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

Presented to the County & AFA (HCD) Staff in charge of the SHEP PLUS Model Farmer Groups during the FT-FaDDE

Prepared by SHEP PLUS
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.
- It can also be processed into flour, canned slices, jam, jelly 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

"Chinese Dwarf"

• A short variety
• The plant does not require propping
• Grows in areas with altitude as high as 2,100 m
• Resistant to fusarium wilt (Panama disease)
• Susceptible to Cigar-end Rot & Sigatoka

"Giant Cavendish"

• The following are the common varieties grown in Kenya
• A tall variety
• Resistant to Fusarium wilt (Panama disease)
• Susceptible to Sigatoka
• Has a strong pseudo-stem
• The plant requires propping
1.2 Common Varieties Cont’

“Grand Nain”

“Williams Hybrid”
1.2 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 colour
- Mature fruits have good shelf life
- Requires propping

“Williams Hybrid”
- Produces large bunches with fruits which have excellent flavour, aroma, and taste when ripe
- Ripe fruits have short shelf life

“Valery”
- A tall variety and has good taste
- Strong pseudo-stem
1.2 Common Varieties Cont’

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:
- Ngombe, Lacatan, Apple (Sweet/ Sukari), Gross Michel, Poyo, Kisii Matoke, Muraru, Bogoya, Kampala, Kisigame, Manyoke, Kiganda & Mutahato
## 1.3 Optimal Ecological Requirements

<table>
<thead>
<tr>
<th>Altitude</th>
<th>0-1,800 metres above sea level</th>
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<tbody>
<tr>
<td>Rainfall</td>
<td>1,000 – 2,000 mm of rainfall annually</td>
</tr>
<tr>
<td>Growing Temperature</td>
<td>20 – 30 °C</td>
</tr>
<tr>
<td>Soils</td>
<td>• Deep well drained soils</td>
</tr>
<tr>
<td></td>
<td>• pH range 6.0 – 7.5</td>
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- **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

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

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

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
3.1 Quality Planting Materials
(G20: Q5)

Tissue Culture Banana Seedlings

Sword suckers
3.1 Quality Planting Materials

(G20: 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 required)
3.1.1 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, Aberdare Technologies & Africa Harvest Biotech Foundation
- Registered hardening nurseries
- Advantages of using tissue culture seedlings; elimination of risks of pests & diseases, production of uniform banana crop and higher yields
3.1.2 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 or being moved.

Sword suckers in a field
3.1.3 Suckers Disinfection through Hot Water Treatment

Sword suckers

Disinfection of Banana Suckers
3.1.3 Sucker Disinfection through Hot Water Treatment (1/2)

- 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 orchard therefore it is necessary to treat the suckers with hot **water** to **eliminate nematodes & banana weevils**.
3.1.3 Suckers Disinfection through Hot Water Treatment (2/2)

- This process involves the following:
  1. Trimming 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 30 seconds.
4. Cultural Practices:
4.1 Land Preparation

Photo: SHEP PLUS

Weighing Manure
4. Cultural Practices:

4.1 Land Preparation

(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**
4. Cultural Practices:
4.1 Land Preparation

4.1.1 Recommended Spacing
(GHCP&PHHT20: Q10)

- Short Varieties: $3 \text{ m} \times 3 \text{ m}$ (444 plants/acre)
- Medium Varieties: $3 \text{ m} \times 4 \text{ m}$ (333 plants/acre)
- Tall Varieties: $4 \text{ m} \times 4 \text{ m}$ (250 plants/acre)

4.1.2 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 (20-30 kgs) 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
4.2 Transplanting

- 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 at the **onset of the rains**

- However, if irrigation water is available, planting can be done throughout the year

**Banana Seedlings After Transplanting**
4.3 Crop Management
4.3.1 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 in the growing part

- The process should start 2 months after planting and be repeated every 45 days till the plant flowers
4.3.2 Propping

- It is the process of supporting banana plants which have mature or immature fruit bunches to prevent them from lodging.

