



Report on the MusaNet Asian Regional Workshop on *Musa* Characterization and Documentation, Kuala Terengganu, Malaysia

Organised by MusaNet, Bioversity International and the Malaysian Agricultural Research and Development Institute (MARDI)

13-17 November 2017



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Background

The Global *Musa* Genetic Resources Network (MusaNet, www.musanet.org) in partnership with Bioversity International and the Malaysian Agricultural Research and Development Institute (MARDI, www.mardi.gov.my), held a workshop to address the need for a standardized characterization and documentation of *Musa spp* (bananas). This third regional MusaNet workshop took place in Kuala Terengganu, Malaysia, from 13-17 November 2017. The workshop was built on the experiences of four previous MusaNet workshops: in 2013 at CIRAD in Guadeloupe, in 2014 at the National Research Centre for Banana (NRCB) in India, in 2015 at the Centre Africain de Recherches sur Bananiers et Plantains (CARBAP) in Cameroon and in 2016 at the National Agricultural Research Organization (NARO) in Uganda.

In attendance at the Malaysia workshop were 13 invited curators of national *Musa* collections and members of the Asia and Pacific banana network, BAPNET (<http://banana-networks.org/Bapnet/>). Also present were key experts and staff from MARDI and Bioversity International. The programme and background documents were developed by the organizing committee from MARDI and Bioversity International. The workshop was financed by the CGIAR research programme on Roots, Tubers and Bananas (RTB) and on the Genebanks Platform.

The overall **Aim** of the workshop was:

To forge a standardized characterization and documentation methodology for Asian 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 for gathering data in the field – including data entry and data management.
- Discuss and propose solutions for optimum *Musa* germplasm data management (MGIS).
- Discuss the next steps towards a standardized *Musa* characterization and documentation methodology.

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: Conclusion and workshop evaluation

This report, by the MusaNet Secretariat, serves as an official record of the workshop, including the minutes of discussions and [links](#) to all presentations (in pdf format). This report and all the presentations are found on the MusaNet website (www.musanet.org) under the tab 'Meetings'.

Opening session

The workshop was officially opened on 13 November 2017 with a welcome speech by MARDI Governing Council Member YB Wan Abdul Hakim Wan Mokhtar and a presentation by MusaNet Coordinator, Dr. Nicolas Roux (Bioversity International). [Link to Nicolas Roux's presentation.](#)



Fig 1. Nicolas Roux presenting at the opening session of the MusaNet Asian regional workshop.

Session 1 - Introduction to the workshop and curator presentations

Objectives of this 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), the workshop facilitator, gave an overview of the aims and objectives of the workshop and presented the programme for the week (see *Annex 1*).

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

Curators' expectations from the workshop

- To strengthen collaboration with other collections in Asia
- Learn more about tools for characterization
- Learn to use *Musa* descriptors with the tablet
- Share experiences of curators
- Get practical experience in the field
- How to collect data with the tablet and standardize the information
- Learn about data management of other collections
- That all collections will participate in MGIS
- Know how to best manage collections
- Exchange of information – strengthen ties (through BAPNET as well)
- Make new friends

The 13 collection curators each made a short presentation on the current status of their collections (links to presentations in pdf are below):

[Bangladesh \(BARI\) – Madan Gopal Saha](#)

[Cambodia \(CARDI\) – Thun Vathany](#)

[China \(IFTR\) – Ou Sheng](#)

[India \(NRCB\) – Palani Durai](#)

[Indonesia \(ITFRI\) – Fitriana Nasution](#)

[Laos \(BEI\)– Kosonh Xayphaskatsa](#)

[Malaysia \(MARDI\) – Sivanewari Chalaparmal](#)

[Myanmar \(DARI\) – Min San Thein](#)

[Philippines \(BPI\) – Jonalyn Pabuaya](#)

[Papua New Guinea \(NARI\) – Janet Paofa](#)

[Taiwan \(TBRI\) – Yu-Yen Su](#)

[Thailand \(HRI\) – Penchan Suthanukool](#)

[Vietnam \(FAVRI\) – Ngo Xuan Phong](#)

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

Introduction to bananas

Agus Sutanto (ITFRI) gave a general overview on types of bananas with a focus on the diversity of Indonesian cultivars. [Link to presentation](#).

Presentation on photography in the field

Lavern Gueco (UPLB) then presented how to take good photographs of plants when doing field work. [Link to presentation](#).

Visit to a local banana farm

The participants visited a banana farm about 15 minutes from the hotel to see what varieties are being grown and gain more knowledge on local banana production. Eight banana varieties are being grown on this fairly diverse farm, along with other crops (e.g. citrus and oil palm). The farmer very kindly answered a wide range of questions from the group – ranging from questions on market prices of the bananas to field management techniques.



Fig 2. The visit to the local banana farm. Group photo (top), touring while listening to Saleh describe the farm (bottom left), and some local banana products for snacks (bottom right).

