

# Grow bananas better

## Extension training guide



## A Preamble

Banana is still the most preferred staple crop in Uganda. Its ability to fruit all year round makes it more important for household food security and income. However, of recent, the crop has faced decline in productivity attributed to diseases (Banana Xanthomonas Wilt and Black Sigatoka), weevils, nematodes, soil degradation, low use of fertilizers, low adoption of improved crop management techniques, variation in prices among others.

In order to reverse the decline in productivity, the National Banana Research Programme (NBRP) of National Agricultural Research Organization (NARO) Uganda and other development partners have developed, evaluated and promoted technologies.

They include:

- (i) Plantation management practices (weeding, sucker removal and management, leaf and bud removal, propping and intercropping)
- (ii) Soil and water conservation and management practices (mulching, use of organic and inorganic fertilizers and construction of soil and water retention ditches and bands)
- (iii) Pests and disease prevention and control measures (banana weevil and nematode control through use of clean planting material, trapping the weevils and use of chemicals)
- (iv) Control of BXW with the use of practices such as single diseased stem removal, suspension of pruning in affected gardens, male bud removal and disinfection of tools with fire or sodium hypochlorite; (v) Integration of trees in banana plantations; and
- (vi) The introduction of new matooke hybrid banana varieties.

The production of this extension guide is therefore timely. The guide contains all the relevant information on various technologies needed for banana production therefore, it will help deliver right information on application of above technologies. It is a very important and most relevant tool for extension staff and other stakeholders who seek to effectively deliver information on banana production and productivity to the farmers.

We commend the assistance of Bill and Melinda Gates Foundation through the Banana Agronomy Project towards the production of this extension guide.

**Wilberforce Tushemererirwe**

**Director of Research, NARL**



## Brief about the project

The Bill and Melinda Gates Foundation (B&MGF) funded Banana Agronomy project aims at bridging this yield gap by improving banana agronomy practices for small-scale farmers in highland banana cropping systems in East Africa.

Part of the project activities involves packaging critical information necessary for increasing banana productivity. Such information includes synergies and trade-offs between crop-soil management technologies, pest (weevil) and disease (BXW, black Sigatoka) management practices, nutrient limitations and their interactions with pest damage, and enhancement of nutrient and water uptake. This information will be packaged into decision support tools (DSTs) that will aid the scaling agents to meaningfully contribute to increasing banana productivity on farmers' fields.

This extension training guide was developed to support extension staff in providing critical advice to farmers.

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Enoch Kikulwe

## **IITA**

Richard Malingumu  
Jabungu Allan  
Godfrey Tulya  
Dianah Nakubulwa  
Zaharah Najuma

## **Farmer Institutions Representatives**

Steven Musisi                      Kyasanga Farmer group, Nakaseke  
Henry Turyakira                    Rwimi Revolutionary Groups  
Sarah Tusingwire                    Banana producers cooperative

## **Extension Representatives (Public, NGOs & Radio)**

Aloysius Karugaba                Isingiro  
Benono Kahangi                    Nakaseke  
Agnes Tumusabe                    Bunyangabo  
Fredica Baguma                    NGO RUHEPAI  
Senabulya Vincent                 Radio Musana

## **CABI**

Christine Aloit  
Abigael Mchana  
James Watiti

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# How to use this guide

This extension manual is for use by extension personnel, lead farmers and community based facilitators who may serve as scaling agents. It is designed as a guide to be used to facilitate farmers on improving banana production. Training lessons have been set in easy-going formats comprising pictorial and only small amounts of text to bring out the trainers' creativity within varied contexts.

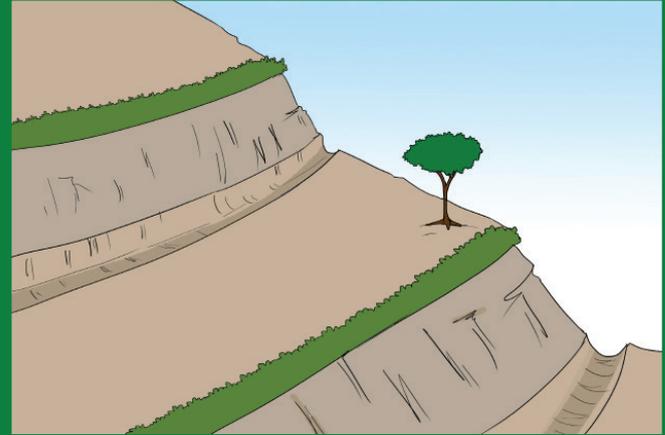
The format is designed to enhance interactivity between the trainer and amongst the farmers. It consciously avoids a prescriptive training package but rather considers the farmer's existing knowledge and strives to build upon it. All sessions therefore begin by bringing to the fore, farmer knowledge to make the trainer alert to what information he should impart. Preparation for the training sessions is therefore very important. By training in groups, farmers are empowered to share their vast and varied experiences and improve their problem solving and decision making skills. The trainer's role is therefore that of a facilitator. It is recommended that one or utmost two short topics are covered in each training session.

The recommended setting for most of the training is on banana plantations to make the learning contextual and align it to the realities and constraints of the farmer's environment. Learning on the farm makes it active and practical and gives the farmer a better chance at recall of content, as real sites facilitate practical demonstration alongside discussion with peers. The trainer should therefore prepare for the training with this in mind. Awareness by the trainer of different learning styles by the farmers is vital to actively connect with them. Discussion, demonstration and use of examples are useful methods.

Learning is incomplete without an assessment of whether the farmer's needs have been met. Various methods can help determine this; informal discussions with farmers, meetings with community leaders and visible improvements on the farm.

# Module 1

## Pre-planting



### Session 1: Site selection

Item	Content
Introductions	The trainer introduces him/herself to the trainees. Let the trainees introduce themselves too
Objectives	Improve farmers knowledge on suitable sites for banana production
Key message	Farmers should be able to identify suitable sites for banana production
Training materials	Flip charts, marker pens, masking tape etc.
Training Duration	30 minutes Identify a time keeper
Training rules and regulations	Guide the trainees to set the rules and regulations for the training e.g. noise making, putting phones on silent mode etc.



## Activity 1: Sharing experience

- Let the farmers share experiences on what they consider to be a suitable site for banana production according to their different localities.

### Discussion on suitable site selection

After listening to the farmers' experiences, discuss and emphasize on the suitable sites for banana production as follows:

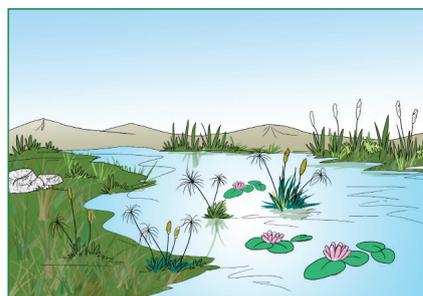
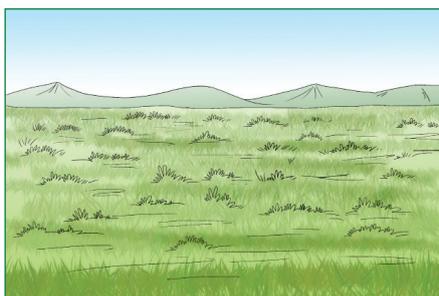
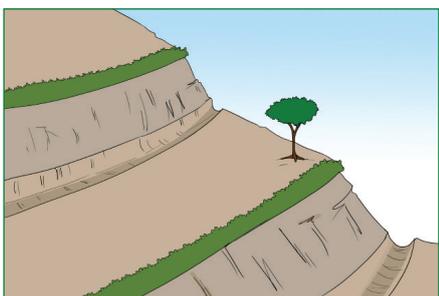
- Bananas grow best in well-drained deep soils
- Do not tolerate poor drainage and select sites that are well draining for your banana plantation.

### Why select well-drained soils

The roots can easily penetrate, allowing for aeration

### Avoid swampy areas to prevent the following:

- Environmental degradation
- Restricted root development
- Higher chances of leaching (washing of plant nutrients from the upper soil layers to the bottom layers of the soil)



## Activity 2: Assessment



1. Let the farmers ask questions regarding what they may not have understood and provide answers and further clarifications as needed.
2. Pair the participants to tell each other what they have understood and what they have not understood and then report back accordingly.
3. Plan for follow up farm visits and assessment (2 months)
4. Agree on the training time, date, venue and the topic for the next training.

Thank the trainees for their participation and invites a volunteer to close according to the protocols that may be present

## Session 2: Land preparation

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	To equip farmers with skills and knowledge on land preparation for banana establishment.
Key message	Farmers should be able to prepare a suitable seed bed for planting bananas
Training material and tools	Flip charts, marker pens, masking tape, pangas, hoes, wheel barrow, forked hoe, slashers, axes etc. Herbicides for application, spray pumps
Training Duration	1 hour Identify a time keeper
Training rules and regulations	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site.*
- *It is recommended that farmers be informed about the venue/training site in advance, and that the selected site is used for all future practical training sessions.*



### Activity 1: Sharing experience

- Divide the farmers into groups of 3 or more. Ask them to discuss how they prepare their land for banana production.
- Let the farmers present their group findings in plenary.

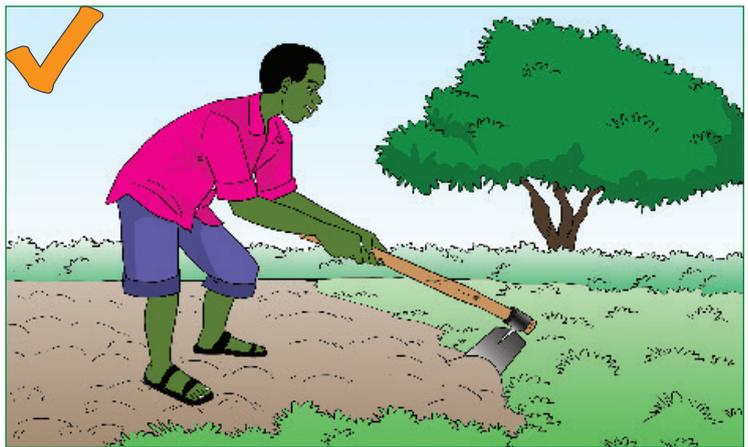
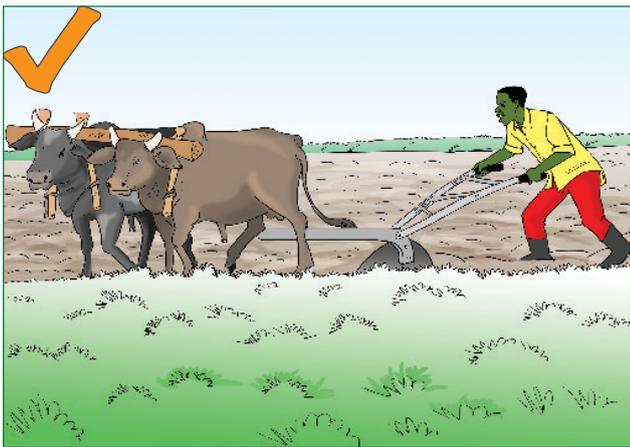
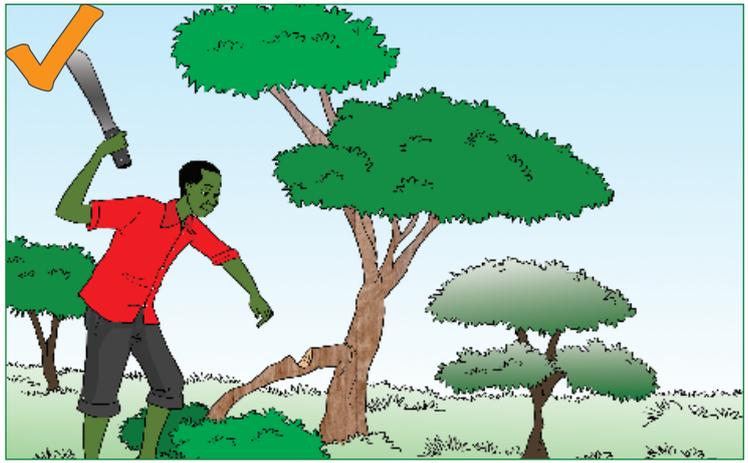
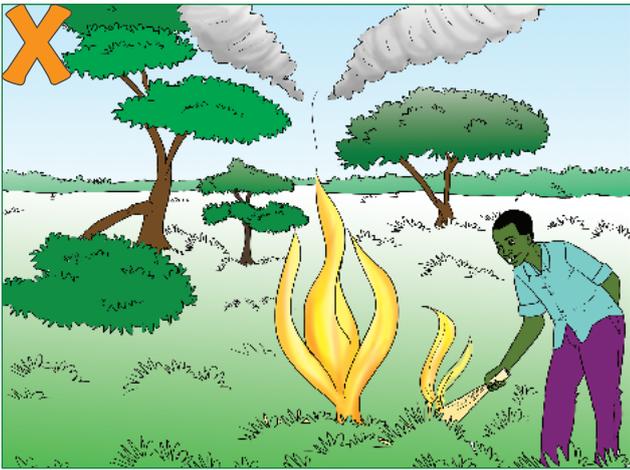
### Technical emphasis and guidance by the trainer

In relation to the plenary, the trainer can emphasize on the recommended land preparation procedures using the outlined procedure:

- Carry out bush clearing and uproot any stumps.
- Do first deep ploughing to loosen the hard surface (break any hard pans) close to the surface to improve aeration and water infiltration.
- Do not burn bushes. Residues from bush clearing can be used for mulching

After emphasising on the above, practical demonstration of land preparation procedures should be done as follows:

- Bush clearing
- Deep ploughing
- Describing the functionality of each of the tools
- Use of herbicides to avoid perennial weeds



## Activity 2: Demonstrations

1. The trainer should categorise the farmers in order to identify those who want to establish new plantations
2. The trainer should arrange visits to the sites of those farmers who plan to establish new plantations and provide further advice on suitable land preparation procedures.

3. Monitoring – plan for farm visits and assessment (2 months).
4. Agree on the date, time, venue and topic for the next training.

Thank the trainees for their participation and invites a volunteer to close according to the protocols that may be present.



## Session 3: Spacing and planting holes

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	To enable farmers be able to plant bananas using appropriate spacing To enable farmers understand how to make proper holes for banana planting
Key message	Enable the farmers to determine the optimum plant population Enable the farmers understand how to make holes appropriate for water retention
Training material and tools	Flip charts, marker pens, masking tape, pangas, hoes, tape measure, pegs, peak axe and strings Attendance/registration sheets
Training Duration	2 hours Identify a time keeper
Training rules and regulations	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site accordingly.*
- *It is recommended that farmers are informed about the venue/training site in advance.*



### Activity 1: Sharing experience

- The trainer should let the farmers share their experiences on how they make holes and space banana plants. (Farmers can use their hands or any other appropriate approach to demonstrate).

### Discussion and experience comparison

The trainer should help farmers discuss and compare their experiences on how they do spacing and make holes in their own localities.

