda than reported previously in other parts of the world, but it is becoming clear that improvement in crop management may partly mitigate these losses.

These findings led to the suggestion that an integrated package of measures that might include improved surveillance with roguing and replacement of BSV-infected plants with clean plantlets, and improved cultural practices to retain/improve soil moisture and nutrients, could act to reduce the rate of spread of the virus and reduce its effect on banana productivity. A further aim of this project was to investigate transmission of BSV by mealybugs as vectors, and to more clearly determine the effects of defined cultural crop management practices on BSV development and crop productivity on-farm. The findings of this research would inform and enhance IPM strategies intended for future promotion.

Demand for research of the nature described above has emanated from a wide range of sources, not least the UNBRP that, as indicated above, has placed emphasis on the promotion and transfer of IPM technologies to farmers. Intermediary stakeholders including NGOs and CBOs have requested improved technologies through interaction with the UNBRP, including improved planting material. Farmers have also expressed immense interest in new technologies, particularly those who participated in, or became informed of, the research activities recently undertaken in Luwero as part of CPP projects R7567, R7529 and R7972 who mobilised to form farmer groups as a means of sharing resources, facilitate decision-making and influence potential recipients of their product. As a result of lobbying by farmers, the Minister of Agriculture contacted the UNBRP in 2003 to request expansion of the programme's area of activity and provision of materials and information to farmers.

3. Project Purpose

The project will assist the UNBRP to promote and disseminate recommended banana crop and resource management technologies suitable for different agro-ecological zones and farming systems in Uganda to a wide range of stakeholders dependant on the production of bananas for their livelihoods. Key objectives will be to assist the UNBRP to select technologies for promotion, identify intended beneficiaries (including farmers and consumers) and identify channels appropriate to promotion. The project will facilitate promotion, uptake and adoption of practices that most effectively improve banana plant health and reduce losses due to diseases. Further research will also be undertaken to clarify the mechanisms of BSV transmission and spread, and to determine the impact of 'good banana management' in reducing disease development and spread and crop loss as a basis for further improving IPM practice. By doing this, the project will enhance the capacity of farmers to produce bananas in

sufficient quantity and of a required standard, thereby helping to reverse the general decline in banana production in Uganda seen in recent years. The demonstrative and training elements of farmer and other stakeholder participation in particular will contribute significantly to the rapid uptake and adoption of suitable technologies to achieve early impact for improved and sustainable banana production. Successful promotion will lead to increased production, utilisation and consumption of bananas and banana products in Uganda and therefore increase food availability and income of poor people.

4. Research Activities

Note:
Due to the nature of the promotional work undertaken during the course of the project, no attempt is made to differentiate outputs, in terms of research findings, from the activities. As a consequence the promotional process, and general outcomes, are therefore reported collectively under Activities Section 4.2 below, with key outputs being highlighted in brief under Section 5.

Due to the urgent need to increase public awareness of BBW, PMF Activity 1.2e (participatory rural appraisal in Ntungamo and Rakai to determine costs to farmers of crop management practices) was reformulated as a baseline survey with focus group discussions on farmers' perceptions and understanding of pests and diseases problems in Ntungamo, Luwero, Kayunga and Mukono districts. Preliminary results of this work are reported in Section 4.2.4.2

4.1 Field and laboratory based research on transmission, development and management of BSV (*relates to Activities 1.2b to 1.2e*)

4.1.1 BSV transmission experiments in screen houses using mealybugs *(relates to Activity 1.2b)*

During previous project R7529, cultures of the mealybug species *Dysmicoccus brevipes*, *Planococcus citri* and a *Pseudococcus* species had been established on pumpkin fruits in cages at Kawanda research station using single egg-bearing females collected from banana plants in the field. Species identification was done by preparing several individuals from each colony and examining them with a microscope and using the identification key developed previously (Watson and Kubiriba, 2005). Further transmission experiments were carried out as described previously (FTR: R7529) using nymphs from the cultures of these mealybugs.

4.1.2 Effects of management on BSV and banana productivity in ratoon crops grown on-station *(relates to Activity 1.2c)*

Objective

This activity was an extension of work undertaken under project R7529; Management strategies for banana streak virus. That project reported the first results of an experiment at two research stations (Kawanda and Mbarara) that sought to investigate the effects of crop management on BSV incidence and severity, and on crop growth and yield. For most of the mother crop, bunch weights were increased by 62% and 51% by optimal crop management at Kawanda and Mbarara, respectively. At Kawanda, BSV reduced bunch yields by 17% under optimal management compared with 23% under minimal management. BSV reduced bunch weights by 1.2% under optimal management and 14% under minimal management at Mbarara. The work reported here used the same experiments to extend the study to all of the mother crop, and to the ratoon crops. The objective was to examine the effects of crop management on BSV incidence and severity, and on crop growth and yield of East African Highland (EA-AAA) bananas.

Methods

Full details are given in Wheeler *et al.*, 2001 (Technical Report of Project R7529). In brief, a split-plot experiment was established in October/ November 2001 with 4 replicate blocks at two contrasting locations; Kawanda and Mbarara. Each block consisted of main plots of a management treatment (optimal and minimal), and sub-plots of banana varieties (Cavendish 'Williams' and Mbwazirume). Regular observations were made of BSV incidence and severity, and of crop growth, development and yield. Since var. Cavendish showed no symptoms during the entire experimental period it was excluded from the analyses of the

effects of BSV. The observations were of the mother crop and some of the first ratoon for project R7529, and continued up to the second ratoon for in project R8342.

4.1.3 Effects of crop management on BSV and banana productivity, and spread of BSV in farmers' plantations *(relates to Activity 1.2d)*

4.1.3.1 Assessment of crop management practices in reducing incidence and severity of BSV and/or increasing banana productivity in Ntungamo

Objective

The on-station experiments reported under Activity 1.2c showed that the impact of BSV on banana productivity can be affected by how well the crop is managed. That study purposely used a broad definition of 'management', and imposed two quite different sets of management conditions, in order to try to identify any possible effects of crop management practices. Activity 1.2d sought to take this approach on to farmer's fields. The objective of this activity was to investigate under farmer conditions, the effect of cultural management practices on BSV incidence and severity, and crop productivity of East African Highland bananas.

Methods

The study was conducted from August 2001 to July 2003 on farmers' banana fields in Kikoni parish, Ntungamo district, in south-west Uganda. A random sample of sixty banana fields across the villages of Mutanoga, Muyumbu, Kyangara, Kalegeya, Kamunyiga and Musaana in the study area was assessed for BSV status and the dominant farmer cultural practices. From these, 30 farms, were selected to participate in the study. In each of the 30 farms a quadrant measuring 30m x 30m was randomly positioned in the banana fields and 40 plants selected from within.

Management of the banana crop on each farm was assessed on the basis of 8 cultural practices, each scored as either adequate (1) or absent/minimal (0) (Table 1).

Crop data were collected on the 40 marked plants, in each of the 30 farmers' banana fields on 16 different occasions, 9 in the first year (August 2001 – July 2002) and 7 in the second year (August 2002 – July 2003). BSV symptom expression (severity and incidence), banana growth and bunch weights of mature plants, were recorded for each plant along with the proportion accommodating at least one mealybug colony (mealybug incidence) and the number of mealybug colonies on each marked plant (mealybug abundance).

The effects of farmer cultural practices on BSV incidence were determined using generalized linear model procedures (GENMOD) in SAS. BSV incidence was assessed as the proportion of plants showing symptoms. This was a binary response and hence the error was binomially distribution. BSV severity at a particular time was assessed using a Symptom Severity Index (SSI) which was determined by scoring individual leaves of the infected plants using a 0-3 scale and deriving a SSI for each plant using the method of Dahal *et al*. (1997). BSV severity over a time period was expressed as an Area Under Disease Progress Curve (AUDPC) that was the area under the SSI curve for 6 months prior to harvest. For analyses, A value for AUDPC of 0 was no BSV, $0 < AUPDC < 5$ was termed mild symptoms, and a value greater than 5 was termed severe symptoms. The effects of cultural practice on BSV severity, growth (plant height and girth) and bunch weights were analysed using general linear model procedures (GLM) in SAS. BSV severity (MSSI and AUDPC), growth (plant height and girth) and bunch weights were analyzed as averages for each year.

Table 1 Cultural practices recorded, with definitions of the scores assigned to each.

Cultural Practice	Score
Soil and water conservation structures (eg soil bunds)	**0** is no contour soil bunds in banana fields on gentle slopes < 5%, or 1 contour soil bund on steep slopes > 10% over 30m distance **1** is at least 1 contour soil bund on gentle slopes, or 2 soil bunds on steep slopes
Application of organic mulch	**0** is no mulch evident in the banana field **1** is mulch cover of > 5 cm for ≥ 5 months a year
Removal of excess suckers	**0** is 4 plants per mat for ≥ 5 months a year **1** is ≤ 3 plants per mat for > 7 months, but ≤ 4 plants for the remaining months of the year
Regular removal of senescent leaves and sheath	**0** is dead leaves and sheaths present on plants for > 7 months a year **1** is dead leaves and sheath present on plants for < 5 months a year
Application of manure	**0** is no or trace amounts applied in the banana field **1** is more than trace amounts of manure applied in the field
The removal of corms of harvested plants	**0** is harvested corms present in banana fields for ≥ 7 months a year **1** is harvested corms in banana fields for < 5 months a year
Weeding	**0** is many weeds in banana fields for ≥ 5 months a year **1** is no or few weeds in banana fields for > 7 months a year
Use of intercrops	**0** is sole cropping, with no systematic intercrops in the banana field **1** is intercropping, with systematic intercrops in banana field

4.1.3.2 Spread of BSV into plots of cultivars Kisansa and Williams in Ntungamo and Rakai

Four small plots (4 plants x 4 plants) of virus-indexed cv Williams plantlets were planted within banana plantations with high BSV incidence in both Rakai and Ntungamo in May 2001 as part of R7529. The plots were maintained by the farmers in the same way as the surrounding plantations, and the plants in the plots were regularly assessed for presence of mealybugs and symptoms of BSV infection. Also in Rakai, a plot (23 plants x 23 plants) had been planted in 1998 with suckers of cv Kisansa taken from a plantation where symptoms of BSV had not been observed for at least the previous 5 years. This plot was assessed for ingress and spread of BSV approximately every three months, while a more recently (April 2002) planted plot of cv Kisansa (12 x 12) in Ntungamo was assessed approximately every month (for further details see Appendix 1[1]).

[1] Kubiriba, J., Kenyon, L., Chancellor, T.C.B. and Tushemereirwe, W.K. (2005) Spread of *Banana streak virus* (*Badnavirus*) within plots of banana plants in Ntungamo and Rakai districts of Uganda (*in prep*.)

4.2 Promotion and dissemination of banana management technologies to banana stakeholders (*relates to activities 2, 3, 4, 5 and 6*)

4.2.1 Planning meeting, Kawanda, Uganda

An initial planning meeting was held at KARI, Kampala, in November 2003 between members of the UK project team (Mike Rutherford, Richard Lamboll, Savitri Abeyasekera and Lawrence Kenyon) and the Uganda project team. Primary objectives of the visit were to:

- Review overall project outputs and activities, as specified in the project logframe
- Discuss specific activities and develop an initial workplan defining roles and responsibilities, timeframe, and how and when each activity is undertaken
- Review scientific findings, including those emanating from preceding IPM and BSV projects R7567, R7529 and R7972 and prioritise technologies for selection
- Initiate development of a communication strategy to encompass project activities.

A full report of the proceedings and conclusions of this meeting is provided in Appendix 2[2]. In summary, the following key points emerged:

- BSV activities – decisions were made with respect to continuation/temination of on-farm trials relating to BSV transmission and the effects of management practices
- A framework, originally developed for CPP-funded data management project R8301, would be utilised for defining the project research process by defining activities, activity specific roles and responsibilities and when, where (geographically) and how activities would be undertaken (see Appendices 3 and 4 of proceedings).
- IPM technologies considered suitable for promotion were identified as a basis for subsequent presentation to banana stakeholders, mechanisms as to how this could be achieved defined and stakeholders who should be consulted identified. A preliminary list of stakeholders was produced
- The geographic focus of the project was defined as Luwero, Mukono and Kayunga districts in central Uganda
- Plans for holding a stakeholder workshop in Mukono in February 2004, to which stakeholders from the three districts would be invited, were developed

Of significance, there was a consensus that R8342 was not a marketing project but a communication and promotion project, with the aim of informing (directly or indirectly) farmers and other stakeholders of existing banana management technologies. As such, there should be close and sustained interaction between the project team and other stakeholders. Given previous experience the UNBRP was convinced that a participatory development communication (PDC) approach as opposed to a 'top down' dissemination of technologies promised more sustainable technology adoption by farmers and chose to employ this option. The project team, while already well informed of management technologies and in a position to promote and provide them (i.e. to empower beneficiaries), would also play a key role as facilitators of the communication/promotion process. Other stakeholders, particularly farmers, should be the main decisions makers as to what they require, when and how. It was also generally agreed that the project's aims were consistent with a PDC approach developed and already utilised broadly by the UNBRP. The project's activities should therefore correspond, as closely as possible, to the ten stages of the PDC, which are:

1. Establishing a relationship with a local community and understanding the local setting

[2] Rutherford, M.A. and Lamboll, R. (2003). DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Report of visit to Uganda to plan project activities, 10-13th November 2003. CABI International, Egham & NRI, Chatham, UK

2. Involving the community in problem identification and prioritization, identification of potential solutions and the decision to carry out a concrete initiative
3. Identification of the different community groups and other stakeholders concerned with the identified problem or goal and initiative
4. Identifying communication needs and objectives of the different community groups and the corresponding activities
5. Identification, production, pre-testing of appropriate communication tools;
6. Facilitation of partnerships
7. Producing an implementation plan for information sharing
8. Sharing and utilization of results from the initiative
9. Monitoring, Evaluation; Documentation
10. Impact assessment of the initiated activities

Following the planning meeting, a team of UNBRP scientists visited the identified stakeholders to further investigate their interests, whether they felt that they could contribute to or gain from the promotional activities and whether they wished to participate in the proposed stakeholder workshop in Mukono.