Session 2 - Description and discussion of field exercise

The field and discussion sessions were held over three days at MARDI Jerangau Station, 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 accessions using the Minimum List of Descriptors for *Musa* (version Jan 2016) on their individual tablets. Rachel Chase explained the objectives and procedure to be followed in the meeting room before the participants went to the farm.

Objectives of the Field Exercise

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

The Minimum List of Descriptors for *Musa*

Agus Sutanto introduced the participants to the Minimum List of Descriptors for *Musa*, which was the focus of the field work. The list is a compilation of 33 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 here in *Annex 3*.

Introduction to the mobile device and application

Max Ruas (Bioversity International) 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 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 presentation.](#)

Groups for the Field Exercise

Table 1. Each of the four groups was composed of four curators, a group leader and an assistant.

	Group A	Group B	Group C	Group D
Leaders	Lavern Gueco	Agus Sutanto	Maimun Tahir	Nicolas Roux
Curators	Fitriana Nasution	Jonalyn Pabuaya	Penchan Suthanukool	Siva Chalaparmal
	Ngo Xuan Phong	Ou Sheng	Thun Vathany	Janet Paofa
	Madan Gopal Saha	Palani Durai	Kosonh Xayphaskatsa	Yu-Yen Su
	Salehuddin bin Md Radzuan	Nurulijannah binti Alias	Guiming Deng	Min San Thein
Assistants	Rosliza Jajuli	Rachel Chase	Max Ruas	Vida Sinohin



Field Exercise (mornings of 14-16 November)

The field exercise focused on the following four accessions in the MARDI field collection at Jerangau Station:

1. Pisang Raja Udang Merah (AAA)
2. Pisang Gala (BB)
3. Pisang Lilin (AA)
4. Burro Cemsa (ABB)

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 20-30 minutes at each accession. The minimum list was divided into three sections – one for each day:

Field Exercise 1 – 14 descriptors (Vegetative)

Field Exercise 2 – 11 descriptors (Floral)

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 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 3. The field exercises that took place over three mornings at MARDI Jerangau Station.

Discussions in the meeting room (afternoons of 14-16 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](#).
- Photos of a particular accession and descriptor were also projected next to the graph for visual reference.
- Led by Agus Sutanto, 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. Rachel took notes of the discussion.
- This process was repeated for all the descriptors.



Fig 4. Agus describing flower morphology before the field exercise.



Fig 5. Group discussion of the descriptors in the Jerangau Station meeting room.

Field management discussion/tour of MARDI field collection

On Wednesday 15 November, Siva Chalaparmal gave an overview of the germplasm present in the collection and Salehuddin Radzuan conducted a discussion on field management techniques while in the MARDI field collection. This included a Q and A session and a demonstration on how they remove suckers by Mohd Ismail. Salehuddin and Izlamira Roslan then guided the group via bus to the other important field collections at the station, including trees and herbs.



Fig 6 . The tour of the MARDI field collection, led by Siva, Salehuddin and Izlamira.

MusaID demonstration in the field

Max Ruas demonstrated the updated version of MusaID in the MARDI collection, which each participant already had loaded 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 that is fully documented using the 121 descriptors (IPGRI/CIRAD 1996). This important tool can be significantly improved if more national collections could be fully documented and integrated as references. Participants could realize the usefulness to document and share data within the Musa GR community to make this tool even more powerful.



Fig 7. Max demonstrating the MusaID application in the MARDI field collection.

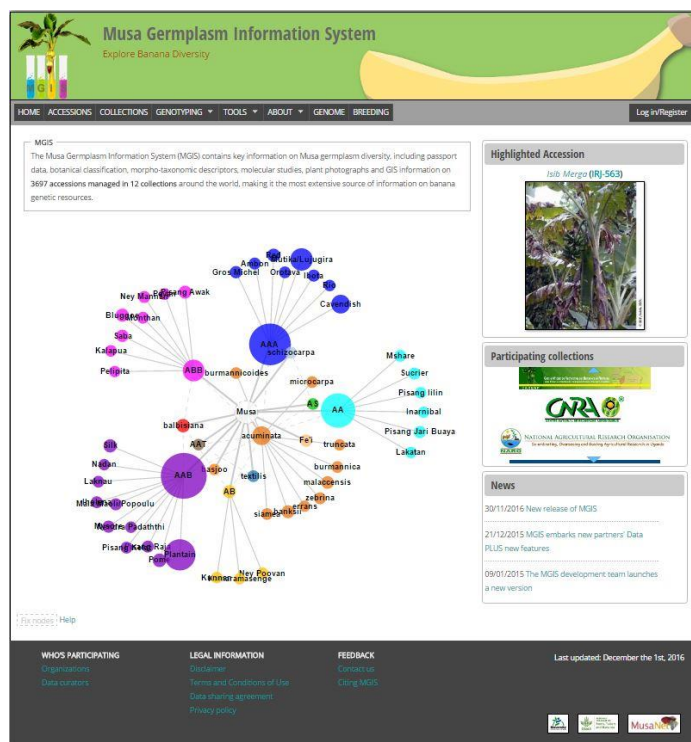
Session 3: Documentation and sharing of information

