African Organic Agriculture Training Manual

A Resource Manual for Trainers

9-22 MANGO

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Ready for field testing

FiBL

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Learning targets for farmers:

- Recognize good husbandry practices in mango orchards
- Learn proper propagation of mango seedlings
- Learn proper diversification in mango orchards
- Learn proper management of mango pests and diseases
- Receive guidance on organic certification in mango production

1. Introduction

Mango trees (Mangifera indica L.) are cultivated in many countries of East, South and West Africa. In these countries, mangoes contribute to farmer family diets as well as serving as a cash crop. Mangoes are a delicate fruit and, therefore, sensitive to transport, which limits trade opportunities. However, there is considerable market interest in processed mango—in pulp or dried form.

Common challenges to mango production in Africa

Many farmers in Africa invest in mango orchards. However, there are a number of production-related hindrances at farm level, including:

- **Limited access to good quality planting materials -** There is a general shortage of grafted planting materials of improved and higher yielding varieties in many areas. Farmers often use inferior seedlings obtained by germinating mango seeds from indigenous varieties. Such ungrafted trees take much longer to bear fruit. Whereas grafted trees begin to bear fruit within 3 to 4 years, ungrafted trees will take at least 5 years to bear fruit, depending on the growing conditions.
- **Pest and disease problems -** Mangoes have many devastating pests and diseases, which can result in total yield loss. Major pests include the fruit fly *(Bactrocera invadens)*, seed weevil *(Sternochetus mangiferae)* and mealy bugs *(Rastrococcus invadens)*. Diseases like anthracnose and powdery mildew are common in almost all mango growing areas.

POOR MANAGEMENT

GOOD MANAGEMENT

- **Poor orchard management -** In many areas, mango trees are left to grow so big that pest and disease management, harvesting and other field operations are difficult to implement. Except in big or commercial farms, mango trees are normally scattered around the gardens, ranging from 2 to 100 trees per household. This scattered nature makes mango a commonly neglected crop in terms of management, but becomes important only during the harvesting season.
- **Postharvest losses -** Fruit damage is a common problem as a result of poor pest and disease management and the poor harvesting practices. Also, a lot of fruit is lost after harvest, especially during the peak seasons due to the limited capacity to store and process fruit. This is further worsened by the poor roads and transport infrastructure to markets.
- **Limited returns from mango production -** Mango is highly seasonal and harvest is only expected at certain times of the year depending on the local conditions. During this time, most areas are harvesting and so the local markets are saturated and, therefore, offer very low prices, which may not even cover transportation costs.

Mango production is becoming a very important economic activity with potential to improve food and income security. Strategies are, therefore, needed to minimize risks associated with mango production and improve the productivity of mango orchards. This chapter, therefore, introduces organic approaches that can contribute to better production conditions of mangoes, and can be adapted to the prevailing local conditions.

2. Proper establishment of the mango orchard

2.1 Choice of the proper location and suitable varieties

The ideal climate for mango trees ranges from the humid tropical to the semi-arid sub-tropical, wherever a dry period exists of at least 3 to 4 months and sufficient light to induce flowering. Once the trees are established, they can tolerate drought except during flowering and fruit setting. Mangoes can be grown successfully in a wide range of soils, but a healthy, high-yielding plantation is only possible on fertile, deep and well-drained soils.

Discussion: Evaluation of the local situation

Inquire about the farmers' estimation of mango production and especially about the challenges they face. Do they experience any of the above or other challenges, and how have they tried to address them?

Main characteristics that differentiate varieties are the fruit shape, size, aroma, sweetness, colour, fibre content, taste, seed size and resistance to diseases. Proper selection of a mango cultivar for an organic plantation has to take into account the following criteria:

- good adaptation to the local conditions (e.g. rainfall and dry periods)
- alternation of flowering and fruiting
- tolerance to pest and disease infections
- designated use and market requirements

Both local and exotic or improved varieties are commonly available. Improved varieties are usually grafted on the local varieties and are grown for export. Examples of improved varieties include, Kent, Keith, Palmer, Parwin, Tommy Atkins, Van Dyke, Sensation, Amelie, Alphonso and Haden. Local varieties vary a lot across countries, and although most of them have high fibre content and are thus unpopular for fresh consumption, some are commercially important. Examples in East Africa are Apple, Ngowe and Dodo.

