



Organic Agriculture Training Manual for Africa

A booklet for mango producers in Mali

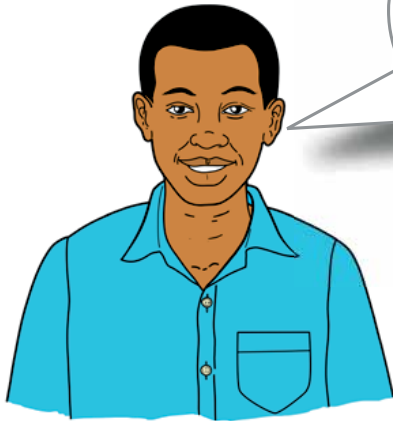
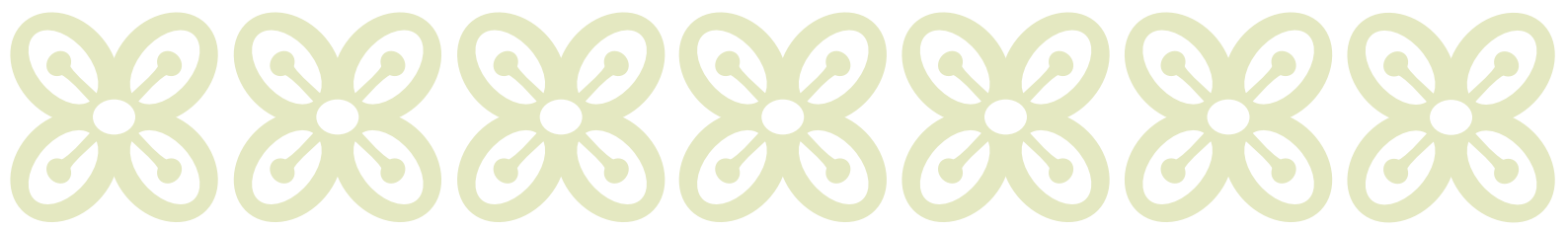
PRODUCING GOOD QUALITY ORGANIC MANGOES



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

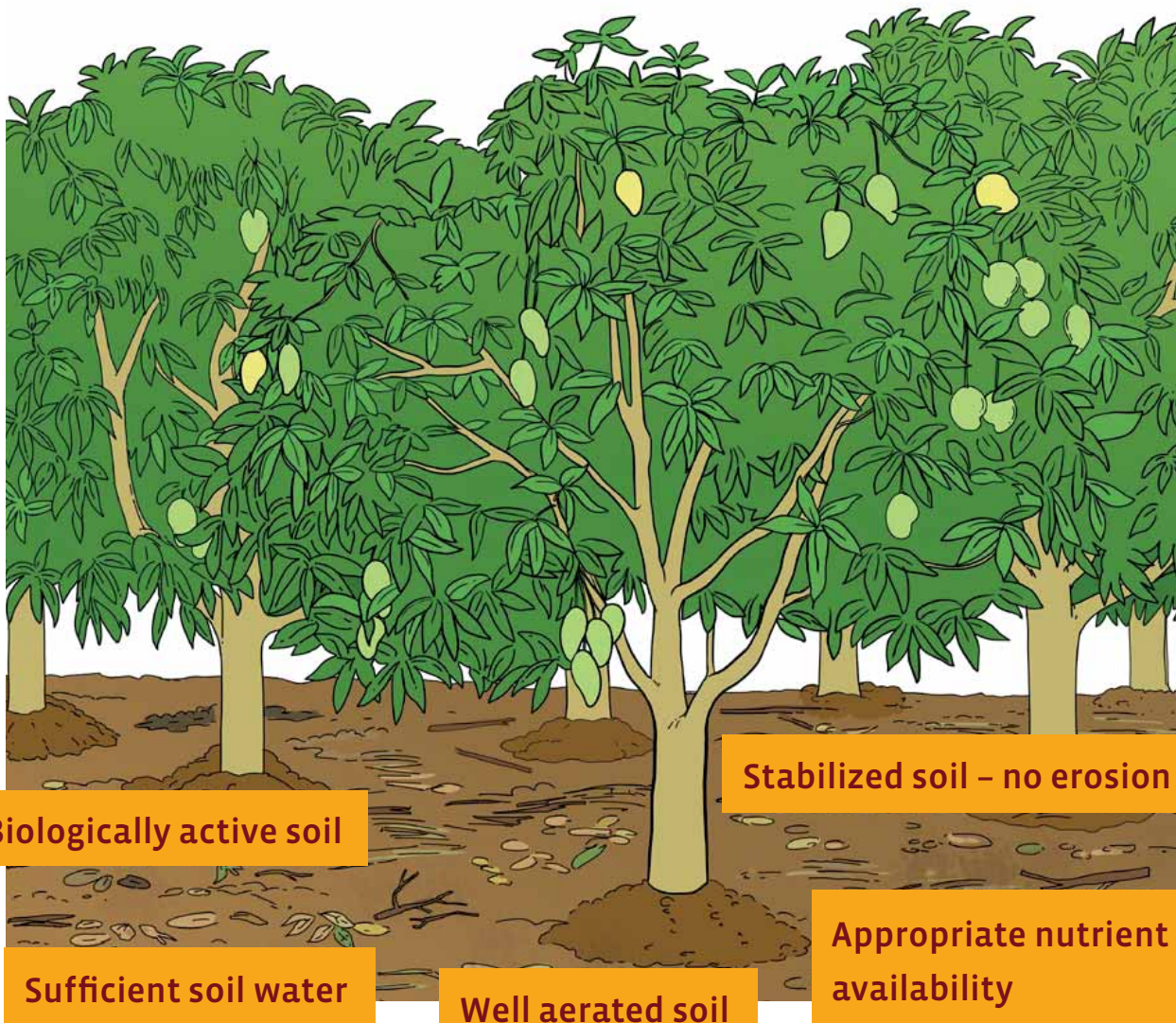
- Mixed varieties
- Large, dense trees
- Bare, eroding soil
- Crop hygiene
- Pest and disease control
- Timely harvesting
- Fruit-damaging harvesting techniques
- Handling of fruits after harvest



Creating favourable soil conditions

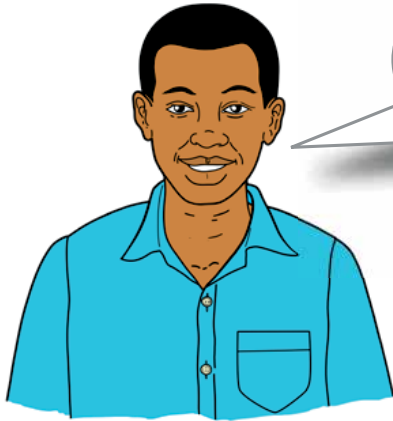
Covering the soil with organic materials protects it during drought, high temperatures and heavy rainfall. It creates a favourable environment for soil organisms, which contribute to good soil fertility and mango growth.

