Organic Agriculture Training Manual for Africa

A booklet for mango producers in Mali

# PRODUCING GOOD QUALITY ORGANIC MANGOES

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FiBL

You can produce high quality organic mangoes, if you manage soil fertility well and handle fruits carefully.

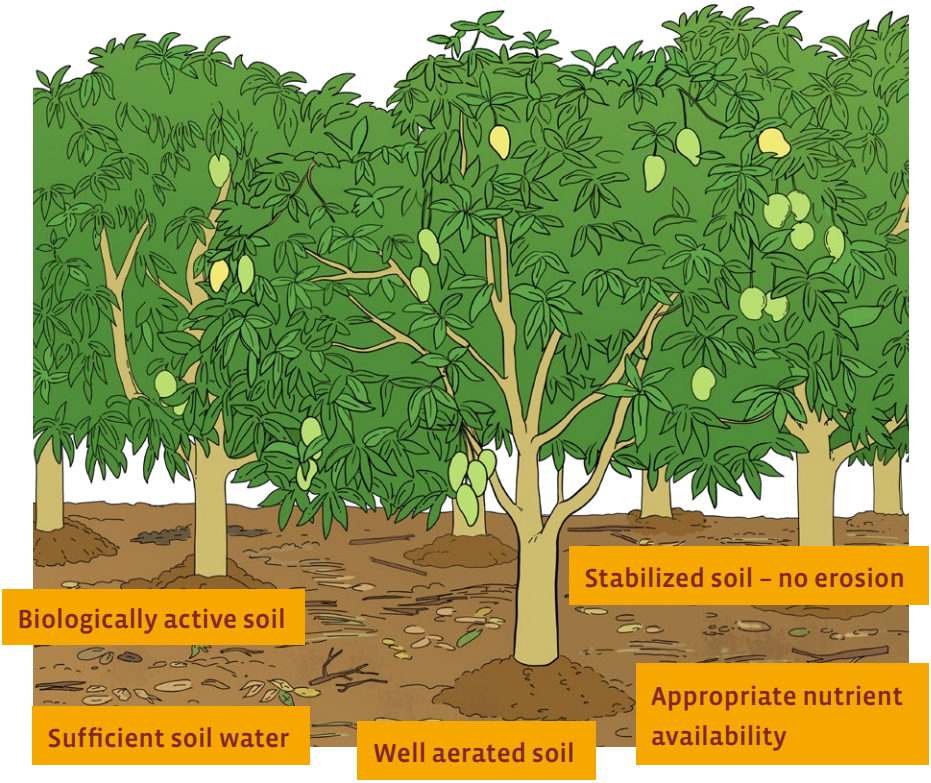
## Challenges related to production and handling of mango

- Mixed varieties
- Large, dense trees
- Bare, eroding soil
- Crop hygiene
- Pest and disease control
- Timely harvesting
- Fruit-damaging harvesting techniques
- Handling of fruits after harvest

# Creating favourable soil conditions

Covering the soil with organic materials protects it during drought, high temperatures and heavy rainfall. It creates a favourable environment for soil organisms, which contribute to good soil fertility and mango growth.

## Favourable soil conditions for mango growth




As with other crops, **good soil fertility management** contributes to quick growth of young trees, and timely and adequate flowering and fruiting of mature mango trees.

# Managing soil fertility

Soil fertility management in mango production starts with adequate soil protection.

**Step 1: Protect the soil from water loss and stabilize it from erosion**

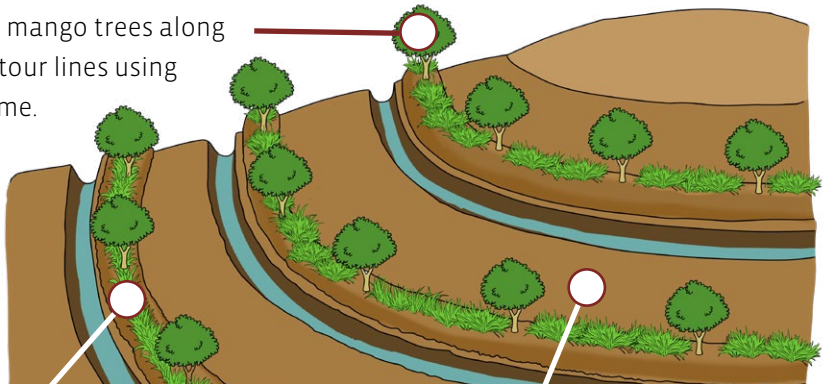
**Step 2: Improve soil organic matter content by adding composted plant materials and and animal droppings**

**Step 3: Apply permitted external fertilizers, soil amendments and irrigation to improve and balance nutrients in the soil**

# Preventing soil erosion

On moderately steep slopes, construct water catchment structures such as ridges and bunds, combined with strips of grass and/or shrubs planted on the ridges of contour lines to stabilize the soil and avoid loss through erosion.

Plant the mango trees along the countour lines using the A-frame.



Plant grass on the bunds to stabilize them.

