Report on the MusaNet Latin American and Caribbean Regional Workshop on *Musa* Characterization and Documentation, Guápiles, Costa Rica

Organised by MusaNet, Bioversity International and CORBANA

12-17 November 2018

Table of Contents

Background

The Global *Musa* Genetic Resources Network (MusaNet, www.musanet.org), in partnership with Bioversity International and the Corporación Bananera Nacional of Costa Rica (CORBANA), held a workshop to address the need for a standardized characterization and documentation methodology for bananas (*Musa spp)*. This fourth regional MusaNet workshop took place in Guápiles, Costa Rica, from 12-17 November 2018. The workshop was built on the experience of three previous regional MusaNet workshops: in 2015 at the Centre Africain de Recherches sur Bananiers et Plantains (CARBAP) in Cameroon, in 2016 at the National Agricultural Research Organization (NARO) in Uganda and in 2017 at the Malaysian Agricultural Research and Development Institute (MARDI) in Malaysia.

In attendance at the Costa Rica workshop were 14 invited curators of national *Musa* collections and members of the Latin American and Caribbean (LAC) banana network, MusaLAC (http://banana-networks.org/musalac/). Also present were key experts and staff from CORBANA and Bioversity International who developed the programme and background documents.

The **overall aim** of the workshop was to forge a standardized characterization and documentation methodology for LAC national *Musa* collections.

The **objectives** of the workshop were to:

- Review and better understand the status and characterization methodology of each of the countries' field collections.
- Have a common understanding and agree on the minimum descriptors used to characterize *Musa spp*.
- Share knowledge and experience to promote best practices for the field management of *Musa* germplasm collections.
- Test and validate the mobile device application (MusaTab) for gathering data in the field – including data entry and data management.
- Discuss and propose solutions for optimum *Musa* germplasm data management (using the *Musa* Germplasm Information System (MGIS)).
- Discuss the next steps towards a standardized *Musa* characterization and documentation methodology.
- Demonstration on early screening methods for priority traits such as resistance to nematodes and Black leaf streak.

Summary of the Workshop Programme

The workshop was divided into the following sessions (see *Annex 1* for the full programme):

- Opening session
- Session 1: Introduction to the workshop
- Session 2: Field Exercise and discussions
- Session 3: Documentation and sharing of information
- Session 4: Next steps
- Session 5: Conclusion and workshop evaluation
- Session 6: Evaluation experiments at CORBANA

This report, by the MusaNet Secretariat, serves as an official record of the workshop, including links to all presentations (in pdf format). This report and all the presentations are also downloadable from the MusaNet website (www.musanet.org) under the tab 'Meetings'.

Opening session

The workshop was officially opened on Monday 12 November 2018 with words of welcome by CORBANA general manager Jorge Sauma, Bioversity International Costa Rica office coordinator Anna Muller (link to Anna's presentation), and a presentation by MusaNet Coordinator**,** Nicolas Roux (Bioversity International). Link to Nicolas' presentation. Jorge Sandoval, Director of Research at CORBANA, also warmly welcomed participants.

Fig 1. The opening session of the LAC regional workshop. Left: Jorge Sauma, Anna Muller and Nicolas Roux. Right: Jorge Sandoval, Director of Research at CORBANA, welcoming participants.

Session 1: Introduction to the workshop and curator presentations

Objectives of the session

- Clear understanding of the purpose of the workshop, aim and objectives
- Introduction of each participant, their institute and position
- Participants' expectations of what will be achieved during (and after) this workshop
- Presentations illustrating each curator's collection, its history, status, strengths and challenges

Rachel Chase (Bioversity International) gave an overview of the aims and objectives of the workshop and presented the programme for the week (see *Annex 1*).

Each participant then introduced themselves by stating their name, position and institute. They were also asked to share their expectations for this workshop, including their personal objectives. General expectations of all participants are summarized below.

Contact information, including names, institutes and email addresses for all participants is found in *Annex 2*.

Participants' expectations of the workshop

- To be part of and benefit from the MusaLAC group
- To improve our genebank in terms of missing characterization information
- To 'speak the same language' about banana germplasm
- To work together toward common goals
- To acquire skills in characterization
- To share experiences and exchange information
- To collaborate with other countries
- To have a clear vision on why and how to maintain germplasm

Curator Presentations

The 14 collection curators each made a short presentation on the current status of their collections (links to presentations in pdf are below):

1. Brazil (EMBRAPA) – Janay Almeida dos Santos Serejo
2. Colombia (Agrosavia) – Alvaro Caicedo Arana
3. Colombia (FEDEPLATANO) – Silverio González
4. Costa Rica (CORBANA) – Miguel González
5. Cuba (INIVIT) – Lianet González Díaz
6. Dominican Republic (IDIAF) – Ewddy Pérez Carrera
7. Ecuador (INIAP) – Geover Peña Monserrate
8. Guadeloupe (CIRAD) – Michel Roux-Cuvelier
9. Jamaica (Banana Board) – Errol Steen
10. Mexico (INIFAP) – Mario Orozco Santos
11. Panama (IDIAP) – David Ramos
12. Peru (INIA) – Juan Carlos Rojas Llanque
13. Puerto Rico (USDA) - Tomas Ayala-Silva
14. Venezuela (INIAP-CENIAP) – Gustavo Martinez

Experts

Musa taxonomists and members of the Taxonomic Advisory Group (TAG) of MusaNet Christophe Jenny (CIRAD) and Gabe Sachter-Smith were invited to the workshop to instruct and offer guidance to participants in the field and during discussions.

Introduction to bananas

Gabe Sachter-Smith gave a general overview on the major types of bananas worldwide. Link to Gabe's presentation.

Photography guidelines for the field

Christophe Jenny and Max Ruas (Bioversity International) then presented how to take good photographs of plants when doing field work. Link to Christophe's presentation.

Christophe also provided guidelines for the minimal description of bananas (English) (Spanish), which contains the following information:

- Description of pictures
- A synthetic table of the pictures to be taken.
- A form with some complementary information, in order to precise the conditions of observation of the plant.
- A short protocol for preparing and sending leaves samples
- Annex illustrating the various steps of this protocol with schemes and photographs.

Digital Agriculture Services

Carlos Quiros (Bioversity International, Costa Rica) presented IBM Watson, which allows farmers to connect directly through a mobile phone to a help network to get information on agricultural practices and issues. Link to Carlos's presentation.

Session 2: Description and discussion of field exercise

The field and discussion sessions were held over three days at the CORBANA station in Guápiles, consisting of mornings in the field collection and afternoons in the meeting room discussing the descriptors that were scored each morning. All participants scored the same four banana accessions using the Minimum List of Descriptors for *Musa* (see Annex 3) on their individual tablets. Rachel Chase explained the objectives and procedure to be followed on Tuesday morning 13 November.

Objectives of the Field Exercise

- Share experiences on the interpretation of the Minimum List of Descriptors for *Musa* and agree on the most appropriate modifications needed
- Training of and feedback on using the tablets and the applications MusaTab and MusaID
- Knowledge and training on characterizing *Musa* in general

The Minimum List of Descriptors for *Musa*

The field work focused on the Minimum List of Descriptors for *Musa*, which is a compilation of 34 descriptors extracted from the book *Descriptors for Banana* (IPGRI/CIRAD 1996) that are considered highly discriminating for *Musa*. The minimum list was developed by the Taxonomic Advisory Group (TAG) of MusaNet in 2010 and has been revised several times following previous MusaNet workshops (see Background on page 1), where participants were able to test and give feedback on the list. The Minimum List of Descriptors for *Musa* is published on the MusaNet website and also found in *Annex 3* of this report.

Introduction to the mobile device and application

Before the field sessions began, Max Ruas presented the mobile device (tablet) and the MusaTab application that was developed by Bioversity International for the field characterization of bananas. The application contained the Minimum List of Descriptors for *Musa* divided into 3 field sessions for the four pre-selected banana accessions that will be scored for the workshop. He showed the curators the many functions of MusaTab and how they would record the descriptors into their tablets during the field sessions. Link to Max's presentation.

For more information on MusaTab, see the project page on MusaNet - https://sites.google.com/a/cgxchange.org/musanet/projects/musatab

Groups for the Field Exercise

Table 1. For the field sessions, each of the four groups was composed of three to four curators, a group leader and an assistant. Each group had a different coloured bandana (in parentheses).