4.2.2 Stakeholder workshop, Mukono, Uganda

In order to introduce and promote approved IPM technologies to a wider community, and to help empower banana stakeholders to manage the promotion and dissemination process, it was necessary to develop new partnerships and also to strengthen existing working relationships between the public sector (NARO, agricultural extension [AGRIC-Extension] and National Agricultural and Advisory Services [NAADS]), the private sector (NGOs and small-scale entrepreneurs) and banana farmers. To facilitate this process, and initiate the mobilisation of stakeholders, a stakeholders' workshop was held at Mukono Agricultural Research and Development Centre (ARDC) on 26th and 27th February 2004. Participants were invited from 15 subcounties in Central Uganda for which the promotional activities were planned. These subcounties were: Katikamu, Kamira, Kikyusa, Nyimbwa, Kalagala, Zirobwe, Bamunanika (Luwero district); Najjembe, Kyampisi, Goma, Kimenyedde (Mukono district) Kangulumira, Kayunga, Nazigo and Busaana (Kayunga district). Banana stakeholders from each sub-county comprised: two farmer representatives; a community leader at LCIII level; the sub-county Secretary for Production; sub-county Agricultural Extension staff; two representatives (the chief executive and field supervisor) from each of the NGOs undertaking activities relating to agriculture generally or banana production specifically; a representative of banana traders, processors and exporters. The workshop was facilitated by Dr Martin Kimani (CABI Regional Agricultural Centre, Nairobi) and UNBRP staff.

The objectives of the workshop were to:

- Introduce, share and promote results of UNBRP research activities
- Share stakeholders' experiences, interests, knowledge and activities
- Identify communication needs, pathways/approaches and opportunities for improving communication between stakeholders
- Identify banana IPM technologies to be promoted and identify strengths and weaknesses in promotion partnerships and networking

During the workshop, UNBRP researchers and farmers from Bamunanika benchmark site in Luwero introduced and shared examples of IPM technologies that had been evaluated at the site and had been recommended for promotion to other banana producing areas. These technologies included the improved banana cultivars FHIA 1, FHIA 3, FHIA 17, FHIA 23 and Yangambi Km5[3]), the East African banana cultivars Mplogoma, Kisansa, Atwalira and

[3] Local synonyms: FHIA 1 = Kabana 1, FHIA 3 = Kabana 2, FHIA 17 = Kabana 3,

Musakala, clean planting materials (tissue culture suckers and paired corms), soil fertility amendments (organic and inorganic fertilisers, mulch and manure), improved crop husbandry and control options for pests (weevil and nematodes) and diseases (Black Leaf Streak, fusarium wilt, banana bacterial wilt[4]). Participants identified banana technologies or activities they considered should be taken forward for promotion in their respective districts. Across the three districts of Mukono, Kayunga and Luwero these encompassed pest and disease control options (especially for BBW), soil and water management options, promotion of banana tissue culture material, post harvest and processing technologies, dissemination of market information, integrated farming, communication technologies and the formation of stakeholder (especially farmer) groups.

By allocating the stakeholders into six common interest groups (farmers, agricultural extension and NGOs, traders, community leaders, researchers and telecentre managers), the stakeholders discussed activities they are involved in, problems they encounter and possible solutions for solving the problems faced. They identified communication needs, pathways and opportunities and partnerships for improving communication and conveyed current methods of accessing information on banana production including via training, meetings and seminars, agriculture extension, agriculture shows, radios, newspapers, television. They perceived information gained through agriculture extension as very appropriate as extensionists have extensive knowledge of agriculture and can also obtain information first hand through seminars and training. They pointed out that, while newspapers, radio reports and television documentaries are suitable communication pathways, very few farmers can access them in rural areas. The participants expressed a desire to acquire more information through more training, field tours and two-way communication of technologies.

Through the workshop different players in different districts, including NGOs, traders and private sector entrepreneurs, were identified who could be organised to form partnerships to promote the banana technologies to the wider community. The strengths and weakness of these partners were identified, the main weakness being facilitation or funding of the implementation stages in the promotion process. In order to more accurately determine the specific roles that partners could play in promoting the desired technologies, participants agreed to have follow-up meetings at district level under the coordination of the District Agricultural Offices (DAO) to prepare action plans on how to undertake the promotional activities. For full details of the workshop proceedings, refer to Appendix 3[5]

4.2.3 District stakeholders' planning workshops

4.2.3.1 Overview of the PDC planning workshops and scaling out of PDC outputs

Two planning workshops had already been undertaken in Luwero district in August 2003. As a follow-on to the workshop held in Mukono in February 2004, separate planning workshops were held in Mukono and Kayunga districts under the auspices of the respective DAO to foster farmers' participation in application of IPM technologies, including BBW management, and to develop action plans at to how to progress banana promotion activities. During this phase the working team focused on the three districts and chose to test the PDC model for

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FHIA 23 = Kabana 4 and Yangambi Km5 = Kabana 5

[4] The terms banana xanthomonas wilt (BXW) and banana bacterial wilt (BBW) are synonymous

[5] National Agricultural Research Organisation (2004) DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Proceedings of the stakeholders' workshop for promotion of banana production, commercialisation and utilisation technologies in Luwero, Mukono and Kayunga districts. 26th-27th February 2004. Nankinga, ed. NARO. 95pp. March 2004. Uganda, NARO.

IPM and BBW implementation and control in three pilot sub-counties, three pilot parishes and three pilot villages (Plate 1). Based on experience in these areas the activities would be scaled to other project areas. The UNBRP research team together with communities in the pilot subcounties of Kimenyedde, Nazigo and Bamunanika conducted planning workshops where stakeholders were identified who would be involved throughout all the phases of the PDC research initiative. Stakeholders made action plans and chose task forces that would work with stakeholders in the community towards ensuring that the action plan is implemented. Activities and communication tools developed with these three sub-counties were later scaled through sensitisation workshops to other project sub-counties; Katikamu, Kamira, Kikyusa, Nyimbwa, Kalagala, Zirobwe, (Luwero district); Najjembe, Kyampisi, Goma, (Mukono district) Kayunga, Kangulumira, and Busaana (Kayunga District).

4.2.3.2 Luwero district workshop

Luwero is an area where banana production has declined markedly over the past few decades, to the extent that some areas previously very successful at producing bananas have stopped production in favour of other, more lucrative but less labour intensive, commercial ventures. This decline has partly been due to serious pest and disease outbreaks. As outlined in Section 2, the UNBRP had already been active in Bamunanika benchmark site[6] evaluating and validating local banana cultivars and cultivars recently introduced to Uganda that possess tolerance or resistance to some of the major pests and disease prevalent in the country. Evaluation of management practices to improve plant vigour, namely the use of manure preparations and mulch, also formed a component of this work, which was undertaken through CPP funded project R7567. The majority of the research was undertaken through on-farm, farmer managed trials and, as such, the process of promotion of these technologies had already been initiated. It was further enhance through the controlled dissemination, on demand, of planting material of the improved cultivars to non-participating farmers in the district.

In Luwero district, the UNBRP had already organised two banana stakeholder workshops aimed at scaling up banana production, utilisation and commercialisation in six subcounties. These were held in August 2003, shortly after completion of R7567 and prior to inception of R8342, and were funded by UNBRP. Scaling up was to be achieved primarily though the development of public/private sector partnerships and the provision, on request, of planting material to selected farmers who would establish plantings on their farms as demonstration/dissemination plots. The first of these workshops was held on 12th and 13th August 2003, at Bukalasa Agricultural Research Institute and was attended by 100 invited stakeholders from the sub-counties. For each sub-county, they included three farmers from each of three villages in each of the three pilot parishes Other participants were LCII chairmen, LCIII Secretary for Production, agricultural extension officers and representatives of NGOs and CBO operating in the subcounties. The main objectives of this workshop were to:

1. Develop criteria for selecting contact farmers
2. Expose the participants to improved banana technologies already accepted by farmers in Bamunanika benchmark site
3. Facilitate the development, by stakeholders, of work plans for scaling up activities in the six pilot subcounties, Kamira, Kikyusa, Katikamu, Nyimbwa, Zirobwe and Kalagala
4. Identify roles and responsibilities of partnerships and networking arrangements

During the workshop the available banana technologies, including cultivars, were introduced. Farmers, NGOs and CBOs gave their opinions on the technologies and the relative attributes

[6] As a benchmark site representing Eastern and Central Uganda

(strengths and weaknesses) of approaches to their dissemination were explored. The participants also visited a field site in Bamunanika where the UNBRP had been promoting the management and utilisation of exotic cultivars. By the close of the workshop each sub-county had also prepared an agreed work plan (see Appendix 1 of workshop proceedings) that incorporated key areas of activity: farmer mobilisation; selection and training of contact farmers; training of trainers; field site selection and preparation of ground for sucker multiplication and use as a demonstration/dissemination plot; dissemination of planting material to farmers; planting; participatory monitoring of progress by a multidisciplinary team of farmers, extension, NGOs and UNBRP staff; launching of banana production programme for food and income as a publicity event in each sub-county.

Full details of the Bukalasa workshop are provided in Appendix 4[7].

A second workshop was held on 28 August 2003 in Katikamu sub-county, attended by 40 participants. These included district agricultural extension officers, LCIII secretary for production, sub-county chiefs and representatives of NGOs operating in Luwero (CARITAS, ADRA, VEDCO, JEEP, Plan International, BUCADEF, SASAKAWA, Africa Global 2000 and COD). Here the primary objectives were to progress the formation of farmer, private and public sector (i.e. NARO) partnerships in disseminating proven banana technologies to the farming communities, to identify and share roles and responsibilities within the new partnerships and to identify NGOs and CBOs who were willing to immediately start networking within the local communities in partnership with the UNBRP.

CARITAS, VEDCO and SAO (not among those in list above) offered to begin networking in partnership with the UNBRP and under agreed arrangements to help promote improved banana management. The NGOs agreed to engage with the community to assist with:

- Planning meetings between NGO, CBOs, sub-county agricultural extension, political leaders and scientists
- Mobilisation of farming communities hosting promotional activities
- Contact farmer selection and training
- Selection of suitable field sites and plots
- Field marking and hole preparation
- Distribution of initial planting materials to selected farmers
- Planting multiplication plots for production of suckers for further dissemination
- Monitoring of their own multiplication plots

Following these workshops the partners actively engaged with the community to progress the agreed activities across the six sub-counties. The establishment of field sites and dissemination of banana cultivars was monitored once in each sub-county. Further details of the Katikamu workshop proceedings and monitoring are provided in Appendix 5[8]. A summary of the findings of monitoring activities is also provided in Section 4.2.4.3.

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[7] National Agricultural Research Organisation (2003) DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Proceedings of the stakeholders' planning workshop report for scaling up banana production, commercialisation and utilisation technologies in Luwero, district, August 12th-13th 2003. Ngambeki, D. & Nankinga, C., ed. August 2003. Uganda, NARO.

[8] National Agricultural Research Organisation (2004). DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Monitoring performance of improved banana cultivars disseminated in Luwero district to intended beneficiaries via public agricultural extension and non-government organisations (NGOs). August 2004. Nankinga, C., ed. August 2004. Uganda, NARO.

4.2.3.3 Mukono and Kayunga district workshops

There was an increasing realisation that BBW had spread rapidly and had already caused significant damage to the crop in Mukono and Kayunga in particular, culminating in national policy dictating that BBW management activities be incorporated into the on-going programs of banana stakeholders including the Ministry of Agriculture Animal Industries and Fisheries (MAAIF), local government, National Agricultural Advisory Services (NAADS), NARO, NGOs and training, religious and cultural Institutions. In early 2004 the UNBRP was requested by government to urgently redirect resources to tackle the problem. In Mukono and Kayunga, the PDC therefore took a somewhat different approach to Luwero to ensure integration of IPM promotional activities with the need to raise awareness of, and help to control and contain, the spread of BBW. Here PDC was applied whereby the UNBRP together with staff from the Plant Protection Division of MAAIF worked to interact with farming communities, foster farmers' participation in IPM and BBW management activities and develop and disseminate IPM technologies with special emphasis given to BBW. In Luwero, by contrast, the promotional activities were largely driven by NGOs and public agricultural extension officers.