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

The new MGIS interface

Max Ruas introduced the new 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 five new partners who signed the MGIS Data Sharing Agreement (DSA) and provided their data prior to the workshop. Their data and information related to their collection will be visible on MGIS in January 2018



MusaNet website

Nicolas Roux and Rachel Chase showed the participants the main features of the MusaNet website, including the tabs for the Expert Committee, the *Musa* collection pages and links to MusaNet workshops and publications. Rachel emphasized the importance of the collection pages for better visibility of all the Asian 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 a page on the Taxonomic Reference Collections (TRC) exercise as well as a page on how to send leaves for ploidy and genome constitution determination to the Musa Genotyping Centre based in Olomouc, Czech Republic.

Top 10 varieties of *Musa* by country

Before the workshop, all curators provided Rachel a list of the top 10 varieties of *Musa* (most popular according to 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 ESA region. [Link to presentation.](#)

Discussion on Synonyms

Agus Sutanto led a discussion on synonyms across the different countries based on the lists provided by the participants on their top 10 varieties. He created a table with photos of the accessions and space to fill in the local name for each of the countries, and he asked everyone to please fill in this table as much as possible after the workshop. [Link to table here.](#) This table, when completed, could also be used to update the publication *Banana Cultivar Names and Synonyms in Southeast Asia* (Valmayor et al 2000).



Fig 8. Agus Sutanto discussing synonyms across Asian countries.

Session 4: Follow-up discussions

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 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 work with TAG on revising the Minimum List of Descriptors for *Musa*.
- **Max** to finalize work on the mobile device application MusaTab and MusaID with software developers for release of improved version. He will also release 'how to' videos for users.
- **All curators** to send by email to Rachel up-to-date information about their respective collection for the MusaNet website Asian Collections Page.
- **All curators** to complete and send to Agus the synonym table with information from their respective country.

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

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

- Full participation of the curators from Asian 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 vast 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.

Acknowledgements

The MusaNet Asian Regional workshop in Kuala Terengganu, Malaysia was made possible thanks to the financial contribution from the CGIAR Research Program (CRP) Roots, Tubers and Bananas (RTB) and the Genebanks Platform. MusaNet is grateful to the many individuals and their respective organisations for supporting the overall goal of the workshop.

Great appreciation goes to the staff at MARDI for their excellent organization, professionalism, warm hospitality and expertise in the field collection. Special thanks go to the workshop organizing committee (Ainu Husna M Suhaimi, Rosliza Jajuli, Umikalsum Mohamed Bahari, Aniadila Kamaruddin, Izlamira Roslan, Sivanaswari a/p Chalaparmal, Salehudin bin Md Radzuan, Lavernee Gueco, Agus Sutanto, Vida Sinohin (BAPNET rep for MusaNet), Nicolas Roux, Max Ruas and Rachel Chase) for their hard work preparing the workshop months in advance, and to Silvia Araujo de Lima and Corine Loiseau (Bioversity International), for their support prior to and during the workshop. This report was written by Rachel Chase. Finally, thank you also to all the participants from the BAPNET region for their very active participation that made this workshop a real success!





THANK YOU / TERIMA KASIH!!!

Annex 1. Programme of the MusaNet MARDI workshop

DAY 1	MONDAY 13 NOVEMBER 2017 – AT HOTEL
08:30-10:30	<p>OPENING SESSION – welcome messages and introductions (20 mins each)</p> <p>MARDI Governing Council Member: YB Wan Abdul Hakim Wan Mokhtar MusaNet Coordinator: Dr. Nicolas Roux</p> <p>Introduction to the Workshop - Rachel Chase</p> <p>Aim: To forge a standardized characterization and documentation methodology for Asian national <i>Musa</i> collections.</p> <p>Overview of the Objectives of the workshop (5 mins)</p> <p>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 <i>Musa spp.</i> Share knowledge and experience to promote best practices for the field management of <i>Musa</i> 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 <i>Musa</i> germplasm data management (MGIS). Discuss the next steps towards a standardized <i>Musa</i> characterization and documentation methodology.</p> <p>Presentation of workshop programme (5 mins)</p> <p>Round table introductions and expectations from participants (30 mins)</p>
10:30-11:00	<i>Coffee/tea break + Group photo</i>
11:00-13:00	<p>SESSION 1: INTRODUCTION TO THE WORKSHOP (cont)</p> <p>Presentations from curators</p> <p>Presentation of each partner collection (10 mins each)</p> <p>Bangladesh – Madan Gopal Saha Cambodia – Thun Vathany China – Ou Sheng India – Palani Durai Indonesia – Fitriana Nasution Laos – Kosonh Xayphaskatsa Malaysia – Siva Chalaparmal Myanmar – Min San Thein Philippines – Jonalyn Pabuaya PNG – Janet Paofa Taiwan – Yu-Yen Su</p>
13:00-14:00	<i>Lunch</i>
14:00-15h30	<p>Continue presentations of partner collections</p> <p>Thailand – Penchan Suthanukool</p>

