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African Organic Agriculture Training Manual

A Resource Manual for Trainers

PEST AND DISEASE MANAGEMENT IN SELECTED ORGANIC CROPS

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The manual is intended for use by trainers during trainings of farmers on the management of pests and diseases in organic production.

Comments and recommendations for improvement to this version are welcome.

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SET OF TRANSPARENCIES

Guide to users of this manual

The main purpose of this manual is to both present generic principles of organic pest and disease management, as well as specific measures that apply to particular pests and diseases of prioritised crops in selected GIZ Green Innovation Centres (GIC) programme countries that are part of the Organic Agriculture Working Group. For this purpose, four crops have been prioritised, that is, cocoa commonly grown in Cameroon and Togo, field beans commonly grown in Benin, Cameroon, India, Malawi, Mali, Mozambique, Zambia and Togo; groundnuts commonly grown in Malawi, Zambia and Togo; and pineapple commonly grown in Benin and Togo. Detailed description of good production practices of some of these crops is available on the Africa Organic Agriculture Training Manual platform (www.organic-africa.net).

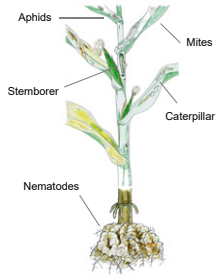
Further, the training manual also outlines some of the regulatory considerations for use of various inputs in organic crop production, especially when farmers are considering marketing. The changes to the new EU regulations, for example, and potential implications to the smallholder organic farming are also outlined.

Key learning targets for trainers of trainers and or trainers of farmers:

- Distinguish between pest and disease damage on the crops.
- Develop a more in-depth understanding of how pests and disease-causing organisms that limit production and storage of agricultural products can be effectively managed in organic farming.
- Understand that the organic approach to management of pests and diseases is primarily focused on prevention (as compared to direct control through use of bio-pesticides) as the first strategy, by providing good growing conditions for the plants to enhance their resilience and resistance and encouraging natural control mechanisms through promotion of natural enemies.
- Recognise that a combination of prevention and management measures are required to effectively manage pests and diseases (toolbox), and that no one measure is adequate on its own.

TYPES OF PESTS

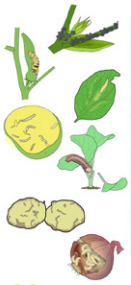
Different pest types



African Organic Agriculture Training Manual Pest and Disease Management 1

EXAMPLES OF PEST DAMAGE

Examples of pest damage



Affected part	Typical damages	Pest types
Plants	Withering plants, damping-off young plants, eaten roots	Larvae of noctuids or stemborer
	Missing young plants	Birds like sparrows, starlings and crows
	Yellowish, withering and dying plants	Nematodes on plant roots
Leaves	Leaves with holes or missing parts	Caterpillars, weevils
	Curled leaves	Aphids sucking sap
	Woven tissue on yellowish leaves	Spider mites
Fruits	Damaged or rotten fruit	Larvae of fruit flies
Seeds	Holes in seeds	Seed beetle, grain borer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1 Introduction

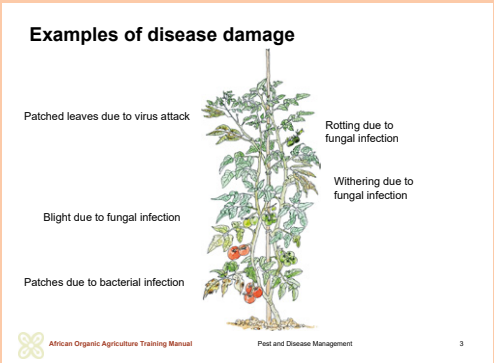
Organisms that attack and destroy crops completely or partially, thus reducing the yields, are considered by farmers as pests or diseases. Pest damage can manifest in many different forms:

- Insects - leaves with holes or missing parts caused by caterpillars or weevils; curled leaves because of aphids or mites sucking sap from the leaves; damaged or rotten fruit after being eaten by larvae of fruit flies; withering plants caused by larvae of noctuids, or stem borer; branches or trunks with holes caused by wood-eating insects; and others.
- Mites are very small pests and cannot be seen clearly with the naked eye. Infested plants, leaves and fruit turn yellowish among other symptoms.
- Nematodes are also very small, live in the soil, and are not easily observed by the naked eye. They mostly attack plant roots resulting in yellowish plants that wither and die.
- Larger animals like elephants, monkeys or mice, voles, and birds like sparrows, starlings and crows can also damage crops, but these are not the focus of this Training Manual.

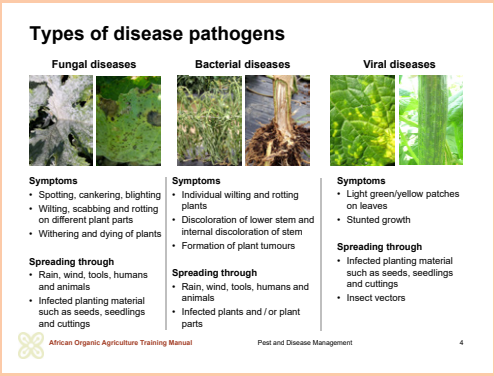
On the other hand, disease damage is any ill health or abnormality on the plant caused by fungi, bacteria, and viruses, when they interrupt or modify the vital functions of growing plants or stored produce. Most crop diseases are caused by fungi, bacteria or viruses:

- Fungi cause the great majority of infectious plant diseases. They are responsible for most cases of spotting, cankering, blighting, wilting, scabbing and rotting on different plant parts. Fungi can cause parts of plants or the entire plant to wither and die.
- Bacteria causes the breakdown of the cell walls of plants, so that the plant starts to rot. Damaged plant tissue or the blocking of water uptake causes early death of the plant, and overgrowth of plant tissue causes tumours.
- Viruses mostly cause leaves and other green plant parts to change in colour. Light green or yellow patches of various shades, shapes and sizes appear in affected leaves resulting in a general reduction in the growth and vigour of the plant.

TYPES OF DISEASE DAMAGES



TYPES OF DISEASE CAUSING PATHOGENS



When do pests and diseases become a problem?

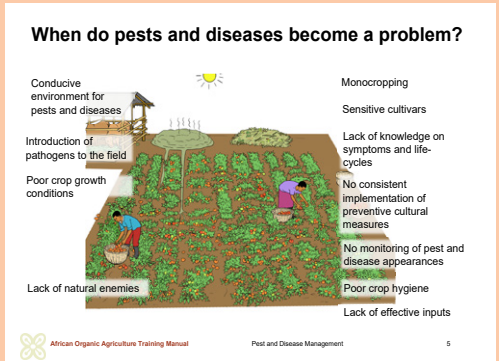
From an ecological perspective, all organisms are part of nature, irrespective of what they do. Therefore, presence of these organisms in crop fields is natural, and nature normally balances these organisms through pest-predator relationships. However, when nature is distorted through different farming operations, for example growing one type of crop season after season without rotation (monoculture) or factors that cause habitats to be unfavourable, some types of organisms will increase in numbers beyond a certain level and cause substantial damage to the plants and a reduction in crop yields or quality of harvested produce. Pests and diseases regularly become a problem among African smallholder farmers due to the following reasons:

- **Conducive environment for pests and diseases:** In many parts of sub-Saharan Africa, a wide variety of pests and diseases occur because of the favourable, humid conditions nearly throughout the year. In addition, new pests, and disease-causing organisms evolve or are introduced, mostly accidentally, in the region. It, therefore, proves very challenging for the smallholder farmers to recognise, distinguish and control the different pests and diseases.
- **Limited availability of cultivars** that have resistance to specific diseases or pests.
- **Inadequate diversification within crop fields:** Inadequate diversification within crop fields leads to lack of suitable natural habitats and food for beneficial organisms, a situation which is compounded by repeated application of broad-spectrum pesticides in monocropping systems.
- **Lack of knowledge** of the characteristics of specific pests and diseases, and inability to conduct systematic monitoring for pest and disease symptoms.
- **Lack of knowledge of the life cycles of pests and diseases and effective control measures:** As a result of this, farmers cannot apply timely suitable preventive measures, nor implement appropriate direct control measures in case of strong infestations or infections.
- **Insufficient implementation of effective crop and field hygiene measures.**
- **Limited availability of good quality organic pest and disease control inputs:** There is a wide variety of conventional pesticides available on the market, including ineffective ones but very few organic approved ones. Since the majority of farmers cannot read and interpret the contents, prescriptions and other precautions, they cannot make proper choices and follow the correct procedures on the best pesticides. They instead rely on recommendations from the

Field visit or exercise to identify pest and disease causing organisms

Collect plant samples showing different pest and disease damage, and invite the farmers to categorise the disease symptoms into fungal, bacterial or viral infections.

REASONS FOR PEST AND DISEASE PROBLEMS



IMPLICATIONS OF POOR PEST AND DISEASE MANAGEMENT

pesticide retailers, who often lack the proper knowledge themselves and are often more motivated to make sales than advise farmers.

› Lack of knowledge on the effectiveness of pesticides, their harmful effects against beneficial organisms, and good application practices for optimal results.

This is a clear indication that effective management of pests and diseases among many farmers all over Africa would thus require a focus on affordable and effective measures which are:

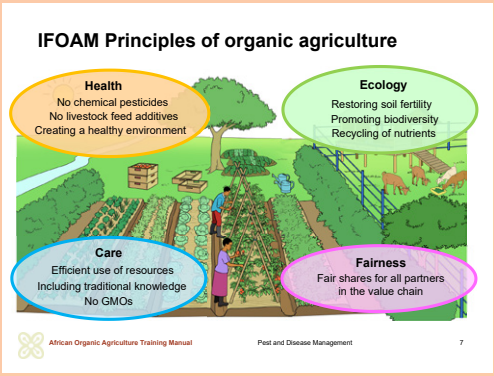
› Readily available.
› Easy to apply at minimal extra cost.
› Applicable in the local situation and conditions.
› Safe to handle, with minimal or no residual effect (i. e. acceptable in organic production).

1.1 General approaches and strategies to organic pest and disease management – the 3-step approach and associated tools

Organic farming is the way of producing good quality farm products in harmony with nature. Organic farmers optimise the growing conditions of crops by enhancing the natural fertility of the soil to ensure good nutrient and water supply, creating diverse cropping systems, and promoting natural enemies of pests, recycling organic materials and manures, and using natural inputs while renouncing synthetic chemical pesticides and fertilisers.

The organic approach to plant pest and disease management makes reference to the four principles of organic agriculture: the principle of health, the principle of ecology, the principle of fairness, and the principle of care (see IFOAM principles of organic agriculture). Generally, organic farmers aim at sustaining and enhancing the health of their soils, plants, animals, humankind and—in the broad sense—the planet. The health of individuals and communities cannot be separated from the health of ecosystems. Therefore, by encouraging healthy and fertile soils, establishing diversified natural cropping systems and maintaining a diverse natural environment, farmers can produce healthy crops that foster the health of animals and people.

PRINCIPLES OF ORGANIC FARMING



Healthy plants resist and tolerate physiological disruption and damage from disease-causing organisms and pests better. Thus, organic farmers aim at optimising the growing conditions for their crops to make them strong and resilient. At the same time, they encourage natural control mechanisms like the promotion of beneficial organisms to limit the spread of pests and diseases. Doing so, organic farmers give priority to preventive measures instead of relying on direct control measures only. Direct control measures are only applied when the pests and disease pathogens threaten to cause major losses.

The three-step approach

Organic pest, and disease management can be seen as a three-step approach with multiple tools.

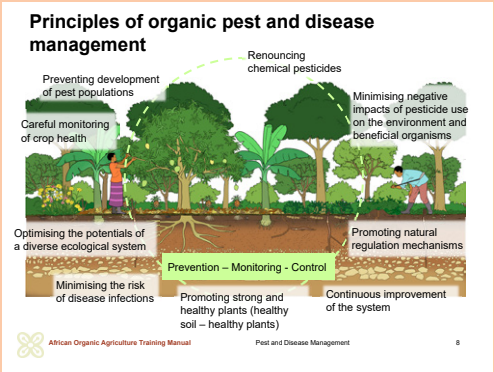
Step 1: Consists of providing good growing conditions for plants to enhance their resilience and resistance and hence withstand pest and disease attacks better.

Step 2: Consists of encouraging natural control mechanisms through promotion of natural enemies, ensuring good crop hygiene, and monitoring pests and diseases populations for timely action.

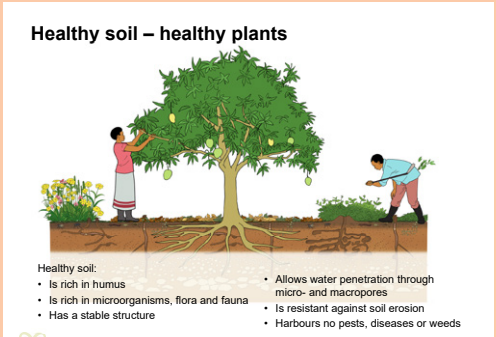
Discussion comparing human health with plant health

Invite the farmers to identify the similarities and differences between human health and plant health care. The functioning of plant health care can be elaborated on in groups and discussed in a plenary session.

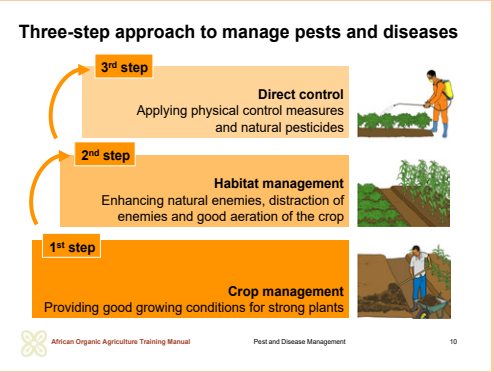
PRINCIPLES OF ORGANIC PEST AND DISEASE MANAGEMENT



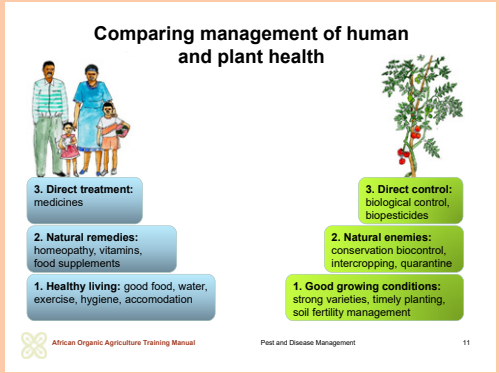
THE ROLE OF THE SOIL FOR PEST AND DISEASE MANAGEMENT



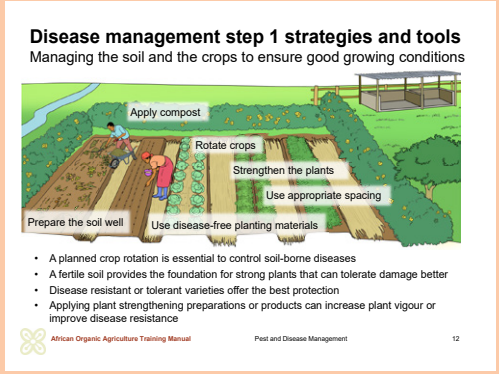
THREE-STEP APPROACH



HUMAN AND PLANT HEALTH MANAGEMENT



DISEASE MANAGEMENT STEP 1



Step 3: Involves application of direct control measures to kill the pests or disease-causing organisms when they reach critical levels in a way that has minimum residual effect to the ecosystem.

Each step of the three-step approach builds the foundation for the next step. The aim is to optimise steps 1 and 2 to encourage natural self-control of pathogens and to minimise the direct control measures in step 3. With proper and efficient application of steps 1 and 2, direct intervention is usually not needed. This saves on costs and prevents negative impacts of some direct control measures on the environment.

Decades of practical experiences from organic farmers and results of scientific research on organic pest and disease management in the last 30 years have shown that the combination of indirect and direct control measures is most effective. As knowledge of the interaction of pest and disease pathogens and their natural enemies increases further, efficiency of this holistic approach also increases. Ideally, farmers will eventually be able to abandon any direct control measures and instead maximise the use of natural processes.

In comparison, the three-step approach also applies to human health care management:

1st step measures: Provision of sufficient and healthy food and water, and the preservation of a healthy environment to encourage human health. It also includes good behavioural practices to avoid illness by simple measures of hygiene (e.g. washing hands regularly and brushing teeth), appropriate exercise to strengthen the body and refraining from risky conditions or situations.

2nd step measures: Preventive intake of vitamins when necessary, antioxidants or probiotic agents and the use of natural medicine against illness (e.g. traditional medicine, medical herbs and homeopathy).

