Report on the East and Southern African Regional Workshop on East African Highland Banana Characterization and Documentation

Organised by MusaNet, Bioversity International and the National Agricultural Research Organization (NARO), Uganda

12-16 December 2016

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1. Background

The Global *Musa* Genetic Resources Network (MusaNet, www.musanet.org) in partnership with Bioversity International and the National Agricultural Research Organization (NARO, www.naro.go.ug), held a workshop to address the need for a standardized characterization and documentation of the East African Highland Bananas (EAHBs). This second regional MusaNet workshop took place in Mbarara, Uganda from 12-16 December 2016. The workshop was built on the experience of three previous MusaNet workshops: in 2013 at CIRAD in Guadeloupe, in 2014 at the National Research Centre for Banana (NRCB) in India and in 2015 at the Centre Africain de Recherches sur Bananiers et Plantains (CARBAP) in Cameroon.

In attendance at Mbarara were 16 invited curators of national *Musa* collections and members of the East and Southern African banana network, BARNESA (http://banana-networks.org/barnesa/). Also present were key experts, and staff from NARO and Bioversity International. The programme and background documents were developed by an Expert Team from NARO and Bioversity International, led by *Musa* taxonomists Deborah Karamura and Kodjo Tomekpe. The workshop was financed by the CGIAR research programmes on Roots, Tubers and Bananas (RTB) and on Genebanks.

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

To forge a standardized East African Highland Banana (EAHB) characterization and documentation methodology for East and Southern Africa (ESA) national *Musa* collections.

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

- Review and better understand the status and characterisation methodology of each of the ESA field collections.
- Have a common understanding and agree on the minimum descriptors used to characterize EAHBs.
- 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 MGIS).
- Discuss the next steps towards a standardized EAHB characterization and documentation methodology.

2. 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: Follow-up discussion
- Session 5: 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'.

3. Opening session

The workshop was officially opened on 12 December 2016 with speeches by Programme Leader of the National Banana Research Programme or NARO, Dr. Jerome Kurbiriba, BARNESA Regional Representative Dr. Eldad Karamura (Bioversity International), and MusaNet Coordinator**,** Dr. Nicolas Roux (Bioversity International). Link to Nicolas Roux's presentation.

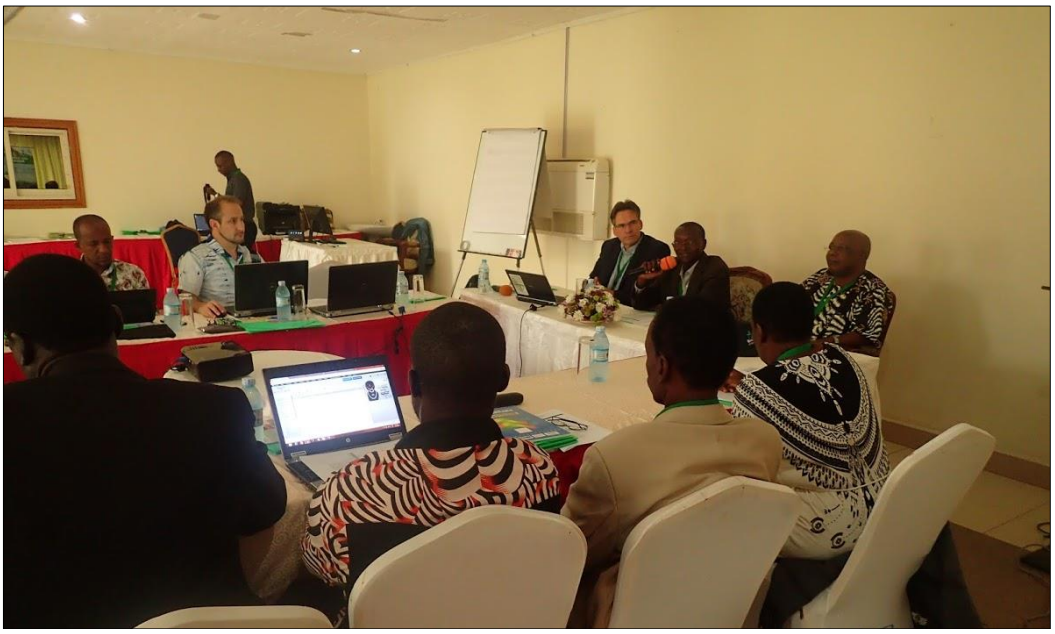


Fig 1. Opening session of the MusaNet ESA regional workshop.

4. 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.

Expectations from the workshop

- Learn more about ESA collections and how to promote the diversity in this region
- To release the tablet software on MGIS website
- Learn more about EAHBs and tools for characterization
- Learn to use EAHB descriptors and tablet
- Share experiences of curators and improve descriptors
- Learn more about banana conservation
- Better understand banana in order to start a new collection
- Get practical experience and exchange
- How to collect data with the tablet and to re-collect lost data

- How to collect and standardize information
- Learn more about characterization, the tablet and knowledge sharing
- To have standard characterization
- Learn about data management of collections
- That all collections will participate in MGIS and will learn to use the tablet
- Know how to best manage the collection and understand the list of EAHB descriptors
- To go back and use the tools but also give feedback to your BARNESA country representative
- Ask questions!!!

