

Ecological approach to pest and disease management in the Tropics

Prevention and direct control measures

Pests and diseases can severely reduce crop yields. However, the use of synthetic agrochemicals to control them threatens human and environmental health, by polluting our soils and water systems, causing diseases, and killing beneficial organisms. Management of pests and diseases in organic farming requires not only renouncing synthetic agrochemicals, but including integrated approaches (e.g., companion cropping, push-pull technology, crop rotations, biorationals, i.e., botanicals, etc.).

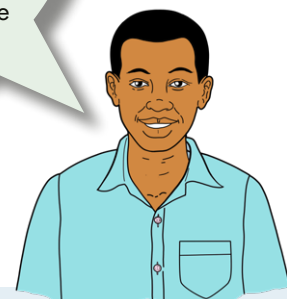
This factsheet introduces the integrated ecological approach to organic pest and disease management, how to best prevent problems and direct control methods. The information is based on long-term experiments and on-farm research conducted in the scope of three projects across different countries in Africa, as well as Bolivia and India. Further products in the series, e.g., posters, videos and more, are linked in the 'Further information' section on the last page of this factsheet.

Key findings from the research

- Organic farming provides an alternative and **environmentally sound approach** to the use of harmful and expensive synthetic agrochemicals in conventional farming.
- Pest and disease pressure can be a major challenge in organic systems that mimic conventional methods by only substituting synthetic agrochemical with biorationals.
- Pest management in organic farming requires a **holistic approach**: focusing on practices which act to restore the habitat and support the balance between beneficial insects and pests.
- This approach can **reduce input costs** for the farmers while reducing chemical residues in our food and the environment.



The organisms that we call pests and those that cause diseases are part of the natural farming system. However, the activities of these organisms can negatively impact crops health, quality and yields. Organic pest and disease managements' first line of defence is: prevention. Many of the preventative measures used act both to promote on-farm diversity and keep pest and diseases at a level which does not cause economic damage. If pests reach critical levels, the second line of defence is employed: direct control measures.



Prevention: Organics' first line of defence against pest and diseases

Organic systems that mimic the standard approach of pest and disease control, only replacing synthetic agrochemicals with biorationals, will face many challenges. Preventing a problem from arising, rather than treating a problem, is the ecological organic approach to pest and disease management.

There are many ways to effectively decrease pressure from pests and diseases organically while also improving overall farm health. The following section describes some techniques recommended from the research.

Best practices on the field

As a farmer, you can prevent outbreaks of pests and diseases with some field practices that are sustainable, as they require less money and are safe. Some examples include:

- **Scout plants** early for pest and disease: In the SysCom trials this was done in 14 day intervals and was proven successful at discovering a pest before it infest the crop.
- Use bait, light, colour or pheromone **traps** for monitoring insect pests: In SysCom India, pheromone traps were used to monitor the cotton bollworm.

What are biorationals?

Pest and disease control substances or products with low environmental impact. Some, but not all, biorationals qualify for use on organic farms. The major categories of biorationals include: botanicals (plant-derived, e.g., pyrethrum), microbials (derived from micro-organisms, e.g., Bt), minerals (e.g., copper or sulphur), and synthetic materials (e.g., soap).

- Grow **healthy, resistant crops**: They can better fend off pests. Robust plants produce compounds that deter pests when under attack. See the 'Productivity' factsheet for more > [Link](#)
- **Improve field hygiene**: Remove host plants for pests and diseases, and properly dispose of infected plants or plant parts.
- Maintain **healthy soil**: Produce and use organic manures and compost. These are especially valuable in providing suitable conditions for many beneficial organisms, to increase humus in the soil, and to add micro-organisms which help suppress diseases. See the 'Soil' factsheet > [Link](#) for further information.
- Use **physical barriers**: Fine nets or fruit wraps can be used to prevent pests, such as moths, thrips and whiteflies, from reaching their host crops like tomatoes and cabbage.



