

2nd Edition

CROP PEST PROTECTION



Kenya Organic Agriculture Network

Ecological Pest Management (Epm)

Ecological Pest Management (EPM) is integration of available techniques to reduce pest populations and maintain them below levels that would not cause economic damage and by using ways that reduce harmful side effects.

Economic injury – This is the level of damage that prompts one to use money, effort and resources to manage a pest.

Pest management (organic) - This is manipulation of a pest population in order to keep it from reaching a damaging level

A crop **pest** is any living organism that destroys crops either directly by inflicting physical damage, or indirectly by introducing disease causing organisms into the crop plant.

Pests inflict damage to crops in the field or harvested produce in storage. They can be classified into:

- Insects
- Mites
- Nematodes
- Rodents (rats, mice, moles, squirrels, porcupines)
- Large animals (monkeys and large game)
- Domestic animals (poultry, sheep, goats, cattle, donkeys)
- Man (thieves and arsonists).

Here, emphasis will be placed on common insects, mites and nematodes; how and where they attack, how to recognize them, their effective stages, and how to control them using Ecological Pest Management (EPM) approaches.

Harmful effects of crops pests

- Termites and nematodes damage the crop's lower stem and roots causing wilting and eventual death of plants.
- Crickets and loppers destroy crop leaves, lowering the plants photosynthetic functions and hence reducing plants yields or even causing death.
- Mites, aphids and thrips suck plants sap from leaves, twigs and stem retarding growth and development.
- Fruit flies and borers attack flowers, buds, fruit embryos and fruits themselves, lowering output, fruit quality and the germination potential of seeds.



- Some loppers, aphids and mealy bugs transmit disease pathogens. Indeed, a good example is the green lopper which transmits the maize streak virus from infected to healthy maize crops.

Classification and identification of crop pests

Crop pests are with us all the time. We see them flying around us in our gardens and farms. Often, we wrongly assume that all insects are harmful, while in actual fact some of them are very beneficial to us. Some appear harmless and weak, but often, they are our deadliest enemies because they cause major damage to crops. Before we can fully identify and classify pests, it is important to first look at their feeding behavior, and the nature of harm done to our crops, as follows:

a) Classification of pests based on their feeding habits

Examine some crickets or loppers, cutworms and caterpillars you have chanced upon in your farm. You will notice that as they eat, their mouth parts move continuously, just as yours do during meal time. The movement of their mouth parts may be up and down and from side to center, but the net result is that they are biting and chewing. These pests have biting and chewing mouth parts and will eventually eat all the green leaves, buds, flowers and even soft twigs and barks. Cutworms have strong mouth-parts that saw and chew through the soft stems of seedlings.

On the other hand, some pests are seen as very small clusters on the leaf underside, around buds and young flowers or even on fruit twigs, branches and stems. Eventually, crop leaves start curling inwards, turning them brown and finally falling off. Others gradually develop transparent net-like patches on the upper surface before drying off. This will especially be observed on kales, capsicums and potatoes. Tomatoes and capsicums will show needle like prick marks.

Interestingly, when examined under a powerful magnifying glass, the mouth parts of these pests do not seem to move at all. And they resemble the beaks of birds or better still, the sting of bees. These are pests with piercing and sucking mouth parts and they are as deadly as those with biting and chewing mouth parts. Among the most notorious in this category are mites and aphids.



b) Identification of pests based on their mode of attack

Crops attacked

Some pests will only attack specific types of crops which are their source of food. Examples of these include:

- Stalk borers - These are the larva stage of night-flying moth and will always be found in or around members of the grass family like maize, sorghum and rice, among others. The maize stalk borer will always be found inside the stalk, maize cobs or within the green cob husks.
- Bean flies - These are very small adult bean flies that are found around all types of beans. When the plant is shaken, they fly around, but gradually settle on the leaves.
- White flies - These speck-like white flies are found on the underside of the tomatoes and brinjals (egg plants). When disturbed, they fly around the plant and gradually settle on leaves when left alone.

Stage of pest development

Some pests will only attack crops during their larval stage. As adults, they feed on a totally different diet. Some insects are very harmful at the larval stage, only to turn out to be beneficial to farmers or totally harmless to crops at the adult stage. A good example is the destructive larval stage of the moth when they are stalk borers or fruit borers.

Equally, other insect pests are harmless throughout their metamorphosis only to become extremely harmful pests during their adult stage. Good examples are aphids and thrips.