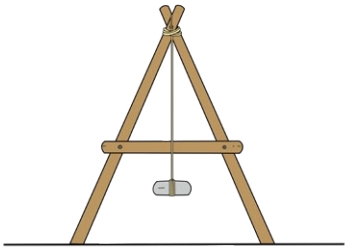
Plant annual crops between rows of mangoes.

Water pits can be dug along the contour to capture running water and encourage infiltration into the ground. Grasses or forage legumes can be planted in strips across the slope to slow down runoff. These plants can also provide food for animals, or be used as green manures to further improve soil fertility.

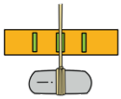
## Determine the contour lines with the A-frame

### Making the A-frame

1. Attach two 6-foot poles and a 4-foot pole together to form an “A”.

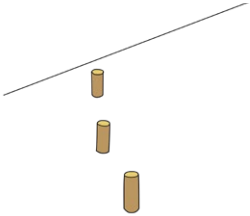


2. Tie a strong string at the top of the frame. The string should be long enough to reach beyond the 4-foot bar from the top of the frame.



3. Attach a weight to the lower end of the string. Calibrate the frame on level ground by turning the frame in both directions. Mark where the rope crosses the bar (this should be the middle of the 4-foot bar).

### Using the A-frame



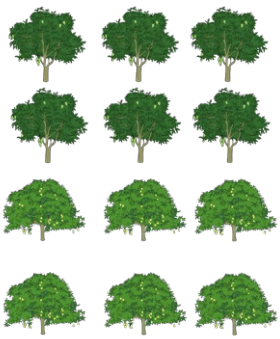
1. Start at one end of the field, where the terrace will start from. Mark that location with a peg and place one leg of the A-frame at the start point.

2. Swivel the second leg of the frame up or down the slope so that the string crosses the 4-foot bar where the mark is. Mark the location of the second leg of the frame with a peg and continue as above.

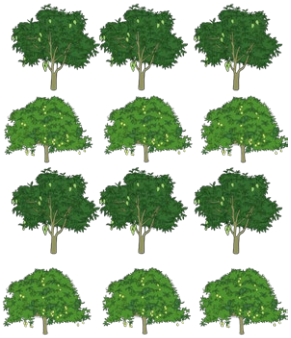
# Arranging the varieties in a practical way

If you grow different varieties on your farm, you may profit from different market requirements and a longer harvest period.
Different varieties though may require different and timely separate cultural measures.
To ensure optimal maintenance of the varieties, it is recommended to arrange them in separate orchards or in separate lanes in an orchard.
Randomly mixed varieties are difficult to manage.

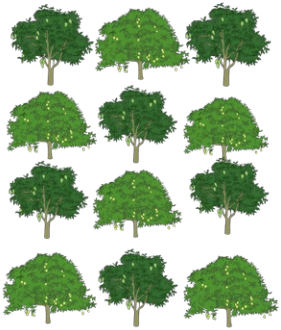
Separate orchards



Separate lanes
in the same orchard



Random mixing
of varieties



# Selecting varieties and seedlings

## Select appropriate varieties

When planting new trees, it is recommended to select improved varieties, as they will produce higher yields and satisfy the requirements of the market.

Common improved varieties are:
**Fresh mangoes for export:**
Keitt, Kent
**Dried mangoes:**
Amélie, Brooks
**Other improved varieties:**
Valencia, Bevery

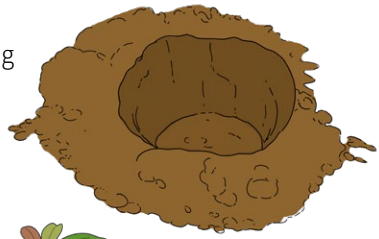

## Select healthy grafted seedlings

Use grafted or budded seedlings for quicker establishment of the trees.
Purchase quality grafted mango seedlings from a reputable nursery only.
Select healthy seedlings with no signs of pests and diseases.
The seedlings should have a size of at least 50 cm.

# Planting of new trees

## How to plant young mango trees

Before the onset of a rainy season, dig planting holes of 1 meter depth and 1 meter width and length. Recommended planting distance between mango trees in dry climates is 10 meters × 10 meters.



Before planting, re-fill the planting holes by a fourth with top soil. Add some mature compost.

Remove the polyethylene bag carefully while holding the seedling upright.

Place the seedling in the hole and fill the hole to half with top soil. Press the soil gently towards the roots of the seedling.

Pour water into the half-filled hole and allow it to drain. Then fill the hole completely with soil. Create a basin for water capture around the seedling.

## Protecting the soil at all stages

### Young trees

Cover the ground around the trees with leaves, grass, twigs, crop residues or straw. Leave the part around the trunk free to protect the seedling from fungal attack.

### In the first years

Grow seasonal crops such as beans, corn, rice, groundnuts or vegetables between the young trees.
Leave crop residues in the orchard to protect the soil.

### After a few years

When soil moisture is available, grow appropriate cover crops between the trees. They will fix nitrogen into the soil, protect it from erosion and provide organic matter to feed the soil.

