FINAL REPORT

FOR PERIOD JULY 2014 – DECEMBER 2016

Development of an Integrated Disease Management Programme for Black Sigatoka Disease funded by the Caribbean Development Bank

Caribbean Development Bank Project Grant No. GA 163/REG
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EXECUTIVE SUMMARY

In banana and plantain cultivation, Black Sigatoka Disease (BSD)—caused by the fungal pathogen, *Mycosphaerella fijiensis*—is devastating. Approximately 97% of all banana and plantain varieties grown in the Caribbean are susceptible to BSD. The disease is aggressive and challenging to control, resulting in significant yield loss and increased cost of production. An Integrated Disease Management (IDM) approach is required for effective disease management. The success of the IDM programme depends on keeping the disease at a very low level in the field and keeping the plants healthy.

In November 2013, the Caribbean Development Bank (CDB) conducted an analysis of the BSD country programmes of Dominica, St Lucia and St Vincent and the Grenadines (SVG), which revealed that the countries were not using an IDM approach but had a propensity towards the use of fungicides in their islands’ BSD management. The use of fungicides has a negative impact on the environment and can be hazardous to humans when used on farms close to villages. Also, if a fungicide programme is not well monitored, the result may be the evolution of the fungus becoming more aggressive and tolerant to the fungicide over time, thus reducing the fungicide’s efficacy.

The Ministries of Agriculture in Dominica, Guyana, St Lucia and St Vincent and the Grenadines through the Caribbean Agricultural Research & Development Institute (CARDI) requested financial assistance from the CDB to develop an IDM programme for BSD. CARDI became the executing agent for the resulting CDB-funded project, ‘Development of an Integrated Disease Management Programme for Black Sigatoka Disease’ (hereafter referred to as the Project). The objectives of the Project were to develop an integrated disease management programme for BSD and to train stakeholders in BSD management strategies thus enhancing the framework for BSD management in the Windward Islands and Guyana.

The Project commenced in July 2014.
OPERATING HIGHLIGHTS

**Project staffing**

Staffing of the Project began with the recruitment of the Project Coordinator/ Plant Pathologist in July 2014. The Project Coordinator reviewed the Project document and developed the project implementation plan, which included the implementation methodology, tasks with their associated timelines, budget and financial coding, and the Project’s projected cash flow. Following the submission of the implementation plan to CDB, advertisements and interviews for Research Assistants in the participating countries commenced. By July 2015, a Research Assistant was recruited for each country participating in the Project.

**Project sensitization**

The four participating Project countries, Guyana, Dominica, St Vincent and the Grenadines and St Lucia, were formally advised of the Project commencement. Following which a Letter of Understanding between CARDI and the participating countries’ Ministry of Agriculture was developed and sent to the countries (Appendices 1 and 2).

**Development of an Integrated Disease Management strategy**

- Evaluation of tolerant banana and plantain cultivars

The BSD-tolerant banana and plantain hybrids for evaluation were carefully selected and imported into each participating country as tissue culture material (Appendix 3). Bioversity International (formerly the International Network for the Improvement of Banana and Plantain – INIBAP) and International Institute for Tropical Agriculture
(IITA), both well reputed for promoting and disseminating hybrids worldwide from their Musa collection, were selected to provide germplasm for the Project. The first shipment of BSD-tolerant banana and plantain germplasm to be used under the Project was received by the Orange Hill Tissue Culture Laboratory, St Vincent in January, 2014. The laboratory multiplied this germplasm in sufficient quantities to establish the germplasm evaluation sites in Dominica, St Lucia and St Vincent and the Grenadines. As Moko disease is present in St Vincent, the participating counties requested that the multiplied germplasm be certified ‘Moko disease free’.

In December 2014, a training programme on Moko disease diagnostics was conducted in St Vincent (Appendix 4). Nine technicians (5 females and 4 males) were trained in the immunoassay diagnostic techniques for Moko disease. Included in the training programme were Plant Quarantine Officers and persons responsible for germplasm multiplication. Subsequently, a distribution schedule for the multiplied germplasm was developed. The St Vincent laboratory supplied germplasm for the establishment of the BSD-tolerant germplasm evaluation blocks in Dominica, St Lucia and St Vincent. Upon receipt, the tissue culture material was weaned and hardened prior to field establishment.

The tissue culture laboratory at the National Agricultural Research and Extension Institute (NAREI), Guyana also received BSD-tolerant plantain hybrids directly from the International Institute for Tropical Agriculture (IITA) and Bioversity International in May 2015. NAREI was then responsible for multiplying the material in sufficient quantities for the varietal evaluation in Guyana. At the request of NAREI, their laboratory received technical assistance from Mr. Rohan McDonald, Manager, Orange Hill Tissue Culture Laboratory, St Vincent, to support this activity (Appendix 6). Six technicians (4 females and 2 male) were trained in tissue culture laboratory techniques and management. Under the Project, materials and supplies were acquired for the laboratory at NAREI to support this activity. However, NAREI had continuous
challenges with contamination of cultures and death of germplasm. Mr. Rohan McDonald was again approached in November 2015 to support this activity by receiving and multiplying the germplasm needed to establish the varietal evaluation blocks in Guyana. In July 2016, Guyana received from the Orange Hill Tissue Culture Laboratory its quota of germplasm to establish its varietal evaluation blocks.

The Orange Hill laboratory received a shipment of germplasm directly from IITA in December 2015. This shipment replaced germplasm accessions lost due to contamination. The full list of imported germplasm under the Project and a description of the germplasm is itemized (in Appendix3) which is available for Regional distribution.

During 2015—2016, most varietal evaluation blocks were established in the participating countries, except for Guyana which established its evaluation blocks in October 2016. Data collection commenced three months after planting at all locations as prescribed in the experimental methodology. Disease, agronomic and yield data were collected. An organoleptic evaluation of fruits was also conducted. Data collection continued to December 2016.

In St Vincent, there were challenges with other pest and disease to consider in the evaluation blocks. Moko disease was present at one site and cucumber mosaic virus at another. The presence of both diseases was of concern, and steps were put in place to manage the diseases. This, of course, made data collection challenging, as plants designated for evaluation often died prematurely. However, the presence of these diseases at the evaluation field sites reflected the real challenges experienced by banana and plantain farmers in St Vincent and the Grenadines.

Dominica also experienced challenges. Tropical Storm Erika passed over Dominica on 27 August 2015 causing loss of life and structural damage to the country. Though the storm did not cause direct damage to the varietal evaluation blocks, the land occupied
by one of the evaluation blocks was reassigned to housing causing the loss of that experimental site to the Project. Hence, a BSD-tolerant banana and plantain evaluation site previously established by a local banana company, DAPEX, in Giraudel, Dominica was assumed under the Project.

Tropical Storm Matthew moved through the Lesser Antilles on 28 September 2016. BSD-tolerant banana and plantain varietal evaluation plots in Dominica, St Lucia and SVG were damaged, with Dominica and SVG sustaining the most damage. Following the storm, an assessment of the plots was conducted on each island and the Research Assistants met virtually with the Project Coordinator and CARDI Biometricians to chart a way forward with the objective of minimizing data loss.

The evaluation of introduced BSD-tolerant banana and plantain varieties at varying agroecological zones in the four participating countries aimed at collecting agronomical and disease development data from mother plants and their first ratoon. Thus far, the experience has been that the agroecological zones have a significant effect on the agronomical development of the varieties, with some locations coming to harvest as much as 526 days before others. This has impacted the duration required to collect the necessary data from all locations. It also highlights the economic impact of selecting the ideal location for banana and plantain production.

Data collected from the mother plants have shown that all the Fundacion Hondurena de Investigacion Agricola (FHIA) accessions evaluated for their tolerance to BSD have performed in the field well against the disease, as demonstrated with high functional leaf numbers at both flowering and harvest. FHIA 17 and the only plantain accession evaluated, FHIA 21 had short a crop cycle, good bunch weight and a positive organoleptic response. FHIA 17 was positive as a fresh fruit and FHIA 21, cooked. However, both accessions were slow to multiply in vitro and will produce a challenge for increased distribution of germplasm. FHIA 23, though had a significantly longer crop cycle (375 days) than FHIA 17 (324 days), produced a significantly larger bunch (30 kg)
than FHIA 17 (25Kg) and was acceptable to consumers both as a fresh fruit and cooked. FHIA 03, however, should not be discounted. Although it was not considered as a fresh fruit, it was preferred as cooked green fruit.

- **Construction of an integrated disease management programme**

In Dominica, Guyana, St Lucia and St Vincent and the Grenadines, a workshop aimed to strengthen the capacity of Black Sigatoka Disease management in banana and plantain was conducted. The workshop used a combination of classroom, laboratory and field sessions and was facilitated by Dr Robert Power of Suriname who is a Plant Pathologist with extensive experience in commercial banana production and research. The Project Coordinator assisted. Representatives from Fairtrade International, the Canadian Hunger Foundation, as well as delegates from each of the participating countries’ banana units, plant protection departments, farmers’ organization and the Ministries of Agriculture attended the workshop. At the interactive, 10-day workshop, participants were taught the phyto-pathological cycle and epidemiology of BSD, integrated disease management, climatic forecasting methods and the measurement of disease intensity with a view towards developing and sustaining robust detection, monitoring and disease management strategies. Participants were also taught methods of measuring fungicide efficacy and crop productivity. A total of 92 technicians (22 females and 70 males) were trained, with 27 from Dominica, 25 each from Guyana and St Vincent and the Grenadines, and 15 from St Lucia. In each participating country, the workshop was favourably received in each country. There was media coverage of the programme in each participating country.

A follow-up report on, ‘Recommended strategy in Black Sigatoka Disease management; Progressing from routine systemic-spray cycles to best practice in cultivation, combined with timely protective actions, using disease monitoring and weather forecasting...
records', for Dominica, Guyana, St. Lucia and St. Vincent and the Grenadines was written by Dr Robert H. Power, Consultant Specialist for the Project. It was presented to all Ministers and Permanent Secretaries of Agriculture in the participating countries. The report was very comprehensive, highlighting the present practices of the countries and providing guidance for future activities.

**Capacity Building**

Guyana commenced their farmer field school (FFS) training. Training in Guyana started in November 2015 and continued to September 2016. A total of 293 persons were trained in the following topics: selection of planting materials and planting; fertility management; and pest and disease management. There was an IDM sensitization session conducted in Dominica for farmers in the Cochrane area and in St Lucia for college students.

A 2016 calendar highlighting Black Sigatoka Disease management was published and distributed to stakeholders and farmers in each of the Project participating countries.

The Project Research Assistant from Dominica, Mr. Gregory Linton, was selected to present, on behalf of the Project Team, the research findings on the evaluation of the BSD-tolerant varieties at the Caribbean Food Crop Society (CFCS) 52nd Annual Meeting in Le Gosier, Guadeloupe from 10—16 July, 2016. His oral presentation was well received.

Interviews were conducted for Geographic Information System (GIS) and Public Relations (PR) consultants, who were selected and offered contracts. The contract for the GIS consultant was awarded to Mr Jim Joseph of St Lucia. His consultancy commenced in October 2016 and was scheduled to end December 2016, however Mr. Joseph requested a time extension to his consultancy to March 2017. Four persons were short listed and interviewed for the PR position. Ms Carol-Anne McKenzie of Trinidad was awarded the contract. Her consultancy commenced in October 2016 and she submitted her final report in December 2016.
An application for a no-cost extension of the Project to December 2017, was submitted to the CDB. The proposed extension will conclude the varietal evaluation trials as well as the capacity building in IDM techniques in the four participating countries. The grand total of expenditure under the project was USD 430,523.54. The remaining, USD 194,476.46 will be utilized to complete the proposed Project deliverables.
INTRODUCTION

BACKGROUND

Agriculture remains essential for addressing rural poverty, economic growth and environmental sustainability. In the Caribbean, agricultural production is dominated by smallholder farmers. Banana and plantain cultivation is an important income earner for smallholder farmers, particularly in Guyana and the Windward Islands, providing a staple for household consumption, traded both at the local and regional markets and for export to industrialized countries.

Diseases are an important constraint in banana and plantain production worldwide. Black Sigatoka Disease (BSD), caused by the fungal pathogen, *Mycosphaerella fijiensis*, is the most devastating leaf spot disease. It is an aggressive disease that is challenging to control, resulting in crop damage of both banana and plantain cultivations. The disease was detected in Trinidad and Tobago in 2003. By 2012, it was detected in all the banana and plantain producing countries in the Caribbean. The disease thrives in warm tropical, high humidity and high rainfall regions.

BSD affects the leaves of the banana and plantain plant, reducing their photosynthetic assimilation and thus affects the crop by (a) reducing the size and weight of banana and plantain bunches at harvest, sometimes by as much as 35-50% of potential yield; (b) causing early and uneven ripening of fruit, thus reducing the time between harvesting and ripening and curtailing extra-regional sales; and (c) causing poor ratooning of the stool. The economic damage caused by this disease has been a 90% reduction of exported bananas from St Vincent and the Grenadines and 100% decline in exports of plantain from Guyana within 2 to 3 years of disease establishment.

The main challenge in disease management is to ensure that the plant survives and produces a viable economic return. This requires an Integrated Disease Management (IDM)
approach, the success of which depends on: (a) keeping the disease at a very low level in the field by utilizing tolerant varieties and field sanitation etc.; and (b) keeping the plants healthy by, for example, optimal plant nutrition and pest control.

In November 2013, as reported in the CDB Grant 163/REG Project document, an analysis of the BSD country programmes of Dominica, St Lucia, and St Vincent and the Grenadines was conducted revealing a propensity towards the use of fungicides in their islands’ management programmes. The cost for disease control by employing the use of fungicides, increases production costs by as much as 25%. The use of fungicides also has a negative impact on the environment, as it is hazardous to humans when used in farms close to villages and if not well monitored may result in the evolution of the fungus becoming more aggressive and tolerant to the fungicides, rendering the fungicides less effective.

The Ministries of Agriculture of Dominica, Guyana, St Lucia, and St Vincent and the Grenadines, through the Caribbean Agricultural Research and Development Institute (CARDI), requested financial assistance from the Caribbean Development Bank (CDB) to develop an IDM programme for BSD.

As a component of IDM, CARDI had recognized the potential benefit of the successful introduction and evaluation of BSD-tolerant varieties and made contact with the Fundación Hondureña de Investigación Agrícola (FHIA), which has produced a number of BSD-tolerant varieties. Although the varieties were not internationally commercial, it was thought that they may have the potential to provide for household consumption as well as for the earning of income on the local and regional markets.

The ultimate aim of an IDM programme is to empower its users to engage in sustainable farming so that the farmer is enriched. For success to be achieved it requires the participation of farmers, building their capacity in a participatory approach in IDM.
**Project Objectives:**

1. To develop an enhanced IDM framework for BSD management in the Windward Islands and Guyana
2. Improved productivity in banana and plantain production

**Outputs:**

1. An IDM framework for BSD management
2. Information products including brochures and fact sheets
3. Stakeholders trained in BSD IDM
4. An evaluation report on the performance of the introduced BSD-tolerant varieties
5. In-country access to BSD-tolerant varieties

**Project Outcome:**

An enhanced framework for BSD management in the Windward Islands (Dominica, St Lucia, and St Vincent and the Grenadines) and Guyana.
METHODOLOGY

DEVELOPMENT OF AN INTEGRATED DISEASE MANAGEMENT PROGRAMME

Evaluation of BSD-tolerant banana and plantain cultivars

Importation of tolerant varieties

The FHIA varieties had to be imported in a manner acceptable to the importing country utilizing guidelines. As such, all germplasm was moved from country to country in the form of tissue culture material with full documentation of complete indexing procedures and results (germplasm health status).

Biodiversity International’s *Musa* germplasm collection was identified as the most likely source of the BSD-tolerant varietal material because of its high laboratory standards and its acceptability by the Project’s participating countries. However, the quantity of tissue culture material supplied was insufficient for supplying the anticipated amount required by the Project. Hence, the material was imported into St Vincent and the Grenadines (SVG) and the tissue culture material was multiplied in sufficient quantities required by the Project. As Bioversity International had only one plantain variety available for distribution, additional disease tolerant plantain varieties were sought through the International Institute for Tropical Agriculture (IITA). The germplasm material was imported into Guyana as tissue culture material. However, Guyana had great difficulty in multiplying the germplasm material and thus it was sent to SVG.

Following the multiplication of the tissue culture material, it was exported to each of the participating countries (Dominica, Guyana, St Lucia, and St Vincent and the Grenadines) where it was weaned and hardened.
Establishment of evaluation plots

It was first proposed that the evaluation of the BSD-tolerant varieties would be conducted in two agro-ecological zones in each of the participating countries. However, due to the mountainous nature of the Windward Islands and the resulting micro-climates, four agro-ecological zones were identified for the establishment of the evaluation plots. At each of the agro-ecological zones, one experimental evaluation site was established. At each site there was sufficient presence of the pathogen to ensure that the disease pressure on the varieties was high. Moreover, in the field layout, the varieties to be evaluated were interspersed with susceptible local clones of Cavendish banana to ensure that all the BSD-tolerant varieties were equally exposed to BSD as recommended in the INIBAP Technical Guidelines 6 15.

Experimental design

In each participating country, a total of four experimental sites were established in the most important banana and/or plantain growing agro-ecological zones. At each experimental site (experimental block), plots of the test varieties were independently randomized. A plot consisted of nine plants of a test variety to be evaluated. Each plot was bordered by a row of susceptible banana plants (plantain plants in Guyana). The layout of blocks in the field aimed to minimize variability (e.g. soil changes, such as pH). There was a 2.5-meter space between plants in each row and 2.5 meters between rows.