### Technical guidance and emphasis on recommended spacing

The trainer should assess farmers' practices from the discussions and then emphasise on the following standard recommended spacing:

- If a farm has good soil fertility and is located in an area that receives high rainfall (over 1200mm/annum), use spacing of 2.5mx2.5m from plant to plant for varieties with normal suckering traits. Over suckering traits use 3mx3m
- Under low rainfall (low rainfall: 700-1200mm), use 3mx3m for both traits
- Measurement should be from the middle of the hole

## Importance of proper spacing

It is important for the farmers to understand the importance of proper spacing e.g.

- Ensures optimum plant population
- Minimizes plant competition for growth production resources
- Enables sunlight penetration
- Allows proper management practices e.g. when mulching or harvesting

## Disadvantages of poor spacing

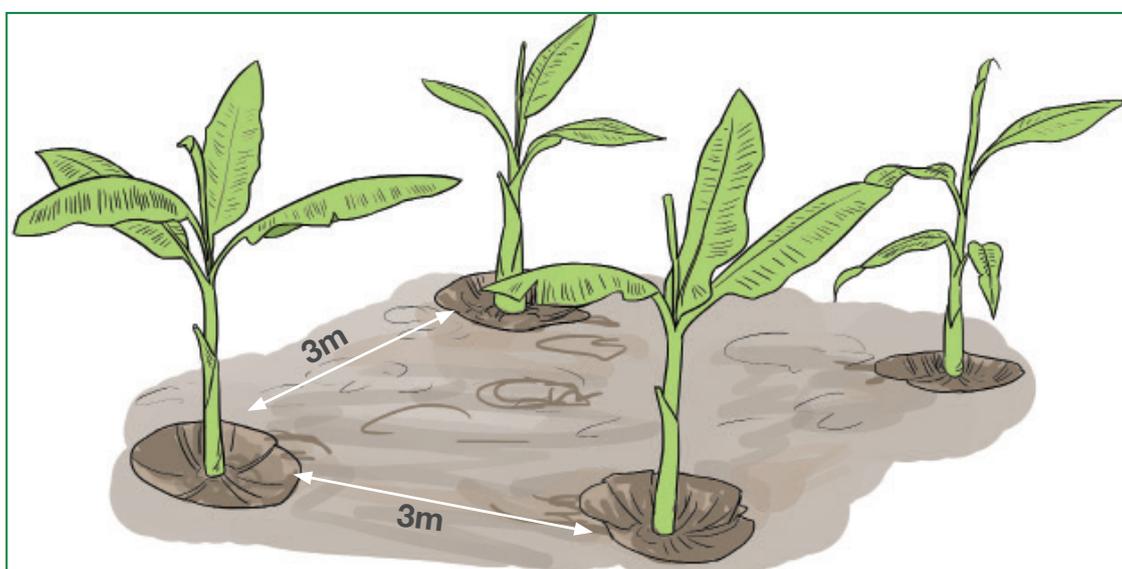
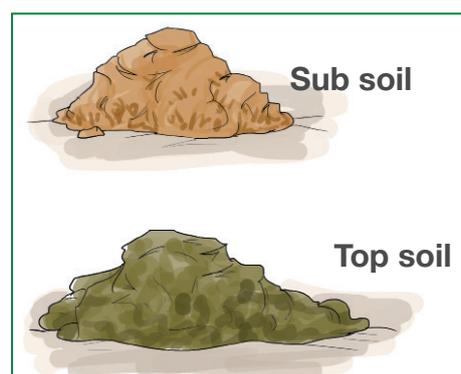
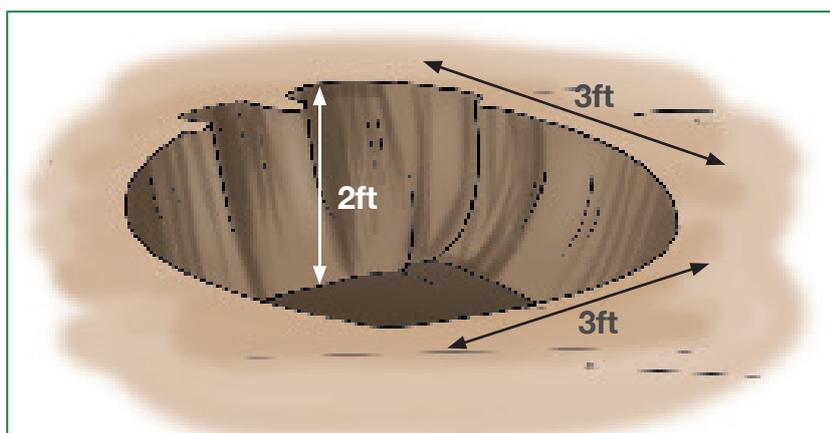
It is important for the farmers to understand the disadvantages of poor spacing e.g.

- The pseudo stems become weak and long resulting in tiny banana fingers/bunches
- When plants are spaced too close together it results in too much competition for nutrients and when placed far apart the farmer gets fewer bunches per unit area.

## Digging of the holes

The trainer should demonstrate the procedure to be followed in digging holes as follows:

- Dig holes of 2ft deep, 3ft wide and 3ft long to allow for root expansion and water retention. Large holes collect enough water for the bananas and improves root penetration
- Separate top soil from sub soil when starting to dig. On sloppy land, top soil (fertile soil) should be preferably placed uphill and sub soil downhill. In case of water runoff, the top soil is placed back in the hole





## Activity 2: Group exercise

1. Divide the farmers into groups of 3 or more and let them take the measurements and dig holes under the trainer's supervision.
2. After each participant has dug a hole, the trainer should check each one to ensure they meet the recommended standard, while emphasising the importance of each aspect.
3. Farmers should make holes according to the recommended standard in their own gardens

4. The trainer to follow up on the farmers to ensure implementation
5. Agree on the next meeting training date, time and venue

Thank the trainees for their participation and invite a volunteer to close according to the protocols that may be present.



# Session 4: Variety selection

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	To ensure farmers understand how to select appropriate varieties suitable for different sites and ecological zones
Key message	Enable the farmers understand appropriate recommended varieties that can be productive enough and that are suitable for the different market demands.
Training material and tools	Flip charts, marker pens, masking tape, registration/attendance list and samples of different varieties
Training Duration	1.5 hours Identify a time keeper
Training rules regulation	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the discussions

- *This is intended to be a discussion session and should thus be held at an appropriate and convenient venue.*
- *The trainer should always inform farmers about the venue in advance for adequate preparation by the farmers.*



## Activity 1: Sharing experience

- The trainer should let the farmers share their experiences on how they identify banana varieties for planting in their different localities. This can be done by show of hands or by any other appropriate approach thus open discussions should be guided accordingly.

### Technical guidance and emphasis on variety selection

The trainer should assess the discussions and then emphasise on the recommended new and good local varieties. The trainer should also emphasize on the benefits of the recommended varieties as below.

It is advisable to use improved varieties that have been conventionally bred to solve specific production constraints such as:

- Diseases and pests
- Low yield and moisture stress/drought

Notably, specific varieties to be grown also depend on the farmer's choice and production constraint to be addressed which also varies from one agro-ecological zone to another.

The trainer can inform farmers about examples of improved cultivars available at NARO Kawanda

which include:

- Kabana 6H (M9, Kiwangaazi)
- Kabana 7H (M2)
- NAROBan 3
- NAROBan 4 etc.

Planting materials for these improved cultivars can be accessed from research institutes and certified nurseries/ multipliers in the country.

The trainer should also explain about the recommended local varieties and their traits e.g.

- Mbwazirume
- Kibuzi
- Mpologoma
- Musakara etc.

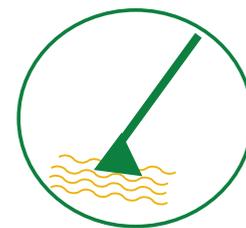
Together with farmers, the trainer should establish demonstration gardens where different varieties can be grown in order to show differences in traits.



## Activity 2: Question and answer & demonstrations

1. The trainer should let farmers ask questions and answers provided accordingly.
2. The trainer should ask the farmers about the existing myths and perceptions towards different varieties according to their different localities e.g. improved varieties cause banana bacterial wilt.

3. Trainer should move with farmers in nearby banana plantation to identify the different varieties and give their attributes.
4. Set up demonstrations of the different varieties so that farmers are able to see their performance in terms of productivity.
5. Encourage farmers to keep visiting the demonstration sites to keep observing the performance of different varieties.



6. The trainer should plan for follow up visits to the farmers' gardens to ensure they have recommended varieties (whether local or improved).
7. Agree on the next meeting training date, time and venue

Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks

# Session 5: Selecting planting materials

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objective	To enable farmers to select and prepare proper banana planting materials
Key message	How to select and prepare proper clean banana planting materials
Training material and tools	Different types and sizes of suckers for planting, flip charts, marker pens, masking tape, pangas, pick axe, knife, mattock, registration/attendance sheets etc.
Training Duration	1 hour Identify a time keeper
Training rules and regulations	Guide the trainees to set the rules and regulations for the training e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site/garden where the materials are to be selected from. The trainer should visit the selected farm/site prior to the training day.*
- *It is also recommended that farmers are informed about the venue/training site in advance.*



## Activity 1: Sharing experience

- The trainer should let the farmers share and compare experiences on how they select and prepare their planting materials in different localities in plenary session. Alternatively select a few farmers and ask each one to pick from provided suckers which on they would select to plant and why
- This can be done by show of hands but can also entail practical demonstration by a few farmers. Farmers should be encouraged to share their reasons for preparing their planting material in particular ways.

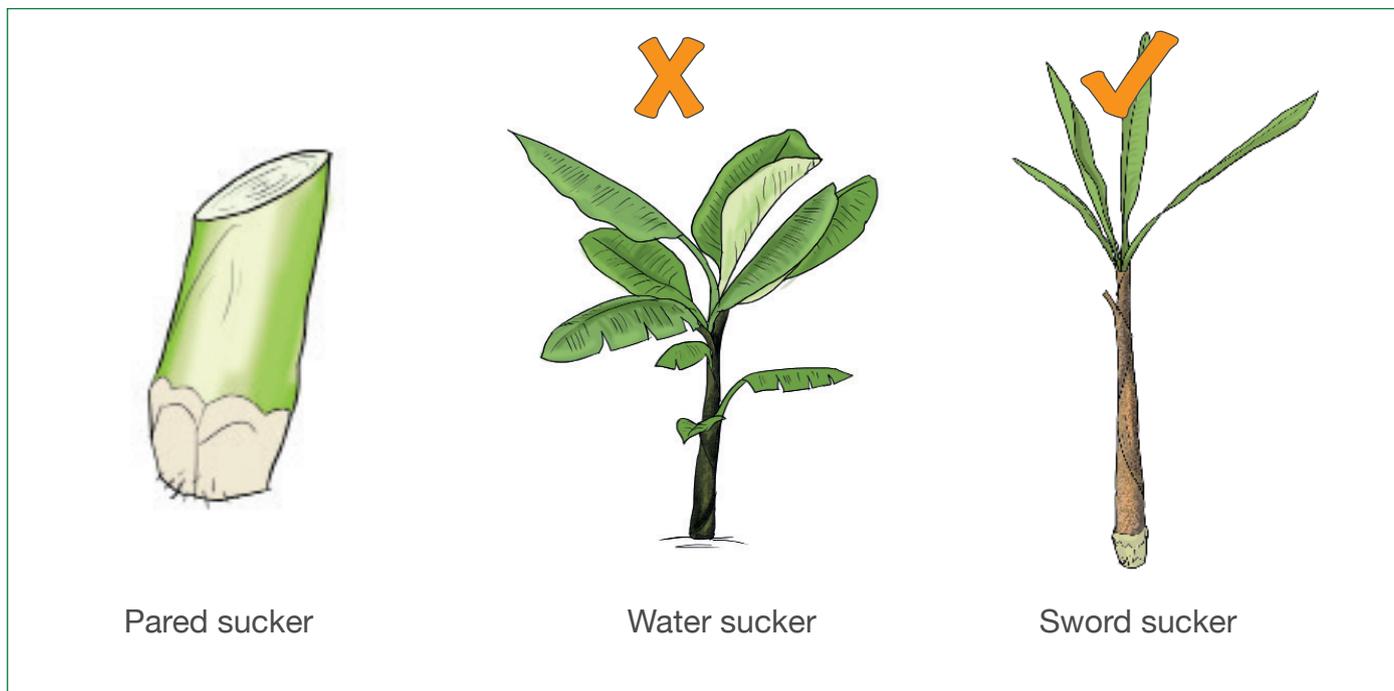
### Technical guidance and emphasis on proper planting material selection and preparation

The trainer should assess the discussion and then emphasise on the following standard recommended procedures:

- It is recommended to always begin with clean planting materials
- To achieve better crop establishment, select sword suckers that are vigorous and which are free from pests and diseases
- When cleaning suckers for planting, remove all roots and dead tissues (paring).
- Cut the corm at the base to ensure a flat base and make a slanting cut at the top (at most at 1.5 feet (45cm) from the base)
- The slanting cut allows rain water to flow off and avoids rotting.

- Paring is done to ensure pest free planting material and the pared sucker will develop its own roots.

**Note:** Use of older suckers will result into small bunches in first harvest. Unpared suckers will lead to spread of pests and diseases



## Activity 2: Practical Exercise

1. The trainer should allow the participants to practically select and prepare planting materials as outlined in the processes above.
2. The trainer should arrange for the preparation of a seedbed and agree on the planting time.
3. Each farmer should record what action they will take from what they have learnt
4. Agree on the next training date, time and venue
5. Trainer to thank the trainees for their participation

The trainer can identify a volunteer from the participants to give closing remarks.

# Session 6: Manure preparation & application

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objective	To enable farmers understand proper manure application before planting
Key message	Farmers should be able to understand the manure quality, quantity and placement required to supply effective nutrient rates
Training material and tools	Flip charts, wheel burrow, hoe, manure, spade, basin, forked hoe
Training Duration	2 hours Identify a time keeper
Training rules and regulations	Guide the trainees to set the rules and regulations for the training e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site/garden where manure can be applied.*
- *It is recommended that farmers are informed about the venue/training site in advance.*



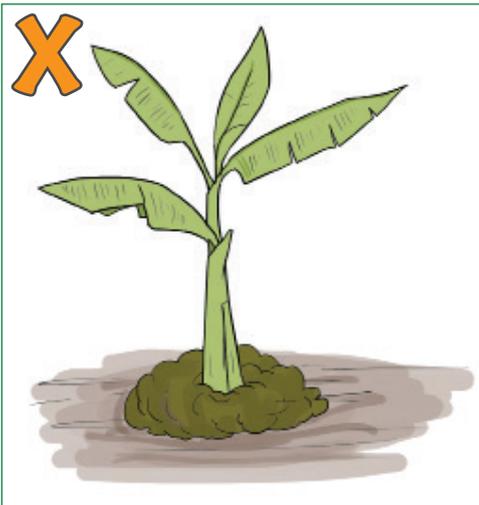
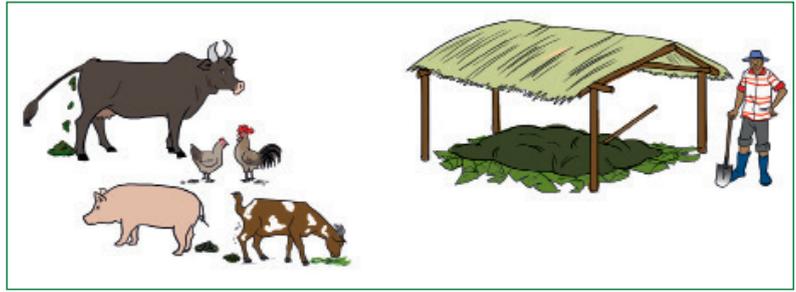
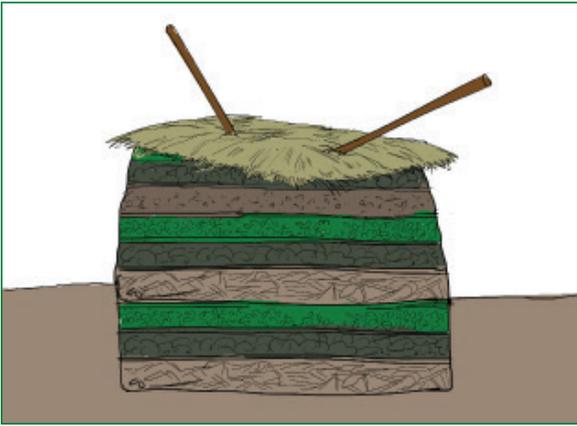
## Activity 1: Sharing experience

- The trainer should let the farmers share and compare experiences, if they use manure, on how they select and prepare different types of manure.
- This can be done by show of hands but they can also be allowed to show practically how they do select and prepare manure and also share reasons why they do it that way.

