Summary Report for the

Workshop on Best Practices for *Musa* Germplasm Collection and Data Management

Organised by the Global *Musa* Genetic Resources Network – MusaNet
Bioversity International in collaboration with CIRAD and Centre for Biological Resources Tropical Plants (INRA-CIRAD)
Guadeloupe, Monday 9 to Saturday 14 December 2013

Table of contents

1. Background

The Global *Musa* Genetic Resources Network, MusaNet held a workshop to address the most urgent needs of *Musa* collection curators vis à vis the management of the germplasm and its associated information. It included ensuring the correct identification of the materials conserved and making this information available to all users.

It has been observed that when several curators characterized plants from the same accessions, i.e. the same International Transit Centre (ITC) source or the same well-known cultivars, descriptions were far from uniform, with therefore negative impact for *Musa* Germplasm Information System (MGIS) as a source of taxonomic information on germplasm in collections. In order to resolve this problem, it was recommended that a set of cultivars, referred to as the Taxonomic Reference Collection (TRC), representing the basic variation in edible bananas and their wild relatives, be established in the important field collections. A set of 34 accessions maintained at the ITC was selected to develop and test descriptors that could be applied across the range of environments. A key step is to get a taxonomic agreement on these cultivars, which represent the basic diversity of the *Musa* germplasm. Such standardized description would then serve as the reference for all other cultivars and relevant taxa. A number of these cultivars are already described as part of the project verifying the true-to-type morphology of the ITC accessions, referred to as the Field Verification Project.

The MusaNet workshop took place in the field collection of the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) in Guadeloupe, where materials were available for the 12 partners in the TRC Project to agree on the minimum descriptors and share experience and find solutions for common difficulties in *Musa* collection management.

2. Workshop Objectives and Participants

1. Share knowledge and experience to promote best practices for the conservation and documentation of *Musa* germplasm, including the safe-movement of materials.
2. Review the practical and common *Musa* germplasm characterisation with the Taxonomic Reference Collection Project partners and resources people.
3. Have a common understanding and agree on the minimum descriptors to be used in the field, i.e. descriptors stable across environments are interpreted and recorded in the same way by all curators.
4. Make recommendations for improving the management of *Musa* collections germplasm and associated information that can help resolve key constraints of most collection managers.

Partners of the TRC Project and key resource people attended the workshop. See List of Participants in *Annex 1.*

3. Programme Summary

The programme covered the following 4 main areas:

1. Acquisition of materials from the ITC: including introduction, acclimatisation from *in vitro* to field plants, tissue culture, virus indexing, health testing etc.
2. Management of the materials in the field: good management practices for growing the plants in the best conditions for reaching the proper level of maturity and health. Including pest and disease management, soil fertility and other agricultural and environmental conditions.

3. Characterisation of the key descriptors: testing the guidelines for the minimum descriptors and for taking photos.
4. Documentation and management of the data: how to best capture the data for sharing and analysis (Excel etc.), linked to good genebank management system (GRIN-Global), equipment and tools.

The programme was divided into 8 sessions:

- Session 1: Introduction to the workshop
- Session 2: Where are we now with the TRC Project?
- Session 3: Safe movement of germplasm
- Session 4: *In vitro* collection*:* Acquisition and introduction of materials from the ITC
- Session 5: Best management practices for field management:
- Session 6: Characterisation of the key descriptors
- Session 7: Documentation and management of the data
- Session 8: Conclusions and recommendations

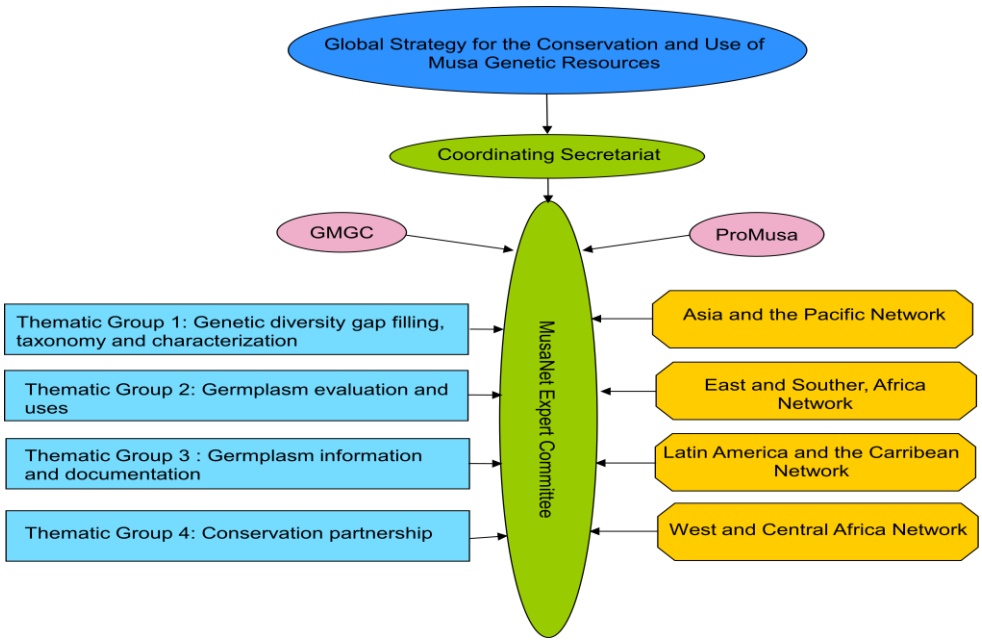
4. Session 1 – Introduction to the Workshop

The workshop started with welcome messages from CIRAD (from *Kodjo Tompekpe* and *Dominique Polti*) and a general discussion on logistical information (*Kodjo Tompekpe*).

Nicolas Roux presented background on MusaNet and the MusaNet Thematic Groups on Conservation and Information/Documentation and (CTG and ITG) were presented by *Ines van den houwe* and *Max Ruas.* Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9Uai15TVNzdi1MVzg/edit

Key points:

- MusaNet was launched in March 2011
- Overview of MusaNet vision, mission and structure
- MusaNet vision is: A world, in which *Musa* genetic resources diversity is secured, valued and used to support livelihoods through sustainable production.
- Purpose*:* To provide a collaborative framework to support the implementation of the Global Strategy for the Conservation and Use of *Musa* Genetic Resources.
- Four thematic groups are: (1) Genetic Diversity Gap Filling, Taxonomy and Characterization, (2) Conservation Partnership and safe movement of germplasm, (3) Germplasm Evaluation and Use and (4) Germplasm Information and Documentation
- The strategic framework of MusaNet is provided by the Global Strategy for the Conservation and Use of Musa Genetic Resources.
- MusaNet Structure:



An introduction to the Centre for Biological Resources Tropical Plants of CIRAD-INRA was presented by *Claudie Pavis*. Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9Ub2FBTzFoek1nY3M/edit

Key points:

- A CIRAD-INRA joint structure – multi-crop germplasm collection (incl. *Musa*) and research unit in Guadeloupe and Martinique
- Purpose is to conserve and distribute accessions, deal with sanitary and regulation issues and product information on accessions and make it available
- Banana material requested includes fruit, pollen, leaves, suckers, bunches - to CIRAD research teams (80%) and breeders (20%).
- Overview of goals, projects and facilities.

Participants then introduced themselves (*see Annex 1 for full list of participants*).

Brigitte concluded the session by presenting the workshop objectives, expected outputs and processes.

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UaVcyN0twaml5c0k/edit

Key points:

- Overview of workshop participants and purpose
- A key constraint – the characterisation of key descriptors and the TRC
- Overview of workshop objectives and sessions
- Workshop programme day by day
- Characterisation field exercise and accessions

5. Session 2 – Where we are with the Taxonomic Reference Collection Project

In the second session, a description of the TRC Project: importance of characterisations, the genesis, objectives, purpose and current status and the technical guidelines and tools were presented by *Julie Sardos. Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UVXlSVmN0ZXRhTnc/edit*

Key points:

- There is a need for a common and shared language => standard descriptors. For *Musa* spp there are 120 descriptors in total and a set of 34 'minimum, highly discriminating descriptors'.
- Outputs proposed in the 2006 Global Conservation Strategy for *Musa* were: (1) Genetic diversity is comprehensively characterized (2) Genetic diversity is documented (3) Taxonomy is harmonized and (4) Collections are rationalized. To achieve this, a set of reference accessions for all collections with a common shared language is needed.
- Objectives of the TRC (1) to be used to test the stability of the standard descriptors across environment (2) both the set of selected "stable" descriptors and the TRC could be used to achieve the four goals cited in the Global Strategy and (3) to be used in capacity building.
- Status at this point (Dec 2013): out of 12 collections, 4 complete or near complete sets of minimum descriptors (first cycle) and 3 nearly complete full descriptors (second cycle)

Edmond De Langhe then presented the background on the selection of the 34 accessions making the TRC. *Full presentation:* https://docs.google.com/file/d/0B7GWjizl3d9UZlA4Y1ptd0pjMGM/edit

Key points:

- Objectives of the TRC: (1) Test the robustness of the standardized descriptors across environments (2) Identify environmental factors that impact phenotypes (3) Promote accessions fully characterized that will serve as reference and standards in all collections.
- A same cultivar in different Environments could show different states for a same descriptor leading to the question is that difference is due to difference in interpretation? TRC exercise should sort this out.
- Uniform correct field management across all collections should reduce environment role to Neutral.
- Problem: several Subgroups contain many cultivars. Their distinction calls for many adapted descriptor states, typical for each subgroup, leading to ill-defined clusters in statistical analysis of characterization data.
- Hierarchical alternative: select 1 cultivar per subgroup and add a few edible AA and wild AA, BBs as general references. Edible germplasm diversity definitely characterized.
- Implementation of TRC – 3 phases (1) virus free limitation (2) temporary bottleneck complex (3) description of cultivars of local subgroups.

<u>General notes from discussion</u>

It was proposed that information on the health status of the materials, particularly regarding the presence of Banana Streak Virus (BSV) be communicated to the partners when sending the accessions from ITC. It was noted also that not all accessions and cultivars should be managed in the say way. And the different management practices should be considered in the interpretation of the results,

particularly with pest and disease control management. The collections have to be managed based on the most susceptible cultivars.

The choice of the 34 accessions is to ensure coverage of full spectrum of triploids. This list may increase in the future. Of these, 4 accessions were Off Type (OT) and have been removed. It is important to keep the cultivars selected for the statistical analysis.

The TRC is an important tool for improving communication and can play an important role in capacity building. Ideally each *Musa* collection should maintain the TRC.

Presentations from the TRC project partners

Each curator presented the current status of the TRC Project at their field collection and provided feedback on their experiences thus far. The data from the presentations are summarized in Table 1 below.

1. Brazil – EMBRAPA – *Janay Serejo*
2. Burundi - IRAZ - *Ferdinand Ngezahayo*
3. Cameroun – CARBAP - *Emmanuel Fondi*
4. Costa Rica – CORBANA - *Jorge Sandoval*
5. India - NRCB - *Uma Subburaya*
6. Indonesia –ITFRI - *Agus Sutanto*
7. Nigeria – IITA - *Delphine Amah*
8. Philippines – BPI– *represented by Lavernee Gueco from UPLB*
9. Uganda – NARO– *Sedrach Muhangi*
10. USA – Puerto Rico - USDA-ARS – *Brian Irish*
11. Vietnam – FAVRI - *Phong Ngô Xuân*
12. Tahiti French Polynesia - SDR-MAP - *Maurice Wong*

Table 1. Summary of TRC status (as of December 2013) in the 12 collections

Collection	Planted	1st cycle	2nd cycle	Photos	Difficulties
EMBRAPA	20 in Jan 2013				Strong drought
IRAZ	32 in Feb 2010	29	29	32	Some accessions not adapted to conditions some did not achieve maturity and some were dwarfs. Problem with photos, internet connection and with MGIS.
CARBAP	31 in April 2010	30	None	30	TRC replanted in 2013. Budget too small, need available and motivated staff, need numerical tool to input data, need subgroup specific descriptors e.g. plantains
CORBANA	27 in August 2011	25	25	25	Gophers, disease (Sigatoka), theft of bunches, budget too small, need better photo equipment, 10 plantlets/cv would be better.
NRCB	22 in March 2011	22	16	19	Minimum funding needed to find identity under national programmes for time

Collection	Planted	1st cycle	2nd cycle	Photos	Difficulties
					frame, feedback and reporting process
ITFRI	22 in December 2011	17	-	17	Need specific descriptors for Fe'i. Hard to manage disease constraints. Training needed in characterization for young curators.
IITA	Planned for April 2014	-	-	-	-
BPI	30 in January 2011	27	27	30	Unfavourable weather conditions and plant positioning.
NARO	26	8	18	-	Every descriptor should be demonstrated with a photo
USDA-ARS	31 in June 2010	31	31	31	Difficult for one person to accomplish. Colours are very subjective.
FAVRI	30 in March 2010	24	24	24	Would like guidance on implementation of identification practices, description and documentation of each characteristic.
SDR-MAP	Not yet planted	-	-	-	-

6. Session 3 – Safe Movement of Germplasm

The third session concerned issues encountered in the movement of germplasm, including pests and diseases.