# Replacing individual old trees

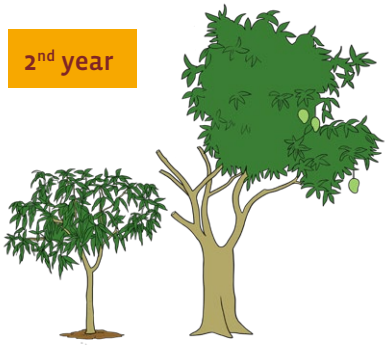
The replacement of old trees with improved or recommended varieties can be done gradually with the method described below.

**1st year**

Remove old unproductive branches on one side of the tree.

Plant a new mango tree in the row between the old trees.

**2nd year**



Continue pruning the old tree as the young tree grows.

**3rd year**

Cut down the old tree, when the young tree starts to produce fruit.

# Feeding the soil and the crop


## Apply organic fertilizers

Organic animal and plant fertilizers provide nutrients, which encourage soil organisms and are made available to trees as they grow. Compost helps to make the soil more stable and improves water retention by the soil.

### At planting

Add compost or composted manure to the hole when planting the tree.

## To trees in growth

10 t per ha per year or
4 wheelbarrows per tree

Add compost or composted manure around the feet of the growing trees every year.

## To trees in production

20 t per ha per year or
8 wheelbarrows per tree

Double the amount of compost or composted manure when the trees go into production.

## Promote nutrient availability

In case of unfavourable growing conditions such as very low pH or deficiency symptoms, supplements can contribute to better nutrient availability.

### Liquid farm fertilizers

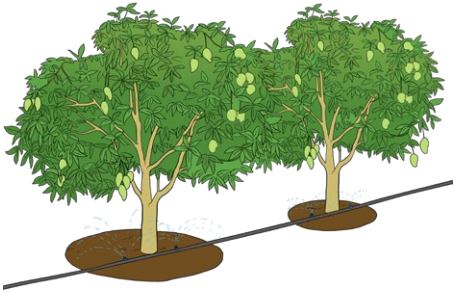
Liquid fertilizers produced on the farm such as liquid manure or plant preparations are rich in nitrogen that is easily accessible to plants.

### Lime

Lime is used to increase soil pH to improve the availability of nutrients in the soil.

### Microbial inoculations

Microbial inoculations of selected mycorrhizae and rhizobia strains can promote growth and flowering induction of the mango trees.



### Irrigation water

Adequate irrigation improves nutrient availability and encourages biological activity.

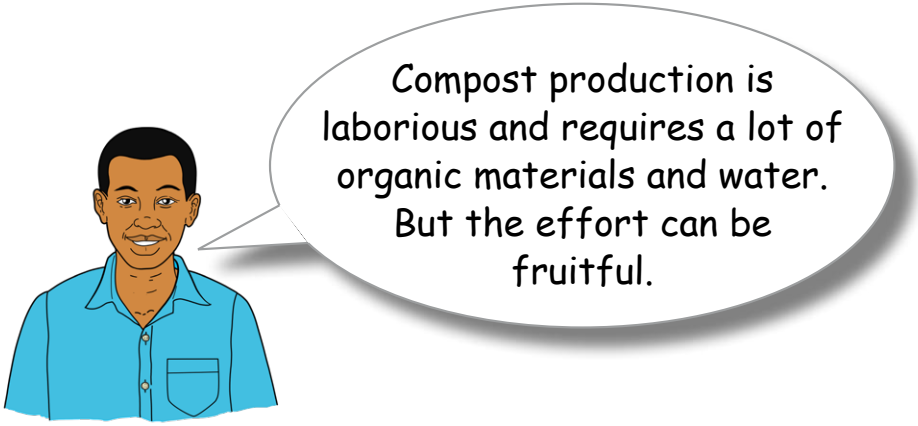
## Complement with commercial fertilizers

Selected commercial organic or mineral fertilizers can provide specific nutrients to compensate for nutrient deficiencies. As these fertilizers are expensive, their use must be carefully evaluated. In certified organic farming only natural fertilizers are allowed.

| Organic fertilizers | | | |
|---|---|---|---|
| Fertilizers | Fertilizing effect | Availability of N | Comments |
| Guano (dried seabird droppings) | N, P | ●●● | • P content higher than plant demand |
| Hoof and horn powder | N, P | ●(●) | • The finer the powder, the faster the N is available |
| Seaweed | Minerals | | • May contain heavy metals depending on origin |
| Oil cakes | N, P | ●(●) | • Examples: castor, neem or groundnut meal |
| Hair, wool, feathers | N | ●●(●) | |
| Agro-industrial by-products | N, P, K | ●● | • Must be free of significant contaminants<br>• Preferably compost before use |
| Composts | N, P, K | ● | • Must be free of significant contaminants |
| Preparations and extracts of plants | N, P, K | ●●● | • The effect depends on the original material |