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 animal droppings



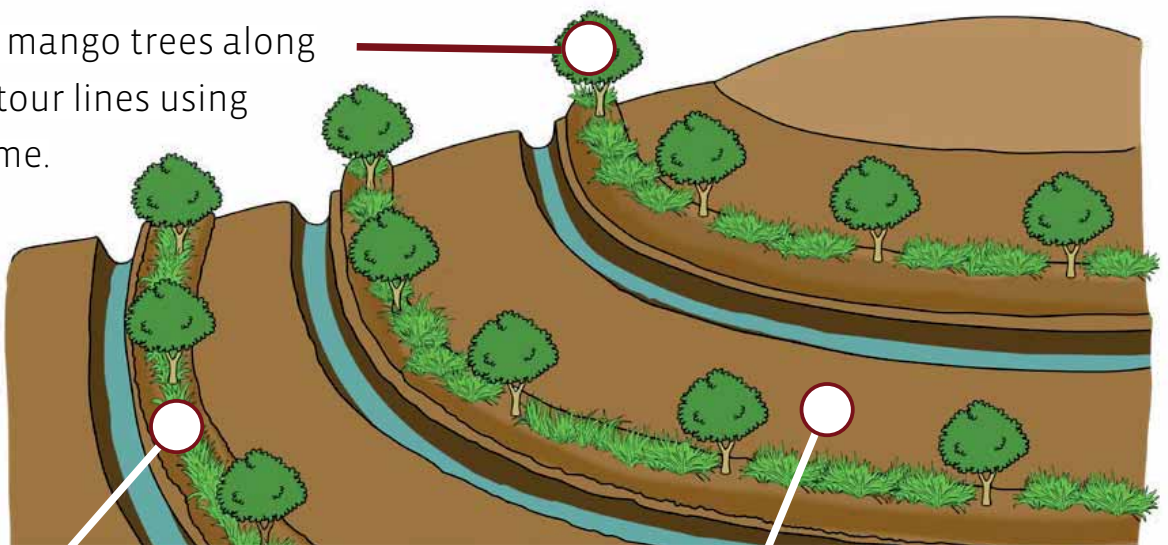
Step 3: Apply permitted external fertilizers, soil amendments and irrigation to improve and balance nutrients in the soil



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.

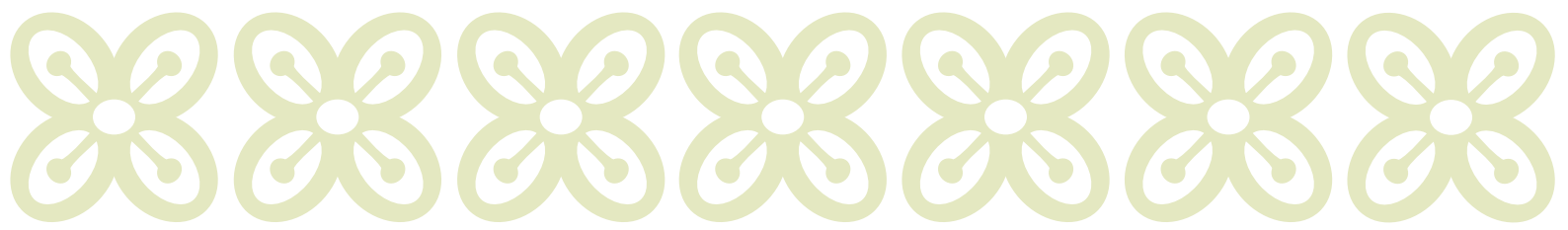
Plant the mango trees along the contour lines using the A-frame.



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.



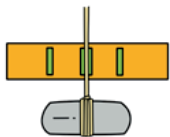
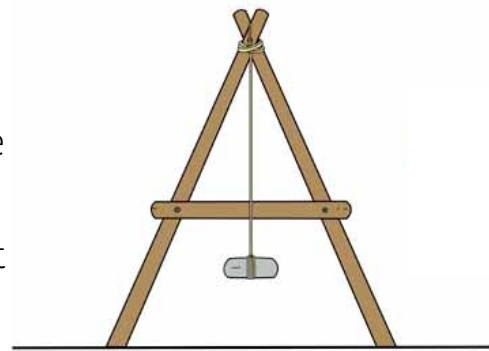
Determine the contour lines with the A-frame



Making the A-frame

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

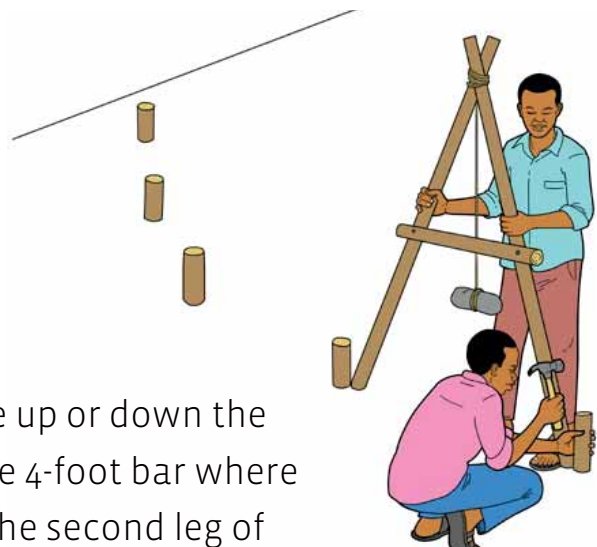
- ② Tie a strong string at the top of the frame. The string should be long enough to reach beyond the 4-foot bar from the top of the frame.



- 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

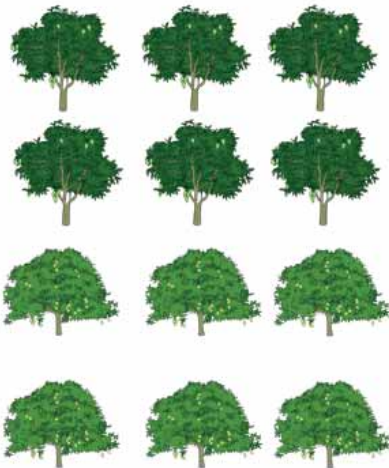
If you grow different varieties on your farm, you may profit from different market requirements and a longer harvest period.

Different varieties though may require different and timely separate cultural measures.

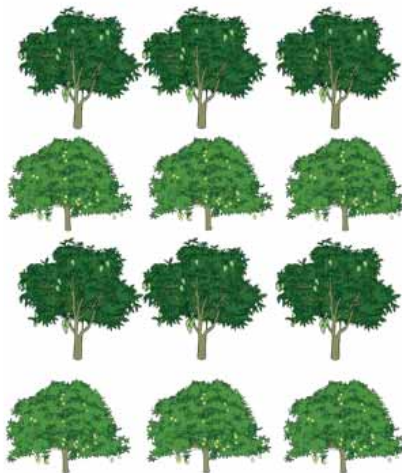
To ensure optimal maintenance of the varieties, it is recommended to arrange them in separate orchards or in separate lanes in an orchard.

Randomly mixed varieties are difficult to manage.

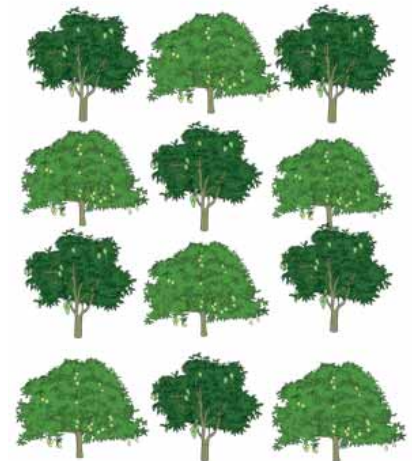
Separate orchards



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, Beverly



Ask your extension officer, which varieties are recommended for your situation.



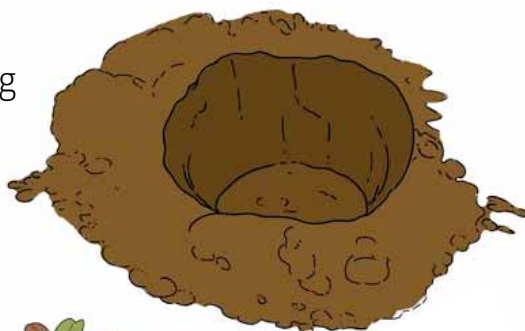
Select healthy grafted seedlings

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.