Sharing knowledge on mango varieties

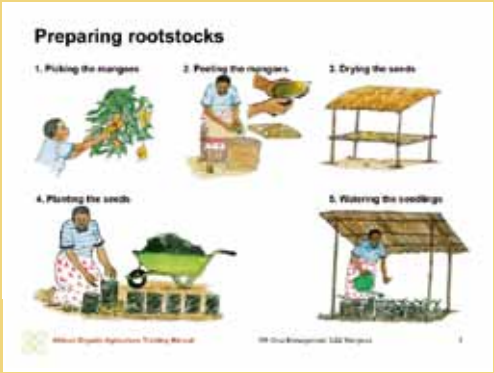
Inquire among the farmers about the commonly grown mango varieties. List the different varieties as well as their advantages and disadvantages, especially for organic production (for example: quality, yields, pest and disease resistance).

2.2 Mango seedling production

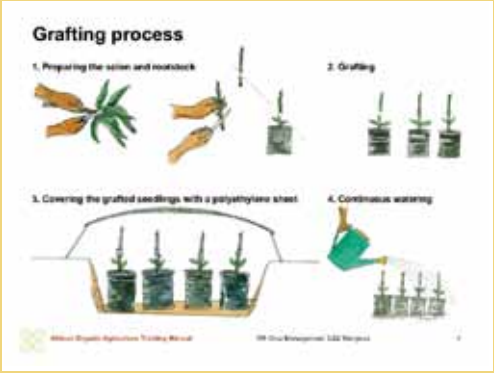
Mango farmers can produce planting material on-farm by raising their own rootstocks and grafting them with the preferred cultivars. Rootstocks should be raised from seeds selected from healthy looking and very ripe fruit, preferably fruit that are ready to fall off the mother tree. Such fruit should be picked from a known mango tree variety that is hardy and well adapted to local conditions. The fresh mangoes should be peeled and all the flesh removed from the seed and the seeds spread in a dry, clean place under shade to harden for about one week. Mango seeds quickly lose their viability so they should not be kept for a long time.

For the nursery, polyethylene bags (PE-bags) with a diameter of 15 cm and a height of 30 to 40 cm are used. A mixture of 50 % ripe compost and 50 % of soil with a high humus content is filled into these bags. The seeds should be slit on one side to help the embryo germinate quickly through the endocarp (hard part of the seed). Seeds are then placed on their sides, with the most prominently curved edge upwards, so that they produce a straight stem. The seeds should then be completely covered with soil and the bags aligned under a shaded area (e.g. shaded roof, palm leaves). The soil in the bags should be kept moist.

PREPARING ROOTSTOCK SEEDLINGS



GRAFTING PROCESS



When the seedlings (root stocks) are about 50 cm in height and 8 to 10 mm in diameter, they are ready to be grafted. Some varieties produce two shoots, whereby both can be grafted or one cut off. Varieties with strong foliage development, the desired fruit type and a good flower formation and fruit production history should be selected to provide scions. Length of the scions should be about 10 cm (with at least 3 buds, same size as the root stock). The scions should then be harvested and collected into a re-sealable plastic bag while removing all the fully formed leaves from the scions. A diagonal side-wedge is made of the scion in such a way that it just fits the diagonal side-wedge made on the rootstock stem, and then bound together firmly with a polythene wrap or rubber band in an upright position.

The grafted seedlings should be covered under a transparent polyethylene sheet to encourage quick sprouting of the scion. As soon as the buds of the scion start sprouting, then the sheet should be slowly removed and the seedlings left to grow in a shaded area. Appropriate watering of the seedlings and monitoring for any pest or disease attack is necessary.

After grafting, the seedlings are grown for 4 weeks in the nursery before they are transplanted to the field. At this point, the scions should have produced a second flush of leaves.

