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

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

MANGO 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

Mango (Embe)
1. Introduction:

1.1 Background

- Mango is a member of the *Anacardiaceae* family which includes plants such as *Cashew*, *Pistachio Nut* and *Pepper tree*
- It is best adapted to a **warm tropical climate** with a dry season (**>3 months**) followed by rains
- Most important considerations for Mango production are a **dry period at flowering** and **sufficient heat during ripening**
- Main fruit seasons in Kenya are from **November to April** and **May to July**
- The main export markets for Kenyan mangoes is the **Middle East countries**
1. Introduction:

1.1 Background Cont’

- The fruit can be used as fresh fruit, juice, puree, jam, chutney, pickles, canned or dried.
- The fruit contains almost all known vitamins and many essential minerals including Thiamine, Niacin, Ca, Fe etc.
- Mango fruits of various cultivars differ greatly in shape, size, appearance and internal characteristics.
- The quality of fruit is based on scarcity of fibre, sweetness and minimum turpentine taste.
1.2 Common Varieties

“Apple”

“Kent”
1.2 Common Varieties

“Apple”

- The fruits are medium to large, nearly round in shape and have a rich yellow/orange to red colour
- The skin is smooth and thin, the juicy yellow flesh has excellent flavour and a melting texture virtually free from fibre
- **Average Length:** 9.7 cm with a width of 11 cm
- **Weight:** 397g (medium/large)
- **Harvesting Periods:** Oct to Mar and May to Jul
- **Advantages:** Early cultivar of excellent fruit quality, small/medium seed size, free from fibres
- **Disadvantages:** Susceptible to Anthracnose and Powdery Mildew, Alternate Bearing, range of altitude adaptation is limited

http://www.cglrc.cgiar.org/icraf/mangoBook/default.htm#Description_of_Mango_Cultivars.htm
1.2 Common Varieties Cont’

“Kent”

- The fruits are large & ovate with a greenish-yellow skin, red or crimson blush shoulders and a rounded base shape
- The skin is thick and tough with small numerous yellow lenticels; the flesh is juicy, melting, deep yellow, fibreless and of a rich flavour
- **Length:** 12.4 cm with a width of 9.7 cm (Large)
- **Weight:** 545 g (Large)
- **Advantages:** late maturing, fibreless and of excellent internal quality. Fruits ship well
- **Disadvantages:** skin coloration is often inadequate, prone to storage diseases, may exhibit alternate bearing

http://www.cglrc.cgiar.org/icraf/mangoBook/default.htm#Description_of_Mango_Cultivars.htm
1.2 Common Varieties Cont’

“Tommy Atkins”

“Ngowe”

Photo: By Asit K. Ghosh Thaumaturgist - (CC BY-SA 3.0), https://commons.wikimedia.org/w/index.php?curid=9833525

Photo: SHEP PLUS
1.2 Common Varieties Cont’

“Tommy Atkins”

- The fruits are **medium to large**, oval to oblong longer than broad, **orange/yellow** with a heavy red blush, **numerous white lenticels** and a broadly rounded base
- **Resistant** to anthracnose and powdery mildew
- The smooth skin is **tough and thick**
- **Average Length:** 12.6 cm with a width of 9.9 cm
- **Average Weight:** 522 g
- **Early to mid-season** cultivar
- **Advantages:** very attractive fruits, excellent shipping and shelf-life qualities, consistent producer, good resistance to Anthracnose and Powdery Mildew
- **Disadvantages:** danger of internal breakdown (jelly seed), fibre content is slightly higher than average
1.2 Common Varieties Cont’

“Ngowe”

- The fruits are large, slender, oblong longer than broad with a very prominent hook-like beak at the apex
- The deep yellow flesh is of excellent quality, virtually fibreless, melting, and carries no turpentine taste
- **Average Length:** 14 cm with a width of 9.5 cm
- **Weight:** 523 g (Large)
- **Harvesting Periods:** November – March
- **Advantages:** Good to excellent fruit quality, moderate tree size, good shipper, seed propagation possible (polyembryonic), Excellent for processing
- **Disadvantages:** Susceptible to Powdery Mildew, tendency of alternate bearing

http://www.cglrc.cgiar.org/icraf/mangoBook/default.htm#Description_of_Mango_Cultivars.htm
1.2 Common Varieties Cont’

“Keitt”

“Van Dyke”

“Sensation”

“Haden”

“Maya”
1.2 Common Varieties Cont’

Other varieties grown in Kenya are:

- **“Keitt”:** Large, ovate & plumb, rounded base shape and without a beak. **Average Length:** 11.7 cm by 9.2 cm in wide. **Weight:** 456 g (Large).