	Group A (red)	**Group B (black)**	**Group C (blue)**	**Group D (green)**
Leaders	**Nicolas**	**Christophe**	**Gabe**	**Jorge**
Curators	Miguel Gonzalez (CORBANA)	Michel-Roux Cuvelier (Cirad)	Janay Serejo (EMBRAPA)	Alvaro Caicedo Arana (Agrosavia)
	Silverio Gonzalez Florez (FEDEPLATANO)	Juan Carlos Rojas Llanque (INIA)	Errol Steen (Banana Board)	Ewddy Perez Carrera (IDIAF)
	Gustavo Martinez (INIAP-CENIAP)	Mario Orozco Santos (INIFAP)	Tomas Ayala-Silva (USDA)	David Ramos (IDIAP)
	Lianet Gonzalez Diaz (INIVIT)	Marco Acuña (local farmer, Wed. only)		Geover Pena (INIAP)
Assistants	Rachel Chase	Max Ruas	Cindy Castillo	Bryan Alfaro Perez

Field Exercise (mornings of 13-15 November)

The field exercise focused on the following four accessions in the CORBANA field collection.

1. *Musa truncata* (AAw)
2. Dominico 500 (AAB)
3. Pelipita (ABB)
4. Datil (AA)

Each day of the field exercise, the four groups rotated among the four accessions scoring the Minimum List of Descriptors for *Musa* on their tablets. Each group spent approximately 30 minutes at each accession. The minimum list was divided into three sections – one for each day:

Tuesday 13 Nov: Field Exercise 1 – 15 descriptors (Vegetative)

Wednesday 14 Nov: Field Exercise 2 – 11 descriptors (Floral)

Thursday 15 Nov: Field Exercise 3 – 8 descriptors (Fruit)

Curators were asked not to communicate within their groups during the field exercise in order to have the most realistic and objective representation of results. Group leaders were there only to guide them. Curators were also asked to take photos of the descriptors using their tablets for practice and to serve as a reference during the discussions.


Fig 2. The characterization exercises that took place over three mornings at the CORBANA field collection.

Discussions in the meeting room (afternoons of 13-15 November)

- For each descriptor, the results for the four accessions were displayed by projector. These results for all three days are found here for Vegetative Descriptors, Floral Descriptors and Fruit Descriptors.
- During the discussion, photos of each accession and descriptor were also projected next to the graph for visual reference. Link to comparative photos of the four accessions.
- Led by experts Christophe Jenny and Gabe Sachter-Smith, the participants discussed the results (bar graphs – see links above) and examined the photos of each descriptor.
- They then discussed the possible reasons for the discrepancies (if any) and how the descriptors could be improved to reduce discrepancies among curators. This process was repeated for all four accessions.
- This process was repeated for all the descriptors.

Fig 3. Left: Group discussion of the descriptors in the CORBANA meeting room. Right: The results and photos of each descriptor were displayed during the discussions.

Visit to EARTH Institute

In the afternoon of Tuesday 13 November, the group made a visit to the EARTH institute to see their banana collection. Director of Research Professor Luis Pocasangre gave a brief tour of a field trial on agroecological practices and integrated pest management. This was followed by a visit to the EARTH *Musa* field collection.

Fig 4. Tour of the EARTH institute field collection (left) led by Luis Pocasangre (right).

Tour of the CORBANA Banana Field Collection and Research Centre and field management session

On Wednesday 14 November, CORBANA curator Miguel Gonzalez gave an overview of the germplasm present in the collection and led a discussion on field management techniques used in the field. The participants were then given a tour of the various laboratories on the CORBANA campus, including those working on nematology, phytopathology, tissue culture, chemical and physical analysis of soils, molecular biology, biological control, agrophysiology and the Banaclima programme.

Fig 5. The tour of the CORBANA field collection, led Miguel Gonzalez (centre).

Fig 6. The tour of the CORBANA research centre labs, including tissue culture, soil analyses, phytopathology and nematology.

Banana Mapper

Max Ruas presented a powerpoint prepared by David Brown (Bioversity International, Costa Rica) on the banana mapper (www.crop-mapper.org/banana), a web mapping application that aims to collect and share spatial information on global banana production in a single centralized database. Link to David's presentation.

iNaturalist

Christophe Jenny presented iNaturalist, an online citizen science project and social network of naturalists who report observations of plants and animals with spatial information, notes and photos. He has developed a 'banana natural biodiversity mapping' subpage of iNaturalist and encourages everyone to participate. Link to Christophe's presentation (Spanish) (English).

For further information on iNaturalist, go to the MusaNet project page:
https://sites.google.com/a/cgxchange.org/musanet/news/inaturalistgeographicalorganizationoftheinsitudiversityofmusa

The ITC Usage Survey and Impact Study for LAC

Sirena Montalvo-Katz virtually presented her work on the impact assessment of ITC accessions over the last 15 years in the LAC region. Over a two-year period working for Bioversity, she contacted LAC *Musa* collections that had ordered ITC germplasm and asked them questions (through the Usage Survey) on their maintenance, importance and impact within their countries. The study focuses on three cases (USDA, INIVIT and CORBANA) that describe in depth how accessions are used and who benefits from them at different levels of usage. Link to Sirena's presentation.

MusaID demonstration in the field

On Thursday morning 15 November, Max Ruas demonstrated the updated version of MusaID in the CORBANA collection, which each participant already had on their tablet. MusaID is a taxonomy decision-making aid package that helps users to identify an unknown taxonomic unit (taxon) by comparison with a reference collection of known taxa described by a set of qualitative descriptors. It is designed to assist researchers with identifications, and it is also a useful working tool for taxonomists. Taxa are identified through an interactive step-by-step process, with a descriptor assigned a value at each step. The descriptor is selected by the user, or it is proposed by the system in order to optimize the identification sequence by minimizing the number of characters required. The progress of an identification session is evaluated by likelihood measurements, indicating the extent to which an unknown taxon is identical to taxa of the reference collection.

MusaID uses as a reference the CIRAD field collection in Guadeloupe that is fully documented using the Descriptors for Banana (IPGRI/CIRAD 1996). This important tool can be significantly improved if more national collections could be fully documented and integrated as references.

For further information on MusaID, go to the MusaNet project page: https://sites.google.com/a/cgxchange.org/musanet/projects/musaid

Session 3: Documentation and sharing of information

Objectives of the session

- Understanding how to link the tablet to a personal computer for data upload and storage.
- Introduction to the new MGIS interface and its features
- Overview of the MusaNet website
- Presentation and discussion of 10 varieties for each country
- Discussion of synonyms across countries

MGIS website

Max Ruas introduced the MGIS website and discussed its functions/applications (https://www.crop-diversity.org/mgis/). The new interface has many new features such as the accessions search page on which we take time to explain the several criteria available. An emphasis was put on the possibility to request material from ITC directly online by going through the different step of the request process. We thanked the new partners who signed the MGIS Data Sharing Agreement (DSA) and provided their data prior to the workshop.

MGIS.net

Max also installed MGIS.net on all the curators' personal computers during the week and had a session on how to use it on Friday afternoon 16 November. Max showed everyone how to enter a new accession in their collection and how to edit the data of an accession. They also tested the transfer of data from MGIS.Net to MusaTab regarding field characterization, entered data into MusaTab and moved the observations into the database.

MusaNet website

Nicolas Roux and Rachel Chase showed the participants the main features of the MusaNet website (www.musanet.org), including the tabs for the Expert Committee, link to MusaLAC, the *Musa* collection pages and technical guidelines and other publications. Rachel emphasized the importance of the collection pages for better visibility of all the LAC collections and asked that everyone please update the information by sending it to her by email (r.chase@cgiar.org). It was agreed to add more information on the threat of Fusarium Wilt (TR4) which is especially important for the LAC region, and to include environmental data for each collection (e.g. soil, elevation, climate).