| Mineral fertilizers | | |
|---|---|---|
| Fertilizers | Characteristics | Application |
| Plant ashes | • Easy supply of minerals<br>• Wood ash: rich in K and Ca | • Compost (best solution)<br>• Around the base of the plants |
| Limestone (ground limestone, algae) | • Buffers a low pH<br>• Algae: rich in trace elements | • Every 2 or 3 years when soil pH is low |
| Stone powder | • Trace elements depending on the source<br>• Better adsorbance with fine powder | • Application with manure or compost reduces nitrogen losses and promotes their decomposition |
| Mineral potassium (for ex. potassium sulphate, potash muriate, kainite, sylvanite, patentkali) | • Potassium sulphate: easily available<br>• Patentkali: high Mg and S content; easily available | • Only in the case of a proven deficiency |
| Rock phosphate (pulverized rock containing P) | • Easily adsorbed to minerals, but weakly adsorbed to organic matter<br>• Slow reaction | • To be applied to compos<br>• Do not apply to reddish soils (irreversible adsorption) and high pH soils |
| Clay | | • Requires large quantities to improve the soil |
| Sulphide | • Potassium sulphate: readily available, but can be lost by leaching<br>• Elementary sulphur: slow reaction | |
| Trace elements (inorganic or complex salts) | • Complex salts: better available for plants, but more expensive | • Applied otto the plants<br>• Onlyin case of a documented deficiency |

# Producing good compost




## Collect materials

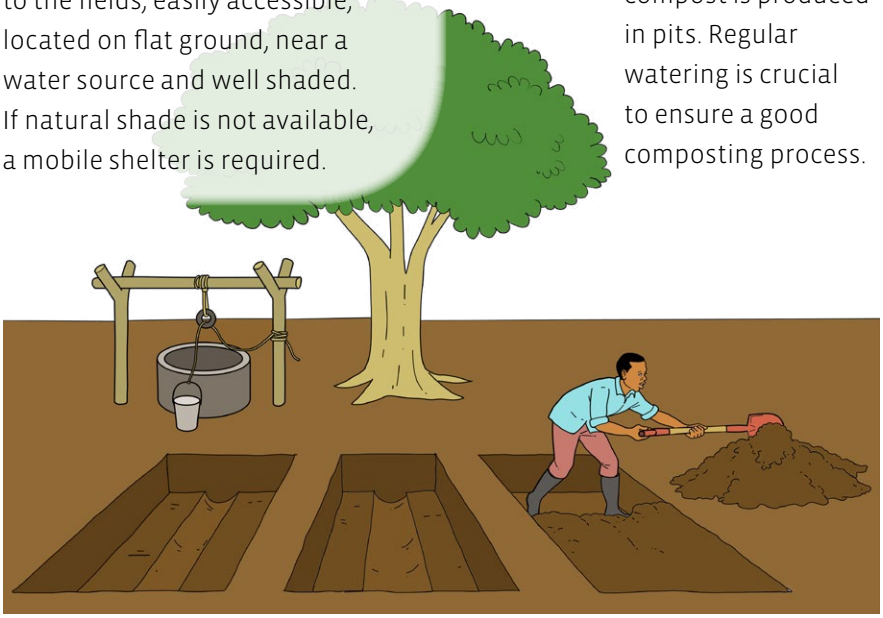
Composting requires large quantities of suitable materials.

Compost is made from equal amounts of animal manure, fresh plant material and dry plant material. Wood ash and some old compost can also be added.

## Choose a convenient site

The composting site must be close to the fields, easily accessible, located on flat ground, near a water source and well shaded. If natural shade is not available, a mobile shelter is required.

In dry climates, compost is produced in pits. Regular watering is crucial to ensure a good composting process.



## Prepare the materials

Chop the plant material to the size of a finger.

Mix the different materials.

## Stacking the materials

Fill the different materials in layers, starting with the dry material.

Check the temperature regularly with a metal stick.

When the temperature in the pile has dropped, turn the pile.

After 3 to 6 weeks, the compost is ready to use.

# Forming and pruning of the trees

## How to train the young trees

The formation of young trees serves to create a wide and well-ventilated canopy within the first three years after planting.

**1st pruning**
Cut to about 1 m to create horizontal branches.

**2nd pruning**
Leave 3 to 4 branches. Cut the branches to a length of about 50 cm.

**In the follow-up**
Cut off the tips of the branches every year.

## Annual pruning of the trees in production

Proper tree pruning after each harvest season facilitates pest and harvest control and encourages good fruit yield. An open canopy improves ventilation and exposure of the interior to light. Cutting branch tips encourages fruit production and limits tree growth.

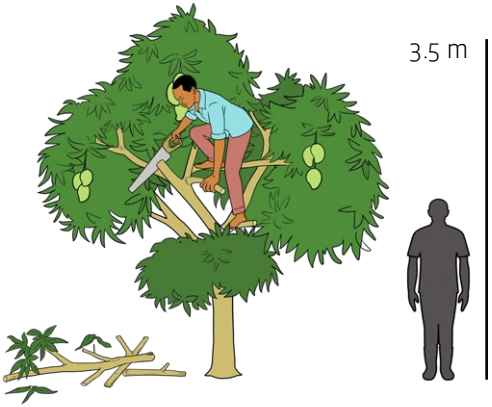
Limit the height of the tree.