The 16 ESA curators each made a short presentation on the current status of their collections (links to presentations are below):

- Ferdinand NGEZEHAYO (IRAZ, Burundi)
- Hamza AZALI (INRAPE, Comores)
- Joseph ADHEKA (UNIKIS, Democratic Republic of Congo)
- Benjamin DOWIYA (INERA, Democratic Republic of Congo)
- Girma KEBEDE (Melkassa, Ethiopia)
- Kwach JOHNSON (KALRO, Kenya) (no presentation)
- Fleuron NANY (FOFIFA, Madagascar)
- Modester KACHAPILA (Malawi)
- Babita DUSSORUTH (AREU, Mauritius)
- Cecilia Ruth BILA (Mozambique)
- Sveta GAIDASHOVA (RAB, Rwanda)
- Lucio ZUMA (ARC, South Africa)
- Elsadig Ahmed ABDALLA (ARC, Sudan)
- Jasmeck KILANGI (ARI, Tanzania)
- Abdalla SALIM (Zanzibar)
- Sedrach MUHUNGI (NARO, Uganda)

A table of names, institutes and email addresses for all participants is found in *Annex 2*.

Introduction to bananas

Deborah Karamura (Bioversity International) gave a general overview on bananas. She talked about the importance of the crop globally, the principal growing areas, taxonomic classification, examples of different groups and subgroups and the problems faced within different groups. Link to presentation. Note: please also see the presentation on subgroups in Section 6 of this report.

Introduction to the EAHB subgroup

Deborah Karamura then presented an overview of the East African Highland Banana subgroup. This included information on the principal growing areas, photos of the key characteristics of EAHBs and the different clone sets. Link to presentation.

Breeding of EAHBs

Robooni Tumuhimbise (NARO) made a presentation on the *Genetic Improvement of EAHBs for Multiple Resistance to Pests and Diseases, and Consumer Acceptability*. The talk included some characteristics of bananas that affect breeding, objectives of banana breeding, common strategies and selection processes, challenges and opportunities and some results from his work with NARO. Link to presentation.

After the coffee break, the participants took a tour of the BARNESA Regional collection, mother garden and other trials (led by Deborah Karamura, Sedrach Muhangi and Robooni Tumuhimbise).

Fig 2. The ESA curators at the regional collection (top), Deborah Karamura (left), and Eldad Karamura at one of the field trials (right).

5. Session 2 - Description and discussion of field exercise

The field and discussion sessions were held over three days, consisting of mornings on a local farm characterizing four different EAHB accessions and afternoons discussing the descriptors that were scored each morning. All participants scored the accessions using the Minimum List of Descriptors for EAHBs 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

- Test the recently developed Minimum List of Descriptors for EAHBs.
- Share experiences on the interpretation of the descriptors and agree on the most appropriate definitions/modifications needed.
- Practical training and knowledge exchange on the descriptors and EAHBs in general.
- Training of and feedback on using the tablets and the application.

The Minimum List of Descriptors for EAHBS

Rachel Chase and Deborah Karamura introduced the participants to the Minimum List of Descriptors for EAHBS, which was the focus of the field work. The list, developed specifically for this workshop, is a compilation of 15 descriptors from the Minimum List of Descriptors for *Musa* (www.musanet.org) plus 17 descriptors that were identified as highly discriminating for EAHB by Deborah Karamura and Kodjo Tomekpe (the experts of the Organizing Committee). The Minimum List of Descriptors for EAHBS is found in *Annex 3*.

Introduction the mobile device and application

Max Ruas (Bioversity International) presented the mobile device (tablet) and the MusaTab application that was developed for the field characterization of bananas. The application contained the Minimum List of

Descriptors for EAHBS divided into 3 field sessions for the four EAHB accessions. He showed the curators the many functions of the tablet and application and how they would record the descriptors into their tablets during the field sessions. Link to presentation.

Field Groups

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	**Deborah Karamura**	**Eldad Karamura**	**Robooni Tumuhimbise**	**Joseph Adheka**
Curators	Noel Madalla	Cecilia Ruth	Svetlana Gaidashova	Ferdinand Ngezahayo
	Jasmeck Kilangi	Sedrach Muhangi	Girma Kibede	Dr Hamza Azali
	Kwach Johnson	Benjamin Dowiya	Abdallah Salim	Babita Dussoruth
	Lucio Zuma	Elsadig Abdalla	Modester Kachapila	Fleuron Nany
Assistants	Max Ruas	Miracle Arikiza	Rachel Chase	Nicolas Roux


Group A


Group B


Group C


Group D

Field exercise procedure (mornings of 13-15 December)

During the field exercise, 4 groups of curators rotated among the following four EAHB accessions at a local farm:

Accession 1 – **Enyeru** (Nfuuka clone set)

Accession 2 – **Kisansa** (Musakala clone set)

Accession 3 – **Entaragaza** (Nakitembe clone set)

Accession 4 – **Embururu** (Nakabululu clone set)

The groups rotated among the four accessions scoring the Minimum List of Descriptors for EAHBS on their tablets. Each group spent approximately 30 minutes at each accession. The list was divided into three field exercises:

1. Field Exercise 1 – 10 descriptors (Vegetative)
2. Field Exercise 2 – 11 descriptors (Floral)
3. Field Exercise 3 – 11 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 to guide them only. They 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 3 days on a local farm.