- **Advantages:** Late maturity, good marketing qualities and productivity, fair resistance to Anthracnose

- **“Van Dyke”:** Ovate shape, bright yellow ground colour with a heavy crimson blush and prominent beak.

  - **Average Length:** 10.5 cm by 7.9 cm in width. **Weight:** 280g (Small/Medium).

- **Advantages:** Good resistance to Anthracnose and Powdery Mildew, regular bearer
1.2 Common Varieties Cont’

• “Sensation”: Oval/oblique, deep yellow colour with a prominent dark-red to purple blush. **Average Length: 10.8 cm by 7.8 cm in width.** **Weight: 307g** (Medium).

• **Advantages:** Beautifully coloured late cultivar, none to scanty fibres, heavy yielder

• “Sabine”: Elongated, bright yellow colour with a dark red blush. **Average Length: 14.2 cm by 6.6 cm in width.** **Weight: 435g** (Medium/large).

• **Advantages:** Only slightly affected by Anthracnose and Powdery Mildew, no distinct biennial bearing, no fibres
1.2 Common Varieties Cont’

- **“Haden”**: Bright yellow colour with deep crimson or red blush, numerous large whitish/yellow glands. **Average Length**: 10 cm by 8 cm in width. **Weight**: 431g (Medium/large). **Advantages**: Excellent fruit quality, suitable for commercial plantings, good shipper.

- **“Maya”**: Ovate and plumb, yellow colour with a reddish blush. **Average Length**: 10.3 cm by 7.8 cm in width. **Weight**: 295g (Medium). **Advantages**: Resembles Haden, good to excellent eating quality.
1.3 Optimal Ecological Requirements

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<table>
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<tr>
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<tbody>
<tr>
<td>Altitude</td>
<td>0 – 1,500 meter above sea level</td>
</tr>
<tr>
<td>Rainfall</td>
<td>500 – 1,000 mm of rainfall annually</td>
</tr>
<tr>
<td>Growing Temperature</td>
<td>24 – 27 °C</td>
</tr>
<tr>
<td>Soils</td>
<td>• Sandy, loam, black cotton and even murrram soils</td>
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<tr>
<td></td>
<td>• Well drained, deep soils</td>
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<tr>
<td></td>
<td>• pH range 5.5 – 7.5</td>
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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 Soil and Leaf Analysis

• **Leaf analysis** when the trees are dormant is also recommended

• Leaves collected must be **fully expanded** and “hardened off” i.e. green not red or pink

• The leaves selected should come from **the end of the branch**, the 3\(^{rd}\) and 4\(^{th}\) leaf from the terminal bud

• **About 24 leaves from each tree** are needed for a sample
3.2 Land Preparation

A group facilitator demonstrating how to prepare planting holes

Size of Planting Hole

Photo: SHEP PLUS

Source: Trees and their management (IIRR, 1992)
3.2 Land Preparation
(GHCP&PHHT20: Q6)

3.2.1 Land Clearing

- Slashing weedy fields and removal of stumps of shrubs
- In some cases, hoeing to loosen the soil is done before planting/transplanting
- On a slope if irrigation is required, construction of drainage channels and choice of proper orchard layout system (square, hexagonal etc.) are done
- In wind prone zones, the planting of windbreak rows of fast growing trees is necessary ideally 2 – 3 years before establishment of the orchard
3.1.2 Recommended Spacing (GHCP&PHHT20: Q10)

- **Spacing:** Range from 9 x 9 m to 13 x 13 m depending on growth characteristic of the individual variety, the type of soil, and agro-ecological conditions
- **Closer Spacing:** 6 X 4 m or 5 X 5 m could be used, however, alternate plants should be removed once overcrowding starts to set in
- **Hole Size:** 60 x 60 x 60 cm. Separate the topsoil and the subsoil
3.2 Land Preparation Cont’