A presentation on virus types and spread including tissue culture, indexing and eradication and the Technical Guidelines for the Safe Movement of *Musa* Germplasm (TGSMG) was given by *John Thomas.* *Full presentation:* *https://docs.google.com/file/d/0B7GWjizl3d9UdXJLMjV1aHlleE0/edit*

Key points:

- The different common viruses of banana were presented: Banana Bunchy Top Virus (BBTV), Banana Streak Virus (BSV), Cucumber Mosaic Virus (CMV), Banana Mild Mosaic Virus (BanMMV), Banana Virus X (BVX), Banana Bract Mosaic Virus (BBrMV), Abaca Bunchy Top Virus (ABTV), Sugarcane Mosaic Virus (SCMV-Aba).
- Spread of banana viruses – vectors include aphids, mealy bugs and unknown. BSV is activated by tissue culture.
- Technical Guidelines for Safe Movement of Germplasm – 2nd edition published in 1996 however it is currently being updated with new information including new viruses, molecular data and integration of BSV characterized.
- Procedure for transferring germplasm
- Eradication of viruses from germplasm by different means: meristem tip culture, shoot tip culture, thermotherapy, chemotherapy and cryopreservation.

Pierre-Yves Teycheney then presented an update on Banana Streak Virus (BSV)

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UOF9BcnJxa1dNb2M/edit

Key points:

- History of BSV – first reported in 1963 in Ivory Coast and spread worldwide in the 1990s.

- BSV symptoms include necrotic leaves, dark spots on petioles, splitting pseudostem and abnormal flowering.
- BSV is spread by 4 species of mealy bug and can be transferred horizontally.
- *In vitro* multiplication of AAB and AAAB can lead to diffusion of BSV – it has become a major constraint for the movement, multiplication and improvement of *Musa* germplasm.
- Breakthroughs in research on BSV – unravelling the molecular structure, PCR tools for screening germplasm, genetic improvement of *M. balbisiana* and segregation of infectious eBSV alleles.

Ines van den houwe and John Thomas discussed the exchange of disease-free germplasm, distribution and introduction from ITC.

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UbUNRc0dfdlprT28/edit

Key points:

- *Musa* germplasm collection maintained at ITC – holdings total 1,434 accessions from 57 sources in 37 countries.
- Conservation is done in three methods: *in vitro*, cryopreserved (backed up in IRD Montpellier, France) and lyophilized leaf tissue.
- Processes for ITC safe movement of germplasm, assuring disease free germplasm, minimising the BSV problem and distributing disease free germplasm.
- ITC guidelines for outgoing material
- National Repositories Multiplication and Distribution Centres (NRMDC) and Regional Multiplication and Distribution Centres (RMDC) – enhancing the distribution of disease free germplasm from ITC.

Group discussions

A group discussion followed on germplasm health status issues and particularly how can we insure that the ITC Reference Collection material is healthy: virus indexing, health testing. Participants were divided into 3 small groups each and discussed one of the following 3 questions:

1. *What are the most critical phytosanitary issues for collection management and germplasm exchange? What measures should be taken?*
   - Geographical distribution of pest and diseases should be mapped with focus index.
   - Facilitate introduction of known resistant materials
   - Flexibility to adapt measures
   - Strengthening capacity for virus indexing
   - Double testing of materials
   - International exchange – should it always be tissue culture? Not always - eg collected materials.
   - Measures to protect germplasm mandate to distribute material. Move collections to remote places such as islands.
   - Phytosanitary policies – make sure each country has policies. Quarantine block for each genebank.
   - Is the virus indexing for most common viruses good enough? Not for poorly described viruses. Each country should have its own virus indexing unit.
   - Knowing the risks in local collections and how to focus on those risks with specific strategies.

2. *What health testing capacity may need to be strengthened? What are the roles of the different partners?*
    - Need methods to test for virus in each genebank. Develop test kits for use by non-virologists.
    - NARS distribute material over borders. They should have indexing facilities.
    - Need for visual ID training of disease in each genebank.
    - Need for training in diagnosis in diseases.
    - Need for capacity building in treatment of disease.
    - Need regional level centres where curators can be trained and have test kits. NARS can then rely on these centres.
    - Genebanks could be a backup for ITC?
    - Fusarium needs to be identified easily in tissue culture.

3. *How to facilitate the availability of healthy germplasm? Should we re-think the establishment of NRMDCs in support of safe exchange of germplasm?*
    - Quantity of germplasm is the limiting factor
    - Example of CARBAP as a National Repository, Multiplication and Distribution Centre (NRMDC) – worked well but no longer functioning. Only supported through projects and not long-term.
    - International *Musa* Testing Programme (IMTP) could be a reason for large distribution of germplasm.
    - BSV –what do we do if it's infected? ITC cannot distribute infected material.
    - For TRC, it's too difficult to increase number of accessions. Partner collections could multiply.
    - NRMDCs – pros: more availability of material in region with more impact. Is this our role as a genebank, not a seed system. Gives a better idea of what is needed in each region and gives more capacity to the region. There are discussions in RTB to create regional hubs. Cons: financial limitations to create and maintain. Also risk of loss of quality control (disease and genetic integrity). For TRC – materials should only come from one source.

7. Session 4: Best Management Practices for *In Vitro* Collection

The fourth session began with a presentation on *in vitro* collections: management practices, storage, requirements for conservation and genetic integrity by *Ines van den houwe.*
Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UUjFpd3JZRnE2RGM/edit

Key points:
- *In vitro* conservation of *Musa*: slow growth storage and cryopreservation specifications.
- Genebank standards and guidelines: links to guidelines provided in presentation.
- Crop Genebank Knowledge Base – a website that provides access to procedures, standards and practices for genebank curators and technicians. *http://cropgenebank.sgrp.cgiar.org*
- Overview of *in vitro* and slow growth storage
- Overview of long term security of stored germplasm
- Data recording and management procedures.

Discussion on *in vitro*:

The question was raised of how to get feedback of status of material sent out by ITC? Consultative Group on International Agricultural Research (CGIAR) is developing genebank surveys for users.

Also how to gather more data on ITC accessions – one idea proposed was to require data on first shipment before the person can receive a second shipment from ITC. Example is National Research Centre for Banana (NRCB) in India.

Visits of laboratory facilities

Participants were then divided into 2 groups of 15-16 participants and alternatively visited virology lab and the small tissue culture lab facility on the CIRAD campus.

Demo 1: At the tissue culture lab – *Ines van den Houwe and Chantal Guiougou*

1 Good practices for *in vitro* collections
2 Demonstration of meristem culture technique and its applications - useful techniques to avoid or overcome contamination problems as well as to eliminate BBTV.
3 Demonstration of Indexing for latent contamination - share practices for managing latent contamination

Demo 2: At the virus lab – *John Thomas and Pierre-Yves Teycheney*

1 Demonstration of equipment and facilities needed for virus indexing
2 Discussion on how viruses are controlled
3 Requirements for virus indexing

Group discussions

The participants were then divided into 3 small groups to discuss the following key question:

Given what we have discussed and learnt (in demos), what is missing to bring up the capacity of collection management? What is needed at the local/national, regional and global level?

Discussion on key question:

Specific guidelines needed for:

- Field management including specific info on groups and ecological regions
- Wild species field management
- Collecting new material on missions
- Acquiring new materials in a collection
- Seed bank management
- Data management and use of the descriptors

General notes from discussion

It was agreed that each field genebank should be working very closely with and be backed up by an *in vitro* collection. There is also a need to ensure access to all publications and guidelines at the regional level (e.g. Secretariat of the Pacific Community (SPC)) .

It is important to strengthen the regional networks by organising national and regional workshops and stimulating academic exchange between national, regional and international centres and genebanks.

It would also be helpful to develop academic training in plant genetic resources management and increase capacity building for virus indexing and molecular characterisation. Training at national and regional level on human resources management is also needed to ensure that each genebank has a succession plan for the next curators' generation. There should be an incentive to curators such as recognition for their work. It would be beneficial to improve information technology capacity (software and hardware) and ensure the completeness of MGIS with data on all available germplasm.

Actions are needed to address BSV and its constraints for germplasm exchange and policies need to be strengthened for Fusarium quarantine restrictions. Each collection should clarify the objectives (breeding, conservation etc.) to better understand its use.

It is imperative that the *Musa* descriptor book be updated.

8. Session 5: Best Management Practices for Field Collections

In the fifth session *Kodjo Tomekpe* presented good management practices for growing the plants in the field in the best conditions for reaching the proper level of maturity and health - including pest and disease management, soil fertility and other agricultural and environmental conditions.

Full presentation:
https://drive.google.com/a/cgxchange.org/file/d/0B6WMCDtu_LjpUmQ2WXd1blJkd3c/view?usp=sharing

Key points:

- Ideally planting should be done at the beginning of the rainy season, but can be done all year round if there is enough moisture.
- Tips on field selection and preparation and planting layout, density and distance
- Source of planting material from field – choose plants at flowering or harvest and avoid those with somatic variation or pest and disease.
- Overview on preparing planting material and crop management.
- What information to document during regeneration

A field demonstration on the best practices for field collections demonstrated and virus symptoms viewed was led by *Kodjo Tomekpe* and *John Thomas*. Next, a demonstration of *ex vitro* acclimatisation (including nursery management) (CIRAD/Guadeloupe) was presented by *Kodjo Tomekpe and Claude Parvis/Nilda.* The focus of the demonstration was the adaptation of *in vitro* plants, acclimatisation from *in vitro* to field plants, using the example of the ITC plants sent to the Reference Collection partners and sharing of experience.

Distribution of document:

- *Regeneration Guidelines: Banana* by Kodjo Tomekpe and Emmanuel Fondi

General discussion on field management

There is no one best management practice as they vary across environments and constraints and among factors such as pest and disease. Efficient management depends on the level of expertise on plants and threats etc. This is why capacity building is very important – to transfer the expertise from mentors to new staff.

Tissue culture is usually more fragile than suckers in establishment phase and needs more attention.

Protecting your collection from harm is a critical part of management (e.g. quarantine laws).

The following key issues that influence the management of the TRC should be included in guidelines:

- De-suckering
- Grasses
- Naked soils
- Cover crops
- Sigatoka
- Regeneration

It was mentioned that Solanaceae and cucurbits should be avoided as they attract weevils etc.

9. Session 6: Characterisation

The sixth session focused on the field characterization exercise and began with an introduction to the exercise, method and process, presented by *Brigitte Laliberte and Edmond De Langhe.*

Distribution of documents

- Table of the 20 most difficult descriptors to be completed in the field exercise
- Illustrated minimum set of descriptors for bananas by Taxonomic Advisory Group (TAG)
- Hands-on Training session – 20 difficult descriptors and how they were selected by Edmond de Langhe
- Full booklet of the descriptors

Method

1 Morphological characterization of widely different reference accessions for intensive study of the most difficult descriptors.
2 Individual observation and agreement.

Proposed process

1 Curators are assisted by a participant to hold materials while they document the accessions.
2 Description should not be discussed with the assistant.
3 For plant parts far to reach and observe, the part will be cut and observed at ground level. Preferably the bunch cut but this could create differences in colour after 3-4 hours for the first superficial bracts and flowers.
4 Time estimated for describing one accession with the 20 descriptors is 1 hour.

The field exercise using the 20 descriptors was carried out on the following 4 accessions:

1 Pisang Kelat
2 Kunnan
3 Pisang jari buaya
4 Pisang Lilin

Outside the meeting room where several bunches were displayed, a discussion was held on the remaining descriptors on bunches and flowers for Pisang lilin and Pisant Kelat.

The data from the field exercise were compiled by *Max Ruas and Julie Sardos*, who then presented a breakdown of the results for each of the 20 descriptors (see the link below).

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UTVM3Mkd1TXJvdlE/edit

An example slide from the presentation is given below, illustrating the results from descriptor 6.3.1, Blotches at petiole base. In this case, the results were varied for all four accessions and therefore it was decided that this descriptor, along with others analyzed in the same manner, would be the subject of further discussion and field demonstration by experts the following day (see Table 2 below).