Agroforestry methods – Cacao-based systems

From the experiences of SysCom Bolivia, in cacao-based agroforestry systems with the application of good agricultural practices total pest and disease incidence was low in all cacao production systems. Good practices to maintain healthy perennial crops, like cocoa, include:

- Choose **disease tolerant** or **resistant varieties**: Local research institutes may inform about their availability.
- Design agroforestry systems with **regular spacing of shade trees**: Rather than leaving only little and big trees, include a variety of trees aiming to mimic the natural forest structure.
- **Prune cocoa tree height** regularly: This allows light to penetrate to the trees centre and will increase air circulation, reducing risk of disease.
- **Prune shade trees** and **fruit trees** regularly: Including stratification (giving each species its specific space in the canopy).
- **Harvest** cocoa pods **regularly**: to prevent disease and over ripening.
- **Remove diseased pods** with the regular harvests: a minimum of once every 15 days.
- **Weed the understorey**: Especially in young plantations.

Use adapted, local seeds and plants

Seeds contain the instructions for how the plant will grow and reproduce (genetic information). This information is constantly adapting according to the conditions and will be passed on, via their genetic materials i.e. seeds, to the next generation. Seeds can also be treated to prevent diseases.

- **Use crop varieties with high pest tolerance** and those **well adapted** to the **local environment**: they are better suited to defend themselves from pest and disease attacks and survive, because they have better genetic instructions.
- **Treat seeds**: Seeds can carry diseases from the last season into the next. Treating seeds can help break this disease cycle. In SysCom India trials, locally-available ingredients were combined to coat seeds – this helped protect them from harmful fungi and bacteria during germination, while supplying nutrients to seedlings, and increasing germination rates. See



the leaflet series: 'Preparation and Application of self-made organic pest control products' for more information > [Link](#).

Increasing diversity of crops

Diverse fields are complex habitats that attract more beneficials, resulting in a reduction of pests. Increasing on-farm diversity can also reduce pests simply by making it difficult for them to find their host plants. Crop diversification strategies that reduce pests include:

- **Companion cropping**: Growing two or more crops on a field at the same time decreases the risk of pests and disease infestations. For example, SysCom Kenya trials showed that cabbage intercropped with coriander helped to deter pests, and added an additional marketable crop.
- **Push – pull intercropping**: An example from the research is maize and *desmodium*. *Desmodium*, a 'push' plant, when planted in between the rows of maize it repels problem pests and reduces weed pressure.
- **Maintain** a balanced and diverse **crop rotation**: This increases diversity of crops over time and limits the build-up of pests and diseases.
- **Include cover crops**: These crops provide many services to the farming system, including protecting the soil from erosion, improving water infiltration, providing habitat for beneficial organisms and suppressing diseases.

Supporting on-farm beneficial organisms

Supporting beneficial organisms on-farm can be an effective way of minimising pest pressure. In fact, organic systems have a higher ratio of beneficials to pests. The natural defences of organic systems can help to defend the crops against negative pressures from pest and diseases. To support beneficials on your farm, focus on providing year-round food and habitat to ensure their presence within or near crops.

To boost the beneficial organisms on your farm, there are some effective strategies:

- **Increase on-farm diversity:** By growing a high diversity of crops and not using synthetic agrochemicals, you support a diverse community of beneficial organisms, above and below ground.
- **Maintain a variety of flowering plants** throughout the year: In hedges, field borders or within fields. Pollen and nectar from flowers are essential food sources for some beneficials such as wild bees, butterflies and hoverflies. Be sure to time the plantings in a succession so that beneficials have food year-round. Plant flowering plants in clumps of at least five per species to make them easier for pollinators to find.

What are beneficial organisms?

In organic farming, pests and diseases are kept in check by their natural enemies, or beneficial organisms. These are the 'good guys' in the field who perform services like pollination and pest control. Some examples of beneficial organisms include: honey bees and wild bees, butterflies, beetles, flies, spiders, ants, beetles, hoverflies, etc.

- **Keep and support wild and native plant species:** They are adapted to the local climate, soil and therefore support native pollinators.
 - **Provide habitat** after harvest: Once the main crop is harvested, additional habitat is needed to maintain the population of beneficials.
 - **Set aside natural and semi-natural areas:** Wild or semi-wild areas with no management can provide beneficial insects a haven for breeding and living. Examples of this include hedgerows, piles of rocks or fallen wood.
 - **Apply organic manures and composts:** They are especially valuable in providing suitable conditions for many beneficials who spend part of their life in the soil.
 - **Reduce tillage:** Tillage can negatively affect beneficials in the soil and destroys their habitat.
- For more information on which practices support on-farm biodiversity, refer to the 'Biodiversity and adaptation' factsheet > [Link](#).