## Technical guidance and emphasis on proper manure preparation, handling and application

The trainer should assess the discussion and then emphasise on the following standard recommended procedures/criteria:

1. Mix all the top soil with 2 basins of well decomposed manure and pour in the hole (to about half-full) to allow for water retention.
2. Dig around the hole to get more top soil if the top soil is not enough. **Ignore the sub-soil because it is compact and does not contain any nutrients.**



## Activity 2: Practical Exercise

The trainer should do a practical demonstration as outlined below:

1. Demonstrate on how to prepare and handle manure
2. Explain how long one should wait before applying the manure
3. Show the right quantity to be applied and how to apply it
4. Farmers should set a time to prepare manure

**Note:** The extension officer should guide the farmers on pros and cons of either making or buying manure. [Detailed notes on preparation of manure is presented in Annex B](#)

5. The extension officer and the farmers design a follow-up program to monitor progress
6. Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.



# Module 2

## Planting



### Session 1: How to plant suckers

Item	Content
Introductions	<p>The trainer introduces him/herself to the trainees</p> <p>Let the trainees introduce themselves too.</p> <p>The trainer should brief the participants about the reasons for the practical trainings and site selected</p>
Objective	<p>To enable farmers understand proper planting of suckers</p> <p>To understand how and when to plant</p>
Key message	Understand the importance and impact of timely planting (at the onset of the rains) on productivity
Training materials and tools	Pictorial flip chat, wheel burrow, hoe, prepared suckers, mulches for spot mulching, strings, pegs etc.
Training duration	<p>2 hours</p> <p>Identify a time keeper</p>
Training rules and regulations	<p>Guide the trainees to set the rules and regulations for the training e.g.</p> <p>Everyone must participate in the activities</p>

- This is intended to be a practical session and should thus be held on farm/site/garden where the real establishment is to be done.
- It is recommended that farmers are informed about the venue/training site in advance for better preparation of tools and other materials and for effective participation.



### Activity 1: Role play

- The trainer should allow the farmers to demonstrate their methods of planting by getting 2 or 3 volunteers do it practically in the garden.

#### Demonstration by the trainer

The trainer should then demonstrate proper planting by following the procedures below:

- When planting, make a depression in the middle of the hole
- Place the sucker in the depression
- Planting should preferably be done at the onset of the rains for good establishment
- Cover the planted sucker with a thin layer of soil of about 3 – 4cm for easy sprouting
- Apply spot mulch to conserve moisture in the planted hole
- For tissue culture plantlets, remove the polythene wrap while maintaining the soil, place in the hole and cover the plant up to the root collar; or the point where the leaves begin to grow.
- Planting on time enables the plant to benefit from the nitrogen flash, reduces competition between plants and weeds. In addition the crop can easily establish itself and can easily resist pests and diseases.

The trainer should compare the planting procedures used by the farmers with the recommended procedure and make emphasis on the proper planting procedures recommended above.



#### Action points

1. Continuous monitoring of the already established plants to assess their performance
2. Encourage farmers to plant in their own gardens following the recommended procedures.
3. Agree on the next training date, venue and time if required.



Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.

# Module 3

## Post-planting



### Session 1: Gap filling

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	To ensure farmers understand how to maintain the recommended plant population for increased productivity
Key message	Enable the farmers understand the importance of gap filling and appropriate gap filling procedures
Training material and tools	Flip charts, marker pens, masking tape, registration/attendance sheets
Training Duration	45 Minutes Identify a time keeper
Training rules and regulations	Guide the trainees to set the rules and regulations for the training

- This is intended to be a discussion session and should thus be held at an appropriate and convenient venue.
- It is recommended that farmers are informed about the venue in advance to ensure timely arrival.



### Activity 1: Sharing experience

- The trainer should let the farmers share and compare experiences on gap filling (how and when they think it should be done).
- This can be done by show of hands or any other appropriate approach thus an open discussion should be guided accordingly.

### Technical guidance and emphasis on gap filling

The trainer should assess the discussion and then emphasize on the recommended gap filling procedures as follows:

- Gap filling is the replanting of suckers to maintain the recommended plant population in the field.
- Missing plants are usually caused by; wrong spacing or death of plants due to varying stresses.
- For newly established fields, gap filling of plants that have died should follow similar steps to those applied during the initial planting.
- Take into consideration the level of pest infestation, and the history of disease presence both in your garden and in your source of planting material.
- Avoid planting material from pest and disease affected plantations
- If the gap is due to Banana Xanthomonas Wilt (BXW), wait for 6 months before gap filling

When gap filling, avoid gap filling short varieties with tall varieties because this will result in unfair competition. It is better to have recommended plant population than scatter plants achieving less in a given area.



### Activity 2: Question and answer

1. The trainer should let farmers ask questions and answers provided accordingly
2. Remember to emphasize these recommendations during the subsequent practical training on site by practically identifying the gaps that need filling and demonstrating how gap filling should be done.
3. If possible, the trainer should also make follow up visits to farmers' gardens to ensure gap-filling recommendations are followed.
4. Agree on the next meeting training date, time and venue.

Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.

## Session 2: Intercropping

Item	Content
Introductions	The trainer introduces him/herself to the trainees. Let the trainees introduce themselves too.
Objectives	To enable the farmers understand intercropping recommendations for banana production
Key message	Enable farmers to understand the appropriate crops recommended for intercropping with banana, their impact on banana performance and possible diseases that may arise from intercropping
Training material and tools	Flip charts, marker pens, masking tape, registration/ attendance sheets
Training duration	45 Minutes Identify a time keeper
Training rules regulation	Guide the trainees to set the rules and regulations for the training

- *This is intended to be a discussion session and thus should be held at an appropriate and convenient venue.*
- *It is recommended that farmers are informed about the venue in advance to ensure timely arrival.*



### Activity 1: Sharing experience

- The trainer should let the farmers share their experiences on how they practice intercropping in their own localities.
- This can be done by show of hands or any other appropriate means but an open discussion should be guided accordingly.

### Technical emphasis on intercropping

The trainer should take note of the recommended intercrop combinations and determine the main crop vis-à-vis each farmer's objectives.

The trainer should keep reflecting on the experiences of farmers, keep comparing with their experiences, and emphasize to the farmers as below:

- Where banana is the main crop, for every two lines of banana, plant one line of coffee (Robusta at 3m x 3m and Arabica at 2.4m x 2.4m) or one coffee bush versus 4 banana mats, that is, coffee bushes shouldn't exceed 500 per hectare (about 200 plants per acre).
- If coffee is the main crop, the banana mats should not exceed 750 mats per hectare (about 303 plants per acre).

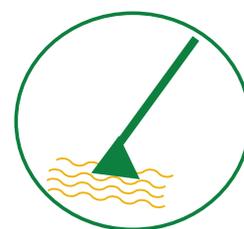
- When intercropping with beans, farmers are encouraged to plant beans in rows to minimize competition. At flower shooting stage, deleaf bananas to not less than 7 leaves in order to reduce shading the beans. It is also important to incorporate crop residue from the beans as mulch.
- If you must plant other crops such as roots, tubers and other crops, plant at the edges of the banana field e.g. cassava, Irish potatoes, sweet potatoes, vegetables etc.

*Note: Never intercrop banana with cereal crops like maize, rice*



### Activity 2: Question and answer

1. The trainer should let farmers ask questions and provide detailed clarifications to key issues arising from this session.
2. The trainer should ask the farmers about existing myths and perceptions towards intercropping in their different localities.
3. The trainer should plan follow up visits to the farmers' gardens to ensure they have intercropped bananas with the recommended crops.
4. The trainer can, together with farmers, visit a nearby intercropped banana garden and a sole-crop banana garden in order for the farmers to appreciate the importance of intercropping.
5. Agree on the next meeting training date, time and venue



Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks

## Session 3: De-suckering/sucker selection

Item	Content
Introductions	The trainer introduces him/herself to the trainees.  Let the trainees introduce themselves too.  The trainer should brief the participants about the reasons for the practical trainings and site selected
Objective	To equip farmers with knowledge and skills for removal of unwanted suckers and the benefits of de-suckering to increase yields.
Key message	Understand the identification and practical removal of unwanted suckers to avoid competition for production resources (nutrients, moisture, space etc.)
Training materials and tools	Pictorial flip chat, wheel burrow, de-suckering spear, panga, knife and sack
Training duration	1 hour  Identify a time keeper
Training rules regulation	Guide the trainees to set the rules and regulations for the training e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site/garden where there is an already established garden that is not de-suckered or has all the suckers.*
- *It is recommended that farmers are informed about the venue/training site in advance for better preparation of tools and other materials and for effective participation.*



### Activity 1: Role play

- The trainer should ask the farmers if they desucker and why. Let the farmers demonstrate their methods of sucker selection and how they remove unwanted suckers.
- Let at least 4 or 5 people do a practical demonstration based on their own understanding.
- Each farmer can go to each of the de-suckered mats and explain how and why they have de-suckered in a particular manner. Open discussions should be encouraged while the practical demonstrations are going on.

### Practical demonstration by the trainer following the recommended procedures

It is important for the trainer to explain the process of sucker selection and the importance of de-suckering.

The trainer should then demonstrate proper sucker selection and de-suckering procedures in relation to the farmers' practices already demonstrated as follows:

- De-suckering is the removal of excess suckers with the aim of maintaining optimum plant population per mat.
- Note that it should be done carefully to avoid injury to the mother plant and other suckers (preferably using a de-suckering spear)
- For normal suckering varieties, maintain 3 plants per mat and for over-suckering varieties, maintain up to 6 plants per mat.
- In case of low fertility and low rainfall areas as well as steep sloping areas, maintain 2 plants per mat
- Carefully select which suckers to remove in order to avoid losing the best plants by employing staggered sucker selection.

It is recommended that the trainer defines or explains the meaning of:

- **Staggered sucker selection**-this is the selection of suckers in stages such that the farmer has a continuous harvest. While selecting suckers, the farmer should not only focus on choosing vigorous suckers but should also consider selection based on the suckers' growth stages and direction in order to ensure continued production.

### Why carry out staggered sucker selection

1. To allow the farmer have consistent production/harvest throughout the year, which ensures household food security and income.
2. It reduces nutrient competition because nutrients are well utilized by the suckers that remain on the mat at that particular time.
3. The higher the number of plants the higher the nutritional requirements.





## Activity 2: Question and answer

1. The trainer can let the farmers ask questions if they have them and clarifications provided in relation to farmer practices and recommended de-suckering procedures.
2. The trainer can let the farmers discuss the existing myths and perceptions about de-suckering in their communities.e.g. some people think the more suckers maintained on a mat, the more food secure you are which is not the case, due to the small sized bunches that will be produced.
3. All farmers should be encouraged to do proper sucker selection and de-suckering in their own plantations following the recommended procedures.
4. The trainer should follow up with the farmers to provide more advice as needed.
5. Agree on the next training date, venue and time if required.



Thank the trainees for their participation and identify a volunteer to give closing remarks.



## Session 4: Forking

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	Understand and appreciate the relevance of forking in banana production Acquire the knowledge and skills on proper forking procedures
Key message	Farmers should be able to do proper forking with appropriate tools
Training materials	Forked hoe, knife, foot ruler
Training duration	1 hour
Training rules regulation	Guide the trainees to set the rules and regulations for the training e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site accordingly.*
- *It is recommended that farmers are informed about the venue/training site in advance*



### Activity 1: Sharing experience

- Divide the farmers into appropriate groups depending on the number of participants and let them share experiences on what they know about forking and how they do it.
- The different groups should then present to the plenary.

### Discussion on appropriate forking

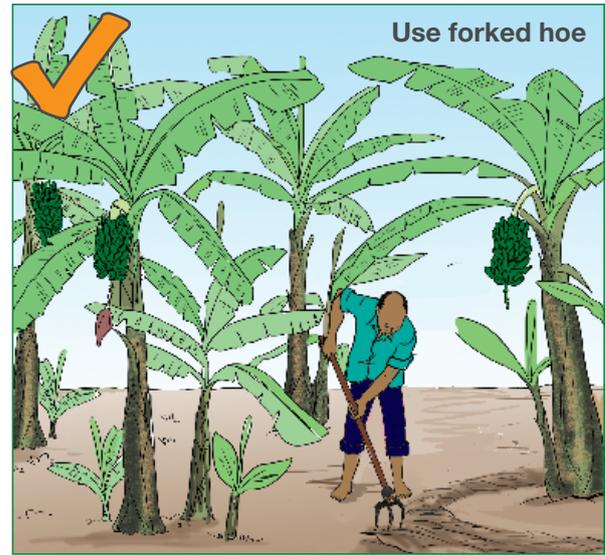
- Farmers present in plenary their experiences and trainer emphasizes on the appropriate forking procedures as outlined below.

#### Why do forking?

- Improves infiltration of water into the soil
- Reduces run off and thus controls soil erosion
- Enables the plant to easily access externally applied nutrients e.g. from manure

Forking refers to loosening the soil around the mat using a forked hoe.

1. Assemble clean tools
2. Show the farmers the use of each tool available
3. Clean the base of the pseudo stem by removing dead tissues and weeds around it
4. Measure a distance of 2ft from the mat



5. While standing outside the marked area, use a forked hoe to dig carefully within 2ft around the mat.
6. To reduce root damage, dig once at each point and avoid dragging the soil.

#### When should forking be done?

- Forking should be done when applying manure, mulching, or when soils are compacted.
- Preferably, forking should be done close to or at the onset of rains.

*Note: Never use a hand hoe for it cuts and damages the plant roots.*



#### Activity 2: Practical session

1. Farmers are organised into 3 groups and each group does the forking according to the illustrated procedure as they interact with trainer.
2. The trainees express their views about how the exercise has been done.
3. Farmers make action plans on what they will apply from what they have learnt
4. Farm visit by the trainer/ group leaders to check if farmers are using the right tools and whether they are following the right procedure.

Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.



# Session 5: Mulching

Item	Content
Introductions	<p>The trainer introduces him/herself to the trainees</p> <p>Let the trainees introduce themselves too</p> <p>The trainer should brief the participants about the reasons for the practical trainings and site selected</p>
Objective	To enable farmers appreciate the importance of mulching as a concept of soil and water management
Key message	Farmers should be able to understand recommended mulching materials for banana, and the role of mulching in soil and water management and weed suppression
Training materials and tools	Pictorial flip chat, wheel burrow, panga, sack, dry mulching materials.
Training duration	<p>1 hour</p> <p>Identify a time keeper</p>
Training rules and regulations	<p>Guide the trainees to set the rules and regulations for the training .e.g.</p> <p>Everyone must participate in the activities</p>

- *This should be a practical session and should thus be held on farm/site/garden where there is an already established garden that is not mulched.*
- *It is recommended that farmers are informed about the venue/training site in advance for better preparation of tools and other materials and for effective participation.*



## Activity 1: Role play

1. The trainer helps farmers to divide themselves into small manageable groups where they demonstrate the mulching process.
2. Let at least 4 or 5 people do a practical demonstration of mulching based on their own understanding while giving reasons for their choice of mulching materials.
3. On each of the mats demonstrated there can be a detailed discussion on each for better experience sharing.

## Practical demonstration by the trainer and participants following the recommended procedures

Mulching in banana refers to covering of soil with plant residues. Some of the benefits of mulching include:

- Ensures better water retention in the soil
- Reduces soil erosion
- Improves soil fertility in the long run.
- Mulch suppresses weeds

*Note: Mulching adds to soil fertility only if the mulch is sourced externally from crop residues outside the banana plantation. The nutrient content of mulch depends on the soil fertility at the source of mulch.*

### How to mulch

- A good field should be fully mulched (blanket mulch)
- A good mulch should be between at least 8-15 cm thick
- Mulch should be placed 1.5 - 2 ft from the mats to allow space for forking to loosen the soil and for effective weevil control. When mulch is close to the mat, roots tend to come up towards the surface and this weakens the plant making it susceptible to toppling
- In a newly established field, apply mulch around the plant (spot mulching)



### Mulching in case of intercrops:

- Banana- beans intercrop; first apply mulching before planting beans, then spot plant beans using a knife, panga or small hoe.

### Mulching materials

- Preferably apply dry crop residues
- Banana residues (self- mulch) e.g. leaves, chopped pseudo stems
- Other crop residues e.g. maize stover, rice straw, bean straw, napier grass

### Identifying the right mulch:

- Not all grasses are good for mulch. Remove weeds (such as couch grass, comelina, and cyperus) from mulch materials as these can multiply in the field and increase the weeds

burden.

- When using external banana residues, avoid using materials affected by pests and diseases.

### Mulching frequency

When the mulch thickness wears below the recommended depth



### Action points

1. All farmers should be encouraged to do proper mulching in their own plantations following the recommended procedures.
2. The trainer should follow up with the farmers to confirm whether the recommended mulching is practiced and provide more advice as needed.

3. Agree on the next training date, venue and time if required.

Thank the trainees for their participation and identify a volunteer to give closing remarks.

## Session 6: Corm removal

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	Understand and appreciate the relevance of corm removal in banana production Acquire the knowledge and skills on proper corm removal procedures
Key message	Farmers should be able to do proper corm removal using appropriate tools
Training materials	Pick axe, panga
Training duration	1 hour
Training rules regulation	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site accordingly.*
- *It is recommended that farmers are informed about the venue/training site in advance.*



### Activity 1: Sharing experience

- Divide the farmers into appropriate groups depending on the number of participants and let them share experiences on how and when they do corm removal.
- The different groups then present to the plenary.

### Discussions on corm removal

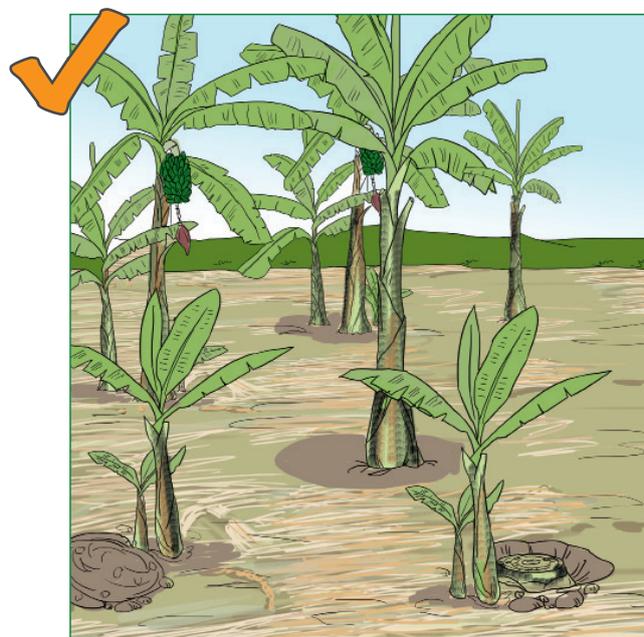
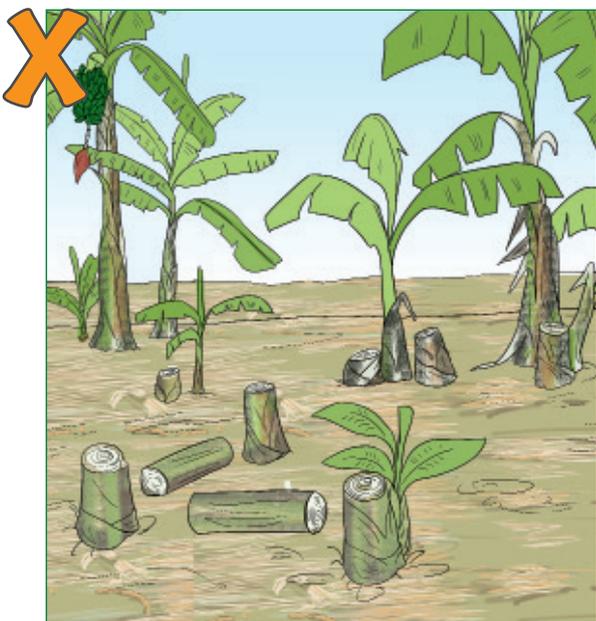
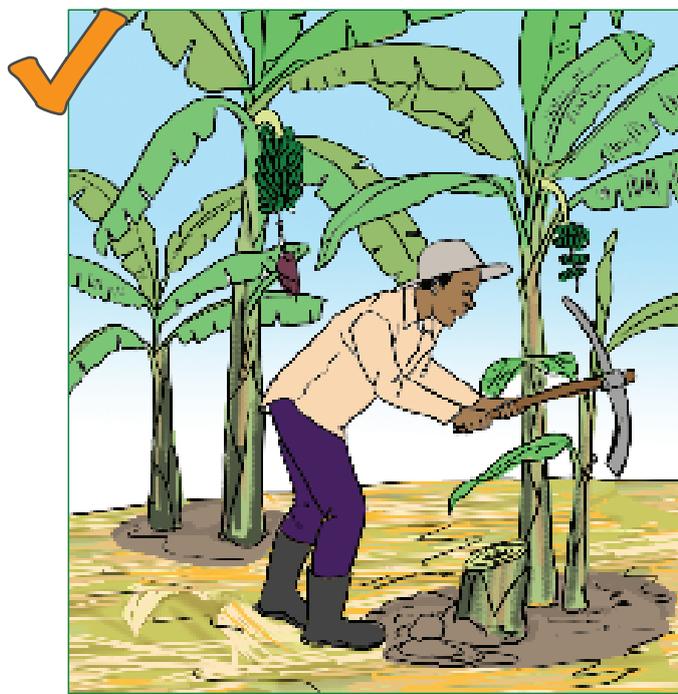
After listening to the farmers stories on corm removal, discuss and emphasize on the appropriate corm removal procedure.

### Advantage of corm removal

Removal of the corm helps to destroy the breeding ground for weevils

### Procedure

- Assemble clean tools
- Show the farmers the use of each tool available
- Corm removal depends on extent of weevil damage in the field. If the field is clean, corms that are immediately adjoined to suckers are left to support the mat but they should be covered with soil. All other previous corms should be removed.
- If the harvested corm is heavily damaged, cut off the damaged tissue and leave the clean part to support the mat.
- Removed corms should be cut into small pieces to ensure quick drying and destruction of eggs and larvae of the weevils.



## Activity 2: Practical session

1. Farmers are organised into 3 groups and each group does a practical demonstration of corm removal according to the illustrated procedure under the supervision of the trainer.
2. The trainees express their views about how the exercise has been done and make individual action plans.
3. Farm visit by the trainer/ group leaders to check if farmers are using the right tools and whether they are following the right procedure.



Trainer to thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.



# Session 7: Pruning

Item	Content
Introductions	The trainer introduces him/herself to the trainees. Let the trainees introduce themselves too
Objectives	Understand and appreciate the relevance of pruning in banana production Acquire the knowledge and skills of the proper pruning procedure
Key message	Farmers should be able to do proper pruning using the appropriate tools
Training materials	Knife, curved knife
Training duration	30 minutes
Training rules regulation	Guide the trainees to set the rules and regulations for the training e.g. Everyone must participate in the activities

- This is intended to be a practical session and should thus be held on farm/site accordingly.
- It is recommended that farmers are informed about the venue/training site in advance.



## Activity 1: Sharing experience

- The trainer should let the farmers share their experiences on how they prune banana plants.
- This can be done by show of hands or any other appropriate approach.

## Discussion on appropriate pruning

After listening to the farmers' stories, start to discuss and emphasize on the appropriate pruning procedure as follows:

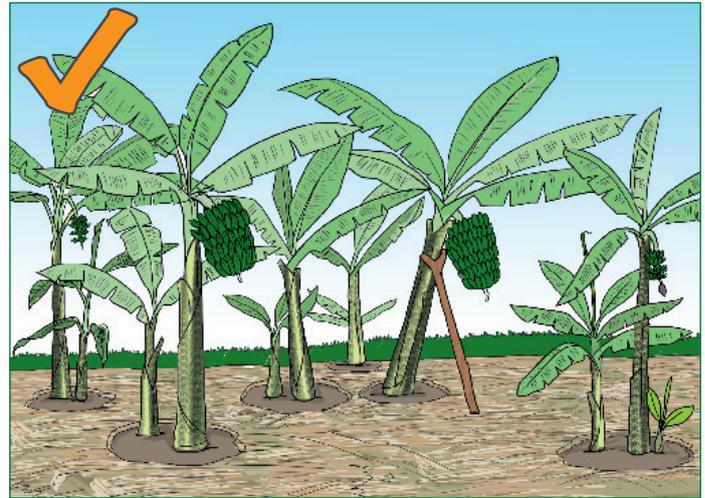
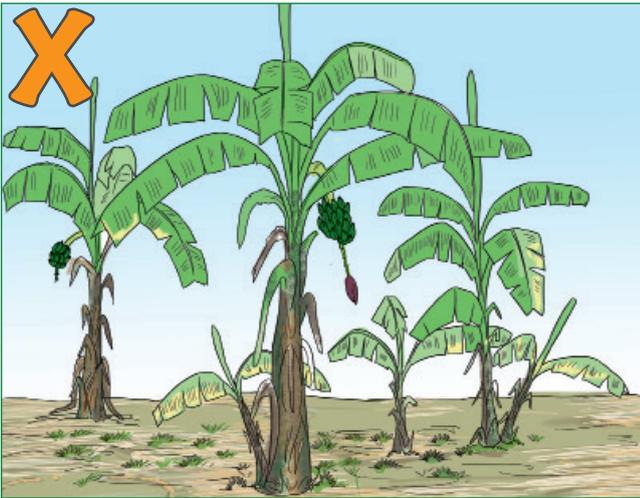
- Assemble clean tools
- Show the farmers the use of each tool available
- Starting from the outermost layer of leaf sheaths, trim any dead leaves with a sharp knife or curved knife. Be sure to only cut the dry leaves and sheaths to avoid contact with plant sap.

## Importance of pruning

- Improves penetration of sunlight
- Improves air circulation in the field
- Provides internal mulch
- Reduces the spread of black sigatoka
- Prevents harboring of banana weevils
- Makes the plantation look attractive

## How and when to prune

- Prune only when the leaves and sheaths of the pseudo stem are dry



### Activity 2: Practical session

1. The trainer should let the participants do a practical demonstration of pruning according to the already described procedure.
2. The trainees express their views about how the exercise has been done and make individual workplans.
3. Farm visit by the trainer/ group leaders to check if farmers are using the right tools and whether they are following the right procedure.

Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.

## Session 8: Male bud removal

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	Understand and appreciate the importance of removing male buds Acquire the knowledge and skills on the timing and tools for male bud removal
Key message	Farmers should be able to properly remove male bud at appropriate times
Training materials	Two-forked sticks
Training duration	30 minutes
Training rules regulation	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the activities

*This is intended to be a practical session and should thus be held on farm/site accordingly. It is recommended that farmers are informed about the venue/training site in advance.*



### Activity 1: Sharing experience

Gender-based open discussion to share experiences on:

- How farmers do male bud removal
- Why they do male bud removal
- What happens if male buds are not removed?

### Discussion on male bud removal

After listening to the farmers' stories, start to discuss and emphasize on the appropriate male bud removal procedure. Focus more on the tools, timing and how.

#### Why remove male bud?

The male bud is a wasteful nutrient sink because instead of nutrients going to the fingers (fruits), they go into the bud. Male bud removal could ensure a good bunch weight. It also controls the spread of banana bacterial wilt.

#### Procedure

- Prepare the tool
- Survey the appearance of the last cluster on bunches
- If sheaths of last cluster have dropped off, it's time to remove the male bud
- Use forked stick and not sharp objects to prevent disease spread. Forked stick should not damage the fingers
- Fix the forked stick towards the middle of the male bud stalk and twist clockwise until it drops off



## Activity 2: Practical session

1. The trainer will do a practical demonstration and then let the trainees practice according to the illustrated procedure.
2. The trainees express their views about how the exercise has been done and make individual action plans.

Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.



## Session 9: Use of organic & inorganic fertilizers

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objective	To enable farmers understand proper application of organic and inorganic fertilizers before planting or when maintaining banana plantations
Key message	Farmers should be able to understand the manure quality, quantity and placement required to supply effective nutrient rates Farmers should be able to clearly understand when and how to use organic or inorganic fertilizers
Training material and tools	Stationery for the trainer and trainees, wheel burrow, hoe, manure, spade, basin, forked hoe, manure (animal waste of either goats, cows), muriate of potash sample of inorganic manure
Training duration	1 hour and 20 minutes Identify a timekeeper to help in time management
Training rules regulation	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the activities

- *This is intended to be a practical session and should thus be held on farm/site/garden where manure and inorganic fertilizers can be applied.*
- *It is recommended that farmers are informed about the venue/training site in advance.*



### Activity 1: Sharing experience

- Let the farmers discuss the following: the manure types they use, their sources of manure and how they usually determine quantities to apply
- For manure, the trainer should let farmers discuss reasons for their particular choices.
- The discussion should be open and practical so that farmers demonstrate how they apply different types of manure in different stages required for soil nutrient supplementation.