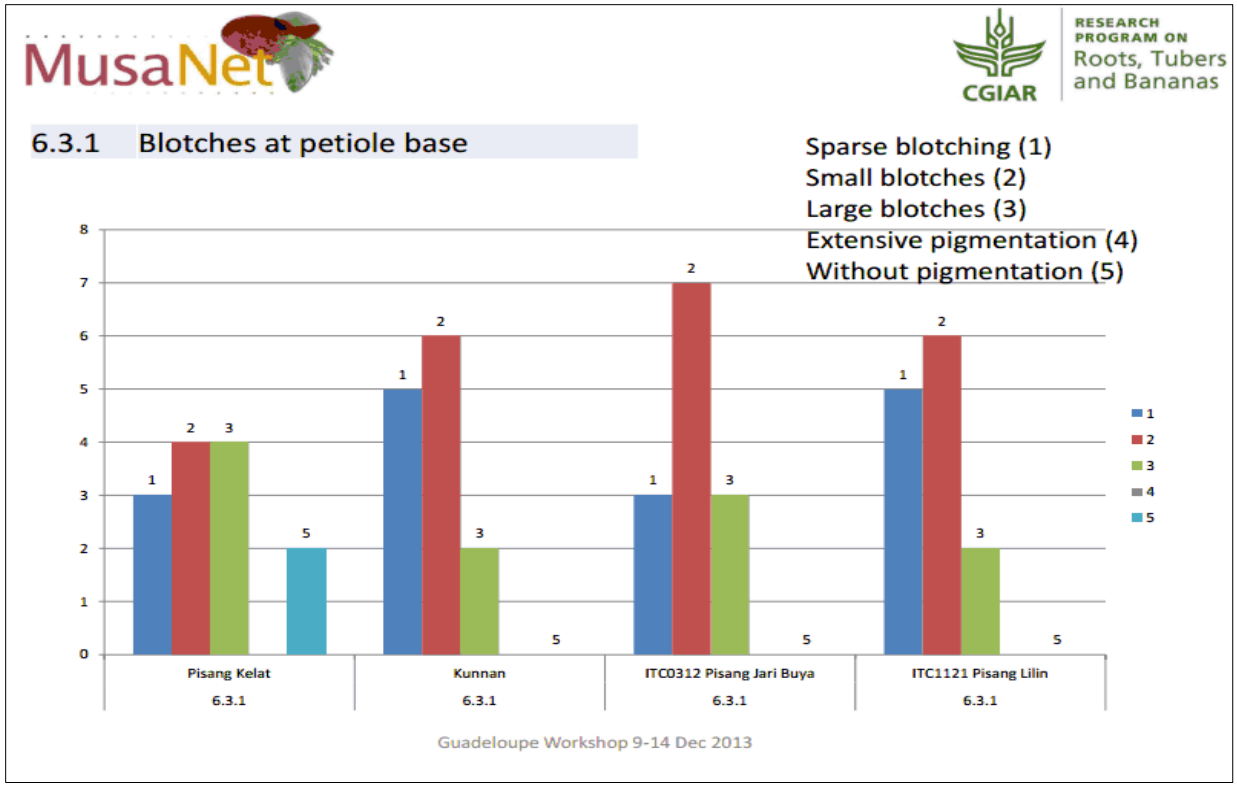


Table 2. The 4 accessions required further discussion and demonstration in the field the next day.

Pisang Kelat	Pisang jari buaya	Kunnan	Pisang Lilin
6.3.1	6.3.1	6.2.5	6.2.5
6.6.2	6.5.1	6.3.1	6.3.1
6.3.3	6.5.2	6.7.4	6.3.3
6.3.3	6.3.4	6.7.6	6.5.5
6.5.3	6.7.4		6.7.6
6.6.4	6.5.5		
6.7.7	6.3.6		
6.6.13	6.7.11		
6.6.13	6.6.13		
	6.4.15		

Recommendations and Next Steps for the Descriptors

There was then a discussion on the future revision of the descriptors in which the following proposals were made:

- Check all descriptions, notes and photos and correct the errors noted (booklet and TRC guidelines)
- Add notes and clarifications for the TRC technical guidelines
- Get a small expert group to work on the descriptors requiring revision
- Test the revised descriptors with a small group first and a wider group
- Produce guidelines and training materials – using video and photos

It was noted that the TRC has been using the current descriptors and if they are modified now then it could be a problem for the data analysis; however it may be easy enough to switch some data on the TRC. All descriptors eventually need to be revised after the minimum list.

In summary, the revision of the descriptors comprises 2 main tasks:

1 Clarify and improve what the TRC is doing now on the minimum descriptors
2 Full revision of all descriptors

10. Session 7: Documentation and Management of the Data

The seventh session focused on the information aspects of collection management. It began with two presentations by *Max Ruas*, firstly on the global status of *Musa* documentation and management of data (Morphological/Evaluation/Photos/Molecular).

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9URDBZb0dVRlZhYTA/edit

Key points:

- Overview of results from the survey using the information provided by 52 collections until April 2013: Technology used for recording passport data; technology used for recording characterization data; the number of accessions from each species/group; plans, needs or constraints on managing accession information.
- How to improve the knowledge of *Musa* GR? Where to efficiently act? Where to focus first?

Max Ruas then presented a talk on MGIS: purpose, current status, the uploading mechanism and the MGIS Data Sharing Agreement (DSA).

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UQXM1al9ya1R5ZjQ/edit

Key points:

- Purpose of MGIS is a database where accessions can be documented in a standardised manner following the Bioversity Descriptors guidelines.
- A few descriptors have changed since 1997 and EAHB descriptors added. Data mainly comes voluntarily from workshops.
- MGIS content – data from accessions described (see presentation).
- Data is accessed through the website or CD-Rom following a data sharing agreement (DSA) and terms of use.
- Online ordering system for ITC accessions.

Group Discussion

The participants then divided into 3 small groups and discussed the 2 key questions below*:*

1. *MGIS: What are the conditions needed to adopt MGIS?*
2. *What tools are needed to help curators document and share data?*

Key points:

- Each collection should have a database documentation system
- A good internet connection is crucial
- Develop a light MGIS version for slow internet connections
- If no internet: CR-ROM and USB keys and send excel files for uploading
- Necessary hard and software needed
- Facilitate the transfer of raw local data to MGIS – ready format
- Spreadsheets needed to upload and transfer from local to MGIS
- Provision of updated data from CD-ROM and spreadsheets
- Mobile documentation devices needed to minimise errors and save time
- Should provide MGIS administration login to use as local documentation system
- MGIS needs to be more user-friendly
- Databases to be more flexible
- Adopt databases developed by others if no own database
- Dedicated infrastructure needed
- Qualified staff with IT skills needed
- General training on databases management desired
- Training on how to use MGIS, other GB management systems and to raise awareness
- National and regional network systems are important
- Dialogue required to convince heads of National Agriculture Research Systems (NARS) to share data
- Promote MGIS through MusaNet and ProMusa
- Promote MGIS through regional networks
- Close contact with the collection curators and inform when there are changes to MGIS
- Communication information through MusaNet and ProMusa when a new collection joins MGIS and when new material is available from ITC
- Enrich the content of MGIS with characterisation and evaluation data and photos
- More visibility and acknowledgement of curators and data providers – helps to share data
- Develop a 'fan" page for MGIS and encourage community of practice
- On-line help and videos on how to use MGIS and order germplasm
- Options for other languages would be beneficial

The following six presentations followed the group discussion:

1. (OLGA) (Local Tool for Management of Accessions) for the CRB (Biological Resources Centre) *Franciane Nuissier.*
2. *Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UYnFtdFhLUE5rUkE/edit*
3. GRIN-GLOBAL – *Max Ruas*

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UMlRVOFZiOFd5UFE/edit

4. The use of a tablet/mobile devices to capture characterization data in the hands-on prototype – *Max Ruas – no presentation*
5. Guidelines to taking photos – *Lavernee Gueco*
   Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UcC1MbjdXdEd6RzQ/edit
6. Photo editing (to include resizing and putting labels on photos) – *Lavernee Gueco – no presentation*
7. How to tackle classification using molecular data – *Julie Sardos and Max Ruas.*
   Full presentation Part 1 https://docs.google.com/file/d/0B7GWjizl3d9UR2p3TV92enAzTFE/edit
   Full presentation Part 2 https://docs.google.com/file/d/0B7GWjizl3d9UamVHczU0N3lVMzA/edit

NB: Use the following photo caption to label any photos from the workshop: 'CIRAD/CRB-PT, Guadeloupe'. For photos of the hybrids prior informed consent is required.

11. Session 8: Conclusions and recommendations

The final session concluded the main achievements and results of the workshop. An inventory was taken of recommendations and proposed follow-up actions.

Brigitte Laliberte distributed an abridged version (chapters 1 and 2) of the revised Global Strategy for the Conservation and Use of Banana and Plantain Genetic Resources and presented the overall structure and key points of the document.

Full presentation: https://docs.google.com/file/d/0B7GWjizl3d9UX0ZyUXFiSGdkam8/edit

This linked to a discussion on regional and global networking and potential funding opportunities. The workshop closed with an evaluation by participants on what worked well and what could be improved.

At the end of Session 8, two optional visits were offered to participants:

- CIRAD post-harvest lab
- CIRAD breeding programme – field

Concluding Discussions (arranged by topic):

MGIS:

- MGIS simplified to quickly produce printouts and factsheets of the information it contains – to help see the whole content and help people appreciate what is in there.
- It would be useful to have sets of photos to compare with.
- On-line help and video demos on how to use MGIS on the front page
- Breeders are using MGIS and need to get complete information
- Think of a system to validate all the information in MGIS, not just the taxonomic value from the field verification by TAG (e.g. PlantNet).
- MGIS to include other information (e.g. presence of seeds in a bunch).
- Provide links to download published papers and publications to facilitate access by the entire community.

Global Strategy:

- Needs endorsement by the community
- Needs targets such as actions in 3-5 years
- The global strategy needs to provide a clear link to existing regional strategies (and vice versa) to facilitate the endorsement and support to regional activities (e.g. Pacific strategy needs to link to the global strategy).
- Include the regional priorities
- Regional meetings and consultations to strengthen the regional components
- Include the nodal centres of excellence agreements in West Africa under CORAF (Conseil Ouest et Centre Africaine pour la Recherche et le Developpement Agricoles).
- Regional approaches are political in many cases and identify priority collections is a difficult and sensitive task.
- Consider the financial long-term sustainability of the national and regional collections – these are at risk
- Collections need to be promoted for their key role in promoting seed systems – facilitate access to useful diversity. Their role in conservation should be secondary as donors will give more importance to direct impact to farmers.
- Regional meetings can be useful to endorse priorities since they are led by the heads of NARS.
- Even if the objectives of the regional networks may be different, they are a useful mechanism for endorsing proposals.
- PAPGREN, BABPNET, BARNESA, MUSALAC, Innovate Plantain, Asia Regional Network – these are major consultation platforms for regional consultations.

Taxonomic Reference Collection:

- Curators should address questions when the have uncertainties about some of the descriptors. This can form the basis for discussions about the difficulties. They can contact Jean-Pierre, Edmond and Jeff by email or phone.
- There are 2 main components of the TRC:
- The project of planting and characterisation to test the stability of descriptors across environments
- The collection itself to be used as a reference by all curators in the future
- There are 3 effects on different results between collections and this can be due to: (a) the curator, (b) the management and (c) the environment
- Data on the completed 2nd cycle is available from 3 partners.
- Objective of the first cycle is to clarify material and some of the descriptors.
- The second cycle is to determine the full description
- In order to distribute TRC we need to make sure they are true to type (TT). Secondly we want to verify stability and variability across environments – so these are completely different.
- If this not fully confirmed, partners can go through a 3rd and 4th cycle.
- Would it be possible to recommend a minimum fertiliser recommendation?
- Full data on all descriptors (2nd cycle) is available from 3 partners.
- The data receive should first be analyses.
- TRC materials can already be used for studies such as comparisons and sub-group studies.

- Purpose of the TRC is to also allow curators to compare the same material they already have in their collection and see if this is the same.
- The 30 accessions or so of the TRC should be maintained in each field genebank. But this requires space and labour and has an important funding issues and rationalisation.
- An important purpose of the TRC is also for training.
- When there is a different performance of the same materials compared to the one from ITC, what should be done, replace the one in ITC?
- The TRC material is based on most common and popular.
- Case of Iholena lele from Hawaii
- Compare results from different materials.
- Need to be pragmatic and learn from the experience.
- The TRC is not set in stone and is not an absolute. But it could be assessed based on the experience of the partners.
- The project should not hold or wait until all descriptors are determined but should detect what is different from the TRC accessions.
- The TRC should be used to discuss the sub-groups.
- Develop strategy component for each region and then circulate widely.
- Collections conservation and info are easily presented, but diversity is not as clear as so academic. It is not a package and not easily defined. If we are clear about TRC then we are clear about most of the subgroups. Then next each of the subgroups should be defined for intra subgroup diversity with big packages (West African plantain, East African Highland Banana, SEA edible diploids, Pacific etc.). Then we will have total evaluation of cultivars. The first step is TRC subgroups – 13 collections= 13 projects. In second step each subgroup becomes a programme. Then results are presented in packages. All subjects discussed this week can be components of the packages. This flow will be easier for donors to understand.
- Regional coordination can link to the global strategy. Priorities have to be defined at regional meetings by reps and head of NARS.
- Please curators to look at the parts of the strategy that relate to you.
- What to do if an accession from ITC is different than original in the field? There may be somaclonal variation and must be replaced. Idea is that ITC would have most popular type of each cultivar. Further testing can be done to decipher differences.
- It is very important to determine and validate descriptors for specific subgroup (plantains) to fine tune morphological characterization.