Agronomic practices

The trial was managed according to the prescribed agronomic practices and all management practices were applied uniformly over the whole trial site. Leaf spot diseases were not controlled by chemical sprays but by field sanitation. The data were collected on the mother plant and first sucker.
Data to be collected

Data were collected according to the INIBAP Technical Guidelines 6 (2002).

- Disease evolution data (weekly collection)
  - Disease development time
  - Youngest leaf spotted
  - Leaf emission rate
  - Disease severity

- Agronomic data
  - Planting date
  - Growing phase (once/month)
    - Height of pseudostem
    - Height of following sucker
  - Bunch emergence (at flowering)
    - Number of days between planting and bunch emergence
    - Height of pseudostem
    - Height of following sucker
    - Number of functional leaves
  - Harvest
    - Number of days between planting and harvest (crop cycle)
    - Girth of pseudostem
    - Weight of bunch
    - Number of hands/bunch
    - Number of fruit at harvest
    - Weight of fruit
    - Fruit characteristics
From a weather station situated at the closest proximity to the experiment: rainfall, temperature and humidity

Management data (details of fertilizer application, nematode/weevil control measures and irrigation/drainage management were recorded).

The disease development time and agronomic data was analysed using Repeated Measures Analysis. Yield data was evaluated by a simple analysis of variance (ANOVA).

**Construct Integrated Disease Management (IDM) framework**

BSD was reported in Belize in 1975, Cuba in 1992 and Jamaica in 1997. These countries have successfully developed effective and efficient disease monitoring and management programmes. Learning from the experiences and successes of our Caribbean neighbours, national programmes for the Project participating countries were developed. Jamaica had also successfully integrated selected FHIA varieties into their production system and a review of their strategy had strengthened the methodology of the Project.

Subsequently, it was proposed that the Pathologist and Agronomist visit Jamaica to learn about that country’s BSD management strategies, including implementation processes, successes, challenges and the methodology used to get stakeholder buy-in to the programme. However, the Banana Board in Jamaica could not facilitate a visit in 2015 and, as such, this activity was cancelled.

Also, it was initially projected that a Cuban expert, sourced through the Food and Agriculture Organization (FAO), would be invited to assist in the formulation of an IDM programme, help guide its implementation in each participating country, and review the work of the consultants engaged. However, an expert Plant Pathologist with experience in managing BSD in a commercial banana plantation was considered instead. The expert Plant pathologist visited each of the countries to analyse their current BSD management
programme, provide training in IDM strategies and make recommendations on the way forward.

An IDM system works efficiently when the disease pressure is low and, thus, cultural practices including field sanitation and good plant nutrition, play an important role. The components of the IDM programme aimed to reduce the disease pressure in the field, improve plant health, and increase BSD disease monitoring. The disease pressure within the field was reduced with improved cultural practices including field sanitation, optimum plant density and improved drainage and improved plant health through plant nutrition management, which increased the crops’ photosynthetic area. A protocol aimed at monitoring the development of BSD to improve the disease management decision making and minimize the use of fungicide applications was an important part of the IDM programme.

STAKEHOLDER CAPACITY BUILDING

Stakeholder capacity building was conducted at the levels of the:

- Farmer
- Technician
- Policy maker

Farmer and Technician

Since BSD is spread over distances by wind, effective BSD management should be the same for farms in close proximity to each other. It was therefore important that adjacent farms followed the same stringent management practices and, as such, farmer capacity building was targeted.
The criteria for the selection of participating farmers/farmer group included:

- commercial banana or plantain farmer
- member of a pre-existing functional farmers group
- farms within close proximity of each other

A farmer-centred, farmer field school approach aimed at encouraging farmer participation in IDM using the IDM framework formulated for the country was used as the template. The tasks included:

- Strengthening of farmers’ groups and group sustainability
- Training of Trainers (TOT)

Some special topics taught during the TOT were:

- Growing a healthy banana/plantain crop
- Crop growth stages
- Pests and diseases identification and management
- IDM Black Sigatoka (disease identification, disease monitoring, field sanitation, plant density, de-suckering, drainage)
- Weevil trapping
- Plant nutrition

- Establishment of plots to serve as Farmer Field Schools (FFS)
- Fortnightly meetings with farmers (baseline and close off survey to be conducted)
- Field days to review new tolerant BSD varieties

Technicians had the opportunity to participate in country FFS and field trips to visit variety evaluation trials. Meetings and training on the overall IDM strategy for BSD as well as specific components with regard to disease monitoring and forecasting was identified for training. A Regional Consultation was held in St Lucia during the third quarter of 2015.
Policy makers

To move from pilot and demonstration plots and to scale up to a national strategy there needs to be national policy. A national level meeting, in each participation country, to close off the Project with the Minister of Agriculture and Permanent Secretary in the Ministry of Agriculture in attendance, will review the Project outputs, address the overall IDM strategy, highlight the successes of the Project and brainstorm the way forward. In-country field trip and meetings to address the overall IDM country strategy.
ADMINISTRATIVE REPORT

STAFF RECRUITMENT

Project Coordinator

The Project Coordinator/Plant Pathologist, Ms. Sharon Jones, was recruited on 7 July 2014 and was stationed at the CARDI Headquarters, Trinidad.

Research Assistants

In 2015 the position of the Research Assistants was advertised in each of the participating countries. After short listing, interviewing and selecting candidates, the Project staffing was as follows:

- Research Assistant for Dominica, Mr. Gregory Linton, commenced work on 1 March 2015.
- Research Assistant for St Lucia, Mr. Kwame Gyamfi, commenced work 1 March 2015.
- Research Assistant for St Vincent and the Grenadines, Mr. Casper Samuel, commenced work on 5 April 2015.
- Research Assistant for Guyana, Ms Somwattie Pooran-De Souza, commenced work 15 May 2015 on a part-time of three days per week until August 2015, after which she was employed fulltime.

In Dominica, St Lucia and SVG, the Project Research Assistants were housed at the CARDI Country Unit Offices and supervised by CARDI personnel. However, in Guyana, the National Agricultural Research and Extension Institute (NAREI) assisted in the Project implementation, as there was no CARDI Country Representative domiciled there. A Memorandum of Understanding (MOU) between CARDI and NAREI was signed in June 2015.
Contact between the Project Coordinator and the Project Country Units was maintained by monthly reports, virtual meetings, either by Go-to-Meeting for large gatherings or by Skype and WhatsApp for one-to-one discussions.

The Project Coordinator also made country visits to meet with the Research Assistants and visit the established varietal evaluation blocks. During the visits, the Research Assistants were trained in identifying all stages (stage 1–6) of BSD, monitoring disease development, measuring host productivity and in strategy and practices for integrated disease management and data collection. Also on her visits, the Project Coordinator met with the country personnel involved in BSD monitoring and control. She visited farmers involved in banana and plantain production and made field visits, and also visited the managers of participating tissue culture laboratories in Guyana and SVG and their laboratories.

**Consultants**

The recruitment of Project consultants was concluded following advertisements and interviews. The following consultants were engaged:

- Expert Plant Pathologist, Dr. Robert Power of Suriname, was engaged for the period August 2015 to May 2016.
- Public Relations Consultant, Ms. Carol Mc Kenzie, Trinidad was engaged for the period 26 September to 9 December 2016.
- Geographic Information System Consultant, Mr. Jim Joseph, St Lucia was engaged for the period 26 September 2016 to 31 March 2017.
SENSITIZATION AND COMMITTENT OF PROJECT PARTICIPATING COUNTRIES

In November 2014, the Ministers of Agriculture in all participating countries were advised, in writing, of the commencement of the Project, the recruitment of the Project Coordinator/Plant Pathologist, the Project’s key activities and their anticipated support to the Project (Appendix 1). A follow-up letter to the Ministers in each participating country was sent in January 2015. This subsequent letter outlined the role and responsibilities of both CARDI and the Ministries of Agriculture and requested a confirmation signature from the Minister as a show of their agreement (Appendix 2). The Ministers of Agriculture in all participating countries, except Guyana, signed pledging their commitment to the Project. However, the National Agricultural Research and Extension Institute (NAREI) in Guyana pledged its support to the Project and has assisting in facilitating Project activities.

INCEPTION REPORT

On commencement, the immediate duty of the Project Coordinator was to review the Project document and develop the Project Implementation Plan, which included the implementation methodology, tasks with their associated timeline, budget and financial coding and the projected project cash flow. The Implementation Plan was used to construct the Inception Report, which was submitted to the CDB in November 2015.

QUARTERLY PROGRESS REPORTS

Throughout the Project life, seven quarterly progress reports were submitted to the CDB. The reports highlighted the successes, challenges and general progress of administrative and technical matters under the Project. A financial report was also included in each of the progress reports.
TECHNICAL REPORT

DEVELOPMENT OF AN INTEGRATED DISEASE MANAGEMENT PROGRAMME

INTRODUCE AND EVALUATE BSD-TOLERANT VARIETIES IN IDENTIFIABLE AGRO-ECOLOGICAL ZONE IN EACH PARTICIPATING COUNTRY AND TO DETERMINE THE MOST PROMISING VARIETIES.

Selection of germplasm

The banana and plantain germplasm to be evaluated under the Project were selected using the following criteria:

1. Tolerance to BSD
2. Consistently good performers in previous international and regional evaluations
3. Recorded acceptance for eating and cooking quality

The plantain and banana germplasm selected were:

- Fundación Hondureña de Investigación Agrícola (FHIA): 01, 02, 03, 17, 23, 18, 20 and 21.
- International Institute of Tropical Agriculture (IITA) Plantain: PITA: 14, 17, 21, 22, 23, 24, 26 and 27
- Centre for African Researchers for banana and plantain: CRBP 39 and TMPx 548-9/OP

Introduction and multiplication of germplasm

The introduction of germplasm into the Project participating countries had to be done in a safe manner, acceptable to the plant quarantine regulations of the receiving countries. As such, the material had to be obtained from the safest source possible and as tissue culture material. The proposed FHIA hybrids tolerant to BSD had to be procured from the FHIA in
Honduras. As negotiations were proceeding with FHIA in Honduras, the Project participating country, Dominica, requested the plant material be certified free of banana streak virus (BSV), since the virus had the ability to be integrated into the banana nuclear genome. The disease is expressed when the crop is under stressed conditions. Bioversity International (formerly the International Network for the Improvement of Banana and Plantain – INIBAP) and IITA were well reputed for promoting and disseminating hybrids worldwide from their Musa collection. Both Institutes also provided virus fee certification for their distributed material. Bioversity had a wide selection of banana varieties and very few plantain varieties, whereas, IITA had a wide selection of plantain varieties. As such, both international institutions were approached to supply tolerant BSD Musa sp. hybrids for the Project. Not all hybrids requested were received. Two plantain hybrids TMPx 548-9/OP and PITA 14 were not available for export into the Region. According to the literature, both hybrids demonstrated good performance and farmer and consumer acceptance.

Unfortunately, both international institutions supplied a very limited amount of plant material, which was restricted to five replicate samples per accession/hybrid for direct planting into media or as tissue cultures in stage II (multiplication phase), suitable for further in vitro propagation. Since five replicated samples were vastly insufficient for the Project’s evaluation trials, the material had to be imported as tissue culture Stage II for further in vitro propagation. As such, a laboratory within the Region with sufficient expertise and capacity had to be selected to multiply the germplasm to sufficient quantities for the Project. Two laboratories, both located in a Project participating country, were selected. The Orange Hill Tissue Culture Laboratory in St Vincent and the Grenadines was selected as it had both the expertise and capacity, as well as an existing relationship with CARDI. The Tissue Culture Laboratory at NAREI, Guyana was also selected, as it had been recently refurbished and possessed the potential to provide continuous plant production for Guyana. It was proposed that the germplasm to be utilized to establish the BSD evaluation blocks in Dominica, St Lucia, and St Vincent would be supplied by germplasm
imported directly into St Vincent and that the germplasm to supply Guyana would be imported directly into Guyana.

The first tranche of BSD-tolerant hybrids obtained from Bioversity was received by the tissue culture laboratory in St Vincent in January 2014. NAREI, Guyana, which also received tissue culture BSD-tolerant hybrids, received their germplasm directly from IITA and Bioversity in May 2015. The difference in the dates of receipt was determined by the date of the request made for the material, as well as the availability of material at the international institutes. Also, in December 2015, IITA made an additional shipment of germplasm to St Vincent to replace PITA 22, 24 and 26, which were lost due to slow in vitro growth and culture contamination in the laboratory in Guyana.

Once the germplasm was received from the international agencies, it was then multiplied in sufficient quantities for the Project. Unfortunately, there were some challenges experienced with the imported germplasm. One of the main problems that increased the time to delivery to the Project participating countries was the variable rate of growth of the different accessions, since not all the hybrids multiply at equal rates. The slow multipliers were banana hybrids FHIA 02 and FHIA 17 and plantain hybrids FHIA 21, PITA 22, PITA 24 and PITA 27. The slow multipliers were, unfortunately, not made available to all the participating countries and, in some cases, they were not available for evaluation at all. One of the plantain hybrids, CRBP 39 was lost altogether due to its poor condition when received and subsequent contamination in the laboratory. A list of imported germplasm is detailed in Appendix 3 and their description in Appendix 4.
Training Programme, St Vincent

Since St Vincent has Moko disease of banana and plantain and its tissue culture laboratory was being used to supply tissue culture material to Dominica and St Lucia, the protocols and systems used there for the production of micropropagated banana plantlets were reviewed in December 2014. This was to determine if there existed the possibility of the introduction of Moko disease into the multiplied plantlets earmarked for export to the Project participating countries. The protocols and systems were found to be sufficiently stringent to exclude the introduction of Moko disease into the multiplied plantlets. Tissue culture plantlets prepared for export were tested using enzyme-linked immunosorbent assay (ELISA) for Moko disease. *Ralstonia solanacearum*, the bacteria which causes Moko disease, was not detected in any of the sampled plantlets. The plants were thus certified as disease-free and are therefore fit for export to Dominica and St Lucia.

For future exports of plantlets, local technicians were trained to determine the presence of *R. solanacearum*, by ELISA and ImmunoStrip. The training was well received. A combination of lectures and laboratory exercises were used to teach the diagnostic methods (Appendix
5). There was an improvement in the knowledge of the participants as demonstrated by the pre-workshop evaluation, where participants scored an average of 58% compared to the post-workshop evaluation, where participants scored an average of 96%.

The 11 participants in the two-day training programme came from various Government departments including the Plant Quarantine Department and Crop Protection Unit. The laboratory technicians of the Orange Hill Research and Development Complex participated in an extra day of training under the watchful eye of the CARDI Biotechnologist, Dr Cyril Roberts, to ensure that they were confident in performing the techniques unassisted.

Figure 2  Participants in St Vincent receiving hands-on instructions on Moko diagnosis
Figure 3  Dr. Cyril Roberts of CARDI in St Vincent at an interview by Government Information System

Table 1  Schedule of receipt of germplasm participating country from Orange Hill Laboratory, St Vincent and the Grenadines

<table>
<thead>
<tr>
<th>Dominica</th>
<th>Guyana</th>
<th>St Lucia</th>
<th>St Vincent and the Grenadines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date received: January 2015</td>
<td>Date received: July 2016</td>
<td>Date received: May &amp; August 2015</td>
<td>Date received: October 2014 &amp; September 2015</td>
</tr>
<tr>
<td>FHIA 01</td>
<td>PITA 17</td>
<td>FHIA 01</td>
<td>FHIA 01</td>
</tr>
<tr>
<td>FHIA 02</td>
<td>PITA 21</td>
<td>FHIA 03</td>
<td>FHIA 03</td>
</tr>
<tr>
<td>FHIA 03</td>
<td>PITA 23</td>
<td>FHIA 18</td>
<td>FHIA 17</td>
</tr>
<tr>
<td>FHIA 18</td>
<td>PITA 27</td>
<td>FHIA 21</td>
<td>FHIA 18</td>
</tr>
<tr>
<td>FHIA 21</td>
<td>Grande Naine</td>
<td>FHIA 23</td>
<td>FHIA 21</td>
</tr>
<tr>
<td>FHIA 23</td>
<td>Grande Naine</td>
<td></td>
<td>FHIA 23</td>
</tr>
<tr>
<td>Grande Naine</td>
<td></td>
<td></td>
<td>Grande Naine</td>
</tr>
</tbody>
</table>
GUYANA

In May 2015, Guyana received its germplasm as proliferating tissue through direct importation from the two international institutes. The received germplasm is listed below:

- Bioversity International Transit Centre supplied two banana accessions with both Black Sigatoka and Moko disease tolerance (FHIA 02 and FHIA 03) as well as plantain accessions FHIA 21 and CRBP 39.

- IITA supplied the following plantain Black Sigatoka Disease tolerant accessions: PITA: 17, 21, 22, 23, 24, 26 and 27. Unfortunately, PITA 14, which was requested as it has performed well on the African continent, was not supplied due to phytosanitary concerns.

Figure 4   Plantain germplasm received from IITA as proliferating tissue
The laboratory at NAREI was responsible for the multiplication, weaning and hardening of the germplasm needed for the Guyana germplasm evaluation blocks. However, NAREI requested technical assistance to build its capacity for the multiplication of tissue culture banana and plantain material. In response to the request, CARDI solicited the assistance of
the Mr. Rohan McDonald—who managed the tissue culture facility in St Vincent—through the Government of St Vincent and the Grenadines. Mr. McDonald made two visits to Guyana. During his first visit in May 2015, training at the NAREI biotechnology laboratory focused on improving the skill of the personnel in the tissue culture of plantains and bananas. Also, he concentrated on enhancing skills in the initiation and multiplication of plantains and bananas, and suggested various critical actions to improve the bio-security of the laboratory. Appendix 6 contains his training programme.

