

Biodiversity and climate change adaptation on ecological organic farms in the Tropics

Ecological organic farming takes a holistic system approach which enhances biodiversity and improves the adaptability of farmers. This adaptability is more important than ever as climate change, pandemics, rising food prices, etc. threaten the livelihoods of African farmers. Ecological organic farming provides an alternative to the business as usual, standard approach to farming. Farmers adopting this approach will be more resilient in the face of challenges, while helping to mitigate climate change and protecting valuable biodiversity.

This factsheet introduces: how organic farmers can team up with a diversity of plants, animals and micro-organisms to increase their ability to adapt to changes and reduce risks. It describes farming practices that support biodiversity and adaptation to a changing climate and highlights some benefits that biodiversity can provide for farmers and society. 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.

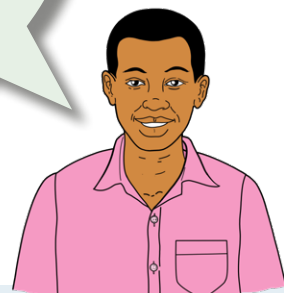


Key findings from the research

- The holistic ecological approach applied in organic farming **promotes biodiversity** on farms and, in turn, **increases a farmer's ability to adapt** to changes – lessening risks.
- Ecological organic farming shows clear human **health and environmental benefits**.
- This farming approach promotes and conserves biodiversity, improves soil health, reduces pollution of water, soil and air and uses more renewable energy, meaning lower greenhouse gas emissions.

Adaptation is the ability of a farm to be flexible and productive in the face of challenges to the system.

Current challenges that require increased adaptability for farmers include: the increasing droughts and intense rain events occurring with climate change, the COVID pandemic, rising fertiliser and food prices, etc.



Which ecological organic farming practices support biodiversity?

Biodiversity is the foundation for productive and resilient farming systems. The ecological organic approach works with nature and supports biodiversity in natural areas, as well as on the farm. This is realised, among other reasons, by the use of favourable farming practices (e.g., mulching, organic manure, crop diversity, integrating animal husbandry) and avoiding inputs that harm the environment. These practices result in favourable conditions for biodiverse organisms.

It is important to note that the older the system, the more biodiversity it gains – thus, the establishment and protection of these areas should have a sustainable, long-term focus.

The recommended active ecological best practices explained in depth in the ‘Productivity’ fact-sheet, video, etc. > [Link](#) are relevant for supporting biodiversity. The following section provides additional important practices that farmers can integrate on their farms to further promote biodiversity on fields, farms, and the landscape in general.

Protect natural and semi-natural areas

Integrating natural and semi-natural areas into a farm benefits both the farm and the surrounding community. These environments can help to increase productivity on ecological organic farms by naturally reducing pest and disease pressure, protecting soil, improving water cycling, and providing windbreaks, shade, food, and medicine for both humans, livestock and crops.

Examples of natural areas include forests and reserves, while semi-natural areas can either be areas that are untouched (e.g., hedgerows), or intentionally planted (e.g., flower strips).

Consider implementing or leaving these natural elements on your farm, as each provides important habitat for beneficial organisms. Some examples of landscape elements that support on-farm biodiversity and provide other benefits like erosion control, water filtration, etc. include:

- Flower strips: strips of flowers, annual or perennial, within fields and/or at field margins.
- Buffer strips: strips of permanent vegetation within a field or alongside a stream or river; help slow the flow of water runoff from fields.
- Hedgerows or ‘living fences’: are closely spaced shrubs/trees planted at field or farm

What is biodiversity?

The variety of living beings, including plants and animals (wild and domesticated), bacteria, and fungi. Each living organisms works together in ecosystems, to maintain balance and support life.

Biodiversity supports ecosystems to provide that which we need to survive: food, clean water, medicine and shelter.



margins; these also provide a windbreak for crops.

- Terraces: used in hilly areas, to create flat surfaces; allow for farming and reduce erosion.
- Trees: either as forests or in groups within fields; provide shade, stabilise the soil, and can be important medicinal and food sources for both people and animals.
- Fallow fields: an area which has been left unplanted for a period of time.
- Water features: examples are ponds and streams; are an important part of the water cycle; used for watering animals and plants.
- Rock, stick, wood piles or walls: create natural farm boundaries; help provide a windbreak for crops and habitat for insects, etc.
- Protect existing wetlands, forests and riparian buffers.