While PDC is a process that takes time, BBW control demanded quick action. As a consequence the UNBRP research team had to move swiftly through the early stages of the PDC to share information and develop communication tools to be used both within and beyond the geographic focus area of the project. Nevertheless, and through the PDC process, farmers identified banana related problems that they were experiencing, agreed on possible solutions to the problems and on how to implement such solutions. They finally developed action plans and established task forces that would work together with other stakeholders in the community to ensure that action plans were implemented.

In both Mukono and Kayunga districts, the UNBRP team initially interacted with banana stakeholders through a workshop held at district level (Plate 2). At the end of these meetings, a pilot or model sub-county was selected by participants through which plans for promotion and implementation of banana management technologies could be progressed. In Mukono, Kayunga and Luwero (where the team had already been working through project R7567) districts, Kimenyedde, Nazigo and Bamunanika subcounties were chosen respectively. At the sub-county meetings, stakeholders were also identified who would be involved throughout all stages of the PDC process. For each pilot model sub-county a further meeting/workshop was held to allow interaction between sub-county stakeholder representatives and development of plans for the sub-county. The selection of participants at this level was driven by sub-county agricultural extension staff. Participants involved in these workshops were largely farmers, extension workers, local leaders, politicians, religious leaders, NGOs, farmer group leaders and school heads. In this meeting the stakeholders agreed on a pilot parish to demonstrate selected IPM activities. Bukassa and Bukamba parishes were selected for Kimenyedde and Nazigo subcounties respectively. Stakeholders from all villages within the selected parish then met to discuss implementation of activities at parish level and also chose a model village where the research team would work closely with the community to implement the village action plan. For Mukono, Kayunga and Luwero districts, Namakomo, Gayaza and Kibanyi villages were chosen respectively.

At all levels of interaction the stakeholders shared their knowledge and used it to formulate action plans for the way forward with regard to IPM and BBW control. At district, sub-county, parish and village level task forces comprising key members of the community were established to help to ensure that was agreed would actually be implemented (Plate 3). Stakeholders from subcounties other than the chosen pilot sub-county were to implement IPM activities as prioritised in the district planning workshop under the coordination of the DAO and follow-up with the research team from the UNBRP.

The objectives of each stakeholder workshop varied depending on the participants. Participants at district and sub-county workshops were primarily community leaders, extension staff, development agencies and farmer representatives. It was hoped that this group could later become trainers promotion of IPM and BBW management. The key objectives for district and sub-county workshops were to:

- Introduce the PDC methodology to banana stakeholders at district and sub-county level
- Share information on IPM and BBW control with banana stakeholders in the identified subcounties
- Facilitate the stakeholders to develop action plans on how to approach the farming community and implement IPM and BBW control at district and sub-county level using a PDC approach
- Facilitate stakeholders to choose a pilot parish from which a village would subsequently be selected for demonstration purposes and as a showpiece for other subcounties

In parish and village meetings, however, the majority of participants were farmers, the actual implementers of IPM and BBW management activities. Here the key objectives were to:

- Share information on IPM and BBW control with banana stakeholders at village and parish level
- Facilitate stakeholders to develop action plans for implementing BBW control and IPM
- Facilitate stakeholders to choose members of task forces that will spear head and oversee the implementation of the BBW control/IPM activities

To progress the development of action plans, facilitators suggested that they the perceived objectives, activities to be implemented in order to achieve the objectives, when the activity would be done and who is responsible for ensuring that it is implemented and what partners may assist in activity implementation.

One day was allocated to district workshops, which involved opening remarks from the DAO, some discussion of participants' expectations and the workshop objectives, presentations and discussion on BBW and general IPM, introduction of PDC (by Nora Odoi) and discussion and formulation of community action plans on IPM and BBW control. Sub-county, parish and village workshops took two days, the first devoted to stakeholders sharing knowledge of BBW and IPM, having group discussions and presentations while the second day was allocated for field demonstrations, formulation of action plans and identification of task forces. District and sub-county meetings were conducted in both English and Luganda (the local dialect) to cater for illiterate participants. Parish and village meetings were conducted only in Luganda as participants were from Buganda region.

An outline of the proceedings of the various workshops and meetings is provided below. For full details refer to Appendix 6[9], which includes a summary table (Annex 1) of dates, participants and outputs of meetings held at sub-county, parish and village level in Mukono and Kayunga districts.

[9] Nankinga Kukiriza, C. and Odoi, N. (2004) DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Working with banana farming communities in Mukono, Kayunga and Luwero districts to develop and disseminate integrated pest management technologies with special emphasis on banana bacterial wilt (BBW). August 2004. Uganda, NARO.

4.2.3.3.1 Mukono district workshop

A one-day workshop was held in Mukono district on 27 April 2004 to facilitate IPM/BBW control using the PDC approach. Participants included banana farmers, local council leaders (LC), sub-county chiefs, secretaries for production, extension officers and NGO among other stakeholders. The workshop was a follow-up to that held at Mukono ARDC in February 2004 and was intended to enable stakeholders to prepare their own communication plans for action with respect to IPM and BBW management again utilising a PDC approach. Having selected and prioritised available banana technologies for promotion in their respective districts at the Mukono ARDC workshop, this workshop provided an opportunity for stakeholders to review these technologies, to share information on IPM and BBW control in more depth and to formulate a community and action plan for promoting and implementing IPM and BBW management through PDC in relation to the needs of Mukono district. It also served as preparation for the meetings to be undertaken subsequently at sub-county, parish and village level to develop more concrete plans for implementation. Workshop participants included agricultural officers, members of Farmers' Letter and Farmer Forum attached to NAADS, CARITAS, BUGADEV, sub-county chiefs and chairmen of Farmers' Associations. Representatives of the various subcounties within Mukono also selected Kimenyedde as the model sub-county through which subsequent activities should be progressed.

Mukono district - Kimenyedde sub-county workshop

Following the Mukono district stakeholders' meeting outlined above, Kimenyede was chosen as the model sub-county through which follow-up activities would be channelled to facilitate further promotion and implementation of IPM and BBW management at parish and ultimately village level. A two-day workshop was organised at Kimenyedde sub-county headquarters on 19th and 20th May 2004 and attended by 40 stakeholders. These included farmers, chairmen of farmers' associations, secretaries for womens' associations, agricultural extension officers, sub-county chiefs, agro forestry coordinators, LCI chairmen, LCII vice chairmen, LCIII councillors and parish chiefs. During the meeting participants discussed problems faced by banana growers, what participants already knew about BBW, how BBW may be differentiated from other diseases, attempts already made by farmers to tackle BBW and the challenges this presents, technologies available for addressing these problems and what communication needs the parish community had. They identified BBW as their main concern but indicated that they lacked knowledge of how to control BBW or of IPM generally, including how to distinguish the improved cultivars that some were aware of. The meeting culminated in action plans being developed for five parishes (Bukassa, Kawonga, Nanga, Namaligga and Kiwafa), including a schedule of subsequent meeting to be held for villages in each parish, and task forces responsible for progressing the agreed activities identified for each parish. Parish representatives selected Bukassa as the model parish through which subsequent activities would be progressed.

Mukono district - Namakomo village workshop

Through successive meetings and discussions held at district, sub-county and then parish level, village representatives attending parish meetings selected Namakomo, with a population of approximately 400, as the model village within Bukassa through which subsequent activities would be progressed. The village was chosen as it was located furthest from the sub-county headquarters and was one of the most neglected villages in Bukassa. It is also the village most severely affected by BBW. On 15th and 16th June 2004 a meeting was held in the village, attended by 60 stakeholders, when problems faced by villagers were discussed in depth with researchers. The villagers highlighted their expectations and needs in terms of constraints to banana production and their management, how they themselves thought the constraints could be tackled and what the preferred management technologies were. The meeting again culminated in action plans being prepared for implementation of improved management practice.

4.2.3.3.2 Kayunga district workshop

A one-day workshop was also held in Kayunga youth centre, Kayunga district, on 14th May 2004. Participants were from various subcounties affected by BBW, namely Nazigo, Kayunga, Busaana, Kangulumira, Kitimbwa, Kayonza and Bbaale and included, among others, farmers, local council leaders, banana traders, agricultural officers, secretaries for production and representatives of NGOs and micro-finance institutions. This workshop again provided a platform for further discussion and review of required technologies for Kayunga district specifically, and for preparation of plans for action at sub-county, parish and village level within the district.

Kayunga district - Nazigo sub-county workshop

A two-day workshop similar to that for Kimenyedde was held in Nazigo sub-county on 27th and 28th May 2004. Management methods used by farmers for pests and diseases, including chemical approaches, were highlighted and discussed. Action plans including timeframes were prepared for eight parishes, Natteta, Kimanya, Nazigo, Nsiima, Kirindi, Bukamba, Katikanyonyi and Bukamba, and task forces identified for each parish. Bukamba was chosen as the model parish.

Kayunga district - Gayaza village workshop

On 24th and 25th June 2004 a meeting was held in the village to discuss implementation of activities within the village.

After initiating activities at village community level, farmers began to aggressively act to restore their banana fields by implementing IPM and specifically tackling BBW, practicing generally recommended management practices for banana production and in some cases requesting BBW-free planting material of cultivars that promised higher yields.

4.2.3.3.3 PDC communication tools developed during the Mukono and Kayunga district community interaction

During this project phase of working with the different farming communities at the different planning and PDC development stages, stakeholders were identified who would progress activities through the consecutive phases of the PDC process. In any one setting or meeting several stages of the PDC process were usually addressed in that, for example, stages one to five were addressed at district, sub-county, parish and village levels. By interacting closely with the local communities the team quickly established good working relationships with stakeholders who became actively involved in the identification and prioritisation of prevailing constraints and the identification of potential solutions, identification of community groups and other identification of stakeholders concerned by each constraint. They also identified key objectives, communication needs and associated activities required by the different groups and also formulated action plans for BBW control. This enabled communication tools to be identified and some tools to be produced, albeit with emphasis on researcher input but nevertheless with the participation of the farming community (Plates 4 and 5). Key communication tools developed during the communication process were:

- A video documentary outlining the PDC procedures and protocols followed in the community to identify IPM and BBW communication needs and related technologies required to resolve them (duration 21 minutes)
- Training and sensitisation documentary (in English[10]) on BBW symptoms, transmission and control (duration 10 minutes)
- Training and sensitisation documentary (in Luganda) on BBW symptoms, transmission and control (duration 10 minutes)

[10] Originally produced in English but being translated into four local languages

- Sensitisation play entitled 'Bampalana' (in Luganda) on BBW. This incorporates community perceptions, training on BBW symptoms, transmission and control and elements of community action to combat the disease
- Oral presentation on the PDC model used, lessons learnt in efforts to combat BBW in Kayunga, Mukono and Luwero districts and how this model can be scaled out to other BBW affected or threatened area of Uganda

4.2.4 Monitoring and evaluating: performance of improved varieties and management technologies, impact of communication and promotion activities, and dissemination, uptake and utilisation of promoted technologies (*relates to activities 1.1, 1.2a, 2.2(ii), 3.3 and 5***).**

Given the range and extent of activities being undertaken, it was realised that there was a need to acquire data that would, firstly, provide information to inform those contributing to the promotional activities and, secondly, provide a measure of success, or impact, of the promotional activities i.e. determine improvements in awareness of IPM technologies and possible uptake of these. The latter is important in helping to whether farmers' livelihoods are likely to improve as a result of the promotional activities. Thirdly, there is an ongoing need to monitor the performance of management technologies, including the agronomic and biological response of improved varieties evaluated and disseminated through R7567. This would allow, for example, any breakdown in inherent resistance to pests and diseases to be detected. Possible approaches to addressing these needs, which involved studies on farmers' perceptions of banana cultivars and assessment of the extent of dissemination, uptake and adoption of technologies, were discussed during a meeting between the team members held immediately after the Mukono stakeholder workshop, in February 2004. Subsequent to these discussions, and with the assistance of the project's statistical advisor (Savitri Abeyasekera), draft technical protocols were developed that the UNBRP team could use to obtain the required data through individual farmer interviews, focus group discussions and visual assessment of on-farm trial sites established under the preceding CPP projects.

Unfortunately, and largely due to new demand to divert project resources to help counteract the already devastating effects of BBW in Mukono and Kayunga districts in particular, the monitoring and evaluation activities could not be addressed as originally planned. Specifically, quantitative assessment of the ongoing performance of improved cultivars evaluated on-farm and with the participation of farmers in Bamunanika sub-county under R7567 was not possible during the project (i.e. activities 1.1 and 1.2a). This will now form part of a proposed follow-on project, to be funded by CPP, commencing in April 2005 (see Section 6). However, short formal studies were undertaken in relation to eliciting criteria used by farmers for evaluation/selection of new technologies and an assessment of farmers' perceptions of pests and diseases (including BBW) and their management. These are outlined in Sections 4.2.4.1 and 4.2.4.2 below, respectively. Details are also provided of activities to monitor the dissemination of banana cultivars in Luwero district with the assistance of NGOs (Section 4.2.4.3), and of review workshops held to ascertain how stakeholders view communication materials developed through the project and what they have learnt from them (Section 4.2.4.4).