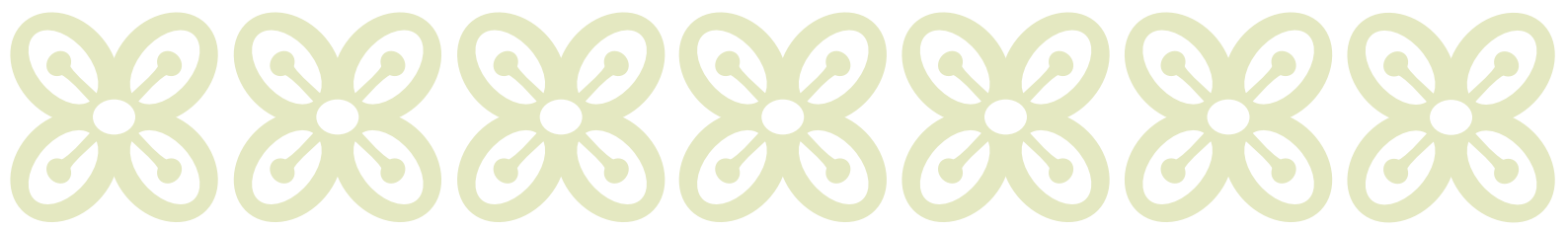
Remove the polyethylene bag carefully while holding the seedling upright.



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.

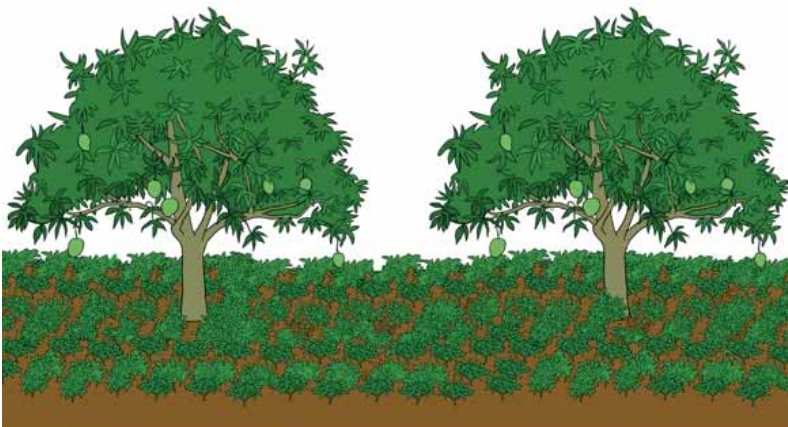
In the first years



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

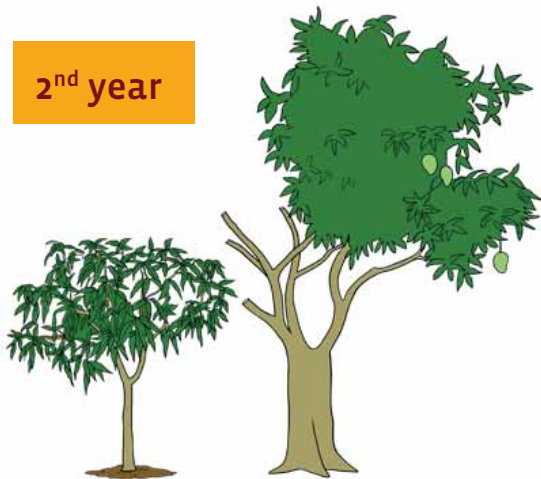


Remove old unproductive branches on one side of the tree.



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



Good soil fertility management contributes to quick growth of young trees as well as timely and adequate flowering and fruiting of the trees.

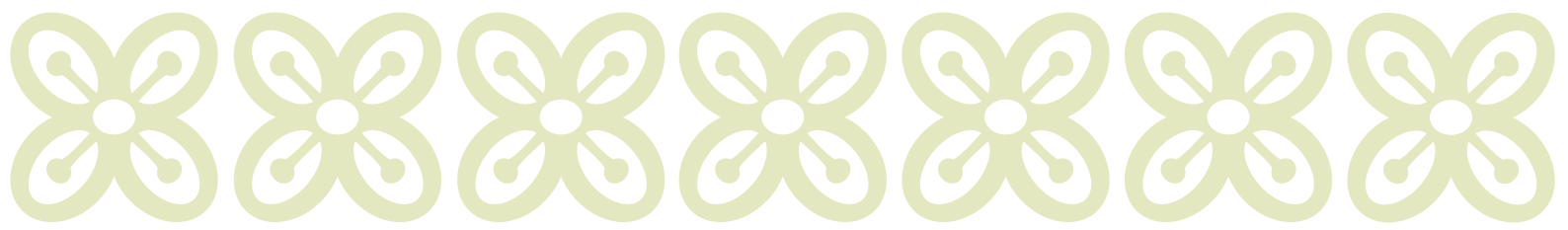
Apply organic fertilizers

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



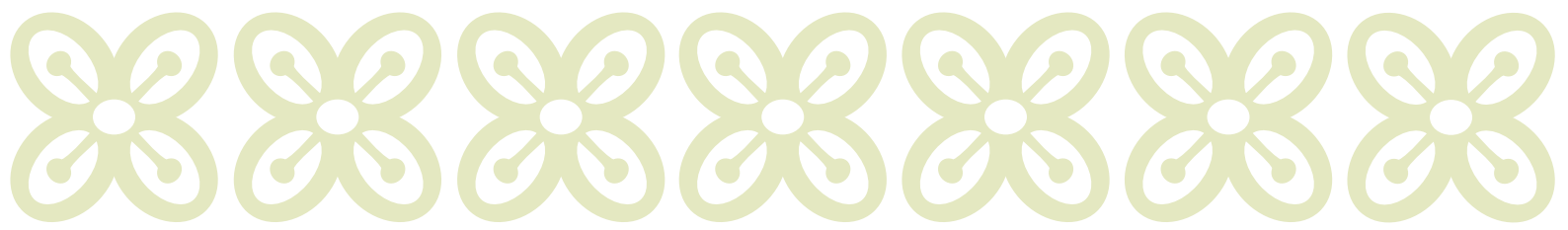
Add compost or composted manure around the feet of the growing trees every year.

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.