Discussions in the meeting room (afternoons 13-15 December)

1. For each descriptor, the results for the 4 accessions were displayed by projector. These results for all three days are found here for Field Exercise 1, Field Exercise 2 and Field Exercise 3.
2. Photos of a particular accession and descriptor were also projected next to the graph for visual reference.
3. Led by Deborah Karamura and Sedrach Muhangi, the group looked at the visual results (bar graphs) and assessed the different results for each descriptor.
4. The group discussed the possible reasons for the discrepancies (if any) and then moved to the next accession to repeat the process for all 4 accessions.
5. The group concluded if the description/explanation of the descriptor needs to be modified/revised and how this might happen. The experts helped make a final decision and Rachel took notes.
6. This process was repeated until the all descriptors were discussed.

Field management

Robooni Tumuhimbise also presented a talk on Field Management in the meeting room, which included an overview of the ecological requirements for banana, the establishment of a new banana field, and management of existing banana fields. Link to presentation.

Sedrach Muhangi conducted an hour long discussion on Field Management in the NARO field collection. He discussed topics such as how to remove roots and pare the base of the sucker to reduce most pests (weevils and nematodes) and diseases, how to mulch to prevent water loss and how to weed regularly. He demonstrated how to use a forked stick to remove male buds if there is an outbreak of banana bacterial wilt disease, how to clean tools with bleach, how to destroy sick plants to prevent the spread of pathogens. He discussed spacing and line planting. Yields can be increased by applying compost pit or animal droppings and staking poles can used to prevent bananas from being destroyed by wind.

MusaID demonstration in the field

Max Ruas demonstrated on the tablet the updated version of MusaID in the NARO collection. 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 will be made available for download in 2017.

Fig 4. Sedrach showing how to cut the base of the sucker before planting (left) and Max demonstrating the application MusaID in the field (right).

Local market visit

On 13th December, the workshop participants were treated to a visit to the local banana market by local farmer, Mrs. Teo Kataratambi. The daily market is important across the region but especially for traders and sellers from Kampala and Rwanda. There were both cooking and dessert varieties such as Bogoya (Gros Michel), Gowanya, Embere. Enyeru and Enteregaza are the most dominant varieties – mostly used for cooking and steaming. Bunches that are transported far to supermarkets (often transport takes a whole day) are wrapped in pseudostem sheaths for protection. The pedicel is left so that bunches are easy to transport and after they are chopped up and used for mulch/compost. They also sell big sacks of fingers that are a mix of varieties often from bunches that were not quite perfect for selling whole, which also benefits those people that also cannot afford to buy a whole bunch. The bunch price shifts throughout the season. Currently a bunch costs about 30k – 40k shillings (10 – 12 dollars). We also saw a woman making Matoke (mashed cooked banana dish) for customers.

Fig 5. Photos of the market visit, with our guide, Mrs. Teo Kataratambi (top). Men packing the bags of single fruits (bottom left) and a woman making Matoke (bottom right).

6. 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
- Sharing techniques for taking good photos in the field
- Overview of the MusaNet website and the African collections page
- Presentation and discussion of 10 varieties for each country

Data transfer from tablet to computer

Max Ruas introduced the procedure for uploading data from the tablet to a computer. However, due to software/hardware incompatibilities, it was not possible for the curators to perform the data transfer. Instead, Max demonstrated the procedure on his computer, and will send instructions (+ video) to all curators following the improvement and release of the application.

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; for example it is now possible to access data from molecular studies (Gigwa). There is now an urgent need for more partners to sign the Data Sharing Agreement (DSA) and upload their data, as only collections that have signed the DSA and have uploaded their data will be visible on the new MGIS (via logos). The main advantage of having the DSA signed and uploading data in MGIS will allow all curators to exchange their data and thus improve the quality of content but also Bioversity will be able to personalise each tablet so that it makes it easier for each curator to characterize his collection using MusaTab. If there are any issues the curator can be supported technically by Bioversity's data manager.

MusaNet website

Rachel Chase demonstrated the MusaNet website, including the tabs for the Expert Committee, the *Musa* collection pages and links to MusaNet workshops and publications. She emphasized the importance of the collection pages for better visibility of all the ESA collections and asked that everyone please update the information by sending it to her by email (r.chase@cgiar.org).