Funding:

- CGIAR Research Programme on Roots, tubers and banana (CRP-RTB) can provide some support but also attract bi-lateral funding.
- CRP-RTB main interest is to achieve impact through working with the national programmes. This provides a great opportunity for the regional *Musa* research networks.
- There is another CRP but for funding to the international collections which includes the ITC, the CRP-Genebanks. But this CRP is keen to support community of practice and ensure that there is a clear global framework for each crop.
- The Global Crop Diversity Trust can also in some case provide small project funds for example collecting wild taxa. But this needs to be complemented.

- Regional networks and coordinators have a key role to play.
- French Pacific fund: 30,000 Euro per year and is complemented by funds from other partners such as SPC, Bioversity and others.

Suggestions for follow-up workshops:

- Implementation of local germplasm management databases.
- How to manage a collection in a modern way.
- Information exchange to improve management
- How to implement a local database and include discussion on the descriptors
- Global workshops should be followed by regional workshop to address the specificities of materials and priorities.
- Exchange between regions is also important to learn from each other. To learn how experts distinguish types. First impression is very important but can be based on instinct. And secondly, investigate why there may be a difference.
- BSV workshop (3 days) with expert and authorities to make decisions about moving materials (political dimension) – quarantine and technical experts. This could be held anywhere. No need for practical field or lab demos.
- ISHS-ProMusa symposium – August 2014 – can this be an opportunity for people to meet from this group? Only 3-4 will participate.
- MusaNET does not have a lot of money for regional workshops so things may remain at global level but perhaps MusaNet can help raise funds. This workshop was planned to be duplicated to be done in regions. Please contact us for info on development – content and material can be used and improved.

All workshop presentations can be found on the following webpage:

https://sites.google.com/a/cgxchange.org/musanet/thematic-groups/conservation-thematic-group/meeting_guadeloupe_9_14122013

Or contact Max Ruas for a copy by CD or further information: m.ruas@cgiar.org

12. Summary of key outcomes from the workshop

The workshop achieved the following key outcomes:

- Identification of the important constraints in establishing, maintaining and managing the TRC collection
- Exchange of knowledge on best practice field management and laboratory techniques
- Better understanding of the specifications of *Musa* morphological descriptors
- Proposals for updating and improving the *Musa* descriptors in the next edition
- Greater understanding of how *Musa* characterisation data (particularly for the TRC) is managed and documented through MGIS
- Proposals on how data exchange and management system could be improved
- Introduction of prototype mobile device (hand-held tablet) that could greatly facilitate data collection in the field
- Proposals for further actions (e.g. workshops and training) to strengthen capacity on a regional level

- Discussion and feedback on the revised *Global Strategy for the Conservation and Use of Musa Genetic Resources*

Annex 1 – List of workshop participants

	Last name	First name	Institute/Address	Email
1.	Amah	Delphine	IITA PMB 5320, Oyo Road, Ibadan 200001, Oyo State, Nigeria	a.delphine@cgiar.org
2.	Chase	Rachel	Bioversity International Parc Scientifique Agropolis II 34397 Montpellier Cedex 5 France	r.chase@cgiar.org
3.	Boisne-Noc	Rosiane	Scientist, Responsible *in vitro* Lab Station Roujol Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	rosiane.boisne-noc@cirad.fr
4.	Bruyere	Saturnin	Field and *in vitro* technician /germplasm management Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	saturnin.bruyere@cirad.fr
5.	Daniells	Jeffrey	Department of Employment, Economic Development and Innovation(DEEDI) Centre for Wet Tropics Agriculture, South Johnstone Research Station PO Box 20 - Qld 4859 South Johnstone Australia	Jeff.Daniells@deedi.qld.gov.au
6.	De Langhe	Edmond	KU Leuven Leeuwerikenstraat 51/08.01 B-3001 Leuven Belgium	edmond.delanghe@chello.be
7.	Fondi	Emmanuel	CARBAP BP 832, Dinde n°110 Bonandjo Njombe – Douala Cameroon	fondien@yahoo.com fondi-emmanuel@hotmail.com
8.	Gueco	Lavernee	University of the Philippines at Los Baños (UPLB) Institute of Plant Breeding / National Plant Genetic Resources Laboratory (IPB - NPGRL) College Los Baños, Laguna 4031 Philippines	laverngueco@yahoo.com
9.	Guiougou	Chantal	Technician, CIV lab. Station Roujol/Neufchateau Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	chantal.guiougou@cirad.fr

	Last name	First name	Institute/Address	Email
10.	Horry	Jean Pierre	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) TA A-108/02 Avenue d'Agropolis 34398 Montpellier cedex 5, France	jean-pierre.horry@cirad.fr
11.	Irish	Brian	Tropical Agriculture Research Station 2200 Pedro Albizu Campos Ave, Suite 201 USDA-ARS TARS Mayaguez, PR 00680 Puerto Rico	Brian.Irish@ARS.USDA.GOV
12.	Laliberté	Brigitte	Via Michelangelo Tamburini 13, Apt 29 Rome, 00154 Italy	Brig.lalib@gmail.com
13.	Mina	Claude	Technician/Quarantine/Nursery an plant hardening Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	claude.mina@cirad.fr
14.	Muhangi	Sedrach	NARO P.O. Box 389, Mbarara Uganda	muhangised@yahoo.co.uk
15.	Ngezahayo	Ferdinand	Institut de Recherche Agronomique et Zootechnique (IRAZ) CEPGL BP. 91 Gitega - Burundi	ngezafrd@yahoo.fr
16.	Ngô Xuân	Phong	Fruit and Vegetable Research Institute (FAVRI) Trau Quy - Gia Lam – Hanoi Vietnam	phongvrq@yahoo.com
17.	Roux	Nicolas	Bioversity International Parc Scientifique Agropolis II 34397 Montpellier Cedex 5 France	n.roux@cgiar.org
18.	Ruas	Max	Bioversity International Parc Scientifique Agropolis II 34397 Montpellier Cedex 5 France	m.ruas@cgiar.org
19.	Sandoval	Jorge	CORBANA Guapiles, Pococi Limón, Costa Rica	JSANDOVAL@CORBANA.CO.CR
20.	Sardos	Julie	Bioversity International Parc Scientifique Agropolis II 34397 Montpellier Cedex 5 France	j.sardos@cgiar.org
21.	Serejo	Janay	EMBRAPA Mandioca e Fruticultura Rua Embrapa s/n Caixa Postal 007 Cruz das Almas-BA Brazil	janay.serejo@embrapa.br ; janay@cnpmf.embrapa.br

	Last name	First name	Institute/Address	Email
22.	Subarraya Chetty	Uma	National Research Centre for Banana (NRCB), Department: Germplasm Management and Biotechnology, Thogamalai Main Road, Thayanur Post, Thiruchippally - 620 102, Tamil Nadu, INDIA	umabinit@yahoo.co.in
23.	Nuissier	Franciane	Computer scientist/ database management INRA Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	franciane.nuissier@antilles.inra.fr
24.	Paulo de la Reberdiere	Nilda	Technical assistant / Germplasm management Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	nilda.paolo-de-la-reberdiere@cirad.fr
25.	Sutanto	Agus	Indonesian Tropical Fruit Research Institute Jl. Raya Solok – Aripan km 8, PO Box 5 Solok 27301 - West Sumatera – Indonesia	bagusutanto_02@yahoo.com
26.	Teycheney	Pierre-Yves	Senior Virologist Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	pierre.yves.teycheney@cirad.fr
27.	Thomas	John	The University of Queensland Queensland Alliance for Agriculture and Food Innovation Ecosciences Precinct, Level 2C west GPO Box 267 - Brisbane Queensland 4001, Australia	john.thomas@deedi.qld.gov.au j.thomas2@uq.edu.au
28.	Tomekpe	Kodjo	Senior scientist / Breeding taxonomy & genetics Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	kodjo.tomekpe@cirad.fr
29.	Van denHouwe	Ines	Bioversity International KU Leuven – Willem de Croylaan 42 bus 2455, 3001 Leuven Belgium	Ines.VanDenHouwe@biw.kuleuven.be
30.	Vingadasalon	Christian	Field technician/germplasm management Cirad Antilles/Guyane Site de Neufchâteau 97130 Capesterre Belle-Eau Guadeloupe	christian.vingadassalon@cirad.fr
31.	Wong	Maurice	Service du développement rural - Tahiti (SDR) Département de la recherche agronomique	maurice.wong@rural.gov.pf

	Last name	First name	Institute/Address	Email
			BP 100 - 98713 Papeete Tahiti, French Polynesia, France	

Annex 2 – 20 Most Difficult Descriptors (used in the field characterization exercise)

P/D*			1	2	3	4	5	6	7	8	Other
	6.2.5	Predominant underlying colour of the pseudostem **(A)**									
F	6.3.1	Blotches at petiole base									
FD	6.3.3	Petiole canal of the 3rd leaf									
F	6.3.4	Petiole margins									
	6.3.6	Petiole margins colour **(A)**									
	6.3.7	Edge of Petiole margin (rim)									
	6.4.6	Bunch position									
D	6.4.15	Male bud shape									
D	6.5.1	Bract base shape (Small → low: Large → high)									
FD	6.5.2	Bract apex shape									
F	6.5.3	Bract imbrication									
	6.5.5	Colour of bract internal face **(A)**									
	6.6.2	Compound tepal basic colour **(B)**									
	6.6.4	Lobe colour (tip of the tepal) of compound tepal **(B)**									
	6.6.13	Anther colour **(B)**									
	6.6.24	Dominant colour of male flower **(B)**									
FD	6.7.4	Fruit shape									
FD	6.7.6	Fruit apex									
FD	6.7.7	Remains of flower relicts at fruit apex									
	6.7.11	Fusion of pedicels									

***P**: Photos available / **D**: Drawing available / (A) Use colour chart A / (B) Use colour chart B

Annex 3 – Illustrated minimum set of descriptors for bananas

Developed by the Taxonomy Advisory Group

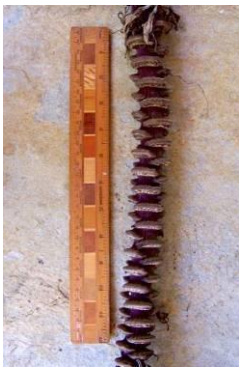
INTRODUCTION

These guidelines are an attempt to establish a standardised procedure for the routine morphological characterization of banana plants. Photographs are provided to help score the minimum descriptors. For any question, remark and feedback on these guidelines, please contact Stéphanie Channelière (s.channeliere@cgiar.org) or Nicolas Roux (n.roux@cgiar.org).

THE APPROPRIATE DEVELOPMENT STAGE FOR OBSERVATION

This document provides instructions on how to document with photos the most highly discriminating descriptors for bananas. The following instructions are to help you determine the best time to take photographs.

The best time to take photos and document the descriptors is when the fruit are green-ripe or yellowing, and the rachis is at least 45 cm long (15 inches). Depending on the variety, the bracts fall off (*left*) or stay on the rachis (*right*).



On a plant that loses its bracts, the development stage can be confirmed by counting the number of nodes (the scars made by the fallen bracts) on the rachis, as shown below. Bracts fall off at the rate of one a day, revealing three parallel spirals. Counting 20 nodes on any of the three spirals means that plant flowered 60 days before. This is the point after which rapid change no longer occurs. Unless otherwise indicated, the photos should be taken on the mother plant.

continue counting up to 20

The photo shows the first 10 nodes (scars) on one of the spiral, which continues on the back of the rachis. The spiral has to have at least 20 nodes to be at the right development stage for photos and description.

The photos in this document were taken by Angela Kay Kepler, Jeff Daniells, Richard Markham, Christophe Jenny, Julio Coto, Emmanuel Fondi, Lorna Herradura and Jimmy Mosas Tindy.

MINIMUM DESCRIPTORS

6.2.1 Pseudostem height (m) (Recorded from the base of the pseudostem to the emerging point of the peduncle)

1. ≤2
2. 2.1 to 2.9
3. ≥3

6.2.5 Predominant underlying colour of the pseudostem (use colour chart A)

Remove the outermost sheath from the pseudostem. Record the main colour of the exposed surface of the underlying pseudostem (do not take into account the pigmentation)

1. Watery green
2. Light green
3. Green
4. Cream
5. Pink-purple
6. Red-purple
7. Purple
8. Other (specify on answer sheet)

6.2.7 Sap colour

Cut the external sheath of pseudostem and record the characteristics of the sap.

1. Watery
2. Milky
3. Red-purple
4. Other (specify on answer sheet)

6.3.1 Blotches at the petiole base

1. Sparse blotching
2. Small blotches
3. Large blotches
4. Extensive pigmentation
5. Without pigmentation

1. 2. 3. 4. 5.