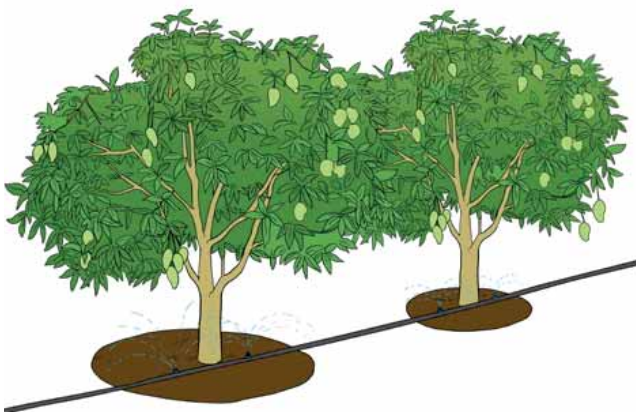


Lime

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

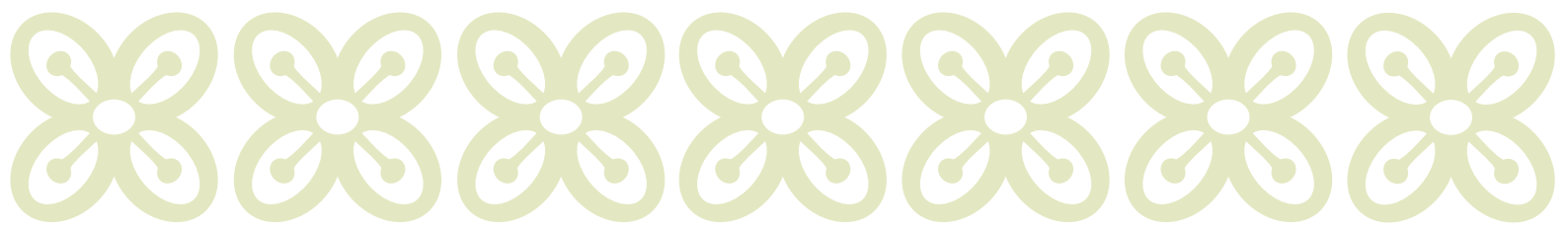
Microbial inoculations

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



Irrigation water

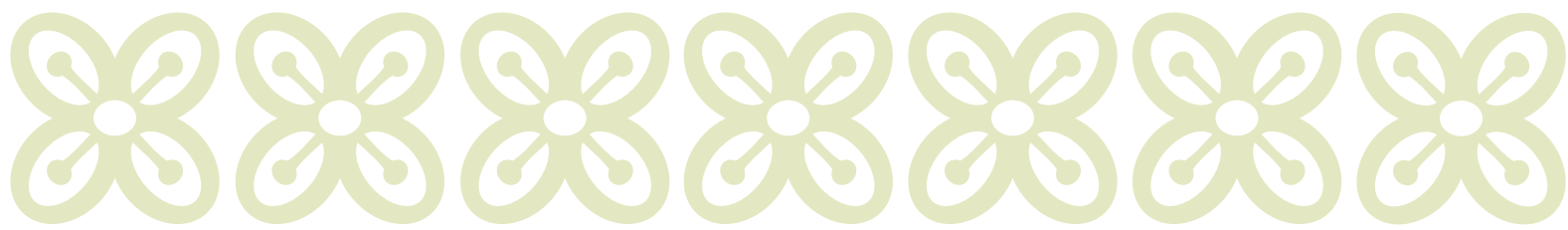
Adequate irrigation improves nutrient availability and encourages biological activity.



Complement with commercial fertilizers

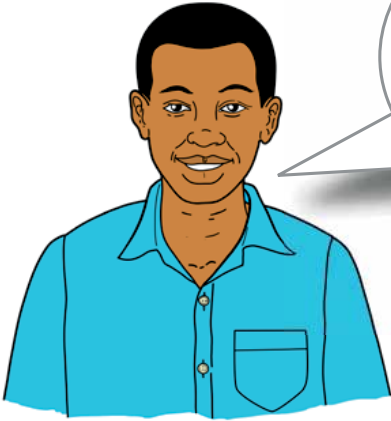
Selected commercial organic or mineral fertilizers can provide specific nutrients to compensate for nutrient deficiencies. As these fertilizers are expensive, their use must be carefully evaluated. In certified organic farming only natural fertilizers are allowed.

Organic fertilizers			
Fertilizers	Fertilizing effect	Availability of N	Comments
Guano (dried seabird droppings)	N, P	●●●	<ul style="list-style-type: none"> • P content higher than plant demand
Hoof and horn powder	N, P	●(●)	<ul style="list-style-type: none"> • The finer the powder, the faster the N is available
Seaweed	Minerals		<ul style="list-style-type: none"> • May contain heavy metals depending on origin
Oil cakes	N, P	●(●)	<ul style="list-style-type: none"> • Examples: castor, neem or groundnut meal
Hair, wool, feathers	N	●●(●)	
Agro-industrial by-products	N, P, K	●●	<ul style="list-style-type: none"> • Must be free of significant contaminants • Preferably compost before use
Composts	N, P, K	●	<ul style="list-style-type: none"> • Must be free of significant contaminants
Preparations and extracts of plants	N, P, K	●●●	<ul style="list-style-type: none"> • The effect depends on the original material



Mineral fertilizers		
Fertilizers	Characteristics	Application
Plant ashes	<ul style="list-style-type: none"> • Easy supply of minerals • Wood ash: rich in K and Ca 	<ul style="list-style-type: none"> • Compost (best solution) • Around the base of the plants
Limestone (ground limestone, algae)	<ul style="list-style-type: none"> • Buffers a low pH • Algae: rich in trace elements 	<ul style="list-style-type: none"> • Every 2 or 3 years when soil pH is low
Stone powder	<ul style="list-style-type: none"> • Trace elements depending on the source • Better adsorbance with fine powder 	<ul style="list-style-type: none"> • Application with manure or compost reduces nitrogen losses and promotes their decomposition
Mineral potassium (for ex. potassium sulphate, potash muriate, kainite, sylvanite, patentkali)	<ul style="list-style-type: none"> • Potassium sulphate: easily available • Patentkali: high Mg and S content; easily available 	<ul style="list-style-type: none"> • Only in the case of a proven deficiency
Rock phosphate (pulverized rock containing P)	<ul style="list-style-type: none"> • Easily adsorbed to minerals, but weakly adsorbed to organic matter • Slow reaction 	<ul style="list-style-type: none"> • To be applied to compost • Do not apply to reddish soils (irreversible adsorption) and high pH soils
Clay		<ul style="list-style-type: none"> • Requires large quantities to improve the soil
Sulphide	<ul style="list-style-type: none"> • Potassium sulphate: readily available, but can be lost by leaching • Elementary sulphur: slow reaction 	
Trace elements (inorganic or complex salts)	<ul style="list-style-type: none"> • Complex salts: better available for plants, but more expensive 	<ul style="list-style-type: none"> • Applied onto the plants • Only in case of a documented deficiency

Producing good compost



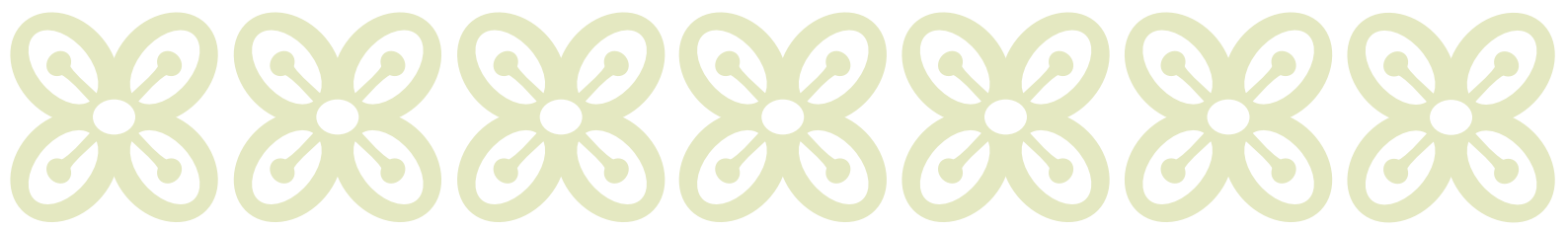
Compost production is laborious and requires a lot of organic materials and water. But the effort can be fruitful.

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.



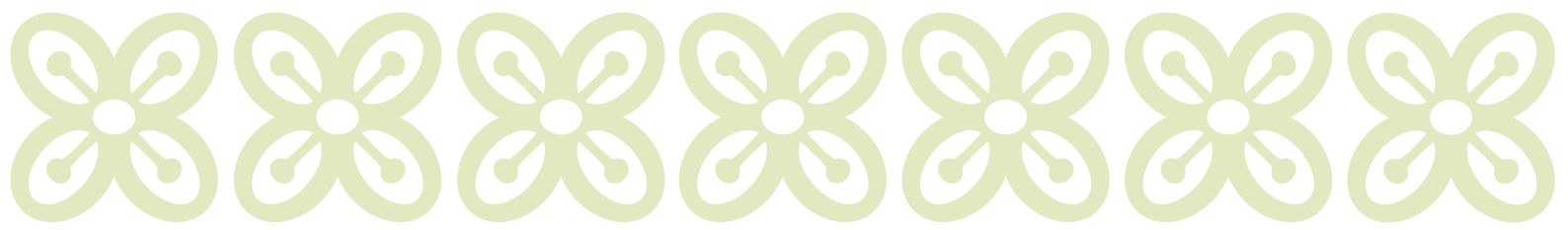
Prepare the materials



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.