	<p>Vietnam – Ngo Xuan Phong</p> <p>Presentation on different types of banana - Agus (30 mins)</p> <p>Presentation on how to take good photos – Lavern (30 mins)</p>
15:30-15h45	<i>Coffee/tea break</i>
15:45-17:30	Visit to local banana farm
18:00-	Welcome cocktail at hotel
DAY 2	TUESDAY 14 NOVEMBER 2017 – AT MARDI JERANGAU
	Bus departure from hotel at 7:30 to Jerangau Station
08:30-9:30	<p>SESSION 2: FIELD EXERCISE</p> <p>In the meeting room:</p> <p>Description of the field exercise for the next 3 days (30 mins) – Rachel</p> <p>Description of the process</p> <p>Description of the 4 accessions to be scored</p> <p>Explanation of the 4 groups</p> <p>Explanation of the descriptors to be scored in the field over the 3 days – 1) vegetative parts 2) flowers and 3) fruits</p> <p>Photos to be taken at last accession <u>on Day 4</u></p> <p>Questions of clarification and agreement</p> <p>Presentation of the mobile device (30 mins) - Max</p> <p>How to use the mobile device and MusaTab in the field and record data</p>
9:30-10:00	<i>Coffee/tea break</i>
10:00-13:00	FIELD EXERCISE - Vegetative descriptors (14) - 45 mins/accession
13:00-14:00	<i>Lunch</i>
14:00-16:00	Discussion in the meeting room of the Vegetative descriptor results
16:00-16:30	<i>Coffee/tea break</i>
16:30-17:30	Discussion in the meeting room of the Vegetative descriptor results
17:30	Return by bus to Hotel
18:30 -	Free evening
DAY 3	WEDNESDAY 15 NOVEMBER 2017 - AT MARDI JERANGAU
	Bus departure from hotel at 7:30 to Jerangau Station

08:30-11:30	FIELD EXERCISE-Flower descriptors (11) - <i>30 mins/accession</i> (<i>coffee/tea break in the field at 10:00</i>)
11:30-13:00	Tour of the Jerangau Banana Field Collection – Siva/Saleh/Izlamira
13:00-14:00	<i>Lunch</i>
14:00-16:00	Discussion in the meeting room of the Flower descriptor results
16:00-16:30	<i>Coffee/tea break</i>
16:30-17:30	Talk on field management (in the Field) - Salleh
17:30	Return by bus to Hotel
19:00	Social Dinner at local restaurant in Terengganu
DAY 4	THURSDAY 16 NOVEMBER 2017 - AT MARDI JERANGAU
	Bus departure from hotel at 7:30 to Jerangau Station
8:30-10:00	Documentation and sharing Information Musa.ID demonstration in the field-Max (1 hr)
10:00-10:15	<i>Coffee/tea break in the field</i>
10:00-13:00	FIELD EXERCISE – Fruit descriptors (8) - <i>30 mins/accession</i>
13:00-14:00	<i>Lunch</i>
14:00-16:00	Discussion in the meeting room of the Fruit descriptor results
16:00-16:30	<i>Coffee/tea break</i>
16:30-17:30	Presentation of Musanet website (Rachel) – 15 mins Presentation of new MGIS website (Max) – 15 mins Discussion of top 10 varieties for each country and cultivar synonyms (Nicolas) - 30 mins
	Free evening
DAY 5	FRIDAY 17 NOVEMBER 2017 – AT HOTEL
08:30-10:00	SESSION 3: DOCUMENTATION AND SHARING OF INFORMATION MGIS set up and training (Mobile device to computer with USB keys)- Max
10:00-10:30	<i>Coffee/tea break</i>

10:30-11:30	CONCLUSION AND EVALUATION – Rachel Round table on personal impressions of the workshop and what we achieved – (30mins) Evaluation of the workshop by participants – (30mins)
11:30-12:30	CLOSING SESSION Closing remarks Nicolas Roux (15 mins) State Director of MARDI – Mr. Fadzlirahimi Ismail (15 mins) Distribution of certificates to participants (30 mins)
13:00-14:00	Lunch
14:30 onwards	- Social visit in Terengganu Noor Arfa Batik (Batik factory and shop) Pantai Batu Burok (beach)
DAY 6	SATURDAY 18 NOVEMBER 2017
	Departure of participants