3.2.3 Basal Application (GHCP&PHHT20: Q8)

• After the preparation of planting holes, apply manure/compost and basal fertilizer. Mix thoroughly with topsoil

Application rate:

• Topsoil is mixed with two debes (40 kg per hole = 4 tons per acre) of well decomposed manure and 125 g of TSP or DSP before refilling the hole

• Allow mixture to settle before planting the seedlings
3.3 Raising Seedlings

Source: SHEP PLUS

A Mango Nursery
3.3 Raising Seedlings
(GHCP&PHHT20: Q9)

3.3.1 Nursery Site Selection:
• Nearness to quality water source
• Good drainage
• Security against animals, thieves etc.
• Accessibility to the road
• Availability of wind breaks (Casuarina, Grevillea etc.)

3.3.2 Nursery Establishment:
• Prepare a seedbed of width 1 m and a desirable length by removing farm soil from the seedbed to a depth of 30 cm and refill the 30 cm depression with sand
3.3 Raising Seedlings Cont’

3.3.3 Seed Preparation:

- Pick fruit **from the tree** rather than from off the ground
- Seeds must be taken from **ripe fruits** of mature, healthy and vigorous trees
- Mango seed should be **healthy, fresh** and **not dried** at the time of planting
- Cultivars used as **rootstocks** are: Peach, Sabre, Sikio punda and Dodo

Photo: Asit K. Ghosh Thaumaturgist - Own work (CC BY 2.0) https://commons.wikimedia.org/wiki/File:Mango_Alponso06_Asit.jpg#/media/File:Mango_Alponso06_Asit.jpg

An extracted seed of mango
3.3 Raising Seedlings Cont’

3.3.3 Seed Preparation Cont’:

• Place seeds into a bucket filled with water, then separate **floating seeds** (poor seeds) with those which sink

• Remove the **hard woody endocarp** to accelerate germination

• Make a small cut at the **distal end of the seed**

• Pull the **husk** away to get the seed **without damaging the embryo**
3.3 Raising Seedlings Cont’

3.3.3 Seed Preparation Cont’:

- Wash the de-husked seeds and dry in the shade for a few days
- Cut off any damaged parts of viable seeds
3.3 Raising Seedlings Cont’

3.3.4 Sowing Seeds:
• Seeds can be sown in nursery beds (sand),
• Sow the seeds at a spacing of 15 cm x 30 cm, 5 cm deep, with the flat basal side downward
• Seedbed should be *mulched* and *watered regularly*
3.3 Raising Seedlings Cont’

3.3.5 Transplanting

Preparation:

- Use forest soil to prepare the potting media (where forest soil is not available, solarized top soil should be used)
- Top soil can also be mixed with well decomposed manure and sand at a ratio of 4:1:1

Appropriate Time:

- Seeds germinate and seedlings emerge 10 – 14 days after planting
3.3 Raising Seedlings Cont’

3.3.5 Transplanting cont’d

- About **4-5 weeks after emergence**, seedlings have **5 to 6 reddish/coppery leaves**, **10 cm high** and ready for transplanting.
- Seedlings are carefully **lifted** with their stones attached and **separated from one another**.
- **Weak plants** with twisted tap roots or stems are not used.
- Transplant in perforated **appropriate potting bags** (eco friendly bags) (15 x 22 cm) or **tins with holes at the base** at least 15 cm deep.
3.3 Raising Seedlings Cont’

Nursery Management:

• **Fertilizer application** (DAP, CAN) results to scorching (burning) of leaves and should only be applied by knowledgeable nursery operators.

• **Foliar feeds** are a better alternative and application should start **3 weeks after potting**.