The plant hole should be made at least 40 x 40 cm and 50 cm deep, topsoil put aside and later mixed with good compost to fill the plant hole after planting the seedling. The PE-bag should be removed before planting and the joined part of the seedling not covered under the soil. Light mulch (about 10 cm) may be applied, but not too close to the seedling stem in order to avoid attracting fungus and insects. Continuous watering is needed for proper establishment.

2.3 Arrangement of the orchard

The method of planting (orchard design) is dependent on the field lay out. When mango is the main fruit in the orchard, a 10 m by 10 m planting distance is desirable.

Since mango trees grow slowly, they can take a relatively long period (up to 5 years) before the trees cover the space in-between. During this period, there are several possibilities to use the available space as cropping area through proper diversification. Diversification in mango production offers the following advantages:

Discussion on mango seedling production

Find out which varieties are good as scions and which ones are good as rootstocks by asking the following questions:

- Which criteria do you consider relevant in variety selection under local conditions?
- Which varieties are known to be most adapted to the local conditions, to be used as root stock for seedlings?
- Which varieties are preferred or demanded by the market?

- better use of underground and aerial space
- the yield risk due to alternate bearing can be compensated with the harvest of the companion crop, hence stable income to the farmer
- protects the soil from erosion
- improves the soil fertility, for example, when legumes are grown underneath the trees
- intercropping reduces the pest and disease pressure due to possible higher populations of beneficial organisms
- better weed management and provides space for pasture production for livestock.

Mango trees can be grown together with many other plants: as border trees on cultivated gardens, in intercropping within the gardens, in very diverse agroforestry systems or in silvi-pastoral systems (using small animals, such as sheep or goats).

a Intercropping in mango plantations

If the area between the organic mango trees is to be used as arable land, an adequate crop rotation should be planned. During the young developing stages of the mango trees, a crop rotation with annual crops such as legume crops, vegetables, cereals and fodder crops can be grown in this case. If the local climatic and soil conditions are suitable, other fruit crops such as papaya (3 to 5 years cropping period) and pineapples (2 to 3 years) can be included in the intercropping system.

Other possibilities to enhance the diversification in mango orchards include leaving some spontaneous plant growths (bushes, flowers, etc.) on the borders or between the trees to create ecological niches.

b. Mango in border areas of cultivated fields

Mango trees as border trees can improve diversification on the farm, it can protect the soil and other crops against wind and it can enhance the income of the farmer.

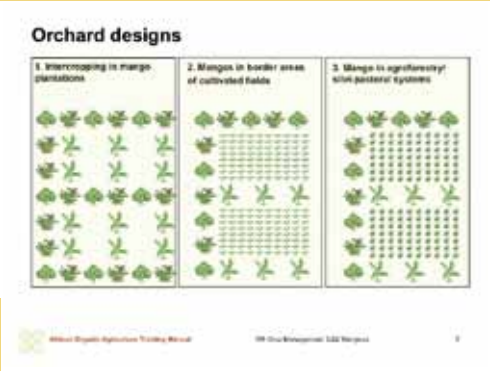
c. Mango in agroforestry or silvi-pastoral systems

Mango trees in agroforestry systems can include crops such as bananas, papayas, cocoa, etc. In silvi-pastoral systems, animals can be allowed to graze on pasture growing on the mango plantation. Windbreak trees are needed because mango

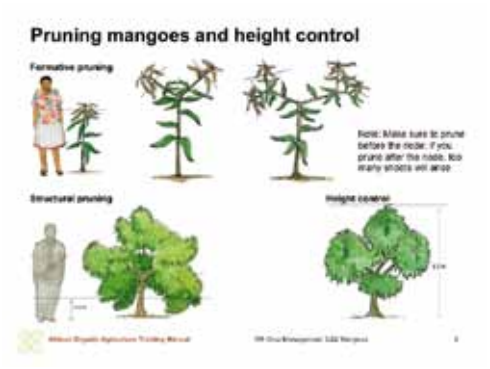
Discussion on diversification in mango production

Ask the farmers to give examples of crops that are normally grown within the young and old mango trees. What benefits do these crops provide, first to the mango trees and secondly to the farmers?

