



Japan International Cooperation Agency



Agriculture, and Food Authority
Horticultural Crops Directorate



Ministry of Agriculture, Livestock and Fisheries
State Department for Crop Development & Agricultural Research

Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS)

*“Changing Farmers’ Mindset from **“Grow and Sell”** to **“Grow to Sell”**”*

BANANA PRODUCTION



Prepared by SHEP PLUS

Training Title: Banana Production**Objective: To provide a guideline on production of Bananas****Specific Objective:**

- **To provide basic information on production, post-harvest handling, and marketing of Banana**

Contents:

1. **Introduction: Background, Common Varieties and Optimal Ecological Requirements**
2. **Pre-Cultivation Preparation 1 – 4**
3. **Cultural Practices 1- 7**
4. **Harvest**
5. **Post-Harvest Handling**
6. **Cost & Income Analysis**
7. **Post-Training Evaluation Exercise**

Contacts:

- **Ministry of Agriculture, Livestock & Fisheries (MOALF):**
Kilimo House, Cathedral Road, P.O. Box 34188-00100, Nairobi, KENYA, Tel: 020-2718870
- **Agriculture and Food Authority (AFA), Horticultural Crops Directorate (HCD):**
Airport Road, Opp. JKIA, P.O. Box 42601-00100, Nairobi, KENYA, Tel: 020-2131560/3597356
- **Japan International Cooperation Agency (JICA) Kenya Office:**
BRITAM Tower, 22nd & 23rd, Hospital Road,
P.O. Box 50572-00200, Nairobi, KENYA, Tel: 020-2775000
- **Smallholder Horticulture Empowerment and Promotion Project for Local and Up-Scaling (SHEP PLUS):**
N.H.I.F. Building, 4th Floor, Ngong Road/Haile Selassie Avenue, Upper Hill
P.O. Box 19024-00100, Nairobi, KENYA
Tel: 0712-504095 /0737-293867, E-mail: info.shepunit@gmail.com

Disclaimer

Banana Production, First published by SHEP in 2009, revised by SHEP PLUS in 2019 (Ver.6)

Editors: James Arim, Stephen Kioko, Collins Otieno, Calistus Efukho, Grace Mbutia, Florence Mangoli, Zablon Oirere, Elizabeth Mbutia, Fransisca Malenge, Calistus Efukho, Jiro Aikawa, Kiyoshi Kita, Harue Kitajima, Yasuhiro Takashina, Taku Seo

Contributors: Grays Kiplagat, Thomas Mumu, Sarah Ndegwa, Antonina Luta, Peter Orangi, Florence Wambua, Raymond Chelule, Murage Henry, Omari Victor, Jacob Keror, Musah Samuel, Carolyne Mwenze

All rights reserved. This publication may be reproduced without permission for non-commercial use. However, the Ministry of Agriculture, Livestock & Fisheries (MOALF), Agriculture and Food Authority (Horticultural Crops Directorate (HCD)) of the Republic of Kenya and the Japan International Cooperation Agency (JICA) should be acknowledged.

This publication was prepared under the Smallholder Horticulture Empowerment and Promotion Project for Local and Up-Scaling (SHEP PLUS) on behalf of Ministry of Agriculture, Livestock and Fisheries (MOALF), and Agriculture and Food Authority (Horticultural Crops Directorate (HCD)) of the Republic of Kenya and Japan International Cooperation Agency (JICA).

The cited agrochemicals are in accordance with "Pest Control Product Registered for Use in Kenya 11th Edition, 2018". The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Products Board.

Preface

- This training material applies the fundamental practices essential for crop production and successful marketing to put into perspective the case of horticultural crop production.
- The fundamental practices are categorized into seven (7) broad topics and twenty (20) sub-topics; the twenty sub-topics are referred to as the General Horticulture Crop Production and Post-Harvest Handling Techniques (GHCP&PHHT20). This categorization is based on the Smallholder Horticulture Empowerment & Promotion Unit Project (SHEP UP) experience in mitigating production and marketing challenges facing smallholder horticultural farmers.
- The seven (7) broad topics are: Pre-Cultivation Preparation; Land Preparation; Crop Establishment (Planting/Transplanting); Crop Management; Harvest; Post-Harvest Handling; and Cost and Income Analysis.
- The sub-topics under each topic are as follows: **Pre-Cultivation Preparation** (market survey, crop planting calendar(s), soil sampling & analysis, composting, and quality seed/planting material(s)); **Land Preparation** (land preparation practices, incorporation of crop residues, and basal application); **Crop Establishment** (raising seedlings, planting/transplanting, fertilizer application); **Crop Management** (water requirement, managing of weeds, top-dressing, pests & diseases management practices, and safe & effective use of pesticides); **Harvest** (harvesting indices); **Post-Harvest Handling** (appropriate containers/standard packaging materials, and value addition techniques); and **Cost and Income Analysis** (cost and income analysis).
- The issues outlined in the twenty (20) sub-topics might not necessarily be applicable in all cases. But where applicable, it is recommended that the instructions issued be given due consideration.