Annex 2. Contact list of participants at the MARDI workshop

Coordinators & experts

1	<p>Dr. Nicolas Roux</p> <p>Bioversity International Parc Scientifique Agropolis II, 34397 Montpellier Cedex 5, FRANCE Tel: +334 6761 1302 Fax: +334 6761 0334 Email: n.roux@cgiar.org</p>
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Minimum List of Descriptors for *Musa*

Developed by the MusaNet Taxonomy Advisory Group – version January 2016

INTRODUCTION

These guidelines, recently revised in 2015, 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

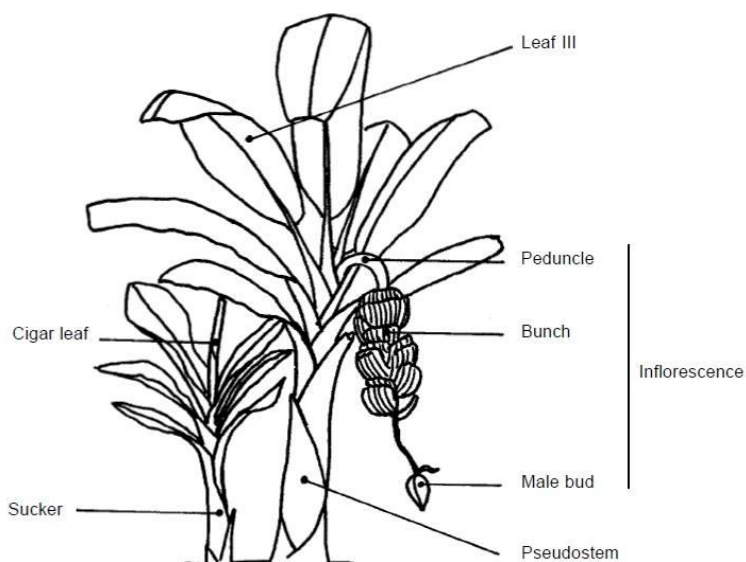
The best time to take photos and document the descriptors is when the fruit are green-ripe or yellowing (“harvest time”), and the rachis is at least 45 cm long (15 inches). All descriptors should be scored at harvest **except** for descriptors 6.3.1, 6.3.3, 6.3.4a, 6.3.4b, 6.3.6, 6.3.7 that should be 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.

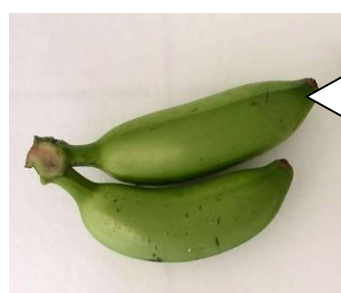
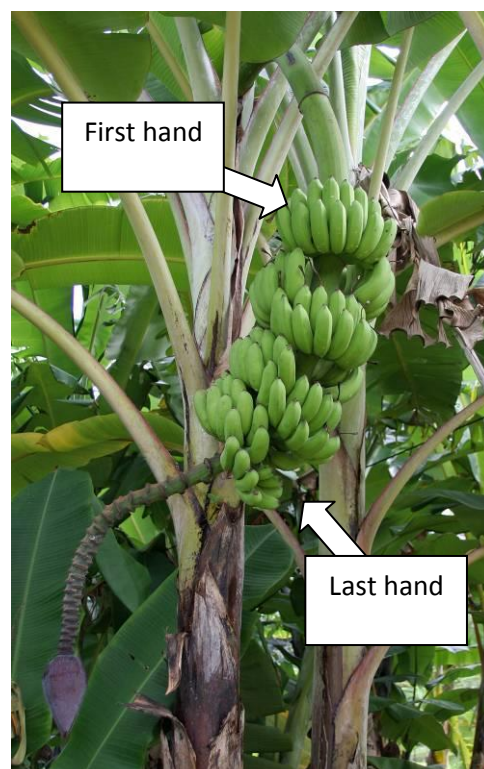
For all **flower descriptors** (6.6.2 - 6.6.13) the material should be fresh as it oxidizes and changes colour rather quickly.

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

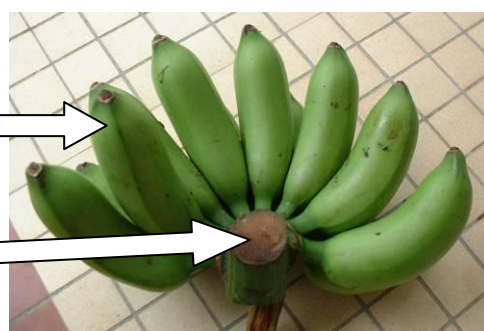


The individual **fruits** also called “fingers” in the **bunch** (photo top-right) are arranged in clusters called “**hands**” along the **rachis** (photo bottom-right)



Fruit

Rachis



VEGETATIVE DESCRIPTORS (14)