6.3.3 Petiole canal of the third leaf

Leaf III is the third leaf counted from the last leaf produced before bunch emergence. Cut the petiole halfway between the pseudostem and the leaf blade and examine the cross section.

1. Open with margins spreading
2. Wide with erect margins
3. Straight with erect margins
4. Margins curved inward
5. Margins overlapping

1. 2. 3. 4. 5.

6.3.4 Petiole margins

Observation should be made on the neck, where the petiole and pseudostem meet.

1. Winged and undulating
2. Winged and not clasping the pseudostem
3. Winged and clasping the pseudostem
4. Not winged and clasping the pseudostem
5. Not winged and not clasping the pseudostem

1. 2. 3. 4. 5.

6.3.6 Petiole margin colour (use colour chart A)

Record the colour of the margin

1. Green
2. Pink/purple to red
3. Purple to blue
4. Other (specify on answer sheet)

6.3.7 Edge of petiole margin (rim)

1. Colourless (without a colour line along)
2. With a colour line (specify colour on answer sheet)

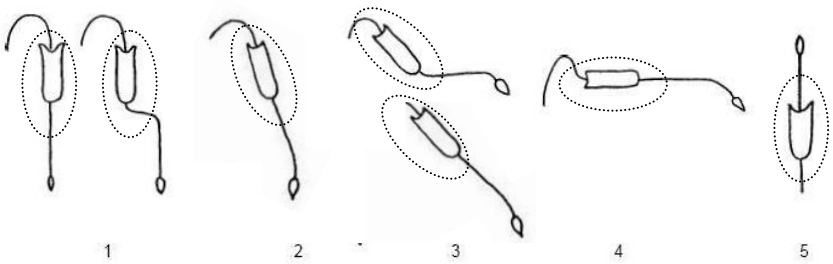
6.3.22 Colour of outer surface of cigar leaf (use colour chart A)

1. Green

2. Red-purple
3. Other (specify on answer sheet)

6.4.6 Bunch position (Angle between the axis of the bunch and the vertical)

1. Hanging vertically
2. Slightly angled
3. Hanging at a 45° angle
4. Horizontal
5. Erect



6.4.7 Bunch shape

1. Cylindrical (length of bunch *more* than twice its width)
2. Truncate cone shaped
3. Asymmetric
4. With a curve in the bunch axis
5. Spiral (all fruit are attached to a unique crown coiled around the stalk)
6. Cylindrical (length of bunch *less* than twice its width)


1.


2.


3.

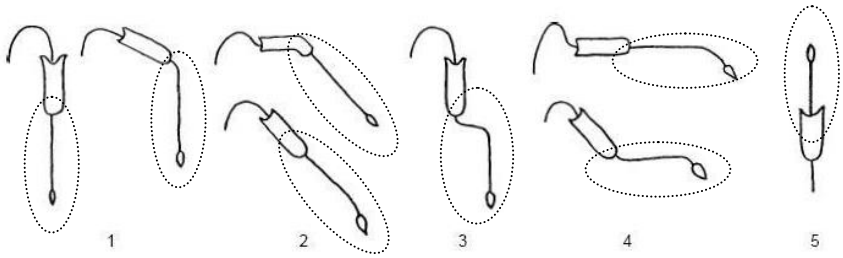

4.


5.


6.

6.4.12 Rachis position (Observe only the part of the rachis between the last hand and the male bud.)

1. Falling vertically
2. At an angle
3. With a curve
4. Horizontal or supra-horizontal
5. Erect



6.4.13 Rachis appearance

1. Bare
2. Neutral flowers on one to few hands only at proximal end near the bunch (rest of stalk is bare)
3. Male flowers/bracts at distal end, above the male bud (rest of stalk is bare)
4. Neutral/male flowers and presence of withered bracts on the entire stalk
5. Neutral/male flowers on the whole stalk without persistent bracts
6. Small bunch from neutral/hermaphrodite flowers just above the male bud
7. Other (specify on answer sheet)


1.


2.


3.


4.

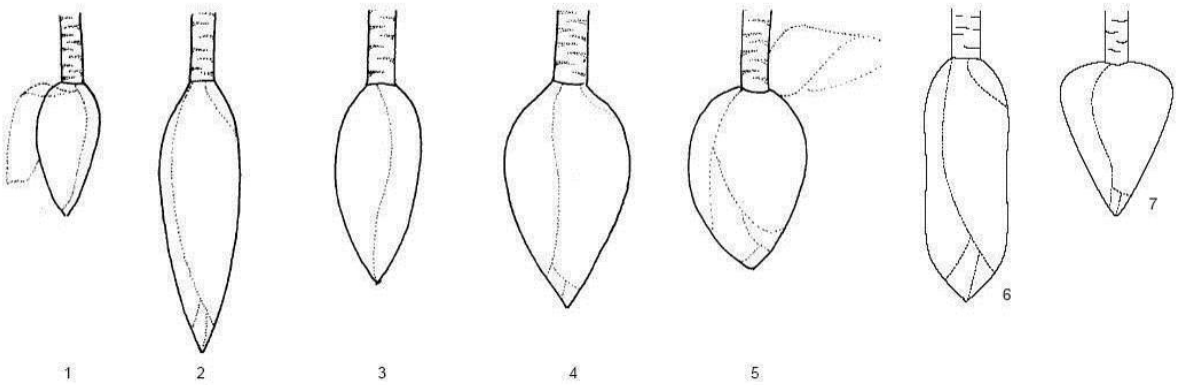

5.


6.

6.4.15 Male bud shape

High shouldered means that the largest width of the bud is within the first third of the length. Low shouldered means it is the largest at mid-length.

1. Like a top (low shoulder, thin and short)
2. Lanceolate (narrowly elliptical)
3. Intermediate
4. Ovoid (low shoulder, wide and pointed)
5. Rounded (wide with obtuse tip)
6. Oblong (high shoulder, fairly straight sides, tapered tip)
7. Heart shaped (high shoulder, wide and short)
8. Other (specify on answer sheet)



6.4.16 Male bud size at harvest (cm)

Largest width
Length

6.5.2 Bract apex shape

1. Lengthily pointed
2. Slightly pointed
3. Intermediate
4. Obtuse
5. Obtuse and split

1. 2. 3. 4. 5.

6.5.3 Bract imbrication (Alignment of bracts at the apex of the male bud)

1. Old bracts overlap at apex of bud (no imbrication)
2. Young bracts slightly overlap (moderate imbrication)
3. Young bracts greatly overlap (deep imbrication)

1.

2.

3.

6.5.4 Colour of the bract external face (use colour chart A)

1. Yellow
2. Green
3. Red
4. Red-purple
5. Purple-brown
6. Purple
7. Blue
8. Pink-purple
9. Orange-red
10. Other (specify on answer sheet)

6.5.5 Colour of the bract internal face (use colour chart A)

1. Whitish
2. Yellow or green
3. Orange red
4. Red
5. Purple
6. Purple brown
7. Pink-purple
8. Other (specify on answer sheet)

6.5.12 Bract behaviour before falling (best to record as bract has lifted up to the horizontal)

1. Revolute (rolling)
2. Not revolute (not rolling)


1.


2.

6.6.2 Compound tepal basic colour (use colour chart B)

1. White
2. Cream
3. Yellow
4. Orange
5. Pink/pink-purple
6. Other (specify on answer sheet)

6.6.4 Lobe colour (tip of the tepal) of compound tepal (use colour chart B)

1. Cream
2. Yellow
3. Orange
4. Green
5. Other (specify on answer sheet)

6.6.13 Anther colour (must be fresh) (use colour chart B)

1. White
2. Cream
3. Yellow
4. Grey
5. Brown/rusty brown
6. Pink/pink-purple
7. Black (anthers aborted)
8. Other (specify on answer sheet)

6.6.24 Dominant colour of male flower (use colour chart B)

1. White
2. Cream
3. Yellow
4. Pink
5. Red-purple

6. Other

7.10 Number of hands on the whole bunch

For the following descriptors, observations should be made on the inner fruit in the middle of the hand

6.7.2 Number of fruits on the third hand

6.7.3 Fruit length (cm)

6.7.4 Fruit shape (longitudinal curvature)

In case of an asymmetric bunch that has straight and curved fruits, please indicate it in the note section and score only the straight fruit.

1. Straight (or slightly curved)
2. Straight in the distal part
3. Curved (sharp curve)
4. Curved in 'S' shape (double curvature)
5. Other

1. 2. 3. 4.

6.7.6 Fruit apex

1. Pointed
2. Lengthily pointed
3. Blunt-tipped
4. Bottle-necked
5. Rounded


1.


2.


3.


4.


5.

6.7.7 Remains of flower relicts at fruit apex

1. Without any floral relicts
2. Persistent flower relicts
3. Only base of the style persists


1.


2.


3.

6.7.8 Fruit pedicel length (mm)

1. ≤10 mm
2. 11 to 20 mm
3 .≥21 mm

6.7.11 Fusion of pedicels (before they join the crown)

1. No visible sign of fusion
2. Partially fused
3. Totally fused

1.

2.

3.

Annex 4 – List of reference materials for the Guadeloupe Workshop

1	Benson E, Harding K, Debouck D, Dumet D, Escobar R, Mafla G, Panis B, Panta A, Tay D, Van denhouwe I, Roux N 2011. Refinement and standardization of storage procedures for clonal crops - Global Public Goods Phase 2: Part I. Project landscape and general status of clonal crop *in vitro* conservation technologies. System-wide Genetic Resources Programme. Link available on MusaNet website.
2	Benson E, Harding K, Debouck D, Dumet D, Escobar R, Mafla G, Panis B, Panta A, Tay D, Van denhouwe I, Roux N 2011. Refinement and standardization of storage procedures for clonal crops - Global Public Goods Phase 2: Part II. Status of *in vitro* conservation technologies for: Andean root and tuber crops, cassava, *Musa*, potato, sweetpotato and yam. Rome, Italy: System-wide Genetic Resources Programme. Link available on MusaNet website.
3	Benson E, Harding K, Debouck D, Dumet D, Escobar R, Mafla G, Panis B, Panta A, Tay D, Van denhouwe I, Roux N 2011. Refinement and standardization of storage procedures for clonal crops - Global Public Goods Phase 2: Part III. Multi-crop guidelines for developing *in vitro* conservation best practices for clonal crops. Rome, Italy: System-wide Genetic Resources Programme. Link available on MusaNet website.
4	Bioversity International. 2009. Key access and utilization descriptors for banana genetic resources. Bioversity International, Rome, Italy. Link available on MusaNet website.
5	Bioversity International. Technical Guidelines for the Multi-location Characterization of ITC Reference Accessions. Date: 14 December 2010
6	Daniells J, Jenny C, Karamura D, Tomekpe K. 2001. Musalogue: Diversity in the genus *Musa*. IPGRI/INIBAP/CTA, Rome, Italy. Available from: http://www.bioversityinternational.org/publications/publications/publication/issue/imusailogue_diversity_in_the_genus_imusai.html (16 MB). Date accessed: 23 March 2010.
7	Denham T, De Langhe E, Vrydaghs L. 2009. Special issue: history of banana domestication. Ethnobotany Research and Applications 7:163-164. Articles included in this special issue available from http://lib-ojs3.lib.sfu.ca:8114/index.php/era/issue/view/25.
8	Diekmann M, Putter CAJ, editors. 1996. FAO/IPGRI Technical Guidelines for the Safe Movement of Germplasm. No.15. *Musa* spp. 2nd edition. Publisher: Food and Agriculture Organization of the United Nations, Rome; International Plant Genetic Resources Intstitute, Rome, Italy. 28 pp. Link available on MusaNet website.
9	Engels JMM, Visser L, editors. 2003. A guide to effective management of germplasm collections. IPGRI Handbooks for Genebanks No. 6. IPGRI, Rome, Italy.
10	Engels JMM, Visser L, editors. 2003. A guide to effective management of germplasm collections. IPGRI Handbooks for Genebanks No. 6. IPGRI, Rome, Italy. Available in English (1.4 MB) and Spanish. (1.5 MB)
11	Garming, H., Roux, N, and Ven den houwe, I. (2010). The Impact of the *Musa* International Transit Centre: review of its services and cost-effectiveness, and recommendations for rationalisaton of its operations. Bioversity International, Montpellier, France
12	Helliot B, Panis B, Frison EA, De Clercq E, Swennen R, Lepoivre P, Neyts J. 2003. The acyclic nucleoside phosphonate analogues, adefovir, tenofovir and PMEDAP, efficiently eliminate banana streak virus from banana (*Musa* spp.). Antiviral Research (NLD), 59 (2):121-126. Link available on MusaNet website.
13	INIBAP. 2006. Global Conservation Strategy for *Musa* (Banana and Plantain). Available from: www.croptrust.org/documents/cropstrategies/banana.pdf. Accessed: 23 March 2010.
14	International Union for the Protection of New Plant Varieties (UPOV). 1991. International Convention for the Protection of New Varieties of Plants. UPOV, Geneva. Available upon request in English, French, German and Spanish from: www.upov.int/en/publications/index.html. Date accessed: 23 March 2010.
15	IPGRI, INIBAP, CIRAD. 1996. Descriptors for Banana (*Musa* spp.). IPGRI, Rome, Italy; INIBAP, Montpellier, France; CIRAD, France. 55 pp. Link available on MusaNet website.
16	Iskra-Caruana M-L, Baurens F-C, Gayral P, Chabannes M (2010) A four-partner plant-virus interaction: enemies can also come from within. Molecular Plant-Microbe Interactions 23, 1394-1402.
17	Jones DR (2000) 'Disease of banana, abacá and enset.' (CABI Publishing: Wallingford)
18	Lassois L., Lepoivre P., Swennen R., van den Houwe I., Panis B. [2013] Thermotherapy, Chemotherapy, and Meristem Culture in Banana. In: Protocol for Micropopagation of Selected Economically – Important Horticultural Plants, Series: Methods in Molecular Biology, Vol. 994. Lambardi M., Ozudogru, E.A., Jain, S. M. (Eds.). Humana-Press Springer. 419-433