The following are some pests and their stages of destruction:



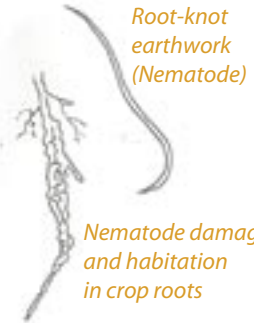
Black cricket



Wrinless termite



Winged adult black tea thrip



Root-knot earthwork (Nematode)

Nematode damage and habitation in crop roots



Adult leaf hopper



Bean aphid showing ares of infections



Adult Red Spider mite



Adult tobacco aphid (winged)

Stage of crop growth

While some pests destroy crops at the seedling stage e.g. cutworm, others like the boll worms and borers attack them at the flowering stage.

Severity or level of damage

Some insect pests cause damage that is so severe that a national alert is put out on them. Examples of these include the red desert locust and the army worms. Note that while army worms are severe at the larval stage, the locust is at its severest at the adult stage.

Other insect pests cause low magnitude damage which many crop plants outgrow. Caterpillars and lesser hoppers fall in this group.

Classification according to habitat

Field pests cause damage in the farm. Examples are loppers, caterpillars, thrips, aphids, borers and boll worms, among others. Other pests are strictly restricted to stored produce. Storage pests include the grain moth, maize and rice weevils, khapra beetles, red flour beetles and bean bruchid.

How pests choose what crops to attack

Just like birds and animals of prey, crop pests develop an instinct to identify their crop victims. It is thus necessary to identify the factors that lead crop pests to their prey, both in the field and in storage.

i) In the field

In the farm the following characteristics will be observed:

- a) Crops that appear weak from nutrient deficiencies are easy victims. Weak crops will display softer leaves which can be chewed easily.
- b) Aphids will develop wings and fly to leathery looking kales because they have a higher concentration of sugar than those which are well nourished with water.
- c) Sickly crops will not have the strong aromas or smell that keep pests away. As such pests will flock to them. Sickly onions, coriander and garlic, which otherwise repel pests, will be easy prey.
- d) Under-nourished or sickly crops will produce fruits with thin and weak skin which can be easily pierced by fruit borers.
- e) When such crops as soybeans and cucurbits lose bristle from their leaves and stem due to disease attack or inadequate nutrients, aphids, thrips and caterpillars, which would otherwise have kept away, will attack them.

ii) In the store

- (i) Bruised produce will present easy entry points for weevils.
- (ii) Improperly dried stored produce will start rotting, hence creating high moisture conditions that will attract the khapra beetles.



Maize weevils



Bean bruchid



Grain moth

PEST CONTROL AND MANAGEMENT

In organic farming, pest control and management is carried out without using any synthetic chemicals whatsoever. This process of controlling pests without recourse to inorganic substances is referred to as Ecological Pest Management (EPM) and involves integration of various techniques that will reduce pest population build up and maintain them at levels that will not cause economic damage to crops. These control techniques can be grouped into different control categories as follows:

1. Cultural pest control

This involves simple but very important farming practices, which are easy to use when controlling pests and also easy to maintain at the farm level. They are just the normal farming practices but have significance in pest control. They include:

- Proper farm management which includes manure (compost) application and green manuring to improve soil fertility and support healthy crops. A crop which is undernourished is in a state of imbalance and is more prone to pests and diseases. Too much application of nitrogen fertilizers will have the same result. Well balanced manure and a healthy organic soil contribute to production of a strong crop which will be resistant to pests and diseases.
- Proper soil tillage like conservation tillage, zero tillage, or double digging and others, depending on the area and season, is important to control pests that exist as larvae or pupae in the soil or in crop residues. When you till the soil, eggs, larvae and pupae are pushed deep into the ground from where they cannot come back to the surface. Tilling could also expose them to the surface where they are burned by the sun or picked by birds and other animals.
- Early weeding to reduce competition for nutrients with crops. Some weeds act as alternative hosts to crop pests.

- Field hygiene is a measure aimed at interrupting the life-cycle of pests by removing the harvested crop residues and composting them. The premature fallen fruits, which might be infested with larvae and pupae, should be removed to prevent further development of pests. By so doing, future pest populations are reduced.
- Crop rotation is also important in pest control as it separates a particular pest in time and space from its host crop. The interruption of the life-cycle by introducing a non host crop reduces the spread of the pests in subsequent seasons.
- Other important things to consider in cultural pest control include proper spacing, timely planting, use of trap crops, crop diversification, choice of crop variety and planting of alternative crops, among others.