Include native species

Native plant species (wild and domesticated) are important to include in and around the farm. These plant species support beneficial organisms, as they have adapted together with native insects in the area that may not be attracted to non-native plants. For instance, larvae of butterflies are known to be very selective of their food source.

Leave it a little messy

One simple way to support biodiversity on-farm is to simply allow some areas of spontaneous vegetation to grow in between crops or at the field margins. These 'weeds' are often the plants and habitats beneficial organisms need to survive.

Additionally, leaving small piles of unused materials, like dead branches, at the field margins saves the farmer time in removing or burning them, and provides important corridors and habitats.

Other practices like selective weeding in agroforestry systems, for instance, can help to increase the number of species, especially native ones, by allowing plants to grow that would usually be removed. Sometimes these can even turn out to be valuable timber or fruit tree species!

Choose diverse crop and livestock varieties

Planting a more diverse variety of crops and raising a range of livestock can diversify farm income, improve a farm's ability to adapt to changes and help preserve local and native crop and livestock varieties.

The increase in biodiversity also benefits the farmer by helping prevent pest and disease outbreaks and lessen the risk potential of crop losses or damage.

Consider some of the recommendations below to increase on-farm diversity:

- Crop varieties: grow different varieties of the same crop – try which varieties do best on your farm and at the market.
- New crops: that could benefit the system like fruit trees, or native trees or bushes that could be used for animal fodder.
- Intercrop two or more crops in the same field.
- Border-crop plants that attract beneficial insects and repel pests, e.g., native flowers, shrubs, etc.
- Crop rotation: design a well-thought-through rotation of different crops in the field throughout the year.
- Agroforestry: integrate trees and shrubs into crop and animal-production systems.
- Livestock varieties: consider different locally-adapted breeds, or hardy cross-breeds.
- Try new livestock on the farm: They could contribute in terms of manure, new products and added value (e.g., meat, milk, eggs, etc.).

Prevent pests and diseases

Although organic biorationals (pest and disease control substances) have a low toxicity and environmental impact compared to conventional agrochemicals, they do also kill some beneficial organisms.

Preventing a problem from arising, rather than just treating the problem, is the ecological approach to organic pest and disease management. To go deeper into this topic, explore the 'Pest and disease' topic factsheet, powerpoint, video, etc. > [Link](#).



How do farmers benefit from supporting biodiversity?

Biodiversity is one of the main currencies of organic agriculture. It provides many benefits, including improving a farm's ability to adapt to challenges, and improved crop, soil and water quality.

In the following section, some of the benefits biodiversity provides to farmers are explained. The information comes from two research projects SysCom and ProEcoAfrica.

Reduced risks – more adaptable

Diversification of production and incomes on the farm and in the plots, e.g., agroforestry, intercropping, crop rotations, etc., helps **reduce the risk** of failure of crops or livestock via pests, diseases, extreme weather events or a change in market conditions. Even in a bad year for some crops, other crops will thrive.

Socio-economic risks are, therefore, also reduced on organic farms as a result of biodiversity. Organic farms are **more flexible** to new environmental situations and consequently can change their production patterns and practices more easily. Additionally, the reduced input costs and focus on using local, natural resources on organic farms contributes to economic resilience.

The **diverse set of knowledge** and levels of organisation seen on successful organic farms, e.g., techniques like composting, crop combinations, seed production, organisation in cooperatives, connection to extension officers, etc., improves a farm's ability to adapt to changes.

Diversification, adaptability, and knowledge allow ecological organic farms to **show more socio-economic and agroecological resilience than their conventional counterparts**.



Cleaner food, environment and water

Because organic farming does not use synthetic agrochemicals, contamination of local food, soil, and water is reduced. In results from SysCom Kenya, it was found that compared to the organic system, products from conventional fields were contaminated with chemical pesticide residues that sometimes exceeded the acceptable thresholds. Those products from organic fields were free from residues of the applied biorationals. Thus, organic farming **reduces chemical contamination** in the environment and food products.