Figure 7 Mr. Rohan McDonald training biotechnology technicians at NAREI

In his follow up visit in late June to early July 2015, Mr. McDonald reviewed the status of the multiplication procedure of the received tissue culture banana and plantain accessions, made inputs to enhance the success of the procedure, as well as trained the biotechnology laboratory staff in techniques used in root and shoot initiation.
However, by August 2015 the Guyana laboratory was facing management challenges. One accession, PITA 23, had been lost and two others, PITA 23 and PITA 26 were struggling to survive.

Figure 8  Technician in Guyana sub-culturing the tissue culture accessions.

Figure 9  Proliferating tissue culture material, PITA 21 accession showing growth.
Figure 10  Accession PITA 23 from IITA struggling to survive.

One of the challenges that the NAREI's laboratory faced was the lack of sufficient tissue culture laboratory supplies to sustain the multiplication and propagation of the imported germplasm. The laboratory therefore placed its priority on the preservation of the imported banana and plantain accessions. CARDI, through the Project, purchased additional laboratory supplies for NAREI as their present stock was inadequate. Once the laboratory received the additional supplies, there was enough for multiplications.

Figure 11  Tissue culture chemicals provided to Biotechnology Laboratory, Guyana
Notwithstanding the technical assistance and funding of laboratory supplies and materials to NAREI by the Project, the tissue culture facility continued to face numerous challenges with the management and multiplication of the introduced banana and plantain accessions. Consequently, three of the accessions received from IITA (PITA 22, 24 and 26) were lost and some of the other accessions were contaminated. It was decided in November 2015 to approach St Vincent and the Grenadines to receive and multiply germplasm material for Guyana. This was done and SVG agreed to both receiving the material and multiplying it in sufficient quantities for the evaluation block in Guyana. IITA was approached and they agreed to resupply the accessions that had been lost.

In December 2015, IITA had successfully sent the replacement material of the lost hybrids to the tissue culture laboratory at the Orange Hill Research Station, SVG. On 25 January 2016, tissue culture material from all nine accessions housed at NAREI were shipped to SVG. Two GA-7 containers of each accession containing approximately five plantlets each, were sealed, labelled, packed and shipped via LIAT QuickPack Services to SVG. The
material was received in fair condition and was set to be multiplied in sufficient quantities for Guyana.

As the germplasm left the Guyana laboratory for St Vincent, activities conducted at the laboratory in Guyana were subsequently scaled down. The clones of introduced germplasm remaining in Guyana were dying. It was decided to wean and harden the remaining germplasm in the greenhouse in an attempt to salvage some of the accessions for field planting into a museum plot at NAREI.

Figure 13  Weaning of banana and plantain accessions for museum plot, NAREI Guyana

The museum plot at NAREI Commercial Farm, Mon Repos was established in June 2016. The plot contains the following varieties: FHIA-02, FHIA-03, FHIA-21, Grande Naine, PITA
17, PITA 23, PITA 27 and the local apple banana plants. The number of plants of each accession and field plan can be seen in Table 2. Subsequent to establishment, in December 2016, suspected cases of Moko disease observed in the museum plot were confirmed positive using ImmunoStrip for *R. solanacearum*.

Figure 14  Development of the museum plot of Black-Sigatoka-tolerant varieties established at NAREI, Guyana. June to September 2016.
Table 2  Imported accession in museum plot Guyana

<table>
<thead>
<tr>
<th>Accessions</th>
<th>Number of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grande Naine</td>
<td>20</td>
</tr>
<tr>
<td>FHIA 21</td>
<td>9</td>
</tr>
<tr>
<td>FHIA-2</td>
<td>1</td>
</tr>
<tr>
<td>FHIA – 3</td>
<td>9</td>
</tr>
<tr>
<td>PITA – 23</td>
<td>2</td>
</tr>
<tr>
<td>PITA -17</td>
<td>1</td>
</tr>
<tr>
<td>FHIA-2</td>
<td>1</td>
</tr>
<tr>
<td>PITA 27</td>
<td>12</td>
</tr>
</tbody>
</table>

Weaning, Hardening and Field establishment of Germplasm – Country Status

DOMINICA

All tissue culture plantlets needed to establish the four BSD-tolerant varietal evaluation blocks were received by 25 January 2015 and were transferred from the agar medium to seedling trays with peat growing medium the following day. The plantlets were successfully weaned and were transferred to black bags for hardening.
CARDI, in conjunction with the Ministry of Agriculture, Dominica, selected sites for the establishment of the evaluation blocks. The sites in four agro ecological zones, shown in Figure 16 are as follows:

1. La Plaine Agricultural Station - ½ acre (South East)
2. Grand Bay Agricultural Station - ½ acre (South East)
3. Woodford Hill Agricultural Station - ½ acre (North East)
4. Milton Farmer’s Holding - ½ acre (West)
While CARDI was set to establish its evaluation blocks, the Ministry of Agriculture was introducing new Cavendish varieties into Dominica for their commercial farmers. They requested that CARDI include these new CAVEDISH varieties into the evaluation blocks. As such, an additional five Cavendish varieties were included for evaluation. Varieties evaluated in Dominica can be seen in Table 3.
Table 3  Accessions evaluated in Dominica

<table>
<thead>
<tr>
<th>Project introduced Black Sigatoka Disease tolerant accessions</th>
<th>Cavendish varieties (Ministry of Agriculture)</th>
<th>Giraudel Black Sigatoka Disease tolerant accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIA01</td>
<td>Jaffa</td>
<td>CRBP 39 (plantain)</td>
</tr>
<tr>
<td>FHIA02</td>
<td>Bamboo</td>
<td>FHIA01</td>
</tr>
<tr>
<td>FHIA03</td>
<td>CV902</td>
<td>FHIA02</td>
</tr>
<tr>
<td>FHIA18</td>
<td>MA13</td>
<td>FHIA03</td>
</tr>
<tr>
<td>FHIA21 (plantain)</td>
<td>Jobo</td>
<td>FHIA18</td>
</tr>
<tr>
<td>FHIA23</td>
<td></td>
<td>FHIA21 (plantain)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FHIA23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FHIA25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SH 3436-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SH 3436-9</td>
</tr>
</tbody>
</table>

In preparation for field establishment, soil samples from the four locations were collected and analysed to determine nematode count, mineral status and soil structure.

In June 2015, the fields were cleared and holes dug. As there was no access to irrigation and with extended dry weather, field establishment was delayed significantly. With the break in the dry weather, two blocks of the varietal evaluation trial, Grand Bay and La Plaine, were established first. Subsequently, the other fields were established as seen in Table 4.
Figure 17  Fields prepared but delayed field establishment due the extreme dry weather conditions in Dominica

Figure 18  Varietal evaluation trial established in Dominica
Table 4  Schedule of field establishment of the evaluation blocks

<table>
<thead>
<tr>
<th>Location</th>
<th>Date of site establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Plaine</td>
<td>03 June 2015</td>
</tr>
<tr>
<td>Woodford Hill</td>
<td>10 July 2015</td>
</tr>
<tr>
<td>Milton</td>
<td>07 July 2015</td>
</tr>
<tr>
<td>Grand Bay</td>
<td>03 June 2015</td>
</tr>
<tr>
<td>Giraudel</td>
<td>07 September 2015; handed over 09 January 2016</td>
</tr>
</tbody>
</table>

By July 2015 the four blocks of the BSD varietal evaluation plots were established. Mr. Luther St Ville of the CDB visited both the La Plaine and Grand Bay varietal evaluation blocks on 11 June 2015 as seen in the picture below (Figure 19).

Figure 19  The CDB Representative visiting the Grand Bay varietal evaluation block
Tropical storm Erika hit Dominica on 27 August 2015. Though there was no damage to the evaluation block as a result of the tropical storm, the country experienced loss of life and extreme infrastructural damage.

Figure 20  Varietal evaluation block at La Plaine, Dominica in August 2015
Field management continued and data collection commenced in September 2015. During November 2015, the evaluation blocks were visited by the Project Coordination/Plant Pathologist, Ms. Sharon Jones, and the Consultant Plant Pathologist, Dr. Robert Power. Guidance was given on field management and data collection.
Figure 23  Field visit to evaluation block at La Plaine by the Project Coordinator/Plant Pathologist and Consultant Pathologist.

Also in November 2015, a field visit was made by personnel of the Ministry of Agriculture and banana and plantain farmers to the varietal evaluation block at La Plaine. At La Plaine, Gregory Linton, Project Research Assistant, Dominica gave a description and overview of CARDI BSD evaluation block; a list of and the description of the varieties present, as well as the management and cultural practices followed. The visitors were exposed to the performance of the BSD-tolerant varieties as compared to the susceptible Cavendish varieties. They also witnessed the integrated disease and crop management strategy employed on the block as described by Mr. Linton.
Grand Bay varietal evaluation block

In late October, CARDI was informed, through informal sources, that the varietal evaluation block at Grand Bay (located on land allocated by the Division of Agriculture: see Appendix 8, memorandum dated 18 March 2015) was compromised and the land it occupied was no longer under the control of the Ministry of Agriculture but was re-allocated for housing post Tropical Storm Erika. The CARDI Executive Director (Ag) promptly wrote the Permanent Secretary (PS) at the Ministry of Agriculture (see letter dated 3 November 2015 in Appendix 9). The letter requested a meeting with the PS to clarify the future of the block and to determine the way forward to secure the germplasm. There was verbal follow-up with the PS on this matter, both by the Officer in Charge in Dominica and by the Project Coordinator on her visit to Dominica. However, the varietal evaluation block in Grand Bay, which was previously progressing well, was unfortunately destroyed without any prior warning to CARDI. This was a major setback to the Integrated Disease Management Project for Black Sigatoka Disease, as substantial resources were invested mainly in material and labour for the establishment and maintenance of that block (approximately US$2,200).
Table 1 in Appendix 10 shows some of the actual expenses incurred on the blocks which are unrecoverable (time, transport, labour and expertise of the Research Assistant in the establishment and monitoring of the block). Materials like hoses, watering cans and other tools which can be reallocated elsewhere were not included. However, the loss to the Project should not be viewed in only its monetary amount for establishment and maintenance but also as a loss of valuable germplasm and data that would have been generated by the block and shared with the Region.

Figure 25 Evaluation block in Grand Bay in October 2015 before its destruction

Figure 26 Area showing where the Grand Bay block was established
In December 2015, the varietal evaluation blocks were again visited by the Caribbean Development Bank Representative, Mr. Luther St Ville on his supervision mission to review the progress of the Project.

![CDB Representative, Mr. Luther St Ville on a field visit to the varietal evaluation block in Milton, Dominica.](image)

**Figure 27** CDB Representative, Mr. Luther St Ville on a field visit to the varietal evaluation block in Milton, Dominica.

In January 2016, the Dominica Agricultural Producer and Exporters Limited (DAPEX) requested that CARDI continue the management of a BSD-tolerant plantain and banana elevation trial they were conducting, as they no longer had the resources to continue the trial. With the destruction of the Grand Bay varietal evaluation block, it was decided to maintain and collect data from a varietal evaluation plot established by DAPEX in Giraudel (Figure 29).
Figure 28  Data collection in Dominica

Figure 29  Varietal evaluation field in Giraudel, Dominica
On 28 September 2016 Tropical Storm Matthew hit Dominica. Fortunately, prior to TS Matthew, most of the ‘mother’ plants of all the varieties in the evaluation plots at La Plaine and Woodford Hill (except FHIA 01) were harvested and the first ratoon plants were being monitored. At Milton and Giraudel however, the ‘mother’ plants were in bunch or at bunch emergence. The number of the monitoring plants lost due to TS Mathew are shown in Table 5, Table 6 and Figure 30.

Table 5  
Number of monitored plants in each variety lost from TS Matthew at La Plaine, Woodford Hill and Milton, Dominica

<table>
<thead>
<tr>
<th>Variety</th>
<th>CR BP 39</th>
<th>FH IA 01</th>
<th>F H I A 02</th>
<th>F H I A 03</th>
<th>F H I A 18</th>
<th>F H I A 21</th>
<th>F H I A 23</th>
<th>F H I A 25</th>
<th>SH3 43-6</th>
<th>SH34 36-9</th>
<th>SH36 40</th>
<th>Total lost #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giraudel</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>17</td>
</tr>
</tbody>
</table>
Table 6  Number of monitored plants in each variety lost from TS Matthew at Giraudel, Dominica

<table>
<thead>
<tr>
<th>Variety</th>
<th>FHIA 01</th>
<th>FHIA 03</th>
<th>FHIA 18</th>
<th>FHIA 21</th>
<th>FHIA 23</th>
<th>Grande Naine</th>
<th>Jaffa</th>
<th>Williams</th>
<th>Total lost #</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Plaine</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Woodford Hill</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Milton</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Total #</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>
GUYANA

In June 2015, Guyana started preparing to establish their BSD-tolerant plantain evaluation blocks. The Research Assistant’s efforts were concentrated on field selection for the establishment of the varietal evaluation blocks, soil sampling of the selected sites and preparations for the weaning and hardening of the multiplied tissue culture material. With the assistance of the Extension Division, a selection of fields in the plantain producing areas were visited and farmers were engaged to discuss the Project, its implementation and the possibility of establishing a contractual agreement for the use of their land for the project duration. The full complement of five fields from within the major plantain production districts were selected (Figure 31).

Figure 30   Field damage caused by TS Matthew at Woodford Hill and Giraudel, Dominica
Figure 31  Map of Guyana illustrating the location of chosen sites for the evaluation blocks
Soil samples were taken and analysed to determine nematode count, soil mineral status and soil structure. The samples were processed by the Guyana Sugar Corporation (GUYSUCO) and NAREI.

Figure 32 Sites chosen, soil sampling and field preparation in Guyana

Following the challenges experienced by the NAREI tissue culture laboratory, which greatly hindered the supply of germplasm available for field establishment of the BSD varietal evaluation blocks in Guyana, no sites were established in 2015. After the many challenges, the Orange Hill Laboratory in SVG was able to produce the necessary plantlets for the establishment of the evaluation blocks in Guyana. Plantlets of BSD-tolerant plantain varieties PITA 17, PITA 21, PITA 23, PITA 27 and Grande Naine were received in Guyana on 13 July 2016 (Figure 33). Unfortunately, CRPB 39 was lost in the laboratory in due to contamination. PITA 22, PITA 24, PITA 26 and FHIA 21 were not supplied due to slow in vitro growth.
Of the plantlets received, there were losses experienced during the weaning and hardening process as recorded in Table 7. After the plantlets losses, there remained only enough plantlets to establish three BSD-tolerant plantain varietal evaluation blocks.

Figure 33  Plantlets received, weaning and hardened in Guyana 2016
Table 7  Number of plantlets received from the Orange Hill Tissue Culture Laboratory and progressive loss from July to August 2016

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Number received 13 July 2016</th>
<th>July 2016</th>
<th>August 2016</th>
<th>September 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grande Naine</td>
<td>127</td>
<td>111</td>
<td>96</td>
<td>95</td>
</tr>
<tr>
<td>PITA 17</td>
<td>120</td>
<td>54</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>PITA 27</td>
<td>97</td>
<td>47</td>
<td>46</td>
<td>44</td>
</tr>
<tr>
<td>PITA 23</td>
<td>122</td>
<td>93</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>PITA 21</td>
<td>131</td>
<td>69</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>TOTAL</td>
<td>597</td>
<td>374</td>
<td>340</td>
<td>337</td>
</tr>
</tbody>
</table>

During the weaning and hardening process, in preparation for the evaluation of BSD-tolerant plantain varieties, prospective farmers were again contacted and sites on their farms were selected. All the sites were prepared for field establishment. The necessary field inputs were procured. As a result of the incumbent dry weather, irrigation was used to ensure the survival and growth of the plantlets upon planting. All evaluation blocks were established in October 2016. The blocks were located at Mon Repos, Mahaica and Parika. There was insufficient germplasm to establish a fourth block at Canal no.2.
ST LUCIA

St Lucia received three shipments of tissue culture material to establish their evaluation blocks. The first shipment from the tissue culture laboratory in St Vincent was received in March 2015. A subsequent shipment was received in May 2015, but the plantlets exhibited signs of chill damage, which may have occurred \textit{en route} from St Vincent and the Grenadines to St Lucia. This chill damage caused great loss of plantlets in the second shipment and thus more germplasm was supplied, which was received in August 2015. The BSD-tolerant accession received in St Lucia were FHIA 01, FHIA 02, FHIA 03, FHIA 18, FHIA 21 and FHIA 23. The Cavendish variety Grande Naine was received as the control variety. Cavendish Valerie was included in the evaluation as the local standard. Once the material was received, it was weaned and hardened in preparation for field establishment.
Figure 35  Tissue culture plantlets of banana and plantain as received by St Lucia showing apparent chill injury

Figure 36  Weaning of tissue culture plantlets of banana and plantain, St Lucia
The experimental sites for the establishment of the varietal evaluation blocks were selected. One site was at the CARDI Field Station, La Ressource and the other three (Belmont, Praslin and Malgretoute) were all located within the banana growing belt on farmers’ holdings (Figure 37).

Figure 37   Sites of the evaluation blocks, St Lucia
The land was prepared and irrigation installed (Figure 38).