- 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, Ngombe etc.
4.3.3 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 bananas 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.
4.3.4 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, uniformity of hands and reduced thrips attack

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

4.3.5 Bunch Covering (Bagging)

• Covering banana bunches with special polybag in order to protect them from being attacked by thrips and other insects

• Fasten maturing bunches
4.4 Water Requirement

(G20: 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/stool weekly (in two splits)
4.5 Managing of Weeds

(G20: Q13)

- Orchards should be kept weed-free through either **hoeing, mulching** or **herbicides**
- 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

Weed Management Through Mulching

Photos: SHEP PLUS
4.6 Top-dressing (2/2)

4.6.1 Top-Dressing by Fertilizer

- Fertilizer should be applied twice a year during the rainy season
- **Apply 200g of CAN** per stool. The top-dressing fertilizer should be applied in a band **60cm** away from the plant.
- Or, an **NPK** fertilizer rich in **K** such as **Mavuno Banana (10-3-20+TE)** **250g** per stool.
- **2 – 4 debes (20-40 kgs)** of well 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.
4.7 Pest & Disease Control
4.7.1 Major Pests

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

A. Burrowing Nematode
B. Banana Silvering Thrips
C. Banana Weevil Borer
D. Moles
E. Fruit Fly
F. Banana Aphids
4.7.1.A: Burrowing Nematodes

- 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 plants, especially in windy conditions 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®)
4.7.1.B: Banana Silvering 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
- High concentration in male flowers

**Control**

- **Removal of male flowers**
- **Covering** of bunches/ Bagging
- Use of **insecticides** such as
  - Deltamethrin (Decis 2.5 EC®)
  - Pirimiphos-Methyl (ACTELLIC 25EC®)
4.7.1.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

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

Weevil damage on a banana corm
4.7.1.C: Banana Weevil Borer

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

Photo: © A.M. Varela, icipe (CC BY-NC-SA 3.0)
http://www.infonet-biovision.org/PlantHealth/Crops/Bananas
4.7.1.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**

Damage:
- **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**

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A Mole making tunnels at the base of Banana stool

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)
4.7.1.E: Fruit Fly

**Description:**
- Two species; *Bactrocera invadens* and *Ceratitis rosa*.
- *Bactrocera invadens* is 2-3mm long prevalent in Kenya and Sudan.
- It is a major pest that leads to rejections in the export market.

**Damages:**
- Fruits show small wet spots with back holes at the centre.

Damage On Green Banana fruits

_Fruit fly (Bactrocera invadens) attack on green banana_
(c) M. K. Billah, icipe (CC BY-NC-SA 3.0)
4.7.1.E: Fruit Fly

Control

- **Hygiene** - remove and destroy infested bananas
- Bagging using polyethylene

*Fruit fly* (*Bactrocera invadens*) attack on green banana
(c) M. K. Billah, icipe  (CC BY-NC-SA 3.0)
4.7.1.F: Banana Aphids

Identification:
- It is a small aphid about 1-2 mm long and blackish-brown in colour.
- Colonies are usually present on the base of young leaves.

Damage:
- The direct damage caused by aphids sucking the plant sap is negligible. However, they are important pests as vectors of the virus causing the bunchy-top disease.

Control:
- Conserve natural enemies. They are important in natural control of aphids.
- Monitor the crop regularly.
- Spray insecticides such as Lambda Cyhalothrin (Karate Zeon®), Oxydemeton-Methyl (HATTRICK EC®).

Photo: Scot Nelson, Public Domain Mark 1.0
https://www.flickr.com/photos/scotnelson/21723079161

Banana Aphids, vector of Banana bunchy top virus (BBTV)
4.7.2 Major Diseases

- The following are the major diseases of bananas in Kenya:

  a. Panama Disease (Fusarium Wilt)
  b. Black Sigatoka
  c. Cigar-end Rot
  d. Banana Bacterial Wilt
  e. Bunchy Top Disease
  f. Anthracnose Disease
4.7.2.a: Panama Disease

3-24a

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

3-24b

Photo: SHEP PLUS

Photo: © Rose Kamau, MOALF 2019
4.7.2.a: Panama Disease

General Description:
- A soil-borne disease also known as “Fusarium Wilt”
- Fungus attacks roots and blocks vascular system causing wilt

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, or, stem cracks before falling
- Internally, there is vascular discoloration in the outer leaf sheath
- 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
4.7.2.a: Panama Disease