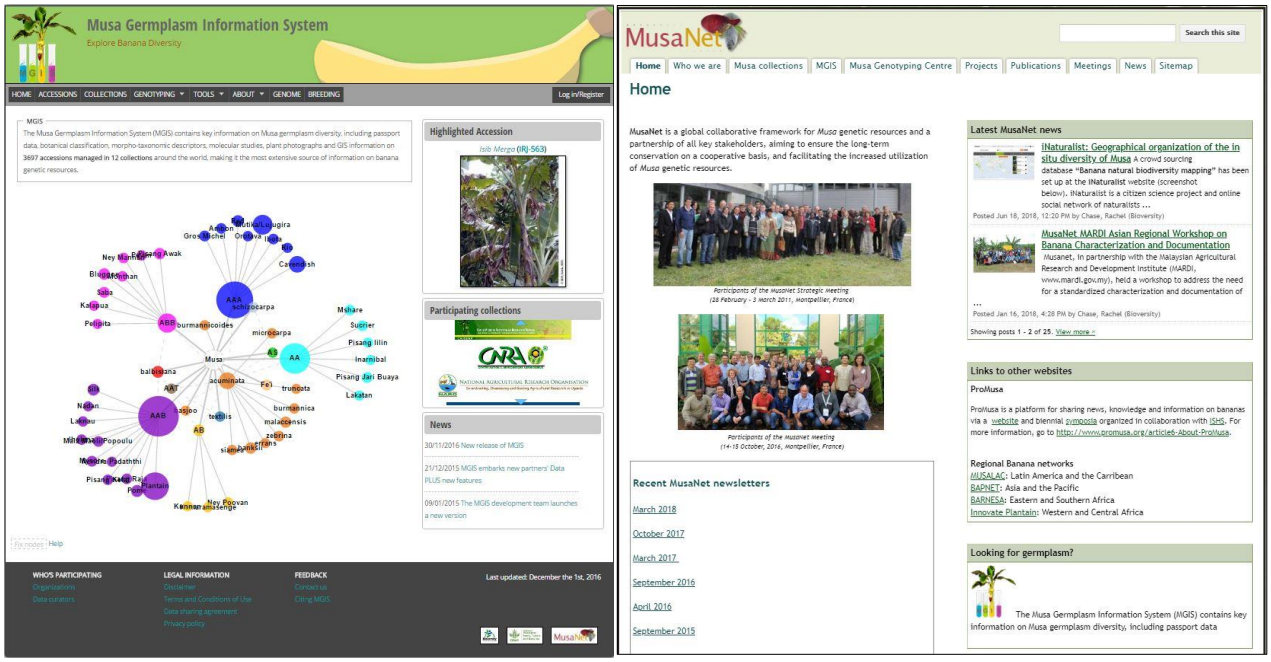


Fig 7. MGIS (left) and MusaNet (right) websites.

Top 10 varieties of *Musa* by country

Before the workshop, all curators provided a list of the top 10 varieties of *Musa* (most popular according the consumer) in their respective country, including common name, genome group and usage (e.g. cooking, chips). During the workshop, each participant presented their country's top 10 varieties, which allowed the group to see the common and different varieties across the LAC region. Link to the top 10 by each country presentation.

Macropropogation at FEDEPLANTANO

Silvero Gonzalez gave an overview of their macroprogation protocol at FEDEPLANTO. Link to Silverio's presentation.

Session 4: Next steps

Objectives of the session

- To discuss and agree on the next steps after the workshop toward achieving the overall aim and objectives, and participants' expectations

It was agreed that some minor revisions are still needed to finalize the Minimum List of Descriptors for *Musa*. This work will continue with the MusaNet Taxonomic Advisory Group in the months following the workshop, with a goal to release the revised list soon as possible. After the modifications, the descriptors should be tested by curators to confirm if they are accurate and adequately capture the diversity of bananas.

To summarize, the particular activities below were proposed for immediate action following the workshop, with the responsible person in bold type:

- **Rachel** to collaborate with the MusaNet Taxonomy Advisory Group on revising the Minimum List of Descriptors for *Musa* (following comments from the workshop discussions).
- **Max** to finalize work on the mobile device application MusaTab and MusaID with software developers for release of improved version.
- **All curators** to send by email to Rachel up-to-date information (including environmental data) about their respective collection so that she can update it on the MusaNet website.

In addition, there are five points of future collaboration expressed by Nicolas in an email sent to all participants after the workshop:

1. **Homologation of cultivar names:** Publication of the synonyms of the cultivars in LAC. As it was done for Asia: "Banana grow names and synonyms in South East Asia" (Valmayor et al., 2000).
2. **Increase the number of institutes with DSA**: Ensure that the LAC institutes that have not yet signed the Data Sharing Agreement (DSA) do so as soon as possible. Also, that the institutes that already signed, send the data of their collection to Max (at least the Passport data). This will allow us to do "cross references" and thus improve the data quality (names and classification taxonomy) of all LAC collections.
3. **Creation of security duplicates**: Once we have the information of each collection and compare it with what is in ITC, the national collections can duplicate their unique material and send us 2-3 suckers (corms with shoots) from each accession to ITC to ensure the safeguarding of biodiversity. For each of the accessions, ITC will make a molecular characterization (ploidy via flow cytometry and SSR markers for group/subgroup determination) and clean them of virus (if necessary). Then the accessions will be stored in the medium-term (in-vitro) and long-term (in cryo-preservation) storage facilities. It is important to know that each country that sent material to ITC can, at any time, request the return of its clean, characterized and in-vitro material. An example to illustrate how to have security duplicates is important, it is the case of the Philippines where the in-vitro national laboratory was burned, and they managed to recover the majority of their collection after ITC returned them their material.
4. **Maintain collaborative networks and the exchange of information**: It is important to continue working not only with Bioversity (ITC, MGIS and other activities) but also directly with each other. It is very important to support countries with difficulties to maintain a *Musa* collection and help them to show their governments the value and importance of conserving these generic resources.
5. **Share information of the collections**: publish a catalogue of your collection with photos, minimum descriptors and flavours. So that curators, scientists or other people interested in conserving or knowing about the *Musa* diversity have access to this information.

Session 5: Conclusion and workshop evaluation

Objectives of the session

- Review of the workshop Aim and Objectives
- Round table from curators on their overall impressions of the workshop
- Personal, anonymous evaluation of the workshop
- Presentation of certificates to participants

Based on a round table discussion by the participants, it was felt that the MusaNet CORBANA workshop achieved the following key outcomes:

- Full participation of the curators from Latin American and Caribbean collections
- Inventory of the 10 most popular varieties per country

- Better understanding of how to score *Musa* descriptors with a tablet
- Agreement on the revision of the Minimum List of Descriptors for *Musa*
- Practical use and feedback on the mobile device (tablet), MusaTab for collecting data in the field
- Better understanding of how to use MusaID for identifying an accession
- Understanding of the features of the new MGIS website and MusaNet website
- Shared experiences of the practices and constraints in establishing, maintaining and managing a field collection
- Exchange of knowledge on best practice field management and documentation

The anonymous evaluation forms completed at the end of the workshop indicated that the majority of participants thought the sessions were very relevant to the workshop objectives and that the time spent on each session was appropriate. Logistical and hosting arrangements were also well received and overall the participants felt that it was an excellent and productive workshop. The results of the evaluations are available on demand – please contact the MusaNet secretariat.

Session 6: Evaluation experiments at CORBANA

The bonus Saturday morning session included presentations on research currently being done at CORBANA on Black leaf streak, nematodes, integrated soil management, Banaclima and biological control. The links to all presentations are found here:

Black Leaf Streak (Mauricio Guzman)

Integrated management of the soils and response of the banana crop (Pedro Emilio Torres Asuaje and Rafael Segura Mena)

Banaclima (Miguel Gonzalez)

Biological control (Claudiana Carr)

Acknowledgements

The MusaNet LAC regional workshop in Guápiles, Costa Rica was made possible thanks to the financial contribution from the German Development Cooperation (GIZ), the CGIAR Research Program (CRP) Roots, Tubers and Bananas (RTB) and the CGIAR Genebanks Platform which are supported by CGIAR Trust Fund Donors. MusaNet is grateful to the many individuals and their respective organisations for supporting the overall goal of the workshop.

Great appreciation goes to Jorge Sandoval, Sonia Jara, and the staff at CORBANA for their excellent organization, professionalism, warm hospitality and expertise in the field collection and research centre. Special thanks go to the workshop organizing committee (Nicolas Roux, Max Ruas, Rachel Chase, Luis Allen, Karol Araya and Jorge Sandoval, Miguel Gonzalez, Christophe Jenny and Gabe Sachter-Smith) for their hard work preparing the workshop months in advance, and to Karol Araya, Luis Allen, Cindy Castillo, Bryan Alfaro and Corine Loiseau (Bioversity International) for their support prior to and during the workshop. This report was written by Rachel Chase and translated into Spanish by Vanessa Ocampo. Finally, thank you also to all the participants from the MusaLAC region for their very active participation that made this workshop a real success!

THANK YOU / MUCHAS GRACIAS!!!