![Figure 38](image)

Figure 38  Land preparation, irrigation installation and field establishment, St Lucia

The schedule for field establishment of the evaluation blocks can be seen in Table 8.

<table>
<thead>
<tr>
<th>Location</th>
<th>Date of establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARDI Field Station, La Ressource</td>
<td>11 June 2015</td>
</tr>
<tr>
<td>Thiobal</td>
<td>21 October 2015</td>
</tr>
<tr>
<td>Malgretoute</td>
<td>27 January 2016</td>
</tr>
<tr>
<td>Praslin</td>
<td>3 February 2016</td>
</tr>
</tbody>
</table>
The varietal evaluation block established progressed well during 2016, with data being collected as prescribed in the methodology. Of all the participating countries, St Lucia experienced the least damage due to TS Matthew as prior to the storm, the mother plants at Thiobal and La Ressource (CARDI Field Station) were harvested and the first ratoon was being monitored. However, at both, Malgretoute and Praslin, which were established in
January 2016, the mother plants were not harvested before the storm. The plots established at Thiobal, Praslin and La Ressource experienced no damage, however, at Malgratoute three plants used for data collection were lost, one of each of the varieties: FHIA 03, FHIA 18 and Valery, as the local standard (Figure 40).

![Damage of the BSD evaluation block at Malgratoute, St Lucia due to Tropical Storm Matthew](image)

**Figure 40** Damage of the BSD evaluation block at Malgratoute, St Lucia due to Tropical Storm Matthew
ST VINCENT AND THE GRENADINES

St Vincent and the Grenadines established three BSD-tolerant germplasm evaluation sites, one at Montreal Gardens, and another at Rabacca and the third at Mount William (Figure 41).

Figure 41 Map of St Vincent illustrating the BSD-tolerant germplasm evaluation sites

Site 1: Montreal Gardens
Site 2: Rabacca
Site 3: Mount William
The test FHIA hybrids introduced by the Project were FHIA 01, 03, 17, 18, 21 and 23. However, the Ministry of Agriculture in St Vincent requested that the BSD-tolerant CIRAD accession be incorporated into the Project evaluation blocks. Therefore, four additional BSD-tolerant accessions were included in the evaluation blocks: F 916, F918, F920 and F924. Cavendish varieties Grande Naine and Jaffa were also included as local standards.

Table 9 List of varieties included in the BSD germplasm evaluation

<table>
<thead>
<tr>
<th>Project introduced BSD-tolerant accessions</th>
<th>CIRAD accessions</th>
<th>Cavendish varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIA01</td>
<td>F916</td>
<td>Grande Naine</td>
</tr>
<tr>
<td>FHIA03</td>
<td>F918</td>
<td>Jaffa</td>
</tr>
<tr>
<td>FHIA17</td>
<td>F920</td>
<td></td>
</tr>
<tr>
<td>FHIA18</td>
<td>F924</td>
<td></td>
</tr>
<tr>
<td>FHIA21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With the assistance of the tissue culture laboratory in St Vincent the tissue culture plantlets were weaned and hardened in preparation for field establishment (Figure 42).
Figure 42  Hardening of FHIA hybrids in St Vincent

The schedule of field establishment is listed in Table 10

<table>
<thead>
<tr>
<th>Location</th>
<th>Field establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montreal</td>
<td>October 2014</td>
</tr>
<tr>
<td>Rabacca</td>
<td>October 2014</td>
</tr>
<tr>
<td>Mount William</td>
<td>November 2015</td>
</tr>
</tbody>
</table>
Figure 43   Variety evaluation trial, Montreal St Vincent, in December 2014 and March 2015

The BSD evaluation blocks were established using the prescribed methodology. The collection of data started three months after field establishment. Agronomic, as well as disease development data were collected.

Figure 44   Varietal evaluation site in Rabacca, St Vincent
Unfortunately, on the varietal evaluation block at Montreal, symptoms of Cucumber mosaic virus were evident. In order to limit the spread of the disease, plants exhibiting disease symptoms were rogued out and new plants were supplied. This made data collection difficult, as there was a continual loss of plants selected for evaluation. Spider mites were also prevalent at this location and an acaricide was applied to the plants (Figure 45).

**Figure 45**  Spider mite management at varietal evaluation block in St Vincent

In May 2015, symptoms of Moko disease were observed in the varietal evaluation block at Rabacca. Symptoms were seen only on the local banana varieties. The immediate response was to contact the Crop Protection Unit of the Ministry of Agriculture, which confirmed that the disease was present at the site. On Tuesday 2 June 2015, a meeting was held with the staff of the CARDI station at Rabacca to discuss the development of the disease. Subsequent to the meeting, the Facilitator delivered a training session on Moko disease management, which included killing infected plants *in situ* by applying a herbicide followed by observing a fallow period of six months.
The Crop Protection Unit identified eight plants with Moko disease in May 2015. The disease was not observed on the FHIA varieties. On 18 June 2015, another 15 plants were identified with the disease, which brought the total number of infected plants to 23. No sign of the disease was found on the FHIA varieties; FHIA 01, FHIA 02 and FHIA 03 are tolerant to Moko disease. Follow up investigations in September 2016 saw no evidence of Moko disease at this site, endorsing the premise that early detection and management of the disease could yield effective disease management.

The experience of Moko disease and Cucumber mosaic virus in the varietal evaluation blocks in St Vincent and the Grenadines mirrors the challenges of the banana industry in the country, where both diseases impact negatively on banana and plantain production. Field sanitation measures were increased and more vigilance was practiced.

![ Symptoms of Moko disease on local varieties at Rabacca, St Vincent ](image)

Figure 46  Symptoms of Moko disease on local varieties at Rabacca, St Vincent
Figure 47  Crop Protection Unit Officer conducting a Moko Management training session at Rabacca, St Vincent and the Grenadines
Figure 48  Susceptible Cavendish control variety showing BSD leaf spot on the left and the tolerant FHIA variety on the right, Montreal St Vincent

Figure 49  Experiment control Cavendish variety with all leaves removed due to severe BSD leaf spot
At both varietal evaluation blocks in Montreal and Mount William, where the evaluation block are on a private farmer’s property, some of the banana bunches were lost due to theft and animal damage. The preferred variety for thieves was FHIA 03.

Figure 50  Progress and continued field maintenance of the third varietal evaluation block, Mount William, SVG

Tropical Storm Matthew sped through the Lesser Antilles on 28 September 2016, causing damage to the BSD-tolerant varietal evaluation plots. Unfortunately, some of the selected evaluation plants used for data collection were destroyed in the storm. This destruction of plants meant a loss of data for the analysis in the determination of the better performing varieties (Figure 51). On the advice of the Biometrician, it was decided that monitored
plants for data collection that were completely uprooted, should be replanted. However, plants that were snapped in half should be cut back, with no further data collected from them.

Figure 51 Damage caused by TS Matthew at the BSD evaluation plot at Rabacca, St Vincent and the Grenadines
Table 11  Number of monitored plants in each variety lost from TS Matthew at Rabacca, Montreal and Mount Williams, St Vincent

<table>
<thead>
<tr>
<th>Variety</th>
<th>FHI A01</th>
<th>FHI A03</th>
<th>FHI A17</th>
<th>FHI A18</th>
<th>FHI A21</th>
<th>FHI A23</th>
<th>C916</th>
<th>C918</th>
<th>C920</th>
<th>C924</th>
<th>Total lost #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabacca</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Montreal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Mount Williams</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total #</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>16</td>
</tr>
</tbody>
</table>

The evaluation plots at Montreal and Rabacca sustained the most damaged with seven of the monitoring plants of FHIA varieties and nine of the monitoring plant of the CIRAD varieties lost (Table 11). There was no damage to the monitoring plant at both Montreal and Mount Williams.
PRELIMINARY DATA ANALYSIS – RESULTS AND DISCUSSION

**BSD tolerance**

The banana plant is a perennial herb with leaf sheaths that form a trunk-like pseudostem or ‘false stem’. The corm, which is just above ground level, is the true stem. The flower stalk grows from the top of the corm near the ground and through the centre of the pseudostem. Once the flower stalk develops, there is no new leaf emission and no increase in the girth of the pseudostem.

The parent plant or ‘mother plant’ is the initial or first established plant. The sucker develops from the underground rhizome of the mother plant. A number of suckers develop from the mother plant; the sucker chosen to replace the mother plant is referred to as the ‘ratoon’ or follower. The data and discussion presented is generated only from the mother plant, as only the mother plants have completed a crop cycle to harvest. (Data collected from the ratoon crop will be presented in a subsequent report.)

**Cone Volume**

The biomass of the pseudostem is influenced by genetic and environmental factors. It increases over the life of the plant and can be considered a yield indicator. The larger the cone volume increase over time may indicate the potential for a greater yield. An assessment of the cone volume, as an indicator of performance of the BSD-tolerant banana and plantain accessions, using statistical analysis repeated for three countries: Dominica, St Lucia and St Vincent. The ANOVA indicated a significant (<.009) variation among accessions over time (Figure 52). FHIA 03 followed by FHIA 18 and FHIA 23 had the largest cone values as seen in Figure 52. FHIA 01 and Grande Naine had the smallest across the three participating countries as compared to the other accession.
Figure 52  Cone volume over time for BSD-tolerant accessions in Dominica, St Lucia, and St Vincent (d.f. 29)
**Functional leaves**

Black Sigatoka Disease causes leaf spot spots and leaf necrosis, reducing the functional leaf area and thus photosynthetic assimilates. This in turn significantly reduces yield. In addition, there is a reduction in the conservative potential or the fruit ‘green life’ causing reduced shelf life and exportability. Maintaining the number of functional leaves to ‘above eight’ at flowering and ‘five’ at harvest is recommended. Consequently, within the evaluation blocks, BSD disease management is practiced by the removal of leaves with more than 50% infection. The varieties with the greatest BSD infection have the most leaves removed compared with those with the greater BSD tolerance having fewer leaves removed. The greater the number of leaves remaining on the plant, the greater the photosynthetic area to support the production of the fruit bunch. The ‘local’ Cavendish variety, Grande Naine, consistently showed high BSD leaf spot, as is expected, since it is susceptible to the disease and thus had fewer leaves and sometime no leaves at bunching.

During the crop cycle, the number of functional leaves at flowering and at harvesting was recorded. The assessment of the number of functional leaves is as an indicator of disease tolerance of the evaluated banana and plantain accessions. Due to the slow replication of some of the FHIA accession, not all countries received the full complement of accessions. As such, the statistical analysis used was that of an unbalanced design using regression to generate the ANOVA.

In the three countries, Dominica, St Lucia and St Vincent, the ANOVA indicated a significant (<.001) variation among accessions (Figure 53). The FHIA BSD-tolerant accession performed significantly better than the Cavendish varieties, Grande Naine, Williams and Jaffa as seen in Figure 53. The FHIA tolerant accessions had more than 10 leaves at flowering whereas the Cavendish varieties had between 6-8 functional leaves. At harvest, the FHIA accessions had more than 6 leaves whereas the Cavendish varieties had less than three leaves. Generally, all the FHIA accessions performed well and demonstrated high tolerance to BSD.
Figure 53  Number of functional leaves at bunching and harvest of the FHIA BSD-tolerant accessions compared to Cavendish varieties across Dominica, St Lucia and St Vincent
Crop cycle

The length of time a producer has to manage the crop is important, as the longer the crop cycle, the greater the delay in realising crop earnings. Figure 54 illustrates the number of days to flowering and harvest for FHIA accessions as compared to the Cavendish varieties.

![Figure 54](image)

<table>
<thead>
<tr>
<th></th>
<th>Number of days to bunching</th>
<th>S.E.D 17.58</th>
<th>L.S.D 34.67</th>
<th>d.f. 9</th>
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<tr>
<td>FHIA01</td>
<td>415</td>
<td></td>
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</tr>
<tr>
<td>FHIA2</td>
<td>332.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA3</td>
<td>343.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA17</td>
<td>323.7</td>
<td></td>
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</tr>
<tr>
<td>FHIA18</td>
<td>340.1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>FHIA21</td>
<td>357.6</td>
<td></td>
<td></td>
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<tr>
<td>FHIA23</td>
<td>374.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRANDDALE</td>
<td>343.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JAPPA</td>
<td>298</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WILLIAMS</td>
<td>314.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Number of days to harvest</th>
<th>S.E.D 15.28</th>
<th>L.S.D 30.17</th>
<th>d.f. 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIA01</td>
<td>302.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA2</td>
<td>250.8</td>
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<td></td>
</tr>
<tr>
<td>FHIA3</td>
<td>251.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA17</td>
<td>241.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA18</td>
<td>266.2</td>
<td></td>
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<tr>
<td>FHIA21</td>
<td>295.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA23</td>
<td>309.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRANDDALE</td>
<td>253.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JAPPA</td>
<td>251</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WILLIAMS</td>
<td>237.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 54  Number of days to bunching and to harvest of the FHIA BSD-tolerant accessions compared to Cavendish varieties across Dominica, St Lucia and St Vincent
The generated data from the statistical analysis of an unbalanced design using regression to generate the ANOVA. There was a significant difference in the performance of the accessions. FHIA 01 had the longest crop cycle, with 302 days to flowering and 415 days to harvest, followed by FHIA 23, a banana and FHIA 21, a plantain. The Cavendish varieties generally had a shorter crop cycle as compared to the FHIA accession, except for FHIA 17 which performed as well as the Cavendish varieties.

It should be noted that there is a significant location effect on the crop cycle of the accessions, highlighting the importance of zoning for banana and plantain production. Montreal (St Vincent), a high altitude and high rainfall location, had the longest crop cycle (Figure 55) of all locations in the three participating countries.

![Figure 55](image.png)

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of days to harvest</th>
<th>Location</th>
<th>Number of days to harvest</th>
<th>Location</th>
<th>Number of days to harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giraudel</td>
<td>421.7</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
<tr>
<td>La Plaine</td>
<td>326.1</td>
<td>Mt William</td>
<td>366.1</td>
<td>Rabacca</td>
<td>313.2</td>
</tr>
<tr>
<td>Milton</td>
<td>392.6</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
<tr>
<td>Woodford Hill</td>
<td>392.1</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
<tr>
<td>Giraudel</td>
<td>421.7</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
<tr>
<td>La Plaine</td>
<td>326.1</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
<tr>
<td>Milton</td>
<td>392.6</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
<tr>
<td>Woodford Hill</td>
<td>392.1</td>
<td>Montreal</td>
<td>550.3</td>
<td>Mt William</td>
<td>264.8</td>
</tr>
</tbody>
</table>

Number of days to harvest  
S.E.D 16.19  
L.S.D 31.96  
d.f. 8

Figure 55  
Average number of days to harvest FHIA BSD-tolerant accessions compared across locations in Dominica, St Lucia and St Vincent
Montreal had an average crop cycle of 550 days, a difference of 286 days when compared to Mount William—also in St Vincent—which had the shortest crop cycle. This extra 286 days (9.5 months) to harvest a crop of bananas is of significant economic importance. Giraudel and Milton in Dominica, also high altitude locations, had a significantly longer crop cycle when compared to low altitude areas of La Plaine, Dominica and locations in St Lucia.

The first order integration between location and accession was computed in the ANOVA and the means days to harvest of the accessions are reported by country in Figure 56. There was a significant difference in the performance of the accessions at the various locations. Consistently, for all locations, FHIA 01 had the longest crop cycle, which varied between 765 days at Montreal and 239 days at Mount Williams, a difference of 526 days. Both locations are within St Vincent, highlighting a significant location effect and the importance of zoning production sites. The significant location effect is demonstrated consistently within each of the participating countries.
Figure 56  Average number of days to harvest FHIA BSD-tolerant accessions compared across locations in Dominica, St Lucia and St Vincent

<table>
<thead>
<tr>
<th>Accession</th>
<th>Number of days crop cycle</th>
<th>S.E.D 28.29</th>
<th>L.S.D 55.85</th>
<th>d.f. 30</th>
</tr>
</thead>
</table>

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The first order interaction between location and accession was computed. The ANOVA and the mean bunch weight (kg) for the various accessions are reported by country in Figure 57. There was a significant difference in performance of the accessions (<0.001) at the various locations within and among participating countries. The importance of the location effect was again exhibited.
Figure 57  Average bunch weight (kg) of FHIA BSD-tolerant accessions at the various evaluation locations in each Dominica, St Lucia and St Vincent

<table>
<thead>
<tr>
<th>Accession</th>
<th>Dominica</th>
<th>St Lucia</th>
<th>St Vincent and the Grenadines</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIA 01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA 02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA 03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA 18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA 21</td>
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<td>FHIA 23</td>
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<td>GNAINE</td>
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<td>JAFFA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WILLIAMS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S.E.D 2.88  L.S.D 5.68  d.f. 30
When considering the average bunch weight across participating locations, there was a significant difference in the performance of the accession. FHIA 23 had the largest bunch weight. FHIA 01, which had a significantly longer crop cycle, also had a significantly smaller harvest. FHIA 17 showed a good balance between crop cycle and weight of harvest.

Figure 58  Average bunch weight (kg) of FHIA BSD-tolerant accessions compared to Cavendish varieties across Dominica, St Lucia and St Vincent
Organoleptic evaluation

Organoleptic or taste evaluation of the BSD-tolerant accessions were conducted in Dominica, St Lucia, and St Vincent and the Grenadines. In each country, persons selected from the general public were asked to taste either ripe or cooked green fruit, which were randomly assigned a number so as not to bias the evaluator. Participants were asked to evaluate the fruit using a scale.