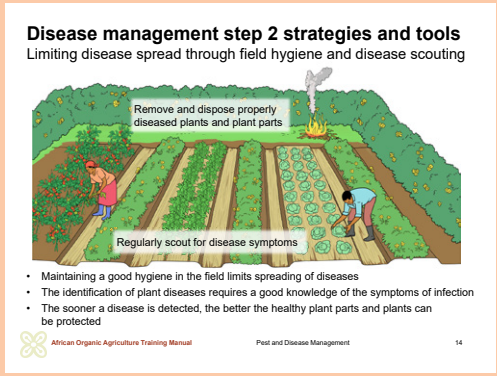
3rd step measures: Direct treatment using antibiotics and other medicines to kill off infections.

1.2 Step 1 strategies and tools

These strategies and tools aim at providing good growing conditions to enhance plant health and prevention of introduction and spread of pests and diseases. This can be achieved through the following practices:

PEST MANAGEMENT STEP 1

DISEASE MANAGEMENT STEP 2



- Choice of appropriate crop varieties suitable for the location. Where possible, varieties tolerant or resistant to pests and diseases should be used.
- Using disease- and pest-free planting materials.
- Soil fertility improvement to encourage strong and vigorous growing plants by using compost, animal manure, green manure, and other natural nutrient sources.
- Intercropping and crop rotation to reduce the multiplication rate of pests and disease-causing organisms.
- Other good management practices to ensure proper growth such as timely planting, proper spacing, water conservation, pruning, shade management and timely harvesting.

1.3 Step 2 strategies and tools

These strategies and tools aim at enhancing the proliferation of a variety of organisms (including natural enemies) around and within the crop fields. These include:

- Planting hedges of indigenous plant species around fields to attract natural enemies. Allowing flowering plant species to grow within crops to provide nectar and pollen for natural enemies like ladybird beetles, hoverflies, and parasitoids.
- Trap cropping to attract pests to non-crops or repel/push away pests from the crops (e. g. the push-pull strategy).
- Field hygiene, including timely weeding to remove alternative hosts, rogueing infected plants and plant parts, proper disposal of infected plants and cleaning or disinfecting tools used on infected plants/fields.

1.4 Step 3 strategies and tools

In situations of heavy infestations or very devastating pests and diseases, direct measures will be needed to minimise losses.

These include:

- Biological control agents such as predatory insects and mites, insect parasitoids, viruses and bacteria (e. g. *Bacillus thuringiensis* Bt).

Assessment of local challenges and practices in pest and disease management

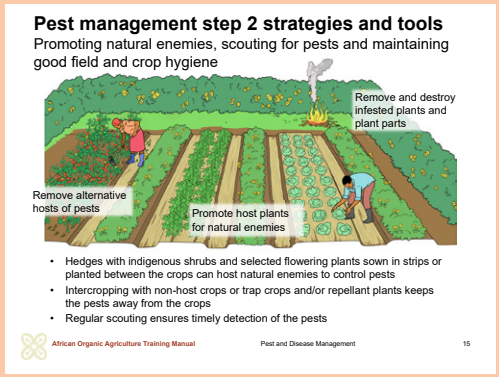
Inquire among the participants what the major challenges related to pest and disease management are, by asking the following questions (focus on a specific crop):

- What are the predominant pests? Can you identify them? What kind of damage do they cause?
- What preventive measures can be applied to avoid or limit these infestations? How effective are they?

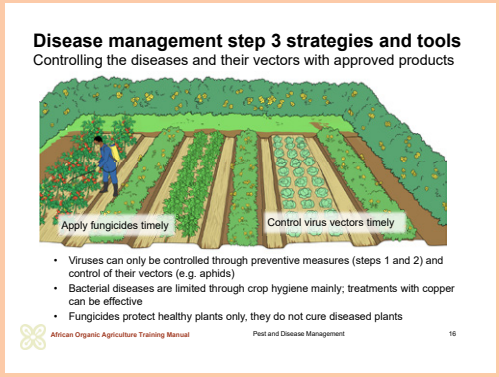
Repeat the same exercise focusing on the diseases. After having collected the participants' answers, discuss the challenges related to pest and disease management.

- How relevant are preventive measures and regular monitoring?

PEST MANAGEMENT STEP 2



DISEASE MANAGEMENT STEP 3



› Approved commercial or self-made insecticides or acaricides (against mites) of biological or mineral origin including plant extracts, plant oils, mineral oil, copper, and sulphur.
› If available, insect pheromone traps may be used to disrupt mating of pests.
› Light, bait or colour traps may be used for mass-trapping pests.
› Hot water treatments of seeds to limit seed-borne diseases.

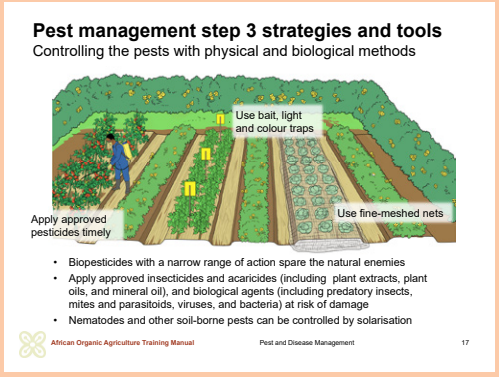
These tools will only be fully effective when tools in the other two steps are applied properly.

Organic plant pest and disease management is based on:

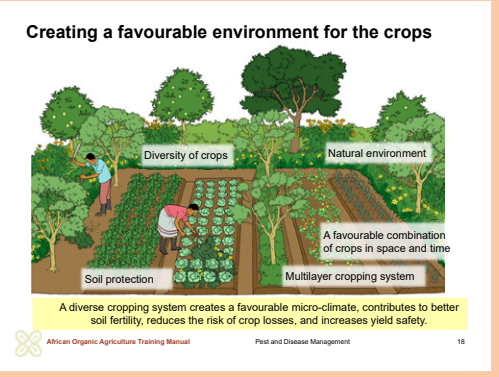
a. Planting into a pest- and disease-free field

Proper land preparation is required to create a suitable soil environment for growing crops, while removing any weeds or crop remnants that could harbour crop pests and diseases. This, together with a good crop rotation reduces the chances of pests and disease-causing organisms incubating in the crop field and building up their populations. An interval of 1 to 3 years between crops of the

PEST MANAGEMENT STEP 3



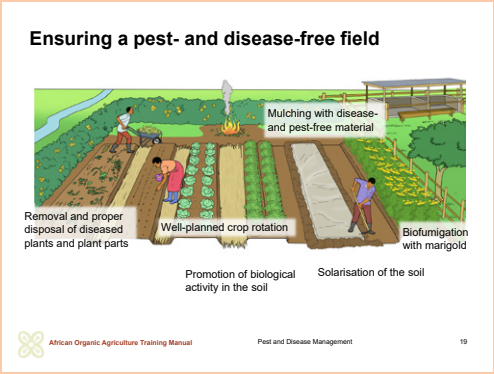
CREATING A FAVOURABLE ENVIRONMENT



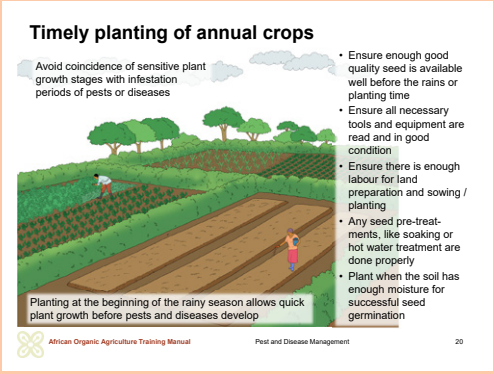
Assessment of local challenges and practices in pest and disease management (continued)

› Which preventive measures prove especially effective? Are there differences between different crops or cropping systems, annual and perennial crops?

PEST- AND DISEASE-FREE FIELD



TIMELY PLANTING



same family grown on the same field breaks the life cycle of most pathogens. The minimal duration of the interval depends on the disease or pest persistence in the soil. Some diseases stay dormant as spores in a field for many years (e.g. bacterial wilt stays infectious for at least 2 years, late blight up to 4 years, and Fusarium wilt up to 6 years). Many pests like bean aphids or plant-parasitic nematodes will easily die from starvation if host crops and or other host plants are not available in the following year. If soil-borne pests and diseases are a problem, improved fallows for at least one season can also be applied if land is not limiting. Biofumigation with plants such as marigolds and rapeseed oil before planting crops can control soil borne pests like nematodes. Burning of any pest or disease infested materials (only mulch with pest and disease-free materials), and solarisation of seedbeds or plots, where feasible, to kill any soil borne pathogens are recommended practices.

b. Timely planting

Planting should be scheduled so that the most susceptible time of plant growth does not coincide with the life stage of pest or disease inoculum that damage the plant. Timing of seeding and planting is used to avoid invasion by migrant pests, or the oviposition period of particular pests, and the introduction of disease in the crop by insect vectors (like aphids and psyllids). In addition, it is used to synchronise the pest or disease attack with its natural enemies, with weather conditions that are adverse for the pest, disease pathogens, or with the abundance of alternative hosts. Although timing needs specific knowledge of the pest or disease pathogen and when it is likely to attack, the commonly promoted practice is to plant as early as possible during the season.

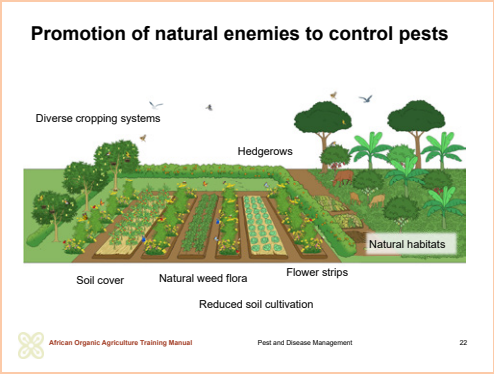
c. Selection of tolerant cultivars, and healthy seeds and planting materials

The use of pest- and disease-free seeds, and planting materials is a very effective tool to limit the introduction and spread of pests and diseases into the crop field. Certified seeds are normally clean, but if such seeds are not available to the farmers, un-certified seeds should be treated before use to eliminate seed-borne diseases (for example using hot water treatment at the recommended temperatures to avoid damaging the seed if the water is too hot).

In addition, the use of crops and varieties tolerant or even resistant against common pests and diseases is another effective measure to lower risks of pest and disease damage. There are more commercial crop varieties with disease re-

VARIETY SELECTION

PROMOTION OF NATURAL ENEMIES



sistance than are known for pest resistance. Therefore, for pest resistance, partial resistance, or field tolerance to pests by locally adapted varieties is more practical. Traditional and locally adapted crop varieties should be prioritised – even 'resistant' varieties need to be adapted to local climatic conditions for effective resistance and usefulness to the farmer.

d. Promotion of natural enemies for biological control

Natural enemies play a critical role in the regulation of pest and disease populations. By encouraging, for example, a diversity of flowering plants, the availability of nectar, pollen, fruits, insects, and other organisms increase and help to keep a check on the pest populations keeping them at low levels that do not threaten the crops. The main natural enemies include a wide variety of spiders, ladybird beetles, long horned grasshoppers, earwigs, wasps, etc. Some of the strategies for promoting the proliferation of natural enemies include:

- Certain flowering plants, especially perennial ones, along the border of the crop fields can attract and promote natural enemies. The flowering plants can also be sown or planted along internal bunds inside the field or as companion crops within the field. These plants act as a source of food in the form of pollen and nectar for adult natural enemies, source of shelter or alternative hosts when primary hosts are not present.
- Promotion of soil-borne natural enemies through regular addition of organic matter to the soil in the form of compost, mulches, farmyard manure, or crop residues. Green manure cover, and careful soil cultivation also enhances below ground biodiversity which reduces soil-borne pests and diseases. Practicing reduced tillage also minimises the destruction of hibernating natural enemies, or their hibernating homes or shelters.

e. Intercropping (or mixed cropping)

Growing different crop and plant species together creates a less favourable habitat that visually or chemically interferes with pest activity. Mixed intercropping systems where two or often more species are grown intermingled without distinct rows are very commonly used in the tropics. Row intercropping (growing two or more crops together in rows) and strip cropping (cropping by growing two or more species in strips) must be sufficiently wide to allow separate management regimes, but sufficiently close to influence each other. These types of mixed cropping systems have been widely investigated as they have great

potential for reducing pest attacks. The mixture of plants needs to be carefully chosen. Anise, chives, garlic, onions, radish, parsley and many other species are reported as good partners for intercropping. Mexican marigold has also shown the advantage of repelling pest insects like aphids and root nematodes when mixed with crops, although it can attract slugs which is a pest for vegetables, if not well monitored.

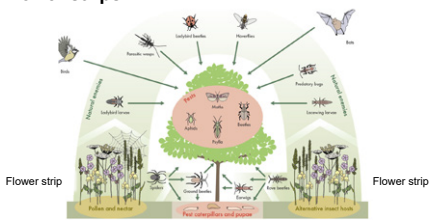
Trap cropping ensures that the trap crop is more attractive to the pest as either a food source or egg laying site than the main crop. A particularly successful example is the push-pull trap cropping used in East African maize production. Push-pull strategy is a simple cropping strategy, whereby Napier grass *(Pennisetum purpureum)* or bracharia grass and desmodium legume *(Desmodium uncinatum)* are used as intercrops in maize. Desmodium is planted in between the rows of maize. It produces an odour that stem borer moths do not like and, therefore, 'pushes' away the stem borer moths from the maize crop. Napier grass is planted around the maize crop as a trap plant. Napier grass is more attractive to stem borer moths than maize and it 'pulls' the moths to lay their eggs on it. But Napier grass does not allow stem borer larvae to develop on it. When the eggs hatch and the small larvae bore into Napier grass stems, the plant produces a sticky, glue-like substance which traps them, and they die. So, very few stem borer larvae survive and the maize is saved because of the 'push-pull' strategy. In addition, the ground cover of desmodium within the maize field reduces witch weed (Striga spp.). Desmodium suppresses the witch weed by herbicidal compounds produced in the roots. Being a legume, desmodium also fixes nitrogen in the soil and thus enriches the soil.

f. Proper soil fertility management

The enhancement of a healthy, fertile soil and good growing conditions promotes healthy plants, improving pest and disease control. A fertile soil enhances plant health and even triggers the immune reaction of plants. Crop rotations especially with leguminous plants which fix nitrogen into the soil, helps to reduce nutrient stress to the plants and enhances crop vigour - vigorous plants are less susceptible to pests and disease damage.

CONTRIBUTION OF FLOWER STRIPS

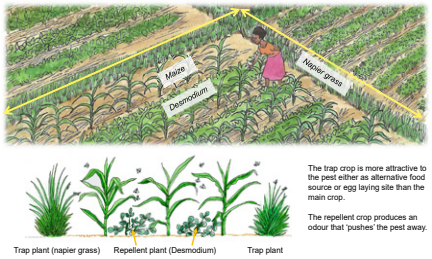
Example of promoting natural enemies with flower strips



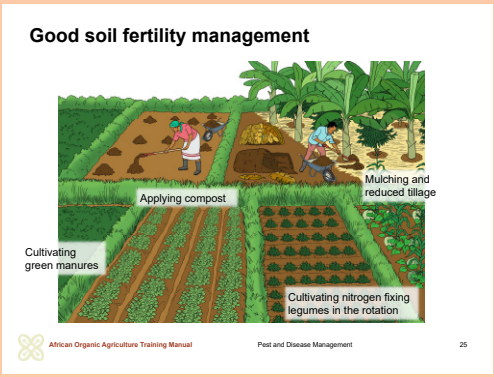
Strips of selected flowers, sown next to fruit trees, can maintain a diverse population of natural enemies close to the trees. In this way, they manage to rapidly control pest populations in a natural way.