Remove shading and dead branches.

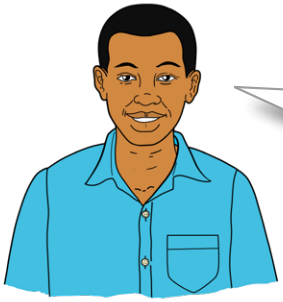
Create openings in the canopy.

Remove branches that touch the ground.

Cut off the tips of the branches.



# Controlling pests and diseases

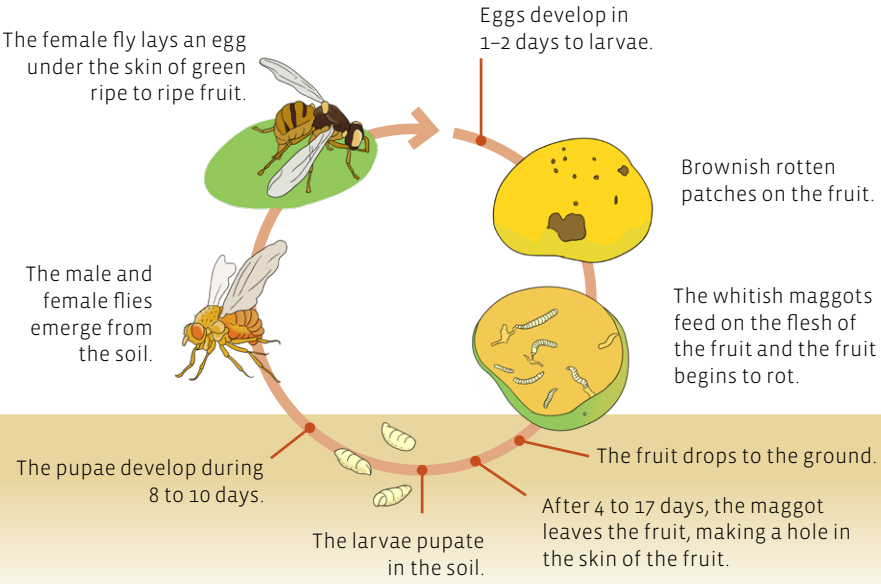


Good pre-harvest pest and disease control increases yield and improves fruit quality.

## Fruit flies

Fruit flies can cause great damage to the fruits. It is therefore very important to implement all available control measures.

### The life cycle of fruit flies




Many natural enemies such as parasitic wasps, grain beetles, weaver ants, spiders, birds and bats can contribute to fruit fly control. Especially weaver ants protect the fruit from the pest by their presence.

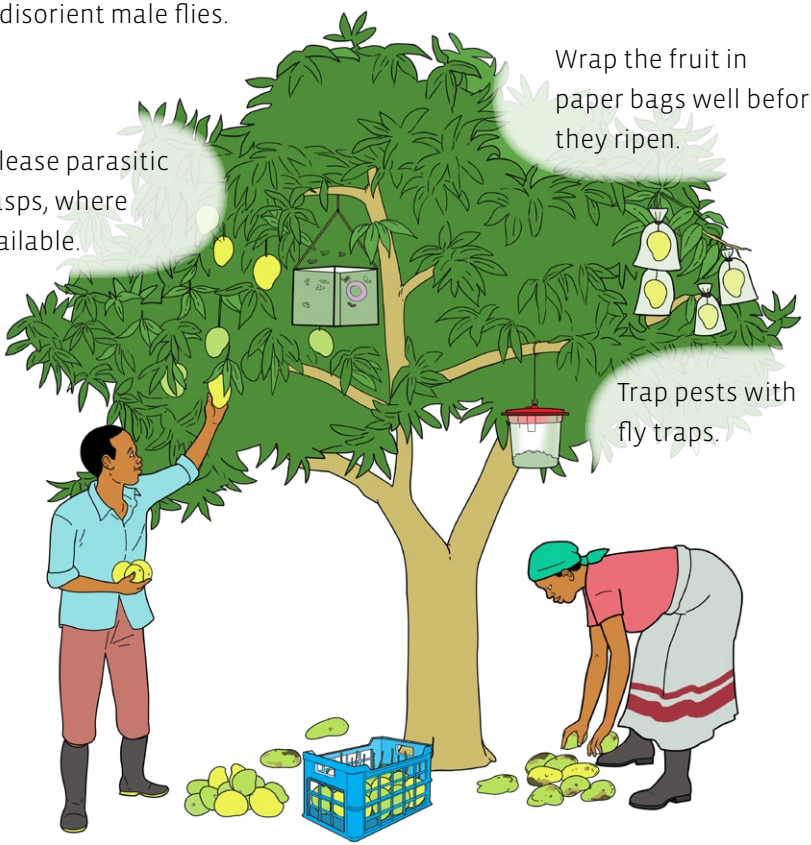
## How to control fruit flies

Continuous sanitation of orchards is important to limit the development of fruit fly populations.

Place pheromone traps in trees to disorient male flies.