Figure 59  Presentation of ripe fruit of BSD-tolerant varieties for test tasting, St Vincent, December 2015
In December 2015, the Project staff in St Vincent conducted taste testing on the CIRAD accessions alone. However, in October 2016, organoleptic tests with ripe fruit were conducted in St Vincent with five accession: FHIA 03, FHIA 17 and CIRAD 916, 920 and 924. As a fresh fruit, the CIRAD accession were preferred over FHIA 03 and FHIA 17, with CIRAD 920 and 924 being the preferred choice. As a ripe fruit, FHIA 03 was disliked with participants preferring FHIA 17, as seen in Table 12.
In Dominica, the organoleptic tests conducted in April 2016 used cooked green fruit. The BSD-tolerant accessions evaluated were FHIA 03, FHIA 18, FHIA 21 and FHIA 23. The analysis of data from a preliminary study using a Chi square design indicated that consumers had a significant preference for FHIA 03 (banana) and FHIA 21 (plantain). Consumers generally agreed that they would consider growing both accessions and would substitute them for the traditionally available accessions. However, in the study, FHIA 18 did not receive such a favourable response (Table 13).
Figure 61  Organoleptic testing of BSD-tolerant accession green cooked fruit, Dominica, April 2016
Table 13  
Response of participant in the organoleptic evaluation of the BSD-tolerant accessions, Dominica

<table>
<thead>
<tr>
<th></th>
<th>FHIA03</th>
<th>FHIA18</th>
<th>FHIA21</th>
<th>FHIA23</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Don’t</td>
<td>Yes</td>
</tr>
<tr>
<td>Do you like it</td>
<td>42</td>
<td>7</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>Don’t</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>know</td>
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<td>Would you buy it</td>
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d.f 6
In St Lucia, organoleptic testing occurred during September 2016. FHIA 23 was preferred among the FHIA accessions as a ripe fruit for its taste, texture and ease of pealing. FHIA 17 ranked second in preference behind FHI 23.

**Summary discussion**

In general, with reference to the mother plants, all the FHIA accessions evaluated for their tolerance to BSD performed well in the field against the disease, as demonstrated with high functional leaf numbers at both flowering and harvest. FHIA 17, and the only plantain accession evaluated—FHIA 21—had short crop cycles, good bunch weights and positive organoleptic responses. FHIA 17 was positive as a fresh fruit, and FHIA 21 as a cooked fruit. However, both accessions were slow to multiply *in vitro* and produced a challenge for increased distribution of germplasm. FHIA 23, though had a significantly longer crop cycle (375 days) than FHIA 17 (324 days), produced a significantly large bunch (30 kg) than FHIA 17 (25Kg) and was acceptable to consumers both as a fresh fruit and cooked. FHIA 03, however, should not be discounted as although it was not considered as a fresh fruit, it was preferred as cooked green fruit.

Going forward, the results from the ratoon crop will further direct the choice of accessions for future evaluation.

Another significant observation was the location effect. The crop cycle of the accessions were significantly influenced by the site location. The location effect caused as much as a difference of 526 days in the crop cycle as demonstrate FHIA 01 when cultivated at Montreal and Mount William, St Vincent. The economic impact of choosing the correct location is hence highlighted.
CONSTRUCTING AN INTEGRATED DISEASE MANAGEMENT (IDM) FRAMEWORK

Visit to Jamaica

In 2014, in discussions with the Jamaica Banana Board (JBB) with regards to the existing BSD management programme in Jamaica, it was revealed that due to budgetary constraints the BSD programme was not as aggressive as it had been previously. This was due to budgetary constraints resulting in Jamaica not exporting bananas. However, the JBB disclosed that Jamaica was currently in a drive to overhaul its BSD management programme but was not in a position to facilitate a visit by the Project Plant Pathologist and Agronomist.

Baseline Survey

The draft interview instrument was developed to capture the existing BSD management strategy being implemented in the four participating countries. The main focus of the questionnaire was (i) Bio-Data of farmers; (ii) production practice; (iii) pest and disease management; and (iv) knowledge and skill of the producer and extension agents. The interview instrument was reviewed by the CARDI biometrician and amended according to the recommendations made.

Stakeholder Capacity Building

Engagement and training conducted by Expert Plant Pathologist Consultant

Following discussions between the CARDI management and the CDB, it was decided to engage an expert consultant with working hands-on knowledge of Black Sigatoka Disease management in commercial banana production. The terms of reference was written and
the budget allocation made. A request for a ‘no objection’ for the engagement of the consultant was submitted to the CDB. Three potential candidates were screened. Dr. Robert Power, Plant pathologist, Suriname was selected, as he had extensive experience in the banana industry in Suriname both as a Plant Pathologist and as the managing director of SURLAND Ltd, the state-owned Banana Company, which gave him the perspective of management efficiency—monetary and otherwise. As Dr. Power was also a full-time lecturer and research plant pathologist at the University of Suriname and Wageningen Agricultural University and the International Agricultural Centre in the Netherlands, he brought with him an in-depth understanding of the science and teaching. He was the Team Leader in the modernization of the banana industry in Suriname and advisor to the President of Suriname on Agriculture he brought an overall vision of the contribution of agriculture to the GDP of a country.

Expert Plant Pathologist Consultant, Dr. Robert Power and the Project Coordinator conducted the training workshop, “Development of an Integrated Management Programme for Black Sigatoka Disease of banana and plantain” in the four Project participating countries. Each 10-day, interactive workshop aimed at strengthening the capacity of Black Sigatoka Disease management in banana and plantain, using a combination of classroom, laboratory and field sessions (Appendix 7). Workshop participants were taught the phyto-pathological cycle of the disease, epidemiology, integrated disease management, climatic forecasting methods and measuring disease intensity with a view towards developing and sustaining robust detection, monitoring and disease management strategy. Participants are also taught methods of measuring fungicide efficacy and crop productivity.

The dates and attendance at the workshops in the participating Project countries are summarized in Table 14.
Table 14  Location, date, participants and gender of participants for the 10-day training workshop titled, “Development of an Integrated Management Programme for Black Sigatoka Disease of banana and plantain”

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<tr>
<th>Location</th>
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<td>St Vincent and the Grenadines</td>
<td>24 August - 4 September</td>
<td>25</td>
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<td>Guyana</td>
<td>28 September - 9 October</td>
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<td>Dominica</td>
<td>23 November - 4 December</td>
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The workshops were attended by representatives from banana companies, Fairtrade International, BSD management personnel, Banana Accompanying Measures (BAM) personnel, plant protection and quarantine units, farmers’ organizations, research and development units, the Ministry of Agriculture extension units and the international agency, and the World University Service Canada (formally, Canadian Hunger Foundation).

The management of Moko disease, Cucumber mosaic virus and nematodes were also addressed in the integrated management of BSD. Each participant received a training manual and a certificate of participation.

The workshops were favourably received in all four project participating countries. Of the 92 persons that have participated in the training programme, over 90% had previously participated in at least one other BSD management training programme. However, 100% of the participants agreed, or strongly agreed, that the information provided in the workshop
was relevant, provided valuable information for the integrated disease management of BSD, was well structured and accomplished its objectives. The participants appreciated the PowerPoint presentations, laboratory and farm visits, and field exercises as well as the group activities and discussions. They thought that the participatory nature of the workshop allowed them to understand the integrated approach in the management of BSD. Participants in Dominica, St Lucia, and St Vincent and the Grenadines were able to visit the BSD-tolerant varietal evaluation blocks to reinforce the role of tolerant varieties in disease management.

The main highlights of the training were:

- The Integrated Disease Management programme focused on the host, banana and plantain plant. BSD management should only be one aspect of the whole production system.

- The identification of the different stages of the disease (Stage 1-6) and understanding on which stages to apply agrochemicals. Agrochemicals are only applied to Stages 1 and 2 when only conidia are present. From Stage 3 onwards pruning is recommended.

- The importance of sound cultural practices such as field sanitation, fertilizer application, nematode and weevil management, pruning and removal of all Stages 3-6 leaves; leaves must be placed down (stacked on top of each other) with the underside facing up to cover ascospores. Timing is critical in terms of fertilizer application, pruning and pest/disease management.

- Chemical control is a last resort and only used if absolutely necessary. Avoid unnecessary contamination of the environment.

- Flowcharting is critical for any serious production system.
Figure 62 Interactive and familiarization laboratory session of the causal organism of Black Sigatoka Disease *Mycosphaerella fijiensis*, in the participating countries (Dominica, Guyana, St Lucia and St Vincent)
Figure 63  Field sessions in the participating countries (Dominica, Guyana, St Lucia and St Vincent)
Figure 64  Classroom sessions in the participating countries (Dominica, Guyana, St Lucia and St Vincent)
Figure 65  Workshop participants in Guyana, St Lucia and St Vincent and the Grenadines (clockwise order)
Training workshop attended in St. Vincent and the Grenadines.

A training workshop was held in St. Vincent and the Grenadines from 21 to 25 November 2016. The workshop brought together, for the first time, the research assistants from the Project participating countries Dominica, Guyana, St Lucia and St Vincent. Key personnel from CARDI Headquarters were also in attendance: Mr. Videsh Jagroo and Mr. Bruce Lauckner, Biometricians and the Project Coordinator. The aims of the 4-day workshop were: to review the damage and loss of data caused by Tropical Storm Matthew, to share field experiences and observations, to harmonize the data collection and data presentation among countries, and to train research assistants in the statistical package GENSTAT. The training workshop included field trips to the BSD evaluation plots (2 days) as well as classroom training sessions and a final half day of country presentations.

On visiting the evaluation plots the biometricians were able to assess the volume of data lost as a result of TS Matthew. Also, Research Assistants were instructed on how to proceed with data collection. Also discussed was management of loss of data as a result of animal damage and praedial larceny. Research assistants were given the opportunity to discuss the performance of the accessions in their particular country and to share techniques acquired in the data collection process. Of interest was the variability of FHIA 03 germplasm in terms of the colour of the pseudostem, length of crop cycle (time from planting to harvest), and presentation of the bunch (angle the bunch emerges from the pseudostem). This observation was common in all the participating countries. Also of concern was the consistent report from the participating countries of wind toppling of FHIA 23.

In a classroom setting, participants were taught data management and analysis using the GENSTAT statistical program. The research assistants had the opportunity to manipulate their data under the tutelage of the biometricians present.
On the final day of the workshop personnel from the SVG Banana Unit, Ministry of Agriculture and the Planning Division were invited to attend presentations by the Research Assistants on the progress of the Project in their respective countries. There was also a demonstration of the automated data loggers presently used by the BSD Unit in St Lucia. There were 16 persons in attendance.

Figure 66  Visit to a field demonstration plot - SVG
Farmers Training – Country Status

Guyana

In November 2015, the cycle of Farmer Field School Training (FFS) on the integrated management of Black Sigatoka Disease commence in Guyana. The training sessions were held at three locations (Canal #2, Parika and Mahaica) in Regions 3 and 5. The training was organized and scheduled in collaboration with NAREI’s Extension officers and farmers. Training topics comprised pest and disease management including, the causative agent, disease spread, symptoms and management of Black Sigatoka Disease, Moko disease, Cucumber mosaic virus, Banana bunchy top virus, nematodes and root/corm weevil, selection of planting materials and planting, and fertility management. A total of 293 persons attended the sessions which were conducted over the course of approximately one year. The combined sessions’ attendance is summarized in Table 15.

Figure 67   Farmer Field School participants, Mahaica, Guyana
Table 15  Schedule of training and attendance of farmers in Guyana

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Constraints and Concerns raised by farmers

Concerns raised by farmers in Guyana, articulated while attending training:

- Access to clean banana and plantain planting materials

Clean planting material remains an important challenge to increasing the production of plantain in Guyana. As the crop is vegetatively propagated, plant propagation by tissue culture is an important way to ensure that clean planting material is available to farmers. The concern is exacerbated as Moko disease, which is present in country, is easily spread by plant material collected from infected fields. Once a farm becomes infected with Moko disease, it must be abandoned to lie fallow out of banana and plantain. The lack of clean planting
material will limit the expansion of plantain production and increase the area affected by Moko disease.

- Scarcity of fresh water.

Water shortages and salt salinity was another major problem for farmers in Mahaica. Many farmers reported crop losses, mainly due to the long dry spell.

Figure 68 Farmer’s Field School Training Session, Parika, Guyana
**Farmer Visits (Guyana)**

To reinforce the FFS training in Guyana, farmers requested farm visits to assist in identifying and responding effectively to their individual farm challenges. The visited to Mr. Rasheed’s farm on 16\textsuperscript{th} April 2016 was to assist in the selection and preparation of quality planting material as well as to reinforce BSD management techniques taught in the FFS programme.

![Figure 69](image_url) Planting materials collected without proper selection.

On the 20\textsuperscript{th} April 2016 two farms were visited. At both farms, symptoms of Moko disease were prevalent. Samples were collected from plants showing symptoms (Figure 71). As potassium deficiency symptoms were also observed soil samples were also collected. The samples were submitted to the NAREI Soil and Plant Pathology laboratories for analysis.
Figure 70  Plantain farm showing even growth

Figure 71  Symptoms of Moko disease: collapse of leaves; internal browning of pseudostem, bacteria oozing and splitting of the fruits
Laboratory analysis on a semi-selective media, Triphenyl tetrazolium chloride (TTC or TTZ) was used to test for *Ralstonia solanacearum*, the causal agent of Moko disease. The test was positive for *R. solanacearum* bacteria on all samples brought from the farms as demonstrated in Figure 72.

Figure 72  *R. solanacearum* growth on semi-selective media

Two farms were visited on the 22 June 2016 at Mahaica. Both farms also showed signs of the presence of Moko disease. BSD was also prevalent at one of the farms. BSD becomes more difficult to manage in a plantation where Moko is existing, as Moko is easily spread by cutting tools used in the management of BSD.

**Farmers Training – St Lucia**

Participants from the National Skills and Development Centre (NSDC) attended a one-month hands-on training session with the Project staff. The three female students were exposed to crop and BSD management protocols.
**Farmers Training Dominica**

Farmers in the Cochrane Village in Dominica benefitted from a training session in IDM of BSD. There were 19 farmers in attendance.

**Sensitization material**

A 2016 calendar featuring the Integrated Disease Management strategy for Black Sigatoka Disease was developed, published and distributed (Appendix 15). The calendar features the stages of disease development that are important in recognizing for effective disease management. The calendar was distributed to farmers and other stakeholders.

The report on “Recommended strategy in Black Sigatoka Disease management; Progressing from routine systemic-spray cycles to best practice in cultivation, combined with timely protective actions, using disease monitoring and weather forecasting records” for Dominica, Guyana, St. Lucia, and St. Vincent and the Grenadines, as written by Dr. Robert H. Power, Consultant Specialist for the Project was presented to all Ministers and Permanent Secretaries of Agriculture in the participating countries (Appendix 12). The Report was divided into three sections. The first section addressed the existing situation and disease management strategy with regards to BSD in each of the participating countries. The second section targeted factors affecting yield while the third section made recommendations for the way forward.

Project Research Assistant, Mr. Gregory Linton, from Dominica was selected to present, on behalf of the Project Team, the research findings in the evaluation of the BSD-tolerant varieties at at the Caribbean Food Crop Society (CFCS) 52nd Annual Meeting in Le Gosier, Guadeloupe from 10–16 July 2016 (Appendix 13). His oral presentation titled “Evaluation of banana and plantain (Musa spp.) accessions tolerant to Black Sigatoka Disease in
Domincia, Guyana, St Lucia and St Vincent and the Grenadines” was well received (Figure 73).

Figure 73  Mr. G. Linton presenting at CFCS 52nd Annual meeting

The Public Relations Consultant to the Project has delivered for publication (Appendix 14):

1. Poster
2. Radio and video script
3. Booklet for policy change

These deliverables will be published during the Project extension.

Media coverage to the Project is detailed in Appendix 15.
FINANCIAL REPORT

RECEIPTS:
The first tranche in the sum of USD 50,000 was received in September 2014. The second tranche of USD 40,000 was received in June 2015, the third in March 2016 of USD 50,000 and the final in September 2016 of USD 50,000. The total receipts are USD 190,000. There have been no further receipts thereafter.

EXPENDITURES:
The grand total of expenditure under the project is USD 430,523.54.

A summary of the inflows and outflows to date is presented below. Based on the total receipts and total expenses to date, there is a deficit of USD 240,523.54.
**Summary of Inflows and Outflows**

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Prepared by: [Signature]
Sharon Jones
Plant Pathologist/ Project Coordinator

Checked by: [Signature]
Curtis Nero
Head, Finance Unit

Approved by: [Signature]
Norman Gibson
Manager, Science, Technology & Innovation
**SUMMARY OF ACTUAL EXPENDITURE**

for the period July, 2014 to December, 2016

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<td>2,757.68</td>
<td>431.71</td>
<td>159.24</td>
<td>-</td>
</tr>
<tr>
<td><strong>Contingencies</strong></td>
<td>16,250.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16,250.00</td>
<td></td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td>161,750.00</td>
<td>4,758.26</td>
<td>4,758.26</td>
<td>4,758.26</td>
<td>4,758.26</td>
<td>4,758.26</td>
<td>4,758.26</td>
<td>4,758.26</td>
<td>79,160.79</td>
<td>213,734.12</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td>625,000.00</td>
<td>39,881.99</td>
<td>99,540.18</td>
<td>50,329.71</td>
<td>97,728.95</td>
<td>363,297.81</td>
<td>152,258.68</td>
<td>140,018.22</td>
<td>510,523.54</td>
<td>394,476.46</td>
</tr>
</tbody>
</table>

**Project title:** Development of an Integrated Disease Management Programme for Black Sigatoka Disease  
**Project Code:** 12112IMEIDM/HQ/VC20175; 12111IISDM/HQ/VC20175  
**Country:** Dominica, Guyana, St Lucia, St Vincent, Headquarters  
**Period:** July 2014 - December 2016
APPENDICES

APPENDIX 1: CARDI’S LETTERS TO THE MINISTERS OF AGRICULTURE INTRODUCING THE PROJECT

21 November, 2014

Honourable Matthew Walter
Minister of Agriculture and Forestry
Ministry of Agriculture and Forestry
Government Headquarters
Roseau
COMMONWEALTH OF DOMINICA

Dear Honourable Minister,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture and Forestry.