More beneficial organisms

Preserving natural and semi-natural habitats, including native species, and 'leaving things a little messy' on the farm promote beneficial organisms like birds, bees, beetles, earthworms, etc. This benefits farmers as these organisms perform essential services in farming, e.g., pollination, natural pest and disease control, and seed dispersal.

In results from SysCom Bolivia, it was found that **diverse agroforestry systems promoted a higher diversity of animals, micro-organism and pollinators**, due to the higher plant diversity. To go deeper into this topic, see page 4 of the 'Pest and disease' factsheet > [Link](#).

Improved nutrient cycling

The ecological approach to organic farming emphasises closed nutrient cycling, using locally available, sustainable, natural resources. The aim is to produce and conserve key nutrients like nitrogen and phosphorus on-farm where they are useful. This reduces the need for purchasing fertilisers – of particular interest as agrochemical prices are exposed to price fluctuations.

Livestock, crops and micro-organisms play an important role in nutrient cycling: animal, crop, tree and household wastes can be composted and spread on the fields. Micro-organisms transform these materials into humus/organic matter, protecting nutrients against run-off and leaching. This would not be possible without a biodiverse soil.



Soil life depends on sufficient organic matter and low soil disturbance to perform their tasks. Organic farming practices support underground ecosystems, and farmers reap the benefits in a variety of ways.

Healthier, more biologically active soil

Soils are diverse, complex systems that are full of life, and home to micro-organisms, plants and animals. All elements interact with each other to provide food for plants and many other ecosystem services. In fact, about a quarter of the living species on earth are found in the soil.

Organic practices support these underground ecosystems by encouraging healthier, more biologically active soils – which can **improve the nutrient availability for crops, physical and chemical soil properties** and the capacity of crops to adapt to climate-related stress situations.

Earthworms, often called ‘best friends of the farmers’, play an important role in soil formation, fertility and health. In SysCom India, more earthworms were found on organic plots than conventional throughout the growing season – a testament to the healthier soils in the organic system.

Improved water management

Lack of water is a factor that crucially restricts agriculture, especially in the arid regions of Africa. Severe water shortages have devastated many regions and are predicted to be an ongoing challenge to food production and security.

The research shows that ecological organic farming systems can help mitigate these risks – as **high soil fertility and organic matter help to balance water, reduce erosion and improve a farms ability to adapt** to extreme weather events, e.g., droughts or heavy rainfalls.

In the healthy soils found on well-managed ecological organic farms, the presence of roots and organic matter help to **turn the soil into a sponge**, which can absorb a large of surface water in a short time (infiltration rate), while also storing it for a long time (retention).

In addition to improved infiltration and retention, SysCom Bolivia found that agroforestry systems, containing shade and cacao trees, can benefit farmers in many ways:

- During extreme weather events, e.g., heavy rainfalls or droughts, **organic practices can protect the soil and water** in the environment.
- Shade trees used water resources from deeper layers than cacao trees – **increasing soil and air humidity compared to monocultures**.
- **Agroforestry system buffered daily temperature extremes, and the soil temperature was lower** compared to the monoculture systems. Further, reducing soil evaporation, leading to higher soil moisture content and more water availability for the plants.
- **Better water management practices** compared to conventional farms: e.g., the treatment of waste water in terms of disposal or reuse, water storage capacity and the use of rainwater.

How does society benefit from the ecological approach in terms of biodiversity and climate change?

Ecological organic farming practices provide many services to society, like increased biodiversity, healthier soils, and a cleaner environment, all while making organic farmers more resilient to changing farming conditions. While these 'ecosystem services' are not always directly connected with compensation, there are increasing opportunities through carbon payment schemes, eco-tourism and governmental subsidies.

Ecological farming can also benefit society by providing food and other products while helping to mitigate climate change via capturing and storing carbon from the atmosphere, and by operating in ways that are more energy-efficient.

In addition to the benefits to farmers discussed in the previous chapter, many of which are also relevant for society, the next section explains further services that the ecological approach to organic farming provides to ecosystems and society.