Wrap the fruit in paper bags well before they ripen.

Release parasitic wasps, where available.



Trap pests with fly traps.

Pick fruits that are too ripe, as they attract fruit flies.

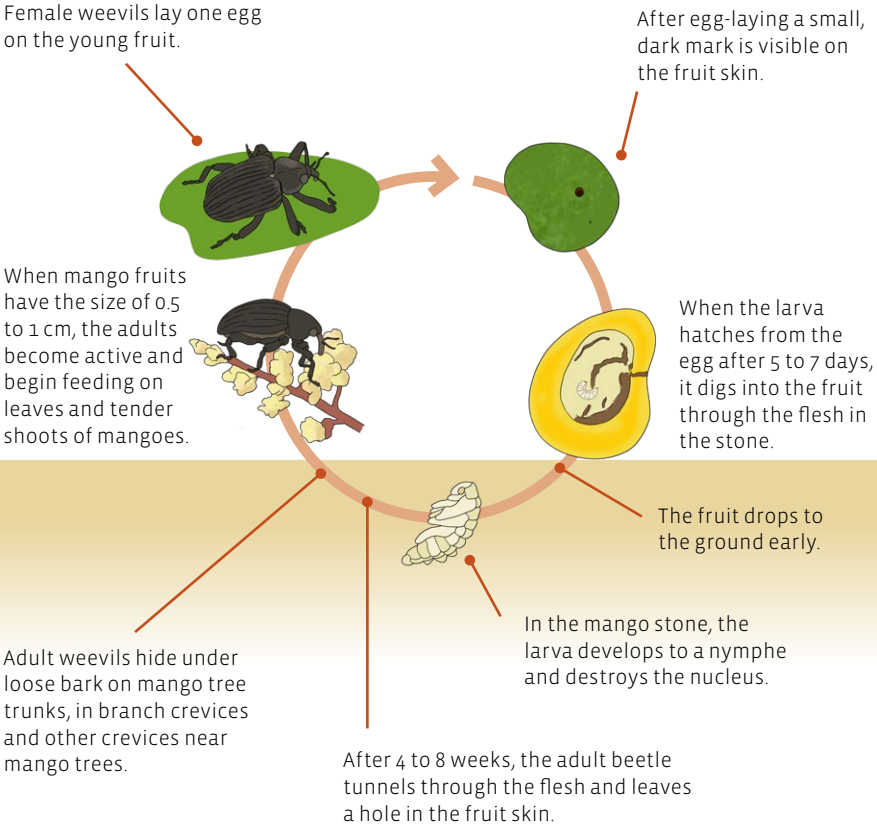
Remove dimpled fruits and those that ooze light sap.

Collect fallen fruit at least twice a week during the fruit season. Burn or bury them at least 50 cm deep.

## Mango weevil

Attacks of mango weevils (also called mango kernel or seed weevils) are often detected during storage or cutting of the fruit only, although infection happened in the field.

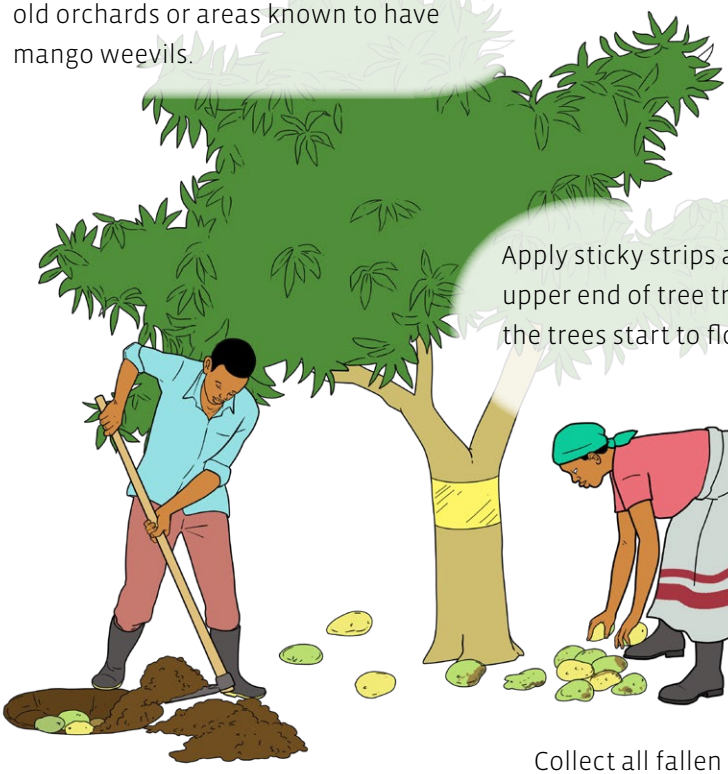
### The life cycle of the weevil



## Mango weevil control

The periodic inspection of growing fruit makes it possible to detect the pest early and remove the fruit with egg-laying marks, before the weevils infest other fruits.

Limit the movement of fruit from old orchards or areas known to have mango weevils.