Your letter to the Caribbean Development Bank (CDB) dated November 20th 2013, supporting CARDE’s initiative to develop a management programme for Black Sigatoka Disease (BSD) has met with success. The CDB has funded a regional project “Development of an integrated disease management (IDM) programme for Black Sigatoka Disease (BSD)” on banana and plantain. The Project will be implemented in Dominica, Grenada, St Lucia and St Vincent and the Grenadines. The Project Coordinator and Plant Pathologist is Mr Sharon Jones. The CARDE Representative in your country will be responsible for the daily management of the Project.

The Project’s key activities are:

1. To introduce and evaluate BSD tolerant banana and plantain varieties in identifiable agro-ecological zones in your country and to determine the most promising varieties. The BSD tolerant hybrids will be evaluated in two agro-ecological zones in your country.

2. To develop an integrated disease management (IDM) programme for BSD. The IDM will include disease surveillance and monitoring as well as cultural practices which reduce the disease inoculum levels in the field.

3. To conduct stakeholder capacity building in components of the integrated disease management programme for BSD.

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Your support is essential for the success of the Project as it will complement the resources funded by the project. The support anticipated is as follows:

1. The assigning of an extension officer to assist in the implementation of the project.
2. Technical, administrative and logistical support to training programmes, approximately US $6,000 per year.
3. Recording of all support given by your Ministry to the Project so that a concise record of counterpart funding can be established.
4. Our Office in Charge Ms Dorian Etienne will seek a meeting with you and/or your representative to discuss the details of the project in your country.

CARDI welcomes your Ministry and its participation and looks forward to a successful institutional collaboration in this effort which should ultimately advance the agricultural sector and the economy of the Region.

I take this opportunity to extend to you the assurances of my highest consideration.

H Arlington D Cherry
Executive Director

cc: Mr Harold Guirre, Permanent Secretary, Ministry of Agriculture and Forestry
Mr Dorian Etienne, Officer in Charge, Dominica Unit
Dr Francis Aisleit, Manager Technical Services
Ms Sharon Jones, Project Manager

HADC/SJ/cad
19 November, 2014

Honourable Dr. Leslie Ramsammy
Minister of Agriculture
Ministry of Agriculture
Regent & Vilcogen Road
Georgetown
GUYANA

Dear Honourable Minister,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture.

Your letter to the Caribbean Development Bank (CDB) dated November 20th 2013, supporting CARDI’s initiative to develop a management programme for Black Sigatoka Disease (BSD) has met with success. The CDB has funded a regional project “Development of an integrated disease management (IDM) programme for Black Sigatoka Disease (BSD)” on banana and plantain. The Project will be implemented in Dominica, Guyana, St Lucia and St Vincent and the Grenadines. The Project Coordinator and Plant Pathologist is Mr. Sharon Jones. The CARDI Representative in your country will be responsible for the daily management of the Project.

The Project’s key activities are:

1. To introduce and evaluate BSD tolerant banana and plantain varieties in identifiable agro-ecological zones in your country and to determine the most promising varieties. The BSD tolerant hybrids will be evaluated in two agro-ecological zones in your country.

2. To develop an integrated disease management (IDM) programme for BSD. The IDM will include disease surveillance and monitoring as well as cultural practices which reduce the disease inoculum levels in the field.

3. To conduct stakeholder capacity building in components of the integrated disease management programme for BSD.

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Your support is essential for the success of the Project as it will complement the resources funded by the project. The support anticipated is as follows:

1. The assigning of an extension officer to assist in the implementation of the project.
2. Technical, administrative and logistical support to training programmes, approximately US 6,000 per year.
3. Recording of all support given by your Ministry to the Project so that a concise record of Countryfunding can be established.
4. Our Country Representative Dr. Arlington Chesney will seek a meeting with you and/or your representative to discuss the details of the project in your country.

CARDe welcomes your Ministry and its participation and looks forward to a successful institutional collaboration in this effort which should ultimately advance the agricultural sector and the economy of the Region.

I take this opportunity to extend to you the assurances of my highest consideration.

H. Arlington D. Chesney
Executive Director

CC: Mr. George Jervis, Permanent Secretary Ministry of Agriculture
    Dr. Arlington Chesney, Country Representative, CARDe Guyana
    Dr. Francis Asiedu, Manager Technical Services
    Mr. Sharon Jones, Project Manager

HADCi/cad
19 November, 2014

Honourable Moses Jn Baptiste
Minister of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development
Ministry of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development
4th and 5th Floor, Sir Stanislaus James Building
Waterfront, Castries
ST. LUCIA

Dear Honourable Minister,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development.

Your letter to the Caribbean Development Bank (CDB) dated November 20th 2013, supporting CARDI’s initiative to develop a management programme for Black Sigatoka Disease (BSD) has met with success. The CDB has funded a regional project “Development of an integrated disease management (IDM) programme for Black Sigatoka Disease (BSD)” on banana and plantain. The Project will be implemented in Dominica, Guyana, St Lucia and St Vincent and the Grenadines. The Project Coordinator and Plant Pathologist is Mr Sharen Jones. The CARDI Representative in your country will be responsible for the daily management of the Project.

The Project’s key activities are:

1. To introduce and evaluate BSD tolerant banana and plantain varieties in identifiable agro-ecological zones in your country and to determine the most promising varieties. The BSD tolerant hybrids will be evaluated in two agro-ecological zones in your country.

2. To develop an integrated disease management (IDM) programme for BSD. The IDM will include disease surveillance and monitoring as well as cultural practices which reduce the disease inoculum levels in the field.

3. To conduct stakeholder capacity building in components of the integrated disease management programme for BSD.

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Your support is essential for the success of the Project as it will complement the resources funded by the project. The support anticipated is as follows:

1. The assigning of an extension officer to assist in the implementation of the project.
2. Technical, administrative and logistical support to training programmes, approximately US 6,000 per year
3. Recording of all support given by your Ministry in the Project so that a concise record of Counterpart funding can be established
4. Our Country Representative Mr Ronald Pignin will seek a meeting with you and/or your representative to discuss the details of the project in your country.

CARDI welcomes your Ministry and its participation and looks forward to a successful institutional collaboration in this effort which should ultimately advance the agricultural sector and the economy of the Region.

I take this opportunity to extend to you the assurance of my highest consideration.

H Arlington D. Chasey
Executive Director

cc: Dr. Darius Gabriel, Agriculture, Food Production, Fisheries, Co-operatives and Rural Development
Mr Ronald Pignin, Country Representative, St Lucia Unit
Dr Francis Assiedu, Manager Technical Services
Mr. Sharon Jones, Project Manager

HADC/53/cad
19 November, 2014

Honourable Saboto Caesar
Minister of Agriculture, Forestry and Fisheries and Rural Transformation
Ministry of Agriculture, Forestry, Fisheries and Rural Transformation
Government Headquarters
Richmond Hill
Kingstown
ST. VINCENT AND THE GRENADINES

Dear Honourable Minister,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture, Forestry, Fisheries and Rural Transformation.

Your letter to the Caribbean Development Bank (CDB) dated November 20th 2013, supporting CARDI’s initiative to develop a management programme for Black Sigatoka Disease (BSD) has met with success. The CDB has funded a regional project “Development of an integrated disease management (IDM) programme for Black Sigatoka Disease (BSD)” on banana and plantain. The Project will be implemented in Dominica, Grenada, St Lucia and St Vincent and the Grenadines. The Project Coordinator and Plant Pathologist is Mr. Sharon Annis. The CARDI Representative in your country will be responsible for the daily management of the Project.

The Project’s key activities are:

1. To introduce and evaluate BSD tolerant banana and plantain varieties in identifiable agro-ecological zones in your country and to determine the most promising varieties. The BSD tolerant hybrids will be evaluated in two agro-ecological zones in your country.

2. To develop an integrated disease management (IDM) programme for BSD. The IDM will include disease surveillance and monitoring as well as cultural practices which reduce the disease inoculum levels in the field.

3. To conduct stakeholder capacity building in components of the integrated disease management programme for BSD.

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Montserrat • St Kitts & Nevis • St Lucia • St Vincent & the Grenadines • Trinidad & Tobago

Page 120 Project Progress Report (July 2014 - December 2016)
Your support is essential for the success of the Project as it will complement the resources funded by the project. The support anticipated is as follows:

1. The assigning of an extension officer to assist in the implementation of the project.
2. Technical, administrative and logistical support to training programmes, approximately US 6,000 per year.
3. Recording of all support given by your Ministry to the Project so that a concise record of counterpart funding can be established.
4. Our Country Representative Dr Gregory Robin will seek a meeting with you and/or your representative to discuss the details of the project in your country.

CARDI welcomes your Ministry and its participation and looks forward to a successful institutional collaboration in this effort which should ultimately advance the agricultural sector and the economy of the Region.

I take this opportunity to extend to you the assurances of my highest consideration.

H Arlington D Cheaney
Executive Director

cc: Mr Raymond Ryan, Permanent Secretary Ministry of Agriculture, Forestry, Fisheries and Rural Transformation
Dr Gregory Robin, Country Representative, St Vincent and the Grenadines Unit
Dr Francis Aieda, Manager Technical Services
Mr Sharon Jones, Project Manager

HADOSS/cad

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APPENDIX 2: MINISTERS OF AGRICULTURE LETTERS OF COMMITMENT TO THE PROJECT

12 January 2015

Honourable Moses Jn Baptiste
Minister of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development
Ministry of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development
4th and 5th Floors, Sir Stanislaus James Building
Waterfront, Castries
ST. LUCIA

Dear Honourable Minister:

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture Food Production, Fisheries, Co-operatives and Rural Development.

By letter, dated 19 November 2014, reference number, HADC/SJ/ead, (copy attached for ease of reference). I introduced the Project “Development of an Integrated Disease Management (IDM) programme for Black Sigatoka Disease (BSD)” that CARDI was implementing with grant funding from the Caribbean Development Bank (CDB). I now write to seek your concurrence on the specified roles and responsibilities of the Ministry and CARDI. I wish to emphasise that the agreement of these roles and responsibilities is mandated by the CDB in the Grant Agreement for the Project. The concurrence on the roles and responsibilities, which are detailed below, is critical to our successful collaboration during the implementation of the Project.

CARDI, as the Executing Agency for the Project, shall:

1. Have the overall responsibility for the implementation and management of the Project.
2. Have the responsibility for the daily management of the Project in country through the CARDI Country Representative.
3. Employ a Research Assistant for the implementation of the tasks of the Project in your country.
4. Provide Professional Services estimated at approximately US$12,500.

The Ministry of Agriculture, Food Production, Fisheries, Cooperatives and Rural Development shall:

1. Work cooperatively with CARDI to implement the Project.
2. Support the Project by assigning for the duration of the project an Extension Officer (s) to assist in the implementation of the project.
3. Record its counterpart in-kind contribution to the Project estimated at approximately US$6,000.

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4. Give technical, administrative and logistical support to training programmes, information dissemination and overall capacity building of target producers with regards to the project implementation.

5. Provide technical, administrative and logistical support to the project to assist in the adoption and sustainability of the project interventions during the project life and following the project closure.

Kindly confirm your agreement with the identified roles and responsibilities by signing two copies of this letter and returning one hard copy to CARDI.

CARDI welcomes the participation of the Ministry and looks forward to a successful institutional collaboration in this effort which would ultimately advance the contribution of the agricultural sector and the economy of St. Lucia, specifically, and the Region generally.

I take this opportunity to extend to you the assurances of my highest consideration.

H. Arlington Chesney
Executive Director

Honourable Moses Jn Baptiste
Minister of Agriculture, Food Production, Fisheries, Co-operatives and Rural Development

HADC/dm

Date

22/1/2015

Date
Dear Honourable Minister,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture and Fisheries.

By letter, dated 21 November 2014, reference number, HADC/CS/Head, (copy attached for ease of reference), I introduced the Project “Development of an Integrated Disease Management (IDM) programme for Black Sigatoka Disease (BSD)” that CARDI was implementing with grant funding from the Caribbean Development Bank (CDB). I now write to seek your concurrence on the specified roles and responsibilities of the Ministry and CARDI. I wish to emphasise that the agreement of these roles and responsibilities is mandated by the CDB in the Grant Agreement for the Project. The concurrence on the roles and responsibilities, which are detailed below, is critical to our successful collaboration during the implementation of the Project.

CARDI, as the Executing Agency for the Project, shall:

1. Have the overall responsibility for the implementation and management of the Project.
2. Have the responsibility for the daily management of the Project in country through the CARDI Country Representative.
3. Employ a Research Assistant for the implementation of the tasks of the Project in your country.
4. Provide Professional Services estimated at approximately US$12,500.

The Ministry of Agriculture and Fisheries shall:

1. Work cooperatively with CARDI to implement the Project.
2. Support the Project by assigning, for the duration of the project an Extension Officer(s) to assist in the implementation of the project.
3. Record its counterpart in-kind contribution to the Project estimated at approximately US$6,000.
4. Give technical, administrative and logistical support to training programmes, information dissemination and overall capacity building of target producers with regards to the project implementation.

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5. Provide technical, administrative and logistical support to the project to assist in the adoption and sustainability of the project interventions during the project life and following the project closure.

Kindly confirm your agreement with the identified roles and responsibilities by signing two copies of this letter and returning one hard copy to CARDI.

CARDI welcomes the participation of the Ministry and looks forward to a successful institutional collaboration in this effort which would ultimately advance the contribution of the agricultural sector and the economy of, Dominica, specifically, and the Region generally.

I take this opportunity to extend to you the assurances of my highest consideration.

[Signature]
H. Amirgue D. Chestney
Executive Director

[Signature]
H. Amirgue D. Chestney
Executive Director

[Signature]
Mr. Johnson Drigo
Minister of Agriculture and Fisheries

[Signature]
Mr. Johnson Drigo
Minister of Agriculture and Fisheries

[Signature]
HADC/an

[Signature]
HADC/an

Date

[Signature]
Date
DEVELOPMENT OF AN INTEGRATED DISEASE MANAGEMENT PROGRAMME FOR BLACK SIGATOKA DISEASE

OFFICE OF THE EXECUTIVE DIRECTOR

17 January 2015

Honourable Saboté Cassar
Minister of Agriculture, Forestry and Fisheries and Rural Transformation
Ministry of Agriculture, Forestry, Fisheries and Rural Transformation
Government Headquarters
Rosalmond Hill
Kingstown

ST. VINCENT AND THE GRENADINES

Dear Honourable Minister,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you to the Ministry of Agriculture, Forestry, Fisheries and Rural Transformation.

By letter, dated 16 November 2014, reference number: HADC/56/14a, (copy attached for ease of reference), I introduced the Project "Development of an Integrated Disease Management (IDM) programme for Black Sigatoka Disease (BSD)" that CARDI was implementing with grant funding from the Caribbean Development Bank (CDB). I now write to seek your concurrence on the specified role and responsibilities of the Ministry and CARDI. I wish to emphasise that the agreement of these roles and responsibilities is mandated by the CDB in the Grant Agreement for the Project. The concurrence on the roles and responsibilities, which are detailed below, is critical to our successful collaboration during the implementation of the Project.

CARDI, as the Executive Agency for the Project, shall:

1. Have the overall responsibility for the implementation and management of the Project;
2. Have the responsibility for the daily management of the Project in country through the CARDI Country Representative;
3. Employ a Research Assistant for the implementation of the tasks of the Project in your country;
4. Provide Professional Services estimated at approximately USD$2,500.

The Ministry of Agriculture, Forestry, Fisheries and Rural Transformation shall:

1. Work cooperatively with CARDI to implement the Project;
2. Support the Project by assigning the duration of the project an Extension Officer (s) in charge in the implementation of the project;
3. Record its counterpart in-kind contribution to the Project estimated at approximately USD$0.00;
4. Give technical, administrative and logistical support to training programmes, information dissemination and overall capacity building of target producers with regards to the project implementation.

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OFFICE IN Antigua & Barbuda • Barbados • Belize • Dominica • Grenada • Guyana • Jamaica • Montserrat • St. Kitts & Nevis • St. Lucia • St. Vincent & the Grenadines • Trinidad & Tobago
5. Provide technical, administrative and logistical support to the project to assist in the adoption and sustainability of the project interventions during the project life and following the project closure.

Kindly confirm your agreement with the identified roles and responsibilities by signing two copies of this letter and returning one hard copy to CARDI.

CARDI welcomes the participation of the Ministry and looks forward to a successful institutional collaboration in this effort which would ultimately advance the contribution of the agricultural sector and the economy of St Vincent and the Grenadines, specifically, and the Region generally.

I take this opportunity to extend to you the assurances of my highest consideration.