ORCHARD DESIGNS



PRUNING OF MANGO TREES



trees are very susceptible to wind damage. Therefore, some trees are needed to protect from strong winds on the side of the prevailing winds.

3. Proper maintenance of mango trees

Mango trees need continuous attention in order to ensure continued harvests and to improve the lifespan of the orchard trees.

3.1 Pruning

The form and height of a mango tree needs to be controlled to guide the tree and to facilitate harvesting at a later stage.

- **Formative pruning -** is done in the first years of the young tree to guide the tree into the desired shape. In the first year, when the trees are about 1 m from the ground, cap the seedling in order to encourage side branches (3 to 4 well branches). Thereafter, every second flush of leaves should be removed.
- **Structural pruning -** should be done for proper maintenance of the trees. The height of the trees should be controlled to about 3.5 m in height and at this stage, all branches at knee level (about 0.5 m) should be pruned (skirt pruning). Any dead branches and sucker branches should be removed to allow more sunlight through the canopy to the ground under the tree. This should be done every year in order to maintain the tree at 3.5 m and develop a suitable canopy density.

3.2 Improving flowering and fruit formation

Young grafted trees may flower within two years, but fruit formation should be avoided as it can considerably affect the growth of the trees. All blossoms should be plucked away until the fourth year when flowers should be permitted to develop. It is further recommended to keep the orchard area clean by removing all ripe fruit and weeds from around the tree. In addition, up to one third of undersized fruit should be removed after fruit set in order to encourage a larger size of the remaining fruit.

Field visit and discussion on intercropping or agroforestry in mango orchards

Organise a field visit to different mango orchards in order to observe the different diversification systems within the orchards. Build groups with about 3 to 5 participants and let each group discuss the advantages and challenges of different diversified orchard designs (agroforestry, intercropping, etc.). Let each group discuss and present the results in a plenary session.

SMOKING TO INDUCE FLOWERING AND CONTROL PESTS

Alternation of flowering and fruit formation (fructification) is still a problem in mango production, especially in humid areas. This problem is characterized by the alternated production cycles of abundant flowering and fructification in one year, with low flowering and fructification the next year. The alternation of flowering and fructification in mango trees is caused by many different factors. For example:

- **Biological factors -** varieties differ on the grade of alternation (e.g. varieties that flower regularly in one region can have a strong alternation in different regions and the age of the plant makes a difference in that younger plants tend to have more alternation).
- **Environmental factors -** mango trees are sensitive to climatic variations (e.g. reduction in sunlight causes alteration in mango flowering and fructification, low temperatures during the night and a dry climate improve flower formation, while high rainfall coupled with good soils favour excessive vegetative growth). Strong winds on the other hand, may cause loss of flowers and fruit.

Smudging is the practice of smoking moist organic materials like grass or leaves under the tree canopies, either in a smoking heap or in cans, in order to induce flowering. Smudging is commonly done towards the dry season when mango trees are ready to flower (i.e. trees with leaves that are dull green with dormant shoots). Older trees are known to respond better than younger ones. For best results, a good supply of water—through irrigation or watering—is required. The practice helps to have an altered earlier harvest in a period of undersupply for a better market price.

On top of improving fruit setting, mango smoking also reduces insects. The smoking material can be mixed with aromatic herbs like lemongrass or lantana leaves to produce a repellant smoke that chases away insects from the tree.

3.3 Pegging heavy branches

With some mango varieties, the tree branch may become so heavy with mango fruit that it eventually breaks. The farmer can thus intervene to save the harvest by pegging the heavy branches with wooden poles.

Discussion about the maintenance of mango trees

Ask the farmers about common management practices of mango trees by asking the following questions:

- How do they look after the mango trees to ensure continuous flowering and yields?
- Are there any special practices done to induce flowering and fruiting?

PEGGING OF MANGOES

4. Improving soil fertility

Farmers need to implement proper management strategies to improve the fertility of the soil in the orchard.