Annex 1. Programme for the MusaNet Latin American and Caribbean Regional Workshop on *Musa* Characterization and Documentation

DAY 1	MONDAY 12 NOVEMBER 2018
08:30-10:30	**OPENING SESSION –** welcome messages and introductions (10 mins each) • **CORBANA general manager** – Dr. Jorge Sauma • **Bioversity International Costa Rica office coordinator** – Dr. Anna Muller • **MusaNet Coordinator** – Dr. Nicolas Roux **Introduction to the Workshop -** Rachel Chase **Aim**: To forge a standardized characterization and documentation methodology for Latin American and Caribbean (LAC) national *Musa* collections. **Overview of the Objectives of the workshop** (5 mins) • Review and better understand the status and characterization methodology of each of the countries' field collections. • Have a common understanding and agree on the minimum descriptors used to characterize *Musa spp*. • Share knowledge and experience to promote best practices for the field management of *Musa* germplasm collections. • Test and validate the mobile device application for gathering data in the field – including data entry and data management. • Discuss and propose solutions for optimum *Musa* germplasm data management (using the *Musa* Germplasm Information System (MGIS)). • Discuss the next steps towards a standardized *Musa* characterization and documentation methodology. • Demonstration on early screening methods for priority traits such as resistance to nematodes and Black leaf streak. **Presentation of workshop programme** (5 mins) **Round table introductions and expectations from participants** (30+ mins)
10:30-11:00	***Coffee/tea break + Group photo!***
11:00-13:00	**SESSION 1: INTRODUCTION TO THE WORKSHOP (cont)** **Presentations from curators** • Presentation of each partner collection (**10 mins each**) ➢ Brazil (EMBRAPA) – Janay Almeida dos Santos Serejo ➢ Colombia (Agrosavia/CORPOICA) – Alvaro Caicedo Arana ➢ Colombia (FEDEPLATANO) – Silverio González Florez ➢ Costa Rica (CORBANA) – Miguel González ➢ Cuba (INIVIT) – Lianet González Díaz ➢ Dominican Republic (IDIAF) – Ewddy Pérez Carrera ➢ Ecuador (INIAP) – Geover Peña Monserrate ➢ Guadeloupe (CIRAD) – Michel Roux-Cuvelier ➢ Jamaica (Banana Board) – Errol Steen
13:00-14:00	***Lunch***

14:00-15h30	Continue presentations of collections ➢ Mexico (INIFAP) – Mario Orozco Santos ➢ Panama (IDIAP) – David Ramos ➢ Peru (INIA) – Juan Carlos Rojas Llanque ➢ Puerto Rico (USDA) - Tomas Ayala-Silva ➢ Venezuela (INIAP-CENIAP) – Gustavo Martinez
15:30-15h45	***Coffee/tea break***
15:45-17:30	• Presentation on different types of banana (Gabriel Sachter-Smith) - 30 mins • Presentation on taking good photos (Christophe Jenny) - 30 mins • Presentation on Digital Agriculture service (Carlos Quiros) - 20 mins
19:00-	**Opening dinner at Hotel Suerre**
DAY 2	**TUESDAY 13 NOVEMBER 2018**
08:30-9:45	**SESSION 2: FIELD EXERCISE** **In the meeting room:** **Description of the field exercise for the next 3 days (30 mins) –** Rachel Chase • Description of the process • Description of the 4 accessions to be scored • Explanation of the 4 working groups • Explanation of the descriptors to be scored in the field over the 3 days – 1) vegetative parts 2) flowers and 3) fruits • Questions of clarification and agreement **Presentation of the mobile device (30 mins) -** Max Ruas How to use the mobile device and MusaTab in the field and record data
9:45-10:00	***Coffee/tea break***
10:00-13:00	**FIELD EXERCISE - Vegetative descriptors (15) - *45 mins/accession***
13:00-14:00	***Lunch***
14:00-15:30	**Discussion in the meeting room of the Vegetative descriptor results**
15:30-15:45	***Coffee/tea break***
15:45-	**Field Trip to EARTH Institute**
	Free evening

DAY 3	WEDNESDAY 14 NOVEMBER 2018
08:30-11:30	**FIELD EXERCISE-Flower descriptors (11) - *30 mins/accession*** ***(coffee/tea break in the field at 10:00)***
11:30-13:00	**Tour of the CORBANA Banana Field Collection and Research Centre + field management session** (Miguel González)
13:00-14:00	***Lunch***
14:00-16:00	**Discussion in the meeting room of the Vegetative and Flower descriptor results**
16:00-16:15	***Coffee/tea break***
16:15-17:30	• Presentation on banana mapper (David Brown) – 20 mins • Presentation on iNaturalist (Christophe Jenny) – 20 mins • Presentation on the ITC Usage Survey and Impact Study (Sirena Montalvo-Katz) – 20 mins
	Free Evening
DAY 4	**THURSDAY 15 NOVEMBER 2018**
8:30-10:00	**Documentation and sharing Information** Musa.ID and iNaturalist demonstration in the field (Max and Christophe) (1 hr)
10:00-10:15	***Coffee/tea break in the field***
10:00-13:00	**FIELD EXERCISE – Fruit descriptors (8) -*30 mins/accession***
13:00-14:00	***Lunch***
14:00-16:00	**Discussion in the meeting room of the Fruit descriptor results**
16:00-16:15	***Coffee/tea break***
16:15-17:30	• Presentation of Musanet website (Rachel) – 15 mins • Presentation of MGIS website (Max) – 15 mins • Discussion of top 10 varieties for each country and cultivar synonyms (Nicolas) - 30 mins
19:00-	**Social Dinner**

DAY 5	FRIDAY 16 NOVEMBER 2018
07:00-12:30	Field Trip
13:00-14:00	***Lunch***
14:30 - onwards	**SESSION 3: DOCUMENTATION AND SHARING OF INFORMATION** MGIS set up and training (Mobile device to computer with USB keys)- Max **CONCLUSION AND EVALUATION –** Rachel • Round table on personal impressions of the workshop and what we achieved – (30mins) • Evaluation of the workshop by participants – (30mins) **CLOSING SESSION** • Closing remarks ➢ Nicolas Roux (15 mins) ➢ Jorge Sauma (15 mins) • Distribution of certificates to participants (30 mins)
	Free Evening
DAY 6	**SATURDAY 17 NOVEMBER 2018**
9:30-13:00	**EVALUATION SESSION** Demonstration of screening experiments at CORBANA - Black leaf streak (Mauricio Guzman), nematodes (Pedro Torres), nutrition (Rafael Segura), biological control (Claudiana Carr)
13:00-14:00	***Lunch***
14:00-	**Departure of participants to San Jose**

Annex 2. Contact list of participants at the MusaNet CORBANA workshop

MUSANET/CORBANA Regional LAC Workshop
Guapiles, Costa Rica
12-17 November 2018

PARTICIPANTS

PAX	NAME	INSTITUTE	COUNTRY	CORREO ELECTRÓNICO	SIGNATURE
1	David Ramos	IDIAP	Panama	davramos31@yahoo.es	
2	Ewddy Pérez Carrera	IDIAF	Dominican Rep	neris_1989@hotmail.com	
3	Geover Peña Monserrate	INIAP (Pichilinge)	Ecuador	geover.pena@iniap.gob.ec	
4	Juan Carlos Rojas Llanque	INIA	Peru	bananaperu@yahoo.com; vflorida_frutales@inia.gob.pe	
5	Lianet González Díaz	INIVIT	Cuba	geneticamusa@inivit.cu	
6	Janay Almeida dos Santos Serejo	EMBRAPA	Brazil	janay.serejo@embrapa.br	
7	Gustavo Martinez	INIAP-CENIAP	Venezuela	martinezgve(at)yahoo.es	
8	Alvaro Caicedo Arana	Agrosavia (CORPOICA)	Colombia	acaicedo@agrosavia.co	
9	Errol Steen	Banana Board	Jamaica	errole3@yahoo.com	
10	Tomas Ayala-Silva	USDA	USA /Puerto Rico	Tomas.Ayala-Silva@ARS.USDA.GOV	
11	Mario Orozco	INIFAP	Mexico	orozco.mario@inifap.gob.mx	
12	Michel Roux-Cuvelier	CIRAD	Guadeloupe	michel.roux-cuvelier@cirad.fr	
13	Miguel Gonzalez	CORBANA	Costa Rica	mgonzalez@corbana.co.cr	
14	Silverio Gonzalez	FEDEPLATANO	Colombia	silveriogonzalez2003@yahoo.es	
15	Bryan Alfaro	CTP La Suiza	Costa Rica	bryanalfaro45674@gmail.com	
16	Cindy Castillo	BIOVERSITY	Costa Rica	c.castillo@cgiar.org	
17	Jorge Sandoval	CORBANA	Costa Rica	JSANDOVAL@corbana.co.cr	
18	Nicolas Roux	BIOVERSITY	France	n.roux@cgiar.org	
19	Max Ruas	BIOVERSITY	France	m.ruas@cgiar.org	
20	Rachel Chase	BIOVERSITY	France	r.chase@cgiar.org	
21	Christophe Jenny	CIRAD	France	christophe.jenny@cirad.fr	
22	Gabriel Sachter-Smith	-	Hawaii	gabe.sachter@gmail.com	

Annex 3. Minimum List of Descriptors for *Musa* used during the MusaNet CORBANA workshop