19	Lassoudiere A. 2007. Le bananier et sa culture. Editions Quae, Versail es Cedex, France. 383 pp.
20	Mbida MC, Doutrelepont H, Vrydaghs L, Swennen R, Swennen RJ, Beeckman H, De Langhe E, de Maret P. 2004. Yes, there were bananas in Cameroon more than 2000 years ago. Infomusa 13 (1):40-42. Link available on MusaNet website.
21	Mbida MC, Doutrelepont H, Vrydaghs L, Swennen R, Swennen RJ, Beeckman H, De Langhe E, de Maret P. 2005. The initial history of bananas in Africa. A reply to Jan Vansina, Azania, 2003. Azania XL. The British Institute in Eastern Africa. pp. 128-135.
22	Murashige T, Skoog F. 1962. A revised medium for rapid growth and bioassays with tobacco cell cultures. Physiologia Plantarum 15:473-497. Link available on MusaNet website.
23	Ploetz RC, Kepler AK, Daniells J, Nelson SC 2007. Banana and plantain-an overview with emphasis on Pacific island cultivars. Available from: www.agroforestry.net/tti/Banana-plantain-overview.pdf. Date accessed: 23 March 2010.
24	Purseglove JW. 1972. Tropical Crops. Monocotyledons. Vol. 2. Longman, London, UK.
25	Rao NK, Hanson J, Dulloo ME, Ghosh K, Nowel D, Larinde M. 2006. Manual of seed handling in genebanks. Handbooks for Genebanks No. 8. Bioversity International, Rome, Italy. Available in English (1.5 MB), Spanish (1.4 MB) and French. (1.9 MB)
26	Robinson JC, de Villiers EA. 2007. The cultivation of banana. ARC-Institute for Tropical and Subtropical Crops, Nelspruit, South Africa/Du Roi Laboratory, Letsitele, South Africa. 258 pp.
27	Simmonds NW, Shepherd K. 1955. The taxonomy and origins of the cultivated bananas. Journal of the Linnean Society (Bot.), 55 (359):302-312. Abstract available from: www3.interscience.wiley.com/journal/119777761/abstract?CRETRY=1&SRETRY=0. Date accessed: 23 March 2010.
28	Simmonds NW, Weatherup STC. 1990. Numerical taxonomy of the cultivated bananas. Tropical Agriculture 67 (1):90-92.
29	Simmonds NW, Weatherup STC. 1990. Numerical taxonomy of the wild bananas (*Musa*). New Phytologist 115 (3):567-571.
30	Simmonds NW. 1962. The evolution of the bananas. Tropical Agricultural Series. Longman Scientific and Technical, UK. 170 pp.
31	Simmonds, N.W. and Shepherd, K. 1955. The taxonomy and origins of the cultivated bananas. Journal of the Linnean Society (Bot.), 55(359), p. 302-312 Abstract available from: www3.interscience.wiley.com/journal/119777761/abstract?CRETRY=1&SRETRY=0. Date accessed: 23 March 2010.
32	Stover RH, Simmonds NW. 1987. Bananas. Longman Scientific and Technical, New York, USA. 468 pp.
33	Stover RH, Simmonds NW. 1987. Bananas. Tropical Agricultural Series. Longman Scientific and Technical, UK. 468 pp.
34	Swennen, R. 1990. Plantain Cultivation under West African Conditions: A Reference Manual. IITA, Ibadan, Nigeria. 24p.
35	Tenkouano A, Swennen R. 2004. Progress in breeding and delivering improved plantain and banana to African farmers. Chronica Horticulturae 44(1):9-15.
36	Tomekpe K. and Fondi E. 2008. Regeneration guidelines: banana. In: Dulloo M.E., Thormann I., Jorge M.A. and Hanson J., editors. Crop specific regeneration guidelines [CD-ROM]. CGIAR System-wide Genetic Resource Programme, Rome, Italy. 9 pp.
37	Updated *Musa* Safe-Movement guidelines - DRAFT 2013
38	Van den Houwe I, De Smet K, Tezenas du Montcel H, Swennen R. 1995. Variability in storage potential of banana shoot cultures under medium term storage conditions. Plant Cell, Tissue and Organ Culture 42:267-274. Link available on MusaNet website.
39	Van den Houwe I, Guns J, Swennen R. 1998. Bacterial contamination in *Musa* shoot tip cultures. International Symposium on Banana in the Subtropics. Acta Horticulturae 490:485-492. Link available on MusaNet website.
40	Van den Houwe I, Swennen R. 2000. Characterization and control of bacterial contaminants in *in vitro* cultures of banana (*Musa* spp.). Meeting: International Symposium on Methods and Markers for Quality Assurance in Micropropagation. Acta Horticulturae 530:69-79. Link available on MusaNet website.

Annex 5 – Revised programme (including schedule changes due to weather)

DAY 1	MONDAY 9 December
09:00-10:30	**SESSION 1: INTRODUCTION to the Workshop** • Welcome addresses - *Kodjo Tompekpe and Dominique Polti* • Logistic information - *Kodjo Tompekpe – 5 minutes* • Introduction to participants - *Brigitte Laliberté, Facilitator* • PRESENTATION: MusaNet - The Global *Musa* Genetic Resources Network – *Nicolas Roux* • PRESENTATION: MusaNet Thematic Groups on Conservation and Information/Documentation and (CTG and ITG) : objectives and plans in the framework of the workshop – *Nicolas Roux, Ines van den houwe and Max Ruas* • PRESENTATION: Introduction to the Centre for Biological Resources Tropical Plants of CIRAD-INRA - *Claudie Pavis* • PRESENTATION: Workshop objectives, expected outputs and process - *Brigitte Laliberté*
10:30-11:00	***Coffee/tea break***
11:00-11:30	**SESSION 2: WHERE WE ARE NMOW with the Taxonomic Reference Collection (TRC) Project** • PRESENTATION: Description of the Reference Collection Project: importance of characterisations, the genesis of the TRC project, objectives, purpose and current status and the technical guidelines and tools – *Julie Sardos* • PRESENTATION: Background on the selecti.0on of the accessions making the Reference Collection – *Edmond De Langhe* • General discussion
11:30-12:30	**Presentations: Current status and feedback from Project partners** 1. Brazil – EMBRAPA – *Janay Serejo* 2. Burundi - IRAZ - *Ferdinand Ngezahayo* 3. Cameroun – CARBAP - *Emmanuel Fondi* 4. Costa Rica – CORBANA - *Jorge Sandoval*
12:30-14:00	***Lunch break***
14:00-15:30	5. India - NRCB - *Uma Subburaya* 6. Indonesia –ITFRI - *Agus Sutanto* 7. Nigeria – IITA - *Delphine Amah* 8. Philippines – BPI– *represented by Lavernee Gueco from UPLB* 9. Uganda – NARO– *Sedrach Muhangi* 10. USA – Puerto Rico - USDA-ARS – *Brian Irish* 11. Vietnam – FAVRI - *Phong Ngô Xuân* 12. Tahiti French Polynesia - SDR-MAP - *Maurice Wong*
15:30-16:00	***Coffee/tea break***
16:00-17:00	**SESSION 3: SAFE MOVEMENT of Germplasm** • PRESENTATION: Viruses: types, spread including tissue culture, indexing (Technical Guidelines for

	the Safe Movement of *Musa* Germplasm - TGSMG), eradication – *John Thomas* • PRESENTATION: Update on Banana Streak Virus (BSV) – *Pierre-Yves Teycheney* • PRESENTATION: Exchange of disease-free germplasm, distribution and introduction from ITC – *Ines van den houwe and John Thomas* • Discussion
17:00-18:00	**<u>Group discussion on germplasm health status issues</u>** • **How can we insure that the ITC Reference Collection material is healthy: virus indexing, health testing, demo, discussions** **Proposed process:** 3 small groups each discussing one of the following 3 questions - *30 minutes* **1.** What are the most critical phytosanitary issues for collection management and germplasm exchange? What measures should be taken? **2.** What health testing capacity may need to be strengthened? What are the roles of the different partners? **3.** How to facilitate the availability of healthy germplasm? Should we rethink the establishment of National Repository, Multiplication, and Distribution Centres (NRMDCs) in support to safe exchange of germplasm? Reports back in plenary and discussions - *30 minutes*
EVENING	***Social dinner – restaurant near CIRAD station***
DAY 2	**TUESDAY 10 December**
09:00-12:30	**<u>SESSION 6: CHARACTERISATION</u>** **<u>FIELD EXCERCISE</u>** Introduction to the exercise and method for the next 2 days – *Brigitte Laliberte and Edmond De Langhe* • Purpose • Forming the 4 groups of curators • Indicate where 4 accessions are located in the field • Explain how the groups will move from one to the other • Description of procedure and manipulations • Distribution of documents: o Annex 1: Table to be completed for the 20 descriptors o Annex 2: Technical guidelines o Full booklet of the descriptors • Questions and points for clarification **Method:** 1. Morphological characterization of widely different Reference accessions for intensive study of the most difficult descriptors. 2. Individual observation and agreement. **Proposed process:**

	3. Curators are assisted by a participant to hold materials while they document the accessions. 1. Description should not be discussed with the assistant. 2. For plant parts far to reach and observe, the part will be cut and observed at ground level. Preferably the bunch cut but this could create differences in color after 3-4 hours for the first superficial bracts and flowers. 3. Time estimated for describing one accession with the 20 descriptors is 1 hour. **The Accessions:** **1.** Pisang Kelat **2.** Kunnan **3.** Pisang jari buaya **4.** Pisang Lilin			
12:30-14:00	***Lunch break***			
14:00-15:30	**MEETING ROOM** Presentation on the results Discussion of the results			
15:30-16:00	***Coffee/tea break***			
16:00-17:30	Agreement on the descriptors for each 4 accessions that require discussion and demonstration in the field the next day			
	Pisang Kelat 4. 6.3.1 5. 6.3.1 6. 6.6.2 7. 6.3.3 8. 6.3.3 9. 6.5.3 10. 6.6.4 11. 6.7.7 12. 6.6.13 13. 6.6.13	Pisang jari buaya 14. 6.3.1 15. 6.5.1 16. 6.5.2 17. 6.3.4 18. 6.7.4 19. 6.5.5 20. 6.3.6 21. 6.7.11 22. 6.6.13 23. 6.4.15	Kunnan 24. 6.2.5 25. 6.3.1 26. 6.7.4 27. 6.7.6	Pisang Lilin 28. 6.2.5 29. 6.3.1 30. 6.3.3 31. 6.5.5 32. 6.7.6

DAY 3	WEDNESDAY 11 December
09:00-09:30	Part of Session 7 on documentation (rainy conditions outside): 33. PRESENTATION: Guidelines to taking photos – *Lavernee Gueco* 34. Discussion
09:30-12:30	**SESSION 6: CHARACTERISATION - *continued*** **FIELD EXCERCISE** Demonstration and discussion on the 20 descriptors around the 4 accessions studied. **1.** Pisang Kelat **2.** Kunnan **3.** Pisang jari buaya **4.** Pisang Lilin
12:30-14:00	***Lunch break***
14:00-15:30	**MEETING ROOM and outside where the bunches were displayed** • Discussion around remaining descriptors of bunches and flowers for pisang lilin and kelat • Descriptions of bracts
15:30-16:00	***Coffee/tea break***
16:00-17:00	Discussion on the next steps for the work on descriptors
17:00-17:30	**SESSION 5: BEST MANAGEMENT PRACTICES for field collections** • PRESENTATION: Good management practices for growing the plants in the field in the best conditions for reaching the proper level of maturity and health - including pest and disease management, soil fertility and other agricultural and environmental conditions – *Kodjo Tomekpe* • Discussion
DAY 4	**THURSDAY 12 December**
09:00-10:00	**FIELD DEMONSTRATION** • Best practices for field collections demonstrated and virus symptoms viewed – *Kodjo Tomekpe and John Thomas*
10:00-11:00	**GREENHOUSE: Demonstration of *ex vitro* acclimatisation (including nursery management) (CIRAD/Guadeloupe) – CIRAD GREENHOUSE/FIELD – *Kodjo and Claude/Nilda*** • Adaptation of *in vitro* plants, acclimatisation from *in vitro* to field plants, using the example of the ITC plants sent to the Reference Collection partners and sharing of experience.
11:00-11:30	***Coffee/tea break***
11:30-12:00	**SESSION 4: Best management practices for *In Vitro* Collection:**