The following management strategies for soil protection and weed management in organic mango production can be recommended:

- Planting cover crops especially in mango orchards before fruit production starts. A more permanent cover crop can be established and managed by slashing and weeding out of undesired plants that may compete with the cover crops or mango trees. The vegetative organic material left on the soil surface provides a mulching layer that protects the soil and positively influences the water retaining capacity of the soil.
- Mulching, especially in the young mango trees.
- Weeds can also be controlled by using small animals like goat and sheep to graze on the pasture under the mango trees. The farmer must be careful not to overgraze and to monitor the animals to avoid damaging the mango trees.

4.1 Application of organic fertilizers

The nutrient requirements of mangoes are dependent on the stage of growth. Mangoes especially require a good supply of nutrients during the active growth stage until about 4 years when they start fruit production and thereafter, more nutrients are required, especially during flowering and fruit formation.
The following general nutrient supply measures can be adopted:

- During the early development of the mango tree (during the first four years), a regular supply of compost and green manure is provided to improve the foliar development.
- As soon as the mango tree produces fruit (from the 4th year on), application of organic fertilizers (compost made of farm yard manure or other organic material) should always follow the flowering, so that enough nutrients are available for fruit formation and fruit development.

Mango trees under optimal conditions can achieve yields between 10 to 30 tons per ha and year. The yield varies per tree from 50 to 500 kg depending on the planting system, size of the tree and variety.

Discussion on improving soil fertility

Ask the farmers about their approach to soil fertility management in the mango orchard.

- How do you enhance soil fertility?
- Do you add any organic materials and at what stage of growth or season?

COMPOST AND MULCHING PLANTATIONS

5. Pest and Disease Management

In organic farming systems, preventive methods based on proper crop and habitat management are encouraged. Direct methods of control are reserved for emergencies only. Synthetic insecticides and fungicides are not allowed in organic mango production.

The most destructive mango pests are the mango seed weevil and the mango fruit fly, common nearly in all mango producing areas.

Mango seed weevil *(Sternochetus mangiferae)*
Mango seed weevil, also called the *mango stone weevil*, is one of the major pests of mangoes in sub-Saharan Africa. The larva, which is the damaging stage of the pest, enters the fruit by burrowing through the flesh into the seeds, where it feeds until pupation, destroying the seed. Early attack (when the fruit is forming) leads to premature fruit fall. If the attacks occur at a later stage, fruit infestation is very difficult to detect, since there are no external signs of infestation. When the adult emerges, it tunnels through the flesh, leaving a hole in the fruit skin which may serve as an entry point for secondary fungal infections, greatly affecting the quality of the fruit. This is particularly a problem because, in many instances, weevil attack remains undetected in the field, and is first noticed in storage or when cutting the fruit.

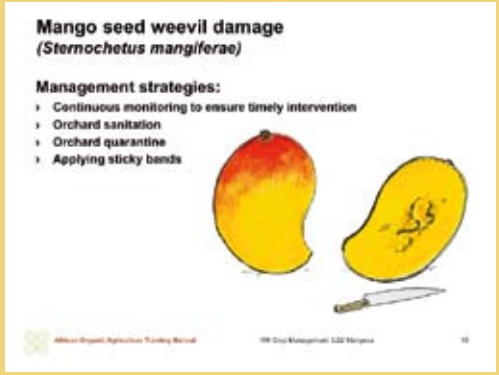
The weevil spreads into clean areas through the movement of infested fruit for propagation or consumption. It can, however, be managed by:

- **Continuous monitoring to ensure timely intervention** is important, for instance, a weevil attack can be detected by monitoring for egg-laying marks on young fruit. Regular fruit scouting is important to detect adult activity during fruit growth.
- **Ensuring good orchard sanitation** by collecting and destroying all scattered mango seeds and fallen fruit. All collected fruit and seeds should be buried deeply (about 50 cm deep).
- **Ensuring orchard quarantine** by restricting movement of fruit from old orchards or areas known to have mango seed weevils to areas where young orchards, free of seed weevil, have been established.
- **Applying sticky bands** at the upper end of tree trunks when the trees start flowering to reduce migration of weevils to branches for egg laying.