Minimum List of Descriptors for *Musa*

Developed by the MusaNet Taxonomy Advisory Group – version Sept 2018

INTRODUCTION

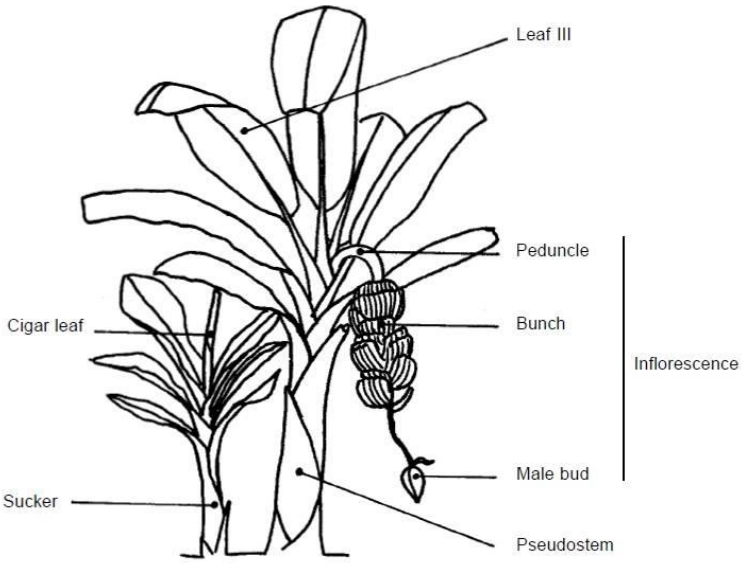
These guidelines, recently revised in 2018, aim to establish a standardised procedure for the routine morphological characterization of banana plants. Photographs are provided to help score the minimum descriptors. For any question, remark and feedback on these guidelines, please contact Rachel Chase (r.chase@cgiar.org) or Nicolas Roux (n.roux@cgiar.org).

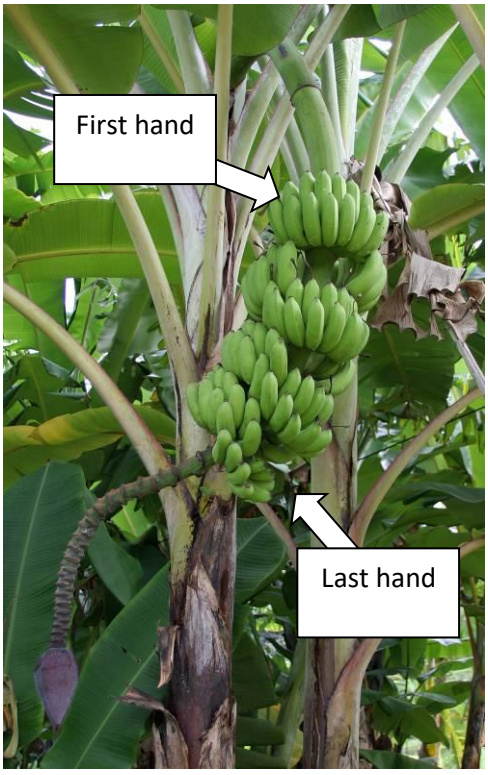
THE APPROPRIATE DEVELOPMENT STAGE FOR OBSERVATION

The best time to take photos and document the descriptors is when the fruit are green-ripe or yellowing ("harvest time"), and the rachis is at least 45 cm long (15 inches). All descriptors should be scored at harvest **except** for descriptors 6.3.1, 6.3.3, 6.3.4a, 6.3.4b, 6.3.6, 6.3.7 that should be recorded at flowering time (emergence of the inflorescence) to avoid the desiccation of the petiole margin that often occurs at harvest time.

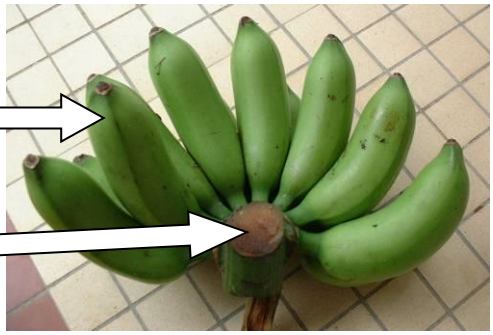
For all **colour descriptors**, colour should be determined with the appropriate colour chart and out of direct sunlight. The best time to observe colour descriptors is in the morning when the light is clearer than in the afternoon.
For all **flower descriptors** (6.6.2 - 6.6.13) the material should be fresh as it oxidizes and changes colour rather quickly.
For the **fruit descriptors** (6.7.3 - 6.7.11) observation must be done on several fruits in order to reflect the dominant case.

THE BANANA PLANT





The individual **fruits** also called "fingers"
in the **bunch** (photo top-right)
are arranged in clusters called "**hands**"
along the **rachis** (photo bottom-right)



Fruit

Rachis

VEGETATIVE DESCRIPTORS (15)

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 Main underlying colour of the pseudostem

Detach the **outermost sheath** from the pseudostem (the sheath should not be too dry). Record the overall impression of colour of the exposed surface of the underlying pseudostem. Note that this 'main colour' should cover more than 75% of the underlying pseudostem surface. Use colour chart A and observe out of direct sunlight.

1. Cream
2. Yellow
3. Watery green
4. Green yellow
5. Light green
6. Medium green
7. Green
8. Dark green
9. Whitish
10. Orange red
11. Red
12. Pink-purple
13. Purple-brown
14. Red-purple
15. Purple
16. Blue

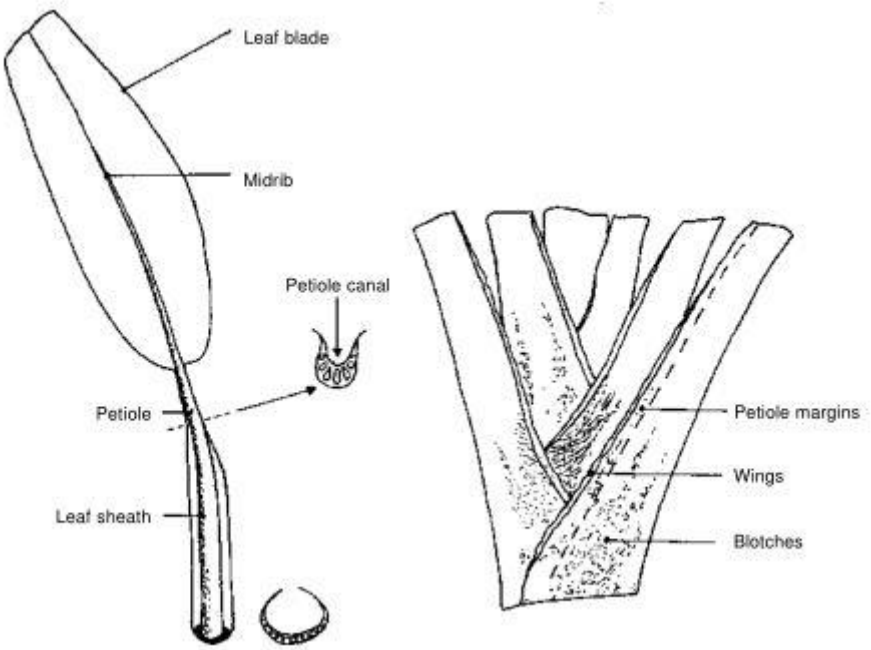


Figure 1. Petiole/midrib/leaf (from Champion 1963 (left), De Langhe 1961 (right). This diagram is used to help with descriptors 6.3.1 through 6.3.7.

6.3.1 Blotches at the petiole base

Record the relative surface area coverage by blotches. Look at several plants if possible to get an overall idea. Observe at flowering time.

1. No pigmentation
2. Sparse blotching (<20%)
3 Moderate blotching (20%-50%)
4. Extensive pigmentation (>50%)

1. 2. 3. 4.

6.3.2 Blotches colour (petiole base) – scored on the upper leaf sheath

1. Orange-brown (like in Pisang Mas)
2. Brown
3. Black-purple
4. Other

6.3.3 Petiole canal of the third leaf

The third leaf (Leaf III) is 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. Observe at flowering time.

1. Margins spreading
2. Margins erect
3. Margins curved inward
4. Margins overlapping

1. 2. 3. 4.

For descriptors **6.3.4 to 6.3.8** observations on the margins and petiole wings should be made where the petiole and pseudostem meet at shooting.

6.3.4.1 Petiole margins winged

Margin is the part of the petiole that can be bent outwards/inwards. Observe at flowering time.

1. Winged (undulating or non-undulating)
2. Not winged


1.


2.

6.3.4.2 – Petiole margins clasping

Observation should be made at shooting on the neck, where the petiole and pseudostem meet. Margin is the part of the petiole that can be bent outwards/inwards. Observe at flowering time.

1. Clasping
2. Not clasping


1.


2.