Direct control measures: Organics' second line of defense against pests and diseases

Some pest and disease issues are unavoidable, especially during the first years of transitioning a farm to organic management. Our research shows that, on-farm pest and disease pressure is usually a sign that the ratio of beneficials to pests is imbalanced.

Try to mimic nature in your farming system by taking a systems approach and following the practices outlined in the previous chapter. With time and experience, most pest and disease outbreaks can be avoided. Additionally by not relying on direct control measures, money and time is saved.

However, if a pest or disease outbreak takes place, direct control measures, or biorationals, can support you in controlling them.

Botanicals are a type of biorational; plant-based, homemade organic pesticides, made from locally available resources which can be used to fight pest and disease outbreaks. These should be used sparingly, as they will also kill some beneficial organisms.

Here are some examples of self-made organic pest control products, proven effective from the research. More information about preparation is available in the leaflet series: 'Preparation and Application of self-made organic pest control products' > [Link](#):

Success with botanicals for bio-pesticides

A botanical developed and tested in SysCom Kenya manages aphids, diamond back moths, and others pests in cabbage, kale, and french beans. When cabbage was companion cropped with coriander and this botanical was used, there was a very low pest pressure.



Organic vs. conventional farming: impacts on environmental contamination

Continuous use of synthetic agrochemicals, e.g., pesticides, fungicides, in conventional farming may pose a potential threat to human and environmental health due to agrochemical residues in soils, water and crops.

Results after six years of comparative cultivation at two SysCom project sites in Kenya have shown:

- Conventional fields were contaminated with pesticide residues and sometimes exceeded the acceptable thresholds.
- Soil, plant products and running water from organic fields were free from residues of the applied botanicals.

The use of preventive control measures and biorationals in organic farming minimises agrochemical residue contamination. Thus, organic farming provides an effective alternative and environmentally sound approach to the pollution problem in agriculture.

Garlic-Onion-Chili (GOC) mix

This bio-pesticide repels insects with its pungent odour. It also causes tingling and stinging to the insects and can directly kill the soft-bodied juvenile life stages. It can effectively control suckling insects (e.g., aphids, flies, mites) and bollworms, a particular problem pest in cotton production.





Further information

- Complimentary knowledge products, e.g., a poster, powerpoint, video about pest and disease management on organic farms > [Link](#)
- Further knowledge products, e.g., posters, videos and more, in the series cover topics such as: the ecological approach, productivity, soil, profitability and biodiversity > [Link](#)
- Leaflet series: 'Preparation and Application of self-made organic pest control products' Mandloi, L. et al. 2014 > [Link](#)
- Organic Africa Manual Module 4: Pest, Disease and Weed Management, Wyss E. et al. (2011): The module describes the general approach of organic farming to pest, disease and weed management, and presents the different tools to manage pests, diseases and weeds in crops and in storage > [Link](#)
- What is the contribution of organic agriculture to sustainable development?, Bhullar et al. (2021): A synthesis of twelve years (2007-2019) of the 'long-term farming systems comparison in the tropics (SysCom)'. The SysCom team published a first report which synthesises the scientific findings of SysCom. The report is presented in a form that is easy to understand for an 'educated non-expert' audience > [Link](#)
- Push-pull platform developed by scientists at the International Centre of Insect Physiology and Ecology (icipe), Kenya, Rothamsted Research, in the U.K., in collaboration with other national partners. 'Push-pull' is a novel integrated pest preventative practice > [Link](#)
- Ecological Organic Agriculture | Organic Pest Control from ESAFF Uganda TV. The video shows a farmer illustrating how organic pesticides are made using urine and different wild plants > [Link](#)

Imprint

This factsheet is a part of a series of knowledge products created within the KCOA project, analysing the outcomes of the SysCom and ProEcoAfrica projects. For further information on these projects refer to the corresponding project brief > [Link](#).

The purpose of this series is to educate African farmers and advisors on research results related to organic farming.

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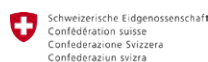
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