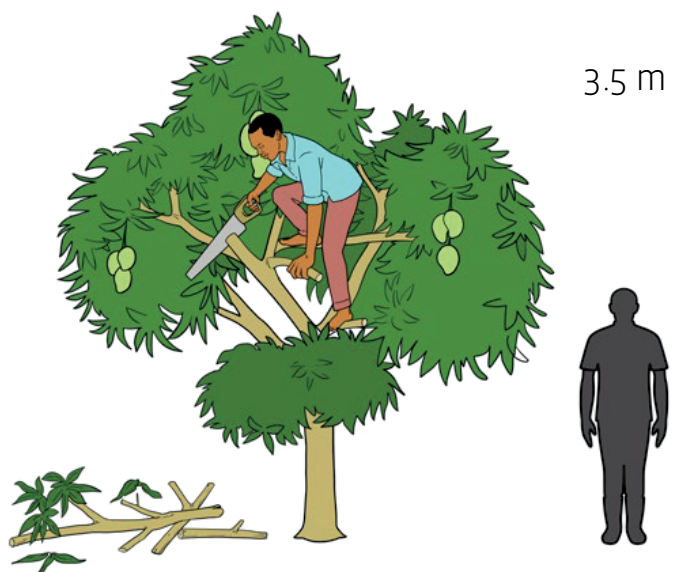
Limit the height of the tree.

Remove shading and dead branches.

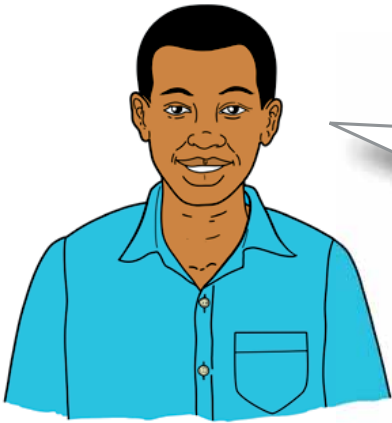
Create openings in the canopy.

Remove branches that touch the ground.

Cut off the tips of the branches.



Controlling pests and diseases

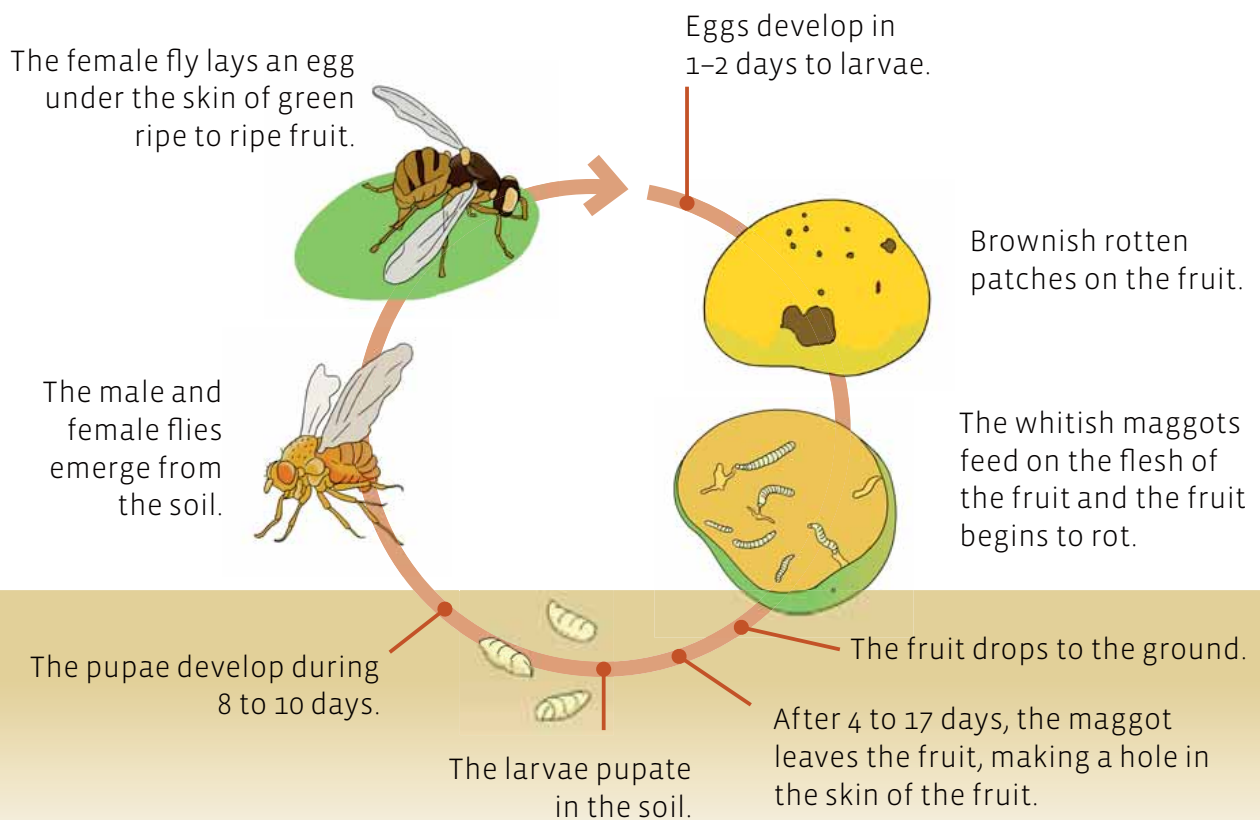


Good pre-harvest pest and disease control increases yield and improves fruit quality.