1. Introduction:

1.1 Background

1-1



Banana (Ndizi)

1. Introduction:

1.1 Background



Banana (Ndizi)

1. Introduction:

1.1 Background

- Banana is mainly cultivated for its fruit which can either be eaten **ripe** (dessert) or **cooked**
- The ripe fruit is a good source of **vitamins A, B₆ & C** and **potassium**, while cooked one is rich in carbohydrates
- Can also be processed into **flour, canned slices, jam, jelly, puree, vinegar, wine** and **beer**
- The popularity of the crop makes it a **good cash crop** for smallholder farmers
- The **foliage** and **pseudo-stems** are used as cattle feed during drought
- The **banana leaves** are also used as **packing** and **roofing material**

1.2 Common Varieties



“Giant Cavendish”



“Chinese Dwarf”

1.2 Common Varieties



“Giant Cavendish”



“Chinese Dwarf”

1.2 Some Common Varieties

- The following are the common varieties grown in Kenya

“Giant Cavendish”

- A tall variety
- Resistant to fusarium wilt (Panama Disease)
- Susceptible to Black Sigatoka Disease
- Has a strong pseudo-stem
- The plant requires propping

“Chinese Dwarf”

- A short variety
- The plant does not require propping
- Grow in areas with altitude as high as 2,100 m
- Resistant to fusarium wilt (Panama Disease)
- Susceptible to “Cigar-end Rot” and Black Sigatoka

1.2 Common Varieties Cont'



“Grand Naine”



“Williams Hybrid”

1.2 Common Varieties Cont'

1-4



“Grand Naine”

1-5



“Williams Hybrid”

1.2 Some Common Varieties Cont'

“Grand Nain”

- A cultivar of Cavendish type
- Tolerant to environmental stress
- Produces good quality bunches with fruits which are uniformly yellow in color
- Mature fruits have good shelf life
- Requires propping

“Williams Hybrid”

- Produces large bunches with fruits which have excellent flavor, aroma, and taste when ripe
- Ripe fruits have short shelf life

“Valery”

- A tall variety and has good taste
- Strong pseudo-stem

FHIA Hybrids: “FHIA-17, 18, 23, 25”

- Varieties which have been developed by International Institute of Tropical Agriculture
- Resistant to “Black Sigatoka”
- Used for cooking and dessert
- Produce heavy bunches with an average weight of 50 kg
- The plants require support to prevent lodging

Other varieties include:

- Ngombe, Lacatan, Apple (Sweet), Gross Michel, Poyo, Kisii Matoke, Muraru, Sweet/ Sukari, Bogoya, Kampala, Kisigame, Manyoke, Kiganda & Mutahato

1.3 Optimal Ecological Requirements

Altitude	0-1,800 metres above sea level
Rainfall	1,000 – 2,000 mm of rainfall annually
Growing Temperature	20 – 30 °C
Soils	<ul style="list-style-type: none">• Deep well drained soils• pH range 6.0 – 7.5

1.3 Optimal Ecological Requirements

Altitude	0-1,800 metres above sea level
Rainfall	1,000 – 2,000 mm of rainfall annually
Growing Temperature	20 – 30 °C
Soils	<ul style="list-style-type: none"> • Deep well drained soils • pH range 6.0 – 7.5

1.3 Optimal Ecological Requirements

Banana is one of the most grown crops in Kenya. The followings are the optimal ecological requirements.

- **Altitude:** Hot and humid conditions are ideal. These conditions are found in altitudes between 0 and 1,800 m above sea level
- **Rainfall:** 1,000 – 2,000 mm/year is required. To achieve good yields, 200 – 220 mm/month, well distributed throughout the year.
- **Temperature:** Optimal temperature for growth is about 27 °C
- **Soil:** Deep friable loam soils rich in organic matter with pH range of 6.0 – 7.5
- **Wind:** Bananas are sensitive to strong wind which causes tearing of leaves and lodging of plants hence need for protection from strong winds by establishing wind breaks

2. G20 technologies

1. Market survey
2. Crop planting calendar
3. Soil testing
4. Composting
5. Use of quality planting materials
6. Recommended land preparation practices
7. Incorporating crop residues
8. Basal application of compost/ manure
9. Recommended practices of seedling preparation/ seedlings from registered nursery

2. G20 technologies

2. G20 technologies

1. Market survey
2. Crop planting calendar
3. Soil testing
4. Composting
5. Use of quality planting materials
6. Recommended land preparation practices
7. Incorporating crop residues
8. Basal application of compost/ manure
9. Recommended practices of seedling preparation/ seedlings from registered nursery

[G20 Technologies]

Make sure to support farmers carry out G20 techniques for any crop

2. G20 technologies

10. Recommended spacing

11. Recommended fertilizer application rate

12. Supplementing water

13. Timely weeding

14. Top-dressing

15. IPM practices

16. Safe and effective use of pesticides

17. Use of harvesting indices

18. Appropriate post harvest handling containers

19. Value addition techniques

20. Keeping farm records

2. G20 technologies

2. G20 technologies

- | | |
|---|--|
| 10. Recommended spacing | 16. Safe and effective use of pesticides |
| 11. Recommended fertilizer application rate | 17. Use of harvesting indices |
| 12. Supplementing water | 18. Appropriate post harvest handling containers |
| 13. Timely weeding | 19. Value addition techniques |
| 14. Top-dressing | 20. Keeping farm records |
| 15. IPM practices | |