6.3.6 Petiole margin colour

Use colour chart A and observe out of direct sunlight. Record the colour of the margin (general colour is below the rim). Observe at flowering time.

1. Cream
2. Yellow
3. Watery green
4. Green yellow
5. Light green
6. Medium green
7. Green
8. Dark green
9. Whitish
10. Orange red
11. Red
12. Pink-purple
13. Purple-brown
14. Red-purple
15. Purple
16. Blue

6.3.7 Edge of petiole margin (rim)

Observation should be made at shooting. Record on the last developed leaf at flowering stage.

1. No contrast between margin and petiole (without a colour line along)
2. Contrast between margin and petiole (with a contrasting colour line along)

1. 2.

6.3.22 Pigmentation of outer surface of cigar leaf

Use colour chart A. Observation should be made before shooting, on a developed sucker or on another plant of the same accession. Look at the visible face (future lower face) of the cigar leaf before it is unfurled and before the plant flowers.

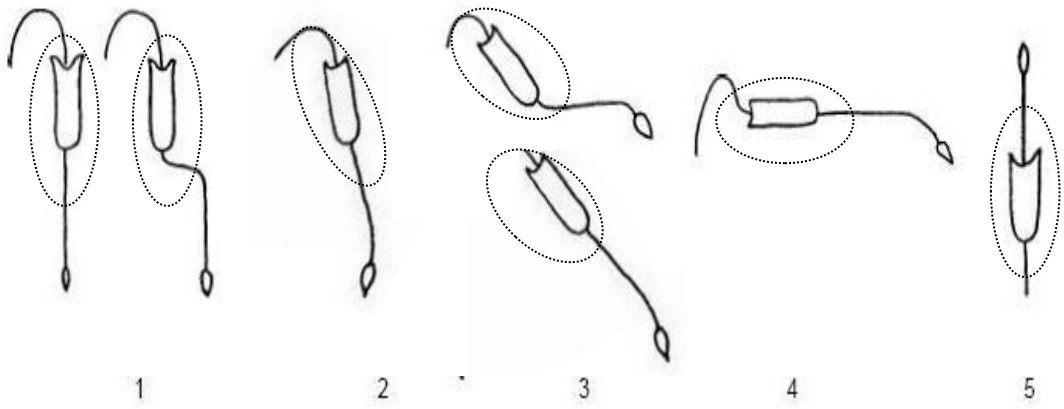
1. Green
2. Red-purple
3. Other (specify on answer sheet)

6.4.5 Peduncle hairiness

1. Hairless
2. Slightly hairy
3. Very hairy, short hairs (similar to velvet touch)
4. Very hairy, long hairs (>2mm)

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

Score on fully developed plant with no environmental stress.

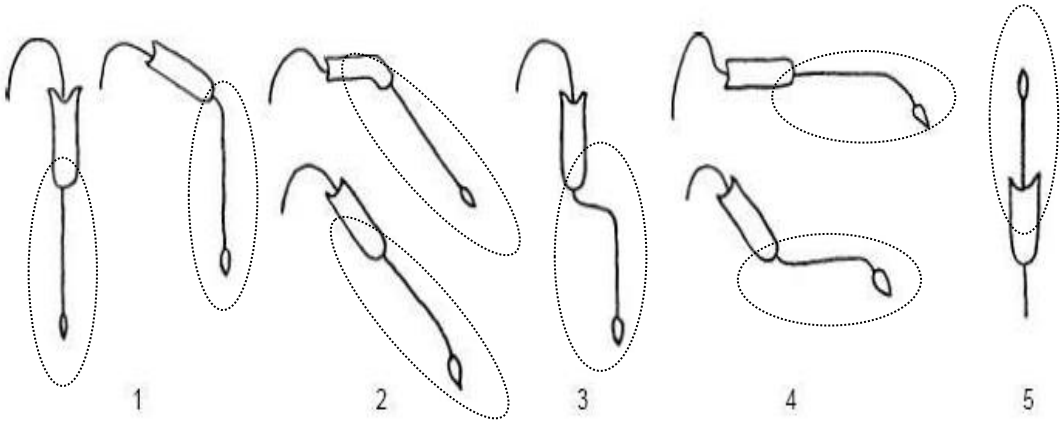
1. Cylindrical
2. Truncate (= cone shaped)
3. Asymmetrical
4. Spiral (all fruit are attached to a unique crown coiled around the stalk)
5. Other

1. 2. 3. 4.

6.4.12 Male 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 Male rachis appearance

1. Bare
2. Neutral flowers on one to few hands only near the bunch (rest of stalk is bare)
3. Male flowers/bracts 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 (still firmly attached to the rachis)
6. Small bunch from neutral/hermaphrodite flowers just above the male bud
7. Other


1.


2.


3.


4.


5.


6.

FLOWER DESCRIPTORS (11)

For the following descriptors, measure the values w, x, y.

"w" is the broadest width of the male bud. "x" is the length from the base of the male bud to the point of broadest width 'w'; "y" is the total length of the male bud. As the figure shows, these parameters express the profile of the bud. Do not measure the dimensions along the bud but rather on a projection/outline of the bud (e.g. trace the outline of the bud on paper).

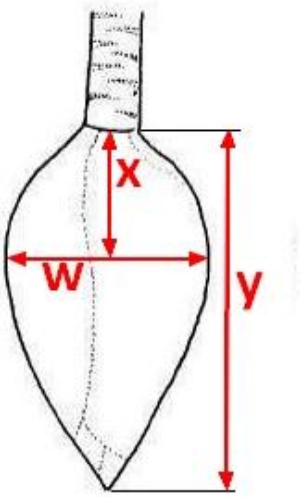


Figure 2. Male bud shape dimensions to be used in 6.4.15, 6.4.16, and 6.4.17

6.4.15 Male bud shape

Calculate the ratio w/y (see figure 2 above).

1. Skinny (w/y ≤ 0.45)
2. Medium (0.45 < w/y < 0.55)
3. Fat (w/y ≥ 0.55)

6.4.16 Male bud length (cm)

Measure the length (y) of male bud at harvest (see figure 2 above).

1. Short (y ≤ 20 cm)
2. Medium (20 cm < y < 30 cm)
3. Long (≥ 30 cm)

6.4.17 Male bud shoulder

Calculate the ratio x/y (see figure 2 above).

1. High shouldered (x/y ≤ 0.28)
2. Medium shouldered (0.28 < x/y < 0.30)
3. Low shouldered (x/y ≥ 0.30)

6.5.2 Bract apex shape

Refers to the first external unlifted bract. Flatten bracts to determine shape.

1. Pointed
2. Intermediate
3. Obtuse
4. Obtuse and split

1. 2. 3. 4.

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

1. Convolute
2. Moderately imbricate
3. Highly imbricate

1. 2. 3.

6.5.12 Bract behaviour before falling

Refers to the last lifted bract. Best to record as bract has lifted up to the horizontal.

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

1.

2.

6.5.4 Colour of the bract external face

Refers to the first external unlifted bract. Remove any wax before scoring. Use colour chart A and observe out of direct sunlight.

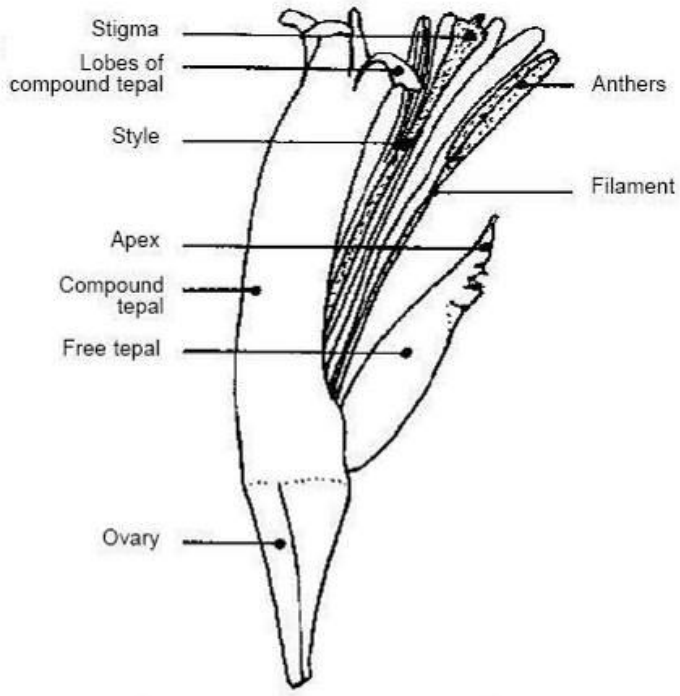
1. Cream
2. Yellow
3. Watery green
4. Green yellow
5. Light green
6. Medium green
7. Green
8. Dark green
9. Whitish
10. Orange red
11. Red
12. Pink-purple
13. Purple-brown
14. Red-purple
15. Purple
16. Blue

6.5.5 Colour of the bract internal face.

Refers to the first external unlifted bract. Do not consider basal part of bract. Use colour chart A and observe out of direct sunlight.