Extensive and systematic monitoring, evaluation and documentation of the promotional activities undertaken during this project will form a major component of the proposed follow-on research (see Section 6).

4.2.4.1 Farmers perceptions of improved cultivars

Due to the demand for promotion of banana technologies to production areas other than Bamunanika sub-county (Luwero), it was initially desirable to identify cultivars considered most popular by farmers who had participated in the on-farm cultivar evaluation trials

undertaken in the sub-county as part of R7567. Such an exercise must be based on criteria that farmers consider as important when choosing cultivars for growing on their farm. With this in mind, a study on eliciting criteria used by farmers for evaluating (and therefore selecting) banana cultivars (reported below) and a follow-up study (not yet undertaken) of farmers' preferred choice of cultivars based on the prominent criteria were formulated.

The first phase of this study, eliciting criteria, was conducted in Bamunanika in August 2004, the results of which would be available to inform subsequent promotion of banana cultivars, initially in Mukono, Kayunga and Luwero districts but, potentially, further afield. The main aim was to assess farmers' views of exotic cultivars that had been explored in previous IPM project R7567 for their disease and pest resistant properties. It was considered more appropriate to elicit farmers' own criteria for cultivar evaluation, rather than those set by researchers, and to fulfil this through farmer group (male and female) discussions at village level based on a questionnaire and individual voting. In summary, the findings revealed that farmers use a wide range of criteria when deciding which cultivars to grow on their farms. In total 14 criteria were mentioned, with more than half of the eight farmer groups participating considering bunch size, marketability, maturity period, taste, resistance to adverse conditions, proliferation rate and multiple uses as criteria of importance. Except for proliferation rate, all of these criteria were also given high importance in the voting exercise. Full details of the methodology and findings of the study are provided in Appendix 7[11].

As indicated above, the next step in this process would have been a further field exercise to determine, based on the identified criteria, farmers' views of banana cultivars investigated during R7567. Unfortunately this was possible due to project resources being redeployed to address the more important issue of controlling BBW. There were also ethical issues associated with asking farmers for their opinion of cultivars if such cultivars had been affected by BBW. Nevertheless, the information obtained on farmers' criteria will be useful in future assessments of cultivars and investigations of their adoption by farmers. These will form part of the proposed follow-on project.

4.2.4.2 Farmers' perceptions of pests and diseases and current approaches to pest and disease management

With a view to assessing the impact of promotional activities, a baseline survey of farmers' perceptions of pests and diseases was planned in March 2004 and the field work undertaken in July/August 2004 in Kayunga, Luwero, Mukono districts in central Uganda and Ntungamo district, south-west Uganda. The survey was conducted by Charles Murekezi and Jerome Kubiriba, assisted by Yusuf Mulumba (UNBRP statistician) and Enoch Kikulwe (UNBRP socio-economist). Preliminary findings[12] of qualitative responses of farmers are shown in Tables 2-5. In terms of a scientist's interpretation, a broad range of pest and disease constraints were observed, of which weevils were the most prevalent (in terms of the number of farms on which they were found across the four districts) followed by nematodes, Sigatoka leaf spots and fusarium wilt (Table 2). Farmers highlighted a wide range of symptoms on their farms, which both they (Table 5) and scientists (Table 3) could attribute to a number of constraints (e.g leaf yellowing associated with Sigatoka leaf spots, fusarium wilt, BSV and BBW). Of significance, farmers across the districts perceived symptoms associated with a particular pest or disease (as identified by scientists) to be caused by a range of problems

[11] Atiku, L., Abeyasekera, S. and Mulumba, Y. (2005) DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Eliciting criteria for evaluating banana cultivars. February 2005. NARO, Uganda and University of Reading, UK.

[12] At the time of writing, a full report of the findings of this work was being prepared by UNBRP staff and was nearing completion. A copy of the finalised report will be forwarded to CPP by the project leader as soon as possible after submission of the FTR.

(Table 4). For example, farmers associated symptoms of Sigatoka leaf spot with weevils, infertility, drought, sun or disease. Indeed, the findings confirm previous reports of farmers attributing a wide range of constraints to weevils, possibly due to the ease with which weevils are observed in and around banana mats.

While the findings are preliminary they clearly highlight the differing perceptions held among farmers of pests and diseases and the differing opinions of farmers and scientists. The study has also helped to show the extent of farmers' knowledge in relation to the various constraints, that efforts to improve farmer awareness are required and where these should be focused. Follow-up studies with the same farmers will also help to determine the extent to which the project's activities have helped to improved farmer awareness.

Table 2 Incidence of pests and diseases in sampled farms 2004 in Kayunga, Luwero, Mukono and Ntungamo districts of Uganda

Constraint	No. of farms where observed				Total
	Kayunga	Luwero	Mukono	Ntungamo	
Sigatoka	24 (80%)	17 (57%)	24 (80%)		65 (53%)
Nutritional deficiency	4 (13%)	10 (33%)	14 (47%)	15 (47%)	43 (35%)
Fusarium wilt	1 (3%)	16 (53%)	16 (53%)	25 (78%)	58 (48%)
BSV	0 (0%)	7 (23%)	4 (13%)	6 (19%)	17 (14%)
Weevils	25 (83%)	28 (93%)	28 (93%)	31 (97%)	112 (92%)
Nematodes	19 (63%)	23 (77%)	20 (67%)	20 (63%)	82 (67%)
BBW	30 (100%)	6 (20%)	12 (40%)	0 (0%)	48 (39%)
Leaf speckle				1 (3%)	1 (0.8%)
Total no. farms	30 (100%)	30 (100%)	30 (100%)	32 (100%)	122 (100%)

NB Figures in parentheses denote number of farms where observed as a percentage of the total number of farms sampled in the district

Table 3 'Bad' symptoms identified by farmer and scientists' interpretation of symptoms

Scientists' interpretation of symptoms	Symptoms as identified by farmer for pest/disease constraint on farm
Sigatoka	Drying of leaves (65), yellowing of leaves – Kayinja (2)
Nutritional deficiency	Poor growth (13), soil infertility (17), poor yields (4)
Fusarium wilt	Yellowing of leaves-Kayinha (44), yellowing of leaves in Ndiizi (5)
BSV	Yellowing of leaves-Matooke (6), Yellowing of leaves-Kayinja (5)
Weevils	Tunneling of pseudostem (106), Toppling (5)
Nematodes	Toppling (77)
BBW	Leaves yellowing and premature ripening (26), premature ripening (6)

NB Figures in parentheses denote number of farms on which symptoms were observed

Table 4 Causes attributed by farmer to symptoms he/she identified, and scientists' interpretation of such symptoms

Scientists' interpretation	Cause attributed by farmer to symptoms they identified
Sigatoka	Weevils (17), Infertility (7), drought (6), sun (4), disease (4)
Nutritional deficiency	Infertility (28)
Fusarium wilt	Weevils (26), disease (18)
BSV	Weevils (7)
Weevils	Weevils (103), Kaasa(ants) (15)
Nematodes	Weevils (3), winds (24), Kaasa(9), disease(6)
BBW	Disease (2), weevils (12)

NB Figures in parentheses denote number of farms on which symptoms were observed

Table 5 Symptoms identified by farmer or researcher in the farmer's field, and cause attributed to the symptom by the farmer

Symptoms identified by farmer	Causes attributed by farmer to the symptom identified	No. of farmers
Drying of leaves	Weevils (22), drought (10), aging (8), infertility (7), disease (6), leaves aging (4), sun (4), worms with manure (2), kaasa (1), BBW (2) , kikadiye (1), nematodes (1)	83
Tunneling of pseudostem	Weevils (91), ants/termites (13), kaasa (10), termites/ants (3), kassa (1), disease (1)	107
Yellowing of leaves (matooke)	Weevils (6), drought (4), disease (2), infertility (2), kaasa (1), nematodes (1)	22
Yellowing of leaves (Kayinja)	Weevils (26), disease (15), infertility (1), drought (1), kaasa (1)	57
Toppling	Weevils (29), disease (6), infertility (2), kaasa (10), winds (24), nematodes (1),	85
Leaves yellowing and premature ripening	Weevils (8), disease (9), bees (2)	28
Dying back, flowering with difficulty or leaves yellowing	Weevils (1), disease (3), leaves aging (1)	10
Poor growth	Infertility (12), weevils (3), drought (1), stony soils (1), weeds (1)	18

NB Figures in parentheses denote number of farms on which symptoms were observed

4.2.4.3 Promotion and dissemination of improved banana cultivars in Luwero

In response to requests from partner NGOs and extension staff in Luwero, planting material of cultivars Mpologoma, Atwalira, Kisansa, Gonja, Kabana 3 (FHIA 17) and FHIA 25 were provided by the UNBRP for dissemination to farmers in the six pilot subcounties in which they were operating. CARITAS established 36 and 21 production plots with farmers in Kikyusa and Kamira subcounties respectively. In Nyimbwa sub-county, VEDCO established 25 plots while another 12 plots were established in partnership with the local administration and agriculture extension. VEDCO also established 19 plots in Katikamu. In Zilobwe sub-county a total of 38 production plots were established, 12 directly with farmers coordinated by SAO and 26 through a partnership developed between SAO and the sub-county agricultural extension. The NGOs and agricultural extension effectively mobilised farmers to plant their plots between October 2003 and April 2004.

Full details of the reports of monitoring of each sub-county are provided in Appendix 5[13]. Table 6, extracted from Appendix 5, provides a summary of the extent of distribution in terms of, for example, partners involved, dates of activities, numbers of farmers hosting field plots and the general condition of each. Tables 7 and 8 provide summaries of the extent of cultivar dissemination of differing banana cultivars, in total and by parish respectively, in two of the subcounties, Katikamu and Nyimbwa[14], and the extent of adoption in terms of mats established. Four months after sucker dissemination, and across the four parishes, the highest rate of establishment was for FHIA types (81%, not differentiated) and the lowest for the EA-AAA highlands type Atwalira (78%). Since establishment of the plots, monitoring by UNBRP and its partners has taken place once, again partly due to the need to allocate resources to the fight against BBW. As shown by the reports, the extent of information provided by subcounties' reports is variable, and depended on the group undertaking the promotional work, the greatest amount of detail, for example, being provided in the report submitted by VEDCO for Nyimbwa and Katikamu subcounties. Further monitoring of the performance, dissemination and utilisation of the cultivars and sites is planned for 2005 as part of the follow-up phase of research, funded by CPP. This phase will focus on more comprehensive and in-depth evaluation of these and the other promotion/communication activities undertaken under R8342 than that possible to date.

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[13] National Agricultural Research Organisation (2004). DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Monitoring performance of improved banana cultivars disseminated in Luwero district to intended beneficiaries via public agricultural extension and non-government organisations (NGOs). August 2004. Nankinga, C., ed. August 2004. Uganda, NARO.

[14] Data is available for other subcounties and parishes, for subsequent monitoring visits (August 2004), for agronomic criteria (e.g. plant length, no. leaves) and for management practices applied by the farmer (e.g. weeding, mulching) in relation to 37 farmers. At the time of writing this data had not been collated and analysed.

Table 6 Promotion of banana planting materials in Luwero district

Sub-county	Partner in IPM promotion	Date activities initiated	Date activities monitored	No. parishes	No. villages	No. plants distributed	No. of farmers	No. farmers evaluated[a]	Condition		
									Good	Fair	Bad
Nyimbwa	VEDCO & Ext. staff	Oct 2003	Aug 2004	3 (out of 6)	16	50 per farmer	25	13	8	4	1
Katikamu	VEDCO	Oct 2003	Aug 2004	2 (out of 7)	14		19	19	12	5	2
Kamira	CARITAS	Apr 2004	July 2004	3 (out of 7)	6		21	21	9	2	10
Kalagala	Ext. staff	Nov 2003	July 2004	3 (out of 8)	8[b]	1460	80	40	14	16	10
Zirobwe	Ext. staff & SAO	Nov 2003	July 2004	8 (out of 8)	20		38	38	18	12	8
Kikyuusa	CARITAS	Nov 2003		3 (out of 7)	9		36				

[a] Short comments were also available in the report for each farmer, describing the status of the farm, e.g. whether mulching and/or weeding had taken place.
[b] Each village received 195 suckers for distribution to 10 farmers.