Apply sticky strips at the upper end of tree trunks when the trees start to flower.

Collect all fallen fruits and scattered mango stones.

Bury the fruits and stones collected 50 cm deep in the ground.

## Anthracnose, the most important disease of mango trees

Anthracnose creates dark spots on leaves, stems and flower plumes and weakens young branches, but it is the fruit that is most damaged. Several measures are needed to reduce the pressure of the disease. Weekly monitoring of trees is essential to detect infestation symptoms as early as possible.

### Anthracnose control

Remove wild mango trees in the vicinity of the orchard.

Prune the trees each year to ensure that light and air enter the canopy.

Ensure a wide spacing between the trees.

Plant healthy plants from credible nurseries only.

Collect and burn fallen fruits, leaves and branches regularly.

In case of high disease pressure, repeated preventive applications of copper offer good protection.

At harvest, handle the fruit with care.

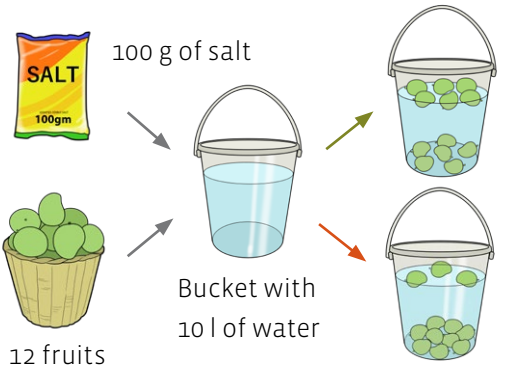
# Defining fruit maturity for harvesting

Harvesting the fruit at the appropriate stage depending on its use is important to ensure the best possible quality, to avoid high susceptibility to injury and to achieve the necessary shelf-life.

### Maturity stages of mangoes

| Not ripe | A little ripe | Ripe | Very ripe |
|---|---|---|---|
|  |  |  |  |
| • Sensitive to injuries caused by refrigeration<br>• Do not mature properly<br>• Inferior flavour<br>• Bad taste | Pale yellow flesh<br>**Maturity for export** | Visible maturity (1/4 to ½ ripe)<br>**Maturity for the domestic market**<br>**Maturity for fruit drying** | • Good taste<br>• Very sensitive to injuries and rotting<br>• Rapid loss of water and quality<br>• Short storage only<br>**Maturity for processing**<br>**Maturity for fast consumption** |

### Testing the maturity of fruits for export



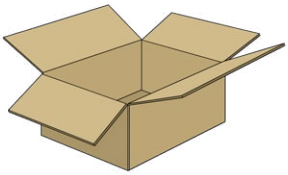
# Selecting harvesting tools and containers

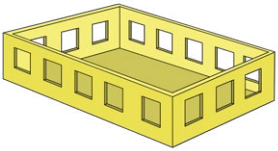
A ladder, shears and a net with a stem or a large net to catch individual fruits are essential tools for harvesting.

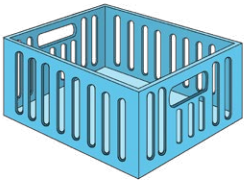
## Harvesting tools

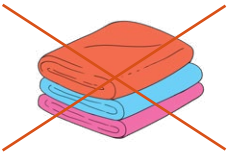
## Containers

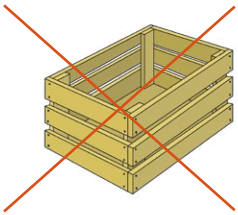
The choice of suitable containers avoids loss of quality during transport.

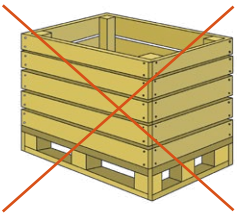






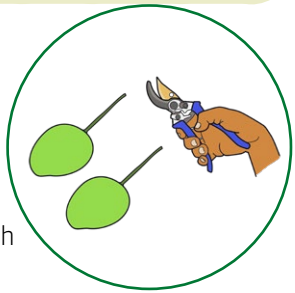






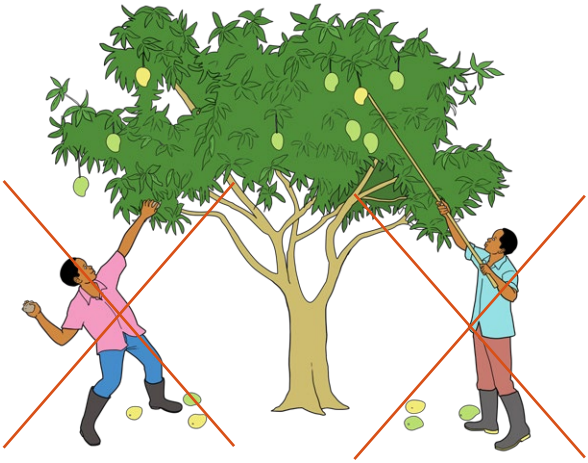
# Ensuring a careful harvest

Individual and careful harvesting of the fruit with 10 cm long stalks ensures that the products are intact and free of latex stains.