Presentation on field photography

Sedrach Muhangi made a presentation (adopted from one made by Lavern Gueco (from UPLB in the Philippines)) on how to take good photos of banana plants. The following software are recommended and available free from the internet: Faststone (editing), Easy thumbnails (re-sizing) and Picture Shark (for adding labels). Link to presentation.

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 ESA region. Link to presentation.

The classification of edible bananas

Nicolas Roux presented (on behalf of Kodjo Tomekpe (CIRAD)) the key morphological characteristics of each major subgroup of edible bananas. Discussion among the participants will be helpful in finalizing the presentation to help curators know the differences between the major banana cultivar types. Link to presentation (to be updated).

7. 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 EAHBs. This work will continue with the Expert Team of the Organizing Committee in the months following the workshop, with a goal to release the list soon as possible. After the modifications, the descriptors should be tested by small group of curators to confirm if they are accurate and adequately capture the diversity of plantains.

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 the Expert Team (**Deborah, Kodjo and Sedrach**) on revising the Minimum List of Descriptors for EAHBs.
- **Max** to finalized 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 African Collections Page.
- **All curators** to have the DSA signed by their institute and update their data to be submitted via MGIS

8. 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 on the curators' impressions, the Uganda workshop achieved the following key outcomes:

- Full participation of the curators from ESA collections
- Inventory of the 10 most popular varieties per country
- Better understanding of how to score *Musa* descriptors
- Agreement on the revision of the Minimum List of Descriptors for EAHBs
- 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
- Proposals and agreement on the next steps needed following the workshop

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.

9. Acknowledgements

The MusaNet regional workshop in Mbarara, Uganda was made possible thanks to the financial contribution from the CGIAR Research Program (CRP) Roots, Tubers and Bananas (RTB) and CRP Genebanks. MusaNet is grateful to the many individuals and their respective organisations for supporting the overall goal of the workshop. Great appreciation goes to Dr. Kurbiriba, Robooni Tumuhimbise and Sedrach Muhangi from NARO and to Eldad Karamura, Coordinator of BARNESA. Special thanks go to the Organizing Committee (Deborah Karamura, Kodjo Tomekpe, Nicolas Roux, Max Ruas, Rachel Chase), Bioversity Montpellier support Silvia Araujo de Lima and Mathilde Jourdan, as well as the Bioversity Uganda support team (Miracle Arikiza, Ambrose Atuhaire, Siifa Lwasa, Rose Taremwa, Esther Arinda and Christopher Semakula) for their efforts prior to and during the workshop. This report was written by Rachel Chase. Finally, thank you also to all the participants of the BARNESA region for their very active participation that made this workshop a real success!

THANK YOU!!!

Annex 1. Programme of the Uganda workshop

DAY 1	MONDAY 12 DECEMBER 2016
08:30-10:30	**OPENING SESSION –** welcome messages and introductions (20 mins each) • **NARO:** Dr. Jerome Kubiriba • **Bioversity International :** Dr. Eldad Karamura • **MusaNet Coordinator:** Dr. Nicolas Roux **Introduction to the Workshop -** Rachel Chase **Aim**: To forge a standardized EAHB characterization and documentation methodology for East and Southern African (ESA) national *Musa* collections. **Overview of the Objectives of the workshop** (5 mins) • Review and better understand the status and characterisation methodology of each of the ESA field collections. • Have a common understanding and agree on the minimum descriptors used to characterise EAHBs. • 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 EAHB characterization and documentation methodology. **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 ESA curators** • Presentation of each partner collection (10 mins each) ➢ Burundi – NGEZEHAYO, Ferdinand ➢ Comores – AZALI, Hamza ➢ DRC (UNIKIS) –ADHEKA, Joseph ➢ DRC (INERA) – DOWIYA, Benjamin ➢ Ethiopia - KEBEDE, Girma ➢ Kenya – JOHNSON, Kwach ➢ Madagascar – NANY, Fleuron ➢ Malawi – KACHAPILA, Modester ➢ Mauritius - DUSSORUTH, Babita ➢ Mozambique - BILA, Cecilia Ruth ➢ Rwanda - GAIDASHOVA, Sveta ➢ South Africa – ZUMA, Lucio
13:00-14:00	***Lunch***
14:00-15h30	More presentations of partner collections (40 mins)