[G20 Technologies]

Make sure to support farmers carry out G20 techniques for any crop

2.1 Quality Planting Materials



**Tissue Culture
banana seedlings**

Sword suckers

2.1 Quality Planting Materials



Tissue Culture Bananas seedlings



Sword suckers

2.4 Quality Planting Materials (GHCP&PHHT20: Q5)

- Bananas in Kenya are **propagated vegetatively** using **tissue culture** and **sword suckers**
- **Tissue Culture:** these are normally disease & pest-free plantlets that are multiplied under controlled conditions (laboratories) before being transferred to nurseries for hardening before sale
- **Sword Suckers:** the commonly used method by most smallholder farmers (**Hot water treatment** before planting)

2.1.1 Tissue Culture Seedlings



Tissue culture hardening nursery



Tissue culture banana seedlings ready for transplanting

2.1.1 Tissue Culture Seedlings



Tissue culture hardening nursery



Tissue culture banana seedlings ready for transplanting

2.4.1 Tissue Culture Seedlings

- The planting material should be sourced from **registered nurseries** that are known to sell Tissue Culture seedlings e.g. **KALRO, JKUAT** & some private companies, such as **Genetic Technologies, Africa Harvest Biotech Foundation & Aberdare Technologies Ltd.**
- Advantages of using tissue culture seedling are the elimination of risks of pests & diseases, production of uniform banana crop and higher yields

2.1.2 Sword Suckers



Photo: SHEP PLUS

Banana sword suckers

2.1.2 Sword Suckers



Photo: SHEP PLUS

Banana sword suckers

2.4.2 Sword Suckers

- Most farmers use sword suckers obtained from own farm or from neighbors to extend existing or establish new banana orchards
- The common farmer practice of using infected sword suckers has continuously perpetuated the spread of banana diseases and pests
- To mitigate this problem, suckers need to be disinfected before planting

2.1.3 Suckers Disinfection through Hot Water Treatment



Sword suckers



Disinfection of Banana Suckers

2.1.3 Suckers Disinfection through Hot Water Treatment



Disinfection of Banana Suckers for nematode/weevil control

2.4.3 Suckers Disinfection through Hot Water Treatment

- In the absence of Tissue Culture banana seedlings, **sword suckers** can be used as the propagation material
- Sword suckers are shoots with narrow leaves with height of about **1 m** and **15 cm** diameter at the base
- Sword suckers are sourced from existing banana orchards therefore it is necessary to treat the suckers with hot **water to eliminate nematodes & banana weevils**
- **This process involves the following:**
 1. Trimming of all the roots
 2. Cutting off **1 cm** of tissue around the corm until you get clean white tissue
 3. Prepare hot water
 4. Immerse the trimmed corm in the hot water bath at **50 – 55 °C** for **20 minutes**
- **Note:** In farm situation where there is no thermometer, the suckers can be dipped in **boiling water** for **0.5 minute (30 seconds)**

3. Cultural Practices:

3.1 Land Preparation



Weighing manure

3. Cultural Practices:

3.1 Land Preparation



Weighing manure

3. Cultural Practices:

3.1 Land Preparation Practices (GHCP&PHHT20: Q6)

- Before planting, **deep soil cultivation** by ploughing & harrowing is recommended
- The field should be **free of trees, bushes** and especially **perennial weeds**
- A planting hole measuring **60 cm x 60 cm x 60 cm** is recommended although this may vary depending on water availability
- In **dry & semi-arid areas**, it is recommended to use holes measuring **90 cm x 90 cm x 90 cm**
- Bananas **cannot withstand stagnant water** hence **soil should have good drainage**

3.1.1 Recommended Spacing (GHCP&PHHT20: Q10)

- Short Varieties: **3 m x 3 m** (444 plants/acre)
- Medium Varieties: **3 m x 4 m** (333 plants/acre)
- Tall Varieties: **4 m x 4 m** (250 plants/acre)

3.1.2 Fertilizer Application Method & Rates (GHCP&PHHT20: Q11)

- The **top soil** and **sub soil** should be kept separate
- Mix the top soil with **2-3 “debes” (about 20-30 kg)** of well decomposed manure and **200 g** of Triple Super Phosphate (TSP)
- Refill the hole with the top soil first followed by the sub soil
- Allow it to settle for at least **2 weeks** before transplanting

3.2 Transplanting



Banana seedlings after transplanting

3.2 Transplanting

3-3



**Banana seedlings after
transplanting**

3.2 Transplanting

3.2.1 Appropriate Time

- Transplanting should be done when tissue culture seedlings are about **30 cm** and have produced **at least 5 healthy leaves**
- To ensure **good anchorage**, a sucker or seedling should be placed **30 cm** deep in the planting hole
- **A heavy cover of mulch** should be placed around each plant to conserve soil moisture
- Under rain fed conditions, planting should be carried out only at **the onset of the rains**
- However, if irrigation water is available, planting can be done throughout the year