PUSH-PULL STRATEGY IN MAIZE

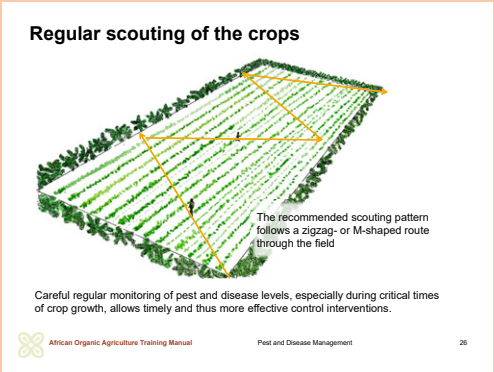
Controlling stemborer with the push-pull method



SOIL FERTILITY MANAGEMENT



SCOUTING

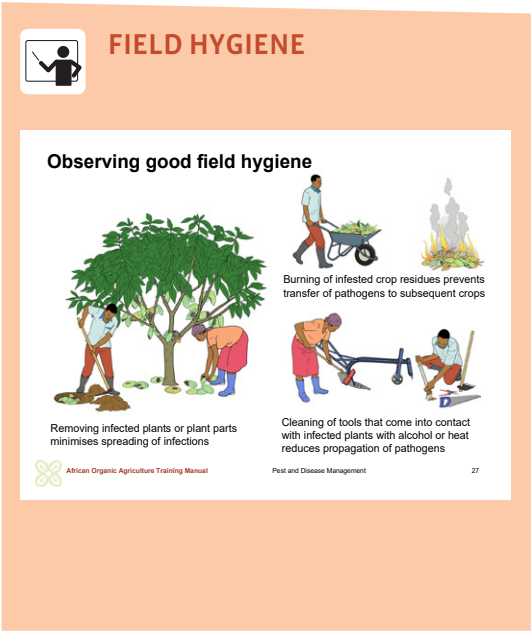


Soil fertility can be improved through the following approaches:

- Planting cover crops and green manures, which besides feeding the soil also improves its organic matter content and reduces pests by interrupting their movements across the field and diseases through biofumigation. Pest species like aphids, root flies or weevils will not find the crop plants due to the intercrop causing smell-related confusion as the cover crops or green manures emit different odours.
- Application of compost can help control plant pests and diseases through (i) successful amendment of the soil with insect pathogenic microorganisms (ii) antibiotic production by beneficial microorganisms and (iii) activation of pest-tolerance or disease resistant genes in plants by essential nutrients from compost. Some of the microorganisms, for example Trichoderma fungus, exhibit antagonistic characteristics against diseases causing microorganisms and prevent them from multiplying. Just like compost, application of disease and pest free organic mulches also can, in special cases, reduce pests like root flies, cutworms or aphids, by altering the immediate microenvironment around the crop or by reducing raindrop splash-dispersal of some soilborne diseases. However, organic mulches might also enhance some fungal diseases by moderating soil moisture.

g. Regular scouting

Regular monitoring of the presence of pests in the field should begin as soon as the crop emerges after planting and should continue throughout the growing cycle. Randomly locate specific sites (about 5) in the field along a Z-path, visit them following a defined schedule (e.g. weekly), recording counts of insects as per procedure finalised for individual insects. For disease scouting, the cause of the symptom may not be obvious. What may appear as disease symptoms of fungal, bacterial, viral pathogens, are sometimes effects of abiotic factors such as weather, fertilisers, nutrient deficiencies, damage by pesticides, or soil related problems and it is important that farmers know these differences for appropriate action. Generally abiotic problems cause regular, uniform colouring symptoms (except viruses), as compared to fungal diseases which cause irregular growth & spotting colour patterns, cankering, blighting; wilting, scabbing and rotting on different plant parts, and withering or dying of plants. Viruses cause light green/yellow patches on leaves, and stunted growth, while bacteria cause rotting plant parts, and early dying of the plant or tumours.



To monitor insect pest populations, different traps can also be used. The simple idea is to know more about the presence of the insect pests in the field, especially the fast moving (mobile) insect pests (e.g. fruit flies, lepidopteran pests) as described in section i below (direct control of insects).

h. Field hygiene and sanitation

Maintaining sanitation practices in the field prevents the introduction and spread of pests and disease-causing organisms.

- Sanitation of existing crops, especially perennial crops should be done regularly. Poorly managed or abandoned perennial crops can result in buildup of pest and disease problems. All damaged plant materials and rotten fruits from the ground must be either burned or deeply buried at least 50 cm deep.
- Pruning is an important operation especially in plantation or tree crops. It eliminates inoculum in perennial crops. All infected branches or shoots should be cut at least 20 cm below the visible damage and burnt. Pruning also improves aeration and light exposure to the crown, exposing the hiding places of pests and disease-causing organisms.
- Regular cleaning of all the tools used for pruning infected plants or gardens is important, especially in the case of bacterial and viral diseases. If possible, alcohol (>70 %) can be used to disinfect the tools or heating the metal parts of tools over a fire.

i. Natural direct control measures

Direct control measures that respect and protect the natural resources - soil, water, air, and biodiversity are encouraged. Negative impact on the environment is also avoided by not using synthetic and potentially harmful pesticides.

Examples of organic direct control measures;

- Direct biological control of pests involves the release of mass-reared live agents such as bacteria, viruses, fungi, insect predators and insect parasitoids into crop fields to control pests for a brief or extended period. However, not all commercially available biocontrol agents can be used in organic agriculture; for instance, genetically modified organisms are prohibited. Direct biological control is widely used in greenhouse crops.
- Insecticides of vegetal or mineral origin. There are commercial organic insecticides available in many countries of Africa (e.g., neem, rotenone, pyrethrum). Most of them can be produced by a farmer on the farm.

INSECTICIDAL PLANTS

African plants with insecticidal properties

Plants	Range of action and caution
Neem (*Azadirachta indica*)	many insects, nematodes (neem cake)
Pyrethrum (*Chrysanthemum cinerarifolium*)	most insects and mites
Fish bean (*Tephrosia vogelii*)	caterpillars, mites
Chili (*Capsicum frutescens*)	many insects
Tobacco (*Nicotiana* spp.)	all insects and mites (very toxic for humans)
Mexican and African marigold (*Tagetes* spp.)	repellent against insects, effects against nematodes
Garlic (*Allium sativum*)	anti-feedant for insects
Wild basil (*Ocimum suave*)	repellent against insects

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PEST TRAPS

Monitoring insect pests with traps

Yellow or blue sticky traps → Insects

Homemade trap → fruit flies

Pheromone trap → pest insects

Light trap → noctuids

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› Pheromone traps are mostly used for monitoring pest insect populations in the crop field, but can also be used for mass-trapping of pests. Pheromone dispensers release a sex hormone similar to that produced naturally by the female insect, which attract the male insects into the trap in which they get stuck. Several types of pheromone traps have been developed for monitoring African bollworms, cutworms, fruit flies, etc. and are widely used. However, in most parts of Africa, pheromone traps are not locally available and imported ones are not affordable to small-holder farmers. Sex pheromones can also be used for mating disruption. Here, a high number of dispensers are installed in the crop (fruit orchards, or vineyard) to get a pheromone cloud within or over the crop. Male insects will then not be able to find the female and mating is, therefore, disrupted. Consequently, the pest offsprings will be reduced, hence lower damage to the crop.

› Mass-traps often can easily be built with cheap material. For example, light traps can be used to catch moths such as armyworms, cutworms, stem borers and other night flying insects. Coloured sticky traps (blue, yellow or white) can be used to monitor and mass trap adult thrips, house flies and fruit flies in the crop nursery or field. Yellow sticky traps can specifically be used to mass-trap whiteflies, aphids and leaf mining flies. Alternatively, water traps (with few drops of a detergent) with a surface area of 250 to 500 cm^2, and preferably round, with the water level about 2 cm below the rim can also be used.

› Physical barriers against pests like fruit bagging also help to prevent fruit flies or other pests from laying eggs inside or on the fruits.

Direct measures should be used as a last option for the control of pests and diseases when all methods used in preceding steps fail. For certified organic production, only agents of non-synthetic origin are permitted. One allowed exception is the use of synthetic pheromones because they are contained in dispensers and, therefore, do not come into contact with crops. It is therefore important for certified organic farmers to check with their organic certifiers before applying any commercial products.

The intensity of these direct measures will depend on the pest or disease being targeted as well as the type of crop being considered (annual or perennial crops). They should therefore be taken in combination, not in isolation. For example, when armies are preparing for combat warfare, they take time to study the opponent in terms of their numbers, type of weapons they have, from where

they are likely to attack and potentially when, in order to equip themselves well if they are to win the fight. For the farmer, the pest or disease-causing organism is the opponent that he or she needs to know the type of the pest or disease-causing organism, how it is transmitted, what stage of the plant it attacks and the damage it causes.

Monitoring improves the knowledge on pest or disease development and helps the farmer to manage them more effectively.

The following questions may help one to better understand pest behaviour;

- At what stage of its lifecycle is the insect a pest: When it is a larva/ a caterpillar, a nymph or an adult?
- Which stage of the plant does it attack: the seedling, the growing plant or the mature plant?
- Which part of the plant does it attack: leaves, roots, the stem, fruits, seeds or the entire plant?
- What kind of damage does it cause: chewing, sucking or wilting?
- When does it attack: in the dry season or in the wet season?
- At what time of day is the pest most active – night or day?

The same process can be repeated for any disease.

2. Pest and diseases management in organic field beans

Common Beans *(Phaseolus vulgaris)* belong to the very large family of Fabaceae (also called Leguminoseae), which includes food plants such as beans, peas, peanuts, and soybeans.

Like other legumes too, beans transform atmospheric nitrogen into nitrogen that can be taken up by plants. They do this with the help of Rhizobium bacteria that live in their roots. Thus, they fit well as an intercrop or as part of a crop rotation plan.

However, beans suffer from a number of pests and diseases. The major insect pests in order of importance are aphids, cutworms, bean stem maggots (bean fly) and storage pests such as bruchids (bean weevil), while bean mosaic viruses, blight, leaf rust, root rots, anthracnose and angular leaf spot are the most important diseases.

BEAN COMMON MOSAIC VIRUS

Bean common mosaic virus (BCMV)

Source: iStock

Important to know	• Disease transmitted by viruses and through infected seeds
Measures before planting	• If possible, choose varieties that are resistant to BCMV. • Use seeds from approved seed suppliers. • Maintain a cultivation interval of at least 3 years (also of related species such as peas, soybean and peanuts).
Measures after planting	• Ensure proper plant nutrition to ensure strong and healthy plants. • Effectively control aphids.
Measures in case of infestation	• Maintain good field hygiene by removing any plants with virus symptoms from the field and burning or burying them.

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Organic management of pests and diseases in bean production is based on an integrated preventive package, which encourages that a range of practices are applied simultaneously to prevent the introduction and spread of pests and diseases. Individual management of specific bean pests and diseases is difficult in beans since they are very short-term crops. The combination of these approaches is provided in the sections below, highlighting those measures which should be applied before planting, after planting before infestations, and after planting when infestation occurs.

Bean common mosaic virus (BCMV)

Important to know

› BCMV causes cupping and twisting of leaves with a light and dark green mosaic pattern.
› Affected plants produce smaller, curled pods significantly reducing yields.
› The virus is seed-borne and transmitted by aphids.

Measures before planting

› Choose varieties with good yield potential and, if possible, resistant to BCMV.
› Seeds should be obtained from approved seed suppliers or carefully selected by the farmer to avoid introduction of BCMV.
› Maintain a crop rotation of at least two seasons before planting the next bean or related crop (such as peas, soybean, peanuts).

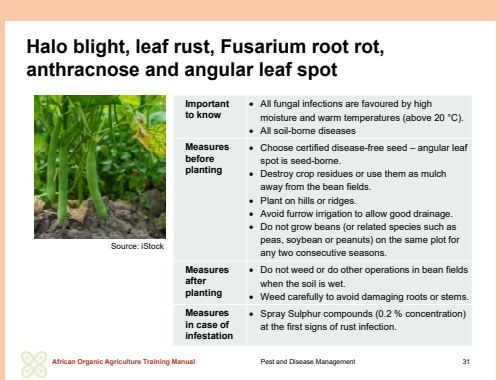
Measures after planting

› Improve soil fertility to ensure strong and healthy plants taking caution to not oversupply nitrogen as beans can fix their own nitrogen and excessive application is detrimental.
› Effectively control aphids when they are threatening the bean crop, as explained below.

Measures in case of infestation

› Remove any plants with virus symptoms from the field - burn, bury, make compost or use disease infested materials as mulch in other fields like perennial crop fields.

HALO BLIGHT, LEAF RUST, FUSARIUM ROOT ROT, ANTHRACNOSE AND ANGULAR LEAF SPOT



Halo blight, leaf rust, Fusarium root rot, anthracnose and angular leaf spot

Important to know

- Halo blight *(Pseudomonas syringe* pv. *phaseolicola)* causes small water-soaked pin-pricks-like spots on bean leaves. These spots eventually turn brown and the surrounding tissue gradually becomes yellow-green.
- Angular leaf spot *(Phaeoisariopsis griseola)* causes numerous small dark brown spots with angular edges, which join together causing yellowing, dying of affected leaves and premature defoliation. It also affects pods causing brown blotches.
- Anthracnose *(Colletotrichum lindemuthianum)* forms dark-brown lesions on leaves, but also on the stem and pods which appear black, elongated and sunken. Ultimately the infected seeds become discoloured.
- Bean rust *(Uromyces appendiculatus* var. *appendiculatus)* causes rust spots or pustules on all parts of the plant, but mostly on the leaves. The disease is spread by wind, farm tools, insects or water splash.
- Fusarium root rot *(Fusarium solani* f.sp. *phaseoli)* affects leaves, turning yellow and necrotic and later causing wilting, especially seedlings. The fungus can survive in the soil for up to 6 years.
- As fungal infections, they are favoured by high moisture and warm temperatures (above 20 degrees Celsius).

Measures before planting

- Choose certified disease-free seed – angular leaf spot is seed-borne.
- Destroy crop residues or use them as mulch away from the bean fields.
- Plant on raised beds or ridges, and avoid furrow irrigation to allow good drainage especially in areas susceptible to water logging.
- Crop rotation is essential to limit these soil-borne diseases – ideally beans should not be grown on the same plot for any two consecutive seasons.

Measures after planting

- Weeding and other operations in bean fields when the soil is wet encourages the spread of soil-borne diseases, and should be avoided when possible.
- Ensure shallow tillage, e.g. during weeding, as damage to the roots or stem will encourage infection by soil borne diseases.

BEAN APHIDS

Bean aphids

Source: Pixabay

Important to know	• Black ants are very common on plants with aphid infestations – they feed on the honeydew produced by aphids. • Aphids attack beans at any stage, from seedling to flowering/fruiting, and they attack any parts of the growing plant.
Measures before planting	• Do not grow beans (or related species such as peas, soybean, or peanuts) on the same plot for any two consecutive seasons. • Intercrop with chives or garlic to repel aphids. • Plant early to avoid water stress. • Grow or leave natural areas around the boundary or along strips in the field.
Measures after planting	• Regularly monitor fields to detect aphids early. • Remove weeds which compete with beans for nutrients.
Measures in case of infestation	• Apply neem or pyrethrum-based products.

Measures in case of infestation

› Sulphur compounds: spray Sulphur compounds (0.2 % concentration) at the first signs of infection. Some varieties are susceptible to Sulphur, it is recommended that farmers make trial sprayings before treating the whole crop.

Aphids

Important to know

› There are many species of aphids attacking many different types of crops (legumes, cereals, fruits and vegetables). For beans, it's the black bean aphid *(Aphis fabae)*.

› Aphids pierce plant tissues to feed on the sap causing curled leaves, malformed flowers and fruits, and stunted growth. Heavily attacked leaves turn yellow and eventually wilt. Aphids excrete a sugary, sticky liquid called honeydew which due to fungal growth forms sooty black mould on the plant.

› Black ants are very common on plants with aphid infestations – they feed on the honeydew.

› Aphids attack beans at any stage from seedling to flowering/fruiting and any part of the growing plant.

Measures before planting

› Crop rotation – ideally, beans should not be grown on the same plot for any two consecutive seasons.

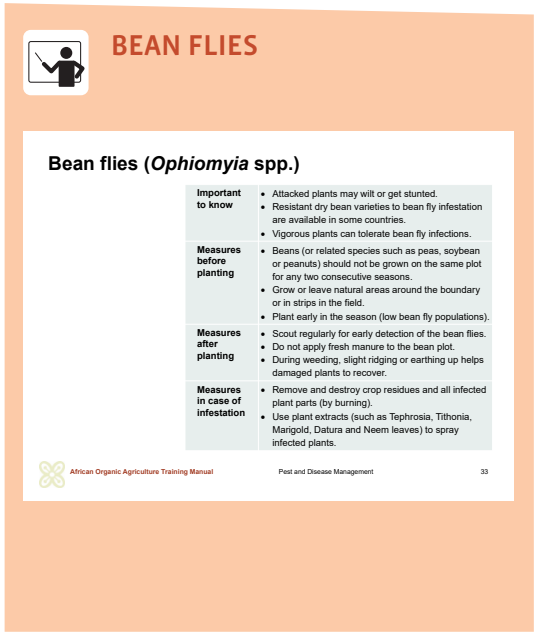
› Intercropping with chives or garlic helps repel aphids.

› Early planting is recommended to avoid water stress. Early planting will also enhance quick growth of the bean plants and evade attacks at sensitive stages.

› Encourage natural enemies, for example by growing or leaving natural areas (including flowering plants) around the boundary or along strips in the field. There are so many bugs, beetles and hoverflies that feed on aphids.

Measures after planting

› Regular monitoring of aphid infestation – regularly scout the bean field examining the underside of the leaves and growing points. Early detection is important as aphids multiply very fast. Especially watch out for the presence of ants which are attracted to the nectar released by the feeding activity of the aphids.