	➢ Sudan - ABDALLA, Elsadig Ahmed ➢ Tanzania - KILANGI, Jasmeck ➢ Zanzibar - SALIM, Abdalla ➢ Uganda –MUHUNGI, Sedrach • Presentation on different types of banana – Deborah (15 mins) • Introduction of EAHB –Deborah (15 mins) • Presentation on breeding EAHBs – Robooni (15 mins)
15:30-15h45	***Coffee/tea break***
15:45-17:30	Visit of BARNESA Regional collection, mother garden and other trials (led by Deborah, Sedrach and Robooni) . **Welcome Cocktail at hotel**
DAY 2	**TUESDAY 13 DECEMBER 2016**
08:00-9:00	**SESSION 2: FIELD EXERCISE** **In the meeting room:** **Description of the field exercise for the next 3 days (30 mins) –** Rachel • Description of the process • Description of the 4 accessions to be scored • Explanation of the 4 groups • Explanation of the Compound List of Descriptors to be scored in the field over the 3 days – 1) vegetative parts 2) flowers and 3) fruits • Photos to be taken at last accession (Day 4) • Questions of clarification and agreement **Presentation of the mobile device (30 mins) -** Max How to use the mobile device and MusaTab in the field and record data
9:00-13:00	**FIELD EXERCISE - Vegetative descriptors**
13:00-14:00	***Lunch***
14:00-16:00	**Discussion in the meeting room of the Vegetative descriptor results with experts (Deborah and Sedrach)**
16:00-16:30	***Coffee/tea break***
16:30-17:30	**Discussion in the meeting room of the Vegetative descriptor results with experts (Deborah and Sedrach)**
DAY 3	**WEDNESDAY 14 DECEMBER 2016**
08:00-11:30	***FIELD EXERCISE-Flower descriptors***
11:30-13:00	**Market visit**
13:00-14:00	***Lunch***

14:00-16:00	**Discussion in the meeting room of the Flower descriptor results with experts (Deborah and Sedrach)**
16:00-16:30	***Coffee/tea break***
16:30-17:30	**Field management (in the meeting room + Field) – Robooni**
DAY 4	**THURSDAY 15 DECEMBER 2016**
8:30-10:00	**Documentation and sharing Information** **MusaID demonstration in the field-Max (1 hr)**
10:00-13:00	**FIELD EXERCISE – Fruit descriptors**
13:00-14:00	***Lunch***
14:00-16:00	**Discussion in the meeting room of the Fruit descriptor results with experts (Deborah and Sedrach)**
16:00-16:30	***Coffee/tea break***
16:30-17:30	• Presentation of Musanet website (Rachel) – 15 mins • Presentation of new MGIS website (Max) – 15 mins • Discussion of different genotypes (prepared by Kodjo) – Nicolas • Discussion of top 10 varieties for each country (Nicolas)-45 mins **Social Dinner at hotel**
DAY 5	**FRIDAY 16 DECEMBER 2016**
08:30-10:00	**SESSION 3: DOCUMENTATION AND SHARING OF INFORMATION** MGIS set up and training (Mobile device to computer)-Max
10:00-10:30	***Coffee/tea break***
10:30-13:00	**FOLLOW UP DISCUSSIONS** • Presentation on taking good photos in the field (Sedrach) -30 mins • Next steps for development of the EAHB minimum descriptor list (Rachel) -15 mins **CONCLUSION AND EVALUATION – Rachel** • Round table on personal impressions of the workshop and what we achieved – 30mins • Evaluation of the workshop by participants -20mins
13:00-14:00	***Lunch***
14:00	**Departure of some participants**
	Trip to the Cultural Centre
DAY 6	**SATURDAY 17 DECEMBER 2016**

08:00-17:00	**FIELD TRIP** • On the way from Mbarara to Kampala we will visit the Lake Mburu National Park (led by Robooni) • Departure of some travelling participants in the evening from Kampala
DAY 7	**SUNDAY 18 DECEMBER 2016**
	Departure of other travelling participants

Annex 2. Details of participants at the Uganda workshop

No	Last name	First name	Institute, Country	Email
1.	Abdalla	Elsadig	ARC, Sudan	elsadigabdalla@gmail.com
2.	Adheka	Joseph	UNIKIS, DRC	jadheka@yahoo.fr
3.	Azali	Hamza	INRAPE, Comores	abdouazalihamza@gmail.com
4.	Dowiya	Benjamin	INERA, DRC	dowiya@yahoo.com
5.	Dussoruth	Babita	AREU, Mauritius	babita3jdussoruth@gmail.com
6.	Gaidashova	Svetlana	RAB, Rwanda	gaidashova@yahoo.com
7.	Johnson	Kwach	KALRO, Kenya	kwachjk@gmail.com
8.	Kachapila	Modester	Malawi	mauldyka83@gmail.com
9.	Kebede	Girma	Melkassa, Ethiopia	agirmak99@yahoo.com
10.	Kilangi	Jasmeck	ARI Maruku, Tanzania	jasmeckkilangi@gmail.com
11.	Madalla	Noel	Bioversity International, Arusha	N.Madalla@cgiar.org
12.	Muhangi	Sedrach	NARO, Uganda	muhangised@yahoo.co.uk
13.	Nany	Fleuron	FOFIFA, Madagascar	nanyfleuron@yahoo.fr
14.	Ngezahayo	Ferdinand	IRAZ, Burundi	ngezafrd@yahoo.fr
15.	Ruth	Cecilia	Mozambique	ruthbila@yahoo.com
16.	Salim	Abdallah	Zanzibar	abdallasalim200@yahoo.co.uk
17.	Tumuhimbise	Rooboni	NARO, Uganda	rtumuhimbise@hotmail.com

Annex 3. Minimum List of Descriptors for EAHBs

Minimum List of Descriptors for EAHBs

Developed by the MusaNet Diversity Thematic Group – version December 2016

INTRODUCTION

This **Minimum List of Descriptors for East African Highland bananas** has been developed for the *MusaNet East and Southern African Regional Workshop on EAHB Characterization and Documentation* at NARO, Mbarara, Uganda in December 2016, and will be fine-tuned after the workshop. It is a compilation of descriptors from the Minimum List of Descriptors for *Musa* **(in blue type)** plus several descriptors that are highly discriminating for EAHB **(in brown type)** as identified by Deborah Karamura, Kodjo Tomekpe, the Expert Team of the Organization Committee of the workshop and the East African banana curators.