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

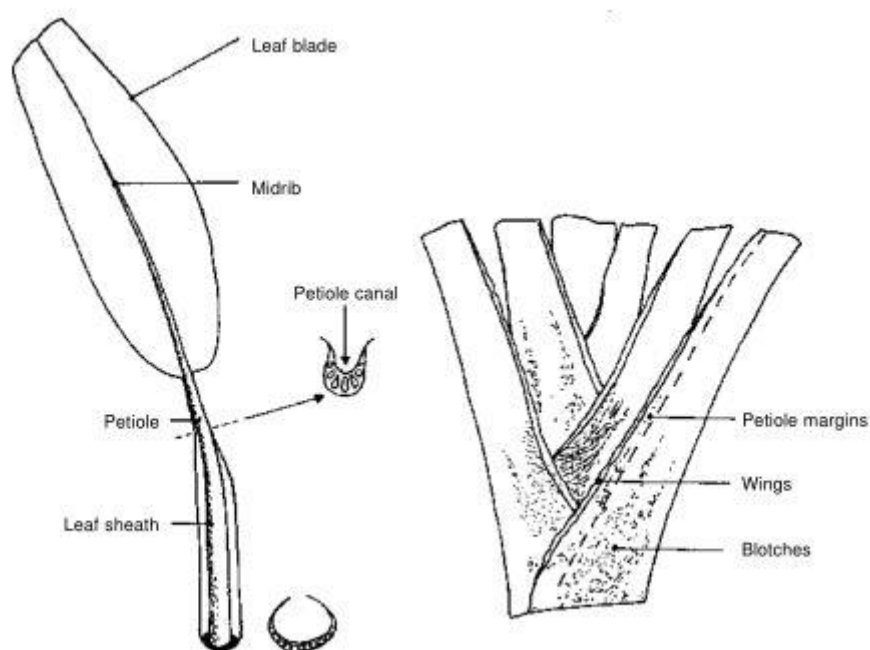
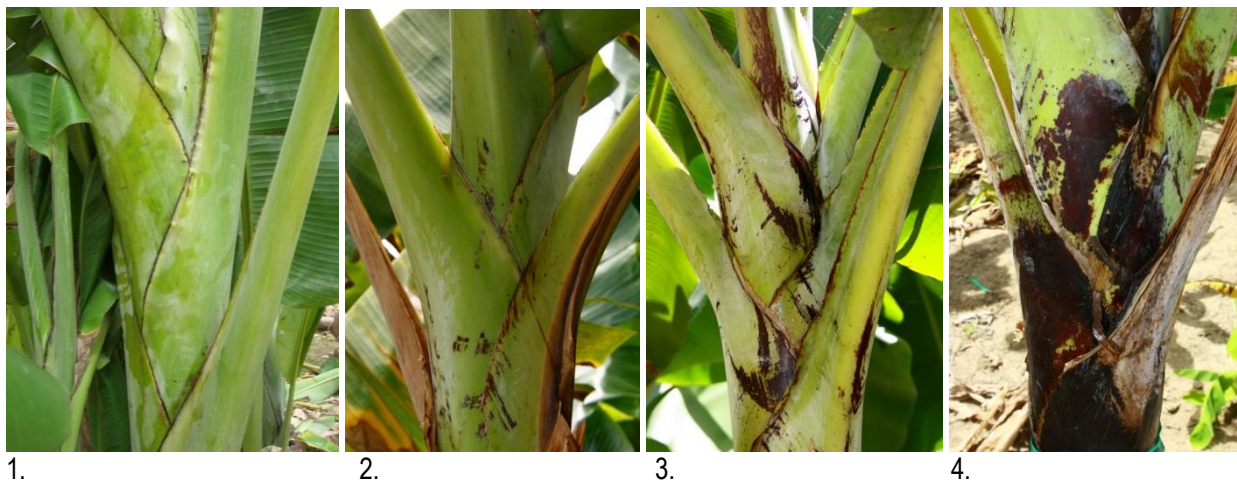


Figure 1. Petiole/midrib/leaf (from Champion 1963 (left), De Langhe 1961 (right)). This diagram is used to help with descriptors 6.3.1 through 6.3.7.

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%)



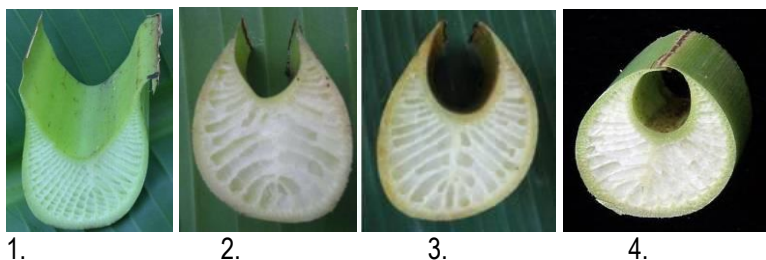
6.3.2 Blotches colour (petiole base) – scored on the upper leaf sheath

1. Orange-brown (mahogany, 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



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.