Working group/ field visit: Pest and disease identification

Visit different orchards in the area and identify any observable signs of pests and diseases. Let the farmers identify them. Discuss ways of managing these infections together.

MANGO SEED WEEVIL DAMAGE

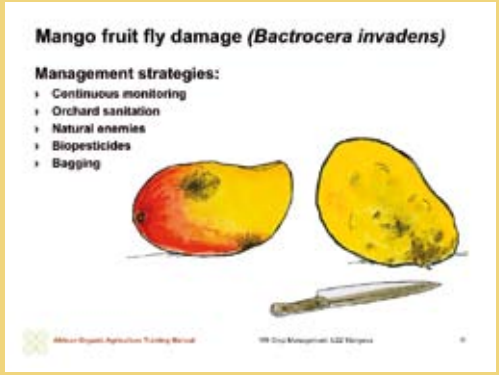


Mango fruit flies *(Bactrocera invadens)*

Female fruit flies puncture the fruit skin and lay eggs that develop into maggots (larvae) in the flesh of the fruit after hatching. The larvae feed on the fruit and cause it to drop prematurely and destroy the pulp of the fruit. Generally the fruit falls to the ground as, or just before, the maggots pupate. In fruit for export, fruit flies cause indirect losses resulting from quarantine restrictions that are imposed by importing countries to prevent introduction of fruit flies. Nearly all fruit fly species are quarantine pests. Fruit flies attack soft, fleshy fruit of a wide variety of fruit and vegetables. Management strategies of fruit flies include:

- **Continuous monitoring** of fruit flies to determine when they arrive in the orchard and to decide when treatment is needed. Monitoring can be done using bait traps like the 'bucket trap' *(Also see transparency 4-18)*. The farmer should, however, be able to identify fruit flies from among other trapped insects. Pheromone traps are also available to attract male fruit flies, hence reducing reproducing populations.
- **Orchard sanitation** is important as poorly managed or abandoned orchards can result in buildup of fruit fly populations. All fruit with dimples and oozing, clear sap should regularly (e.g. twice a week for the entire season) be removed from the tree as well as all rotten fruit from the ground. The maggots are killed by burning or tying collected fruit in black plastic bags and exposing them to the heat of the sun for some hours. The fruit can also be buried deep, at least 50 cm (about two feet), to prevent emerging adult flies from reaching the soil surface.
- Several **natural enemies** can contribute to the suppression of fruit flies. Major natural enemies are parasitic wasps (e.g. *Bracon* spp.) that attack the maggots of fruit flies and predators such as rove beetles, weaver ants, spiders, and birds and bats. In particular, weaver ants have been shown to be very efficient in protecting fruit trees from pests, including fruit flies. These ants pray on fruit flies, but most importantly, their presence and foraging activity hinders the fruit flies from laying eggs, resulting in reduced fruit fly damage, as shown in mango orchards in Benin. Although natural enemies alone do not give satisfactory control of fruit flies, efforts should be made to protect them, and to complement their effect on fruit flies with other management options. Dill, parsley, yarrow, zinnia, clover, alfalfa, parsley, cosmos, sunflower and marigold are flowering crops that attract the native wasp populations and provide good habitats for them.

MANGO FRUIT FLY DAMAGE



› **Biopesticides** such as a spray pyrethrum solution is effective in controlling fruit flies. Other plant extracts like neem, garlic, chilli and tephrosia can also be used. The biopesticides can also kill beneficial insects like bees if they are sprayed directly. Therefore, it is best to spray in the evenings after most of the bees are back in their hives (after 6 pm).
› **Bagging** prevents fruit flies from laying eggs on the fruit *(See also transparency 4-19)*. In addition, the bag provides physical protection from mechanical injuries (scars and scratches). Although laborious, it is cheap, safe and gives a more reliable estimate of the projected harvest. Bagging not only protects fruit from fruit fly damage, but protects the fruit from physical damage improving the market appearance of the fruit. However, it is only practicable on small trees.

Other common pests of mangoes include scales, mealy bugs, aphids and mango flies.