## Technical guidance and emphasis on proper manure and inorganic fertilizers application.

The trainer should assess the discussion and then emphasise on the following standard recommended procedures /criteria of manure and fertilizer application.

It is important for the trainer to explain to the farmers what manure is and what fertilizer is, in all perspectives.

### 1. Use of organic manure

*Manure is fertilizer* derived from animal and plant matter. *Organic fertilizers* include: animal wastes from meat processing, peat, slurry.

It is important for the trainer to outline the benefits of using manure such as:

- To increase soil fertility
- Improve the soil structure
- Reduce soil erosion
- Increase organic matter in the soil and soil living organisms which may increase soil aeration and drainage
- Increase moisture retention in the soil

#### How to apply manure

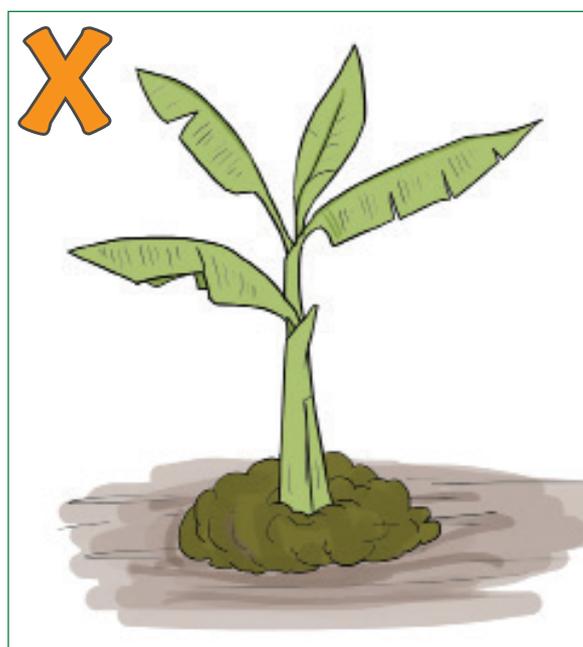
It is important for the trainer to further demonstrate how manure/fertilizer is applied in relation to the farmers' experiences. The trainer's demonstration should follow the recommended procedures as below;

#### Application at establishment

1. Mix all the top soil with 2 basins of well decomposed manure and pour in the hole (to about half-full) to allow for water retention.
2. Ignore the sub soil because it is compact and does not contain nutrients. Dig around the hole to get more top soil if the top soil is not enough.
3. Apply 18 kg (approximately two basins) per mat
4. This should be mixed with top soil and placed inside the hole

#### Application at rehabilitation

- Clean the plantation, fork around the mat, and then apply 2 basins poured around the mat (at 2 feet away from the mat to allow proper root growth)
- The quantities can be increased depending on the state of the field





### Application for maintenance

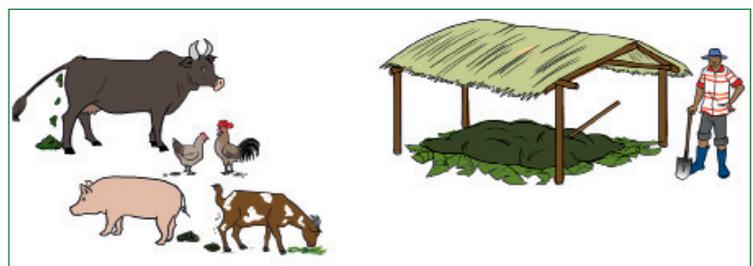
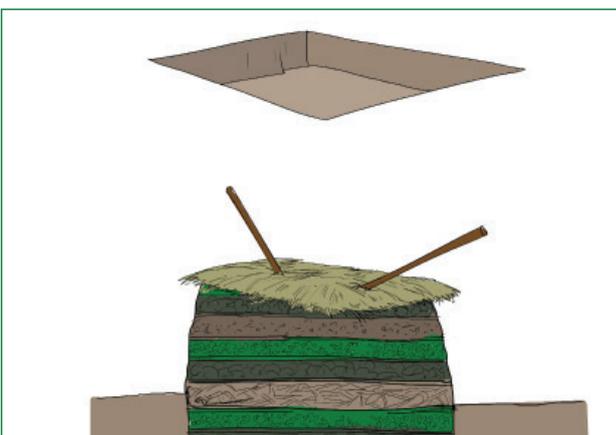
The trainer should strictly demonstrate fertilizer application while maintaining the plantation because it is different from when doing a fresh establishment. The recommended procedure should be demonstrated and its advantages explained.

Depending on the status of the mats, apply at least one basin per mat per year. Alternatively, make use of water troughs (basins) in between 4 neighbouring mats to apply manure.

### Quality of Manure

To have good quality manure, keep it under the shade, well decomposed and not dry. Always source for fresh farmyard manure for use in composting.

*Note: Manure should be well decomposed before application*



## 2. Use of inorganic fertilizers

Inorganic fertilizers, also referred to as synthetic fertilizers, are manufactured artificially and contain minerals or synthetic chemicals. They are a proven vital input to minimize the problem of declining soil fertility in banana production.

### Advantages of inorganic fertilizers

- One can be sure of the quantities of the nutrients applied
- Favours areas without livestock
- Plants respond faster compared to when organic manure is used

Bananas need three times as much potassium (K) as nitrogen (N), a ratio of N:K of 1:3. For effective uptake of nutrients, mineral fertilizers applied should be those that supply a high amount of potassium for instance Potassium chloride or Muriate of Potash (MOP) 50 - 52% K or potassium nitrate 37%K and NPK 28% K. Urea has the highest nitrogen content (46.7%) among nitrogen fertilizers.

Timing of application is important and mineral fertilizers should only be applied in periods of adequate soil moisture and avoided during drought. Their efficiency is also increased when they are used together with organic manures, as nutrient uptake improves with increase in soil organic content. Proper application helps to increase gains and minimize the risk of economic loss.

### How to apply inorganic fertilizers

- Make a ring or a shallow furrow in the shape of a ring about 2 feet away (60 -100cm) from the mat and sprinkle in the fertilizer and cover with soil forked from around the mat.
- Apply 95g (water bottle top) of MOP per mat two times in each of the rainy seasons. This should be applied alongside one basinful (about 9 kg) of good quality manure once a year. Where manure is not easily available, change the measure to a half basin (about 4.5 kgs) of manure per mat once a year and supplement with 25g (water bottle top) of urea and 126g of MOP per mat in each of the two rainy seasons.

**Note: Do not apply large quantities of Urea in areas that are fairly dry (less than 1000mm) of rainfall.**

A farmer can also apply:

- 120 g of NPK and 92g of MOP per stool (stem) two times, in each of the two rainy seasons  
or
- Apply 165g of potassium nitrate and 36g of MOP per stool (stem) in each of two rainy seasons a year.

**Advise to farmers establishing plantations:** Inorganic inputs of N and K should not be applied at planting before the plant has established roots to take them up. They are highly soluble and mobile in soil thus will be leached before uptake.

**Note:** Manure and mineral fertilizers should be applied at least 60 cm from the base of the plants and covered with soil forked from around the mat.



## Activity 2: Sharing experience

- Let the farmers discuss the following: the inorganic fertilizers they use, their sources and how they usually determine quantities to apply
- For inorganic fertilizers, the trainer should let farmers discuss reasons for their particular choices.
- The discussion should be open and practical so that farmers demonstrate how they apply different types of fertilizer in different stages required for soil nutrient supplementation.



**Note:** The extension officer should guide the farmers on the pros and cons of either making or buying manure, use of organic manure or inorganic fertilizers.



## Action points

- The trainer and the farmers should design a follow-up program to assess progress on farmers' gardens
- The trainer should agree on the next training, time and venue.

Thank the trainees for their participation and identify a volunteer to give closing remarks.



# Module 4

## Water harvesting structures



### Session 1: Water harvesting structures

Item	Content
Introductions	<p>The trainer introduces him/herself to the trainees.</p> <p>Let the trainees introduce themselves too</p> <p>The trainer should brief the participants about the reasons for the practical trainings and site selected</p>
Objective	<p>To enable farmers appreciate the importance of harvesting running water in the banana garden for improving production</p> <p>To equip farmers with knowledge and skills on construction of water harvesting structures</p>
Key message	<p>Collecting and assembling water which is running and likely to be lost for future use benefits the garden that in many cases would have less soil water. Where there is excess water in the field, the excess water should be channeled off using larger gullies or trenches into dams, water tanks, ponds etc.</p>
Training tools	<p>Pictorial flip chart , hoe, pick axe, spade, shovel, pegs, strings etc.</p>
Training duration	<p>2 hours - Identify a time keeper</p>
Training rules regulation	<p>Guide the trainees to set the rules and regulations for the training e.g. Everyone must participate in the activities</p>

- This training is intended to be a practical session and should thus be held on farm/site/garden where water structures can be constructed.
- It is recommended that farmers are informed about the venue/training site in advance for effective participation and better preparation of tools and other materials.

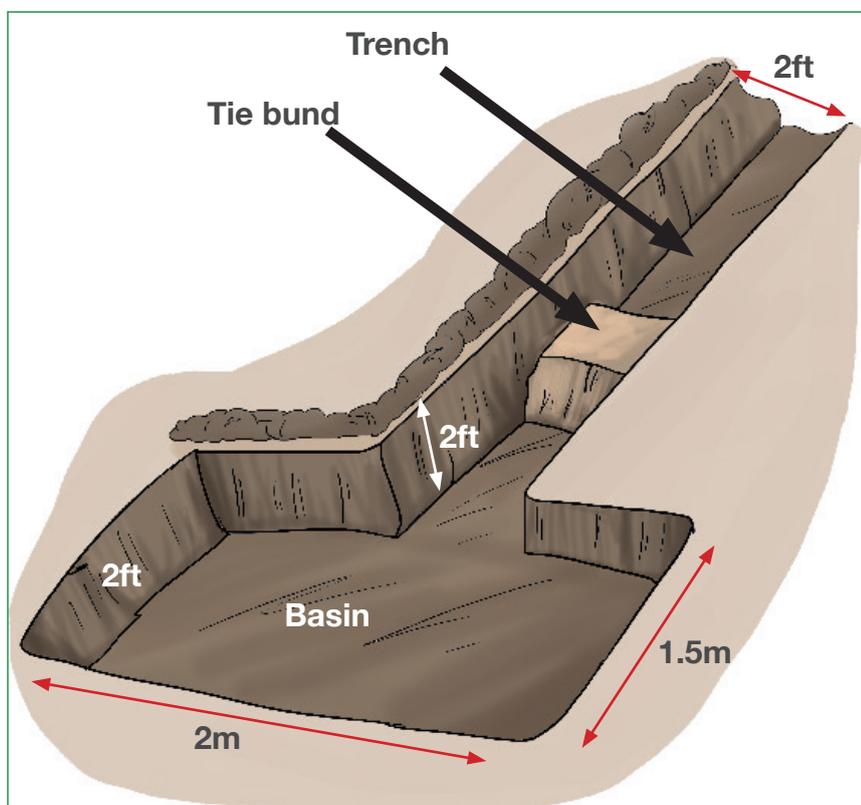


### Activity 1: Role play

- The trainer should let the farmers demonstrate their methods of constructing different types of water harvesting structures.
- The trainer should then demonstrate the proper method of constructing the different types of water harvesting structures.

The appropriate water harvesting structures in a banana garden include:

- Large trenches/gullies running in the direction of the slope or around the field periphery to drain off large volumes of water which would otherwise be erosive. These are necessary in areas prone to flooding.
- Large water troughs or basins close to the edge of the field to break the speed of running water and serve as water reservoirs.
- Trenches to channel water into the field. They should be at least 2 feet wide so as to harvest enough water.
- Small water troughs/basins to retain water within the field. They should be 2m (length) x 1.5m (width) x 2 feet (depth).



**NB:**

The basins are designed based on the size of the slope. The larger the size of the basin, the better. They could be used as points for chopping pseudo stems and adding in manure.

Trenches can be continuous or with tie bands.

Continuous trenches are applicable for gentle and uniform slopes. The depths should be varied at different points to enable water retention in field.

Tie bands apply to steep gradients or multi directional slopes. The band should be 1 ft.

When constructing the first trench uphill, the soil should be put on the lower side (*Fanya chini*) in order to harvest water into your field. For the last trench downhill soil should be placed at the upper side (*Fanya juu*). Other trenches within the field can be alternated.

Plant grasses such as *vetiva*, elephant grass on the *fanya juu* or *fanya chini* to stabilise it. Some agroforestry shrubs such as *caliandra* can also be planted.

In areas where there are many stones, stone bands can be used to control soil erosion.

**Note:** Farmers must remember to de-silt the trenches and continue maintaining the size of the trench and volume of water.



**Action points**

1. Encourage farmers to construct appropriate water harvesting structures for their banana gardens.
2. Farmers should make personal action plans with regard to water.
3. Agree on the follow up timeframe for the trainer to do farm visits and assess progress.
4. Agree on the next training date, venue and time if required.

Thank the trainees for their participation and identify a volunteer from the participants to give closing remarks.

# Module 5

## Pest & disease management



### Session 1: Management of pests and diseases

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objective	Enable farmers identify and manager the various pests and diseases affecting banana production Acquire the knowledge and skills in managing different pests and diseases affecting banana plants
Key message	Farmers should action skills in appropriate management of pests and diseases
Training material and tools	Stationery for both the trainer and trainees, banana agronomy story charts, knife, panga, blades, Pest Management Decision guides (PMDGs) etc.
Training duration	3 hours
Training rules regulation	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the activities

- This is intended to be a practical session and should thus be held on farm/site accordingly.
- It is recommended that farmers are informed about the venue/training site in advance.



### Activity 1: Sharing experience

1. Divide the farmers into groups depending on the number of participants and let them share experiences on identification and management of different pests and diseases.
2. The different groups should then present to the plenary.

## Discussion on pests and disease management

After listening to the farmers' stories, start to discuss and emphasize on the identification and appropriate management of pests and diseases, highlighting the most common diseases and pests and how to differentiate between their symptoms.

As a guide, the following diseases and pests should be discussed (additional pest management decision guides presented in Annex).

### A. Banana diseases

#### 1. Banana Bacterial Wilt

- This disease can cause up to 100% yield loss. It is spread through sharing of unsterilized tools between plants, using infected planting materials and by insects that visit the male buds.
- The symptoms include yellow ooze from the pseudo stem, premature ripening of fruits, yellowing and eventually death of leaves.

#### Control measures

1. Always use clean planting materials (tissue culture or from a clean field)
2. Perform routine inspection of your field for symptoms of the disease
3. Remove the male bud after formation of the last cluster (using a forked stick) to prevent spread of disease by pollinating insects
4. After working on each stool, disinfect tools (pangas, hoes, knives) by dipping them in 20% solution of Jik (1 volume of Jik to 4 volumes of water) before moving to the next stool or flame the cutting tools to disinfect.
5. Prune only when leaves are dry to prevent contamination of tools by sap
6. Remove each diseased stem to eliminate source of the disease (inoculum)
7. Suspend all cutting operations for 3 months when you observe disease infection to avoid spread (you can continue to remove the male bud using a forked stick, or removing weeds by hand pulling). After 3 months remove all the diseased plants.