Table 7 Dissemination of banana suckers to farmers in four parishes in Katikamu and Nyimbwa subcounties, Luwero district by cultivar and extent of (mat) establishment[1]

Cultivar	No. suckers provided	Sucker establishment (% of no. provided)
Atwalira	236	78.09c
FHIA types	314	91.10a
Gonja	123	89.27ab
Kisansa	375	83.33bc
Mpologoma	704	86.56b
Total	**1752**	**Mean** **85.67**

1 Suckers distributed Oct. 2003, plots monitored Feb. 2004

Table 8 Dissemination of banana suckers to farmers Katikamu and Nyimbwa subcounties, Luwero district by parish and cultivar and extent of (mat) establishment[1]

Parish	Cultivar	No. suckers provided	Sucker establishment (% of no. provided)
Buyuki	Atwalira	53	85.31
	FHIA types	80	88.03
	Gonja	33	90.37
	Kisansa	134	89.62
	Mpologoma	143	84.27
Kiyanda	Atwalira	35	70.06
	FHIA types	45	94.98
	Gonja	20	75.99
	Kisansa	30	72.99
	Mpologoma	120	88.98
Musaale	Atwalira	57	78.84
	FHIA types	72	93.96
	Gonja	22	94.05
	Kisansa	133	85.58
	Mpologoma	129	84.66
Sambwe	Atwalira	91	76.34b
	FHIA types	117	92.61a
	Gonja	48	93.33a
	Kisansa	78	82.27b
	Mpologoma	312	91.64a

1 Suckers distributed Oct. 2003, plots monitored Feb. 2004

NB: Means followed by the same letter in Tables 7 and 8 are not significantly different (P>0.05) by t-test of the pair-wise comparison of least square means

4.2.4.4 Sensitisation and review workshops

As a follow-up to the development of action plans for addressing IPM and specifically BBW in the various communities, stakeholder sensitisation and review workshops were held between October and November 2004 in each of the 15 subcounties originally represented at the Mukono workshop in early 2004. Through these meetings the research team was able to qualitatively evaluate, by obtaining feedback directly from participants, the effectiveness of communication tools that had been developed through interaction with stakeholders in the three model subcounties, Kimenyedde, Nazigo and Bamunanika. The primary PDC communication tools evaluated were:

1. Fact sheets on BBW
2. Training and sensitisation documentary (in Luganda) on BBW symptoms, transmission and control (duration 10 minutes)
3. Sensitisation play entitled 'Bampalana' (in Luganda) on BBW. This incorporates community perceptions, training on BBW symptoms, transmission and control and elements of community action to combat the disease
4. Banana production manual containing sections on general banana management, pest and disease management with reference to BBW, soil and water management, types of banana cultivars and their utilisation
5. Posters depicting BBW

Other objectives of the workshops were to sensitise the community about BBW, review IPM activities currently being undertaken to contain or eradicate the disease, form sub-county task forces and, where possible, select representatives who may become members of parish task forces. While an overview of the proceedings of the workshops is provided here, full details for each sub-county is provided in Appendix 8[15].

Prior to the sensitisation and review workshops, letters of invitations accompanied by fact sheets on BBW were sent to different cadres of leadership in the community including individual farmers, farmer group leaders, local councillors (LCI, LCII and LCIII), sub-county chiefs, parish chiefs, Kabaka's representatives (Abaami ba Ssabasajja, ababaka ba Nabagereka) at village, parish and sub-county levels, heads of primary schools, secondary schools and other educational institutions, religious leaders (churches and mosques), NGOs and other local community and opinion leaders. The intention of the letters was to create awareness of BBW within the community and also to provide them with information that would enable them to access disseminated information on BBW containment and eradication through all available avenues within the communities.

The workshops were conducted primarily in Luganda. After an initial session of open discussion to allow participants to share their experiences of BBW and its control within their respective communities, two videos[16] were presented to sensitise the participants about BBW symptoms, transmission and control (Plate 6). The first was a video of a play depicting BBW

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[15] Nankinga Kukiriza, C., Nzaire, D, Atiku, L., Kiwendo, M. and Pande (2005). DFID CPP funded project ZA0595: Promotion of improved IPM practices for banana diseases and pests in Uganda. Proceedings of the stakeholders' review and sensitisation workshops on BBW in Luwero, Mukono and Kayunga districts. Nankinga Kukiriza, C., ed. February 2005. Uganda, NARO

[16] National Agricultural Research Organisation (2004) A sensitisation drama production in Luganda entitled 'Bampalana' depicting community perceptions, symptoms, transmission and control of BBW.

National Agricultural Research Organisation (2004) A training and sensitisation documentary in Luganda on BBW symptoms, transmission and control (12 minutes duration). NARO.

entitled ‘Bampalana’, performed by Kisoga BBW task force team from Mukono district and presented in Luganda. This incorporates community perceptions, training on BBW symptoms, transmission and control and elements of community action to combat the disease. One of the intentions of showing this documentary was to probe a discussion from the participants on community action against BBW. The second video was a training and sensitisation documentary, again presented in Luganda, on BBW symptoms, transmission and control. Following the video shows, the participants were asked to write on a piece of paper what they had learnt from the videos. Individuals were also selected randomly to present summaries of what they had learnt on flip charts. Where school children were involved in the workshops, their session lasted for a maximum of one hour and on occasion separate sessions were run for school pupils and for adults (Plates 7 and 8).

In summary, participants indicated key lessons that they had learnt from the video documentaries as:

- The importance of attending meetings and trainings whenever they are organized in the community
- Both adults and school pupils could narrate the spread of BBW by bees, transmission through movement of different banana parts (bunches, leaves, suckers etc), farm tools and soil erosion
- BBW symptoms and control measures - cutting of male buds, destruction of infected plants, disinfecting farm tools, planting of suckers from healthy fields only etc
- Importance of the male bud in the transmission of BBW
- Spread of BBW through the traditional harvesting and marketing system for beer bananas, especially ‘Kayinja’ types
- There is a need for each household to have its own farm tools to avoid transmitting the disease
- There is a need to restrict hired labour since labourers move with their farm tools from one field to another
- Importance of cutting off male buds in controlling BBW
- Use of a two-pronged stick to remove male buds
- Having strong leaders that are committed is very important in the efforts to combat BBW
- People should not blame the cause of BBW on witchcraft or malice from society
- People realised the need for the community to handle their problems rather than waiting for the government to control and contain BBW
- The need and importance of people putting into action what they are trained to do
- Since BBW control and containment can be difficult with some members in the community, there is a need for community voluntary action and efforts to control the disease
- Importance of frequent interactions with agricultural officers and using them whenever they are
- Intensive sensitisation is needed for the control and containment of BBW
- There is a need to use different communication channels for changing peoples attitudes towards control and containment of BBW e.g. churches and mosques, schools, learning institutions, social functions in the community
- Importance of videos and posters in the dissemination of BBW control and containment information
- Everyone who attends these training and sensitisation meetings should be an information disseminator and trainer in the community
- People noted BBW already exists in the community but farmers lack knowledge on how to recognise the disease and properly control it

- Having byelaws could help in the control and containment of BBW especially with members of the community that don't adhere to BBW control practices
- Quarantine is important in the control of BBW
- There is a need for the concerned officials in the community to quickly respond with solutions for problems reported within that community
- Importance of giving children a chance to share their learning experience with other, elder members in the family
- Importance of having an interest in banana plantations and checking them regularly so as to locate the disease quickly in the garden
- People should learn to report anything that seems suspicious in the area and their gardens
- For effective implementation of recommended practices, there is need for a monitoring team to check activities that are being done (e.g. cutting of male buds, destruction of infected plants etc)

While waiting for participants to enter the meeting room a video documentary on general banana management, with emphasis on soil and water management, was also shown

A short review of what the community was doing about BBW was undertaken. This was achieved either by prompting the audience to indicate IPM practices or by a short presentation from chairpersons or representatives of task forces (if present). In the latter case, the chairpersons or representatives were asked, prior to their presentation, to highlight who the task force members were, what the task force duties were, what had been achieved and what problems or constraints had been encountered (Plate 9). They were also asked to provide examples of successful implementation of BBW management and of possible solutions to the problems they faced in sensitising their community and implementing recommended management practices (Plates 10-12). Of the four subcounties (Kimenyedde, Nazigo, Bamunanika and Zilobwe) in which task forces had already been formed, good process was reported for Kimenyedde, Nazigo and Zilobwe with regard to dissemination of BBW information through local council meetings, social functions, funerals, parties etc and in the removal of male buds and destruction of diseased plants. The task force representatives also highlighted challenges that they faced during implementation of BBW activities as:

- Some political leaders were not supportive to the mobilisation and BBW implementation activities
- Farmers growing Kayinja do not want to destroy infected banana plants
- Some farmers are not convinced to remove the whole stool of a BBW affected plant, but prefer cutting only the affected plant and leave the remaining suckers intact because to them they appear healthy and can also produce banana bunches which they can feed on
- Some members in the community do not attend meetings and training when called upon. People have an attitude that it is waste of time and not of much benefit
- Farmers complain that destruction of infected banana plants is labour intensive
- Trained farmers do not put in practice what they have learnt
- There is a tendency for people in the community to despise fellow members in the community and in so doing they don't take the training messages from other people seriously. People prefer to have people from outside to come and train them
- Most farmers, especially those with Kayinja plantations, are old and therefore do not have the energy to destroy infected plants
- Some farmers ask the taskforce members to destroy infected banana plants themselves
- Some farmers do not want to cut down Kayinja male buds as they say that this agronomic practice dilutes the juice concentration. Many incidences were also reported where male buds should be removed from Kayinja bananas as they are used

as indicators of maturity in the bunch, and the male bud peduncles are helpful in lifting the harvested bunches etc
- Lack of facilitation of the task forces to undertake this work. Task forces demanded bicycles, fuel to move through the villages, pens, flip chats, books etc

It was generally resolved that there was a need for community action to overcome most of the problems faced in the implementation of BBW control, with everyone in the community sharing responsibility for controlling the disease on his or her own homestead and reaching out to others to support them whenever possible. Political support was also critical if all people were to be mobilised to undertake BBW control seriously – community bylaws need to be enacted immediately to address members of the community not complying with BBW control. In order to supervise and monitor success in BBW control activities, there should be a facilitated monitoring and supervisory system. Massive awareness campaigns on BBW were required from national level through to the grass root implementers (i.e. farmers). All BBW sensitisation, training and communication tools such as posters, brochures and videos should be disseminated through to village level to enable the community to learn from distant communities. The government should also avail funds to support implementation of the community activities.

Formation of BBW task forces

This was facilitated in such a manner that leaders of the subcounties led a session on task force formation and development of subsequent work plans for the community. Through sharing the lessons learnt from the video, participants realised the need for BBW task force formation. It was considered important that LCIII and Gombolola chiefs become members of the sub-county task force teams and lead others in the formulation of action plans for BBW. Formation of task forces would vary from situation to situation. The Mukono district DAO and sub-county agricultural extension requested that they use the review and sensitisation workshop as an opportunity to gather people together and form task forces at least for sub-county level, the main objective being to then have a task force that would spearhead formation of task forces at parish and village level within the sub-county. This would be the leading force in mobilising for against BBW and implementing activities. The NBRP would monitor how the task forces performed.

Close

The workshop was closed with sub-county leaders and representatives of agricultural extension and the UNBRP emphasising that community action was required, with all participants being reminded of the roles they can play within their communities, and that the community cannot continue to rely on the UNBRP and other organisations to tackle problems such as BBW. The need for leadership from a high level within communities was also emphasised.

The proceedings of the workshops were also recorded on video with the intention of preparing documentaries to depict the processes followed, facilitate subsequent sensitisation and training meetings and highlight success stories of management measures recommended for BBW proving successful in the community. The following video documentaries have now been produced in draft form:

- Process followed for BBW sensitisation
- Process followed for formation of task forces
- Progress on work done on implementation of BBW control practices in the field, including success stories
- Commonly asked questions relating to BBW

Table 9 provides a summary of where and when sensitisation and review meetings were undertaken in Luwero, Mukono and Kayunga districts, the number of participants, whether sub-county task forces were form ed and what communication materials were disseminated to participants during the meetings.