› **Scales** suck the plant sap. Feeding by scales may cause yellowing of leaves followed by leaf drop, poor growth, dieback of branches, fruit drop and blemishes on fruit. Heavily infested young trees may die. In addition, soft scales excrete honeydew, causing growth of sooty mould. In heavy infestations, fruit and leaves are heavily coated with sooty mould, turning black.
› **Mealy bugs *(Rastrococcus invadens)*** suck sap from the leaves, branches, flowers and fruit. They excrete honeydew that develops into black sooty mould.
› **Whiteflies and Blackflies *(Aleurocanthus woglumi)*** can also be regulated through the beneficial insects. They suck sap from leaves and may weaken the plants when numbers are high. They excrete large amount of honeydew where sooty mould develops. High numbers of these insects can almost blacken trees, reducing photosynthesis and also may cause leaf drop.
› **Mango Aphids *(Toxoptera odinae)*** live in clusters sucking sap on the underside of young leaves, on petioles, young branches and fruit. Their feeding causes slight rolling, or twisting of the leaf midrib. Sooty mould growing on honeydew produced by the aphids may cover leaves, twigs and fruit, reducing its market value.

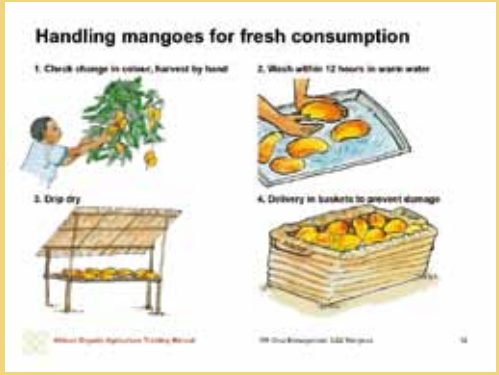
These are all sucking insects that live on leaves, young branches and buds and can cause great damage. However, all of them have natural enemies such as lady beetle larva, wasps, spiders and parasitic fungi. Therefore, improving diversity,

by planting wild flower strips in the orchard and hedge rows, will enhance the beneficial insects. By wrapping a smooth, slippery plastic band around the trunk or any sticky substance will also restrict the movement of the mobile pests. In case of heavy infestation it is possible to control by spraying a 1 % soap solution with 1 % pure alcohol, with an application of paraffin oil (white oil) as a 3 % water emulsion or with a plant extract of neem or other botanicals.

Most diseases of mango are caused by either fungi or bacteria. The first preventive measure is, therefore, to obtain healthy vegetative propagation material free of these infections.

- **Anthracnose** is caused by the fungus *Collectrichum gloeosporioides* and is the most common disease of mango, especially in regions that have high rainfall and heavy dews. It affects leaves, stems and floral panicle, but the fruit receive the most damage. The fungus causes brown spots on leaves and black spots on fruit and flowers and makes the young branches brittle. The infestation can be reduced if dead material (branches, leaves and infested fruit) is removed from the orchard. After harvest, anthracnose can be controlled if the fruit is given a water bath for 3 to 5 minutes at 55° C.
- **Bacterial infection** with *Erwinia* spp. can infect the stem, branches, flowers and young fruit. The symptoms are similar to the spots on the fruit and leaves as in anthracnose. These bacteria can survive in the soil. When it rains, the bacteria spores get under the leaves and fruit through rain splash (when soil particles get pushed into the air on contact with raindrops). Cover crops reduce rain splash, thus reducing the infestation of the leaves and fruit. An active and living soil can also reduce bacterial multiplication because *Erwinia* spp. does not explosively propagate in soil.
- **Powdery mildew** *(Oidium mangiferae)* can damage young fruit and flowers. This fungus appears mostly in warm, humid weather (temperature of 22° C and relative humidity of 65 %). In severe attacks, the entire blossom panicle may be involved and fruit fail to set (affecting yields). An open, well-ventilated and faster drying orchard that is regularly pruned hinders the mildew infestation.
- **Leaf spot disease *(Cercospora mangiferae)*** - causes spots on leaves and fruit. An open, well-ventilated and well-drained orchard is the best preventive measure against *Cercospora* infestation. Infested fruit is not marketable.