• Ensure **regular watering** i.e.) not excess nor too little.
3.3 Raising Seedlings Cont’

Nursery Management Cont’:

• Avoid formation of hard pans on the potted plant by regularly pricking the soil with a sharp stick
• Scout regularly for pests and diseases
  - **Common Pests**: Aphids, Leaf Miners, and White Flies
  - **Common Diseases**: Powdery Mildew, Dieback, and Damping-off in case of excess watering
3.3 Raising Seedlings Cont’

3.3.6: Grafting

Grafting Materials:

1) Rootstock

• The rootstocks is ready for grafting when it is about 5-10 mm thick or pencil thickness and about 20-25 cm above soil level

• Grafted seedlings are ready for planting out to the field after 4 – 6 months
3.2 Raising Seedlings Cont’

Grafting Materials Cont’:

2) Secateurs

3) Grafting Tape

- In the absence of the grafting tape use transparent 20 microns poly bags. Use of black poly bags should be avoided as this encourages desiccation

4) Disinfectant

- A solution can be prepared by mixing 2 ml of “Jik (breach)” in 1 litre of water

5) Plastic Container

6) Grafting Knife or Surgical Blades (size 24)

7) Biodegradable/Eco-bags
3.2 Raising Seedlings Cont’

Grafting Materials Cont’:

8) Scions

- Take scion wood with healthy well developed vegetative shoot with no flower buds
- Shoot buds are long and pointed while flower buds are round and fat
- The plant from which scion is taken must be true to type
- Scions should be collected during dormant stages
- Do not cut buds which have started to grow
- The scion wood should be one year old (growth of previous season)
3.3 Raising Seedlings Cont’

3.3.7: Grafting Techniques:

“Cleft/Wedge Graft”

“Bark Graft”

“Side Graft”

“Whip Graft”
3.3 Raising Seedlings Cont’

Preparation for Grafting Exercise

• Cut the grafting tape into strips of 4 cm x 30 cm
• Dip the secateur, grafting strip, grafting knife into the disinfectant for 5 – 10 minutes before use
• Decide on the method of grafting
“Cleft/ Wedge Graft”
• Gives a stronger graft union

How to do cleft grafting:
• Select and prepare your bud stick/scion
• Cut them about 15 cm long
• Remove all the leaves carefully
• The cut bud stick should be the same thickness as the rootstock stem
3.3 Raising Seedlings Cont’

How to do cleft grafting Cont’:

• With a very sharp knife, cut the bottom of the budstick with two sloping cuts 3 ½ cm long (A)

• Cut off the top of the rootstock about 30 cm above the soil

• Make one straight cut about 3 cm deep in the top of the rootstock (B)
3.3 Raising Seedlings Cont’

How to do cleft grafting Cont’:

• Push the scion firmly into the rootstock cut

• Leave $\frac{1}{2}$ cm of the cut scion outside the rootstock as shown (C)

• Use clear plastic tape (or cut up plastic bags) to wrap firmly around the graft (D)

• Do not remove the tape until the scion begins to grow – showing the graft has been successful

• Remove any buds which grow below the graft
3.3 Raising Seedlings Cont’

Care of Newly grafted seedlings:

- Place the grafted seedling under a shade net of about 30 – 40 % to avoid sun scorching and lay polythene paper beneath them
- If you do not have a shade net, use a poly bag to cover the seedling
- Warm environment helps formation of callus in the new joint
3.3 Raising Seedlings Cont’

Management of Grafted Seedlings:

• **Label** the variety

• **Apply** foliar feed

• Remove the grafting strip **once the graft union has healed** (visible from the swelling at the union)

• The tape is removed when **the first flush turns completely green**

• Prune taproot **once a month** to encourage development of feeder roots
3.3 Raising Seedlings Cont’

Management of Grafted Seedlings Cont’:

- Grafted seedlings should be kept under **appropriate shade** which does not allow direct rays of the sun
- The graft union should be protected from water
- Regular check for moisture content and water should be done when necessary
- Pest and disease control operation are regularly carried out
3.3 Raising Seedlings Cont’

Management of Grafted Seedlings Cont’:
• Any growth from the rootstock should be removed immediately
• The buds will start to shoot after 21 days from the date of grafting
• The shade is reduced when the tender leaves start to turn green
• The shade is removed completely when second flush takes place
3.4 Orchard establishment
Farmers can still plant seeds in situ and graft later on