› Proper weed control especially in bush beans is necessary until the bean foliage covers the rows, thereby inhibiting weed growth. Weeds compete with the beans for nutrients, and some weeds can be hosts for aphid multiplication.

Measures in case of infestation

› Neem based products can be sprayed, but due to slow mode of action repeated sprays may be required and neem is generally safe on natural enemies.
› Pyrethrum based product sprays are most effective against aphids, but they also affect natural enemies.

Bean flies (*Ophiomyia* spp.)

Important to know

› Also called bean stem maggots, bean flies are serious pests in Africa.
› Females pierce the leaves and lay eggs into young leaves. Maggots mine their way from the leaves to the base of the stem, feeding on the tissues and causing the stem to swell and split. Attacked plants may wilt or get stunted.
› Resistant dry bean varieties to bean fly infestation are available in some countries.

Measures before planting

› Crop rotation: Beans should not be grown on the same plot for any two consecutive seasons. Avoid planting beans near cowpea, soybean and many other leguminous crops, that may be the source of bean flies.
› Pests can be regulated by encouraging functional biodiversity – through promotion of natural enemies of pests with flowering natural areas.
› Early planting to enhance quick growth of the bean plants – bean fly populations are low early in the season.
› Vigorously growing plants are more resilient and can tolerate bean fly infections – damage is severe in plants growing in infertile soils or drought conditions.

Measures after planting

› Regular scouting for early detection of the bean flies.
› Fresh manure should not be applied in the bean garden to attract the bean fly.

BRUCHIDS/BEAN WEEVIL

Bruchids/bean weevil (*Acanthoscelides obtectus*)

Source: iStock

Important to know	• They are small beetles, which attack dried beans in storage. • The pest destroys the seeds and reduces germination capacity. • Heavy infestation can lead to total loss of stored crop.
Measures before storage	• Maintain good storage hygiene in the crop store. • Ensure a moisture content of the beans of less than 15 %. • Clean the beans to remove all the chaff. • Store the beans in clean bags or containers. • Store seed material in plastic bags, which can be hermetically sealed (made airtight).
Measures after storage	• Maintain proper ventilation of the storage facility.
Measures in case of infestation	• Place the stored bean seed out in the sun occasionally (once every month) in order to reduce moisture content and to kill off pests.

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› During weeding, slight ridging or earthing up of damage plants will help bean plants to grow adventitious roots, if there is moisture, helping them to recover from bean fly damage.

Measures in case of infestation

› Remove and destroy (by burning) crop residues and all plant parts with symptoms of damage by bean flies.
› Botanical plant extracts (such as Tephrosia, Tithonia, Marigold, Datura and Neem leaves) can be sprayed.

Bruchids/bean weevil (*Acanthoscelides obtectus*)

Important to know

› They are small beetles, which attack dried beans in storage, prevalent across Africa. Bruchid infestations can begin even before the beans are harvested and carried over into storage.
› Females lay eggs inside the bean seeds, and larvae emerge and feed on the seeds and develop to adults. As they emerge from the bean grains they leave small rounds holes on the seeds. The pest destroys the seeds and reduces germination capacity.
› Heavy infestation can lead to total loss of stored crop.

Measures before storage

› Good storage hygiene in the crop store: remove any spilled or leftover grain from last season.
› Proper drying: beans should be dried to a moisture content of less than 15 % (when the seeds are brittle when you bite them with your teeth).
› Beans should be winnowed to remove all the chaff and sorted to remove broken beans, stones, deformed beans, or any remaining plant parts. Broken and deformed beans can be prepared and eaten immediately because they do not store well.
› Storage should be done in clean cloth/sisal bags or sealed containers that should be checked occasionally for early detection of bean weevil infestation.
› In some places, farmers mix the stored beans with ashes, maize or millet flour to keep pests away. This is mostly done for beans that are to be consumed by the farmer when the flour is washed off before cooking the beans.

- Bean seeds for next season's planting can be mixed with dried leaves of marigold, tephrosia, neem or any other locally tried plant, to keep storage pests away.
- Use plastic bags, which can be hermetically sealed (made airtight) to store beans (to be used as seed material). The beans must be well dried (10–11% moisture content) and the plastic bags must be carefully sealed.

Measures during storage
- Maintain proper ventilation of the storage facility.

Measures in case of infestation
- Stored bean seed should be placed out in the sun occasionally (once every month) in order to reduce moisture content and to kill off pests.

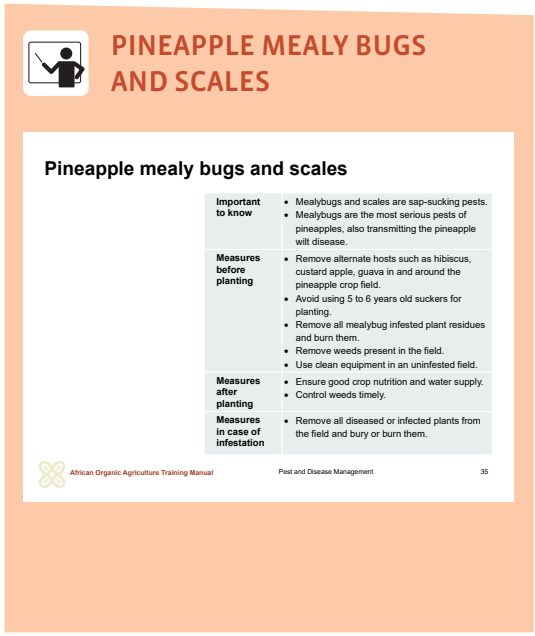
3. Pest and diseases management in organic pineapples

The major pests of pineapple are thrips, mealy bugs and scales, and nematodes, while the two common fungal diseases are *Phytophthora* heart (top) rot and *Phytophthora* root rot. However, harvested pineapples can further be infected mainly by phytopathogenic fungi and bacteria normally through wounds, insect injuries, and physical damage during transportation, handling, and packaging. Black rot *(Thielaviopsis paradoxa)*, fruitlet core rot (disease complex), yeasty fermentation *(Saccharomyces* spp. and *Candida* spp.*)*, pink disease *(Tatumella citrea)*, etc. are the major postharvest diseases of pineapple.

Below is the combination of approaches which should be applied before planting, after planting before infestations, and after planting when infestation occurs.

Mealy bugs and scales

Important to know
- Mealybugs and scales are sap-sucking pests. They manifest as fluffy, wax-like material building up near the fuzzy looking insects, while scales normally hide under waxy or cottony covers.
- Mealybugs are the most serious pests of pineapples, also transmitting the pineapple wilt disease.



Measures before planting

- Remove alternate hosts such as hibiscus, custard apple, guava in and around the pineapple crop field.
- Avoid using 5 to 6 years old suckers for planting as they are likely to contain some mealybugs or scales.
- The mealybug infested fields must be prepared by removing all the plant residues and burning them.
- Remove weeds present in the field as they support an increase in mealybug population by giving them alternate food sources.
- Use clean sterilised equipment when undertaking planting and intercultural operations in an uninfested field.

Measures after planting

- Good soil fertility and water conservation practices promote strong plants that are less susceptible to mealybug/scale attack.
- Timely weeding reduces competition with the growing pineapple plants.

Measures in case of infestation

- All diseased or infected plants should be removed from the field and destroyed.

Root nematodes

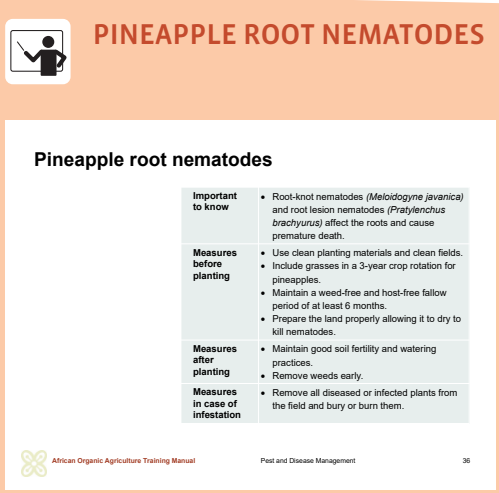
Important to know

- Various nematodes are attracted to pineapples, but root-knot nematodes *(Meloidogyne javanica)* and root lesion nematoes *(Pratylenchus brachyurus)* affect the roots and cause premature death.

Measures before planting

- Controlling nematodes is difficult, so it's recommended to use clean planting materials and clean fields.
- A three-year crop rotation with grasses is further recommended for pineapples. Alternatively, maintain a weed-free and host-free fallow period of at least 6 months for significant decline in nematode population.
- Thorough land preparation will reduce nematode population – it will allow the soil to dry out and accelerates the breakdown of plant material harbouring nematodes.

PINEAPPLE ROOT NEMATODES



Pineapple root nematodes

Important to know	• Root-knot nematodes *(Meloidogyne javanica)* and root lesion nematodes *(Pratylenchus brachyurus)* affect the roots and cause premature death.
Measures before planting	• Use clean planting materials and clean fields. • Include grasses in a 3-year crop rotation for pineapples. • Maintain a weed-free and host-free fallow period of at least 6 months. • Prepare the land properly allowing it to dry to kill nematodes.
Measures after planting	• Maintain good soil fertility and watering practices. • Remove weeds early.
Measures in case of infestation	• Remove all diseased or infected plants from the field and bury or burn them.

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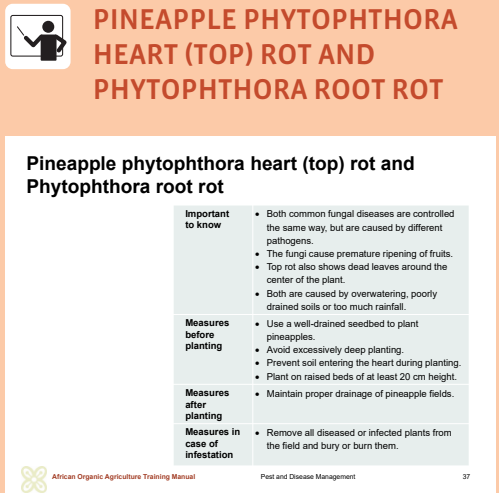
PINEAPPLE PHYTOPHTHORA HEART (TOP) ROT AND PHYTOPHTHORA ROOT ROT



Pineapple phytophthora heart (top) rot and Phytophthora root rot

Important to know	• Both common fungal diseases are controlled the same way, but are caused by different pathogens. • The fungi cause premature ripening of fruits. • Top rot also shows dead leaves around the center of the plant. • Both are caused by overwatering, poorly drained soils or too much rainfall.
Measures before planting	• Use a well-drained seedbed to plant pineapples. • Avoid excessively deep planting. • Prevent soil entering the heart during planting. • Plant on raised beds of at least 20 cm height.
Measures after planting	• Maintain proper drainage of pineapple fields.
Measures in case of infestation	• Remove all diseased or infected plants from the field and bury or burn them.

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Measures after planting

› Good soil fertility management and watering practices to maintain strong healthy plants.
› Timely weeding reduces competition with the pineapple plants.

Measures in case of infestation

› All diseased or infected plants should be removed from the plantation and destroyed.

Phytophthora heart (top) rot and Phytophthora root rot

Important to know

› These two common fungal diseases can be controlled the same way, though they are caused by different pathogens.
› The symptoms of root rot are similar to those caused by nematodes. A plant that looks like it needs to be watered, with drooping leaves and general signs of distress is likely to be infected. Leaves change in colour from a healthy green through various shades of red and yellow. Leaf tips and margins eventually become necrotic, the root system is dead, and plants can easily be pulled from the ground.
› Premature ripening of fruits from infected plants.
› Top rot may show similar signs, but also shows dead leaves around the center of the plant.
› Both are caused by overwatering, poorly drained soils or too much rainfall.

Measures before planting

› A well-drained seed bed is required.
› Avoid excessively deep planting.
› Prevent soil entering the heart during planting.
› Plant on raised beds of at least 20 cm height.

Measures after planting

› Maintain proper drainage for minimising the risk of Phytophthora infection.

Measures in case of infestation

› All diseased or infected plants should be removed from the plantation and destroyed.

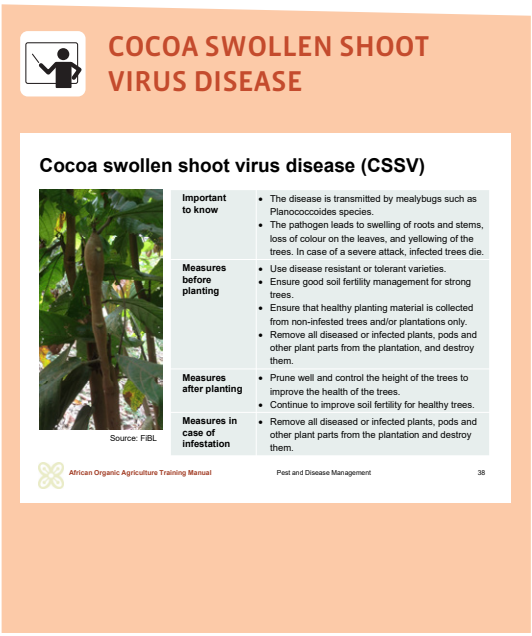
4. Pest and diseases management in organic cocoa

Cocoa can be affected by many pests and diseases, which thrive well in the warm and humid climates where cocoa is commonly grown. However, with proper understanding and implementation of a natural agroecosystem, pests and diseases can be effectively managed. Several experiences and research have shown that it is possible to reduce pests and diseases in cocoa significantly, only by modifying a production system to a more dynamic agroforestry system. A series of relationships have been observed between the supply of light, air, water and nutrients to the cocoa system on one hand and the appearance of diseases and pests on the other hand. Cocoa is a shade-loving crop – all other crops to be mixed with cocoa should either be planted beforehand or at the same time as the cocoa. If the area had any natural growth, then some trees should be left standing during land preparation. On the other hand, fast-growing trees which will rapidly provide cover, such as bananas, pawpaw or castor oil trees should be planted before cocoa is planted.

Most pest and disease infestations in cocoa have been found to occur under the following conditions:

- Ignoring the succession sequences of forest systems. Having originated in the primary forest, cocoa can endure well old primary forest tree species as shade trees, but not old secondary trees.
- Cultivation of cocoa monocultures with a few shade trees and species only.
- High density of vegetation due to densely spaced trees and failure to thin or prune the trees, which creates a conducive, humid environment for the cocoa pests and diseases. Cocoa trees ideally have one stem and only 3 to 5 main branches, with enough side branches and leaves to capture most of the sunlight.

In Africa, the main cocoa diseases are the black pod and cocoa swollen shoot virus (CSSV), while the most common pests are mirids or capsids and mealybugs. Mealybugs are mainly a problem as vectors of cocoa swollen shoot virus (CSSV). These and other pests and diseases can be managed through a combination of approaches and measures applied before planting, after planting before infestations, and after planting when infestation occurs as described below.



Cocoa swollen shoot virus (CSSV) disease

Important to know

- CSSV is caused by the swollen shoot virus and is a major problem in all cocoa growing regions.
- CSSV is transmitted by mealybugs such as Planococcoides species.
- Symptoms include swelling of roots and stems, loss of colour on the leaves, trees becoming yellow, and if there is a severe viral attack, infected trees die.

Measures before planting

- Using disease resistant and pest tolerant varieties: cocoa varieties with tolerance to black pod disease and swollen shoot virus disease exist, for example, in West Africa. Local cocoa research institutes may inform about their availability.
- Maintaining soil fertility: efforts for improving soil fertility are critical, particularly where cocoa is grown on poor soils with low nutrient levels, to ensure a good general health of the tree.
- Ensure healthy planting material shoots are collected from non-infested trees and/or plantations only.
- Ensuring field hygiene: this is probably the single most important method for managing key cocoa diseases. All diseased or infected plants, pods and other plant parts should be removed from the plantation and destroyed.

Measures after planting

- Proper crop husbandry (prunning, and tree height control) to improve the health of the cocoa trees.
- Maintaining soil fertility is critical, particularly where cocoa is grown on poor soils with low nutrient levels, to ensure a good general health of the trees.

Measures in case of infestation

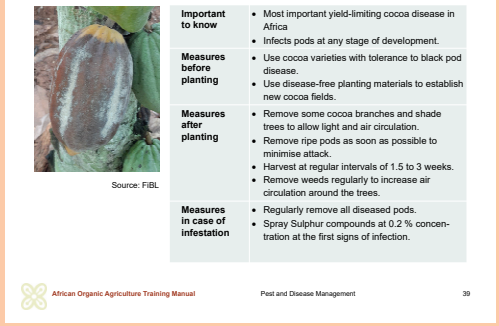
- All diseased or infected plants, pods and other plant parts should be removed from the plantation and destroyed.