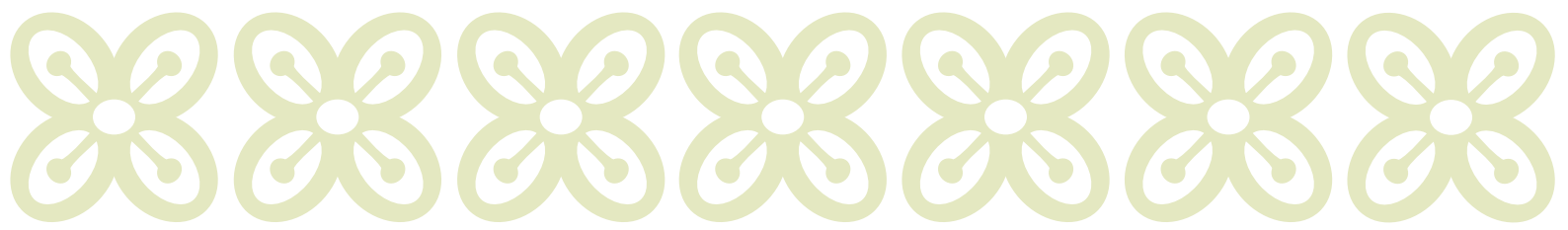
Fruit flies

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

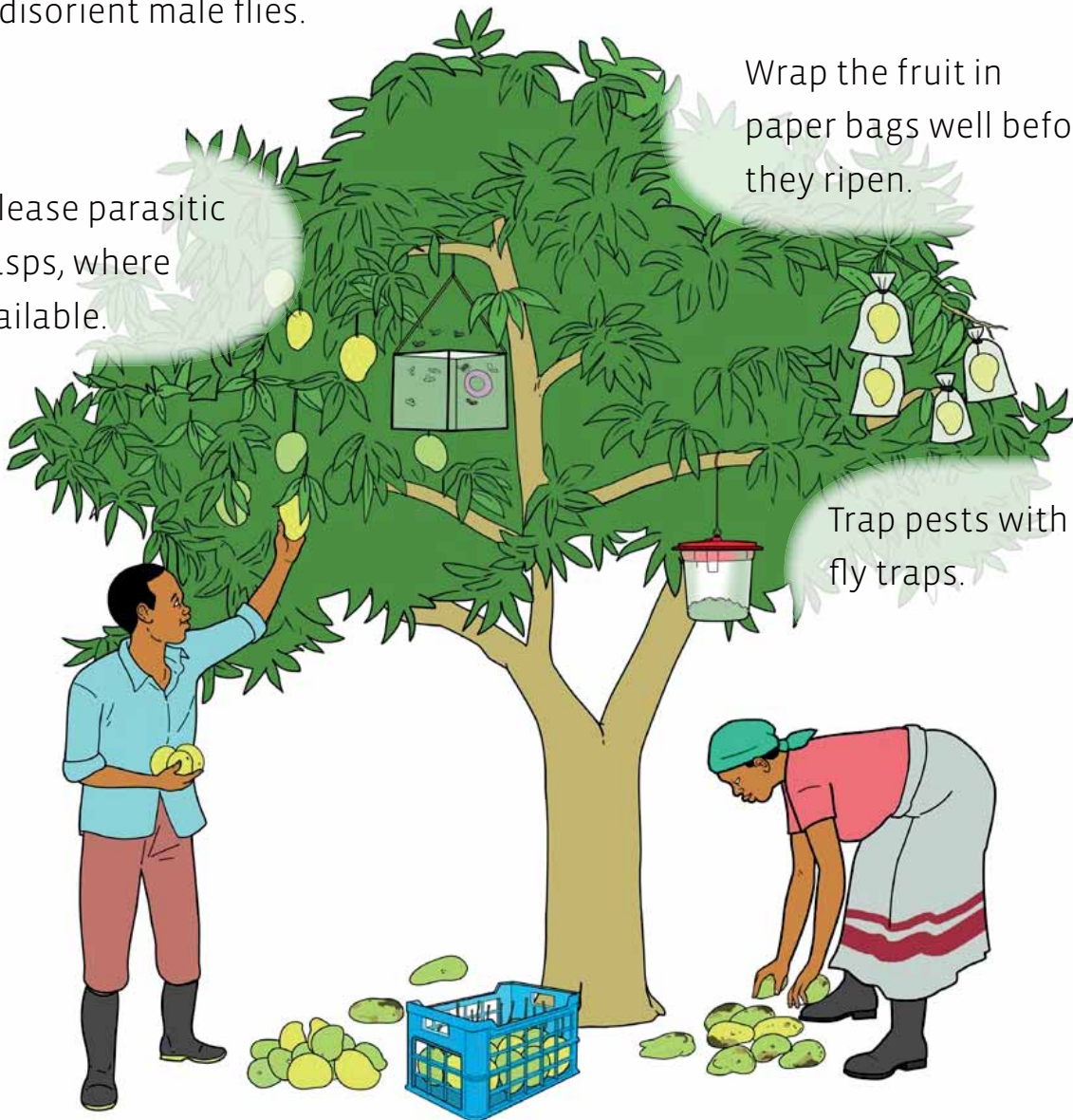
Continuous sanitation of orchards is important to limit the development of fruit fly populations.

Place pheromone traps in trees to disorient male flies.

Release parasitic wasps, where available.

Wrap the fruit in paper bags well before they ripen.

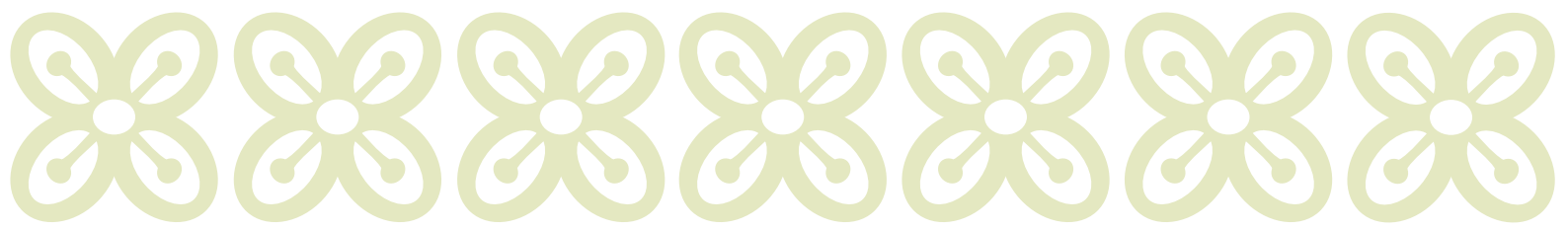
Trap pests with fly traps.



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

Female weevils lay one egg on the young fruit.

After egg-laying a small, dark mark is visible on the fruit skin.

When mango fruits have the size of 0.5 to 1 cm, the adults become active and begin feeding on leaves and tender shoots of mangoes.

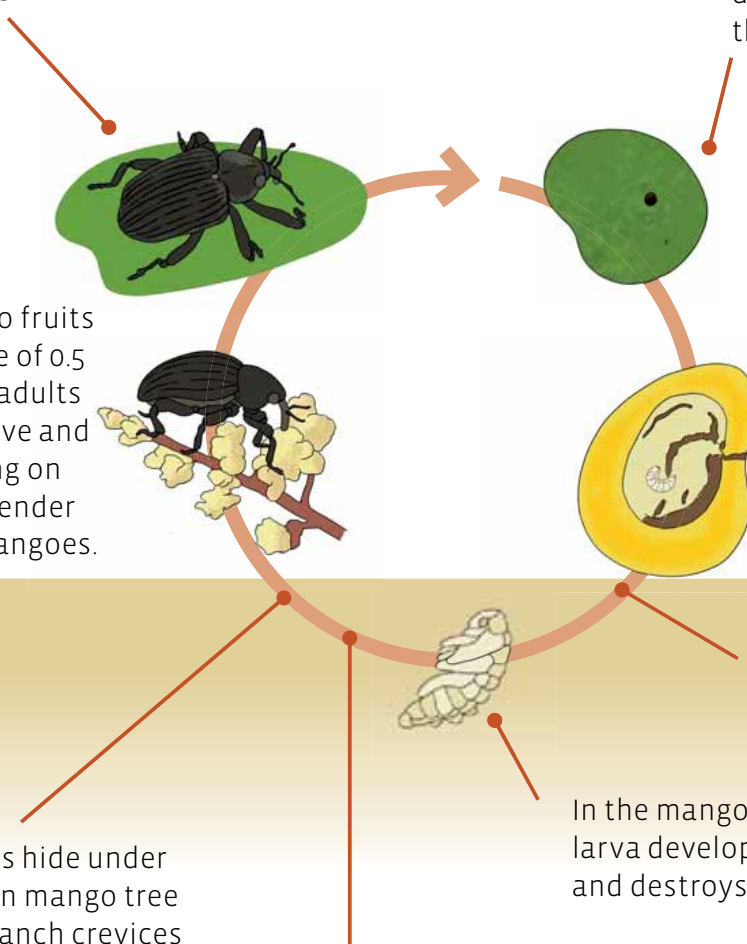
When the larva hatches from the egg after 5 to 7 days, it digs into the fruit through the flesh in the stone.