3.4.1 Appropriate Time:
• Grafted seedlings are ready for transplanting out to the field after 4 – 6 months
• A mango tree must never be transplanted while it is flushing or when the leaves are still tender
• Transplant after the second flush has hardened
• Transplant at the beginning of rains or Water the holes before planting to ensure contact of the roots with moist soil
3.4 Orchard establishment Cont’

3.4.2 Transplanting:

- Carefully remove the seedling from the eco-bag
- Excavate as much soil as necessary at the centre of the planting hole to accommodate the root-ball
- Firmly cover the root-ball with moist soil
- Planting should ensure all roots are well covered and graft union is above the soil surface
- Water well and mulch
3.5 Top-dressing

Apply fertilizer evenly

30cm – 100cm

3cm – 5cm deep

Source: SHEP PLUS

Application of Fertilizer
3.5 Top-dressing (GHCP&PHHT20: Q14)

- Regular fertilizer application is necessary
- Application of fertilizer should gradually increase

<table>
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<th>Year(s) after transplanting</th>
<th>1-3yrs</th>
<th>4-5yrs</th>
<th>6-7yrs+</th>
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<tr>
<td>CAN (g)/ tree</td>
<td>240</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>DAP/TSP (g)/ tree</td>
<td>150</td>
<td>500</td>
<td>1,000</td>
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- Manure of **3 debes (60 kg)** per tree should be applied in the early years

**Application Methods:**
- Apply fertilizer and manure **around the tree canopy** at the beginning of the rains
- Incorporate it well in the soil

Source: FERTILIZER CONSUMPTION AND FERTILIZER USE BY CROP (FUBC) IN KENYA By Edwin Oseko and Tom Dienya September, 2015
3.6 Crop Management:

3.6.1 Training

• Formative training is done when the seedlings are about 1 m high
• The central leader is cut off to encourage lateral growth of branches
• 3 – 4 lateral branches are left to grow to about 40 cm and are cut off to encourage more lateral branches to grow outwards
• 4 – 5 stories are recommended
3.6.2 Pruning

- Pruning can restrict **height** and **branching**
- Mango plants should develop into strong well-shaped trees **within the first 4 years**
- Depending on the cultivar and growth pattern, **selective pruning of branches** may be required to encourage growth of **lateral branches** that better supports fruit production
3.6.3 Flower inducement

- There are several ways of flower inducement (Chemical, Smudging and physiological stress)
- Spraying the trees with 1% potassium nitrate solution when plants are dormant
- **Smudging**: burn smoky fire below the tree canopy, and allow smoke to pass through the foliage for several days
- Induce physiological stress:
  - **Deprive** the trees water for 1-2 months then **irrigate** regularly
  - **Ringing** the branches or **root pruning**
3.6.4 Smudging

Mango hygiene by smudging

Photo: (c) A. M. Varela & A.A. Seif, icipe http://www.infonet-biovision.org/PlantHealth/Crops/Mango (CC BY-NC-SA 3.0)
3.6.4 Smudging

Mango Hygiene by Smudging

• Mango smoking **reduces insect population drastically** and improves fruit setting
• It also **induces flowering** in mango trees

Method:

• Prepare **smoke pots** with **holes** in the bottom for air intake
• Put **wood shavings** or **sawdust** with a topping of **aromatic herbs** (lemongrass etc.) in the pots
• Hang the smoke pots at **strategic places** within the Mango tree
3.6.5 Intercropping

Photo: SHEP PLUS

Intercropping Mango with Tomatoes
3.6.5 Intercropping

Intercropping:

- Intercrops of short-lived fruit trees, such as papaya or annual crops, could be used for better utilization of land in widely spaced young plantations.
- Avoid intercropping with the crops which share common pest/diseases. e.g. Beans

Notes:

- Overcrowding results in the production of fewer fruits which are poorly coloured and infected with diseases.
3.7 Pests & Diseases Control: (GHCP&PHHT20: Q15 & 16)

3.7.1 Major Pests

- The following are the major pests of Mango in Kenya:
  A. Mango Seed Weevil
  B. Mango Gall midges
  C. Fruit Fly
  D. Mango Scales
  E. Mealybugs
3.7.1.A: Mango Seed Weevil