	• PRESENTATION*: In vitro* collections: management practices, storage, requirements for conservation and genetic integrity – *Ines van den houwe* • Discussion
12:00-13:00	**SESSIONS 4 and 5: Points of discussion on collections management – general *in vitro* and field:** **Proposed process:** Break into 3 small groups around the key question below – *30 minutes* • Given what we have discussed and learnt (demos), what is missing to bring up the capacity of collection management? What is needed at the local/national, regional and global level? Plenary reports and general discussion – *30 minutes*
13:00-14:00	***Lunch break***
14:00-16:00	**SESSION 4: *In Vitro* Collection – *continued* – CIRAD LAB** **Lab demonstrations and inspections at CIRAD Capesterre Belle Eau** **Proposed process:** • Participants are divided into 2 groups of 15-16 participants and alternatively visit virology lab and small tissue culture facility. **DEMO 1: At the tissue culture lab** – *Ines van den houwe and Chantal Guiougou* 1. Good practices for *in vitro* collections 2. Demonstration of meristem culture technique and its applications - useful technique to avoid or overcome contamination problems as well as to eliminate BBTV. 3. Demonstration of Indexing for latent contamination - share practices for managing latent contamination **DEMO 2: At the virus lab** – *John Thomas and Pierre-Yves Teycheney* 1. Demonstration of equipment and facilities needed for virus indexing 2. Discussion on how viruses are controlled 3. Requirements for virus indexing
DAY 5	**FRIDAY 13 December**
09:00-10:00	**SESSION 7: DOCUMENTATION and management of the data** • PRESENTATION: Global status of *Musa* documentation and management of data (Morphological/Evaluation/photos/Molecular) – WHERE WE ARE TODAY - *Max Ruas* • Discussion • PRESENTATION: MGIS: purpose, current status, the uploading mechanism and the MGIS Data Sharing Agreement (DSA) – *Max Ruas* • Discussion
10:00-11:00	**Group discussion on MGIS:** **Proposed process:** Break into 3 small groups around the key questions below – *30 minutes* • MGIS: What are the conditions needed to adopt MGIS? • What tools are needed to help curators document and share data? Plenary reports and general discussion – *30 minutes*

11:00-11:30	***Coffee/tea break***
11:30-13:00	• PRESENTATION: OLGA (Local Tool for Management of Accessions) for the CRB (Biological Resources Centre) – *Franciane Nuissier* • Discussion • PRESENTATION: GRIN-GLOBAL – *Max Ruas* • Discussion • PRESENTATION**:** The use of a tablet/mobile devices to capture characterization data in the Hands on with the prototype – *Max Ruas* • Discussion
13:00-14:30	***Lunch break***
14:30-16:00	**VISITS:** • CIRAD post harvest lab • CIRAD breeding programme – field
16:00-17:30	**Demonstration:** • PRESENTATION: Photo editing (to include resizing and putting labels on photos) – *Laverne Gueco* • *Discussion* • PRESENTATION**:** How to tackle classification using molecular data – *Julie Sardos and Max Ruas* • Discussion
Evening	**Social dinner at the Canella Beach Resort**
DAY 6	**SATURDAY 14 December**
09:00-11:00	**<u>SESSION 8: CONCLUSION and RECOMMENDATIONS</u>** • Conclusions of main achievements and results of the workshop • Global Strategy framework
11:00-11:30	***Coffee/tea break***
11:30-13:30	• The future of the Taxonomic Reference Collection project • Regional and Global Networking • Recommendations for follow-up actions • Funding opportunities • Evaluation of the workshop: what worked well and what could be improved • Closing of the workshop
13:30-14:45	***Lunch break***

Annex 6 - Technical Guidelines for the Multi-location Characterization of ITC Reference Accessions

14 December 2013

1. Introduction

Among the four outputs proposed in the Global Conservation Strategy for Musa developed in 2006 is: "genetic diversity is comprehensively characterized and documented, taxonomy is harmonized and collections are rationalized". Since then a minimum set of descriptors and photos and a reference collection was agreed upon by the Taxonomy Advisory Group (TAG). The minimum set of descriptors and photos is currently being used to field verified accessions from ITC that were maintained for more than 10 years in vitro under medium term storage conditions.

Plant characterization descriptors enable an easy and quick discrimination between phenotypes. The best ones for this type of work should be highly heritable (i.e. express equally in all environments) and easy to score. By characterizing fully the reference collection (a set of 34 accessions representing the diversity of Musa) we would like to test each descriptor and identify those that vary less in different environments. In addition, by performing this exercise, each field collection will have a set of accessions that will serve as a taxonomical reference for cultivated bananas (at least to the subgroup level). This reference set can also be used in capacity building. In order to perform this characterization exercise in the most efficient and standardized way and produce data that can be analyzed statistically, the following guidelines have been produced.

2. Selection of sites

Thirteen partners have agreed to receive the reference collection and characterize it: BPI; CARBAP; CORBANA; EMBRAPA; FAVRI, IITA, IITA-ESARC, IRAZ, ITFRI, NARO, NRCB, SDR-MAP, USDA) See ANNEX 1: Map with difference sites.

3. Reference accessions to be characterized in each site

The reference collection is composed of 34 accessions, each representing a major and widely recognized subgroup of Musa (see ANNEX 2). These accessions were selected by the TAG based on the following criteria:

- Representativeness of morphotaxonomic variation within the subgroup;
- Available for distribution from the ITC collection (virus-indexed negative);
- Declared true-to-type during field verification, cytogenetic and molecular studies.

ITC provides 4 rooted plantlets per each accession to the partners. For information on how to handle plant material, see ANNEX 3.

4. Environmental data

Environmental data should be collected from the weather station nearest the trial site. This

should not be a problem for on-station trials, as many research centers have recording equipment. Data should be recorded at least monthly throughout the plant development phases (2 cycles). For your convenience, a format for recording environmental data is provided in ANNEX 4.

5. Agronomic practices:

The trial should be managed according to the local agronomic practices of the collaborating organization and applied uniformly over the whole trial site. Data recording should be conducted for the mother plant crop (1st cycle) and first ratoon (2nd cycle). Fertilization, irrigation and pest and diseases control should be optimized to the greatest extent possible. Details of fertilizer application, pest and diseases control measures and irrigation/drainage should be recorded. Mats should be de-suckered every three months, leaving only the following sucker.

In case you need support in agronomic management, please consult the following Banana Regeneration Guidelines:

http://cropgenebank.sgrp.cgiar.org/images/file/musa/Banana_ENG.pdf

6. Planting layout, density and distance

The 4 rooted plantlets received from ITC per accession, should be planted and data recorded on the 4 plants. However, in case of problems with the survival of the rooted plantlets, a minimum of 2 should be fully established in the field so that characterization should be done on a minimum of 2 plants per accession. Once the plants are established, please complete the form in ANNEX 5 and return the information to the ITC.

Ideally there should be a 2.5-meter space between plants in each row and 3 meters between rows. Make a field plan (in Excel or Word if possible).

Row 1	Accession 1 – plant A	Accession 1 – plant B	Accession 1 – plant C	Accession 1 – plant D
Row 2	Accession 2 – plant A	Accession 2 – plant B	Accession 2 – plant C	Accession 2 – plant D
Row 3	Accession 3 – plant A	Accession 3 – plant B	Accession 3 – plant C	Accession 3 – plant D
Row etc	Accession X plant A	Accession X plant B	Accession X plant C	Etc..

Be sure to label the plants in the field preferably using metallic identification plates in front of the 4 plants. See example below. For each plant, attach an identification (proposed A to D):

ITC0081 Igitsiri (AAA)

7. Characterization data to be collected

- At the end of the first cycle, when the first fruits are ripe, record the MINIMUM set of descriptors (32) and take the minimum set of photos (15) on the mother plant using the "Guidelines for documenting the minimum set of descriptors for bananas, developed by the Taxonomy Advisory Group – see ANNEX 6, 7 and 8. An Excel format is sent separately.
- During the second cycle, the FULL characterization descriptors (121 descriptors) should be taken on the first ratoon crop. As for the first cycle, the descriptors should be recorded when the first ripe fruits have developed, unless otherwise specified. See chapter 6 on Characterization in 'Descriptors for bananas' (CIRAD/INIBAP/IPGRI, 1996) – see Reference 8 A) below. An Excel format is sent separately.
- Agronomic evaluation data should also be recorded during the second cycle. See chapter 7 on evaluation in 'Descriptors for bananas' (CIRAD/INIBAP/IPGRI, 1996). Record mean and standard deviation. (4 plants/accession) are planted in a row). – see Reference 8 A) below. An Excel format is sent separately.
- Data will be entered in the Musa Germplasm Information System (MGIS), according to the completed Excel spreadsheet sent separately – see Reference 8 E) below.

8. References:

A) CIRAD/INIBAP/IPGRI, 1996. Descriptors for bananas. http://bananas.bioversityinternational.org/files/files/pdf/publications/descriptors_en_with_errata.pdf

B) Kodjo Tomekpe and Emmanuel Fondi, 2009. Regeneration Guidelines: Banana. In: Dulloo M.E., Thormann I., Jorge M.A. and Hanson J., editors. Crop specific regeneration guidelines. CGIAR System-wide Genetic Resource Programme, Rome, Italy. 9 pp. http://cropgenebank.sgrp.cgiar.org/images/file/musa/Banana_ENG.pdf

C) The Musa germplasm Information System (MGIS) : http://www.crop-diversity.org/banana/#Home

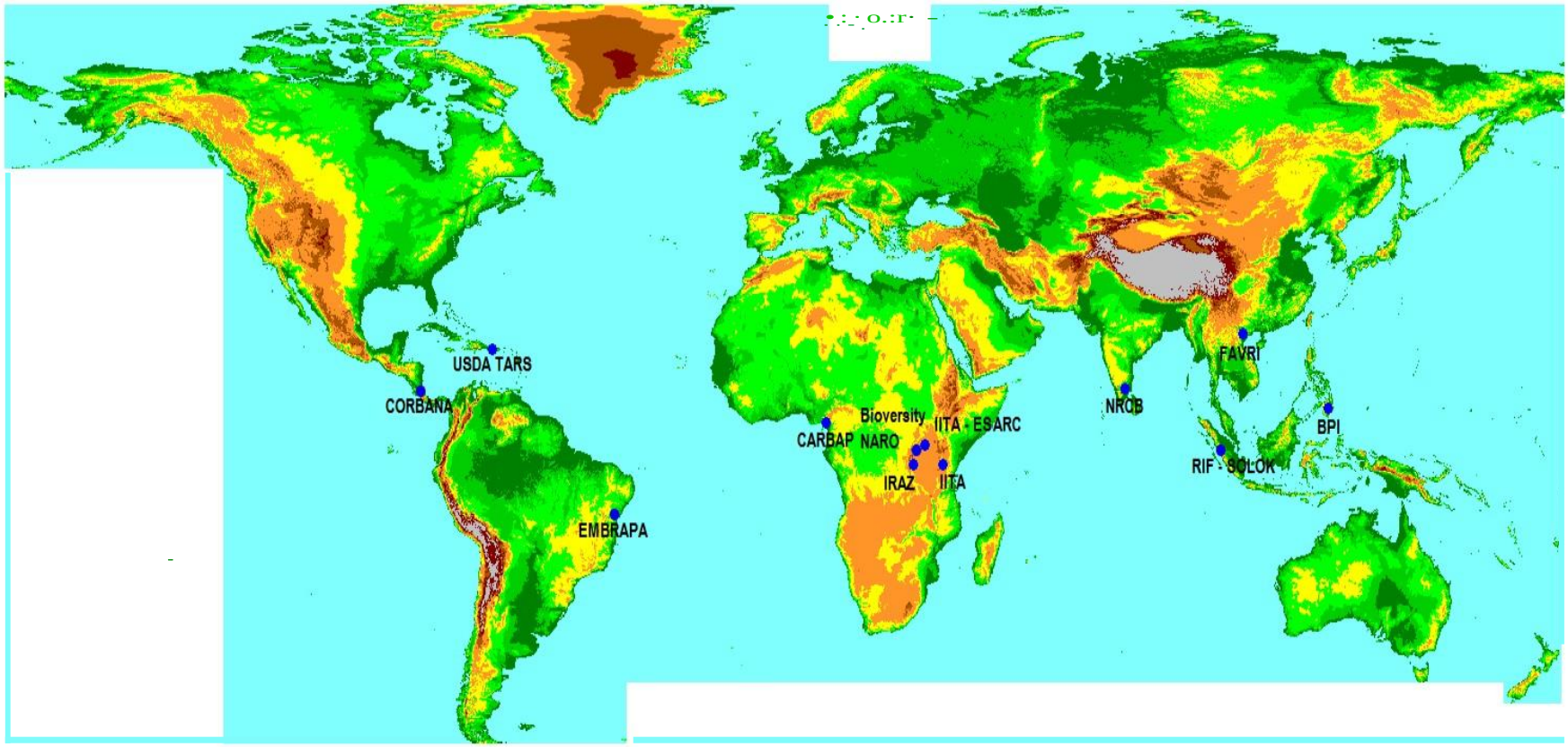
D) Jean Carlier, Dirk De Waele and Jean-Vincent Escalant, 2003. Global evaluation of Musa germplasm for resistance to Fusarium wilt, Mycosphaerella leaf spot diseases and nematodes- In-depth evaluation. http://bananas.bioversityinternational.org/files/files/pdf/publications/tg6_en.pdf

E) Excel Spread Sheet for providing data to the MGIS on the MINIMUM set of descriptors – file sent separately and upon request.