Table 9 Results gathered at the sub-county review and sensitisation workshops

District	Sub-county in IPM promotion	Number of parishes	Date of sensitisation meeting	Number attending	PDC Videos given	Sub-county task formed during the review workshop	Parish BBW task force report given at review	Production manuals given	Posters given to community on BBW
Luwero: (18 subcounties in total)	Nyimbwa	6	25/10/04	70	3	no	no	3	Yes[1]
	Katikamu	7	26/10/04	88	2	No	No		Yes[1]
	Kikyuusa	6	1/11/04	99	2	No	No	2	Yes[1]
	Kalagala	8	28/10/04	74	2	No	No	3	Yes[1]
	Kamira	7	2/11/04	81	1	No	No	1	Yes[1]
	Zirobwe	8	29/10/04	103	1	Existed	Yes	1	Yes[1]
	Bamunanika	6	11/10/04	87	1	Existed as model sub-county	Yes		Yes[1]
Mukono (24 subcounties in total)	Goma	5	08/11/04	108	1	Yes	No	2	Yes[1]
	Kimenyedde	5	02/11/04	103	2	Existed as model sub-county	Yes	3	Yes[1]
	Najjembe	6	04/11/04	73	2	Yes	No	2	Yes[1]
	Kyampisi	5	01/12/04	81	1	Yes	No		Yes[1]
Kayunga (9 subcounties in total)	Kayunga	7	17/11/04	101	1	Yes	No	2	Yes[1]
	Nazigo	7	25/11/04	85	1	Existed as model sub-county	Yes	2	Yes[1]
	Busaana	8	18/11/04	208	1	Yes	No	2	Yes[1]
	Kangulumira	6	4/10/04	182	1	Yes	No		Yes[1]

1 At least one set of posters per parish

Note: In Zirobwe, Bamunanika, Goma, Kimenyedde, Najjembe, Kayunga, Nazigo, Busaana sensitization workshop had school pupils but those did not register. In those subcounties the number reached through PDC exceeded 300 people attending the workshops

5. Outputs

5.1 Field and laboratory based research on transmission, development and management of BSV

5.1.1 BSV transmission experiments in screenhouses using mealybugs

The combined results for all the transmission experiments are presented in Table 10. Under the screenhouse conditions, symptoms of BSV infection did not start to appear until at least four weeks after inoculation. All three mealybug species were able to transmit the virus to cause symptoms in some plants, while all the uninoculated (control) plants remained symptom-free. The high chi-square values and low probability values indicate that the different mealybug species transmitted the virus at different efficiencies.

Table 10 Proportion of test plants showing symptoms of BSV infection two to 16 weeks after inoculating with three mealybug species (Source: Kubiriba, 2005).

	Weeks after inoculation							
Treatment (mealybug species)	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**
D. brevipes	0/80	0/80	0/80	3/80	10/80	13/80	10/80	16/80
P. citri	0/80	0/80	1/80	4/80	18/80	29/80	26/80	26/80
Pseudococcus sp.	0/80	0/80	0/80	0/80	2/80	7/80	9/80	7/80
Chi-square (χ^2)	-	-	-	-	13.96	18.33	16.53	12.80
Probability (p)					<0.01	<0.01	<0.01	<0.01

Total number of test plants inoculated with each species = 80. Chi-square was used to test if the proportion of plants with symptoms was similar for the three mealybug species at each time point.

5.1.2 Effects of management on BSV and banana productivity in ratoon crops grown on-station

Incidence and severity of BSV

BSV incidence and severity were compared separately for each crop cycle and location. A higher proportion of plants with symptoms occurred in plots that were minimally managed for all three crops, but only in the 1st ratoon crop at Kawanda was this difference significant (Table 11). BSV was present in 51% fewer of the plants grown under optimal management compared with minimal management for the first ratoon. Similarly, symptom severity (measured as AUDPC, see Activity 1.2d for definition) was higher (by 23 –111%) in plots that were under minimal management as compared with those that were optimally managed (Table 11). At Kawanda, symptoms were more than twice as severe in minimally managed plots during the 2nd ratoon.

There was also a trend of less incidence of BSV in crops grown under optimal compared with minimal management at Mbarara, but these differences were much smaller than at Kawanda, and were not significant (Table 12). The severity of BSV was 37% less under optimal compared with minimal management for the mother crop at Mbarara, but not for the two ratoons.

Table 11 BSV incidence and symptom severity for mother, 1st ratoon and 2nd ratoon crops at Kawanda

Crop management	Incidence of BSV			Severity of BSV (AUDPC)
	Proportion	Difference (logits) †	Pr Optimal/ Pr Minimal	
Mother crop				
Minimal	0.51			3.48
Optimal	0.46	-0.20^{ns}	0.82	2.84
				P> 0.05
1st Ratoon				
Minimal	0.61			5.88
Optimal	0.31	-1.23***	0.32	4.36
				P> 0.05
2 st Ratoon				
Minimal	0.66			7.18
Optimal	0.59	-0.27^{ns}	0.76	3.41
				P< 0.05

† logits = log(pr/pr-1); **ns** = not significance (P > 0.05) and ******* = Significance at and P < 0.001.

Table 12 BSV incidence and symptom severity for mother, 1st ratoon and 2nd ratoon crops at Mbarara

Crop management	Incidence of BSV			Severity of BSV (AUDPC)
	Proportion	Difference (logits) †	Pr Optimal/ Pr Minimal	
		Mother crop		
Minimal	0.67			3.26
Optimal	0.60	-0.30 **ns**	0.74	2.07
				P< 0.05
		1st Ratoon		
Minimal	0.61			5.08
Optimal	0.54	-0.30 **ns**	0.74	3.65
				P> 0.05
		2 st Ratoon		
Minimal	0.59			5.21
Optimal	0.61	-0.36 **ns**	0.70	4.16
				P> 0.05

† logits = log(pr/pr-1); **ns** = not significance (P > 0.05) and ******* = Significance at and P < 0.001.

Effect of BSV on bunch weights

There were large effects of management and BSV on bunch weights in each of the three crop cycles at Kawanda. Optimal management improved bunch weights by 82%, 134% and 106% in the mother crop and the first and second ratoons, respectively (Table 13). Bunch weights of plants with BSV symptoms were 19%, 20% and 19% less than for those without symptoms in the mother crop and the first and second ratoons, respectively (Table 13). Thus, across all three cycles at Kawanda, optimal management increased yield by 107%, and BSV reduced yield by 19%. BSV reduced yields by an average of 17% under optimal management and 25% under minimal management.

The effects of management and BSV on bunch weights in each of the three crop cycles were slightly different at Mbarara. BSV reduced bunch weights by 6%, 11% and 15% in the mother crop and the first and second ratoons, respectively (Table 14), but these differences were on the margins of significance (0.05 < P < 0.1). Optimal management improved bunch weights by 25% and 35% in the first and second ratoons, respectively (Table 14). Thus at Mbarara, optimal management improved bunch yields by an average of 30% in the ratoon crops, much less of a benefit than was found at Kawanda.

Table 13 Effect of BSV on bunch weight of var. Mbwazirume for the mother crop, first and second ratoon crop cycles at Kawanda.

Crop cycle	BSV symptoms	Bunch weight (kg)		Mean symptoms	diff mgt
		Optimal	Minimal		
Mother					
	Without	19.33	10.96	**15.14**	
	With	16.03	8.50	**12.26**	
	Mean mgt	**17.68**	**9.73**		**7.95****
	diff symptoms	3.30	2.46	**2.88*****	
First ratoon					
	Without	23.59	10.77	**17.18**	
	With	19.65	7.69	**13.67**	
	Mean mgt	**21.62**	**9.23**		**12.39*****
	diff symptoms	3.94	3.08	**3.51*****	
Second ratoon					
	Without	16.79	8.48	**12.64**	
	With	13.93	6.45	**10.19**	
	Mean mgt	**15.36**	**7.47**		**7.89*****
	diff symptoms	2.86	2.03	**2.45*****	

Table 14 Effect of BSV on bunch weight of var. Mbwazirume for the mother crop, first and second ratoon crop cycles at Mbarara.

Crop cycle	BSV symptoms	Bunch weight (kg)		Mean symptoms	diff mgt
		Optimal	Minimal		
Mother					
	Without	12.79	10.44	**11.61**	
	With	12.72	8.99	**10.86**	
	Mean mgt	**12.75**	**9.72**		**3.04** $^{ns\ (P=0.09)}$
	Diff symptoms	0.07	1.45	**0.75**^{ns}	
First ratoon					
	Without	13.29	11.09	**12.19**	
	With	12.32	9.43	**10.87**	
	Mean mgt	**12.80**	**10.26**		**2.55** $^{ns\ (P=0.06)}$
	Diff symptoms	0.97	1.66	**1.32****	
Second ratoon					
	Without	16.32	12.60	**14.46**	
	With	14.45	10.22	**12.33**	
	Mean mgt	**15.38**	**11.42**		**3.96** $^{ns\ (P=0.08)}$
	Diff symptoms	1.87	2.38	**2.13*****	

Conclusions

From Activity 1.2c it is concluded that bunch yields obtained in banana plantations situated on-station at two locations can be greatly improved by optimal crop management. Optimal management also reduced the incidence and severity of BSV in some of the crop cycles. Bunch yields were reduced by BSV by an average of 19% and 11% at two locations.

5.1.3 Effects of crop management on BSV and banana productivity, and spread of BSV in farmers' plantations

5.1.3.1 Assessment of crop management practices in reducing incidence and severity of BSV and/or increasing banana productivity in Ntungamo

For analysis of the effect of farmers' crop management practices on BSV and mealybug incidence and mealybug population size from the Ntungamo data, the farms were divided into three classes based on the range and extent of management practices carried out:

1. Low management class = weeding, desuckering and monocropping.
2. Intermediate management class = weeding, desuckering, monocropping and detrashing.
3. High management class = weeding, desuckering, monocropping, detrashing, manure application, mulching and soil/water conservation measures.

Some farms moved from one class to another during the study. Generally, the farms that were classed as having an intermediate or high level of management supported fewer mealybug colonies ($p<0.05$) than those classed as having a low level of management. Similarly, the intermediate and high management farms had reduced mealybug incidence (proportion of plants with at least one mealybug colony) compared to the farms classed as having a low or poor level of management. The most likely explanation for these findings is that detrashing (done in both the intermediate and high management classed farms) disturbs/destroys the habitat for the mealybugs, and probably leaves the mealybugs exposed to attack by parasites and predators. Why the reduced numbers of mealybugs in the intermediately and intensively managed farms appeared not to result in lower incidences and spread of BSV in those farms remains unclear, but may be related to the semi-persistent nature of the transmission of badnaviruses by mealybugs and the relatively slow dispersion rate of the virus by these vectors.

Crop management at Ntungamo

A pattern of cultural practice use was evident in Ntungamo. Farmers employing 2–4 practices opted for the following practices in order of preference: weeding and desuckering followed by detrashing and removal of harvested corms (Table 15).

In farms using 5 or more cultural practices, either soil and water conservation structures (soil bunds) or manure was the additional cultural practice (Table 15). The ratio of farms employing soil bunds to those applying manure as the fifth practice was 2:1 and 1.7:1 in year 1 and year 2, respectively. Five farms used 6 cultural practices together in year 1 and either manure or mulch was likely to be the sixth practice. Therefore, it appears that when farmers applied 5 practices soil bunds was preferred followed by manure, but manure and mulch had an equal chance of being the sixth practice. Mulch was the least used cultural practice in the study area (Table 15).

Two categories of cultural practices used by farmers were evident. These were low input cultural practices (weeding, desuckering, detrashing and removal of harvested corms) and the labour intensive practices (soil bunds, manure and mulch). The low input cultural practices were dominant in farms with 2–4 practices. The high input practices were used in addition to low input technologies by farmers using 5 and 6 practices together. Minor variations to this general observation were: a farm with manure as one of the 4 practices employed in year 1, and 4 farms in year 2 (Table 15).

Table 15 The frequency of cultural practices at Ntungamo

Total number of practices used	Farms with this number of practices	Cultural practices used and their frequency						
Year 1								
2	2	Weeding (1/2)	Desuckering (2/2)	Intercrop (1/2)				
3	7	Weeding (7/7)	Desuckering (7/7)	Detrashing (7/7)				
4	6	Weeding (6/6)	Desuckering (5/6)	Detrashing (5/6)	Cormrem. (5/6)	Intercrop (1/6)	Manure (1/6)	
5	9	Weeding (9/9)	Desuckering (9/9)	Detrashing (9/9)	Cormrem. (9/9)	Waterbunds (6/9)	Manure (3/9)	
6	5	Weeding (5/5)	Desuckering (5/5)	Detrashing (5/5)	Cormrem. (5/5)	Waterbunds (4/5)	Manure (3/5)	Mulch (3/5)
Year 2								
2	6	Weeding (5/6)	Desuckering (3/5)	Detrashing (1/6)	Cormrem. (1/6)	Intercrop (1/6)	Waterbunds (1/6)	
3	2	Weeding (2/2)	Desuckering (1/2)	Detrashing (1/2)	Cormrem. (1/2)	Mulch (1/2)		
4	12	Weeding (12/12)	Desuckering (11/12)	Detrashing (12/12)	Cormrem. (11/12)	Waterbunds (1/12)	Manure (1/12)	
5	9	Weeding (9/9)	Desuckering (8/9)	Detrashing (9/9)	Cormrem. (9/9)	Soil bunds (6/9)	Manure (4/9)	

Banana cultural practices and BSV incidence

Crop management used on the farms ranged from a single practice to a maximum of 6 (Table 16). Where a given combination of cultural practices was only represented by a single farm (replicate), this combination was omitted from the analyses. BSV incidence was compared in each year separately. The proportion of plants with symptoms of BSV was highest in farms with only two cultural practices in each year (Tables 16 and 17). BSV symptoms were found on 82.5% and 68.8% of the plants where only 2 cultural practices were used in year 1 and 2, respectively. The incidence of BSV was reduced where 3 or more cultural practices were found (with only one exception in year 2). The severity of BSV on plants that had symptoms did not differ with the number of cultural practices (Tables 16 and 17).