6.3.4a Petiole margins winged

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

1. Winged
2. Not winged



1.

2.

6.3.4b – 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 | 9. Whitish |
| 2. Yellow | 10. Orange red |
| 3. Watery green | 11. Red |
| 4. Green yellow | 12. Pink-purple |
| 5. Light green | 13. Purple-brown |
| 6. Medium green | 14. Red-purple |
| 7. Green | 15. Purple |
| 8. Dark green | 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.

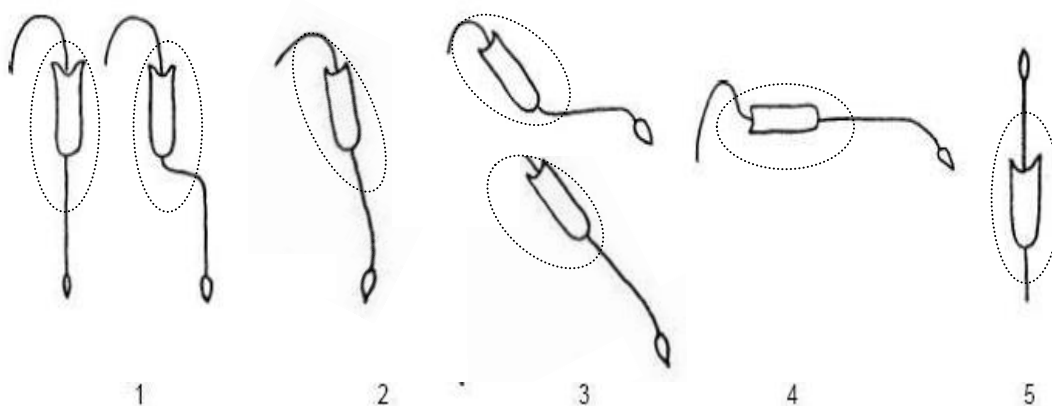
6.3.22 Pigmentation of outer surface of cigar leaf

Use colour chart A. Observation should be made before shooting, on a developed sucker or on another plant of the same accession.

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

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.

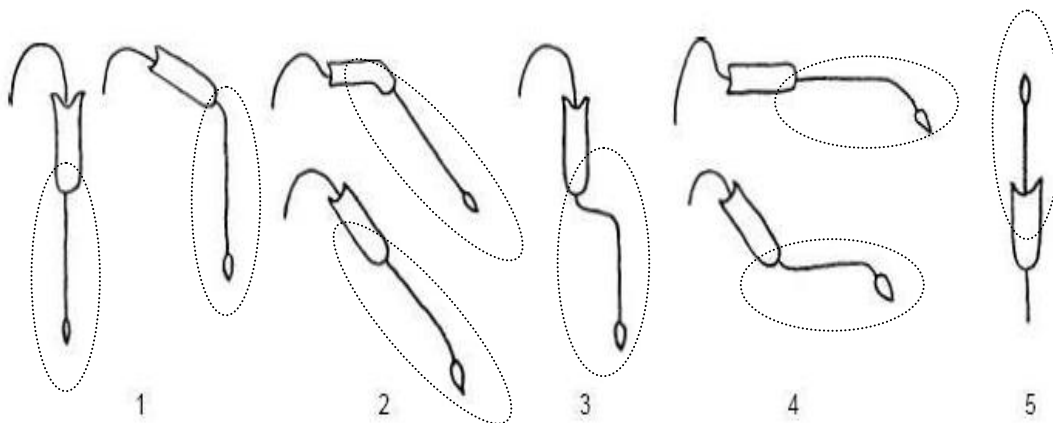


4.

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).