F) Excel Spread Sheet for providing data to the MGIS on the FULL set of descriptors – file sent separately and upon request.

G) Excel Spread Sheet for the EVALUATION descriptors (corresponding to Chapter 7 of the CIRAD/INIBAP/IPGRI, 1996. Descriptors for bananas.)

ANNEX 1: Map with sites for characterization



SDR-tAP

List of reference accessions

	ITC code	Accession name	Species or Genome	Subspecies or Subgroup
1	ITC0081	Igitsiri (Intuntu)	AAA	Mutika/Lujugira (beer)
2	ITC0084	Mbwazirume	AAA	Mutika/Lujugira (cooking)
3	ITC0121	Ihitisim	AAB	Plantain-Horn
4	ITC0123	Simili Radjah	ABB	Peyan
5	ITC0245	Safet Velchi	ABcv	Ney Poovan
6	ITC0247	Honduras	balbisiana	type 1
7	ITC0249	Calcutta 4	acuminata	burmannicoides
8	ITC0277	Leite	AAA	Rio
9	ITC0312	Pisang Jari Buaya	AA	Pisang Jari Buaya
10	ITC0361	Blue Java	ABB	Ney Mannan
11	ITC0450	Pisang Palembang	AAB	Pisang Kelat
12	ITC0472	Pelipita	ABB	Pelipita
13	ITC0519	Obubit Ntanga green mutant	AAB	Plantain- French sombre
14	ITC0575	Red Dacca	AAA	Red
15	ITC0587	Pisang Rajah	AAB	Pisang Raja
16	ITC0649	Foconah	AAB	Pome / Prata
17	ITC0653	Pisang Mas	AA	Sucrier
18	ITC0654	Petite Naine	AAA	Cavendish
19	ITC0659	Namwa Khom	ABB	Pisang Awak
20	ITC0662	Khai Thong Ruang	AAA	Ibota
21	ITC0766	Paliama	acuminata	banksii
22	ITC0767	Dole	ABB	Bluggoe
23	ITC0769	Figue Pomme Géante	AAB	Silk
24	ITC0825	Uzakan	AAB	Iholena
25	ITC1120	Tani	balbisiana	
26	ITC1121	Pisang Lilin	AA	Pisang Lilin
27	ITC1122	Gros-Michel	AAA	Gros Michel
28	ITC1169	Mai'a popo'ulu moa	AAB	Maia Maoli/Popoulu
29	ITC1177	Zebrina	acuminata	zebrina
30	ITC1187	Tomolo	AA	Cooking AA
31	ITC1287	Pisang Berangan	AAA	Philippine Lacatan/Sgr. 555
32	ITC1325	Orishele	AAB	Plantain-False Horn
33	ITC1441	Pisang Ceylan	AAB	Mysore
34	ITC1483	Monthan	ABB	Monthan

ANNEX 3. Handling of *in vitro* rooted plantlets

Clones are supplied by Bioversity's International Transit Centre (ITC) as rooted plantlets derived from tissue culture. *In vitro* rooted plantlets are distributed as sterile cultures, grown on a hardening medium in watertight Cultu saks®. Plantlets that are 5 to 10 cm tall and have well developed roots are ready for planting in pots. If plantlets are smaller or if transplanting is not immediately possible, it is advisable to place the plantlets in the Cultu saks® in an upright position under sufficient light (not direct sunlight), at a temperature of between 20 and 30°C. Under these conditions the plantlets can be kept for a few weeks.

To transplant rooted plantlets to the soil requires some care. Please proceed as follows or use your own proven method.

- Cut open each Cultu sak® chamber at one vertical edge.
- Carefully remove the plantlet from the Cultu sak® by holding the base gently with blunt-end forceps. Place the plantlet in the palm of your hand.
- Remove the culture medium adhering to the roots and leaves by placing the plantlet in a container of water (bucket) and shaking gently. Do not damage the stem nor the root system.
- Transplant the plantlet to plastic pots or bags (15-cm diameter) filled with a pasteurized mixture 30:70 peat:sand of which the upper 2 to 3 cm are fine (sifted). The upper roots should be covered by 2 to 3 cm of soil.

After transplanting, water plantlets immediately.

- Keep the plants in a high humidity atmosphere.
  - A simple humidity chamber can be constructed by enclosing a wooden frame in strong transparent plastic. The humidity chamber (about 40 to 60 cm high) is placed over the pots in a shaded area where the temperature is kept at 25 to 32°C.
  - The humidity inside the chamber is maintained by spraying water regularly to saturate the air. To minimize heat, build up inside the chamber, leave a 2 to 3 cm opening at the base to allow the air to circulate.
  - During the first week after transplanting, mist the humidity chamber twice a day to saturate the atmosphere. This is very important as low relative humidity at this stage could easily destroy the plantlets. Water the plants once a day with a little tap water.
  - One week after transplanting, spray the humidity chamber and the plants once a day.
- One month after transplanting, remove the plants from the humidity chamber.
- Keep the plantlets on a raised surface (not directly on the ground) in a nursery in a shaded area until they are about 30 cm tall (2 to 3 months before establishment in the field).
- Re-potting into a larger pot may be required.
- Transplant the plants into the field during the wet season, but not later than six weeks before the onset of the dry season.

ANNEX 4: Environmental data to be collected at each site from planting to harvest for each cycle (To be sent in Excel format. If needed, electronic forms can be provided by Bioversity International.)

Site:					
Surveyor:					
GPS Reference:					
Latitude:		Longitude:		Altitude:	
Planting date:					

Date to be collected	Month				
	1	2	3	4	…….
Rainfall (mm)					
Highest temperature (℃)					
Lowest temperature (℃)					
Average temperature (℃)					
Highest relative humidity (%)					
Lowest relative humidity (%)					
Average relative humidity (%)					
Number of days with rain					
Number of hours during which relative humidity > 90%					

ANNEX 5. Information on the 34 accessions (4 plantlets per accession) received of the ITC Musa reference collection.

Date of receipt of the ITC plantlets:	*day/month/year*
Date of acclimatization in hardening bed:	*day/month/year*
Date of transfer into pots/bags:	*day/month/year*
Date of field planting:	*day/month/year*
Date of flowering:	*day/month/year*

2. Number of plants per accession fully established in the field (from the 4 plantlets per accessions received from ITC):

ITC Accession Code	Accession name	Plants fully established (0-4)
ITC0081	Igitsiri (Intuntu)	
ITC0084	Mbwazirume	
ITC0121	Ihitisim	
ITC0123	Simili Radjah	
ITC0245	Safet Velchi	
ITC0247	Honduras	
ITC0249	Calcutta 4	
ITC0277	Leite	
ITC0312	Pisang Jari Buaya	
ITC0361	Blue Java	
ITC0450	Pisang Palembang	
ITC0472	Pelipita	
ITC0519	Obubit Ntanga green mutant	
ITC0575	Red Dacca	
ITC0587	Pisang Rajah	
ITC0649	Foconah	
ITC0653	Pisang Mas	
ITC0654	Petite Naine	
ITC0659	Namwa Khom	
ITC0662	Khai Thong Ruang	
ITC0766	Paliama	
ITC0767	Dole	
ITC0769	Figue Pomme Géante	
ITC0825	Uzakan	
ITC1120	Tani	
ITC1121	Pisang Lilin	
ITC1122	Gros-Michel	
ITC1169	Mai'a popo'ulu moa	
ITC1177	Zebrina	
ITC1187	Tomolo	
ITC1287	Pisang Berangan	
ITC1325	Orishele	
ITC1441	Pisang Ceylan	
ITC1483	Monthan	

3. Please indicate any other urgent issue that needs to be addressed by the ITC and the Bioversity team.

Annex 7 – List of Acronyms

Acronym	*Full name*
BAPNET	*Banana Asia-Pacific Network*
BARNESA	*Banana Research Network for Eastern and Southern Africa*
BBTD	*Banana Bunchy Top Disease*
BBTV	*Banana Bunchy Top Virus*
Bioversity	*Bioversity International (formerly IPGRI and IBPGR), Italy*
BLS	*Black Leaf Streak*
BPI	*Bureau of Plant Industry, Philippines*
BSV	*Banana streak virus*
CARBAP	*Centre Africain de Recherche sur Bananiers et Plantains, Cameroun*
CGIAR	*Consultative Group on International Agricultural Research*
CGKB	*Crop Genebank Knowledge Base of the CGIAR*
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement, France*
CORAF	*Conseil Ouest et Centre Africaine pour la Recherche et le Developpement Agricoles*
CORBANA	*Corporación bananera nacional, Costa Rica*
CRB	*Biological Resources Centre*
CRP	*CGIAR Research Programmes*
CRP-RTB	*CRP on Roots, Tubers and Bananas for Food Security and Income*
CTG	*MusaNet Conservation Thematic Group (Conservation Partnership)*
DAFF South Johnstone	*Agri-Science Queensland, Department of Agriculture , forestry and Fisheries, Queensland Government, South Johnstone, Australia*
DSA	*Data Sharing Agreement*
DTG	*MusaNet Diversity Thematic Group (Genetic Diversity Gap Filling, Taxonomy and Characterization)*
EMBRAPA	*Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Research)*
FAVRI	*Fruit and Vegetable Research Institute, Vietnam*
FV	*Field Verification*
GRIN	*Germplasm Resources Information Network, USA*
GRIN-GLOBAL	*Global version of the Germplasm Resource Information Network system*
IITA	*International Institute of Tropical Agriculture, Nigeria*
IMTP	*International Musa Testing Programme*
IPB	*Institute of Plant Breeding, Philippines*
IPGRI	*International Plant Genetic Resources Institute (now Bioversity International)*
IRAZ	*Institut de recherches agronomiques et zootechniques de la CEPGL, Burundi*
IRD	*Institute de Recherche de Développement*
ITC	*Bioversity International Transit Centre*
ITFRI	*Indonesian Tropical Fruit Research Institute, Indonesia*
ITG	*MusaNet Information Thematic Group (Germplasm Information and Documentation)*
KULeuven	*Katholieke Universiteit Leuven, Belgium,*
MGBMS	*Musa Gene Bank Management System of the ITC*
MGIS	*Musa Germplasm Information System*

MUSALAC	*Plantain and Banana Research and Development Network for Latin America and the Caribbean*
MusaNet	*Global Musa Genetic Resources Network*
NARO	*National Agricultural Research Organisation, Uganda*
NARS	*National Agricultural Research Station*
NRMDC	*National Repositories Multiplication and Distribution Centres*
NRCB	*National Research Centre for Banana, India*
OT	*Off Type*
OLGA	*Outil Locale pour la Gestion des Accessions*
PAPGREN	*Pacific Plant Genetic Resources Network*
RMDC	*Regional Multiplication and Distribution Centres*
SDR-MAP	*Service du développement rural, French Polynesia, Tahiti*
SMTA	*Standard Material Transfer Agreement*
SPC	*Secretariat of the Pacific Community, Pacific Islands*
TAG	*Taxonomic Advisory Group*
TGSMG	*Technical Guidelines for the Safe Movement of Germplasm*
TRC	*Taxonomic Reference Collection*
TT	*True to Type*
Trust	*The Global Crop Diversity Trust, Germany*
UPLB	*University of the Philippines Los Baños, Philippines*
USDA	*United States Department of Agriculture, USA*
USDA-ARS	*United States Department of Agriculture, Tropical Agriculture Research Station, Puerto Rico, USA*