Black pod disease

Important to know

- It causes the most important yield losses in cocoa worldwide.
- It is caused by several species of the fungi Phytophthora. Two species – *P.*

COCOA BLACK POD DISEASE



megakarya and *P. palmivora* – cause this most important yield-limiting disease in the African cocoa industry.

› Although Phytophthora species attack all parts of the cocoa tree, the major economic loss comes from infection of the pod. Pods can be infected at any stage of development.

› Symptoms include the appearance of a small translucent spot on the pod. The spot turns into a chocolate brown colour, then darkens and expands until the whole pod turns black and mummifies. Infected pods also have white spores on their surface. This sporulation becomes denser as the disease progresses.

Measures before planting

› Use cocoa varieties with tolerance to black pod disease. Inquire from your local cocoa research institutes or Extension Officer about their availability.

› Planting materials for establishing new cocoa fields should be disease-free.

Measures after planting

› Regulating cocoa tree height, pruning and shade management: Removal of some branches of cocoa and shade trees by pruning and proper maintenance of the height of the cocoa trees will allow light to penetrate to the centre of the tree, and will increase air circulation. Both make the conditions unfavourable for the black pod disease.

› Removing shade trees with a shorter life cycle than cocoa at the end of their life cycle is an important measure to be undertaken in this concern.

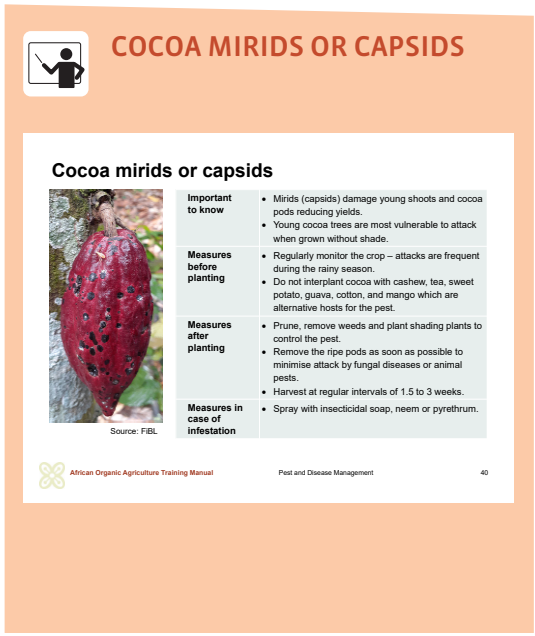
› Ripe pods should be removed as soon as possible to minimise attack by fungal diseases or animal pests. Harvesting should be carried out at regular intervals of 1.5 to 3 weeks.

› Proper weeding increases air circulation and reduces the humidity in the plantation and thereby reduces the incidence of the black pod disease.

Measures in case of infestation

› It has been shown in West Africa that regular removal of diseased pods can suppress the black pod disease.

› Spray Sulphur compounds (0.2 % concentration) at the first signs of infection.



Mirids or capsids (*Distantiella theobromae* and *Sahlbergella singularis*)

Important to know

› Mirids (capsids) are sucking insects.
› They damage young shoots and cocoa pods thereby reducing the yield of cocoa.
› Feeding by mirids is characterised by discoloured, necrotic (blackened) areas or lesions around affected plant tissue.
› Young cocoa trees are very vulnerable to attacks of mirids when they are grown without shade.

Measures before planting

› Regularly monitor the crop – attacks are frequent during the rainy season.
› Do not interplant cocoa with cashew, tea, sweet potato, guava, cotton, and mango which are alternative hosts for the pest.

Measures after planting

› Cultural practices including pruning, weeding and shading schemes have been used in the control of the pest.
› Ripe pods should be removed as soon as possible to minimise attack by fungal diseases or animal pests. Harvesting should be carried out at regular intervals of 1.5 to 3 weeks.

Measures in case of infestation

› Spray with insecticidal soap, neem or pyrethrum

5. Pest and diseases management in organic groundnuts

Several pests and diseases can cause major ground nut yield losses. Groundnut rosette and early and late leaf spot (diseases), and aphids and termites (pests) are of economic importance in groundnut production.

Luckily, groundnut seeds are protected by a shell, which acts as an excellent natural barrier against damage. But, when farmers wait too long before they start harvesting (usually until all leaves are dry), the pods are exposed to attack by rodents and insects, and aflatoxin contamination.

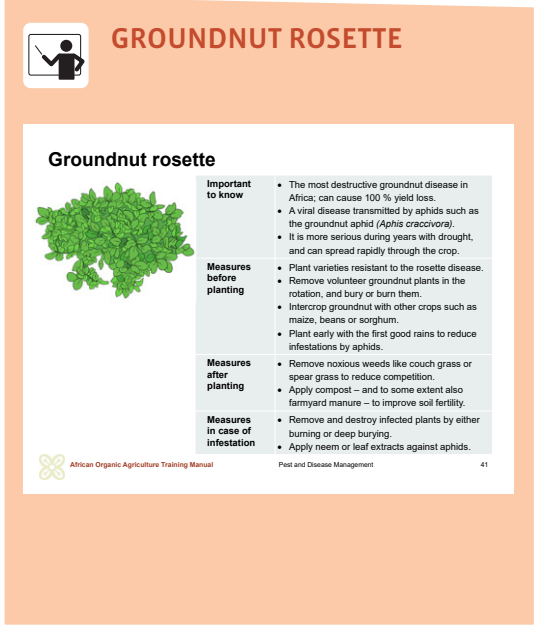
Like the other crops, these and other diseases and pests can be managed through a combination of approaches and measures applied before planting, af-

ter planting before infestations, and after planting when infestation occurs as described below.

Groundnut Rosette

Important to know

- Rosette is the most destructive groundnut disease in Africa which can cause 100 % yield loss in severe cases, especially if the disease occurs at flowering.
- It is a viral disease transmitted by aphids such as the groundnut aphid *(Aphis craccivora)*.
- The leaves appear both as 'chlorotic' (yellow and stunted) and 'green' (green and stunted). Younger leaves may show mottling and flecking while older leaves may be small and very deep green and have in-rolled margins.
- Affected plants take on a bushy appearance due to stunting and distortion of the growing shoots.
- The groundnut Rosette disease is common in all groundnut growing countries. It is more serious during years with serious drought. The disease can spread rapidly through a crop.



Measures before planting

- Cultivating varieties that are resistant to the rosette disease, for example in Malawi, the varieties Baka, Chitala and Nsinjiro are very effective, while the Chalimbana 2005 variety has moderate resistance.
- Interplanting groundnut with other crops such as maize, beans or sorghum is effective in reducing the disease incidence as this confuses the aphids' movement.
- Early, dense planting with the first good rains helps to reduce infestations by aphids by covering the soil as quickly as possible and restricting the movement of the aphids. Late planted crops suffer heavy attacks by aphids that transmit the viral particle.
- Late planting may lead to crop failure and aflatoxin incidence due to drought effect, lower yields of up to 50 %, pests (especially aphids) and disease (rosette and leaf spot) incidences, and reduced quality of the nuts.

Measures after planting

- Proper weed control: Groundnut cannot compete effectively with weeds, particularly at the early stages of growth, from 3 to 6 weeks after sowing.

Therefore, noxious weeds like couch grass or spear grass should be hand-sorted during land preparation to reduce competition with growing groundnut plants.

› Soil fertility management: Groundnut is a legume and therefore has the natural ability to fix nitrogen from the air and soil with the help of bacteria, called Bradyrhizobium, in root nodules. This reduces its need for fertiliser. However addition of organic materials, such as compost – and to some extent also farmyard manure and crop residues – improves the water-holding capacity of the soil, thereby reducing the fungal colonisation and the accumulation of aflatoxin in the groundnut seeds.

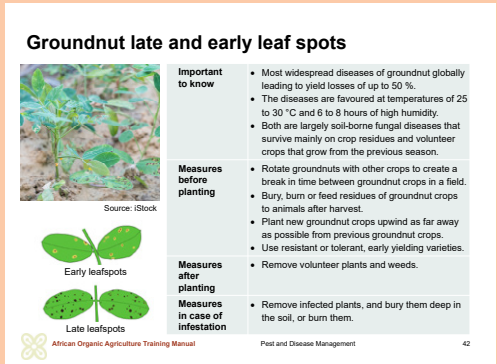
Measures in case of infestation

› Rogueing and destroying infected plants by either burning or deep burying reduces further spreading of the disease.

› Volunteer groundnut plants should be removed and burned, as they may contribute to the development of the disease in the next season.

› Neem seed or leaf extracts can be applied against aphids to limit the further spreading of the disease.

GROUNDNUT LATE AND EARLY LEAF SPOTS



Groundnut late and early leaf spots

Source: iStock

Early leafspots

Late leafspots

Important to know	• Most widespread diseases of groundnut globally leading to yield losses of up to 50 %. • The diseases are favoured at temperatures of 25 to 30 °C and 6 to 8 hours of high humidity. • Both are largely soil-borne fungal diseases that survive mainly on crop residues and volunteer crops that grow from the previous season.
Measures before planting	• Rotate groundnuts with other crops to create a break in time between groundnut crops in a field. • Bury, burn or feed residues of groundnut crops to animals after harvest. • Plant new groundnut crops upwind as far away as possible from previous groundnut crops. • Use resistant or tolerant, early yielding varieties.
Measures after planting	• Remove volunteer plants and weeds.
Measures in case of infestation	• Remove infected plants, and bury them deep in the soil, or burn them.

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Late and early leaf spots, and Leaf rust

Important to know

› Groundnut late and early leaf spots are considered to be the most widespread diseases of groundnut globally leading to pod yield losses of as high as 50 %.

› Early leaf spot manifests early at about one month after planting in form of small spots with yellow halos on the upper side of older leaves. The spots are brown on the lower leaf surface. Between 6 to 8 weeks after sowing, larger, circular black spots appear, which are signs of late leaf spot. The spots also appear on the stems and petioles.

› The disease infection and development is favoured when temperatures of 25 to 30 °C and 6 to 8 hours of high humidity prevail.

› The diseases are due to largely soil-borne fungi that survive mainly on crop residues and on volunteer crops that grow from the previous season.

› Leaf rust can easily be confused for leaf spot. The disease shows as orange-red spots on the leaves, which later turn dark brown, and causes curling of leaves and defoliation. The disease is of little consequence, if it occurs after the pegging and podding stages.

› Both are fungal diseases and thus control measures of leaf rust are similar to early and late leaf spots.

Measures before planting

› Rotation of groundnut with other crops is very important to create a distinct break in time between successive groundnut crops in a field. It reduces survival of the spores of the fungus in the soil.
› Deeply burying, burning or feeding of the residues of groundnut crops to animals after harvest reduces inoculum that may infect the new crop.
› Upwind planting of new groundnut crops as far away as possible from previous infected groundnut crops reduces infection of the new crop.
› Resistant or tolerant, early yielding varieties limit the negative impact of early leaf spot. In Malawi, the Chalimbana 2005 variety has moderate resistance to the disease.

Measures after planting

› Removing volunteer plants and weeds reduces humidity in the crop stand and thus limits risks of infection. Volunteer groundnut plants and other host plants of the fungus should be eradicated between groundnut crops through rotations.

Measures in case of infestation

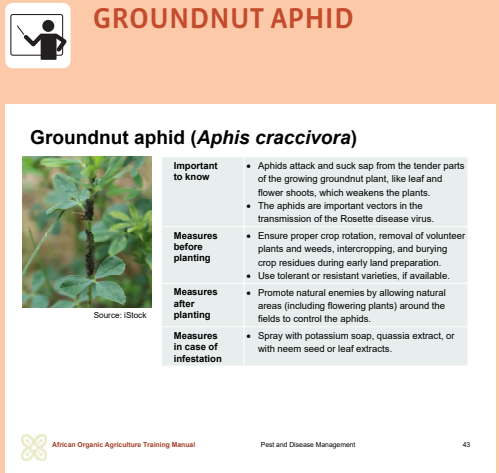
› Infected plants must be removed and buried deep in the soil or burned. They must not be composted, as the spores may survive in the compost and infect new crops.

Groundnut aphid *(Aphis craccivora)*

Important to know

› Aphids attack and suck sap from the tender parts of the growing groundnut plant, like leaf and flower shoots. The removal of sap by the aphids weakens the plants. This causes poor and stunted growth, leaf curling and distorted leaf growth, wilting and reduces resistance to drought conditions, all resulting in yield losses.
› The aphids are important vectors in the transmission of the Rosette disease virus.

GROUNDNUT APHID



Groundnut aphid (*Aphis craccivora*)

Source: iStock

Important to know	• Aphids attack and suck sap from the tender parts of the growing groundnut plant, like leaf and flower shoots, which weakens the plants. • The aphids are important vectors in the transmission of the Rosette disease virus.
Measures before planting	• Ensure proper crop rotation, removal of volunteer plants and weeds, intercropping, and burying crop residues during early land preparation. • Use tolerant or resistant varieties, if available.
Measures after planting	• Promote natural enemies by allowing natural areas (including flowering plants) around the fields to control the aphids.
Measures in case of infestation	• Spray with potassium soap, quassia extract, or with neem seed or leaf extracts.

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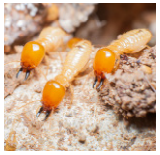
TERMITES

Termites



Source: iStock

Important to know	• Termites can damage groundnut roots and stems, and bore holes in the pods, thereby damaging nuts. When termites damage pods, they also provide an entry point for the *Aspergillus* fungi that produce aflatoxin.
Measures before planting	• Incorporate crop residues into the soil early enough. • Plant early for healthier and more vigorous plants, which can better tolerate termite attack.
Measures after planting	• Harvest in time before termites damage the pods.
Measures in case of infestation	• The use of synthetic termiticides is not allowed in organic production. • Destroy the termite mounds and remove the queen termites.

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Measures before planting

› A proper crop rotation, removal of volunteer plants and weeds, intercropping, and burying crop residues during early land preparation can significantly reduce aphid infestations.

› Tolerant or resistant varieties can be used, if available.

Measures after planting

› The promotion of natural enemies such as Ladybird beetles (*Coccinellidae* species) and hoverflies (*Syrphidae* species), and parasitic wasps and flies can (among others) contribute significantly to the control of aphids in groundnuts. These natural enemies can be promoted with selected flowering plants that provide pollen and nectar for the development of large populations.

Measures in case of infestation

› Spraying with potassium soap, quassia extract or neem seed or leaf extracts. These natural pesticides have a limited negative impact on beneficial insects.

Termites

Important to know

› Termites can damage groundnut roots and stems, and bore holes in the pods, thereby damaging nuts. When termites damage pods, they also provide an entry point for the *Aspergillus* fungi that produce aflatoxin.

Measures before planting

› Incorporating crop residues into the soil early enough repels termites, as the residues produce a heat when they decompose.

› Planting early can result in healthier and more vigorous plants, which can better tolerate termite attack.

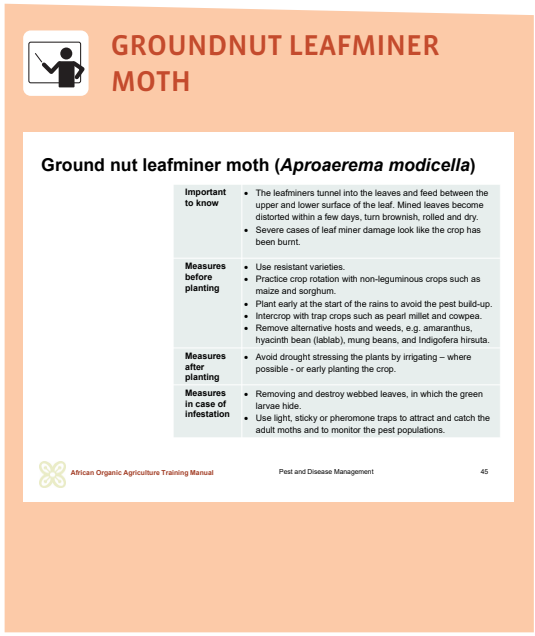
Measures after planting

› Timely harvesting to ‘escape’ termite damage is another useful measure.

Measures in case of infestation

› The use of synthetic termiticides is not allowed in organic production.

› In severe cases, destroying the termite mounds and removing the queen termites may be necessary.



Leafminer moth *(Aproaerema modicella)*

Important to know

- The leafminers can reach epidemic levels and create severe yield losses.
- The mottled adult moth lays eggs on the underside of the groundnut leaf and petioles. Yellowish green caterpillars hatch, tunnel into the leaves and feed between the upper and lower surface of the leaf. Mined leaves become distorted within a few days. When the grey-green caterpillars with a shiny black head emerge from their mines, they make a web around the leaves. Pupation takes place inside the webbed leaflets. Damaged leaves become brownish, rolled, and dry.
- Severe cases of leaf miner damage look like the crop has been burnt.