3.3 Crop Management

3.3.1 De-suckering



**Poorly managed
banana stools**



**Well managed
banana stools**

3.3 Crop Management

3.3.1 De-suckering



Poorly managed banana stools



Well managed banana stools

3.3 Crop Management

3.3.1 De-suckering

- Process of removing unwanted suckers from one stool so that at any moment a stool has only **3 suckers**:
 - One **bearing sucker** (mother plant)
 - One **half-grown sucker** (daughter plant)
 - One **sprouting sucker** (grand daughter plant)
- The surplus suckers are dug out with corm, and can be used as planting material
- In order to prevent sprouting: Insert a peg on the growing part
- The process should start **2 months after planting** and be repeated **every 45 days** till the plant flowers

3.3.2 Propping



Propped up banana plants

3.3.2 Propping



3.3.2 Propping

- It is **the process of supporting banana plants** which have mature or immature bunches to prevent them from lodging/ falling over
- A pole with a **V-shape end** is placed under the bunch to support it
- The prop should be placed carefully to avoid fruit injury
- The major varieties which require propping are: **Grand Nain”, Williams, Valery, Giant Cavendish, FHIA series** etc.

Propped up banana plants

3.3.3 Trimming of Old Dried Leaves



Neglected stool with dried leaves



Well managed orchard without dried leaves

3.3.3 Trimming of Old Dried Leaves



Neglected stool with dried leaves



Well managed orchard without dried leaves

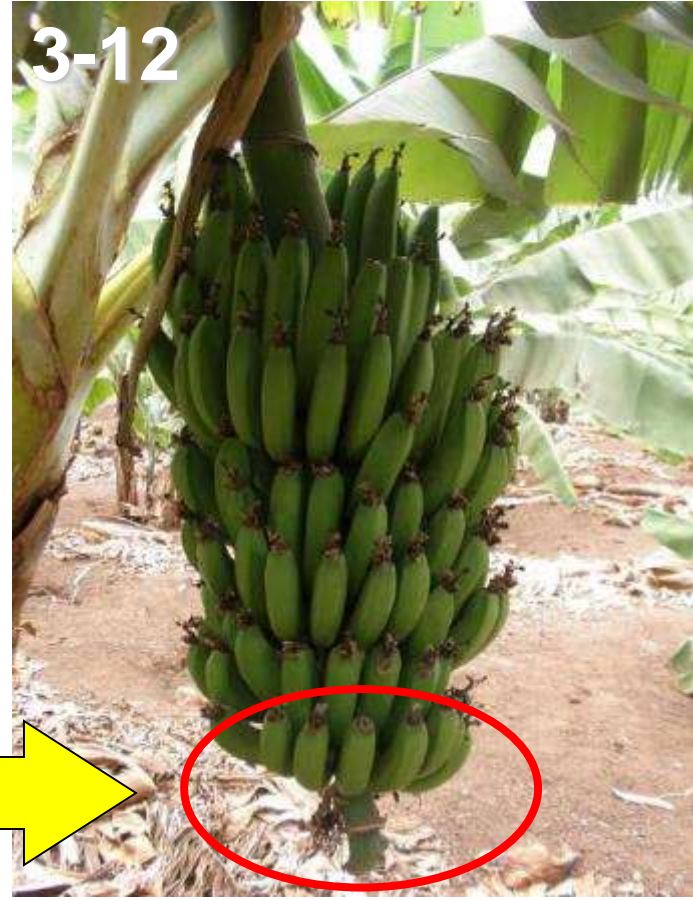
3.3.3 Trimming of Old Dried Leaves

- This activity is useful since it ensures **light penetration** in the orchard and helps reduce certain **leaf diseases** and reduces **injury** caused to banana by the **dry leaves** during **windy periods**
- **All dry/dead leaves** which hang down the sides of the pseudo-stem need to be removed **at least twice a year** (Each pseudo-stem should have **7 leaves** at any one time)
- **Trimming:**
 - Ensures **light penetration** in the orchard
 - Helps **reduce certain leaf diseases**
 - Reduces **injury** caused to banana fruits by the dry leaves during windy periods
- After harvesting, the pseudo-stem should be cut off at ground level, and chopped into small pieces to avoid banana weevil infestation

3.3.4 Removal of Male Bud & Bagging



Before removal



After removal

3.3.4 Removal of Male Bud & Bagging



Before removal



After removal

3.3.4 Removal of Male Bud & Bagging

- The male bud or navel should be removed **after bunch formation is complete**
- The advantages of removing the male bud include **increase in yield, faster maturing of bunches** and **reduced thrips attack**

Note: Tools used during removing male buds and pruning need to be disinfected

3.3.5 Bunch Covering (Bagging)

- A process of covering banana bunches with special polybag in order to protect them from being attacked by thrips and other insects

3.4 Water Requirement



Banana orchard under irrigation

3.4 Water Requirement



Banana orchard under irrigation

3.4 Water Requirement (GHCP&PHHT20: Q12)

- Banana plants require a minimum of **1,000 mm of rainfall annually**
- Irrigation is therefore necessary where the rainfall received is less than this amount
- Water is critical at flowering
- Therefore, in drier areas, supplemental irrigation may be necessary during this time 40-60 litres/plant per week split into 20L **(in two splits)**