Table 16 The incidence and symptom severity (MSSI) of BSV in Year 1 on farms using different numbers of cultural practices

Total number of practices used	Incidence of BSV		Severity of BSV (MSSI)
	Proportion (Logits in brackets)†	Difference with 2 practices (logits)	
2	0.825 (1.55)		0.81
3	0.646 (0.60)	- 0.95 **	0.97
4	0.650 (0.62)	- 0.93 **	0.92
5	0.603 (0.42)	- 1.33 ***	0.73
6	0.660 (0.66)	- 0.89 **	1.07
			P > 0.05

† **logits** = log(pr/pr-1); **ns** = not significance (P > 0.05); ****** and ******* = Significance at P < 0.01 and P < 0.001, respectively; MSSI is mean symptom severity index..

Table 17 The incidence and symptom severity (MSSI) of BSV in Year 2 on farms using different numbers of cultural practices

Total number of practices used	Incidence of BSV		Severity of BSV (MSSI)
	Proportion (Logits in brackets) †	Difference with 2 practices (logits)	
2	0.688 (0.79)		0.93
3	0.363 (-0.56)	-1.35 ***	0.94
4	0.618 (0.48)	-0.31 ns	1.00
5	0.523 (0.09)	-0.70 ***	0.98
		Ns = 0.07	P > 0.05

† **logits** = log(pr/pr-1); **ns** = not significance (P > 0.05); ****** and ******* = Significance at P < 0.01 and P < 0.001, respectively; MSSI is mean symptom severity index..

Banana cultural practices and bunch weights

Bunch weights progressively increased with the number of cultural practices in both years (Table 18). Employing the most cultural practices increased average bunch weights by 43% and 61% in year 1 and 2, respectively, compared with yield under 2 cultural practices. However, only in year 2 was a significant difference in bunch weights detected (Table 18). A significant linear increase (F valve = 12.18; P < 0.01) in bunch weight occurred with increase in the number of cultural practices in year 2.

Table 18 Bunch weights (means and (SE)) on farms with different numbers of cultural practices

Total number of practices used	Bunch weight (kg)			
	Year 1		Year 2	
2	12.1	(3.8)	12.9	(1.6)
3	13.6	(2.0)	15.5	(2.7)
4	13.9	(2.2)	15.4	(1.0)
5	16.4	(1.8)	20.8	(1.3**)
6	17.3	(2.4)		

** Significantly different ($P < 0.01$) by t-test from other levels of cultural practices within the columns, n = 29.

Bunch weights under low-cost cultural practices were compared with those under other practices. Bunches from farms that combined low cost practices and soil bunds were the heaviest (F value = 6.6; $P < 0.01$) compared with farms practising low cost practices combined with manure, and those using low cost practices alone (Figure 1). Banana bunches were 50% heavier (t value = 3.53; $P < 0.01$) in the management regime that included soil bunds compared with the basic low cost management practice. For farms practising the management regime that included manure, banana bunches were 27% heavier (t value = 1.53; $P > 0.05$) compared to those with the low cost practices only.

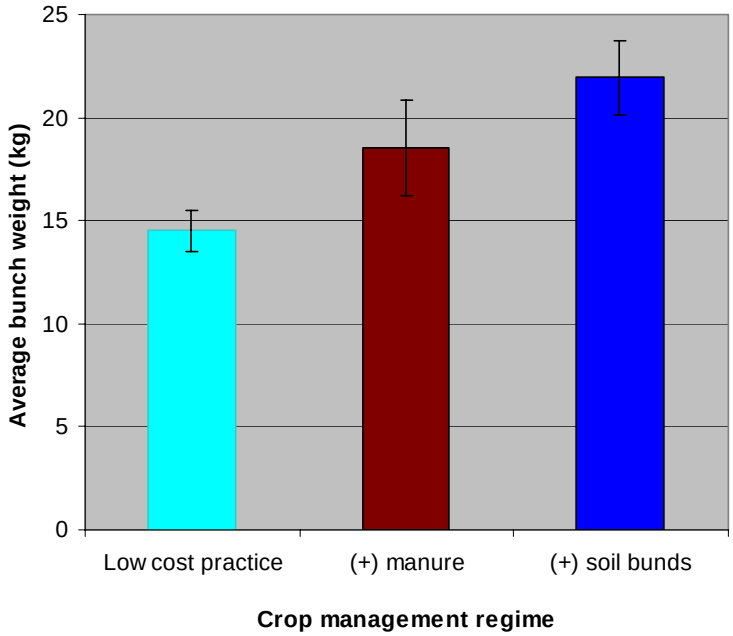

Figure 1 Bunch weights under three categories of cultural practices

BSV incidence and banana growth and yield

BSV reduced the growth and bunch weight of bananas regardless of the number of cultural practices employed on farms. Statistically significant reductions were observed for plant height (in year 1; $P < 0.05$ and year 2; $P < 0.001$), girth (in year 1; $P < 0.01$ and year 2; $P <$

0.001) and bunch weights (in year 2; $P < 0.05$) as shown in Table 19. Bunch weights of symptomatic plants decreased marginally (F value 3.76; $P = 0.07$) compared to those without symptoms in Year 1. Overall, BSV reduced bunch weight by 7 and 14% in year 1 and 2, respectively (Table 19).

Table 19 Plant height, pseudostem girth and bunch weights (means and (SE)) of bananas with and without BSV symptoms

Year	Symptoms	Height (m)	Girth (m)	Yield (kg)
1	Without	3.60 ± 0.05	0.60 ± 0.01	15.2 ± 1.2
	With	3.53 ± 0.05*	0.58 ± 0.01**	14.1 ± 1.2^{ns}
2	Without	3.74 ± 0.06	0.61 ± 0.02	17.4 ± 1.1
	With	3.62 ± 0.06***	0.58 ± 0.01***	15.0 ± 1.0*

^{ns} not significantly different; * significant ($P < 0.05$); ** ($P < 0.05$); and *** ($P < 0.001$) by t-test from without symptoms within the column, n = 29 farms.

The effects of BSV on bunch weight were examined in more detail by dividing BSV disease status into three categories of symptom severity derived from the AUDPC. These were classed as no symptoms, mild and severe symptoms (Figure 2).

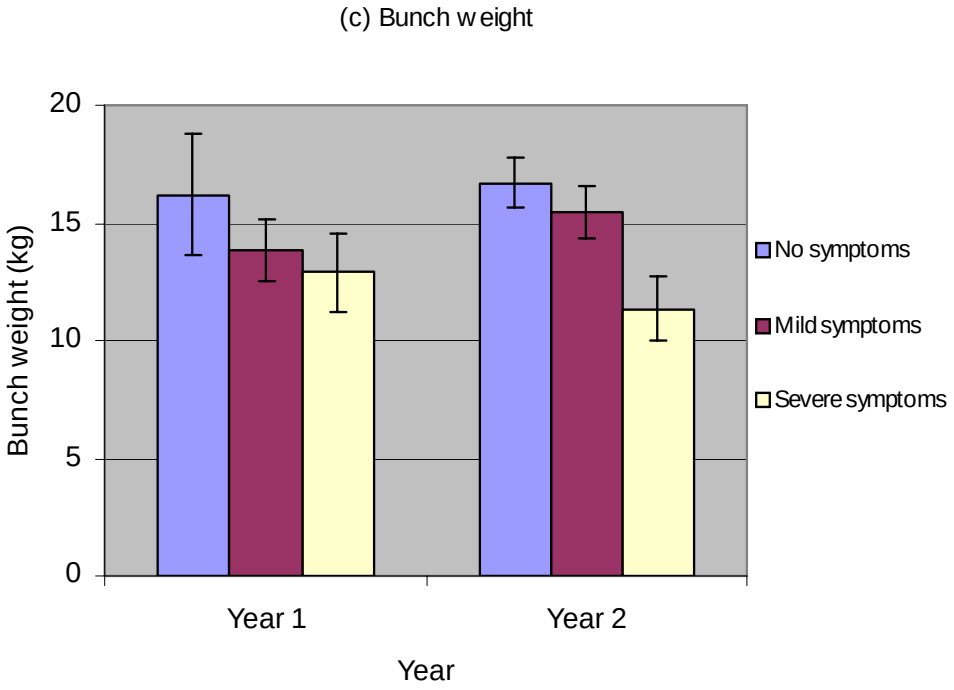

Figure 2 Effect of different levels of BSV severity on bunch weights

Bunch weights were less for plants showing severe symptoms than for those showing mild symptoms (Figure 2). Bunches of bananas with mild symptoms were 15 and 7% lighter compared to symptom-free bananas in year 1 and year 2, respectively. Severe infection resulted in bunch weight loss of 20 and 32 % during during year 1 and 2, respectively.

Conclusions

It is concluded that farmers use a range of cultural practices for the management of their banana plantations in Ntungamo. In general, the more cultural practices that were used, the less was the incidence of BSV, and the greater were the bunch weights of the crop. BSV reduced plant growth and crop yields under farmer's conditions by an average of 7% and 14% in two years. However, reductions in bunch weights were greater as the severity of BSV increased. This study has therefore demonstrated that better crop management reduced the impacts of BSV on banana crops growing under farmer's conditions in Uganda.

5.1.3.2 Spread of BSV into plots of cultivars Kisansa and Williams in Ntungamo and Rakai

One plant in one of the cv Williams plots in Ntungamo developed symptoms of BSV infection within six months of planting, while the other three plots in Ntungamo started to develop symptoms a month or two later. By 23 months after planting, 12 (75%) of the plants in the first plot were showing symptoms of infection, while the incidences in the other three plots in Ntungamo ranged from 12.5% to 31.25%. In contrast, in Rakai only one plant in one of the plots developed symptoms of BSV infection 17 months after planting, and no other plants developed symptoms throughout the course of the observations. In the large plot of cv Kisansa in Rakai the first observation of BSV symptoms was at 25 months after planting, after which the incidence gradually increased to about 28% at 70 months after planting. In the plot of cv Kisansa in Ntungamo, the first plants to show symptoms of BSV infection did so at seven months after planting, and the incidence rose rapidly to reach about 43% by 28 months after planting (see Appendix 1).

Analysis of the patterns of infection within the plots suggests that in Ntungamo much of the primary spread of BSV is over relatively short distances since there were strong "edge-effects", presumably from infection being carried from the nearby surrounding plants to the border plants of the plots. In the large plot of cv Kisansa in Rakai the edge effects were not so great and there were focal points for lose aggregations of infected plants randomly distributed across the plot. This suggests that the primary infections here were carried or blown into the plot from greater distances.

The differences in rates of increase of BSV incidence between the plots in Rakai and those in Ntungamo appeared not to be explained by differences in the sizes of the populations of different mealybug species counted at each site. However, a more long-term and systematic study would be required in order to be more certain about this. Similarly, more detailed studies using molecular biology techniques to identify different virus strains would be required to determine if differences in the rate of spread of the disease in different locations could be explained by differences in the virus strain(s) present.

5.1.4. Overall conclusions from BSV studies

The work undertaken in this (and the previous) project on the epidemiology of BSV confirms that there is spread of BSV in the field in Uganda, but the rate of spread appears to be very location dependent. The pattern of new infections in the trial plots was consistent with the disease being transmitted by relatively immotile vectors such as mealybugs; mealybug nymphs may crawl along leaves and drop onto the leaves of neighbouring plants, or may on occasion be carried longer distances on air currents. The screenhouse transmission experiments confirmed that the disease can be transmitted from banana to banana by nymphs of at least three mealybug species that have been identified from banana plants in Uganda. However, differences in the rate of spread (increase in incidence) of the disease in different locations could not be explained by differences in the populations of mealybugs present in those locations. Similarly, although the farmers' management practice of detrashing appeared to have the effect of reducing mealybug numbers in the study sites in Ntungamo, there was no apparent association between mealybug population size and the incidence of BSV.

From the on-station trials it was apparent that bunch yields can be greatly improved by optimal crop management. Optimal management also reduced the incidence and severity of BSV in some of the crop cycles, while bunch yields were reduced by BSV by an average of 19% and 11% at the two on-station locations. These results were supported by the study on farmers' fields in Ntungamo that showed that BSV has a negative effect on banana plant growth, with severely affected plants having bunch weight losses of up to 32%. Farmers in Ntungamo who employed more intensive (and hence more costly) management practices, particularly soil and water conservation measures and application of mulch and/or manure, achieved consistently better bunch yields than those who did not (especially in a year when the rains were marginal), and there was some indication that the more intensive management practices resulted in less incidence of BSV (though did not reduce BSV symptom severity on the farms in the study).

One of the early suggestions was that the BSV epidemic in Uganda was associated with the very poor plant husbandry (= minimal/basic farmer crop management regime) that resulted from the high incidence of HIV/AIDS in the local human population, which had drastically reduced the labour force able to tend the banana plants. From these studies, it appears that the poor crop management resulting from the reduced available labour could have resulted in both poor growth of the banana plants (and a concomitant yield depression) and in increased incidence of BSV (both through increased spread by mealybugs, and increased symptom expression in plants growing under more stressed environmental conditions).