Measures before planting

- Using resistant varieties.
- Practicing crop rotation with non-leguminous crops such as maize and sorghum reduces the leaf miner population.
- Planting early at the start of the rains to avoid the pest build-up.
- Intercropping groundnut with trap crops such as pearl millet and cowpea, and practicing a proper crop rotation.
- Removal of the alternative hosts and weeds (i. e. amaranthus, hyacinth bean (lablab), mung beans, and *Indigofera hirsuta*) four weeks after planting and at least two times later when weeds are seen, reduces the leafminer population.

Measures after planting

- Drought stressed plants are much more susceptible to leafminer attack than plants that have adequate moisture. Therefore, avoiding drought stress by irrigating, where possible, or early sowing the crop to take advantage of the full season rains reduces damages by the groundnut leafminer.

Measures in case of infestation

- Removing and crushing webbed leaves, in which the green larvae hide, reduces damages on the crop and limits further multiplication of the pest.
- Light, sticky or pheromone traps can be used to attract and catch the adult moths and to monitor the pest populations.

6. Pest and diseases management in organic soybeans

Soybean is attacked by several pests and diseases. The major insect pests in order of importance are nematodes, bean flies, leaf-feeding caterpillars, and storage pests – moth larvae and bruchids. On the other hand, most diseases are transferred through the seed. It is therefore very important to use seed that is free of disease pathogens otherwise chemically treated seeds are highly restricted in organic farming. This way the farmer can prevent losses or reduce them to a minimum. Major diseases include leaf rust, bacterial blight, mosaic virus, and anthracnose.

Proper management of pests and diseases in soybean production is based on a range of practices applied simultaneously to prevent the introduction and spread of infections.

Root-knot nematodes *(Meloidogyne* spp.*)*

Important to know

- Nematodes are small worms residing in the soil and damage the roots.
- The effects of nematode damage are yellow leaves, stunted growth even if soil fertility is good, and wilting even when there is enough water in the soil. The roots of affected plants are distorted, swollen and show characteristic root galls (knots), which eventually rot.

Measures before planting

- Planting resistant varieties, if available.
- By practicing crop rotation with cereals for at least 3 to 4 years. The use of non-host grasses such as Katambora grass (or Katambora Rhodes grass *Chloris gayana*) during fallow periods or rotations can starve off the nematodes and suppress them while also improving soil structure through their deep dense roots.

Measures after planting

- Timely weeding to reduce competition with the groundnut crop.
- Soil fertility improvement to strengthen plants and make them less susceptible.

SOYBEAN ROOT-KNOT NEMATODES

Soybean root-knot nematodes (*Meloidogyne* spp.)

Source: iStock

Important to know	• Nematodes are small worms residing in the soil and damaging the roots. • The effects of nematode damage are yellow leaves, stunted growth, even if soil fertility is good, and wilting even when there is enough water in the soil.
Measures before planting	• Plant resistant varieties, if available. • Practice crop rotation with cereals for at least 3 to 4 years.
Measures after planting	• Remove weeds early to reduce competition with the soybean crop. • Improve soil fertility to strengthen plants and make them less susceptible.
Measures in case of infestation	• Infested plants and fields cannot be effectively treated - rather the land can be put under proper rotation to get rid of the nematodes.

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Measures in case of infestation

› Infested plants and fields cannot be effectively treated – rather the land can be put under proper rotation to get rid of the nematodes.

Bean flies *(Ophiomyia centrosematis* and *O. phaseoli)*

Important to know

› Bean fly maggots feed and destroy the tissue causing the stem to swell and split and reducing formation of lateral roots. Young seedlings and plants under stress wilt and die when attacked by bean flies. Older or vigorous plants may tolerate bean fly attack, but their leaves turn yellow, their growth is stunted and their yield reduced.

Measures before planting

› Timely planting before the bean fly population increases.
› Damage is more severe in plants growing under poor conditions such as infertile soils and drought. Under good conditions, soybean can compensate for minor stand reductions; thus, small gaps dispersed in a field normally are filled by adjacent plants and no yield reductions will be detected.
› Vigorously growing plants are more resilient and can tolerate pests and disease infections.
› Fresh manure should not be applied in the soybean field to avoid the bean-fly.
› Early planting to avoid water-stress and proper weeding will also enhance quick growth of the bean plants.
› Pests, like caterpillars, can be regulated by encouraging functional biodiversity. Caterpillars have a wide range of natural enemies (parasitic wasps and other predators). These natural enemies (beneficial insects) depend on nectar and pollen of host plants. Therefore, it is advisable to plant flowering plants along the boundaries or terraces within the field. Beneficial insects will build up their population and control the plant pest populations.

Measures after planting

› Regular scouting for early detection of the infestation.
› Fresh manure should not be applied in the soybean field to avoid the bean fly.
› During weeding, slight ridging or earthing up of plants will help soybean plants to grow adventitious roots, if there is moisture, helping them to recover from bean fly damage.

Measures in case of infestation

- Remove and destroy crop residues and all plant parts with symptoms of damage by bean flies.
- Use of botanical plant extracts (such as Tephrosia, Tithonia, Marigold, Datura, and Neem leaves) can be used to eliminate any evading pests.

Soybean rust (*Phakopsora pachyrhizi*)

Important to know

- The most common symptoms are grey green to dark brown or reddish-brown lesions particularly on the undersides of the plant leaves. These lesions cause leaf yellowing, and eventually result in premature loss of leaves and pod maturity.
- Rust is most severe during long periods of leaf wetness (rainy seasons) and high humidity. Good ventilation through proper spacing is important to allow good air circulation in the soya bean fields.
- Soybean is susceptible at any stage of development, and rust can reduce yield by as much as 90 %.
- The pathogen is however not seed-borne in soybean.

Measures before planting

- Avoid planting soybean near or in immediate rotation with cowpea, beans, or other leguminous crops, that may be a source of pest and disease infections.
- Disease-infested plant material should not be left in the field, but made into compost. The plot should then be rotated with other crops. Beans or other legumes should not be grown on the same plots for any 2 consecutive seasons.
- Choose improved varieties with good yield potential and, if possible, resistant to common diseases like soya bean rust or tolerant to major pests and adapted to local environmental conditions. Seeds should be obtained from approved seed suppliers or carefully selected by the farmer to avoid introduction of seed-borne disease like viruses.

Measures after planting

- Ensure proper weed control to reduce on field competition and potential alternative hosts of the disease.

SOYBEAN RUST

Soybean rust

Source: iStock

Important to know	• Grey green to dark brown or reddish-brown lesions which cause leaf yellowing, and eventually result in premature loss of leaves and pod maturity. • Most severe during long periods of leaf wetness (rainy seasons) and high humidity • Soybean is susceptible at any development stage, and rust can reduce yield by as much as 90 %. • The pathogen is however not seed-borne in soybean.
Measures before planting	• Avoid planting soybean near or in immediate rotation with cowpea, beans, or other leguminous crops. • Do not grow soybeans or other legumes on the same plots for any 2 consecutive seasons. • Choose resistant varieties. • Ensure proper spacing to allow good air circulation.
Measures after planting	• Remove weeds to reduce on field competition and potential alternative hosts of the disease
Measures in case of infestation	• Remove infested crop residues, and bury or burn them. • Spray Sulphur compounds (0.2 % concentration) at the first signs of infection.

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Measures in case of infestation

› Remove and destroy infested and crop residues and bury or burn them.
› Spray Sulphur compounds (0.2 % concentration) at the first signs of infection.

Soybean bacterial blight *(Pseudomonas savastonoi)*

Important to know

› Blight manifests as small yellow to light brown spots which appear on leaves, but also occur on stems, petioles, and pods. The spot centres soon dry out, turn reddish brown to black, bordered by yellowish-green circles. Young leaves are most susceptible. Infected young leaves are distorted, stunted, and turn yellow.
› The bacterium is seed-borne. Seeds can be infected through the pods during the growing season, or they may be invaded during harvesting. Primary infections on cotyledons often result in secondary lesions on seedlings.
› The bacterium is spread during windy rainstorms and during cultivation or weeding when the foliage is wet.

Measures before planting

› Use certified clean seeds.
› Plant resistant varieties, if available.
› Practice good sanitation throughout.

Measures after planting

› Ensure timely weeding to reduce on competition with the crop.

Measures in case of infestation

› Remove and destroy infected plants.

Soybean mosaic viruses (soya bean mosaic virus or mosaic potyvirus)

Important to know

› Leaves of infected plants are distorted and die, and infected plants may become stunted.
› The disease is transmitted by insects such as aphids, beetles, whiteflies, and infected seeds.

SOYBEAN BACTERIAL BLIGHT

Soybean bacterial blight *(Pseudomonas savastonoi)*

Source: iStock

Important to know	• Small yellow to light brown spots on leaves, but also on stems, petioles, and pods. Young leaves are most susceptible. Infected young leaves are distorted, stunted, and turn yellow. • Seeds can be infected through the pods during the growing season, or they may be invaded during harvesting. • The bacterium is spread during windy rainstorms and during cultivation while the foliage is wet. • The disease is seed-borne.
Measures before planting	• Use certified clean seeds. • Plant resistant varieties, if available. • Practice good sanitation throughout.
Measures after planting	• Remove weeds to reduce on competition with the crop.
Measures in case of infestation	• Remove and destroy infected plants.

SOYBEAN MOSAIC VIRUSES

Soybean mosaic viruses (soybean mosaic virus or mosaic potyvirus)

Source: iStock

Important to know	• Leaves of infected plants are distorted and die, and infected plants may become stunted. • The disease is transmitted by aphids, beetles, whiteflies, and infected seeds.
Measures before planting	• Use certified, disease-free seeds. • Select virus resistant varieties.
Measures after planting	• Remove weeds to reduce on competition with the crop. • Ensure that disease vectors such as aphids and whiteflies are under control.
Measures in case of infestation	• Remove and destroy infected plants.

Measures before planting
› The use of certified disease-free seeds and virus resistant varieties are primary control measures.

Measures after planting
› Timely weeding to reduce on competition with the crop
› Ensure that disease vectors such as aphids and whiteflies are under control

Measures in case of infestation
› Remove and destroy infected plants.

Soybean is rich in protein which makes it very attractive to insects. It also decays quickly, especially under humid conditions. Soybean therefore has to be stored properly, whether for food, sale or seed material. Dried soybean for seed material should be kept in a cool, dry, dark place in airtight containers. There are other techniques locally used by farmers in Africa to preserve and store soybean for seed material. For example, storing seeds in ash of the neem tree or treating seeds with a neem tree solution.

7. Plant protection substances/active ingredients

7.1 Potentials and challenges of natural pesticides

Rising awareness for natural pesticides

The use of synthetic substances potentially poses problems for the environment, biodiversity, human health, and other areas. This is why the use of synthetic substances is not allowed for plant protection in certified organic farming. Awareness is increasing among farmers and consumers in Africa on the advantages of natural pesticides for human health (e. g. lower health risks during application of pesticides, lower or no residues in food), soils (promotion of natural soil fertility and biodiversity (less negative impacts on beneficial insects).

Smallholder farmers can grow or produce the raw materials required to prepare some of the biopesticides which are important for their farming. When they can produce these, the farmers will have ready access to these plant protectants and reduce the cost of plant protection. Some of the plants used to prepare con-

coctions have repellent properties and can protect crops in-situ when growing.

Challenges related to natural pesticides

Organic farmers rely on natural agents to control pests and diseases when the preventive measures for plant protection prove not sufficient. However, reliance on biopesticides is usually linked to some challenges as follows:

- **Unsatisfactory effectiveness of farm-made products:** Some African farmers apply some natural home-made products from local sources. However, some of these products may not prove effective enough for controlling the prevailing pests and diseases. As a result, confidence in the effectiveness of natural inputs is commonly rather low among farmers. Home-made products are fine to strengthen the plants against pest and disease attacks (Step 2 – see page 7). But when they are used as 'pesticides' (Step 3 – see page 7), farmers who export their products to Europe may get in conflict with the EU organic legislation and risk decertification.
- **Limited availability of raw materials locally:** Some effective raw materials may not be readily available locally, e. g. the neem tree is not naturally found everywhere, hence, unless deliberately planted, its use can be limited. In such cases, farmers are encouraged to explore other locally available materials, or plant those not readily available in their area.
- **Limited availability of commercial products:** Commercial plant protection products can be expected to be more effective if used correctly. But in most African countries, the availability of commercial plant protection products for organic/ecological agriculture is very limited with regard to the variety of product categories, the variety of products within the categories, and the quantities. Particularly biopesticides with a narrow spectrum of action with complex production processes are hardly available in Africa so far, and would probably be too expensive for many farmers.
- **Unrealistic promises on the effectiveness of commercial products:** Producers and distributors have a vital interest to encourage farmers to buy their products. For this purpose, they may exaggerate the effectiveness and cost/benefit-ratio of their products. To minimise negative effects for the farmers, independent advice to all farmers is essential to counterbalance potentially exaggerated information by some commercial local and international input companies.

- **Little knowledge on permitted biopesticides:** Knowledge about which plant protection products and active ingredients are permitted for use in organic agriculture is limited. There are many factors which come into play when considering which inputs to use. They include, type of crop, national regulatory standards (if the crops being grown are for marketing as certified organic), standards and regulations in destination export markets, other standards which may apply for the farmer's case, availability, cost, and others.
- **Substances with a broad spectrum of action versus substances with a narrow spectrum of action:** From an agro-ecological perspective, first priority should be given to pesticides with a narrow spectrum of action, which results in minimal damage to beneficial organisms. A typical example is *Bacillus thuringiensis* (Bt). Plant extracts typically have a broader spectrum of action and are thus more likely to affect non-target organisms including beneficial organisms which are friendly to the farmer in keeping the pests under control. From an economic view, farm-based pesticide production would be advantageous for the farmers. However, we consider that in the case of pesticides, priority should be given to ecological considerations. Reversing the priorities might end up using a neem product (because it is local) instead of a potassium soap, even if the soap would be preferable from an ecological point of view. It is important that farmers are made aware of these considerations so as to make informed choices and actions.

7.2 Regulation of plant protection products in different organic standards

In order to know if a certain input can be used, it must be clarified whether the organically produced product shall be sold on the national market, or on the export market. If the product is to be sold on the national market, the national regulatory framework must be complied with. If the product is to be sold on the export market, the regulatory framework of the target country must be complied with. In many cases, an agricultural product that is exported must comply with both the regulatory framework of the target country, as well as the regulatory framework of the country of origin.

Considerations in case of marketing in the country of production

Products that are to be sold on the national market as certified organic must be produced under the provisions of the national regulatory framework on organic agriculture or, alternatively, under the provisions of a private standard or other guideline (such as the IFOAM Norms). Inputs must consequently consist of substances allowed in the relative national or private regulatory framework.

Considerations in case of export

If products shall be exported to a EU country, the inputs must be assessed against the provisions of the EU Regulation 848/2018. For export to the USA, the input must be assessed against the provisions of the USDA National Organic Program 2. For export to other countries with a proper regulatory framework on organic agriculture, the input must be assessed against the provisions of that regulatory framework. For example, for export to Japan, the provisions of the Japanese Organic Agriculture Standards (JAS) must be met. If the product shall be labelled with the brand of a private label organisation with a proper standard, such as Naturland, Bio Suisse or Demeter, the provisions of the respective private standards must be complied with in addition to the legal requirements. As the rules and regulations can change, or can be updated, it is important that farmers are aware of any changes in the requirements and act accordingly and avoid problems with compliance.

National regulations

Almost all countries in the world have a regulatory framework on the use of plant protection agents in agricultural production. This regulatory framework includes lists of substances that are registered for use in national agricultural production. Substances that are not listed may not be used, neither in conventional nor in organic agriculture.

This means, that if a substance is allowed in organic agriculture, e. g. in the EU or the in the USA, this substance can only be used in the national context if it is listed as a plant protection agent in the relative national regulatory framework. If, e. g. pyrethrum, a substance allowed in most regulatory frameworks on organic agriculture, is not registered as a plant protection agent in a specific country, its application in production in that country in both organic and conventional agriculture is prohibited, even if the product is not to be exported.

Regulation of pesticides according to the East African Organic Products Standard

The following are the specifications on pest, disease (and weed management) according to the East African Organic Products Standard of 2007 (www.kilimohai.org/.../Standards/East_African_Organic_pr):

1. Physical, cultural and biological methods for pest, disease and weed management, including the application of heat, may be used.
2. Inputs for pest, disease, weed or growth management approved for use in organic agriculture according to the IFOAM Basic Standards and CAC/GL 32 may be used. Active ingredients of natural origin in inputs for pest, disease, weed or growth management may be used unless listed in Annex C of the standard.
3. Active ingredients of synthetic origin may be used if listed in the standard.
4. Non-active ingredients, such as carriers and wetting agents, shall not be carcinogens, teratogens, mutagens or neurotoxins.