3.5 Managing of Weeds



Weed management through mulching

3.5 Managing of Weeds



**Weed management
through mulching**

3.5 Managing of Weeds (GHCP&PHHT20: Q13)

- Orchards should be kept weed-free through either **hoeing** or **mulching**
- Since Bananas are **shallow-rooted**, care should be taken during weeding to avoid root injury
- A well maintained heavy mulch cover will **suppress weed growth, retain moisture & provide humus** for a good soil structure
- The orchard can also be kept weed-free through **inter-cropping**
- **Use of herbicide** such as Paraquat Dichloride (**Gramoxone®**, **HERBIKILL®**) or Glufosinate - Ammonium (**Basta®**) is also effective

3.6 Top-dressing



Fermenting green manure (Day 3)



Top-dressing using green manure

3.6 Top-dressing



Fermenting green manure (Day 3)



Top-dressing using green manure

3.6 Top-dressing (GHCP&PHHT20: Q14)

3.6.1 Top-Dressing using “Green Manure”

How to prepare “Green Manure” (15 litres):

- **Materials:**
 - **6 kg** of fresh cattle dung
 - **9 litres** of water
 - **4 kg** of green weed called “**Tithonia**”
- **Procedures:**
 - Chop the **4 kg** of “**Tithonia**” into small pieces
 - Mix all materials together in a bucket, and cover with a **piece of cloth or news paper**
 - Keep the bucket under a shade for **1 – 2 weeks** depending on weather
 - When the mixture **stops releasing bubbles and smell ceases**, the green manure is ready
- **How to apply the “Green Manure”**
 - Apply **3 litres** of ready green manure per stool **once in three months**

3.6.2 Top-Dressing by Fertilizer

- **200 g** of **CAN** should be distributed around each stool per year, or, with **250 g** of **Mavuno Banana (N:P:K=10:3:20+TE)** applied **every 6 months**
- The top-dressing fertilizer should be applied in a band **60 cm** away from the plant
- **2 – 4 “debes”** of decomposed farmyard manure is applied **per stem per year** before the rains. This is applied on the outer diameter of the canopy and incorporated into the soil carefully to avoid root damage

3.7 Pests & Diseases Control:

3.7.1 Major Pests



Photo: © A.A. Seif, icipe
<http://www.infonet-biovision.org/PlantHealth/Crops/Bananas>
 (CC BY-NC-SA 3.0)



Photo: Scot Nelson (CC BY 2.0)
<https://www.flickr.com/photos/scotnelson/27755734515/in/photolist-Jb53fP-JhFoSP>

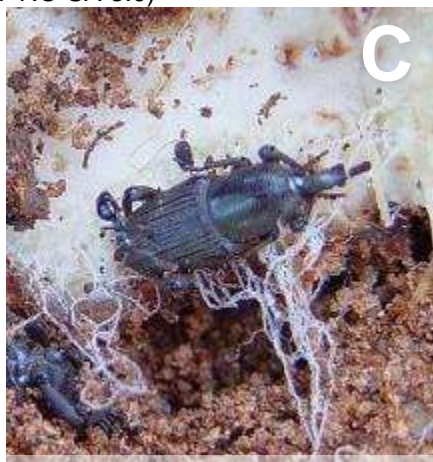


Photo: © A.M. Varela, icipe (CC BY-NC-SA 3.0)
<http://www.infonet-biovision.org/PlantHealth/Crops/Bananas>(9 Dec 2016)



Photo: By Scapanus_latimanus.jpg: Sarah Murray derivative work: WolfmanSF (Scapanus_latimanus.jpg) [CC BY-SA 2.0 (<http://creativecommons.org/licenses/by-sa/2.0/>)], via Wikimedia Commons
https://commons.wikimedia.org/wiki/File%3AScapanus_latimanus2.jpg (9 Dec 2016)

3.7.1 Major Pests



Photo © A.A. Shah (2011)
http://www.cropvet.co.ke/index.php?option=com_content&view=article&id=157:NC-SA-3.0



Photo: Scott Nelson (CC BY 2.0)
https://www.flickr.com/photos/scottnelson/2770673111/size/orig_largest.jpg

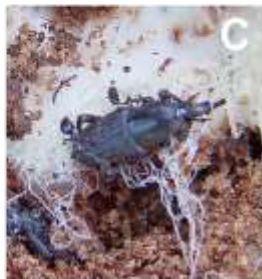


Photo © A.M. Varela (2010) (CC BY-NC-SA 3.0)
<http://www.entomol.de/verhalen.org/1.html#sub/Crop/Banana/3> (Dec 2018)



Photo by Scaphisoma_jamaicense.jpg: Sarah & Kelly Gammale with, Viki from USF (Scaphisoma_jamaicense.jpg) [CC BY-SA 2.0] (http://commons.wikimedia.org/wiki/File:Scaphisoma_jamaicense.jpg) via Wikimedia Commons
https://commons.wikimedia.org/wiki/File:Scaphisoma_jamaicense2.jpg (8 Dec 2018)

**3.7 Pests & Diseases Control:
 3.7.1 Major Pests**

- The following are the important pests of Banana in Kenya:

- A. Burrowing Nematode**
- B. Banana Thrips**
- C. Banana Weevil Borer**
- D. Moles**