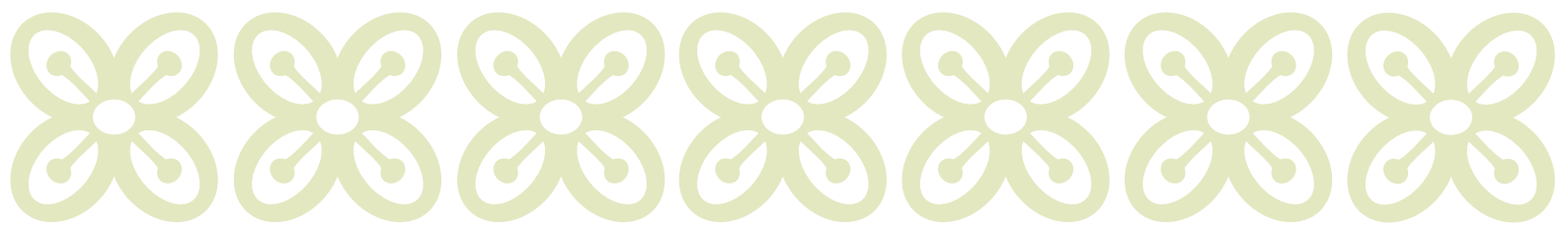
The fruit drops to the ground early.

Adult weevils hide under loose bark on mango tree trunks, in branch crevices and other crevices near mango trees.

In the mango stone, the larva develops to a nympe and destroys the nucleus.

After 4 to 8 weeks, the adult beetle tunnels through the flesh and leaves a hole in the fruit skin.





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.

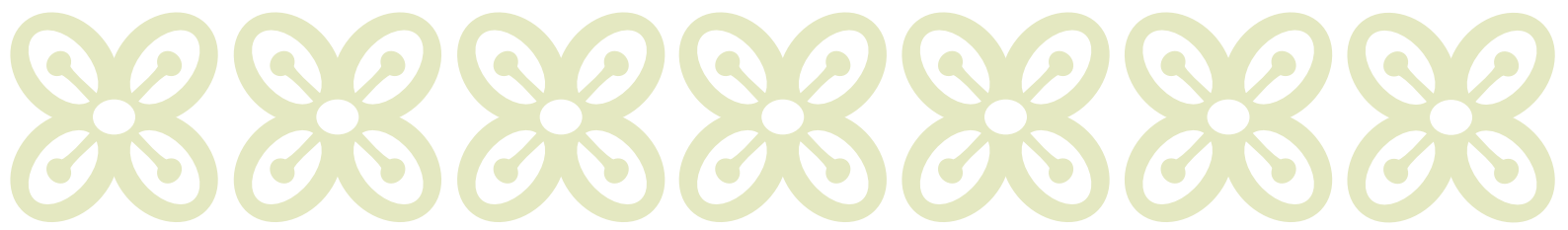
Limit the movement of fruit from old orchards or areas known to have mango weevils.



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

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

Collect all fallen fruits and scattered mango stones.



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.

Ensure a wide spacing between the trees.

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



Plant healthy plants from credible nurseries only.

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

Collect and burn fallen fruits, leaves and branches regularly.

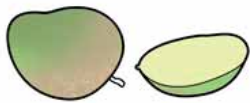
At harvest, handle the fruit with care.

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.

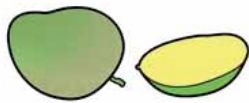
Maturity stages of mangoes

Not ripe



- Sensitive to injuries caused by refrigeration
- Do not mature properly
- Inferior flavour
- Bad taste

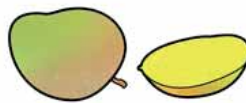
A little ripe



Pale yellow flesh

Maturity for export

Ripe

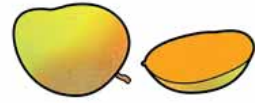


Visible maturity (1/4 to 1/2 ripe)

Maturity for the domestic market

Maturity for fruit drying

Very ripe

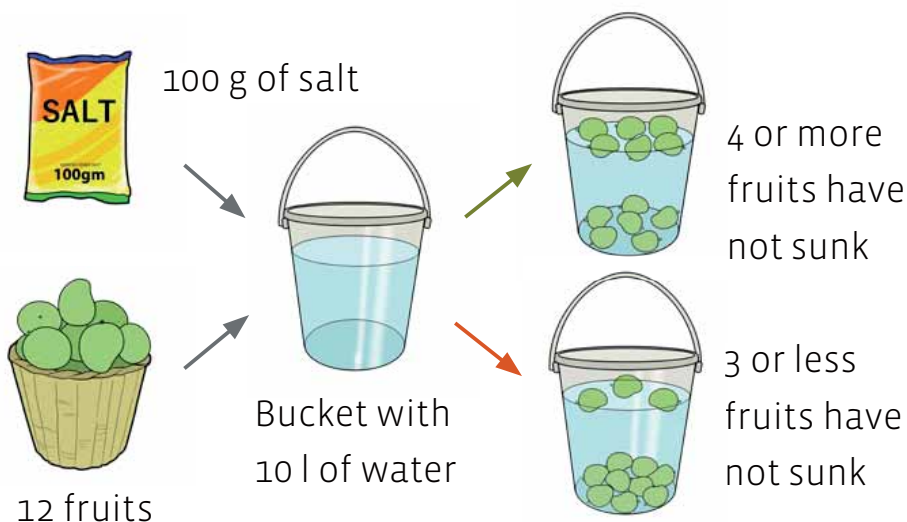


- Good taste
- Very sensitive to injuries and rotting
- Rapid loss of water and quality
- Short storage only

Maturity for processing

Maturity for fast consumption

Testing the maturity of fruits for export



Fruits not yet ripe; wait a few days

Fruits ready for harvest

Selecting harvesting tools and containers

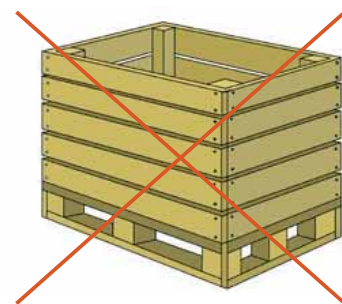
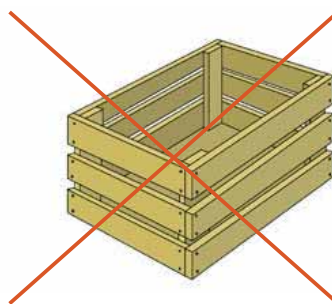
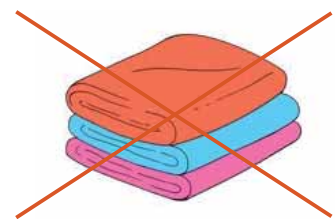
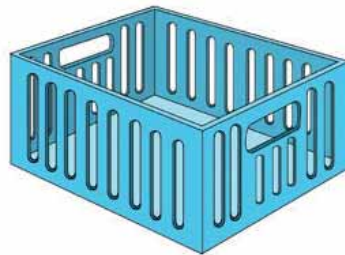
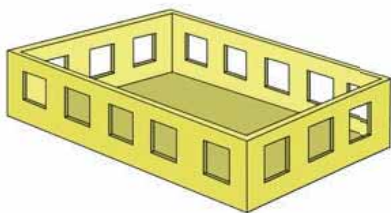
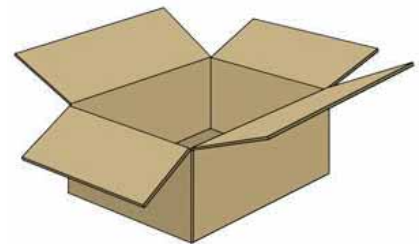
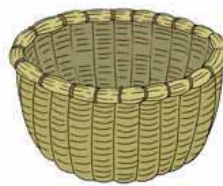
A ladder, shears and a net with a stem or a large net to catch individual fruits are essential tools for harvesting.