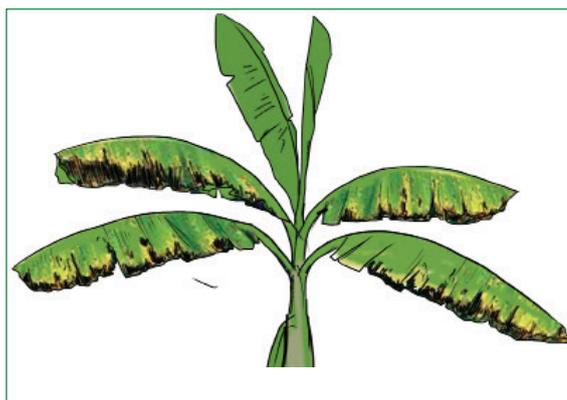
*Note: Some plants can have BXW without showing visible symptoms and so management should be continuous.*

## 2. Black Sigatoka

This is a foliar disease. It spreads through air.

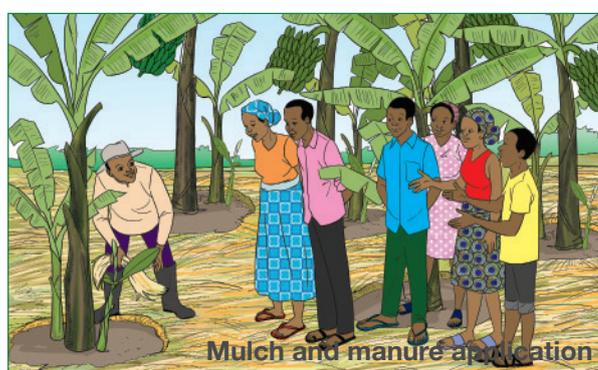
Symptoms are:

- Red-brown streaks, parallel to the veins on leaves, about 1-5 mm long by 0.25 mm wide. especially on the underside of the third or fourth youngest leaf.
- The streaks on leaves expand and become noticeable on the upper surface, darkening and later developing grey, slightly sunken centres with black margins and bright yellow halos



### Control measures

1. Enhance nutrition through use of manure,
2. Use resistant varieties such as M9, NAROBANS
3. Carry out timely pruning when leaves are dry



## B. Banana pests

### 3. Banana weevil

- The larva stage is the most destructive stage.
- Feeds on the corm tissues, as it enters, thus making tunnels in the corm.

Presence is shown by:

- Reddish brown to black tunnels in the corm
- Heart death and rotting at the centre of the corm
- Snapping of bearing plants



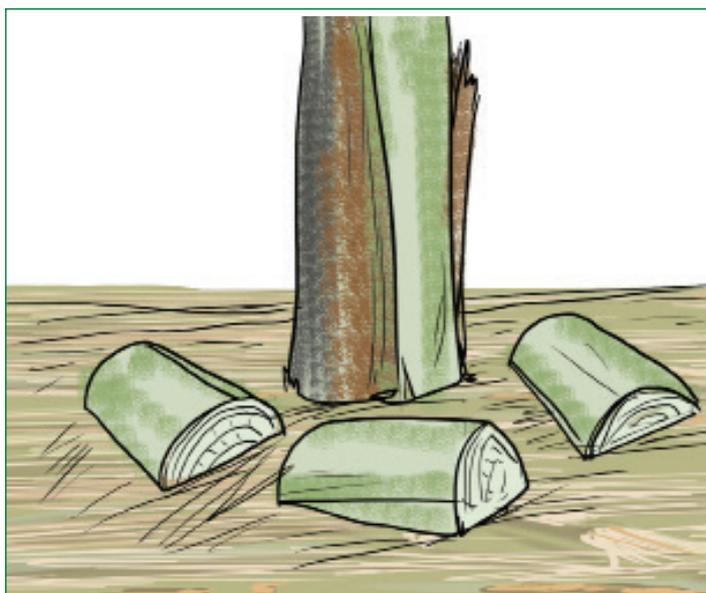
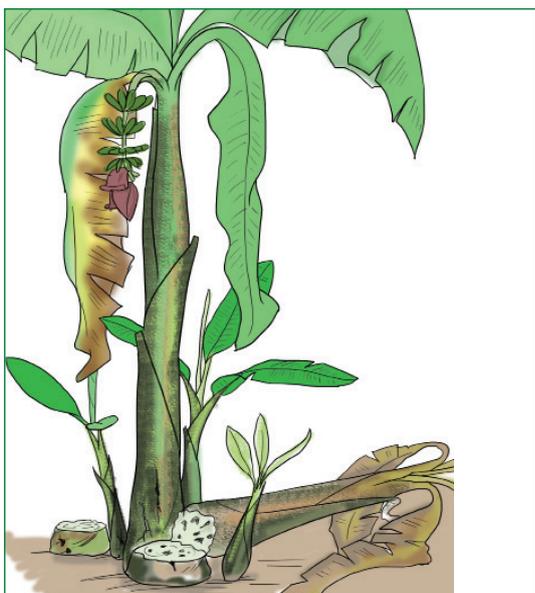
### Control measures

1. Remove rotten corms to destroy breeding sites
2. Use tolerant/resistant varieties such as M9, NAROBANS or use tissue culture plants
3. Remove all roots and damaged parts of the corm from the sucker before planting (paring)
4. Mulch at 2 feet away from the base of the mat
5. Collect and assemble chopped pseudo stems away from the mat to avoid suitable breeding grounds
6. Ensure a clean field before establishing a new plantation and remove volunteer banana plants
7. Trap weevils around the mat using longitudinally-cut pseudo stems, pick and kill weevils. Traps can be improved if systemic pesticides are applied.

*NB: Biorationals and concoctions do not necessarily kill pests but have pest repelling properties in addition to providing more nutrients.*

#### 4. Soil Nematodes

These feed on the root tissues causing gradual death of roots and consequently resulting in toppling of plants.



Look for:

- Single stunted plants in a smallholding or spots of stunted plants in larger plantations
- Plant toppling (due to loss of anchoring roots)
- Wilting of plants even if there is adequate water supply
- Uniform yellowing or chlorosis of the lower leaves even if soil is adequately fertilized. Reduced number and size of leaves
- Brown-coloured rot on root surface. Brown lesions and tunnels within rhizomes.

#### Control measures

1. Use tolerant varieties e.g. M9, NAROBANs or use tissue culture plants
2. Remove all roots and dead tissues from the corm before planting
3. Apply manure at 2 ft from the base of the mat
4. Ensure a clean field before planting
5. Introduce a break crop e.g. cassava and sweet potato before replanting in devastated fields



# Proper chemical use

If chemicals are to be used, proper handling of the chemicals should be followed strictly for safety of the farmers, their families and consumers, the crops and the environment. The following precautions should be observed:

## 1. Place of purchase

- Purchase chemicals from licensed/registered dealers.
- Pesticide should be accompanied by an information leaflet on guidelines on proper use and handling of chemicals.
- Do not use banned or prohibited chemicals. If not sure, consult your logical local agriculture officer. e.g Carbofuran

## 2. Choice of chemical

- Use the correct chemical for crop and pest or disease. Follow information on the leaflet.
- Use recommended chemicals that are accepted in the market. Confirm with your local extension agent.

## 3. Correct timing

- Follow guidelines, check how many days you must allow between spraying and harvesting, that is, pre-entry and pre-harvest intervals.

## 4. Correct mixing

- Follow guidelines on correct compatibilities.

## 5. Correct application

- Follow guidelines on correct application method.

## 6. Correct handling

- Wear overalls with gumboots, the overall covering the gumboots. Cover the head and face to prevent contact with eyes or nose inhaling.
- Do not spray against the wind direction.
- Keep materials for handling spillages ready for use if needed.
- Wash off chemicals that come into contact with body, with water and soap.
- Wash your hands with soap and water before eating, smoking or going to the toilet.
- Bath and change clothes after spraying.
- Wash containers used to spray and mix chemicals.

## 7. Disposal of chemical and containers

- Dispose excess diluted chemicals as per the manufacturer's guidelines.
- Do not leave empty containers lying around.



- Follow manufacturer's instruction on disposal.

## 8. Storage and storage period

- Store pesticides away from human and animal food, away from children, in locked places, outside sleeping house, with warning signs.
- Keep chemicals in their original containers.
- Do not throw in pit latrines
- Storage for period recommended by manufacturers. Don't use after expiry date.



### Activity 2: Practical session

1. Farmers are organised into groups of 3 members, with each group identifying different pests and diseases with guidance from the trainer.
2. The trainees express their feelings about what new things they have learnt from the training and how the exercise has been done.
3. Farm visit by the trainer/ group leaders to check whether farmers are correctly managing pests and diseases.

Thank the trainees for good audience and participation and identify a volunteer from the participants to give closing remarks.

# Module 6

## Agroforestry



### Session 1: Agroforestry

Item	Content
Introductions	The trainer introduces him/herself to the trainees Let the trainees introduce themselves too
Objectives	Build understanding and appreciation of the importance of agroforestry in banana production To educate farmers on the appropriate agroforestry species suitable for banana production
Key message	Farmers should be able to appreciate the importance of agroforestry in banana production Farmers should be able to identify appropriate agroforestry species suitable in banana cropping systems
Training materials	Stationery for both the trainer and trainees, hoe, manure, spade, basin, seeds and seedlings of different agroforestry species
Training duration	1 hour
Training rules regulation	Guide the trainees to set the rules and regulations for the training e.g. Every must participate in the activities

- This session should be practical and should thus be held on farm/site accordingly.
- It is recommended that farmers are informed about the venue/training site in advance.



### Activity 1: Sharing experience

- Different farmers share their experiences on agroforestry in banana production, the different species they grow and reasons why they grow such species.
- Farmers should also be encouraged to share the advantages associated with the species they grow.

### Discussion on agroforestry

1. After listening to the farmers stories, start to discuss and emphasize on the importance of agroforestry and appropriate tree species.

Agroforestry involves growing trees or shrubs around or among crops. Recommended agro forestry trees include albizia, calliandra, castor trees (erect varieties), gravelia and maesopsis (*musizi*).

The trees can be planted as hedge rows or scattered in banana field depending on species and purpose.

#### Why agro forestry?

- Wind breaking
- Improves soil fertility
- Providing staking materials

These can also act as a good source of staking poles, source of fuel wood and animal feeds.



### Activity 2: Practical session

1. Farmers are organised into 3 groups and each group does the planting of one of the suitable tree species as they interact with trainer.
2. The trainees share what they have learnt about agroforestry in banana production and how the exercise has been done.
3. Farm visit by the trainer/group leaders to check if farmers are planting suitable agroforestry tree species in their plantations.

Thank the trainees for good audience and participation and identify a volunteer from the participants to give closing remarks.

# Module 7

## Harvesting



### Session 1: Harvesting

Item	Content
Introductions	<p>The trainer introduces him/herself to the trainees.</p> <p>Let the trainees introduce themselves too.</p> <p>The trainer should brief the participants about the reasons for the practical trainings and site selected.</p>
Objective	<p>To enable farmers understand when to harvest, thus describe indicators of a banana bunch ready for harvest.</p> <p>To teach farmers regarding the proper harvesting of bananas.</p>
Key message	<p>Farmers should be able to identify ready-to-harvest bunches in a plantation.</p> <p>Farmers should be able to demonstrate proper harvesting of bunches with minimum damage to the bunches</p>
Training materials and tools	Pictorial flip chart, machete
Training Duration	1 hour
Training rules and regulations	Guide the trainees to set the rules and regulations for the training .e.g. Everyone must participate in the harvesting activities.

- This is intended to be a practical session and should thus be held on farm/site/garden.
- It is recommended that farmers are informed about the venue/training site in advance for effective participation and better preparation of tools/ other materials that may be required.

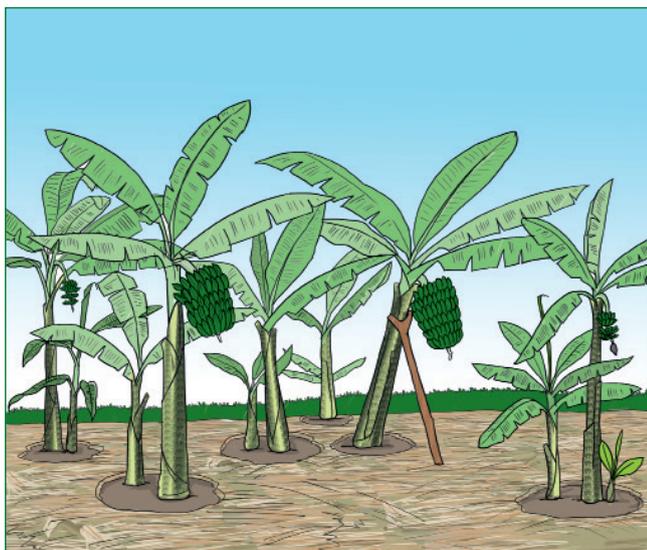


### Activity 1: Role play

- The trainer should let the farmers share their knowledge on when and how to harvest a banana bunch.
- The trainer should then demonstrate how to identify a banana bunch ready for harvest and how to do proper harvesting.

The key steps to follow when harvesting bananas include:

- When harvesting, take care to prevent the bunch from falling heavily on the ground.
- Make a cut (not too deep) in the pseudo stem and allow the bunch to descend slowly under its own weight.
- Cut off the bunch and reduce the pseudo stem to a least one metre. This enables translocation of nutrients into other young suckers.
- The remaining pseudo stem can be cut at the collar and covered with soil within a month after harvest.



### Action points

1. Encourage farmers to do proper harvesting in their banana gardens.
2. Agree on the follow up timeframe for the trainer to do farm visits and assess progress.
3. Agree on the next training date, venue and time if required.

The trainer should thank the trainees for good audience and participation.