3.7.1.A: Burrowing Nematode

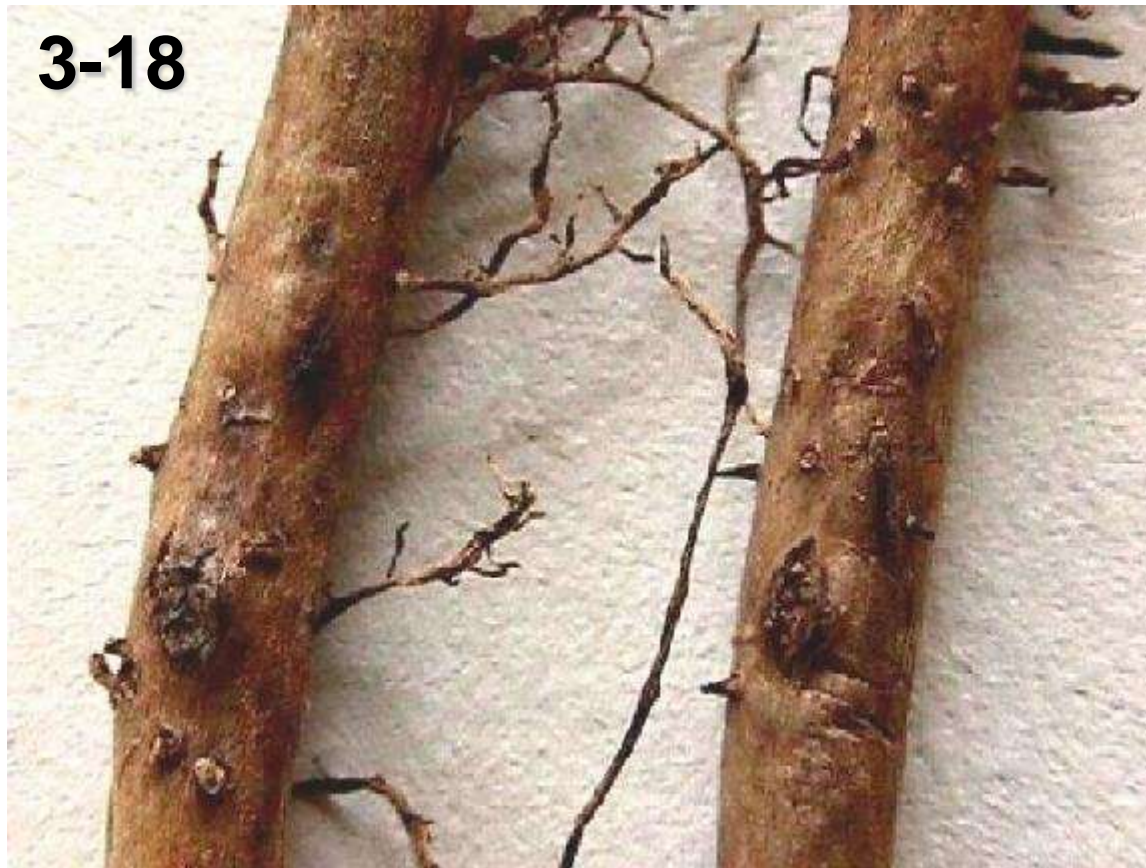


Photo: © A.A. Seif, icipe (CC BY-NC-SA 3.0) <http://www.infonet-biovision.org/PlantHealth/Crops/Bananas> (9 Dec 2016)

Burrowing nematodes on banana roots

3.7.1.A: Nematode



Photo: © A.A. Seif, icipe (CC BY-NC-SA 3.0)

<http://www.infonet-biovision.org/PlantHealth/Crops/Bananas> (9 Dec 2016)

Burrowing nematodes on banana roots

3.7.1.A: Nematode

- Nematodes are **the most damaging pests** causing **over 70 % loss** of the crop

Damages:

- **Lesions** and **tunnels** within the rhizome
- Root destruction leads to toppling of mature plant, especially when the wind blows or during bearing stage

Control:

- Use of **clean planting material (Tissue Culture or by hot water treatment)**
- Use “**Tithonia**” and “**Mexican Marigold**” in banana farm as green manure
- Apply **farmyard manure** or **poultry manure**
- Use of **nematicides** such as **Azadirachtin (Achook®)**, **Ethoprophos (MOCAP GR 10®)**

3.7.1.B: Banana Thrips



Photo: Scot Nelson (CC BY 2.0) <https://www.flickr.com/photos/scotnelson/27755734515/in/photolist-Jb53fP-JhFoSP>

Damage on banana fruits by thrips

3.7.1.B: Banana Thrips



Photo: Scot Nelson (CC BY 2.0)
<https://www.flickr.com/photos/scotnelson/27755734515/in/photolist-Jb53fP-JhFoSP>

Damage on banana fruits by thrips

3.7.1.B: Banana Thrips

Damages:

- **Silvery patches** on the fruits that later turn **brown**
- The skin of heavily infested fruit may crack permitting secondary infection which results in **fruit rot** making it unattractive hence lowering its marketability

Control

- **Removal of male flowers**
- **Covering of bunches/bagging**
- Use of **insecticides**, such as
 - **Deltamethrin (Decis 2.5 EC®)**
 - **Pirimiphos-Methyl (ACTELLIC 25EC®)**