1. Cream
2. Yellow
3. Watery green
4. Green yellow
5. Light green
6. Medium green
7. Green
8. Dark green
9. Whitish
10. Orange red
11. Red
12. Pink-purple
13. Purple-brown
14. Red-purple
15. Purple
16. Blue

The following **flower descriptors** refer to the flowers at the axil of the first external unlifted bract. Fresh material must be used (make the observation as soon as you detach the bract/flowers from the rachis). For photos, place the object upon a very contrasting background and take the photo as close up as possible. The flower parts should be as visible as shown on the figure below.



6.6.2 Compound tepal main colour

Look at backside middle of tepal. Use colour chart B and observe out of direct sunlight.

1. White
2. Cream
3. Ivory
4. Yellow
5. Bright yellow
6. Orange
7. Orange red
8. Red
9. Red-purple
10. Pink/pink-purple
11. Brown/Rusty-brown
12. Beige-pink
13. Silvery
14. Light green
15. Green
16. Dark Green

6.6.4 Lobe colour (tip of the tepal) of compound tepal

Use colour chart B and observe out of direct sunlight.

1. White
2. Cream
3. Ivory
4. Yellow
5. Bright yellow
6. Orange
7. Orange red
8. Red
9. Red-purple
10. Pink/pink-purple
11. Brown/Rusty-brown
12. Beige-pink
13. Silvery
14. Light green
15. Green
16. Dark Green

6.6.13 Anther colour

Observe on the face opposite to the dehiscence split of the anther. Use colour chart B and observe out of direct sunlight.

1. White
2. Cream
3. Ivory
4. Yellow
5. Bright yellow
6. Orange
7. Orange red
8. Red
9. Red-purple
10. Pink/pink-purple
11. Brown/Rusty-brown
12. Beige-pink
13. Silvery
14. Light green
15. Green
16. Dark Green

FRUIT DESCRIPTORS (8)

7.10 Number of hands on the whole bunch
Exact value: ____
Tip: On a bunch with mostly hands of >10 fingers, a possible ultimate hand with 1-5 (rather smaller) fingers should not be counted.

6.7.2 Number of fruits on the mid-hand of the bunch
Count only fully developed fruit. If there is an even number of hands, there will be two middle hands. Count the middle hand that developed first.

1. ≤12
2. 13-16
3. ≥17

6.7.3 Fruit length (cm) at maturity
Measured as the internal arc of the fruit, without pedicel. Record on the inner fruit in the middle of the mid-hand of the bunch. If there is an even number of hands, there will be two middle hands. Count the middle hand that developed first. Record the exact value and range.
Exact value: ____

1. ≤15 cm
2. 16-20 cm
3. 21-25 cm
4. 26-30 cm
5. ≥31 cm

6.7.4 Fruit shape (longitudinal curvature)
Observe the inner fruit in the middle of the mid-hand of the bunch. In case of an asymmetric bunch, score the dominant fruit shape appearing in the bunch.

1. Straight
2. Slightly curved
3. Straight in the distal part
4. Curved (sharp curve)
5. Curved in slight 'S' shape (double curvature)
6. Other
7.


1.


2.

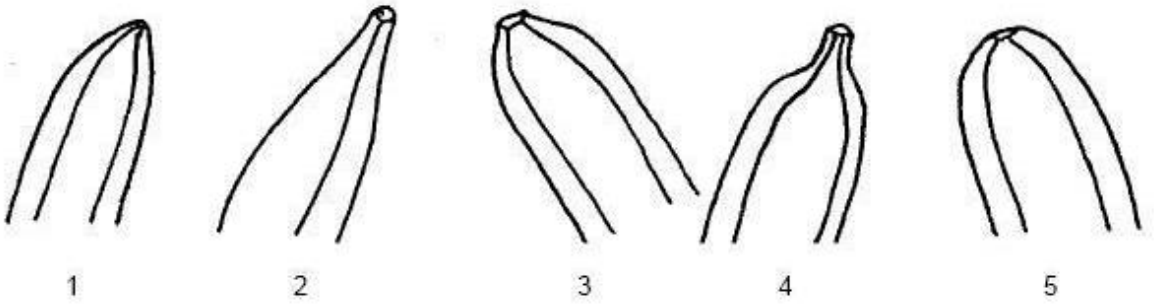

3.


4.


5.

6.7.6 Fruit apex

1. Pointed
2. Lengthily pointed (like plantain)
3. Blunt-tipped (plateau at tip)
4. Bottle-necked (wider under tip than number 2)
5. Rounded



6.7.7 Remains of flower relicts at fruit apex

Observe before cutting the bunch as relicts may fall off.

1. Without flower relicts
2. Few flower relicts (<20% of the fruits with relicts)
3. Persistent flower relicts (>20% of the fruits with relicts)
4. Only base of the style persists

1.

2.

3.

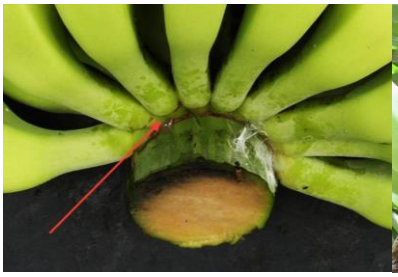
4.

6.7.8 Fruit pedicel length (mm).
Measure from the scar on the rachis until the beginning of the fruit. Record on the inner fruit in the middle of the mid-hand of the bunch. **Tip**: use string to measure or trace outline of fruit on paper. Record the exact value and range.
Exact value: ____

1. ≤10 mm
2. 11 to 20 mm
3. ≥21 mm

6.7.11 Fusion of pedicels
Before they join the rachis at the bract scar. Look up from bottom of bunch**.**

1. No visible sign of fusion
2. Partially fused (up to 50% of the length of the pedicel)
3. Totally fused (more than 50% of the length of the pedicel)


1.


2.


3.

Glossary of terms

Anther – Pollen-bearing portion of stamen.
Apex – Bottom tip (of male bract in this case).
Bract - a leaf-like structure, usually different in form from the foliage leaves, associated with an inflorescence or flower.
Bunch – the descriptive term for all the fruits along the rachis. The individual fruit (also called fingers) are arranged in hands.
Cigar leaf - rolled leaf emerging from the centre of the pseudostem.
Clasping - Partly surrounding the stem.
Convulate -– With one lamina enrolled in another lamina.
Distal – Away from the point of origin or attachment.
Edge –outside rim of the petiole
Hand – Arrangement of the fruit in a bunch, previously clusters of flowers.
Imbrication - Alignment of bracts at the apex of the male bud.
Male bud –The composite of male flowers and their bracts, in the form of a bud at the end of the growing male rachis.
Margin – area just below the edge of the petiole
Node - the place on a plant stem where a leaf is attached.
Rachis – the stem of the entire inflorescence from the first hand to the male bud.
Sheath – the part of the leaf clasping or enveloping the pseudostem.
Pedicel - the stem which supports one flower or fruit.
Peduncle - the stem that supports the inflorescence and attaches it to the pseudostem.
Petiole - the stem of a leaf.
Pseudostem - a false stem made of the rolled bases of leaves.
Tepal - a segment of the outer whorl in a flower that has no differentiation between petals and sepals.

Citation: Taxonomic Advisory Group (TAG) 2010. Minimum Descriptor List for *Musa.* Revised 2018. Bioversity International, Montpellier, France.

Annex 4. Guidelines Against Entry of TR4 in LAC

Joint Declaration for the Protection of the Banana Industry in Latin America and the Caribbean

Against Tropical Race 4 of *Fusarium oxysporum* f. sp. *cubense* (Foc TR4)

In line with the technical and scientific topics to be presented and discussed during the VI International Conference on Banana sponsored by the Corporación Bananera Nacional (CORBANA-Costa Rica) and the XXI International Meeting of the Association for Cooperation in Research and Integral Development of the *Musaceae* (ACORBAT), celebrated in Miami on April 19-22, 2016, and facing the potential threat of the incursion into Latin America and the Caribbean (LAC) of the Tropical Race 4 of the *Fusarium oxysporum* f. sp. *cubense* fungus (Foc TR4), the causal agent of Fusarium wilt (also known as Panama disease), the undersigned scientists consider the protection against Foc TR4 of highest priority and significance for all countries of LAC. They therefore agree to call on the relevant national and international authorities to provide their joint support to the following considerations and recommendations:

Considerations:

1. Banana and plantain are ranked among the five most important crops worldwide, have high socio-economic significance in the producing countries; represents a source of employment and of food security for millions of people; constitute a currency inflow for the producing nations, providing development and an improved quality of life to its population; comprises the raw materials for countless agroindustrial products; and are crops that are rooted in the culture and tradition of many countries around the world.