Harvesting tools



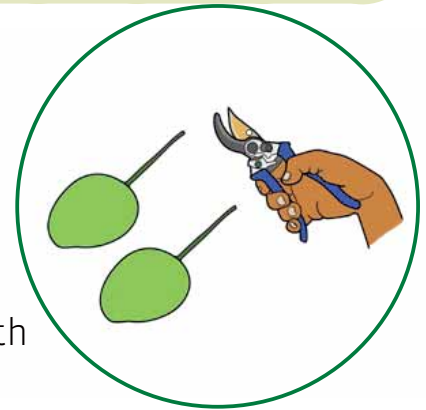
Containers

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



Ensuring a careful harvest

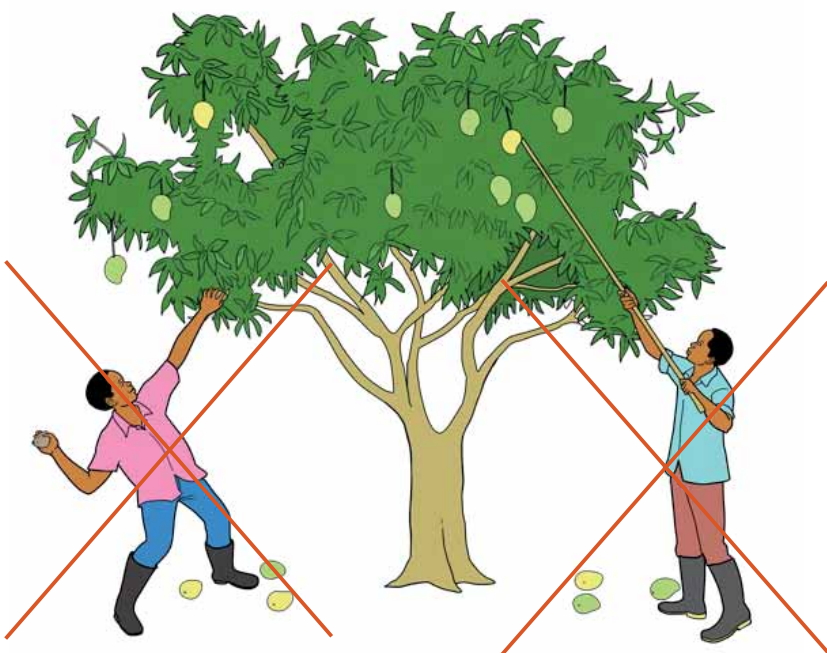
Individual and careful harvesting of the fruit with 10 cm long stalks ensures that the products are intact and free of latex stains.



Cut the mangoes with the stalks.

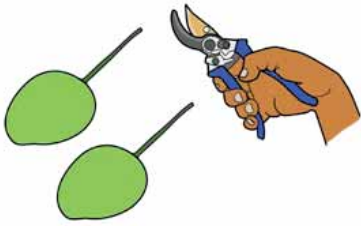


Place the fruit upright without breaking the stalks.



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.

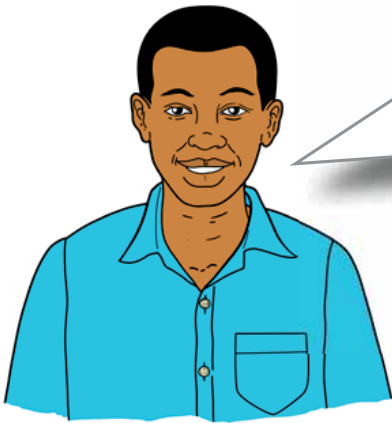
Organic fruits must be separated from conventional fruits at all levels of the food chain: in the field, on the farm, during transport, storage, etc.

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



The consumers have the right to expect mangoes to be safe, of good quality and suitable for consumption. Poor-quality fruits can destroy the commercial credibility of suppliers.

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

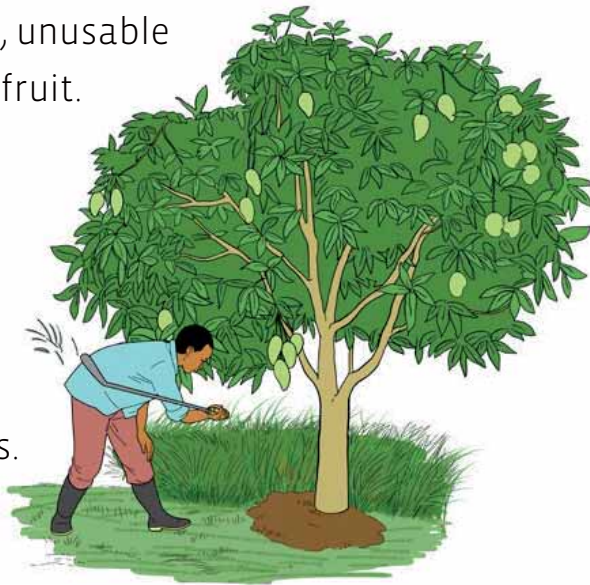
Immediately after the end of the harvest, the mango orchard needs to be cleaned properly for the following season.



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.



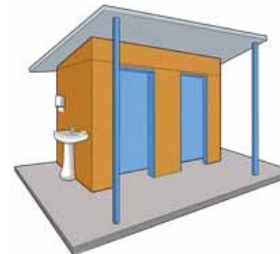
Provide access to restroom facilities, soap, single-use paper towels, and clean water at all times.



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.



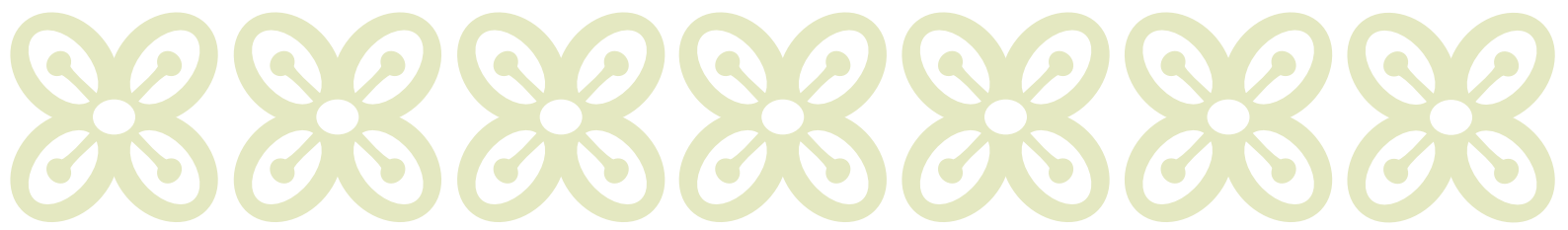
Monitor workers to ensure proper use of facilities.



Do not allow injured or ill workers to handle fruit.



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

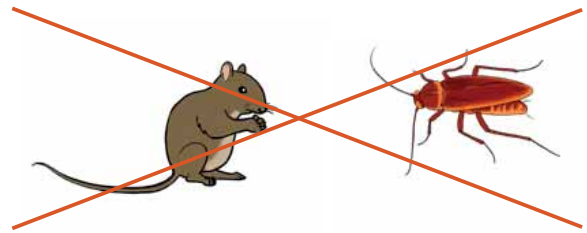


Which measures need to be considered in the packinghouse?

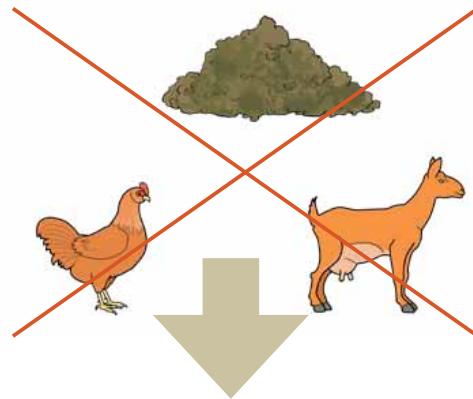
Regular cleaning and sanitation greatly reduces opportunities for pathogen buildup and inoculation to occur.



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.

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