H Arlington D Chesson
Executive Director

Honourable Sabotu Caesa
Minister of Agriculture, Forestry, Fisheries and Rural Transformation

HADC/dm

Date

5th Feb 2015

Date
APPENDIX 3: BANANA AND PLANTAIN ACCESSIONS RECEIVED

Black Sigatoka Disease (BSD) tolerant plantain and banana accessions received under the CDB funded BSD Integrated Disease Management Programme

Received by: St Vincent and the Grenadines for distribution to Dominica and St Lucia

Received Date: 14 January 2013 as proliferating tissue culture material, 5 of each

Received from: Bioversity International (International Transit Centre)

Present Location: Orange Hill Tissue Culture Laboratory, St Vincent

Accessions:

ITC0504 FHIA - 01
ITC0505 FHIA -02
ITC0506 FHIA – 03
ITC1264 FHIA -17
ITC1265 FHIA -23
ITC1319 FHIA -18
ITC1332 FHIA-21
ITC1412 FHIA 18

Received by: Guyana

Received Date: 4 May 2015

Received from: Bioversity International (International Transit Centre)

Present Location: Orange Hill Tissue Culture Laboratory, St Vincent
Accessions:

ITC0505 FHIA -02
ITC0506 FHIA -03
ITC1332 FHIA -21
ITC1344 CRBP 39
ITC1589 Grande Naine

Received by: Guyana

Received Date: 12 May 2015

Received from: International Institute of Tropical Agriculture (IITA)

Present Location: Orange Hill Tissue Culture Laboratory, St Vincent

Accessions:

4479-1 PITA 17
23688-2 PITA 21
23907 -18 PITA 22
25333 –S90 PITA 23
25344 18 PITA 24
26636 -2 PITA 26
26285 PITA 27
## APPENDIX 4: SUMMARY OF IMPORTED BANANA AND PLANTAIN ACCESSIONS

### FHIA hybrids

<table>
<thead>
<tr>
<th>Variety</th>
<th>Morphology</th>
<th>Phenology</th>
<th>Production</th>
<th>Resistance features</th>
<th>Agro-ecological requirement</th>
<th>Crop management</th>
<th>Postharvest</th>
<th>Other comments</th>
</tr>
</thead>
</table>
| FHIA 01 | Plant height: 2.5-3.5m  
No need to prop | Planting – flowering: 290-320 days  
Flower – harvest: 90-100 days | Bunch wt: 25-35 kg  
# fruit/bunch: 130-160 | BSD; Panama disease; moderate resistance to nematodes | Adapted to sub-optimal conditions including fertility | 1600 plants/ha | Fruits do not oxidize | |
| FHIA 02 | Plant height: 2.5-3.7m  
No need to prop | Planting – flowering: 271-370 days | Bunch wt: 30-40 kg  
# fruit/bunch: 155-179 | BSD; Panama disease; Moko bacterial wilt; moderate | Adapted to sub-optimal conditions including fertility | 1600 plants/ha | Good green cooking variety; apple flavour ripe fruit | Tolerant to Moko disease |
<table>
<thead>
<tr>
<th>Variety</th>
<th>Morphology</th>
<th>Phenology</th>
<th>Production</th>
<th>Resistance features</th>
<th>Agro-ecological requirement</th>
<th>Crop management</th>
<th>Postharvest</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHIA 03</td>
<td>Plant height: 3-3.5m</td>
<td>Planting – flowering: 290-320 days; Flowering to harvest 90-100 days</td>
<td>Bunch wt: 25-35 kg; # fruit/bunch: 130-160</td>
<td>resistance to nematodes</td>
<td>Adapted to sub-optimal conditions including fertility</td>
<td>1600 plants/ha</td>
<td>Green cocking variety</td>
<td>Tolerant to Moko disease Source: ITC</td>
</tr>
<tr>
<td>FHIA 17</td>
<td>Plant height: 3-3.5m</td>
<td>Planting – flowering: 290-320 days; Flowering to harvest 90-100 days</td>
<td>Bunch wt: 25-35 kg; # fruit/bunch 130-160</td>
<td>BSD; Moko disease; Panama disease; moderate resistance to nematodes</td>
<td>Adapted to sub-optimal conditions including fertility</td>
<td>1600 plants/ha</td>
<td>Successful in Jamaica</td>
<td></td>
</tr>
<tr>
<td>Variety</td>
<td>Morphology</td>
<td>Phenology</td>
<td>Production</td>
<td>Resistance features</td>
<td>Agro-ecological requirement</td>
<td>Crop management</td>
<td>Postharvest</td>
<td>Other comments</td>
</tr>
<tr>
<td>---------</td>
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<td>--------------------</td>
<td>-----------------------------</td>
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<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>FHIA 18</td>
<td>Plant height: 3-4 m pseudostem vigorous and resistant to the lodging</td>
<td>Flower – harvest: 105 to 119 days</td>
<td>Bunch wt: 20-25 kg; # fruit/bunch: 120-160</td>
<td>BSD Panama disease; moderate resistance to nematodes</td>
<td>Adapted to sub-optimal conditions including fertility</td>
<td>1600 plants/ha</td>
<td>Ripens faster than false horn thus needs age controlled bunching for export</td>
<td>Successful in Jamaica Plantain</td>
</tr>
<tr>
<td>FHIA 21</td>
<td>Plant height: 3.5-4 m</td>
<td>Flower – harvest: 85-100 days</td>
<td>Bunch wt: 22-27 kg; # fruit/bunch: 120-150 thinning recommended to 70-80</td>
<td>BSD Panama disease; susceptible to nematodes</td>
<td>Adapted to sub-optimal conditions including fertility</td>
<td>1600 plants/ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FHIA 23</td>
<td>Plant height: 3-4 m pseudostem vigorous and</td>
<td>Flower – harvest: 84 to 112 days</td>
<td>Bunch wt: 30-40 kg;</td>
<td>BSD Panama disease; moderate</td>
<td>Adapted organic agriculture</td>
<td>1600 plants/ha</td>
<td></td>
<td>Dessert type banana-</td>
</tr>
</tbody>
</table>
## Development of an Integrated Disease Management Programme for Black Sigatoka Disease

### Imported Banana Cavendish Variety

<table>
<thead>
<tr>
<th>Variety</th>
<th>Morphology</th>
<th>Phenology</th>
<th>Production</th>
<th>Resistance features</th>
<th>Agro-ecological requirement</th>
<th>Crop management</th>
<th>Postharvest</th>
<th>Other comments</th>
</tr>
</thead>
</table>
| Grande Naine |             |           |            |                      |                             |                 |             | Cavendish BSD susceptible variety (indicator)  
|              |            |           |            |                      |                             |                 |             | Commercial variety;  
|              |            |           |            |                      |                             |                 |             | Source: ITC                             |

<table>
<thead>
<tr>
<th>Variety</th>
<th>Morphology</th>
<th>Phenology</th>
<th>Production</th>
<th>Resistance features</th>
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<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gros Michel type</td>
</tr>
</tbody>
</table>

Resistant to the lodging: 200-240 fruit/bunch resistance to nematodes
### IMPORTED PLANTAIN ACCESSIONS

<table>
<thead>
<tr>
<th>Variety</th>
<th>Morphology</th>
<th>Phenology</th>
<th>Production</th>
<th>Resistance features</th>
<th>Agro-ecological requirement</th>
<th>Crop management</th>
<th>Postharvest</th>
<th>Other comments</th>
</tr>
</thead>
</table>
| FHIA 21 | Plant height: 3.2-4.5m  
Susceptible to lodging | Flower – harvest: 85-91 days | Bunch wt: 20-30 kg  
# fruit/bunch: 130-160  
thinning recommended to 65-80 | BSD; Panama disease; susceptible to nematodes | Adapted to sub-optimal conditions including fertility | 1600 plants/ha | Tough peel; tolerant to cuts & bruises | Exported in Dominican Republic;  
Source: ITC |
| CRBP 39 | Plant height: 3-4 m | Flower – harvest: 90 days | Bunch wt: 20 – 30 kg;  
# fruit/bunch: 106 fruit | BSD tolerant |  |  | Good agronomic performance;  
Source: ITC | |
| PITA 17 | Plant height: 3-3.5 m | Flower – harvest: 149 days | Bunch wt: 14 kg;  
# fruit/bunch: 83 fruit | BSD tolerant |  |  | Source: IITA | |
<table>
<thead>
<tr>
<th>Variety</th>
<th>Morphology</th>
<th>Phenology</th>
<th>Production</th>
<th>Resistance features</th>
<th>Agro-ecological requirement</th>
<th>Crop management</th>
<th>Postharvest</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PITA 21</td>
<td>Plant height: 3-3.5 m</td>
<td>Flower – harvest: 137 days</td>
<td>Bunch wt: 10 kg; # fruit/bunch: 73 fruit</td>
<td>BSD tolerant</td>
<td></td>
<td></td>
<td></td>
<td>Selected by Cameroon farmers; Source: IITA</td>
</tr>
<tr>
<td>PITA 22</td>
<td></td>
<td></td>
<td>Bunch wt: 11 kg; # fruit/bunch: 59 fruit</td>
<td>BSD tolerant</td>
<td></td>
<td></td>
<td></td>
<td>Source: IITA</td>
</tr>
<tr>
<td>PITA 23</td>
<td>Plant height: 3-3.5 m</td>
<td>Flower – harvest: 127 days</td>
<td>Bunch wt: 15 kg; # fruit/bunch: 151 fruit</td>
<td>Black Sigatoka Disease tolerant</td>
<td></td>
<td></td>
<td></td>
<td>Selected by Cameroon farmers; Source: IITA</td>
</tr>
<tr>
<td>PITA 24</td>
<td></td>
<td></td>
<td>Bunch wt: 23 kg; # fruit/bunch: 119 fruit</td>
<td>BSD tolerant</td>
<td></td>
<td></td>
<td></td>
<td>Yellow fruit; Source: IITA</td>
</tr>
<tr>
<td>PITA 26</td>
<td></td>
<td></td>
<td>BSD tolerant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Source: IITA</td>
</tr>
<tr>
<td>Variety</td>
<td>Morphology</td>
<td>Phenology</td>
<td>Production</td>
<td>Resistance features</td>
<td>Agro-ecological requirement</td>
<td>Crop management</td>
<td>Postharvest</td>
<td>Other comments</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
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<td>-----------------------------</td>
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<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>PITA 27</td>
<td></td>
<td></td>
<td></td>
<td>BSD tolerant</td>
<td></td>
<td></td>
<td></td>
<td>Source: IITA</td>
</tr>
</tbody>
</table>
APPENDIX 5: MOKO DISEASE DIAGNOSTICS TRAINING COURSE, ST VINCENT

Moko disease diagnostics using Immunoassays

St Vincent and the Grenadines

Orange Hill Horticulture Research and Development Complex
St Vincent
17 – 19 December 2014

**Day 1**

- Registration
- Welcome and prayer / R. Mc Donald
- Introductions of Presenters/ R. Mc Donald
- Introduction of Participants
- Workshop overview / S. Jones
- Pre workshop quiz / S. Jones
- Moko Disease – Signs and symptoms / S. Jones
- Moko disease vs Panama disease / S. Jones
- ELISA detection of plant disease / C. Roberts
- Laboratory Exercises / C. Roberts and S. Jones

**Day 2**

- Laboratory Exercises / C. Roberts and S. Jones
- Post workshop quiz / S. Jones
- Wrap-up
APPENDIX 6: AGENDA OF THE TISSUE CULTURE TRAINING PROGRAMME, GUYANA

Consultant: Mr. Rohan Mc Donald

Country visited: Guyana

Institution: National Agricultural, Research and Extension Institute (NAREI)

Objective: Technical Assistance in Tissue culture of plantains and bananas


The following persons were participants in the training:

1. Roberto Mendez Pelegrin - Head of Biotechnology laboratory, NAREI
2. Evan Willabus – Deputy Head of Biotechnology laboratory, NAREI
3. Samantha Brotherson - Laboratory Technician
4. Nalinie Oodith - Laboratory Technician
5. JoAnn Nedd - Griffith - Laboratory Technician
6. Maxine Stuart-Fraser – Laboratory Technician

DAY 1 (18 May 2015)

- PowerPoint presentation titled “Tissue Culture Bananas” covered topics:
  - How to choose a good plant for initiation
  - Initiation
  - Ex plant Preparation
  - Sterilization method
  - Meristem extraction
  - Meristem Disinfection
  - Culturing and sub culturing techniques
o Rooting methods
o Hardening 1st and 2nd stage
o Reviewing of manual for hardening tissue culture bananas

DAY 2 (19 May 2015)

Discussions were held with head of the biotechnology laboratory, Mr. Roberto Mendez, and the following actions were agreed on and carried out:

Morning session

- Securing of the welcome area to ensure that there is no free flow of air from outside to inside of the laboratory
- Designate the welcome area as the area for leaving footwear worn outside of the laboratory
- Establishment of signage to indicate to visitors the ‘no shoes beyond this point’ area
- Discussion on possible 1st and 2nd stage hardening area

Evening session

- Discussion on media preparation
- Making of stock solution and medium for imported plantain varieties

DAY 3 (20 May 2015)

Demonstration of techniques for initiation including:

- surface sterilization
- extraction and culturing of Meristem bases
- Sub culturing demonstration of cultivars from IITA
Consultant: Mr. Rohan Mc Donald

Country visited: Guyana

Institution: National Agricultural, Research and Extension Institute (NAREI)

Objective: Technical Assistance in Tissue culture of plantains and bananas

Period: 28 June to 2 July 2015

The following persons were participants in the training:

1. Roberto Mendez Pelegrin - Head of Biotechnology laboratory, NAREI
2. Evan Willabus – Deputy Head of Biotechnology laboratory, NAREI
3. Samantha Brotherson - Laboratory Technician
4. Nalinie Oodith - Laboratory Technician
5. JoAnn Nedd - Griffith - Laboratory Technician
6. Maxine Stuart-Fraser – Laboratory Technician
APPENDIX 7: BSD INTEGRATED MANAGEMENT TRAINING WORKSHOP ACTIVITY SCHEDULE

Training programme on the Integrated Disease Management programme of Black Sigatoka Disease as conducted in Guyana, St Lucia and St Vincent and the Grenadines.

<table>
<thead>
<tr>
<th>Day number</th>
<th>Training Activity</th>
<th>Required</th>
</tr>
</thead>
</table>
| Day 1 and 2 | Integrated Disease Management/IDM: uniform approaches in optimum yield and product quality:  
- sound cultural practices  
- sound environmental condition  
- *Group work*: flowcharting field (sub) processes of banana/plantain  
- lifecycle of the BSD pathogen & symptom expression:  
- vegetative and generative stages of the BSD pathogen  
- host plant development  
- host syndrome and symptoms useful in BSD pathometry  
- BSD monitoring technique/IDM and related IPM  
*Group work*: quantitative approaches in estimating initial infection (*x0*) and disease severity (*xt*) in BSD  
*Exercises*: calculating infection rate (*r*) in BSD | - Classroom  
- PP-Projector  
- white board/flip chart  
- markers  
- participants to bring scientific calculators  
- printed copy of training manual for each participant |
| Day 3 | AM:  
Field visit to BSD infected banana/plantain field & laboratory microscopic examination of BSD | - Transportation  
- BSD infected field  
- zip lock plastic bags |
<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visit to weather station</td>
<td>- measuring tape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- scissors &amp; machete</td>
</tr>
<tr>
<td></td>
<td>PM: Laboratory visit to examine and prepare field collected samples</td>
<td>- Lab facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- stereoscopic microscope</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- paper towels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- clean water</td>
</tr>
<tr>
<td>Day 4</td>
<td>AM: Field visit to local main meteorological station (institute)</td>
<td>- Transportation to meteorological station</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Classroom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- PP-Projector</td>
</tr>
<tr>
<td></td>
<td>Weather as significant factor in BSD development:</td>
<td>- white board/flip chart</td>
</tr>
<tr>
<td></td>
<td>metro parameters affecting the BSD lifecycle:</td>
<td>- markers</td>
</tr>
<tr>
<td></td>
<td>processing of (multi-annual average) weather data</td>
<td>- participants to bring scientific calculators</td>
</tr>
<tr>
<td></td>
<td>identifying the critical (high risk!) periods of BSD</td>
<td>- graph paper</td>
</tr>
<tr>
<td></td>
<td>viewing $x_0$ and $r$ per unit of time against weather forecasting data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>identifying resistance against chemical pesticides in the BSD pathogen;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>confirmation by laboratory test</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laboratory test pathogen resistance to presently used fungicides to</td>
<td></td>
</tr>
<tr>
<td>Day 5</td>
<td>control BSD</td>
<td>- Laboratory facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Media preparation glassware</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Autoclave</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Laminar flow cabinet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Balance</td>
</tr>
<tr>
<td>Day</td>
<td>Activity</td>
<td>Equipment</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Day 6 | Follow-up identifying resistance against chemical pesticides in the BSD pathogen; Data collection and interpretation laboratory test | - Micro pipettes & tips (100-1000ul)  
- petri dishes (9cm)  
- Incubator  
- Protective equipment (inhalation & skin contact)  
- Calculator  
- scissors  
- Distilled water  
- Ethanol  
- Agar purified (2%)  
- Filter paper  
- Fungicides presently used to control BSD |
| Day 7 | BSD metro pathological forecasting: field trips and data gathered from different locations  
*Group work:* calculating the development of BSD and judgement of a spray cycle in view of predicted weather  
*Group work:* identify environmental conditions and field (sub) processes in banana and plantain cultivation which contribute significantly to the decrease of $x_0$, $x_t$, $r$ and the beneficial use of $t$ in BSD management | - Laboratory  
- Microscope  
- micrometer  
- Classroom  
- PP-Projector  
- white board/flip chart  
- markers  
- participants to bring scientific calculators |
<p>| Day 8 | Moko, nematodes and other diseases important to banana/plantain cultivation |</p>
<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 9</td>
<td>Discuss current country strategy</td>
</tr>
<tr>
<td></td>
<td>Formulate country strategy with tools provided in workshop training</td>
</tr>
<tr>
<td>Day 10</td>
<td>Country Presentation</td>
</tr>
<tr>
<td></td>
<td>Training Review</td>
</tr>
<tr>
<td></td>
<td>Training Evaluation</td>
</tr>
</tbody>
</table>
APPENDIX 8: MEMORANDUM FROM DIRECTOR TO PERMANENT SECRETARY OF AGRICULTURE

MEMORANDUM

FROM: Mr. Ricky Brumant/ Director of Agriculture (Ag.)
TO: Permanent Secretary (Ag.)
Ministry of Agriculture, Fisheries and Forestry
DATE: March 18, 2015
SUBJECT: DEVELOPMENT OF AN INTEGRATED DISEASE MANAGEMENT (IDM) PROGRAMME FOR BLACK SIGATOKA DISEASE (BSD) ON BANANA AND PLANTAIN

Reference is being made to the CARDI letter addressed to the Permanent Secretary dated 16th March, 2015 as it pertains to the captioned subject.