2. Biological pest control

This is where crop pests are controlled using other living organisms referred to as predators. It is important to encourage predators to live on the farm by:

- Providing shelter or improved habitats, hence protecting them from their own predators.
- Increasing the soil fertility as a well-fed and structured soil will provide a habitat for many beneficial soil organisms. Good examples are fungi in fertile soil that trap and kill nematodes as their food.
- Improving plant or crop diversity.
- Avoiding the use of synthetic chemicals as this would, in addition to killing pests, destroy useful predators. A good example is the spider which is very sensitive to chemicals which remain on the crop long after spraying.

Some of the predators that need to be encouraged to live on the farm include:

(a) Parasitic wasps. They are very small and lay their eggs in the larvae of pests. They feed and grow inside the larvae killing it. Wasps can kill caterpillars in large quantities. Encourage them by growing plants with delicate flowers like dill and fennel.

(b) Ladybirds. They are round-shaped beetles with black, red or yellow spots on their shields. They are very efficient predators of aphids.

(c) Chameleon and lizards. Both are insect eaters and help in keeping garden pests under control.



Wasp



Lady bird



Praying mantis



Chameleon

Other important predators include the playing mantis, dragon flies, ground beetles and spiders, among others.

3. Natural pest control

Natural pest control involves the use of natural products and botanicals (plant materials) to control crop pests. The aim is to avoid poisonous chemical products which kill not only the harmful pests, but also a lot of other beneficial organisms. Synthetic chemical products are persistent and have many side effects on human beings, animals and the environment. They are also very expensive that only a few farmers are able to buy them. Advantages associated with natural crop protection include the following:

- They are derived from a combination of plants thus making it less likely for pests to build resistance to them as they would do to a single synthetic chemical pesticide.
- They are selective and have little destructive effect on pest enemies.
- They are less harmful to the health of either humans or farm animals as they are made from plants which degrade quickly.
- They have no damage to the environment or water sources.
- They are cheap and easy to get as the material used to make them are locally available.
- They reduce dependency on external inputs and therefore promote self sufficiency.
- The degradation period is short hence no toxic residues are produced.

4. Plant teas

It is also important to note that pest control on weak crops may not be as effective as expected and therefore there is need to strengthen crops using plant teas made from stinging nettle, Russian comfrey, tithornia (false sunflower), leucaernia and other leguminous perennial green manure crops. Plant teas made from Mexican marigold, hot pepper or chillies, ordinary wood ash, onions and garlic, coriander and bar soap act as pest repellants. Similarly, teas made from pyrethrum, tephrosia, lantana, neem, tick berry (Lantana camara), cow dung and urine, fine ash, diatomite dust (non-organic) and sodium bicarbonate or Magadi soda (non-organic) can act as pest killers.

HOW TO PREPARE HERBAL PESTICIDES AT HOME For controlling field pests

1. Pyrethrum (*Chrysanthemum cinerancefolium*)

It is a perennial daisy-like flowering plant.

Target - Insects and mites (aphids, white flies, spider mites, meal bug, slugs)

Action - Broad-spectrum insecticide.

Parts used- Flowers.

Preparation and use

- Pick flowers on a hot day and dry them in shade.
- Grind into powder and dust on infested plants.
- Alternatively, add 20 gm powder of ground pyrethrum flowers into 1 litre of boiling water (0.02:1) and let it cool. Or soak for 4 to 6 hours in cold water, add a little bar soap (about 4 pinches into 1 litre of water), stir into foam, filter the pyrethrum solution, mix with soapy water and spray on infested crops.



Pyrethrum

Warning!

- Apply in the evening to avoid killing bees.
- Organic farming organizations restrict its excessive use.

2. Onions, leeks and garlic

They are perennial bulbous herbs.

Target - Aphids, cabbage butterfly, mites, scale thrips, white fly, mice, moles and fungal diseases

Action - Repellant, insecticide and fungicide

Part used - Bulbs and leaves



Onion



Leek

Preparation and application

- Crush 1 garlic bulb; add to 1 litre of water, mix with a little bar soap and use immediately.
- Crush leaves or bulb, mix in water and allow to stand for 2-3 days.
- Filter and dilute the solution with an equal amount of soapy water. Apply to infested crops.
- Onions can also be dried, crushed and used as dust.
- Inter crop the onions with other crops to repel pests.

Warning!

- Garlic is a broad spectrum insecticide which will kill even beneficial insects.
- The taste remains on the sprayed or dusted plants for up to one (1) month after being used.
- Do not use allium solutions on legumes or plant beans after onions as this will hinder the production and performance of beans.