# Banana Nematodes

*Pratylenchus* spp., *Helicotylenchus* spp., *Meioidogyne* spp., *Rotylenchulus* spp., *Radopholus* spp (Obisinganyi obusirikitu obutalabirwa na masso)

Prevention	Monitoring	Direct Control	Direct Control	Restrictions
 <p>Banana plant toppling exposing roots (Georgina Mwaka)</p> <ul style="list-style-type: none"> <li>Plant on nematode free land by:-               <ul style="list-style-type: none"> <li>- using land not previously cropped to banana</li> <li>- following land previously under banana for 6-12 months prior to planting to reduce potential nematode populations.</li> <li>- deep ploughing (1 ft) in the dry season to expose nematodes to heat and desiccation.</li> </ul> </li> <li>Use clean planting material e.g. tissue culture plants or corms/suckers from nematode-free fields.</li> <li>Cut roots and trim corms to remove nematode and dip corms in boiling water for 20-30 seconds or in cold water overnight to kill any surviving nematodes before planting.</li> <li>Avoid movement of infested plant material and soil from one field to another.</li> <li>Keep the fields well-manured and mulched.</li> </ul>	<ul style="list-style-type: none"> <li>Scout for symptoms such as:               <ul style="list-style-type: none"> <li>- dead roots on corms 6 months after planting,</li> <li>- toppling of banana plants and exposing the roots,</li> <li>- slow/ stunted plant growth,</li> <li>- reduced size and number of leaves</li> <li>- and delayed fruiting</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Reduce damage and increase tolerance to nematodes by amending soil by applying 20 kg of farmyard manure per plant and inorganic fertilisers e.g. 75 g of NPK 16:6:20 per stool/plant.</li> <li>Plough the field to expose soil to solar energy to kill nematodes.</li> <li>When plantation is highly infested:-               <ul style="list-style-type: none"> <li>- support flowering plants to harvest to minimise toppling or</li> <li>- remove and destroy plants by chopping and</li> <li>- follow the land or plant non hosts (e.g. maize) or cassava that helps to reduce populations in soil.</li> </ul> </li> <li>Apply 2L of fermented (at least 14-21 days) concoction of tithonia, Mexican marigold, black jack, ash, and urine diluted at a ratio of 1: 2, concoction: water.</li> <li>Plant resistant or tolerant cultivars (e.g. Kabana 6 or 'Kiwangazi') singly or in mixtures with the susceptible ones.</li> <li>Plant trap crops (e.g. Sesbania) and non-host cover crops (e.g. Desmodium) at the edge of fields or as intercrops to reduce nematode populations. In case of Sesbania, prune them regularly to avoid negative effects on banana.</li> </ul>	<ul style="list-style-type: none"> <li>Nematicide such as Furadan /Carbofuran are <b>NOT</b> recommended for smallholder farmers as they are generally very toxic and often require specialist equipment for application</li> </ul>	
 <p>Dark spots and lesions on the roots</p>				
 <p>Dark lesions seen when roots are peeled</p>				






**Country: Uganda**  
 CREATED/UPDATED: October 2018  
 AUTHORS: William Tinzaara and Georgina Mwaka (Bioversity International)  
 EDITED BY: Christine Alokot (CABI)

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# Banana Weevil

*Cosmopolites sordidus*. (Kayovu)



Banana weevils on pseudostem trap (Walter Ocimati, Uganda)



Banana corm heavily damaged by weevils (Walter Ocimati, Uganda)

- Prevention**
- ◆ Use clean planting materials (tissue culture and macro-propagated plantlets, or suckers from weevil free fields).
  - ◆ In absence of clean planting materials:
    - Select vigorous healthy suckers and remove the outer leaf sheath to get rid of weevil eggs.
    - Trim corms of suckers to remove parts infested with eggs and larva; i.e. all roots and old leaf sheaths around the root collar. Cut one or two slices and look for tunnels, larvae or pupae. Destroy manually if infested.
    - Dip trimmed suckers in boiling water for 20 to 30 seconds to kill eggs and larva or in cold water overnight to suffocate larva and eggs.
    - Dip suckers in a 20% neem seed solution (2mL in 8mL of water) overnight before planting.
  - ◆ Practice good crop husbandry to increase plant tolerance and minimise infection risk:
    - Apply mulch 2ft away from the base of the stool to keep roots from growing towards the surface and to avoid moist conditions which attract weevils.
    - Regularly clear mats of dead leaves and leaf sheaths and remove weeds.
    - Chop into small pieces harvested and de-suckered stems and/ or corms to quicken drying and to eliminate areas for laying egg and hiding.
    - Destroy alternative hosts (e.g. ensset) and volunteer plants.
    - Plant suckers 1.5-2ft deep in fertile soils to delay infestation.

- Monitoring**
- ◆ Monitor regularly for weevils (black insects with clearly pronounced snout and hard forewings) using cut and split pieces (1 ft long) of pseudo-stems placed near the stools.
    - ◆ Look out for black tunnels and larvae on harvested corms and pseudostems.
    - ◆ Heavily infected plants often break at the base (snapping)
    - ◆ Regularly check the base of the outer leaf sheath of pseudostems (just above ground) for signs of weevils e.g. gummy exudates and irregular circular tunnels or cavities made by young white larvae.

- Direct Control**
- ◆ Manually kill weevils trapped using 2ft long split pieces of pseudostem placed face down near the stools and check after 1-2 days.
    - ◆ Uproot, chop and dry infected corms to kill eggs and larva.
    - ◆ Mulch (2ft away), weed and apply manure to improve their tolerance to weevil attack.
    - ◆ Apply 50 - 100g neem seed powder around each stool at 4 months interval (higher rates can harm the plant)
    - ◆ Apply 1kg of neem leaf mulch per plant around the base of the plant.
    - ◆ Apply 5L per mat concoction of tithonia, mexican marigold, black jack, ash, and urine fermented for 14-21 days and diluted at a ratio of 1: 2, concoction: water. Apply this twice per season

- Direct Control**
- ◆ Dip trimmed suckers in a solution of Chlorpyrifos methyl (e.g. Dursban; 30 ml per 15L of water) for 1 hour to kill any larvae and eggs that might be present.
  - ◆ Always wear protective gear (overalls, gumboots, goggles, caps, gloves and face masks) when handling chemicals.
  - ◆ Always consult your extension worker and read the pesticide label before use.
- Restrictions**
- ◆ WHO Class III; slightly hazardous



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 AUTHOR/S: Tinzaara William and Ocimati Walter (Bioversity International), Lydia Mukasa (Mukono district)  
 EDITED BY: Christine Alokit

PEST MANAGEMENT DECISION GUIDE: GREEN AND YELLOW LIST

# Fusarium wilt on banana (Local names: Todula, Kiwotoka (Luganda))

Causal organism: *Fusarium oxysporum* pv. *cubensis*

Prevention	Monitoring	Direct Control	Direct Control	Restrictions
<ul style="list-style-type: none"> <li>Fusarium wilt spores can survive in the soil for up to 30 years in absence of a susceptible banana, thus prevention is very important.</li> <li>Use clean tissue culture plantlets or corms/suckers from fields with no fusarium history to establish new fields, field expansion or gap filling.</li> <li>Restrict movement of suckers, plant parts or products from infected areas, farms and fields.</li> <li>Disease is soil borne – thus avoid movement of soil (e.g. on vehicles, tools, foot wear) from infected areas.</li> </ul>	<ul style="list-style-type: none"> <li>Monitor plants on farm and in neighbourhood regularly for bright yellow symptoms on older leaves that often break at the petiole and hang down against the stem and longitudinal split of leaf sheaths at the base of the pseudostem.</li> <li>Cut and split open pseudostems and corms of suspected plants to observe purple or reddish or black discolouration of the vascular bundles.</li> <li>Take action when the first symptoms are observed, even on a single plant.</li> </ul>	<ul style="list-style-type: none"> <li>Rouge and destroy infected plants (corms, pseudostem, and leaves) drying and burning to reduce disease inoculum.</li> <li>Use resistant varieties such as matoke, Cavendish types and FHIA's in infected fields.</li> <li>Do not plant susceptible cultivars (dessert types; <i>Bogoya</i>, <i>sukali ndizi</i> and <i>Pisang Awak</i> also known as <i>Kayinja</i> and <i>Bluggoe</i>) in fields with a previous history of fusarium wilt to avoid build-up of pathogen.</li> </ul>	<ul style="list-style-type: none"> <li>No economically viable and environmentally friendly chemical option known or recommended for management of Fusarium wilt of banana</li> </ul>	



Bright yellow older leaves broken at petiole and hanging down the pseudostem (Guy Blomme, www.musarama.org)



Split leaf sheath at pseudostem base (CABI)



Brown to black staining of vascular bundles (Georgina Mwaka)



## Uganda

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 EDITED BY:

PEST MANAGEMENT DECISION GUIDE: GREEN AND YELLOW LIST

# Banana Bacterial Wilt (Local names: “Kiwotoka” (Luganda), “Kajunde” (Runyakole))

Causal agent: *Xanthomonas campestris* pv. *musacearum*

Prevention	Monitoring	Direct Control	Restrictions
 <p>Infected banana plant with wilted and yellow leaves (Walter Ocimati, Bioversity Int.)</p>  <p>An unevenly and prematurely ripened banana bunch (Walter Ocimati)</p>  <p>Yellow ooze on cut pseudostem surface (Walter Ocimati)</p> <ul style="list-style-type: none"> <li>Use clean tissue culture plantlets, macro-propagation plantlets or corms obtained from fields without disease.</li> <li>Remove male buds using a forked stick (<b>NOT</b> with cutting tool) after the last cluster has formed (within two weeks) to prevent the spread from/by insects e.g. stingless bees.</li> <li>Restrict movement of planting materials, products (e.g. through trade), parts and tools from infected fields, farms and regions.</li> <li>Once the disease is already on your farm or neighbourhood and community, disinfect tools (including peeling knives from markets) to protect other plants or mats.</li> <li><b>NB: Infection can be spread to the entire field from a single or few infected but symptomless plant(s) with a tool used to de-leaf or de-sucker in a single farm operation.</b></li> <li>Best to suspend de-suckering and de-leafing with farm tools in the event of infection in the close neighbourhood for at least 3 months. Remove male buds after formation of last cluster with a forked stick.</li> </ul>	<ul style="list-style-type: none"> <li>Regularly scout banana fields and neighbourhood for symptoms of:-                             <ul style="list-style-type: none"> <li>wilting and yellowing of leaves (leaves look as if scorched by fire and break at the mid of the petiole)</li> <li>premature and uneven ripening of fruits.</li> </ul> </li> <li>To confirm, cut the pseudostem of the suspicious plant and check for yellow ooze after 10-30 minutes.</li> <li>A single diseased plant in the field should warrant direct control of the disease.</li> </ul>	<ul style="list-style-type: none"> <li>Singly and carefully cut at soil level infected plants in a mat without injuring healthy looking plants.</li> <li>If the disease has just been introduced on farm and only one or few plants are infected and does not exist in the neighbourhood, completely uprooting mat(s) could eliminate disease.</li> <li>Sterilize tools used on infected plants with 10% JIK (ratio of 1 ml water: 9 ml water) or by passing over fire for 30 seconds before using on another plant.</li> <li>Suspend de-suckering and de-leafing with farm tools in the event a plant or a few show symptoms on farm for at least 3-4 months.</li> </ul>	<ul style="list-style-type: none"> <li>No recommended chemical control measure available for bacterial wilt on bananas</li> </ul>



## Uganda

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AUTHOR/S: Ocimati Walter (Bioversity Int.), Kubiriba Jerome (NARO- Uganda) and Arinaitwe Innocent (Farm Concern Int.)

EDITED BY: Christine Alokit

**plantwise**  
**PEST MANAGEMENT DECISION GUIDE: GREEN AND YELLOW LIST**  
**Potassium deficiency in bananas. Local name: Olunnyu (Luganda)**

Prevention	Monitoring	Direct Control	Direct Control	Restrictions
 <p>Potassium deficiency - Moderate, Stage - 2 Necrosis starts at leaf margins.</p> <p>Necrosis in infant stages (tcbanana.blogspot.com)</p>	<p>When monitoring look for:-</p> <ul style="list-style-type: none"> <li>◆ Yellowing of inward margins followed by necrosis.</li> <li>◆ Chlorosis and down ward curling of the leaf.</li> <li>◆ Drying and breaking of leaves at petioles.</li> <li>◆ Short, slim and deformed banana bunches as a result of poor fruit filling.</li> </ul>	<ul style="list-style-type: none"> <li>◆ Application of farm yard manure (animal refuse and composite manure)</li> <li>◆ At planting apply two basins of farm yard manure mixed with the top soil into the planting hole.</li> <li>◆ To an already existing plantation apply 2 basins of manure around the plant 2 ft away from the mat and then fork to mix well with soil</li> <li>◆ Apply Muriate of Potash (MOP) – 60 gm at planting and 100-200 gm/per mat in established plantations.</li> <li>◆ Apply MOP in a 1 ft ring away from the mat. Sprinkle fertilizer and cover with the soil.</li> <li>◆ Recommended to apply MOP twice a year at the onset of rainy seasons.</li> </ul>	<ul style="list-style-type: none"> <li>◆ Application of MOP (60gm/plant).</li> </ul>	<ul style="list-style-type: none"> <li>◆ Use protective gears when applying MOP (wear gloves).</li> <li>◆ Keep away from children's reach</li> </ul>
 <p>Potassium deficiency - Severe, Stage - 3 Necrosis often covers leaf surface.</p> <p>Necrosis progresses to midrib (tcbanana.blogspot.com)</p>				
 <p>Potassium deficiency - Extreme, Stage - 4 All of the leaf necrotic and the young leaves are severely distorted.</p> <p>Drying of leaves at petioles (tcbanana.blogspot.com)</p>				



**Country: Uganda**  
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 AUTHOR/S: Kimeze D, Arinda M, Tumukuratire S (NARO)  
 EDITED BY: CABI

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# Annex B - Manures and their management

## Compost manure

### Introduction

Compost manure is a product of biological decomposition of organic materials. Inorganic substances such as nitrogenous fertilizers may be added to speed up the decay process. The fertilizing quality of the compost manure will depend on the composition of the materials used and the degree of decomposition. Compost manure can improve the soil physical properties and increase the capacity of the soil to supply plant nutrients. Continuous application of compost manure can enrich poor soils and maintain the fertility of rich soil.

### 1. Making compost manure

Compost manure can be made in different ways. The procedure you choose will depend on the organic material available and labor.

#### *Simple compost from household organic*

##### Trash/crop residues

Regular quantities of compost can be made from household organic trash or crop residues such as banana peelings, bean trash, groundnuts trash, coffee husks, chicken and goats droppings etc.

1. Dig a pit 2m long by 1.5m wide and 1m deep in a cool shady place (pit 1).
2. Fill the pit with the organic materials. As you fill this first pit, dig a second pit (pit 2).
3. When the first pit is full, transfer the material to pit 2, and begin filling pit 1 again.
4. Sprinkle the top with wood ash or a mixture of wood ash and animal dung if available.
5. If animal urine is available, dilute with water by mixing one container of urine with 3 equal containers of water and sprinkle over the heap
6. Cover the heap with top soil about 10 cm thick followed by dry vegetation to avoid evaporation.
7. Water the heap at frequent intervals. This is not necessary when it is raining.
8. Dig a third pit (pit 3).
9. After one month, transfer the contents of pit 2 into pit 3.
10. Cover as for pit 2 and water as required.
11. Repeat the procedure (pit 1 and pit 2).
12. Drive a pointed stick at an angle into the third pit, regularly remove it and feel it for warmth.
13. This should be continued until the stick when removed feels cool. The compost in the pit is then ready.
14. By repeating the process, this technique can supply compost on a continuous basis.

## Vegetation compost

To make vegetation compost, you will need fibrous material such as hedge cuttings, maize stalks, straw, plant material both dry and green, animal manure from e.g. cattle, sheep, goats, pigs, rabbits, poultry etc, top soil, wood ash or charcoal dust, water and a long sharp pointed stick.

1. Select a place sheltered from wind, rain, sun and water run-off. The compost pile should

not get dry or excessively wet. Mark off an area of 1.5 m long by 1.5 m wide.