Kindly be informed that the four (4) locations chosen are namely:

1. Grand Bay Station - ½ acre
2. La Plaine Station - ½ acre
3. Woodford Hill Station - ½ acre
4. Syndicate or Castle Bruce - ½ acre

Also, these areas are chosen as per the four (4) quadrants of the island.

Syndicate or Castle Bruce is potentially chosen to involve on-farm testing as well. A Memorandum of Understanding (MOU) would have to be undertaken with the private farmers.

"An Efficient Service: A Sustainable Future"
Kindest regards,

[Signature]

MR. RICKY BRUMANT
DIRECTOR OF AGRICULTURE

/cp

C.C. Dorian Etienne
OIC CARDI- Dominica
APPENDIX 9: LETTER TO THE PERMANENT SECRETARY (AG)

CARIBBEAN AGRICULTURAL RESEARCH AND DEVELOPMENT INSTITUTE
P.O. Box 212, University Campus, St Augustine, Trinidad, W.I.
Tel: 868-645-1208/7, 3573, 8120, 8121 Fax: 868-645-1208 Email: executive@cardi.org

OFFICE OF THE EXECUTIVE DIRECTOR

3 November 2015

Mr. Harold Guiste
Permanent Secretary (Ag.)
Ministry of Agriculture and Fisheries
Government Headquarters
Roseau
Commonwealth of Dominica

CARDI/ CDB Workshop on the Integrated Disease Management Programme on Black Sigatoka Disease Management of Banana and Plantain

Dear Mr. Guiste,

The Caribbean Agricultural Research and Development Institute (CARDI) presents its compliments to you and through you, to the Ministry of Agriculture and Fisheries.

The CARDI executed Project “Integrated Disease Management (IDM) for Black Sigatoka Disease (BSD) of banana and plantain”, funded by the Caribbean Development Bank (CDB) and endorsed by your Ministry, has introduced and established germplasm of disease tolerant banana and plantain varieties in Dominica. These introduced varieties have been established in varietal evaluation experimental blocks at La Plaine, Milton, Woodford Hill and Grand Bay. At Grand Bay the varietal evaluation experimental block appears to be compromised, as we understand that the land area that the block currently occupies is carded for residential development and some of the plants have already been uprooted. As both the germplasm and the experimental varietal evaluation are important to the banana and plantain industry in Dominica, CARDI will like the opportunity to engage in discussion with your Ministry as to the future of both the germplasm and the experimental block at Grand Bay.

Also, in support of an IDM programme under the Project, CARDI will be conducting a training workshop in Dominica from 23 November to 4 December 2015. This training workshop is intended to strengthen the capacity and equip your BSD management team, extension officers, farmers and representatives from banana and plantain organisations working in BSD management.

A combination of classroom, laboratory and field sessions will be utilised to deliver a dynamic programme to participants. The ten-day workshop will focus on the phyto-pathological cycle of the...
disease, epidemiology, climatic forecasting methods and measuring disease intensity with a view towards developing and sustaining a robust BSD management strategy. Plant Pathologist, Dr. Robert Power from Suriname will be facilitating this workshop. Dr. Power has extensive experience in managing BSD in commercial banana production exporting to Europe. He comes with a wealth of experience and understanding of the industry having worked directly in the banana industry in Suriname, as a plant pathologist for BSD management, a researcher in improving and predicting banana crop yield, as manager of a 2,300 ha banana plantation, the Team Leader in the “Modernization of the banana industry in Suriname” and now as an advisor to the President in Agricultural related issues. Dr. Power has also lectured in crop protection and plant pathology at the University of Suriname, Wageningen Agricultural University and the International Agricultural Centre and thus aptly able to impart his vast knowledge to the workshop participants.

CARDI welcomes the participation of the Ministry and looks forward to a successful institutional collaboration in this effort which should ultimately advance the agricultural sector and the economy of Dominica.

I take this opportunity to extend to you the assurances of my highest consideration.

Francis Asiedu, Manager Technical Services
Barton Clarke, Executive Director

cc: Mr. Dorian Etienne, Officer in Charge, CARDI Dominica Unit
Dr. Gregory Robin, Technical Coordinator, CARDI OECS Units
Ms. Sharon Jones, Project Manager, CARDI/CDB Black Sigatoka Project
## APPENDIX 10: COSTS INCURRED FOR THE ESTABLISHMENT AND MAINTENANCE OF THE GRAND BAY AGRICULTURAL STATION BLOCK

<table>
<thead>
<tr>
<th>Description</th>
<th>Value ECS</th>
<th>Value US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of plantlets</td>
<td>340.20</td>
<td>126.00</td>
</tr>
<tr>
<td>Cost weaning and hardening plantlets</td>
<td>400.00</td>
<td>148.15</td>
</tr>
<tr>
<td>Land clearing Grand Bay Agricultural Station</td>
<td>1,000.00</td>
<td>370.37</td>
</tr>
<tr>
<td>Lining &amp; digging Grand Bay Agricultural Station</td>
<td>800.00</td>
<td>296.30</td>
</tr>
<tr>
<td>Planting and watering Grand Bay Station</td>
<td>600.00</td>
<td>222.22</td>
</tr>
<tr>
<td>Block signs</td>
<td>445.00</td>
<td>164.81</td>
</tr>
<tr>
<td>Mounting block signs</td>
<td>365.00</td>
<td>135.19</td>
</tr>
<tr>
<td>Pine Post for label signs</td>
<td>116.55</td>
<td>43.17</td>
</tr>
<tr>
<td>Label signs</td>
<td>120.00</td>
<td>44.44</td>
</tr>
<tr>
<td>Assembling of label signs</td>
<td>100.00</td>
<td>37.04</td>
</tr>
<tr>
<td>Transportation of Plants in bags</td>
<td>400.00</td>
<td>148.15</td>
</tr>
<tr>
<td>Description</td>
<td>Cost</td>
<td>Percentage</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>Soil tests (including shipping)</td>
<td>106.00</td>
<td>39.26</td>
</tr>
<tr>
<td>Brushcutting</td>
<td>100.00</td>
<td>37.04</td>
</tr>
<tr>
<td>Glyphosate (5 lt)</td>
<td>126.15</td>
<td>46.72</td>
</tr>
<tr>
<td>Paraquat (1 gal +3 L) (69.88 + 87)</td>
<td>156.88</td>
<td>58.10</td>
</tr>
<tr>
<td>Pendimethalin (1 lt)</td>
<td>82.25</td>
<td>30.46</td>
</tr>
<tr>
<td>30-3-15 (25kg x 6)</td>
<td>360.00</td>
<td>133.33</td>
</tr>
<tr>
<td>Oxamyl (x3)</td>
<td>237.00</td>
<td>87.78</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,855.03</strong></td>
<td><strong>2,168.53</strong></td>
</tr>
</tbody>
</table>
APPENDIX 11: 2016 CALENDAR
APPENDIX 12: INTEGRATED DISEASE MANAGEMENT STRATEGY FOR DOMINICA, GUYANA, ST LUCIA AND ST VINCENT AND THE GRENADINES

RECOMMENDED STRATEGY IN BLACK SIGATOKA DISEASE MANAGEMENT

PROGRESSING FROM ROUTINE SYSTEMIC SPRAY CYCLES TO BEST PRACTICE IN CULTIVATION, COMBINED WITH TIMELY PROTECTIVE ACTIONS, USING DISEASE MONITORING AND WEATHER FORECASTING RECORDS

DOMINICA
GUYANA
ST. LUCIA
ST. VINCENT AND THE GRENADINES

DR. ROBERT H. POWER
(CONSULTANT SPECIALIST)
EVALUATION OF BANANA AND PLANTAIN (*Musa* spp.) ACCESSIONS TOLERANT TO BLACK SIGATOKA DISEASE IN DOMINICA, GUYANA, ST. LUCIA and ST. VINCENT and the GRENADINES.

Casper Samuel, Gregory Linton*, Kwame Gyamfi, Somwattie Pooran-DeSouza, Gregory Robin, Dorian Etienne, Ronald Pilgrim, Sharon Jones, Francis Asiedu and Bruce Lauckner,

Caribbean Agricultural Research and Development Institute (CARDI), University Campus St. Augustine, Trinidad and Tobago, WI
ABSTRACT

Banana and plantain (*Musa* spp) are important foreign exchange earners in Guyana and the Windward Islands of the Caribbean. Black Sigatoka Disease (BSD) also referred to as black leaf streak disease is one of the most destructive diseases of banana and plantain and is present within the region. In Guyana within two years following its introduction in 2008, the industry was totally decimated, recording a 100% decline, turning the country to a net banana importer. Also, from 2009 – 2012 the disease spread in the Windward Islands causing as much as 100% decrease in the export of banana. The disease is caused by the ascomycete fungus, *Mycosphaerella fijiensis* (anamorph *Pseudocercospora fijiensis*) and is aggressive, challenging to control and results in enormous crop damage if left uncontrolled. In an effort to develop an integrated management approach to the disease the Caribbean Agricultural Research and Development Institute (CARDI) with financial assistance from the Caribbean Development Bank (CDB) is evaluating five FHIA banana and plantain accessions and eight IITA plantain accessions for tolerance to BSD. The evaluation is presently conducted in four Caribbean countries, Dominica, Guyana, St Lucia and St Vincent and the Grenadines. In each country, four distinct agro-ecological zones were selected for the trial evaluation blocks and using a randomized block design, four blocks were established in each country. Five FHIA accessions: FHIA-01, FHIA-03, FHIA-18, FHIA-21 and FHIA-23 are being evaluated in Dominica, St Lucia, and St Vincent and the Grenadines whereas, plantain accessions: PITA-17, PITA-21, PITA-22, PITA-23, PITA-24 and PITA-26 are to be evaluated in Guyana for tolerance to the disease. Cavendish are used as regional controls and as borders rows to increase disease pressure. The disease parameters evaluated are youngest leaf spotted (YLS), disease
development time (DDT), leaf emission rate (LER), disease severity at 6 months, bunch emergence and harvest, and index of standing leaves. Agronomic data; days from planting to flowering, bunch weight, number of hands in bunch, average weight of hands and average number of fingers per hand and bunch, as well as organoleptic characteristics of both cooked and ripe fruits are also evaluated. The early data collection, of the FHIA only accessions, show trends in the disease tolerance and agronomic performance as well as their adaptability in the different agro-ecological zone. The trends indicate better disease tolerance of FHIA varieties with higher leaf counts before, at bunching and at harvest. The organoleptic test shows a preference to FHIA 03 and FHIA 21.

Keywords: Black Sigatoka, *Mycosphaerella fijiensis*, FHIA, banana, plantain, *Musa* spp., disease tolerance

Presenter/Corresponding author: G. Linton*; email: glinton@cardi.org

MATERIALS AND METHODS

Reference cultivars

Five FHIA: FHIA-01, FHIA-03, FHIA-18, FHIA-21; FHIA-23, and three Cavendish: Grande Naine, Jaffa and Williams varieties are being evaluated in Dominica, St. Lucia and St. Vincent and the Grenadines where a BSD susceptible Cavendish variety was used as border rows. In Guyana seven plantain accessions: PITA-17, PITA-21, PITA-22, PITA-23, PITA-24 and PITA-26 are to be evaluated for tolerance to the disease. The accessions were received, as tissue culture material, from Bioversity International and the International Institute of Tropical Agriculture (IITA). The received accessions were
multiplied in sufficient quantities at the Orange Hill Plant Tissue Culture Laboratory in St. Vincent and the Grenadines and shipped to the participating countries as tissue culture material where they were weaned and hardened prior to field establishment according to protocols developed by McDonald and Chien-Ying (2006, unpublished).

**Establishment of blocks and experimental design**

Using the INIBAP Technical Guidelines 6 (Carlier et al., 2002), the experiment was a randomized complete block design with nine clones per plot. Each plot was bordered by a susceptible Cavendish variety (Williams or Grande Naine). Experimental blocks were established in areas where there was sufficient presence of the pathogen. In each of the three participating countries (Dominica, St. Lucia, St. Vincent and the Grenadines) four experimental blocks were established each in a distinct agro-ecological zone. Evaluation blocks were established between May 2015 and January 2016.

**Agronomic practices**

The trial is being managed according to the local agronomic practices recommended by the Banana Growers Manual -A Guide to Successful Banana Production in the Windward Islands (WIBDECO, 2007). All management practices were applied uniformly and no fungicides were applied. The data are being collected on the mother plant and first sucker.

**Data collected**

*Disease evolution data*

Using the INIBAP Technical Guidelines 6 the following parameters are being recorded: disease development time (DDT), youngest leaf spotted (YLS), leaf emission rate (LER),
disease severity, infection index, agronomic data, fruit characteristics, number of standing leaves (NSL) index of non-spotted leaves (INSL), and environmental data. Powers (2016 unpublished), nondestructive volume of the banana cone was recorded. Number of standing leaves (NSL) and index of no-spotted leaves (INSL) was recorded using the corresponding field forms in INIBAP Technical Guidelines 7 (Carlier et al., 2003), and all other parameters, were recorded using the appropriate field forms in INIBAP Technical Guidelines 6 (Carlier et al., 2002).

Agronomic data

The agronomic data recorded at bunch emergence were time from planting to shooting, height of pseudostem, height of following sucker and number of functional leaves. At harvest number of functional leaves, plant crop cycle, girth of pseudostem, weight of bunch, number of hands in bunch, number of fruits and weight of fruits were recorded at harvest. Number of functional leaves was also recorded at six months.

Organoleptic tests

Organoleptic tests were conducted on the FHIA accessions. In Dominica, preliminary tests were conducted on FHIA 03, 18, 21 and 23. Samples were cooked and offered to the public. Evaluation forms were completed by participating individuals, guided by INIBAP Technical Guidelines 4 (Dadzie, 1998).

Statistical analysis

All data from all participating countries are being analysed at CARDI Headquarters, Trinidad using the Genstat 18.1 statistical software.
RESULTS

The results presented are from data collected in St Vincent during 2015 – 2016 and Dominica during 2016. The preliminary data shows trends in the growth of the accessions, their disease tolerance and consumer taste preference.

At all locations FHIA 18, FHIA 03 and FHIA 21 seemed to performed better than the other BSD-tolerant accessions with regards to growth as measured by Powers (2016 unpublished), non-destructive volume of the banana cone as well as to disease development data. However, these parameters will be further viewed together with days to harvest and yield to determine plant productivity. Presently, FHIA varieties as compared to the Cavendish varieties present higher leaf count, before and after bunching, a measure of higher tolerance to the disease. Performance trends have also been observed in the different agro-ecological zones where higher altitude present longer days to bunch.

The organoleptic tests indicated a consumer preference for FHIA 03 and FHIA 21. Consumers generally agreed that they would consider growing both accessions and would substitute them for the traditionally available accessions. However, FHIA 18 did not receive such a favorable response.

DISCUSSION

The preliminary results have indicated that BSD-tolerant varieties are performing better than Cavendish varieties with relation to leaf count and disease tolerance. Two potential accessions, FHIA 03 and FHIA 21 seem to be presented for further consideration. However, the BSD evaluation trial is on-going.
ACKNOWLEDGEMENTS

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LITERATURE CITED


APPENDIX 14: PUBLIC RELATIONS CONSULTANTS OUT PUT

Proposed poster
Cover of proposed booklet
APPENDIX 15: PROJECT MEDIA COVERAGE

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### Project Progress Report (July 2014 - December 2016)

| Source                          | Event Description                                                                 | URL                                                                 | Date              |
|--------------------------------|----------------------------------------------------------------------------------|                                                                     |                   |
| Agri In Focus: Ministry of Agriculture (Video) | CARDI/CDB Training Workshop                                                       | [https://www.facebook.com/AgricultureInFocus/videos/1621857848068407](https://www.facebook.com/AgricultureInFocus/videos/1621857848068407) | 13 September 2015 |

### Guyana

| Source            | Event Description                                                                 | URL                                                                 | Date             |
|-------------------|----------------------------------------------------------------------------------|                                                                     |                  |
| Guyana Chronicle  | BSD-resistant plantains, bananas to be field-tested by early next year – NAREI  | [https://guyanachronicle.com/2015/10/03/bsd-resistant-plantains-bananas-to-be-field-tested-by-early-next-year-narei](https://guyanachronicle.com/2015/10/03/bsd-resistant-plantains-bananas-to-be-field-tested-by-early-next-year-narei) | 3 October 2015   |
**Dominica**

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