3. Red pepper and chillies

These are shrubs grown for hot spices or sweet pods which are used to flavor foods.

- Target**
- Bacterial, fungal and viral diseases.
 - White flies, aphids, cutworm ants, slugs and snails, caterpillars and mailbags.

Action - Used as a repellant and insecticide.

Part used - Ripe pods and seeds



Preparation and application

- Crush 2 handfuls of chilli pods and soak in 1 litre of water for a day.
- Shake well, filter and add 5 litres of soapy water.
- Spray on the infested or affected crops.
- Equally, chilli powder can be applied around the base of plants to repel ants and cutworms.
- Pounded green chillies can be sprayed to control diseases.
- 50 gm of chilli powder thoroughly mixed with 2 kg of wood ash can be added to the funnels of young maize seedlings to kill stalk borer eggs.

4. Tomato

It is a perennial soft herb, normally grown as an annual for its fruits, which can be eaten fresh or in salads and fried vegetables.

Target - Many insect pests like ants, beetles, cabbage worm, caterpillars, flies, grubs, mites and bacterial wilt.

Action - Used as an insecticide, repellent, attractant, bacterial, fungicide and to prevent egg-laying pests from approaching crops.

Part used - Any part of the plant including roots and fruit.

Preparation and application

- Simmer 1 kg of chopped leaves in 2 litres of water, leave to stand for 5 hours, filter and spray every 2 days.
- Or shred 2 handfuls of leaves/stem/fruits, add 2 litres of water, leave to stand for 5 hours, filter and add a little bar soap (4 pinches per 1 litre water) and spray as above.
- Dry tomato materials can also be ground into powder and used as either a spray or dust.
- Inter-planting tomatoes with other crops is beneficial as their smell helps to keep away beetles and fruit flies.

5. Stinging nettle and Mexican marigold

Stinging nettle is a perennial herb with burning bristles.

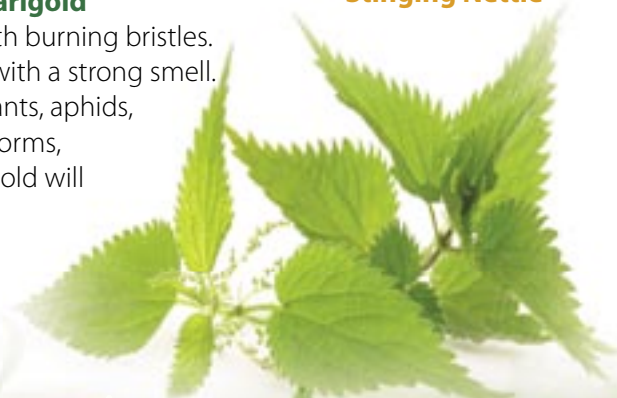
Mexican marigold is an annual herb with a strong smell.

Target - Stinging nettle will repulse ants, aphids, cutworms, caterpillars, thrips, army worms, slugs and snails, while Mexican marigold will repel all those and nematodes.

Action - They are repulsive and act as insecticides.

Part used - Leaves

Stinging Nettle



Preparation and application

- Crush 3 kg of either Mexican marigold or stinging nettle and soak in 4 litres of water.
- Leave for 5-8 days or boil water, add the materials and let to cool, then filter.
- Dilute with equal amount of soapy water.
- Spray on infested crops. for dusting onto aphids and other discarded tobacco p

6. Tick berry (*Lantana camara*)

It is an invasive perennial weed.

Target - A wide range of insect pests, both in field and storage.

Action - Contact poison.

Part used - Leaves, flowers, and branches.



Tickberry (*Lantana*)

Preparation and application

- Crush 1 handful of green leaves in 1 litre of water; let the mixture stand for 2 hours.
- Filter and dilute with equal amount of soapy water and spray the affected crops.
- Dry and grind leaves into dusting powder.
- Dust on infested leaves.
- Burn the whole plant and dust ashes on beetles and leaf margins.
- Collect leaves, dry them and put at the bottom of the storage facility. Place crops to be stored on top.

7. Milk

Target - Fungal and viral diseases like blights, mildews, mosaic viruses on tomato, tobacco, sugar and sorghum.

- Spider mites, caterpillar eggs on crucifers and buck.

N/B. There are many things that can be used to make natural pesticides depending on where one comes from and the availability of materials. Other materials that can be used to make natural pesticides include pawpaw, neem, blackjack, soap, mulch, compost, animal dung and urine, to mention but a few.