Climate change mitigation

Climate change mitigation aims to slow down the climate crisis and its negative effects. This is critical for African farmers who are already burdened by the negative impacts of climate change.

Agriculture is one of the main contributors to climate change, however, it also has great potential for mitigating it. The ecological approach to organic farming has a great capacity to contribute to climate change mitigation by capturing and storing carbon from the atmosphere.

Here are two ways that the ecological approach can contribute to climate change mitigation:

Carbon in soil and biomass

Soil organic carbon (SOC) is a measure of organic matter present in the soil. It is critical to soil functioning and productivity in agricultural systems.

By increasing carbon in the soil, both farmers and the environment benefit. Farmers get healthier and more productive soil, while carbon capture and storage helps remove carbon from the atmosphere where it contributes to warming the planet.

In SysCom, we found **higher SOC in organic farming systems compared to conventional**. These results are mainly due to the active, system approach taken, in combination with sufficient amounts of high-quality inputs like compost, and



best practices, like cover crops and reduced soil disturbance.

Similarly, SysCom Bolivia found that cacao-based **agroforestry systems** showed particular advantages in carbon capture compared to monocultures, for instance, they:

- were **more efficient in adding SOC** to the soil,
- had **higher microbial carbon biomass** in the soil, and
- **stored three times more carbon than monocultures** in the form of aboveground biomass.

Using renewable energy and resources

Although energy use differs depending on the crop, in SysCom Bolivia cacao-based systems, conventional and monoculture systems used more energy from non-renewable resources (from, e.g., fuel, electricity and fertiliser production) compared to organic and agroforestry systems.

Agroforestry systems were more energy-efficient than monocultures (higher return on the energy invested), especially when organically managed; under organic management, less than 10 % of the cumulative energy demand was from non-renewable sources, while it reached 75 % in the conventional systems.

Our research, therefore, implies that the ecological approach to **organic farming can reduce the energy dependence of agricultural systems**.



Conservation of biodiversity

In SysCom, we found that organic farming and agroforestry systems promote local plant and animal species. For example in Bolivia, we found that **organic farming promotes local plant species** (high conservation value) – while intensive, conventional farming systems promoted widely distributed, non-local species (low conservation value).

Agroforestry systems, especially in the more complex systems, play a key role in the restoration and conservation of biodiversity in tropical ecosystems. We observed a **higher rate of bird visits in agroforestry systems compared to monocultures** – increasing with system complexity (monoculture < agroforestry < fallow). The abundance of the cocoa pollinators (order *Thysanoptera*) also increased.

Biodiversity conservation benefits society as a whole, as it is required for health, food and water security, pollination, a functioning food web, some recreational activities, carbon sequestration and much more.

Protecting natural ecosystems

Although an ecological approach to organic farming provides many ecological services, it can never replace natural ecosystems! The species diversity, resilience, water and nutrient cycling and carbon storage functions of natural, protected ecosystems, like forests, wetlands, etc., are necessary for healthy ecosystem functions.

Natural ecosystems, therefore, also have a direct impact on our agricultural systems and vice versa. For instance, even though we can find higher number of forest dwelling bird species in agroforestry systems, some of these birds are only visitors and might be dependent on natural forest for some activities (e.g., breeding). Therefore, agroforestry is not a substitution for natural forest, but can act as a corridor to connect forests in an agricultural landscape.



Further information

- Complimentary knowledge products, e.g., a poster, powerpoint, video about the biodiversity and climate change adaptation on ecological organic farms > [Link](#)
- Further knowledge products, e.g., posters, videos and more, in the series cover topics such as: the ecological approach, pest and disease, productivity, soil and profitability > [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](#)
- Soil and Climate factsheet, Maeder et al. (2022): This factsheet takes a closer look at the multi-faceted role of agriculture in climate change. Various scientific findings are presented that show the potential of organic farming to mitigate climate change > [Link](#)
- Living in abundance – encounters with agroforestry video: different actors share their experiences from the Alto Beni region and demonstrate that agroforestry systems are a real alternative to conventional agriculture with the use of agrochemicals > [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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