3.7.1.C: Banana Weevil Borer



Photo: © A.M. Varela, icipe (CC BY-NC-SA 3.0) <http://www.infonet-biovision.org/PlantHealth/Crops/Bananas>

Banana weevil adult

3.7.1.C: Banana Weevil Borer



Photo: © A.M. Varela, icipe (CC BY-NC-SA 3.0) <http://www.infonet-biovision.org/PlantHealth/Crops/Bananas>

Adult banana weevil

3.7.1.C: Banana Weevil Borer

Identification:

- Weevil: A **brown-black weevil** with a **curved hard shell**
- Borer (grub) form **irregular tunnels** in the rhizome reducing it to a mass of rotten tissue

Damages:

- The leaves of infested plants turn **yellow, wither** and **die prematurely**
- Infested plants are **easily blown over the ground by wind**

Control:

- **Use clean planting material** for propagation (**Tissue Culture** or **hot water treatment**)
- **Do NOT** leave suckers and other planting materials **over night** in the field, as the weevils may lay eggs on them
- After harvest, **cut stems at the ground level** and **cover the cut surface** with a layer of earth to prevent entry of the weevil
- **Cut harvested stems into very small pieces** to allow faster drying and rotting

3.7.1.D: Moles



Photo: By Scapanus_latimanus.jpg: Sarah Murray derivative work: WolfmanSF (Scapanus_latimanus.jpg) [CC BY-SA 2.0 (<http://creativecommons.org/licenses/by-sa/2.0>)], via Wikimedia Commons https://commons.wikimedia.org/wiki/File%3AScapanus_latimanus2.jpg (9 Dec 2016)

**A Mole making tunnels at the base
of banana stool**

3.7.1.D: Moles



Photo: By Scapanus_latimanus.jpg: Sarah Murray derivative work: WolfmanSF (Scapanus_latimanus.jpg) [CC BY-SA 2.0 (<http://creativecommons.org/licenses/by-sa/2.0>)], via Wikimedia Commons
https://commons.wikimedia.org/wiki/File%3AScapanus_latimanus2.jpg (9 Dec 2016)

A Mole making tunnels at the base of banana stool

3.7.1.D: Moles

Identification:

- Moles are **small cylindrical mammals**
- They have velvety fur; tiny or invisible ears and eyes; and short, powerful limbs with large paws oriented for digging
- **Forms mounds of soil** (shaped like a volcano) and/or **surface tunnels**

Damages:

- **Stools fall over** from damage on the roots

Control:

- Keep the basin of the banana stools **always moist** as moles do not like living on wet grounds
- **Do NOT heap/mount soil** around the basin of the banana stool as this might become a hide out for the moles
- Use **traps** with baits
- **Field sanitation**

3.7.2 Major Diseases



3.7.2 Major Diseases



3.7.2 Major Diseases

- The following are the major diseases of bananas in Kenya:
 - a. **Panama Disease (Fusarium Wilt)**
 - b. **Black Sigatoka / Black Leaf Streak**
 - c. **Cigar-end Rot**
 - d. **Banana Bacterial Wilt**

3.7.2.a: Panama Disease

3-24a



3-24b



**Banana plant with collapsed dry leaves (left)
and infected banana pseudo-stem (right)**

3.7.2.a: Panama Disease



Banana plant with collapsed dry leaves



infected banana pseudo-stem

3.7.2.a: Panama Disease

General Descriptions:

- A **soil-borne disease** also known as “**Fusarium Wilt**”
- Fungus attacks roots and **blocks vascular system** causing wilts

Symptoms:

- The **older leaves turn yellow** and collapse while still green at the base
- The leaves fall in order, from the oldest to the youngest until they hang around the pseudo-stem **like a skirt**, and dry up
- The **emerging heart leaf may die** while the stem remains erect till it decays and **falls over**
- Diseased plants **fail to produce normal fruit and die** before the fruit stalk is fully developed
- Apple and Gross Michel/Kampala are **highly susceptible** to this disease

Control:

- Use of resistant varieties, such as **Giant Cavendish, Lacatan or FHIA hybrids**
- **Use disease-free materials** (Tissue Culture and clean suckers)
- Observe **quarantine**

3.7.2.b: Black Sigatoka / Black Leaf Streak



Photo: ©Scot Nelson (CC: BY 2.0) <https://www.flickr.com/photos/scotnelson/29608954871>

A Banana leaf with symptom of “Black Sigatoka” infection

3.7.2.b: Black Sigatoka / Black Leaf Streak



Photo: © Scott Nelson (CC BY 2.0)
<https://www.flickr.com/photos/scottnelson/2903054471/>

A Banana leaf with symptom of “Black Sigatoka” infection

3.7.2.b: Black Sigatoka/ Black Leaf Streak

General Descriptions:

- A **fungal disease** that destroys banana leaves also called **Leaf Streak Sigatoka**
- It can **seriously reduce crop yield**

Symptoms:

- First symptoms are **narrow, rusty, reddish-brown streaks** on the underside of leaves
- These become **dark brown or black spots** on both surfaces and develop **yellow margins & grey centres**
- It causes **significant reduction** in leaf area, premature ripening and yield loss of up to **50 % or more**