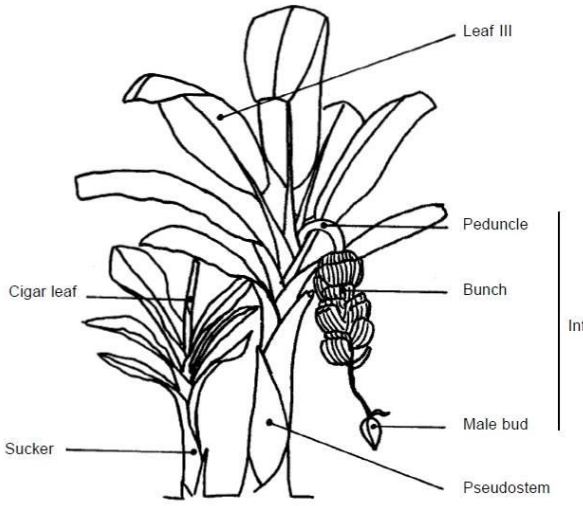
THE APPROPRIATE DEVELOPMENT STAGE FOR OBSERVATION

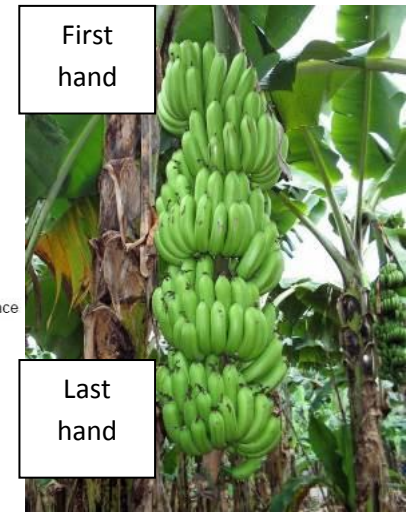
The best time to take photos and document

a) Vegetative descriptors at shooting or within fifteen days of shooting. During this time, maximum development of vegetative parts takes place.
b) Bunch and fruit descriptors are when the fruit are green-ripe or yellowing ("harvest time"). This is separate from the instance of a single ripe fruit generally observed on the first or the second hand of the bunch. Also, do not confuse harvest time with ripe fruit affected by diseases, insect bites or birds.
c) Male inflorescence descriptors are when fruits in the bunch become negatively geotropic, or one month after shooting and the time when male bud are cut off.

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 **floral descriptors** (6.6.2 - 6.6.13) the material should be fresh as it oxidizes and changes colour rather quickly. For the **fruit descriptors** (6.7.1 - 6.7.19) 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.**

VEGETATIVE DESCRIPTORS (10)

6.2.1b Pseudostem height / girth ratio (cm) (Height recorded from the base of the pseudostem (level of root emergence) to the emerging point of the peduncle). Girth measured at lower levels of the pseudostem around 20 cm above the collar

1. < 4.1
2. 4.2 - 5.1
3. > 5.1

6.2.3. b. Pigmentation (blotches) in the pseudostem (outermost sheaths)

1 None
2 Brown/rusty brown
3 Black
4 Other (specify in descriptor Notes 6.8)

2. 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

6.2.7 **Sap colour**

Cut the external sheath of pseudostem or the young fresh leaf of a sucker and record the characteristics of the sap. (Colour chart A)

1 Watery
2 Milky
3 Red-purple
4 Others

6.2.10 b. **Suckers with tubular leaves**

1 Suckers start with tubular leaves
2 Suckers don’t have tubular leaves

1.

6.2.11 Position of suckers

1 Far from parent plant (emerging >50 cm from parent plant)
2 Close to parent (vertical growth)
3 Close to parent (growing at an angle)