Regulation of pesticides according to the Organic Regulation of the EU

Since 2022, plant protection products for organic farming need an explicit authorisation. The authorised active substances and their conditions of use are listed in Annex I of the Implementing Regulation (EU) 2021/1165. Active substances that are not listed there may not be used.

The approved active substances for plant protection are divided into four subcategories:

- Basic substances
- Low-risk active substances
- Microorganisms
- Active substances not included in any of the above categories

Basic substances

Basic substances are substances and mixtures from food production that are not primarily intended for crop protection but can be used in home-made preparations with water to regulate harmful organisms on the farm. Basic substances include products such as vinegar, fructose, sunflower oil, beer and lecithins.

Basic substances are not plant protection products and may not be marketed as such. The use of basic substances is regulated in Annex I of the Implementing Regulation (EC) No. 2021/1165. Basic substances may not be used as herbicides, but only to regulate pests and diseases.

Low-risk active substances

Microorganisms and active substances with least negative effects on human and animal health and on the environment can be approved as a low-risk substances if they meet the regular approval criteria and the low-risk criteria as specified in Annex II, point 5 of the Regulation (EC) 1107/2009. Because of their favourable properties, low-risk products should be preferred by farmers and other users in their approach to manage pests.

Plant strengthening agents

In contrast to plant protection agents, plant strengthening agents are regulated differently in different EU member states. Plant strengthening agents are substances, mixtures and microorganisms that increase the resistance of plants to parasitic infestation and non-parasitic effects. These agents serve exclusively to keep the plant healthy, and do not aim to control disease pathogens or pests.

Such substances my be used for organic farming in the EU. Guidelines of private associations may define stricter requirements. Marketable plant fortifiers are listed in FiBL's farm input lists for individual European countries. For easier identification, they are divided into inorganic-based, organic-based, microbial and homeopathic products, according to FiBL.

Availability of lists of authorised products

Uncertainty on the authorisation of substances that can be used in organic farming are often a barrier for the development of organic agriculture. The publication of lists indicating the products available with an indication whether they are approved according to the EU, US or other regulations brings clarity for all parties involved. Such a list is best managed by a certification body, an NGO, or a governmental institution, and farmers are encouraged to refer to such lists for specifications if they intend to sell their organic products in export markets.

Farm-made inputs and their use in organic agriculture

Although most regulatory frameworks do not specifically address the use and legal status of farm-made inputs, such as plant extracts for pest and disease control, in most cases these inputs can be used without restrictions. However, whether a specific farm-made input can be used is decided by the Certification Body (CB). Therefore, it is recommended, prior to application, to always verify

with the CB whether the product (farm-made or commercially sourced) can be used in organic production.

An example of the ambiguous situation is the use of commercially produced plant extracts that contain substances that have been banned by the EU from usage in organic agriculture, such as rotenone or nicotine. Such products may not be used for organic production. However, farm made plant-extracts containing these substances may nevertheless be authorised by the CB.

Decision-making for the use of plant protection products

Before using an input, farmers should always verify with the CB, or consult the national input list / the input list of the target country, to be sure that a product can be used for a specific context. In case the CB denies authorisation, or in case the product is not listed in the input list, the operator or his organisation can appeal the decision to the CB or urge the provider of the input to apply for inclusion in the input list. There are several steps to follow in making a decision about using a certain input or substance.

Step 1: Verification if the substance is formally registered as a plant protection agent or fertiliser

Verify if a given substance (e. g. pyrethrum) is registered as a plant protection agent in the country where it shall be applied. If the substance is not registered, the substance, or the product containing such a substance, cannot be used, neither in organic, nor in conventional agriculture.

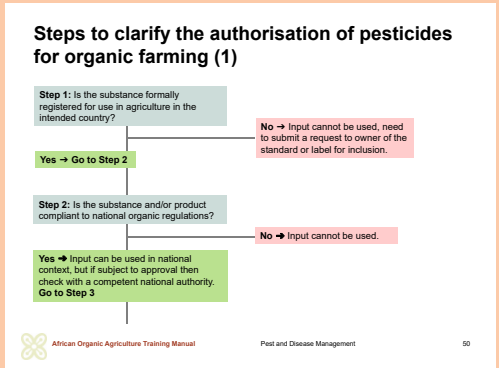
Step 2: Verification if (a) a substance or (b) a product can be used in national organic agriculture

a) Can the substance be used in national organic agriculture?

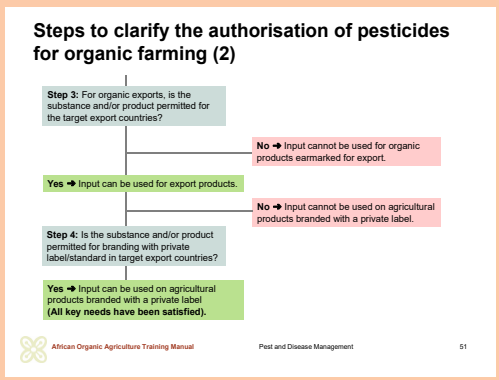
If registered for use in the country, the next step is to verify if the substance can be used according to the national framework on organic agriculture. If not, the substance cannot be used on organic produce for the national market.

If the substance is allowed by the country's regulatory framework on organic agriculture to which the agricultural product shall be exported, the substance can be used, but only if the exporting country does not require certification against its own regulatory framework on organic agriculture as a condition for export from that country.

CLARIFICATION OF PESTICIDE USE (1)



CLARIFICATION OF PESTICIDE USE (2)



b) Can a product containing the allowed substance be used in organic agriculture?

If a substance is allowed for use in the national organic agriculture framework, it is important to then verify if a product containing that particular substance (i. e. all the materials present in the product – the active substance(s), co-adjuvants and inert materials - can be used according to the national framework on organic agriculture or the framework of the country of organic export.

Examples of products that contain a permitted substance but are not allowed for use in organic agriculture:

i) Pyrethrum as a substance is permitted for use in the EU. However, the EU regulation does not allow pyrethrum products containing the co-adjuvant piperonyl butoxide (PBO). Regulatory frameworks of other countries, however, do not have this restriction. Organic produce treated with a product containing pyrethrum and PBO can, therefore, not be exported as organic to the EU.

ii) The product Mankocide contains both an allowed substance, copper hydroxide, and a banned substance, Mancozeb. The product can, therefore not be used in organic agriculture.

Step 3. Verification if the substance is allowed in the country of export

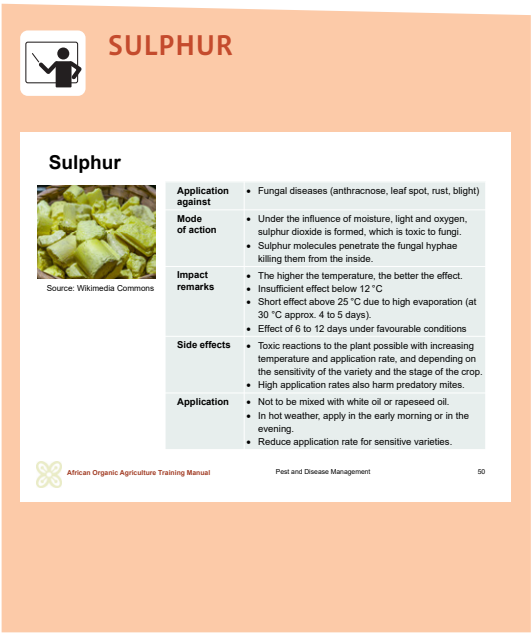
Verify if the substance in the product that is used is allowed in the regulatory framework on organic agriculture of the country of export.

If the substance is not allowed, the substance, or the product containing the substance, cannot be used for produce that is to be exported.

For instance, some national regulatory frameworks on organic agriculture allow the use of the insecticide matrine (an extract from Sophora species). However, the EU Regulation on organic agriculture does not allow the use of matrine and organic produce treated with matrine cannot be sold as organic on the European market.

Step 4: Evaluation if the substance is allowed by the private label standard

If the produce shall be exported and branded with the label of a private standard-owner (e. g. Naturland, Bio Suisse, Demeter), it is necessary to verify if the private label standard allows or limits the use of substances that are applied even though the legal regulatory framework might permit the use of such substances (e. g. copper).



7.3 Fungicides and other agents used against plant diseases

Different active ingredients usually have distinct effects. Similarly to other protection measures, the use of natural inputs for plant protection requires competent advisory support to obtain satisfying results.

Sulphur (sulphur compounds, sulphur powder) and its application

Sulphur can be used to control powdery mildews, certain rusts, leaf blights and fruit rots. In contrary to copper (see below), it is not accumulated in the soil, but represents a risk for certain beneficial organisms. Like all pesticides, sulphur should only be used in view of a real threat to the crop, and not as a disease preventative strategy.

On-farm production of sulphur is not possible. Sulphur is only available as commercial products from international or national suppliers.

The product requires competent advice in the application to obtain optimal results. Practical research under local conditions is very useful to allow for competent advice.

Application against

› Fungal diseases (anthracnose, leaf spot, rust, blight)
› Mites

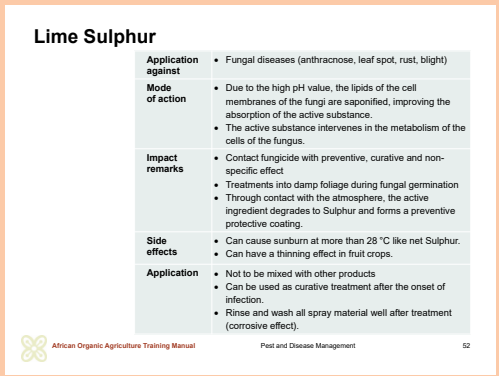
Mode of action

› Under the influence of moisture, light and oxygen, sulphur dioxide is formed, which is toxic to fungi and inhibits growth.
› Sulphur molecules penetrate the fungal hyphae killing them from the inside.

Impact remarks

› The higher the atmospheric temperature during and after application, the better the effect. At temperatures below 12 °C the effect is insufficient, at temperatures above 25 °C the effect is only short-lived due to the high evaporation rate (at 30 °C the sulphur is effective for approximately 4 to 5 days only). Under favourable conditions, the effect lasts 6 to 12 days.

LIME SULPHUR



Lime Sulphur

Application against	• Fungal diseases (anthracnose, leaf spot, rust, blight)
Mode of action	• Due to the high pH value, the lipids of the cell membranes of the fungi are saponified, improving the absorption of the active substance. • The active substance intervenes in the metabolism of the cells of the fungus.
Impact remarks	• Contact fungicide with preventive, curative and non-specific effect • Treatments into damp foliage during fungal germination • Through contact with the atmosphere, the active ingredient degrades to Sulphur and forms a preventive protective coating.
Side effects	• Can cause sunburn at more than 28 °C like net Sulphur. • Can have a thinning effect in fruit crops.
Application	• Not to be mixed with other products • Can be used as curative treatment after the onset of infection. • Rinse and wash all spray material well after treatment (corrosive effect).

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Side effects

› In fruits, for example, with increasing temperature and application rate, and depending on the sensitivity of the variety and the stage of development of the trees, toxic reactions to the plant can occur. High application rates also harm predatory mites.

Application

› Do not mix with white oil or rapeseed oil.
› In hot weather, carry out treatment in the early morning or in the evening.

Lime sulphur

Application against

› Fungal diseases (anthracnose, leaf spot, rust, blight).

Mode of action

› Lime sulphur is alkaline with a pH of around 10.5. This high pH destroys the cell membranes of the fungi and helps the active ingredient to enter into the fungal cells more easily. The higher permeation improves the absorption of the active ingredient.
› When the active substance enters into the fungal cells, it interferes with the normal functions of these cells thereby killing the fungi.

Impact remarks

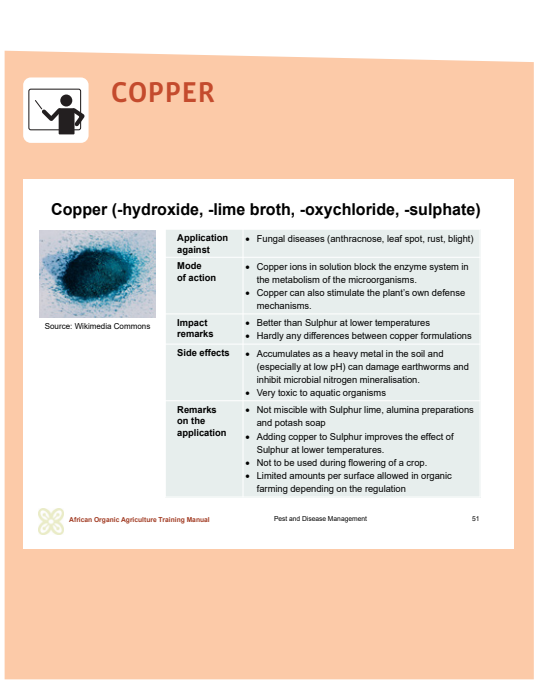
› Lime sulphur is a contact fungicide with preventive, curative and non-specific effect.
› Through contact with the atmosphere, the active ingredient degrades to sulphur and forms a preventive protective coating.

Side effects

› The sulphur coating can cause sunburn at higher temperatures (>28 °C).

Application

› Do not mix with other products.
› Can be used as curative treatment after the onset of infection.
› After treatment, rinse and wash all spray material well (corrosive effect).



› Wait at least 15 days after treatment with paraffin oil.
› Waiting period after application before harvest: 3 weeks for fruits

Copper (-hydroxide, -oxide, -oxychloride, -sulphate)

Copper has a different spectrum of action than sulphur. Copper is a very broadly effective fungicide, but has the disadvantage of being accumulated in the soil. Copper can be applied in several forms, e. g. as hydroxide, oxide, oxychloride or sulphate.

Copper sprays are primarily used to control fungal and more rarely bacterial diseases, e. g. leaf spots, blights, anthracnoses, downy mildews and cankers. Copper sprays are labelled for use on many organic vegetables, fruit and nut crops.

Theoretically, Bordeaux mixture (calcium hydroxide) could be produced on the farm from copper sulphate and hydrated lime. However, nowadays, copper oxychloride and copper hydroxide are more commonly used and are commercially available.

Copper fungicides are seen very critically by the organic sector, and should therefore not be promoted uncritically, but only as a last resort, if all other measures are insufficient. Optimum application (quantity, timing) of copper requires competent advice. For optimum advice, practical research under local conditions is very useful.

The EU organic legislation specifies maximum amounts of copper to be used per ha and year.

Application against

› Fungal diseases (anthracnose, leaf spot, rust, blight).

Mode of action

› The copper ions in solution block the enzyme system in the metabolism of the microorganisms.
› Copper can also stimulate the plant's own defence mechanisms (induced resistance through accumulation of phenols and phytoalexins, activation of enzymes).

Impact remarks

› Works better than sulphur at lower temperatures.
› The different copper formulations show hardly any differences in their effect.

Side effects

- Accumulates as a heavy metal in the soil and (especially at low pH) can damage earthworms and inhibit microbial nitrogen mineralisation if heavily accumulated.
- Very toxic to aquatic organisms with long lasting effects.

Application

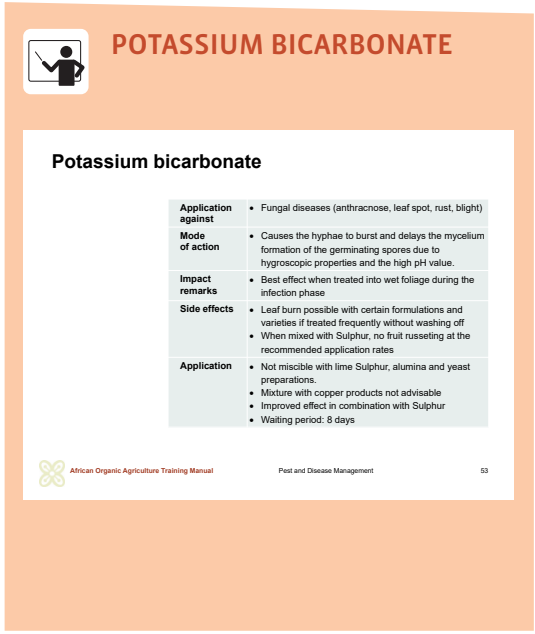
- Not miscible with sulphur lime, alumina preparations and potash soap.
- Adding copper (e. g. to sulphur) makes sense (thanks to its better effect at lower temperatures).
- Do not use during flowering.
- In Europe, the maximum copper quantity allowed for crop protection purposes has been successively restricted over the last decades. Currently, the limit set by the European plant-protection legislation is at a maximum of 28 kg of pure copper per hectare over a period of 7 years (regulation (EU) 2018/1981). This corresponds in average to a maximum of 4 kg of copper per hectare per year. In a year with difficult growing conditions, the annual dose of 4 kg can be surpassed. However, the average dose over 7 years cannot be more than 4 kg. Some private standards have defined stricter limits. Farmers should know about these limitations in the use of copper products, especially in view of target markets.