HANDLING MANGOES FOR MARKETING OF FRESH FRUIT



In acute cases, mildew, anthracnose and leaf spot diseases can be regulated with sulphur or copper preparations, which are allowed in organic farming. However, in case of certified organic mango production, the farmers should consult their certification body for guidance before applying any of those preparations.

6. Postharvest handling

An organic mango orchard may produce its first marketable harvest after 4 to 5 years, depending on the variety and location. The maturity of the fruit is determined by the changes in colour, fullness of fruit and hardened endocarp (fibrous coating of the seed). The fruit is ready for harvest when the colour changes from green/purple to red/yellow/orange and the inside flesh becomes yellow. Since all the fruit do not ripen at the same time, it is necessary to continuously check the change in fruit colour before harvest.

The mango consumed as fresh fruit is harvested by hand using shears or big scissors. If trees are too high, ladders may be used or a long pole with a cloth bag attached at the tip (that can hold two or three fruit). For fresh fruit sales, the fruit should be put in a crate or a basket lined with some leaves. Fruit for processing can be carried in bags, but avoid putting too much fruit in the bags to prevent damage. Injured or damaged fruit should be separated from healthy ones to avoid possible infection with fungi.

Fresh fruit

Harvested fruit should be washed immediately—within12 hours—to remove any sap. Generally, if the mangoes are to be sold as fresh fruit, they must be dipped in a hot water bath (55° C, 3 to 5 minutes) to clean them and then slowly cooled to room temperatures. Afterwards, the mangoes should be left to drip dry, sorted and packed in carton boxes or cushioned wooden boxes ready for delivery.

Dried mangoes

In order to avoid wastage, especially during the peak season, farmers may dry the mangoes so that they can safely store them for a longer time. If there is a market opportunity, then they will earn extra income from the dried mangoes. Drying is based on the fact that microorganisms will not grow when mangoes are dried to a certain moisture level. However, the quality of the dried mangoes

Discussion on postharvest handling

Inquire among the farmers how they commonly utilize mangoes. Do they sell to the fresh fruit market, dry the fruit or produce pulp or juice? Discuss for all uses what the best harvest time is and how postharvest handling is best managed.

A SIMPLE METHOD OF MANGO FRUIT DRYING

will depend on how the process of drying is done. Many technologies for fruit drying are available, depending on the location, ranging from simple plastic tunnel driers to stainless steel cabinet driers. The farmers should contact the local extension officer for guidance. The process of mango drying is, however, done as follows:

- **Sorting -** After harvesting, the fruit should be sorted to obtain only the fresh, fully ripened and unfermented fruit for drying.
- **Washing and peeling -** Mangoes should be washed in clean water to remove any dirt and infections on the fruit skin.
- **Slicing and drying -** The fruit are cut into similar sized pieces and laid out to dry in thin layers on racks, into the dryers at temperatures between 50 and 60° C.
- **Sorting and packaging -** Before they are packed the fruit are sorted again to remove skin remnants and discoloured fruit.

7. Marketing and organic certification of mango production

The decision to certify mango production should be based on the possibility to sell to an organic market. This is because certification comes with an added cost which should be payable from the organic mango sales. In order to reduce certification costs, an individual farmer may join an existing or create a new collective certification group.

General requirements for organic certification of mango production:

- During production of mangoes, the use of synthetic pesticides including herbicides and fertilizers, and genetically modified planting materials is not allowed. Any pesticide contamination from neighbouring conventional coffee gardens through soil erosion or wind drift should also be avoided.
- During postharvest handling of mangoes and processing, use of synthetic materials is not allowed, including use of fungicides to protect harvested mangoes from fungal infections.

Discussion on marketing potential and requirements for organic certification of mango production

Ask the farmers if there are any certified organic mango farmers in the area. Are there any companies that require certified organic mangoes? What are their requirements on production, quality and certification?

Specific national or international organic standards define the requirements for production and postharvest handling of mangoes. Farmers should, therefore, consult an organic certification body operating within the region or country for further guidance on certification.

Further reading
Infonet Biovision: www.infonet-biovision.org