Controlling storage pests

A useful storage approach to minimize damage is to harvest early and then dry the produce well. Equally, storage facilities should be thoroughly cleaned and repaired before any new produce is put into them. Stored produce containers should be thoroughly sealed to deter pest entry. Above that, there are several ways and methods used to protect stored produce from pesticide attack such as:

- a) Use of non-plant materials like manure, sand, animal fat, fine powdery materials (chalk, lime) and salt which have proven effective when well used.
- b) Use of plant materials like ash, burned grass, citrus peels and vegetable oils, has equally proved very effective.

Plants have also been used effectively to control storage pests. Some of the plants used successfully include:

Chilli peppers - Ripe dry pods are crushed and mixed with ashes or dry dung, then thoroughly mixed with cereals like maize, sorghum, beans, green grams, etc. to repel or kill khaphra beetles, grain moths, maize and rice weevils, and bean bruchids.

Thorn apple

(Datura stramonium) - Leaves and stems are dried, crushed and mixed with stored produce to repel storage pest. Care should be taken to wash hands thoroughly after treatment. Better still, rubber gloves are recommended. Produce should be thoroughly cleaned before cooking. Grains for flour should also be thoroughly cleaned and re-dried prior to milling.

Tick berry

(Lantana camara) - Leaves are dried and crushed, then placed among stored pods or grain. Dry lantana leaves can also be lined on the store floor, then produce arranged on them (cobs, pods and tubers). It is also important to place some drier lantana leaves over the produce. Lantana is well known to be effective for controlling potato moth during storage.

Mango

(Mangifera indica) - Leaves, flowers and twigs are crushed, dried and spread over the surface of storage produce as powder. Effective on a wide range of storage pests.

Persian lilac

(Melia azedarach) - Leaves and seeds are dried and powdered separately. 1kg of powdered seeds are adequate for 50 kg of stored produce, and 2 kg powdered leaves for the same amount. Produce treated with Persian lilac has been known to last for up to 2 years without any attack from pests.

Neem

(Azedarach indica)

- Can be used just like Persian lilac.

Neem



Tephrosia

(Tephrosia vogelli)- Whole plant can be dried, crushed and powdered and then mixed well with stored produce to keep away khaphra beetles, maize and rice weevils and kill grain moth. Seeds have more strong ingredients than other parts of the plant and can also be used to control ticks in livestock. Tephrosia is also a nitrogen fixing crop, hence can be used in rotation to maintain soil fertility.

Mexican marigold

(Tagetes minuta) - The whole plant (stem, roots, leaves and flowers) can be dried and placed in 3-5 cm layers at the base of grain bins. Equally, the plant can be dried, powdered and mixed with produce in bags, bins or other containers. While the pungent smell will keep away pests, it can hang strong on produce. It requires thorough washing before using grains. Grains should also be properly washed until all the smell goes away and dried to 13% moisture content before being ground into flour.

Mexican Marigold



Tephrosia



Some of the material in this book was adapted from the books:

1. **Sustainable Agriculture** - by ILRI
2. **Natural Pests And Disease Control**
- By Henry Elwell and Anita Maas
3. **Organic Farming Filed Not book** - by John Njoroge
4. **Soil Fertility Management** - by John Njoroge
5. **IFOAM Training manual**

BOOKLETS IN THIS SERIES:

1. **Organic Agriculture** (Kilimo Hai)
2. **The Living Soil** (Undongo ulio hai)
3. **Soil Fertility** (Rutuba kwenye Udongo)
4. **Composting** (Mboji)
5. **Green Manure** (Mbolea ya Majani)
6. **Soil and Water Conservation In Organic Agriculture**
- Uhifadhi wa Maji na Udongo katika Kilimo Hai
7. **Soil Tillage** (Kutayarisha Undongo)
8. **Crop Rotation** and its role in Soil Fertility
(Mzunguko wa mimea na umuhimu wake katika kuhifadhi rutuba kwenye udongo)
9. **Cropping Systems** (Mbinu za Upanzi)
10. **Crop Pest Protection** (Kukinga Mimea)

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Kenya Organic Agriculture Network (KOAN) is the National Coordinating Body for organic agriculture activities in Kenya.

KOAN's mandate is to coordinate, facilitate and provide leadership and professional advisory services to all members and stakeholders in the areas of production, technical training, marketing, certification, lobbying and advocacy.

It seeks to promote the organic agriculture movement in Kenya, to evolve and become a highly beneficial and integral industry with direct impacts on the environment , poverty reduction, employment and wealth creation



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