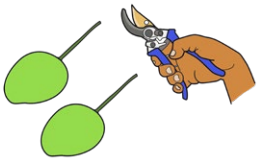
Cut the mangoes with the stalks.

Place the fruit upright without breaking the stalks.



# Handling the fruits after harvest

Good post-harvest management of the mangoes minimizes damage and contamination of the fruit. This will extend the shelf-life and ensure freshness and an attractive appearance.



Cut the stalks to 1 cm.
Remove damaged fruit.

Wash the fruit to remove the latex.

Place the fruit upside down to dry.

Organic fruits must be separated from conventional fruits at all levels of the food chain: in the field, on the farm, during transport, storage, etc.

Pack fruit in clean crates lined with cloth or leaves.


Load the fruit for quick delivery to the market.

# Knowing the quality criteria for the fruits


## Quality criteria according to the Codex Alimentarius

The fruits should be or have …

- Whole, firm, healthy and fresh in appearance
- Clean, practically free of any visible foreign matter
- Without stains or black necrotic traces
- Without significant bruising
- Without external humidity, excluding the condensation resulting from the removal from the cold store
- No damage caused by low or high temperatures
- No foreign odours and/or flavours
- No damage caused by parasites
- Sufficiently developed and of satisfactory maturity
- With stalks 1.0 cm or less in length
- With residue contents of heavy metals, pesticides and other food safety parameters according to the Codex Alimentarius

# Maintaining the orchard after harvest

Immediately after the end of the harvest, the mango orchard needs to be cleaned properly for the following season.

Collect all fallen, unusable or decomposed fruit.

Prune old, weak, shaded or broken branches and twigs.

Cut the grass around the trees.

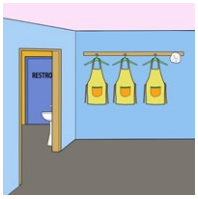
Compost the waste properly or bury it deeply.

# Ensuring proper hygiene

## What hygiene measures do workers have to comply with?

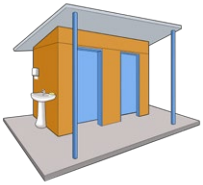
Workers inspecting and handling mangoes must be trained and must adhere to proper hygiene procedures. Workers should understand how personal and facility cleanliness reduce the risk of fruit contamination, which can have serious consequences for the business and their own jobs.

Provide access to restroom facilities, soap, single-use paper towels, and clean water at all times.



Provide a place to remove aprons, hair covers, and gloves and store them outside of the restroom.

Instruct workers to wash hands before and after eating, smoking, or using the restroom.



Monitor workers to ensure proper use of facilities.

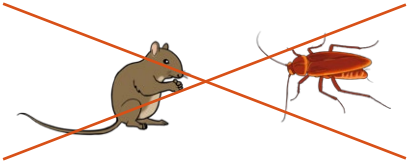
Do not allow injured or ill workers to handle fruit.

Do not allow workers to sit or stand on fruit handling containers and surfaces.

## Which measures need to be considered in the packinghouse?

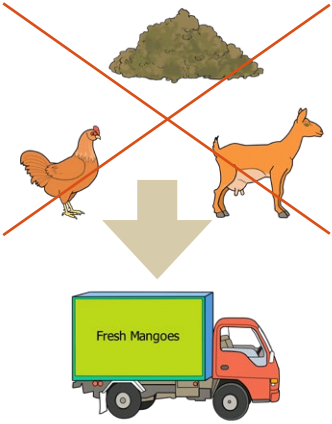
Regular cleaning and sanitation greatly reduces opportunities for pathogen buildup and inoculation to occur.

Clean and sanitize harvesting crates, packing line equipment, refrigeration units, trucks, and other equipment prior to use.



Exclude pets, rodents, birds, and insects from storage and enclosed work areas.


Separate mangoes from chemicals and other potential contaminants.




Do not transport soil, manure, chemicals, livestock, or other animals on trucks that are used to carry mangoes.

This booklet was developed for the Green Innovation Centre in Mali and was conceived for farmers.

**Imprint**

**Publisher:**
Research Institute of Organic Agriculture FiBL
www.fibl.org

**Responsible authors:**
Brian Ssebunya, Irene Kadzere, Paul van den Berge, Lina Tennhardt, Gilles Weidmann (all FiBL)

**Contributors:** Roseline Fischer (GIZ Mali), Yaya Ballo (AFC consulting), Oumar Assarki (AFC consulting), Saro Ratter (Naturland Consultant), Beate Huber (FiBL)

**Illustrateur:** Deogratius Okudi (Uganda)

Version 1.0, January 2020.



The booklet was produced by the Research Institute of Organic Agriculture FiBL in collaboration with IFOAM and Naturland as contributing partners.

The booklet was developed for the Green Innovation Center in Malawi implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) under the framework of the special initiative “One World – No Hunger” on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) of Germany.

Funding for this booklet was provided by the Global Project ‘Green Innovation Centres for the Agriculture and Food Sector’, implemented by GIZ and commissioned by the German Ministry for Economic Cooperation and Development (BMZ).