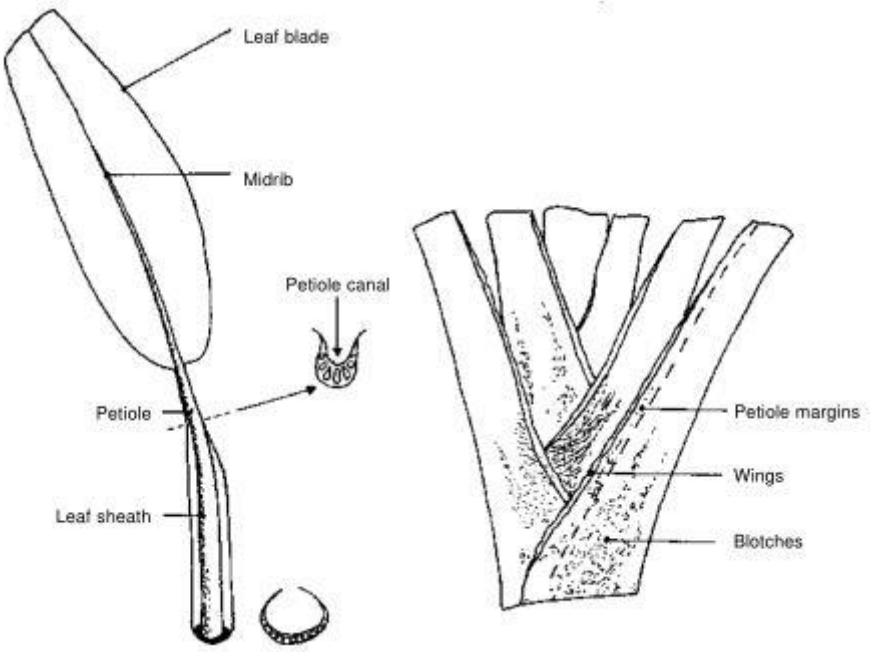
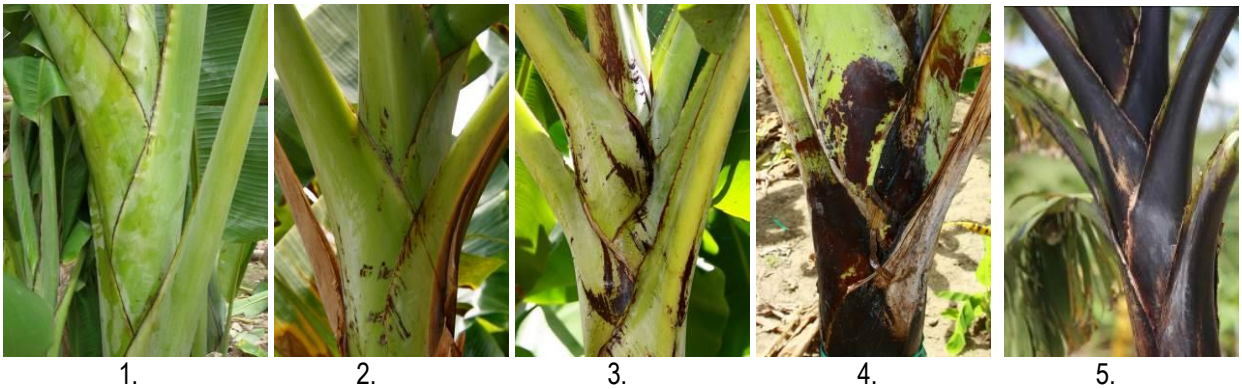


Figure 1. Petiole/midrib/leaf (from Champion 1963 (left), De Langhe 1961 (right). This diagram is used to help with descriptors 6.3.1 through 6.3.7.

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%)
5. Completely covered with blotches



1. 2. 3. 4. 5.

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

6.3.12 **Colour of leaf upper surface** (Colour Chart A)

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

6.3.19 b **Leaf tips**

1. Not twisted
2. Twisted

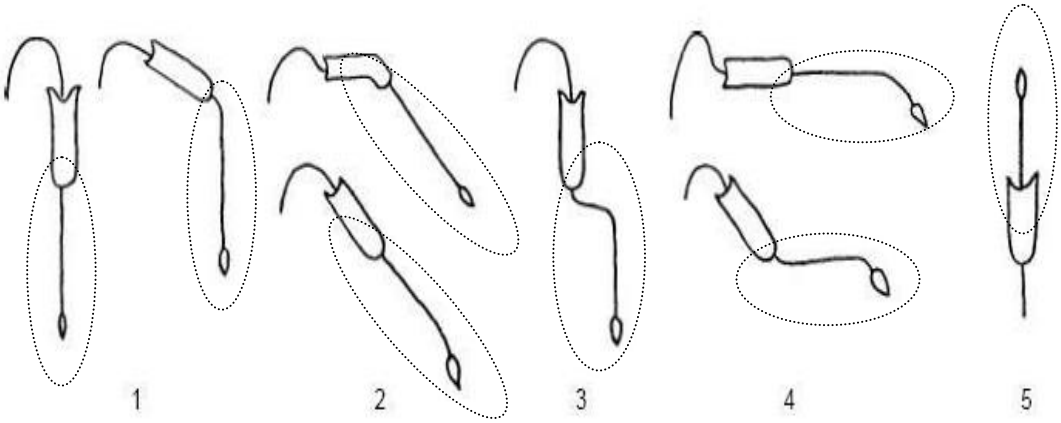
2.

FLORAL DESCRIPTORS (11)

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.