2. Tropical Race 4 of *Fusarium oxysporum* f.sp. *cubense* (Foc TR4), considered as a quarantine pest absent in Latin American and the Caribbean countries is the major threat to the banana sector worldwide, and has the potential to cause a socio-economic crisis of unforeseen dimensions in banana producing countries of Latin America and the Caribbean.

3. There is still a lack of knowledge at the regional, national and local levels of the stakeholders of the banana and plantain production chains in Latin American and the Caribbean region on the threat posed by Foc TR4. Likewise, preventive measures to exclude Foc TR4 from the Latin American and The Caribbean region and preparedness and capabilities to contain and manage a possible outbreak of this pathogens at individual country as well as regional level are not yet sufficient nor effective.

Recommendations:

1. The National and Regional Plant Protection Organizations and other relevant authorities of the corresponding governments, as well as institutions, enterprises and sector organizations

that undertake work on banana and plantain, research centers, educational facilities, services and input providers, certifying bodies, transporters and shippers, and all others involved in the production and trade chains, should incorporate and/or strengthen in their strategies against Foc TR4 the principle of EXCLUSION, which intend to avoid the entrance of Foc TR4 in the Latin American and Caribbean nations.

2. Carry out raising awareness campaigns at local, national and regional levels especially in countries with increased risk of Foc TR4 epidemics on its nature, symptoms and risks, and on simple and practical protective measures that can be taken at farm level, under the principle of COME CLEAN, GO CLEAN. These campaigns should include the recommendations of experts, in order to communicate clear and appropriate messages using efficient means and a suitable language, according to the characteristics of the target group, avoiding ambiguity and sensationalism.

3. Establish collaboration agreements between National and Regional Plant Protection Organizations of countries where Foc TR4 is present and Latin America and the Caribbean to ensure a flow of transparent and reliable information to strengthen prevention strategies as well as preparedness and response capabilities against a possible incursion of Foc TR4.

4. Promote technical and scientific training at national, regional and international levels for the technical personnel of extension services, phytosanitary officers, producers and related stakeholders in order to implement or strengthen actions on phytosanitary surveillance, prevention of entrance, identification of symptoms, identification of the pathogen, monitoring, sampling, collection and transport of suspect samples; and implement appropriate mitigation actions in the case of an eventual incursion of Foc TR4.

5. Regional and National Plant Protection Organization of Bananas and plantain producing countries, in strategic alliance with the International Regional Organization for Agricultural Health (OIRSA, by its Spanish acronym) should jointly review and implement the “Regional Action Plan for the Prevention of the Entrance of Foc TR4 to the American Continent” as well as the “Contingency Plan for an Outbreak of the Tropical Race 4 of *Fusarium oxysporum* f. sp. cubense” elaborated by OIRSA and collaborators.

6. Compliance and strict adherence to the recommendations for travelers visiting countries where Foc TR4 is present, which are laid out in the document released in the year 2011 by Bioversity International, MUSALAC (the Latin American and the Caribbean Network for Research and Development of *Musaceae*) and other industry-related entities. These recommendations should be continuously reviewed, updated, translated to the main relevant languages and widely disseminated.

7. Several reference laboratories for the diagnostic of Foc TR4 and the reception of any suspicious samples should be in place across the region. Likewise, laboratories must be appointed outside the banana and plantain producing-region of Latin America and the Caribbean, to exchange experiences, results, standardization of protocols, training and crosschecks.

8. The importation of plants of the *Musaceae* family from countries outside Latin America and the Caribbean should be allowed only when extremely necessary. In that case the process must be carried out under strict quarantine guidelines. Planting material should come from Foc TR4- free countries, in the form of *in vitro* plantlets grown on media containing no

antimicrobial agents, originating from indexed, certified pest-free mother plants. Official certifications should be attached describing details of the origin of the planting material, details of the procedures used [example sequences of primers, amplification conditions, among others). Certification procedures should be based on the most appropriate and scientifically recommended protocols to diagnostic Foc TR4 at the time of analysis. The analysis should come from laboratories accredited by the National Plant Protection Organization (NPPO) of the country of origin.

9. Cases of *Fusarium oxysporum* f.sp. *cubense* affecting Cavendish varieties or other *Musaceae* commonly affected by the pathogen populations present in Latin America and the Caribbean should be further studied in order to provide scientific information about the identity of these pathogen populations and to built a body of evidence for the absence of Foc TR4 in the American continent and build up a credible diagnostic capability in the region to deal with Foc TR4 and related strains of this pathogen.

10. Genotypic and phenotypic studies of *Fusarium oxysporum* f.sp. *cubense* populations present in banana and plantain-producing countries in Latin America and the Caribbean should be carried out in order to characterize the existing populations and certify that Foc TR4 is not masked within varieties that are susceptible to races 1 and 2. These studies must be performed in a coordinated manner using standard procedures that allow the comparison of results between different countries.

11. Quarantine and surveillance measures in each Latin American and Caribbean country should be jointly reviewed by National Plant Protection Organizations to strengthen inspection procedures at possible entry points. In addition, inspections and simulation exercises on surveillance measures, quarantine and alerts at airports, maritime ports, along land borders and entry gates of banana farm and facilities should be continuously carried out to reduce the risks of Foc TR4 entrance.

12. If an eventual incursion of Foc TR4 is officially detected in a nation under OIRSA's mandate, the guidelines of the OIRSA's Contingency plan for TR4 must be followed. If national contingency plans are already in place, specifically drawn up and approved by the National Plant Protection Organization of the country in question, it should be followed. Countries out OIRSA's mandate and without a National Contingency Plan for Foc TR4, may take advantage of the OIRSA's of follow internal protocols with a the objective to eradicate, contain and/or prevent the further spread of the pathogen at farm, country and regional levels.

13. Regional and national plant protection organizations, Ministry of Agriculture and entities linked to the banana and plantain production chains must identify funding opportunities and options to carry out research projects that support the Regional Action Plan for the prevention of the incursion of Foc TR4 in the Latin American and the Caribbean region developed by OIRSA and collaborators. In order to guarantee an adequate and efficient execution of that Action Plan, a coordinator should be appointed. Governmental agencies should identify appropriate mechanisms to hire a competent expert and guarantee the execution of the Action Plan agenda at national, regional and global levels.

14. Identify mechanisms for the creation of a Regional fund to support research and preventive actions against phytosanitary threats to plantain and bananas in Latin American and the Caribbean.

15. The recommendations and considerations originating from the current scientific symposium should be widely disseminated in all the countries, especially to the Regional and National Plant Protection Organizations, Ministries of Agriculture and national and regional country offices of the FAO in Central and South America and the Caribbean.

Drafted and approved in the city of Miami, Florida, United States of America on the 21st day of April of the year 2016.

_____

Dr. Randy Ploetz University of Florida

U.S.A

_____

Dr. Miguel Angel Dita Rodríguez Brazilian Agricultural Research Corporation –EMBRAPA Brazil

_____

Dr. Gert Kema Wageningen University and Research Centre The Netherlands

_____

Dr. Luis Pérez Vicente Instituto de Investigación y Sanidad Agropecuaria -INISAV Cuba

_____

Dr. Altus Viljoen University of Stellenbosch South Africa

_____

Dr. Agustin Molina Bioversity International Asia - Pacific

_____

Dr. Fernando Haddad Brazilian Agricultural Research Corporation -EMBRAPA Brazil

_____

Dr. André Drenth University of QueenslandAustralia

_____

Dr. Yi Ganjun Guangdong Academy of Agricultural Sciences People's Republic of China

_____

Dr. Juan F. Aguilar Fundación Hondureña de Investigación Agrícola (FHIA) Honduras

_____

Dr. James Dale Queensland University of Technology Australia

_____

Dr. Frédéric Bakry Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) France

_____

Dr. Jorge A. Sandoval F. Research Director of CORBANA Costa Rica

_____

Dr. Marty Dickman Director of Institute for Plant Genomics and Biotechnology, Texas, University. U.S.A. \

Honorary Witnesses:

Minister of Agriculture of Costa Rica, Sr. Felipe Arauz

President of CORBANA, Sr. Eduardo Gómez

General Manager of CORBANA, Sr. Jorge A. Sauma

President of ACORBAT, Sr. Gabriel Elejalde

President of MUSALAC, Mrs. Mildred Cortés

Representative of OIRSA, Sr. Carlos Urías

Representative of WBF /FAO. Sr. Luud Clerck

Representative of "Bioversity International" Mrs. Anne Vézina.

Representative of Agrocalidad. Sr. Carlos Muentes.