Control:

- **Cultural practices** such as removal of affected leaves, adequate spacing of plants and efficient drainage within orchards
- Use of resistant cultivars e.g.) **FHIA 17, 18, 25**, some Cavendish varieties like **Williams** and **Grand Nain**
- Use chemicals such as :
 - **Mancozeb (DITHANE M-45®)**
 - **Thiophanate-Methyl (TOPSIN M Liquid®)**

3.7.2.c: Cigar-end Rot



Photo: ©Scot Nelson (CC: BY 2.0) <https://www.flickr.com/photos/scotnelson/5670474991>

“Cigar-end Rot” damage on a banana fruit

3.7.2.c: Cigar-end Rot



Photo: ©Scot Nelson (CC: BY 2.0)
<https://www.flickr.com/photos/scotnelson/5670474991>

**“Cigar-end Rot” damage
on a banana fruit**

3.7.2.c: Cigar-end Rot

General Descriptions:

- The fungus invades the dry flower parts and penetrates into the skin
- Favoured by **high humidity** due to overcrowded orchard or stool, and abundant leaf trash

Symptoms:

- Tips of the attacked **banana fingers** undergo a dry rot with an **ashy gray appearance** that look like a **cigar**

Control:

- Field hygiene and removal of excess suckers
- **Male flower bud should be removed** when it is **15 cm** below the last hand
- **Use of fungicides**, such as
 - Propineb (**Antracol WP70®**)
 - Thiophanate-Methyl (**Topsin M Liquid®**)
 - Mancozeb (**Dithane M-45 WP®**)

3.7.2.d: Banana Bacterial Wilt



Photo: © Rose Kamau, MOALF 2019

***Xanthomonas* Wilt-
infected banana
pseudostem**



Photo: © IITA (CC BY-NC 2.0) <https://www.flickr.com/photos/iita-media-library/6755031667/in/photostream/>

**Banana fruit
infected with
Xanthomonas
“Bacterial Wilt”**

3.7.2.d: Banana Bacterial Wilt



Photo: © Rose Kamau, MOALF 2019

***Xanthomonas* Wilt-infected banana pseudostem**



Photo: © IITA (CC BY-NC 2.0)
<https://www.flickr.com/photos/iita-media-library/6755031667/in/photostream/>

Banana fruit infected with *Xanthomonas* “Bacterial Wilt”

3.7.2.d: Banana Bacterial Wilt

General Descriptions:

- The disease is easily spread by use of infected planting materials and farm tools
- Transmitted by insects including bees through the male bud
- **Lacatan** is a very susceptible variety

Symptoms:

- **Withering of flowers, wilting of leaves and premature ripening of fruits**
- The leaf sheath turns **dull green, scalded & breaks at petiole**, then all leaves **collapse at pseudo-stem**
- Cross section of the pseudo-stem when cut reveals yellow discoloration bacterial ooze
- **Un-even and premature ripening of fruits**

Control:

- **Field Sanitation:**
- Disinfecting farm tools after use and washing hands **e.g.) use of jik 1:5 water**
- Uprooting, destroying, and burying affected plants
- **Disbudding of male flower buds** after fruiting
- Observe quarantine
- Use of clean planting materials

4. Harvest



**Harvested banana
directly placed on the
ground**



**A harvested bunch of
banana on display**

4. Harvest



Photo: SHEP PLUS

Harvested banana directly placed on the ground



Photo: SHEP PLUS

A harvested bunch of bananas on display

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- **Fruit Size:** length and volume of fruit increases as fruit matures
- **Fruit Shape:**
 - At early stages of development, individual fruits are angular in **cross-section**
 - As the fruit matures, the fingers become more rounded
- **Peel and Pulp Color:**
 - During maturation, the color of the peel changes from **deep green** to **light green** or **yellow**
 - The pulp color changes from **cream** to **orange yellow**
- **Harvesting** involves:
 - **Cutting the bunch** from the **pseudo-stem**
 - For tall varieties, the pseudo-stem may be cut **half-way** to allow the bunch to be reached and thereby prevent it from falling on the ground
- Harvesting starts **9 – 18 months** after planting
- Banana comes to full production in **2 – 3 years**
- Average yield in Kenya has been **6 tons/acre**
- Under good management yields of **20 tons/acre** can be achieved

5. Post-Harvest Handling



**Banana bunch being weighed
before selling**

5. Post-Harvest Handling



Banana bunch being weighed before selling

5.1 Containers & Packaging Materials (G20: Q18)

- Bunches must be **handled gently to avoid bruising**
- Farmers usually transport and market bananas in bunches
- This form of handling exposes the fruits to **mechanical damage** thereby reducing their quality
- In order to reduce this damage it is advisable to **remove the hands and pack in reusable plastic containers**

5.2 Value Addition Techniques: Cleaning, Sorting, Grading, & Processing (G20: Q19)

- **Sorting:** Remove **undesirable fruits** e.g. with **thrips & rust damage, severe latex staining**
- **Processing:**
 - Some products include **flour, juices, puree, chips, crisps, jams/jelly, sweets, vinegar and wine**