2. In the marked area, dig a pit of about ½m deep if you are in a wet region or 1 m if you are in a dry region.
3. Put the fibrous material on the bottom layer about 30 cm thick. The materials should not be large otherwise they should be chopped up.
4. The second layer should be earth taken from animal shades, animal dung, dry leafy material, coffee husks, old compost or slurry from a biogas plant to a thickness of 10cm.
5. Sprinkle topsoil to just cover the materials above and this forms the third layer.
6. The fourth layer should be made up of green vegetation that rots easily e.g. green weeds, grass, leguminous plants, hedge cutting, kitchen trash, etc., to a thickness of 15-20 cm.
7. On top of the fourth layer, sprinkle wood ash or a mixture of wood ash and animal dung or topsoil and water the whole pile adequately.
8. Repeat the procedure until the pile is about 1.5 m high and put a final layer of top soil about 10cm thick.
9. Cover the whole pile with dry vegetation to avoid evaporation. This process should have taken about one week.
10. Take a long sharp stick and drive it into the pile at an angle. This stick assists in showing whether the pile is dry or wet. Within 2 to 3 days decomposition will have started in the pile.
11. The stick when removed should feel warm and moist. Leave the stick in the pile and regularly removed it to monitor warm and moisture.
12. Depending on the weather conditions, the pile should be watered every 3 days. This is not necessary when it is raining.
13. After 3 weeks, turn the pile but do not add any fresh material. Turning should also be done when the stick feels cool. Monitor for warm and moisture using the long sharp stick and water as necessary.
14. Repeat the process a second time.
15. Three weeks after the second turning, monitor the warmth of the compost pile at regular intervals by pulling out the stick and feeling the warmth. The compost is ready when the stick finally feels cool.

## Other composting techniques

Similar composting techniques for mainly perennial crops are sunken basket composting and Trenching composting.

### ***Sunken basket composting***

Composting materials are placed in a circular hole dug in the center of four perennial crop plants like bananas, mangoes, citrus, avocado etc. and then covered with topsoil.

### ***Trench composting***

Composting materials are placed in trenches usually dug between rows in established perennial crops like bananas and coffee and then covered with topsoil.

### ***Basket composting***

Fresh manure mixture from the enclosure is placed in baskets half-buried in garden plots and left to rot.

### ***Sunken basket composting***

Fresh manure mixture from the enclosure is placed in a circular hole dug in the center of four perennial crop plants like bananas, mangoes, citrus, avocado etc. and covered with topsoil.

### ***Trench composting***

Fresh manure mixture from the enclosure is placed in trenches usually dug between rows in established perennial crops like bananas and coffee and then covered with topsoil.

## **2. Making farm yard manure**

Farmyard (animal) manure is made by composting the dung and urine of farm animals, particularly cattle, with any plant material such as straw, maize stalks, weeds, leaves, elephant grass that can rot (bedding and feed residue).

**Note that the plant nutrients in farmyard manure will depend on the following factors:**

1. The composition of the feed given to the animals.
2. The composition of the material used for bedding the animals.
3. The degree of composting or rotting of the bedding material.
4. Losses of ammonia by volatilization.
5. Losses of soluble compounds by drainage and washing out (leaching).

Farmyard manure is therefore a material of very variable value to crops depending on the management

skills of the farmer. When well made, it is a good source of plant nutrients. It can be prepared in solid or liquid form.

### ***Handling manure***

Farmers with livestock are advised to keep the animals in an enclosure (zero grazing). Grazing animals should be kept in the enclosure during the night. This enables collection of urine and dung. Add bedding material preferably once a week and enough of it so that all the urine can soak. To obtain good farmyard manure with various plant nutrients, it is best to use a mixture of bedding materials. The bedding soaks up urine and droppings and reduces losses through leaching or volatilization of ammonia during drying out of the manure. Farmers who regularly put new bedding will make plenty of high-quality farmyard manure

### ***The composting processes***

The manure and bedding should be composted immediately each time it is removed from the enclosure. Farm animals such as cattle, sheep, goats, pigs, rabbits and poultry all produce rich manure. If enough bedding was used in the enclosure, it is not necessary to add more greens since the bedding is plant material(s). Farmers should always compost animal manure before use for best results. Manure and bedding may be taken out either every day or once a week from the enclosure. If taken out daily, the mixture should be put in a pile and a small amount of soil spread on top. This can be continued until there is enough material to build compost. The compost can be made as follows.

1. Dig a pit ½ meter deep behind the enclosure, putting the soil next to the pit. Loosen the bottom of the pit and place a layer of dry vegetation at the bottom.
2. Spread a layer of 10 cm of manure and bedding material from the enclosure into the pit.
3. Sprinkle topsoil just to cover the material.

4. Add another 10 cm layer of manure and bedding and again cover with a layer of topsoil. Repeat the process until the compost pile is about 1 meter high.
5. Complete the pile by covering with a 10 cm layer of topsoil and finally with grass, maize stalk or banana leaves to prevent it from drying. In the dry season, regularly water the pile.
6. Use a stick to monitor the temperature and moisture. If the stick is dry and cold, add more water. The decomposition process proceeds well if the stick is moist and feels warm. After two or three weeks, the pile is turned into the second pit. Again, cover the pile with topsoil and dry grass or banana leaves. continue monitoring and watering the pile as necessary.
7. After two or three more weeks, turn the pile in the second pit into the third pit. Again, cover the pile with topsoil and dry grass or banana leaves. Continue monitoring and watering the pile as necessary.
8. In the third pile, when the stick feels cool, the pile is ready for use. The compost should have a fresh earth smell and no grass or animal droppings should be visible.
9. If the compost is ready for use but the planting season is still far away, remove it and store under a shade covered with a layer of soil or banana leaves or polythene.
10. Remember, compost should be kept moist. Avoid wetness or dryness by properly covering the material.

### ***Guidelines on compost application***

Compost should be placed in such a way that the plant's roots are able to get to it easily. The bigger the amount applied the better for the soil and crops. For perennial crops, 1 basin of compost should be applied in the planting hole at planting time. During the rains 1-2 basins depending on the age of the plant applied around the plant in a trench. For annual crops, apply a handful of compost per planting hole during planting.

### ***Alternative ways of handling manure***

Composting in piles produces quality manure but is a labor-intensive activity. Some farmers are constrained by labor and would opt for alternative handling procedures. These are listed below.

### **Liquid animal manures (best for vegetables)**

Liquid manure is made to provide crops with plant nutrients quickly during the growing cycle. It can be used to complement compost or fertilizer used at planting. Liquid manure should be applied in the morning and evening when cool but not directly to the plant.

### ***Animal dung liquid manure***

To make animal dung liquid manure, you need

- (a) animal dung (preferably fresh) from e.g cattle, sheep, goats, rabbits, pigs, poultry etc.,
- (b) a Container (drum, or a jerrycan or a big pot or a pit lined with plastic sheeting)
- (c) a gunny bag
- (d) a string
- (e) a strong stick (about 1 meter long).

### **Procedure:**

1. Fill the gunny bag with the animal manure or mixture of manures and then tie up the mouth of the bag securely.
2. Suspend the bag from a strong stick placed across the mouth of the container.
3. Fill the container with water and cover it to prevent excessive evaporation.

4. After 3 days, stir the manure every day by lifting the immersed bag out of the drum several times.
5. After about 14 days (when water is blackish), remove the bag.
6. Dilute the contents of the drum by adding to one container of the liquid manure, two equal containers of water.
7. Apply a cupful (about ½ litre) of the diluted liquid manure to annual crops and about 6 cupfuls (about 3 litres) to perennial crops once every two weeks.
8. The manure remaining in the gunny bag can be use as mulch or applied to crops directly as top dressing.

### ***Animal urine manure (also best for vegetables)***

To prepare animal urine manure, use the following guidelines;

1. Make an animal shed with a slanting floor that drains to a common point.
2. Construct a pit in which urine can drain. Cementing the pit or smearing it with cow dung or clayey soil will reduce leakages.
3. When the pit gets full, transfer the urine to a container or to another similar pit constructed under shade.
4. Cover the urine lightly and leave for 14 days.
5. Dilute one container of urine with two equal containers of water.
6. Apply the diluted animal urine manure as for animal dung liquid manure.

### **Green manure**

Green manure involves incorporating fresh plant materials into the soil and allowing it to decompose and release the nutrients over time. In the case of green manure, materials that have the potential to sprout such as coach grass, etc.

Best materials are those that can decompose very first, e.g. materials with low CN (Carbon:Nitrogen) ratio, eg *Tithonia diversifolia*, legume plants etc.

# Annex C: Stepwise approach

## Background information

Smallholder farmers are usually reluctant to adopt improved agricultural practices for various reasons including limited resources within their means to apply the whole range of available Technologies, Innovations and Management Practices (TIMPs) to realise optimum productivity. IITA (2017) working with partners in to implement Climate Smart Investment Pathways (CSIPs) in greater Luwero district of Uganda applied the CSIP approach in stepwise manner. This was intended to help smallholder farmers increase adoption of Climate Smart Agriculture (CSA) practices for better yields and incomes.

### The case for stepwise approach

- Coffee farmers were often not adopting climate smart agriculture (CSA) practices due to limited resources and differing levels of entrepreneurship
- Climate smart investment pathways (CSIPs) breakdown the training on CSA practices into smaller steps which farmers can implement according to the resources available
- There were various types of farmers and farmer differentiation in Greater Luwero, highlighted six different groups of farmers, each with varying levels of resources and entrepreneurship
- Farmer differentiation helped target farmers with appropriate practices derived from the CSIP

Adapted from: IITA Info Note (2017)

### Customising the stepwise approach to boost banana productivity among smallholder farmers

The banana agronomy project aims at increasing yield from average of 10t/ha/yr to 25t/ha/yr in Uganda and Tanzania. This is to be achieved through improving farmers' productivity by providing appropriate knowledge and skills in good management practices.

The stepwise approach was used to cluster banana farmers according to their banana crop management practices in addition to agreed packages of management practices that each cluster was to implement within their resource means as presented in Figure 1.1, starting with the practices with the least resource requirements and management intensity. The different farmers clusters are supported with appropriate knowledge and skills to implement each practice, one at a time before moving to the next with the most resource constrained farmer cluster starting with management package 1;(weeding, de-suckering and de-trashing their banana plantations. This approach can be applied to other banana growing areas as well with

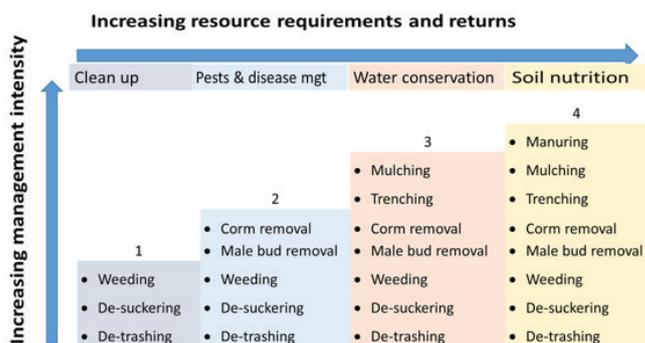


Figure 1.1

modifications.

In order to utilise this training manual, scaling agents need to take time to jointly with farmers and community leaders to come up with the various banana farmer clusters that exist in their respective communities. These should then jointly agree on the feasible stepwise packages to be implemented by the different clusters.

The various banana agronomy topics in this manual are then selected and trained to the respective farmer clusters allowing them time to implement one management practice at a time and consequently graduating to the next level.

### How to do it

1. Within your subcounty or community, convene meeting with selected farmers and community leaders and discuss;
2. The possible different banana farmer clusters that exist in your community and their respective characteristics
3. Using the designed criterion, ask the participants to cluster the households within the community into the various class types.
4. Discuss and agree the appropriate management/ agronomic practices each farmer cluster would consider most feasible to start to apply on their banana plantation e.g. weeding, pruning etc
5. Discuss and agree on next packages that each group would graduate to next level
6. Jointly develop monitoring plan and capture yield increases plus other observations as the practices are implemented
7. Take note and measurements of yields obtained incremental yields annually based on the practices
8. Hold learning sessions with farmers of various clusters at different farmer's banana plantations

*Adopted from IITA Info Note (2017). Redesigning Delivery: Boosting adoption of Coffee management practices in Uganda*

## Annex D: Banana varieties and their traits

Variety	Year of release	Bunch yield (t/ha/yr)	Other key attributes
KABANA 2H (FHIA 01)	1999	39	<ul style="list-style-type: none"> <li>• Dessert and juice variety</li> <li>• Resistant to black sigatoka and banana weevils.</li> <li>• Tolerant to nematodes</li> <li>• Tolerant to drought</li> </ul>
KABANA 2H (FHIA 03)	1999	33	<ul style="list-style-type: none"> <li>• Dessert and juice variety</li> <li>• Resistant to black sigatoka and banana weevils</li> <li>• Tolerant to nematodes</li> <li>• Tolerant to drought</li> </ul>
KABANA 3H (FHIA 17)	2000	44	<ul style="list-style-type: none"> <li>• Dessert and juice variety</li> <li>• Resistant to black sigatoka and banana weevils</li> <li>• Tolerant to nematodes</li> <li>• Tolerant to drought</li> </ul>
KABANA 4H (FHIA 23)	2000	40	<ul style="list-style-type: none"> <li>• Dessert and juice variety</li> <li>• Resistant to black sigatoka, fusarium wilt and banana weevils</li> <li>• Tolerant to nematodes</li> </ul>
KABANA 5 (YAGAMBI)	2000	20	<ul style="list-style-type: none"> <li>• Dessert and juice variety</li> <li>• Resistant to black sigatoka, fusarium wilt and banana weevils</li> <li>• Tolerant to nematodes</li> </ul>
KABANA 6 H (Ki-wangazi, M9)	2010	60	<ul style="list-style-type: none"> <li>• Cooking banana</li> <li>• Resistant to banana weevils, Sigatoka and nematodes</li> <li>• Long lasting i.e., mat disappearance is over 5 years</li> </ul>
KABANA 7H (syn. 'M2') 2014	2014		<ul style="list-style-type: none"> <li>• Cooking banana</li> <li>• Tolerance to the banana weevils and nematodes</li> <li>• Tolerant to black sigatoka</li> <li>• Big bunch size</li> <li>• Early maturing</li> </ul>



NAROBan1 (M19)	2017	54.9	<ul style="list-style-type: none"><li>• Cooking banana</li><li>• Highly resistant to black Sigatoka</li><li>• Resistant to the banana weevils and nematodes</li><li>• Soft, tasty, aromatic, and near-yellow food color</li></ul>
NAROBan2 (M20)	2017	60.4	<ul style="list-style-type: none"><li>• Cooking banana</li><li>• Highly resistant to black Sigatoka</li><li>• Resistant to the banana weevils and nematodes</li><li>• Soft, tasty, aromatic, and near-yellow food color</li></ul>
NAROBan3 (M25)	2017	64.7	<ul style="list-style-type: none"><li>• Cooking banana</li><li>• Highly resistant to black Sigatoka</li><li>• Resistant to the banana weevils and nematodes</li><li>• Soft, tasty, aromatic, and near-yellow food color</li></ul>
NAROBan4 (M27)	2017	68.8	<ul style="list-style-type: none"><li>• Cooking banana</li><li>• Highly resistant to black Sigatoka</li><li>• Resistant to the banana weevils and nematodes</li><li>• Soft, tasty, aromatic, and near-yellow food color</li></ul>





Working in partnership to create down-to-earth messages on integrated soil fertility management