Potassium bicarbonate

Potassium bicarbonate is made industrially from carbon dioxide gas and potassium hydroxide. The substance is harmless and non-toxic to humans and the environment. Potassium bicarbonate has a reduced spectrum of action and is effective against powdery mildews and other fungal diseases.

On-farm production of potassium bicarbonate is not possible. The input is available as commercial product from international or national suppliers.

Farmers could use baking powder (sodium bicarbonate) as substitute for potassium hydroxide. However, it must be purchased too and thus is not more reasonable than potassium bicarbonate. Application of this input requires competent advice for optimal application. As for other biopesticides too, practical research under local conditions is very useful to allow for contextual use.



Application against
› Fungal diseases (anthracnose, leaf spot, rust, blight).

Mode of action
› Causes the fungal hyphae to burst and delays the mycelium formation of the germinating spores due to its high pH value and water absorbing properties which cause drying to the fungus.

Impact remarks
› Best effect when applied into wet foliage during the infection phase.

Side effects
› Leaf burn possible with certain formulations and varieties if treated frequently without washing off.

Application
› Not miscible with sulphur lime and alumina preparations.
› Mixture with copper-containing products not advisable.
› Treatments in combination with sulphur increase the effect.
› Can also be used in higher concentrations for the regulation of hangings in fruit production.

7.4 Insecticides and acaricides

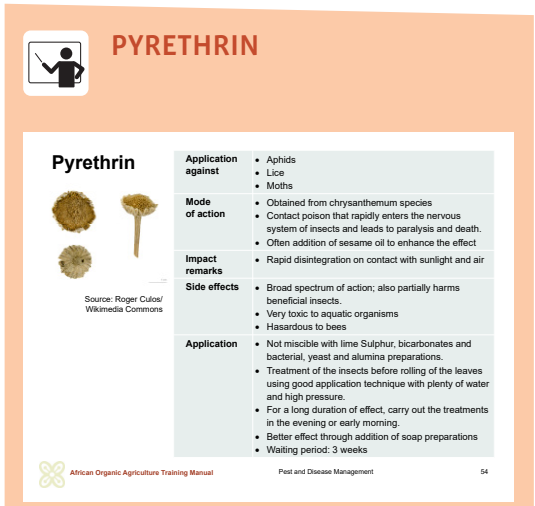
Pyrethrins

Pyrethrins are extracted from flowers of *Chrysanthemum cinerariaefolium*. Kenya is one of the leading producers of natural pyrethrum.

Pyrethrum is an insecticide with broad spectrum of activity and is effective against most aphids, cabbage loopers, leafhoppers, spider mites, stink bugs, thrips and whiteflies. Pyrethrins can damage beneficial organisms.

Pyrethrum products can be produced on-farm, but are more easily, more safely and more reproducibly produced under industrial conditions.

Pyrethrum must not be confused with pyrethroids. Synthetically produced pyrethroids are not allowed in organic farming. Pyrethrum is often combined with piperonyl butoxide (PBO). Some organic labels allow PBO, while others prohibit its use.



Application against

- Aphids
- Lice
- Moths
- Loopers
- Spider mites
- Stink bugs

Mode of action

- Obtained from chrysanthemum species.
- Contact poison that rapidly enters the nervous system of insects and leads to paralysis and death.
- Often addition of sesame oil to enhance the effect.

Impact remarks

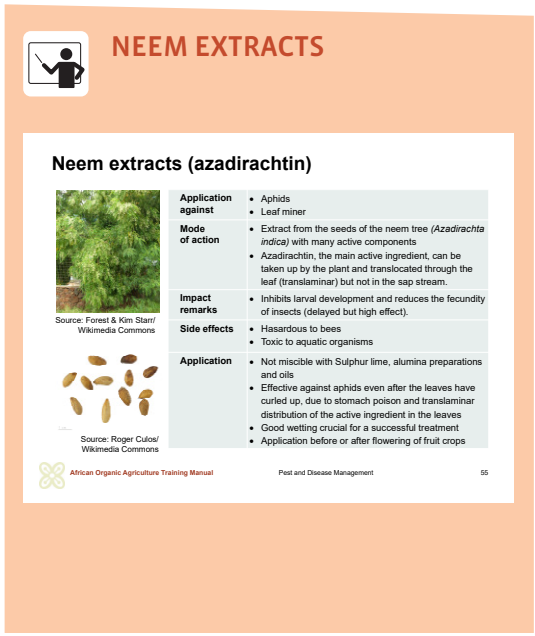
- Rapid disintegration on contact with sunlight and air

Side effects

- Broad spectrum of action; also partially harms beneficial insects.
- Very toxic to aquatic organisms with long lasting effects,
- Hazardous to bees

Application

- Not miscible with sulphur lime, bicarbonates and bacterial, yeast and alumina preparations.
- For good treatment success, ensure good wetting of the insects before the leaves roll up using plenty of water, high application pressure, and good application technique.
- For a long duration of effect, carry out the treatments in the evening or early morning.
- Better effect through addition of soap preparations
- Waiting period: 3 weeks



Neem extracts (azadirachtin)

Neem trees are widespread in Africa. Leaves and seeds are collected commercially by farmers and small industrial producers. Neem has an intermediate spectrum of action. It is effective against more than 400 pests such as African armyworm, African bollwom, aphids, Banana weevil, Cabbage looper, Cabbage moth, Cabbage webworm, Coconut mite, Cutworms, Diamondback moth and Giant looper. Neem products generally do not harm natural enemies of pests like wasps, ladybird beetles, etc. However, neem products with a high oil content can harm certain beneficials and have phytotoxic effects to some plants.

On-farm production of Neem inputs is possible. In Africa, many commercial products from different suppliers are available including mixtures of neem seed oil or extract with other natural ingredients.

Neem oil or seed extract can have a preventive effect against plant diseases such as mildews and rusts. Due to phytotoxic effects, Neem extracts should be tested on a few plants before using them at a large scale.

Application against

- Beetle larvae, butterfly and moth caterpillars
- Stalkborers
- True bugs, plant- and leafhoppers, grasshoppers
- Adult beetles
- Thrips, fruit flies, scale insects, mealybugs
- Mites
- Aphids and whiteflies
- Plant parasitic nematodes

Mode of action

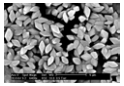
- Extract from the seeds of the neem tree *(Azadirachta indica)* with many active components.
- Azadirachtin, the main active ingredient, can be taken up by the plant and translocated through the leaf but not in the sap stream.

Impact remarks

- Neem extracts inhibit larval development and reduce the ability of insects to reproduce (delayed but high effect).

BACILLUS THURINGIENSIS

Bacillus thuringiensis (Bt)



Crystals of Bt-toxin from *Bacillus thuringiensis*. Source: P.R.Johnston/ Wikimedia Commons

Application against	• Spider moths
Operating principle	• Consist of protein crystals from bacterial spores. • After digestion by the caterpillars, the protein crystals form toxins that dissolve the cells of digestive system.
Impact remarks	• The younger the caterpillars at treatment, the better the effect • At <15 °C, the effect is too low due to insufficient feeding activity.
Side effects	• None known • Only effective against certain butterfly caterpillars, therefore selective
Miscibility	• Not miscible with alkaline agents and additives as well as potassium soap, pyrethrum and copper products
Remarks on the application	• Application only above 15 °C

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Side effects

- Hazardous to bees
- Toxic to aquatic organisms with long lasting effects

Application

- Not miscible with lime sulphur, alumina preparations and oils
- Effective against aphids even after the leaves have curled up, due to frassing toxin and translaminar distribution of the active ingredient in the leaves
- Good wetting is crucial for the success of the treatment.
- Application: before or after flowering in fruit crops.

Bacillus thuringiensis

Bacillus thuringiensis (Bt) has, as other microorganisms or microbial biocontrol agents mostly do, a very narrow spectrum of action. Bt is a naturally occurring soil bacterium. The different Bt strains are effective against armyworms, bollworms, webworms, moths, loopers, leafworms and borers. Bt is not toxic for beneficial organisms and humans.

Inputs made from microorganisms are produced in industrial processes and are available only as commercial products. Bt products are available from agricultural suppliers in most African countries.

Bt-products are ideal for pest management in the tropics due to their easy application, high virulence and narrow host specificity. Bt is a living organism. It is sensitive to high temperatures and has a limited shelf-life.

Application against

- Armyworms, bollworms, and webworms
- Moths
- Loopers
- Leafworms
- Borers

Mode of action

- Bt preparations consist of protein crystals from bacterial spores.
- Digestion activates the protein crystals and they form toxins that bind to the midgut wall and dissolve cells there. The digestive system is destroyed and the caterpillars die.

Impact remarks

- The younger the caterpillars at treatment, the better the effect.
- At less than 15 °C, the frassing activity is too low and thus the effect is insufficient.

Side effects

- None known
- Only effective against certain butterfly caterpillars, therefore selective and beneficial insecticide

Application

- Not miscible with alkaline agents and additives as well as potassium soap, pyrethrin and copper products.
- Only carry out treatments at more than 15 °C atmospheric temperature.
- Carry out treatments before or after flowering.

Fatty acids (potassium soaps)

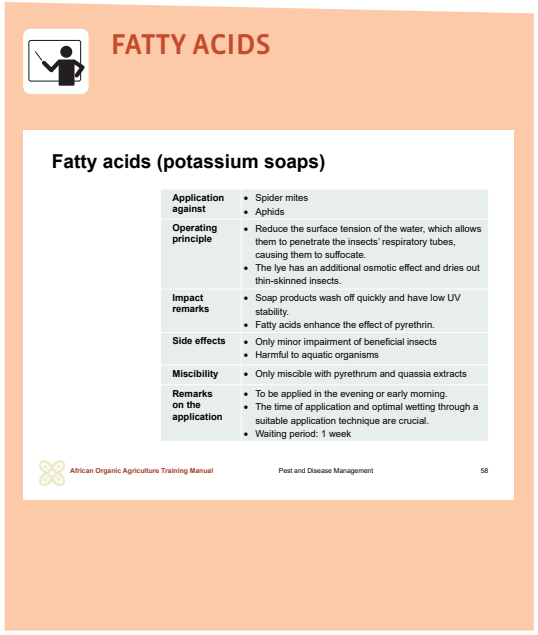
So-called soft soaps are harmless and non-toxic for humans and the environment. They have a limited spectrum of activity and are effective as insecticide against aphids, mealybugs, spider mites, African armyworm, thrips and whiteflies. In addition, soft soaps can also be used as a spreader/sticker to improve the effectiveness of other pesticides.

On-farm production of soft soaps is questionable, whereas small-scale industrial production is possible. So far, there are not many commercial products available in Africa, but many from suppliers overseas. In Africa, many soft soaps made of palm oil or palm tree by-products are available on the market.

The effectiveness against the different pests may have to be tested in local conditions. As the soap spray may injure the foliage of crops (e. g. kales), the products should be tested on a few leaves, and checked after 2 days, before being applied on a full scale.

Application against

- Spider mites
- Aphids
- Mealybugs
- African armyworm



- Thrips
- Whiteflies

Mode of action
- Reduce the surface tension of the water, which allows them to penetrate the insects' respiratory tubes, causing them to suffocate.
- The strongly alkaline solution has an additional osmotic effect and dries out thin-skinned insects.

Impact remarks
- Soap products wash off quickly and have low stability under ultraviolet (UV, direct sun) light.
- Fatty acids enhance the effect of pyrethrin.

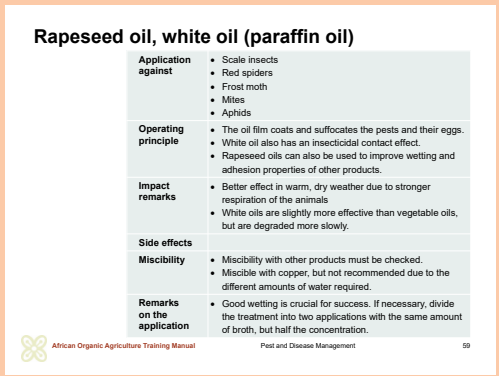
Side effects
- Only minor impairment of beneficial insects
- Fruit russeting possible with repeated treatments (especially at high temperatures).
- Treatments into the flower can have a thinning effect that is difficult to assess.
- Harmful to aquatic organisms with long lasting effects.

Application
- Only miscible with pyrethrin and quassia (*Quassia amara*, bitter-wood) extracts
- Perform treatments in the evening or early morning.
- The time of application and optimal wetting through a suitable application technique are crucial.
- Waiting period: 1 week

Rapeseed oil, white oil

Oils for plant protection can be obtained from various oil plants, or from mineral oil (white oil). They have an intermediate spectrum of activity and are partially effective against aphids, scale insects, spider mites and thrips. Oils can also harm certain beneficial organisms.

RAPESEED OIL, WHITE OIL



Rapeseed oil, white oil (paraffin oil)

Application against	• Scale insects • Red spiders • Frost moth • Mites • Aphids
Operating principle	• The oil film coats and suffocates the pests and their eggs. • White oil also has an insecticidal contact effect. • Rapeseed oils can also be used to improve wetting and adhesion properties of other products.
Impact remarks	• Better effect in warm, dry weather due to stronger respiration of the animals • White oils are slightly more effective than vegetable oils, but are degraded more slowly.
Side effects	
Miscibility	• Miscibility with other products must be checked. • Miscible with copper, but not recommended due to the different amounts of water required.
Remarks on the application	• Good wetting is crucial for success. If necessary, divide the treatment into two applications with the same amount of broth, but half the concentration.

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On-farm production of oils is not recommended, whereas local small-scale industrial production is possible for plant oils. Botanical and mineral oils are available as commercial products from international suppliers.

The effectiveness of oils should be tested under local conditions. Oils are also used to as additives to insecticides to increase their adhesion and performance.

Application against

- Scale insects
- Spider mites
- Frost moth
- Mites
- Aphids
- Mealybugs
- Citrus leaf miner
- Smooth skinned caterpillars

Mode of action

- The oil film coats and suffocates the pests and their eggs.
- White oil also has an insecticidal contact effect.
- Rapeseed oils can also be used to improve wetting and adhesion properties (check approvals and miscibility).

Impact remarks

- Better effect in warm, dry weather due to stronger respiration of the animals
- White oils are slightly more effective than vegetable oils, but are degraded more slowly.

Side effects

- Hardly any side effects, but observations under local conditions is encouraged.

Application

- Check miscibility with other products.
- Miscible with copper, but not recommended due to the different amounts of water required.

› Good wetting (until shortly before dripping) is crucial for success. If necessary, divide treatment into two applications with the same amount of broth, but half the concentration.
› Only use before flowering.

8. Plant strengthening agents

Quassia extract (*Quassia amara*, bitter-wood)

Application against
› Sawflies
› Aphids
› Leaf miner

Mode of action
› Frassing and contact poison.
› Paralyses insects as a neurotoxin.

Impact remarks
› Treatment against the newly hatched larvae immediately after flowering.

Side effects
› Little harm to beneficial insects.

Application
› Not miscible with sulphur lime and alumina preparations.
› Can be made from bitterwood itself.
› Can only be used when the flowers are in bloom.

Aggregates, soil additives, algae extracts, crop aids, homeopathic preparations, microorganism preparations

Scope
› Soil improvement and plant strengthening

Mode of action
› Various, partly unknown

Impact remarks

- In fruit growing, no scientific evidence of a direct plant protection effect known so far.

Biodynamic preparations

Scope

- Soil improvement and plant strengthening.

Mode of action

- The biodynamic preparations primarily serve to strengthen plants and activate the life processes in the soil and in the plants through the integration of cosmic energies that is attributed to them.

Impact remarks

- The six preparations 502 to 507 (yarrow, chamomile, nettle, oak bark, dandelion and valerian – the six co-called biodynamic compost preparations) are used in very small quantities exclusively for biodynamic manure or compost production.
- The so-called field spray preparations of cow dung (preparation 500) and horn silica (preparation 501) are 'dynamised' by stirring and applied in very high dilutions and at certain planetary constellations to the soil (500) and several times to the plants (501).

9. Further readings

- Pest, Disease and Weed Management. www.organic-africa.net
- Pests and Diseases. Infonet Biovision. https://infonet-biovision.org/plant_pests
- Natural Pest Control. Infonet Biovision. https://infonet-biovision.org/natural_pest_control
- European Input List. https://www.inputs.eu/