6.4.14 Male bud type

1. Absent
2. Present

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).

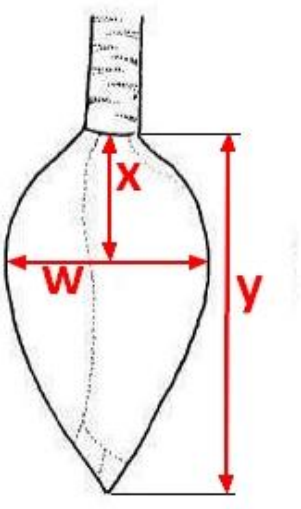


Figure 2. Male bud shape dimensions to be used in 6.4.15, 6.4.16, and 6.4.17

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.

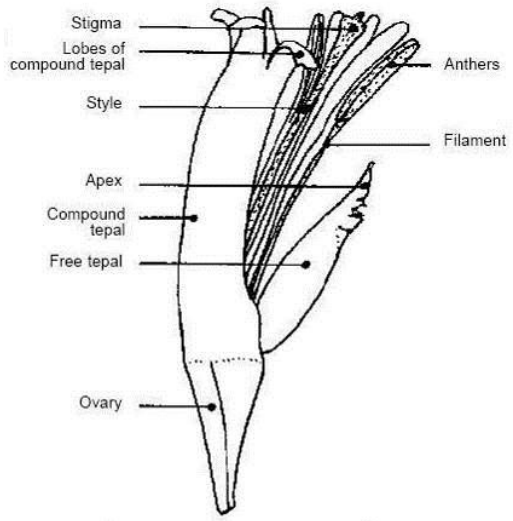
3.

6.5.4 **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
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.



6.6.5b Compound tepal

1 Closed
2 Open

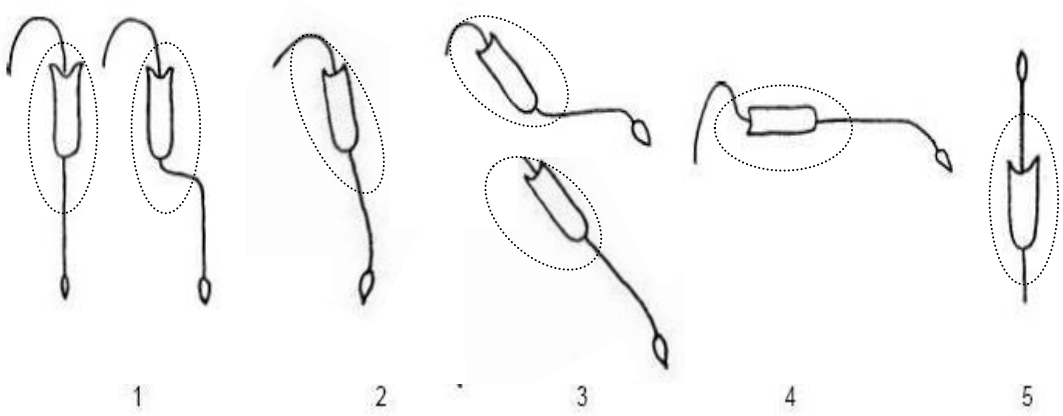
6.6.9b Free tepal margins

1. Entire (not serrated)
2. Serrated

FRUIT DESCRIPTORS (11)

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 (with the bunch length > to twice its diameter)
2. Truncate (= cone shaped)
3. Asymmetrical
4. Spiral (all fruit are attached to a unique crown coiled around the stalk)
5. Cylindrical with the bunch length < to twice its diameter
6. Others

1. 2. 3. 4. 5.

6.4.8 Bunch appearance

The bunch should still be on the plant.

1. Very Lax (one can easily place a hand horizontally between the hands of fruit)
2. Lax (one can easily place a hand obliquely between the hands of fruit)
3. Compact (one can place a finger, but not a hand, between the hands of fruit)
4. Very compact (one cannot place a finger between the hands of fruit)

1.

2.

3.

4.

6.4.10 Fruits (positioning of fruits on the crown)

1. Uniseriate
2. Biseriate
3. Biseriate and fused

1.

2.

3.

6.7.1 Fruit position Recorded only on the fruits arranged symmetrically around the stalk.

1. Curved towards stalk
2. Parallel to the stalk
3. Curved upward (obliquely, at a 45° angle upward)
4. Perpendicular to the stalk
5. Pendant

6. Other

6.7.3 Fruit length /circumference ratio (cm) at maturity

Length measured as the internal arc of the fruit, without pedicel. Circumference measured around the middle of the fruit. 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.

1. ≤ 3.0
2. 3.1-4.0
3. > 4,1

6.7.4b General fruit shape

1. Cucumber shaped
2 Slender (length > six times breadth)
3 Triangular
4. Other

1.

2.

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.

6.7.12 **Immature fruit skin colour**

Recorded on the youngest hand of the bunch, before maturity. (Colour chart B)

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

6.7.19b **Pulp**

1. Without brown sticky sap
2. With brown sticky sap

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