5.2 Promotion and dissemination of banana management technologies to banana stakeholders

Appendices 2-8 provide detailed reports relating to the various promotion activities, and include proceedings of the planning meeting, the various workshops and meetings held for districts, subcounties, parishes and villages and reports from the various stakeholder groups, including farmers, with whom the UNBRP and UK team interacted in pursuing the objectives of the project. The following is a summary;

5.2.1 Process

As detailed in Section 4.2 of this report and in the accompanying appendices, a participatory development communication approach was largely adhered to in order to identify and bring together a broad range of banana stakeholders to discuss and share their knowledge, perceptions and opinions of banana pest and diseases and their management. By doing so the stakeholders sought to find ways in which they may become better farmers by becoming more informed of prevailing constraints and related management approaches, and thereby become better placed to implement improved management strategies that would help to alleviate the yield and revenue losses experienced on a day to day basis. Primarily through activities held within the stakeholders' communities, including a series of workshops and other meetings, on-farm visits, training and hands-on exposure to pest and disease problems and management technologies, constraints were identified and prioritised as were management options perceived as being appropriate to stakeholders' needs. A variety of communication materials were specifically developed, based on needs and capabilities identified by stakeholders, to convey knowledge of the available technologies in an appropriate format. The strengths and weaknesses of potential partners in the communication process were identified and partnerships established to facilitate provision of technologies, by intermediaries, to end-users. Community action plans were developed for implementation of improved pest and disease management, including for BBW, from district through to village level. Improved technologies have been taken up and applied by farmers and, based on the results of limited monitoring and evaluation undertaken to date, are proving successful. Where implementation is limited, key obstacles to uptake and adoption have already been highlighted and will

inform future communication efforts. In-depth evaluation of the success of the promotional activities will form the basis of a proposed follow-on project (see Section 6).

5.2.2. Dissemination

An extensive and comprehensive range of dissemination outputs and communication materials have been produced as a result of the promotional activities and are provided in Section 7. Among these, and of major significance in relation to current and future promotion, uptake and ultimate adoption of management technologies for banana pests and diseases constraints, including BBW, are the following:

Video documentaries highlighting:

- The PDC procedure and protocols followed when working with Mukono and Kayunga district communities to identify IPM and BBW communication needs and related technologies for solving them
- Training and sensitisation on BBW symptoms, transmission and control
- The processes used in BBW sensitisation workshops, highlighting the implementation of BBW control.

Information packages for IPM and BBW management:

- Fact sheets on BBW in English and more than 5 local Uganda languages
- A Banana Production Manual: *A Guide To Successful Banana Production In Uganda*
- Guidelines on formation of task forces for harmonising BBW control activities (3 pp)
- A 2005 calendar with messages about symptoms, spread and control of BBW (2000 copies produced in Luganda and 1000 in English).

The project, in collaboration with partners in Uganda, has also contributed to the following:

- An A3 poster on BBW: how to recognise the disease
- An A3 green poster on BBW: disease spread and control
- BBW brochures on how to recognise and control BBW

Several thousand copies of the calendars, posters, brochures, fact sheets and videos have already been disseminated to banana stakeholders in areas seriously affected by BBW, in partially affected areas and in, as yet, unaffected areas. The proposed follow-on phase of the project will reproduce and disseminate more copies of these materials and also produce and disseminate copies of the banana manual, currently only available in English, in at least one local language.

5.2.3 Monitoring and evaluation

During the project, monitoring and evaluation of technology performance and promotional activities could not be achieved to the extent that had been originally anticipated. In particular, and despite preparation of draft protocols for this purpose, it was not possible to accurately evaluate the level of knowledge held by farmers in relation to their capacity to address the major pest and disease constraints both before and following a phase of promotional activity. Nevertheless baseline information, both quantitative and qualitative, has been collected with respect to farmers' perceptions of improved banana cultivars, of pests and diseases and of possible approaches to management. Information has also been gathered on the dissemination and uptake of local and improved cultivars by farmers in Luwero district. Through the various stakeholder workshops and meetings, extensive feedback has also been obtained with regard to how they perceive the communication process and promotional activities, factors that continue to limit uptake of existing information and implementation of recommended practices and, of major importance, how these may be addressed. All of this information is critical in ensuring that future development, provision and adoption of banana management technologies is undertaken with the needs of farmers as end users in mind, and that farm management is an attractive, practical and rewarding proposition. More

comprehensive monitoring and evaluation will be addressed in a follow-on project (see Section 6).

Though the course of the project, the UNBRP has been instrumental in facilitating the PDC process and related activities, such as the development of community action plans and establishment of stakeholder task forces. The programme also provided stakeholders, generally based on demand, with knowledge relating to the various constraints and methodologies considered appropriate to their management by developing and disseminating a range of communication materials via a variety of uptake pathways. Materials required to implement technologies, namely planting material, were also provided to farmers either directly or via intermediaries such as NGOs.

5.3 Recommendations for future use and effective promotion of established technologies *(relates to Output 6).*

The scientific research and communication activities undertaken through this project provide a platform for ensuring that banana production in Uganda, and management of banana pests and diseases specifically, may be further improved and that the processes that will inform and empower producers may become more effective. Suggestions and recommendations for further improvement have emerged through the research undertaken on BSV, from the short studies on farmers' awareness and perceptions of banana management, from the stakeholder sensitisation and review meetings and, pertinently, from the many other meetings and interactions made possible by the project. Many of these recommendations have been made by farmers and other stakeholders within the farming communities addressed and during community interaction, and have been summarised principally in Section 4 of this report. Full details are provided in the various supplementary reports provided (Appendices 2-8). Specific recommendations are also made in Sections 5.1 and 5.2, and in Section 6 below. In an attempt to reflect the overall views and opinions of the various stakeholders, and with the communication process in mind, the following are suggested as broad areas where future improvements may be made:

- The PDC approach should be further scaled out to facilitate promotional activities beyond the geographic focus area of the project
- The PDC approach should be modified accordingly to help tackle BBW in front line districts (i.e. are under imminent threat from the disease, have only recently been affected and/or have limited damage) to help prevent further spread.
- Existing partnerships with NGOs and community based organisations should be strengthened and new partnerships established to facilitate scaling out of promotion activities
- More aggressive community mobilisation and sensitization is required to encourage communities to implement IPM and control BBW specifically
- Future PDC approaches should develop tools to emphasise the need for a change in attitude towards IPM and BBW control among the stakeholder groups (farmers, processors, users, traders, researchers, public and NGOs extension, political, community leaders etc), and to help them realise that there is a need to safeguard food security within Uganda and in the region as a whole
- There is need to institute and strengthen a facilitated supervision and monitoring system alongside IPM and BBW control activities initiated within the community to assess the impact of PDC efforts
- Increased Government and donor support is required in implementing BBW control

6. Contribution of outputs to developmental impact

The studies undertaken on BSV have revealed that, while some of the yield loss due to the BSV infection can be mitigated by employing good crop management practices (which will probably also reduce the rate of spread of the disease), there would be greater productivity if

the disease were not present at all. Since good crop management is unlikely to completely stop the spread and increase of BSV, the only way of halting its spread is to remove the sources of infection. This can be achieved by either roguing out all infected plants within an established plantation, or, ensuring that there is a sufficient distance (*cordon sanitaire*) between new plantings and existing plantings where BSV is present. For either of these approaches to be cost-effective there is a need to develop systems whereby banana planting material of the desired cultivars and free of the virus can be produced cheaply and in large amounts such that the banana growers are willing and able to purchase them. There will also be need for more wide-spread farmer training and awareness building so that farmers can recognize when plants are infected with BSV and understand that the best solution in the long term is to destroy those plants and replace them with certified virus-free new plants.

In order to have maximum uptake from the training it may be necessary to undertake more rigorous studies on the social and economic benefits to the farmer and other stakeholders in undertaking the prescribed control measures so these can be clearly presented to the farmers (and the extension/service providers). Since BBW appears to be spreading into areas where BSV is present, and because similar or conflicting strategies may be appropriate for controlling the spread and increase of these two diseases, a coordinated approach to the development and promotion of control/eradication campaigns should be implemented.

A major component of this project has focused on the promotion of knowledge, new and or improved management practices and technologies and new banana cultivars in a district of Uganda where the predominance of banana as a staple food and cash crop has declined over the last 50 years. The outputs of earlier projects within the current RNRRS (1995-2005) have contributed to the efficacy of the UNBRP in re-establishing the crop with farmers who will by choice preferentially grow and eat bananas. These outputs have highlighted the principal causes of yield decline and on-farm participatory approaches have been developed to alleviate their effects on plant growth and productivity. Although grown principally for use as a cooked food, bananas have additional uses as a dessert fruit, a source of drink with or without fermentation, processed foodstuffs and materials for food preparation and as handicrafts. Thus when growing and producing well, the crop has a significant contribution to farmers' incomes and livelihoods. This project has strived to provide banana farmers and other stakeholders with the technologies or 'tools' required to manage pests and diseases effectively and by doing so improve banana production. Many of these technologies were previously identified, developed, evaluated and, to some extent, promoted through preceding CPP funded projects. Evidence for the increased incomes of farmers adopting good management practices has been gathered. Channels suitable for technology promotion have been selected by the various banana stakeholder groups participating in the project activities as partners alongside the UNBRP. NGOs and charitable organisations (such as the Kulika Trust) active in the three districts have established partnerships with the national programme and are actively adopting and promoting the research messages that the national programme has disseminated. Promotional activities over a wider area will also be continuing through work supported by the Gatsby Charitable Foundation.

The intention to systematically monitor progress, in terms of the impact of the work on pest and disease control, banana production and farming community livelihoods, was not fulfilled for various reasons, including the emerging need to address BBW. This activity will therefore form the major component of a 10 month follow on phase of research to commence in April, also funded by CPP. This phase will monitor, evaluate and document the success of the promotional activities undertaken to date in selected areas and environments by seeking stakeholders' views and perceptions of the communication approaches employed, and by assessing the extent to which recommended management practices are being applied and proving successful. Furthermore, while management options known to reduce the spread and destructive effects of BBW, and are currently being promoted, new research is needed to

investigate more fully the epidemiology and persistence of the pathogen, *Xanthomonas campestris* pv *musacearum*. More effective and appropriate means of managing the disease also need to be identified, and the long-term importance of the pathogen as a threat to Uganda banana production in Uganda determined.

There are numerous organisations within Uganda who are well placed to take up and promote the outputs of the project. They include the UNBRP, NARO generally and other NARS, extension services, MAAIF, NAADS, CBOs and NGOs. Through the preceding communication and promotion project R8342, linkages have already been identified in Luwero, Mukono and Kayunga districts and partnerships established to facilitate promotion and dissemination of the technologies, communication materials and communication pathways to be evaluated through the proposed project. NGOs are already actively engaged with the UNBRP and farmers and other stakeholders in Luwero to promote and disseminate improved banana cultivars to farmers in the district, and to monitor this process. Many farmers and farmers are now in a position to directly acquire new information from these organisations, and will therefore have access to, and should be informed of, the outputs of this work. More broadly, the outputs may be taken up by international donors, including DFID, members of the CGIAR and international and regional banana networks including INIBAP and BARNESA. The UNBRP also has a vested interest in ensuring that outputs of the project are taken up through its own future research initiatives, including an initiative currently being considered for support by Gatsby Charitable Foundation through the Kulika Trust, and will take appropriate action.

Biometricians Signature

The projects named biometrician must sign off the Final Technical Report before it is submitted to CPP. This cn 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):	Savitri Abeyasekera
Position:	Statistician, University of Reading Statistical Services Centre
Date:	……

7. Dissemination outputs

7.1 Internal Reports

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KALORIZOU, H. A. GOWEN S. R. and T. R. WHEELER (2004**)** Genotypic differences in the shoot growth of bananas (*Musa* spp.) infected with migratory endoparasitic nematodes. Submitted to *Annals of Applied Biology* (submitted July 2004)

KUBIRIBA, J. (2005). Epidemiology of Banana streak virus (BSV) in East African highland bananas (AAA-EA). PhD Thesis, Natural Resources Institute, University of Greenwich, UK. (to be examined April 2005).

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7.5 Information factsheets, manuals etc

NATIONAL AGRICULTURAL RESEARCH ORGANISATION (2004) Fact sheets of important banana constraints and their management. NARO

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NATIONAL AGRICULTURAL RESEARCH ORGANISATION (2004) A training and sensitisation documentary in English on BBW symptoms, transmission and control (12 minutes duration). NARO.

NATIONAL AGRICULTURAL RESEARCH ORGANISATION (2004) A training and sensitisation documentary in Luganda on BBW symptoms, transmission and control (12 minutes duration). NARO.

NATIONAL AGRICULTURAL RESEARCH ORGANISATION (2004) A sensitisation drama production in Luganda entitled 'Bampalana' depicting community perceptions, symptoms, transmission and control of BBW. NARO.

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7.8 Drama productions

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7.9 Websites

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