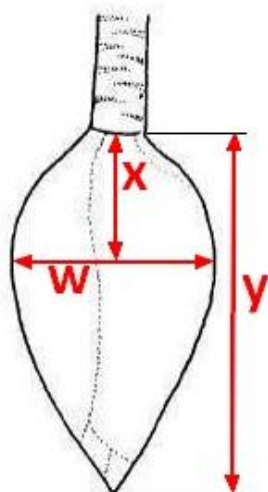


Figure 2. Male bud shape dimensions to be used in 6.4.15, 6.4.16, and 6.4.17

6.4.15 Male bud shape

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

1. Skinny ($w/y \leq 0.45$)
2. Medium ($0.45 < w/y < 0.55$)
3. Fat ($w/y \geq 0.55$)

6.4.16 Male bud length (cm)

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

1. Short ($y \leq 20$ cm)
2. Medium ($20 \text{ cm} < y < 30$ cm)
3. Long ($y \geq 30$ cm)

6.4.17 Male bud shoulder

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

1. High shouldered ($x/y \leq 0.28$)
2. Medium shouldered ($0.28 < x/y < 0.30$)
3. Low shouldered ($x/y \geq 0.30$)

6.5.2 Bract apex shape

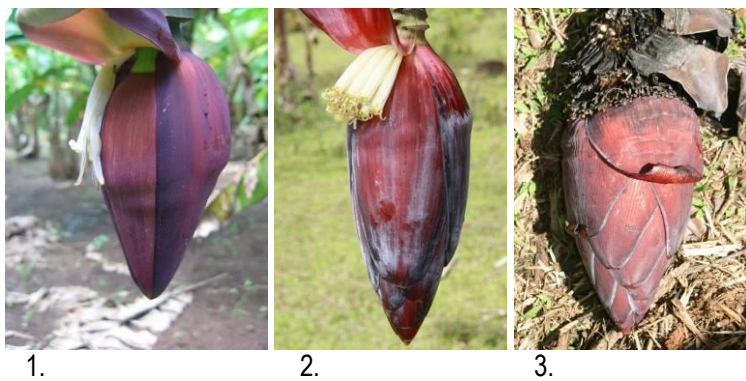
Refers to the first external unlifted bract. Flatten bracts to determine shape.

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



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

1. Convolute
2. Moderately imbricate
3. Highly imbricate



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)



6.5.4 Colour of the bract external face

Refers to the first external unlifted bract. Use colour chart A and observe out of direct sunlight.

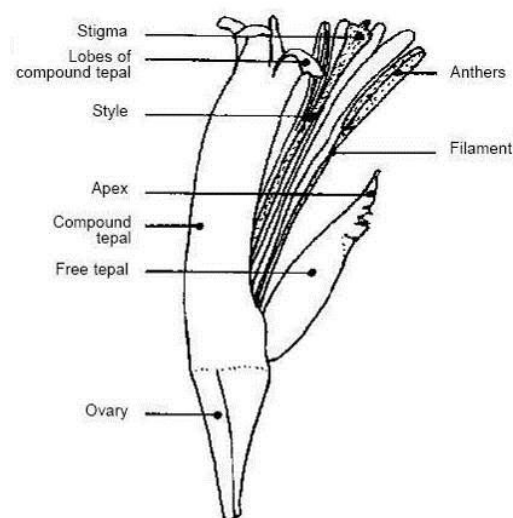
- | | |
|-----------------|------------------|
| 1. Cream | 9. Whitish |
| 2. Yellow | 10. Orange red |
| 3. Watery green | 11. Red |
| 4. Green yellow | 12. Pink-purple |
| 5. Light green | 13. Purple-brown |
| 6. Medium green | 14. Red-purple |
| 7. Green | 15. Purple |
| 8. Dark green | 16. Blue |

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

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 | 9. Red-purple |
| 2. Cream | 10. Pink/pink-purple |
| 3. Ivory | 11. Brown/Rusty-brown |
| 4. Yellow | 12. Beige-pink |
| 5. Bright yellow | 13. Silvery |
| 6. Orange | 14. Light green |
| 7. Orange red | 15. Green |
| 8. Red | 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 | 9. Red-purple |
| 2. Cream | 10. Pink/pink-purple |
| 3. Ivory | 11. Brown/Rusty-brown |
| 4. Yellow | 12. Beige-pink |
| 5. Bright yellow | 13. Silvery |
| 6. Orange | 14. Light green |
| 7. Orange red | 15. Green |
| 8. Red | 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 | 9. Red-purple |
| 2. Cream | 10. Pink/pink-purple |
| 3. Ivory | 11. Brown/Rusty-brown |
| 4. Yellow | 12. Beige-pink |
| 5. Bright yellow | 13. Silvery |
| 6. Orange | 14. Light green |
| 7. Orange red | 15. Green |
| 8. Red | 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 that has straight and curved fruits, please indicate it in the note section and score only the fruit on the upper side of 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



1.



2.



3.



4.



5.

6.7.6 Fruit apex

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



1.



2.



3.



4.



5.

6.7.7 Remains of flower relicts at fruit apex

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.

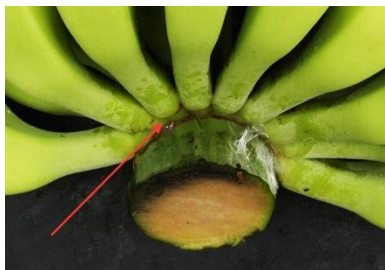
Exact value: ____

1. ≤ 10 mm
2. 11 to 20 mm
3. ≥ 21 mm

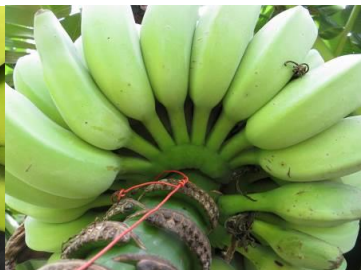
6.7.11 Fusion of pedicels

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.

Convolute -- 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.

Pedicele - 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 2016. Bioversity International, Montpellier, France.