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

Mango Seed Weevil larva and adult
3.7.1.A: Mango Seed Weevil

Identification:

- The adult is 6 – 9 mm long with grayish brown colour
- Usually active after dusk
- Pretend to be dead when disturbed
- Hide on the bark of mango tree trunks

Damage:

- Feeds on leaves, tender shoots or flower buds
- The beetle lays eggs on young fruit
- Larva burrows into the flesh and destroys the seed/embryo
- No external signs of fruit damage
3.7.1.A: Mango Seed Weevil Cont’

Control:

- Collect **fallen fruits** and destroy by burying or burning
- Paint the tree trunk with **agricultural lime mixture** at flowering to prevent adult weevils from climbing up the tree
- Spray biweekly with **Deltamethrin** *(Decis 2.5EC®)*. Spray before flowering and during fruit set and repeat every 14 days focused on single fruits
3.7.1.B: Mango Gall Midge

Mango leaf damaged by the Mango Gall Midges

Photos: http://www.infonet-biovision.org/PlantHealth/Crops/Mango © A.M. Varela, icipe (CC BY-NC-SA 3.0)
3.7.1.B: Mango Gall Midge

Identification:
• The gall midges are small insects measuring about 3 mm in length

Damage
• Adults lay eggs on young tender leaves
• The larvae mine the leaves producing galls or swelling tissues/pimples
• Dark green, circular galls randomly distributed on the leaf blade
• Under heavy infestations, the leaves wrinkle and remain necrotic and eventually drops
3.7.1.B: Mango Gall midge Cont’

Control:

• **Orchard sanitation** is important

• **Clear weedy areas** since adults prefer to stay on these plants

• **Prune crowded branches** (particularly irregular branches) to allow light penetration

• **Conserve natural enemies**

• **Spray insecticides** e.g.) Deltamethrin such as Decis 2.5EC® mixed with mineral oil (mineral oil should Not exceed 2 % i.e. 400 ml in 20 L of water) as soon as new shoots and leaves appear
3.7.1.C: Fruit Fly

Left: Fruit Fly larvae and adult

Right: ADD Trap
3.7.1.C: Fruit Fly

Identification:

• Adult fruit flies are small, about 4 to 7 mm long, dull brownish-yellow to brownish-black with red eyes in some species

• Yellowish flies that are commonly attracted to fermenting fruit of all kinds

• Fruit flies lay eggs under the skin of mature and ripening fruits

• Eggs hatch in 1 – 2 days

• Larvae are about 6 – 7 mm long and can be found in very ripe cull and damaged fruit in the fields
3.7.1.C: Fruit Fly Cont’

Damage:

• Fruit flies cause direct damage by puncturing the fruit skin to lay eggs
• During egg laying, bacteria from the intestinal flora of the fly are introduced into the fruit. These bacteria cause rotting of the tissues surrounding the egg.
• The eggs hatch, maggots feed on the fruit flesh making galleries. These provide entry for pathogens and increase the fruit decay
• Fruit dropping to the ground just before the maggots pupate
• Premature ripening of fruits
3.7.1.C: Fruit Fly Cont’

Control:

• Collect all fallen fruits and destroy by burying at least 50 cm deep or put them in a drum of water with 1 inch oil for 2 weeks
• Spray with Deltamethrin (DECIS2.5 EC®) etc. The chemicals can be mixed with hydrolyzed protein at a rate of 200 – 1,000 ml/tree or sugar/molasses and sprayed to act as bait
• Harvest mangoes before they become ripe
• Use of fruit fly trap such as Auto Dissemination Device (ADD) by Real IPM, Hydrolysed protein (CERA TRAP)
• Use of natural enemies, especially parasitic wasps (Diachasmimorpha longicaudata, Fopius arisanus etc.)
• Post-harvest Treatment (Hot Water Dip): Dip fruits for 5 minutes at 50 °C water
3.7.1.D: Mango Scales

White Scales on the Mango Fruits

Photos: http://www.infonet-biovision.org/PlantHealth/Crops/Mango © A.M. Varela, icipe (CC BY-NC-SA 3.0)
3.7.1.D: Mango Scales

Identification:

- Small round reddish brown to white insects
- Usually found in clusters which are immobile
- Insects can be 1 – 7 mm long while the cluster can be 2 cm in diameter
- Clusters found on upper surface of leaves, branches, stem and fruit
- Females are circular in appearance, have dark spot on one side, have neither wings nor legs
- Adult males have two wings
3.7.1.D: Mango Scales Cont’

Damage:

• Scales *suck the cell sap* from the infested areas
• Infested leaves turn *pale green to yellow eventually die and drop*
• Infested fruits have *pink blemishes and drop*
• *Poor growth and dieback of branches*
• Infested young seedlings may die
• *Honey dew* is produced which form sooty mold, thus reduction of photosynthetic capacity
3.7.1.D: Mango Scales Cont’

Control:

• Cut and burn infested tree parts

• **Use of natural enemies** e.g.) Parasitic Wasps, Ladybird Beetle, Lacewings etc.

• **Spray with insecticide mixed with white mineral oils 2%** : paraffin oil is sprayed at 3 % water emulsion. Avoid spraying mineral oil during very hot periods of the day

• Use of D-C Tron(Caltex oil) to suffocate the insects
3.7.1.E: Mealybugs

Identification:

- Mealybugs are small, flat, soft bodied insects covered with a distinctive segmentation
- Their body is covered with a white woolly secretion

Photo: ©A. M. Varela; icipe
https://www.infonet-biovision.org/PlantHealth/Crops/Mango

Mealybugs on a mango fruit
3.7.1.E: Mealybugs

**Damage:**
- They suck sap from tender leaves, petioles and fruits
- Seriously attacked leaves turn yellow and eventually dry
- This can lead to shedding of leaves, inflorescences, and young fruit
- Mealybugs excrete honeydew on which sooty mould developed.

**Control:**
- Insecticides do not generally provide adequate control of mealybugs owing to their wax coating
- Destroy affected parts at the beginning of the infestation
- Heavily infested branches may be pruned to control the pest, especially on the tender branches before flowering begins.
- Conserve natural enemies.
3.7.2 Major Diseases & Physiological Disorders

- The following are the major diseases and physiological disorders of Mango in Kenya:
  
a. Powdery Mildew
b. Anthracnose
c. Jelly seed
3.7.2.a: Powdery Mildew

Descriptions

- Caused by a fungus which survive in dormant buds
- Infection prevalent during cool and cloudy weather

![Powdery mildew on leaves (left) and panicles (right)](Photo© SHEP PLUS)
3.7.2.a: Powdery Mildew

Symptoms:

- Appears as **white powdery growth** on leaves, flowers, flower stalks, and young fruits
- The white powdery growth **turn black** later in the season
- **Grayish necrotic lesions/spots** on leaves
- Infected leaves **curl** and become **distorted**
- Infected young fruits have **purplish haze**
- Infected flowers and young fruits turn **brown** and **gray** eventually drop
- **Poor fruit set**
3.7.2.a: Powdery Mildew Cont’

Control:

• Choice of resistant varieties e.g.) Sensation, Van Dyke, Tommy Atkins
• Cultural practices e.g.) spacing, pruning, sanitation etc.
• Observe plant nutrition
• Spray 70% Neem Oil
• Pesticides: Trifloxystrobin 100g/L + Tebuconazole 200g/L (NATIVO SC 300®), Thiophanate-methyl 500g/L (TOPSIN M®)
3.7.2.b: Anthracnose

Anthracnose damage on mango fruits

Source: http://www.infonet-biovision.org/PlantHealth/Crops/Mango
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3.7.2.b: Anthracnose

Descriptions:

- Mango anthracnose is caused by the fungus during humid conditions
- Prevalent during flowering and fruit set
- The anthracnose fungus can be re-activated in response to physiological changes associated with ripening, resulting in the development of lesions with subsequent spoilage of the fruit

Symptoms:

- Occur on leaves, twigs, petioles, flower clusters (panicles) and fruits
3.7.2.b: Anthracnose Cont’

Symptoms Cont’:

On Leaves, Petioles, Twigs and Stems

• Lesions start as small angular brown to black spots that can enlarge to form extensive dead areas

• Infection of young leaf flushes may show up as lesions along the margins of the young bronze or pale green leaves, in which case they are semi-circular in shape

• In very humid weather, new twigs may show a dark affected area from the tip backwards, sometimes with defoliation of the young shoots
3.7.2.b: Anthracnose Cont’

Symptoms Cont’:

On Panicles
• **Small black to dark-brown spots** that enlarge, coalesce and **kill the flowers** before fruit set.