Control:
- Use of resistant varieties, such as Giant Cavendish, Lacatan or FHIA hybrids
- Use disease-free material (Tissue Culture and clean suckers)
- Observe quarantine
4.7.2.b: Black Sigatoka/ Black Leaf Streak (1/2)

General Descriptions:
- A fungal disease that destroys banana leaves
- 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 50% or more

A Banana leaf with symptom of “Black Sigatoka” infection

Photo: ©Scot Nelson (CC: BY 2.0)
https://www.flickr.com/photos/scotnelson/29608954871
4.7.2.b: Black Sigatoka/ Black Leaf Streak (2/2)

Control:

- **Cultural practices** such as removal of infected 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
- Avoid overhead irrigation
- Chemical control with fungicides such as Mancozeb (DITHANE M-45®) or Thiophanate-Methyl (TOPSIN M Liquid®)

Photo: Ko Ko Maung, Bugwood.org, (CC BY-NC 3.0 US)

A Banana leaf with symptom of “Black Sigatoka” infection
4.7.2.c: Cigar-end Rot

General Description:
- 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** looking like a **cigar**

Control:
- Field hygiene and removal of excess suckers
- **Male flower bud should be removed at** 15 cm **below the last hand after completion of bunch formation**
- **Use of fungicides**, such as
  - Propineb (Antracol WP70®)
  - Thiophanate-Methyl (Topsin M Liquid®)
  - Mancozeb (Dithane M-45 WP®)
4.7.2.d: Banana Bacterial Wilt

*Xanthomonas* Wilt-infected banana pseudo-stem

Banana fruit infected with *Xanthomonas* “Bacterial Wilt”

Photo: © Rose Kamau, MOALF 2019

Photo: © IITA (CC BY-NC 2.0) https://www.flickr.com/photos/iita-media-library/6755031667/in/photostream/
4.7.2.d: Banana Bacterial Wilt

General Description:
• 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 infected plants
• **Disbudding of male flower bud** after fruiting
• Observe **quarantine**
• Use **clean** planting materials
4.7.2.e: Bunchy Top Disease

Description

- **Virus disease** transmitted by aphids at any growth stage

Symptoms

- Starts as dark green dots/streaks on the minor veins or midrib
- Successive leaves become smaller, chlorotic with upturned margins
- Leaves dry, brittle and erect giving a rosetted “bunchy top” appearance
- Severe in newly planted suckers
- No flowering or very small bunches

Control

- Control **Aphids**
- **Rogue** and destroy infected plants
- Use **virus-free** planting material

© Pearson, M.N. Courtesy of EcoPort, www.ecoport.org
4.7.2.f: Anthracnose Disease

**Description**
- An important Post-harvest disease especially in transit

**Symptoms**
- Pin-size brown/black sunken spots on green fruits
- Spots’ centres darken (fruiting bodies)
- Masses of spores produced with a characteristic salmon (pinkish) colour under moist conditions.
- Pulp not affected unless over-ripe

**Control**
- Good field sanitation
- Minimize bruising in the post-harvest
- Hot water treatment (50°C for 5 mins) on fruits
5. Harvest

Harvested banana bunches ready for transport to the market

A harvested bunch of bananas on display
5. Harvest

5.1 Harvesting Indices (G20: Q17)

- **Fruit Size**: length and volume of fruit increases as fruit matures
- **Fruit Shape**: 
  - At early stage 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 peel changes from deep green to light green or yellow
  - The pulp color changes from cream to orange yellow

5. Harvest

- 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
6. Post-Harvest Handling

6.1 Containers & Packaging Materials (G20: Q18)

- Bunches must be handled gently to avoid bruising
- Farmers usually transport and market their bananas while in form of 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

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

- Sorting: Remove undesirable fruits such as those with thrips/ mechanical damage, rust damage and severe latex staining
- Processing:
  - There are many products which can be made from Bananas
  - Some of these products include flour, juices, chips/crisps, jams/jelly, sweets and wine
7. Post-Harvest Handling

Banana bunch being weighed before selling
Reference

- The proposed agrochemicals are in accordance with “Products Registered for Use on Crops Version 1_2018”. The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Product Board.
- Infonet Biovision (https://www.infonet-biovision.org/PlantHealth/Crops/Bananas)
THANK YOU

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GOZAIMASU

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