On Fruits
• Affected fruits develop **sunken, prominent, dark brown to black decay spots** before or after picking.
3.7.2.b: Anthracnose Cont’

Control:

• **Remove** and **destroy** dead twigs and branches
• Spray Propineb (**Antracol®**) every 14 days before and after flowering

Post-harvest Treatment:

• **Hot Water Dip:** Dip fruits for 5 minutes at 50 °C water
• Store fruits in a cool place
• Pesticides: Carbendazim 500g/L (BENDAZIM 500 SC, RONDAZIM)
3.7.2.c: Jelly Seed

Jelly Seed caused by Calcium Deficiency

Photo: © Scot Nelson https://www.flickr.com/photos/scotnelson/25272628997 Public Domain Mark 1.0
3.7.2.c: Jelly Seed

Descriptions:
• Jelly Seed is a Physiological Disorder caused by the Calcium deficiency

Symptoms:
• Degeneration of fruit pulp after harvesting fruit characterized by premature and uneven ripening of the mesocarp
• Other symptoms include internal breakdown, soft nose, stem-end cavity or spongy tissue

Control:
• Application of dolomitic lime (CaCO$_3$.MgCO$_3$) at the rate of 3.2 tones per acre per year applied once at the onset of long rains (Mar. – Apr.)
4. Harvest

Harvesting Mangoes with sticks

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

• **Maturity Period:** 12 – 16 weeks after fruit set

• **Maturity:** Some indicators of maturity include:
  – Well developed shoulders
  – Skin changes from **green** to **yellow**
  – **Colour of flesh:** The flesh around the seed turn from **white** to **yellow**
  – **Sugar content** increases

• **Harvesting:** Use secateurs. **Do not knock or drop the fruits.** Fruits should be harvested with 3 – 4 cm stalk. Drain the latex from the fruits by turning.

• **Yields:** 10,000 – 15,000kg per acre from the 7th year
5. Post-Harvest Handling

Harvested Mangoes being packed in cardboard boxes
5. Post-Harvest Handling

5.1 Containers & Packaging Materials (GHCP&PHHT20: Q18)
• For export market, pack in single layer in fibreboard cartons of 4 – 5 kg weight. The fruits per carton range from 6 – 24. The cartons should be well ventilated.

5.2 Value Addition Techniques: Sorting, Cleaning & Grading (GHCP&PHHT20: Q19)
• Sorting: Remove diseased, mis-shaped, damaged and unripe fruits and foreign matter.
• Cleaning: Cleaning with a clean damp cloth.
• Grading: According to size, colour, and texture (Class 1 & Class 11).
5. Post-Harvest Handling Cont’

5.2 Value Addition Techniques: Sorting, Cleaning & Grading Cont’

• **Pre-cooling** to slow down the metabolic processes (Temperatures 10 °C – 11.2 °C)

• Place fruits in water containing 100ppm sodium hyperchloride to remove latex and sterilizing

• **Hot Water Treatment:** Immersing the mango fruits in water bath of 50 °C for 5 minutes to minimize **Fruit Fly** damage and **Anthracnose**
5. Post-Harvest Handling Cont’

5.3 Storage
• Mature mangoes are sensitive to chilling injury
• There is impaired ripening resulting to poor colour and flavour development (Temperature 5.5 °C – 15 °C, Relative Humidity 85 % – 90 %)

5.4 Transportation
• Containers should be well stacked to avoid any movement
• Vehicles must always be covered or insulated
• Vehicles must be cushioned
• Fruits must be protected from dust, sun and rain
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- The proposed agrochemicals are in accordance with “Products Registered for Use on Crops Version 1_2018” by Pest Control Products Board. The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Product Board.
THANK YOU

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