Factsheet
2022 | No. 1474

Ecological approach to soil fertility and health in the Tropics

Practices that improve the soil and meet crops needs

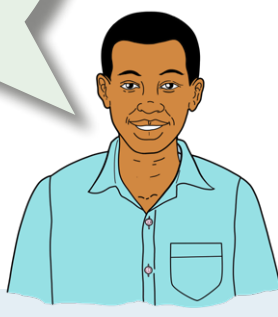
Under current prevalent agricultural management, soil is being rapidly degraded due to erosion, fertility depletion and climate variability - posing serious threats to sustainable crop production and hence food security and livelihoods of smallholder farmers. Soil health is essential for the productivity of diverse crops and nutritious diets to improve the health of animals and humans. In ecological organic farming, improving the soil is the central focus, and this is achieved through a holistic approach.

This factsheet introduces soil fertility and health, explains how the holistic organic farming approach improves soil fertility, provides some practices which contribute to improving soil health and help meet the nutrient requirement of crops, animals and humans. 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 systems can **build up soil fertility** over the long-term if well managed.
- Soils under organic management in annual crops demonstrated **higher nutrient stores** (e.g., soil organic matter, nitrogen, potassium, calcium, micronutrients), higher biological activity, and improved soil properties.
- Healthy soil also have a **good structure** which prevents erosion and provides habitat to diverse and active organisms, both of which lessen risks for farmers.

Soil is the topmost layer on the land surface that acts as a medium for plant growth. It is made of of living and nonliving matter and support plants structurally while also providing them with water and nutrients for growth. From an agricultural perspective, soil is the most important production factor. Soils are diverse and complex systems, full of life, and home to fungi, plants, animals and micro-organisms, all interacting with each other to form the soil microcosm.



FiBL

How does the holistic organic farming approach improve my soil fertility and health?

In the SysCom Kenya trials, after six years of active **ecological organic management, soil fertility was significantly higher compared to the conventional system**. Soils under organic management in annual crops demonstrated higher nutrient stores (e.g., nitrogen, potassium, calcium, magnesium), higher biological activity, and improved chemical properties. In comparison, conventional fields lost more nutrients through crop residue removal and soil depletion via erosion compared to organic.

Additionally, after a decade of **sufficient organic inputs** through compost, liquid manure, mulch (SysCom Kenya), compost, litter fall, cover crops (SysCom Bolivia), and **reduced soil disturbance**, soil organic carbon increased.

These results imply faster soil regeneration of healthier and more productive soils and, therefore, more productive crops and improved profitability under the active ecological organic approach.

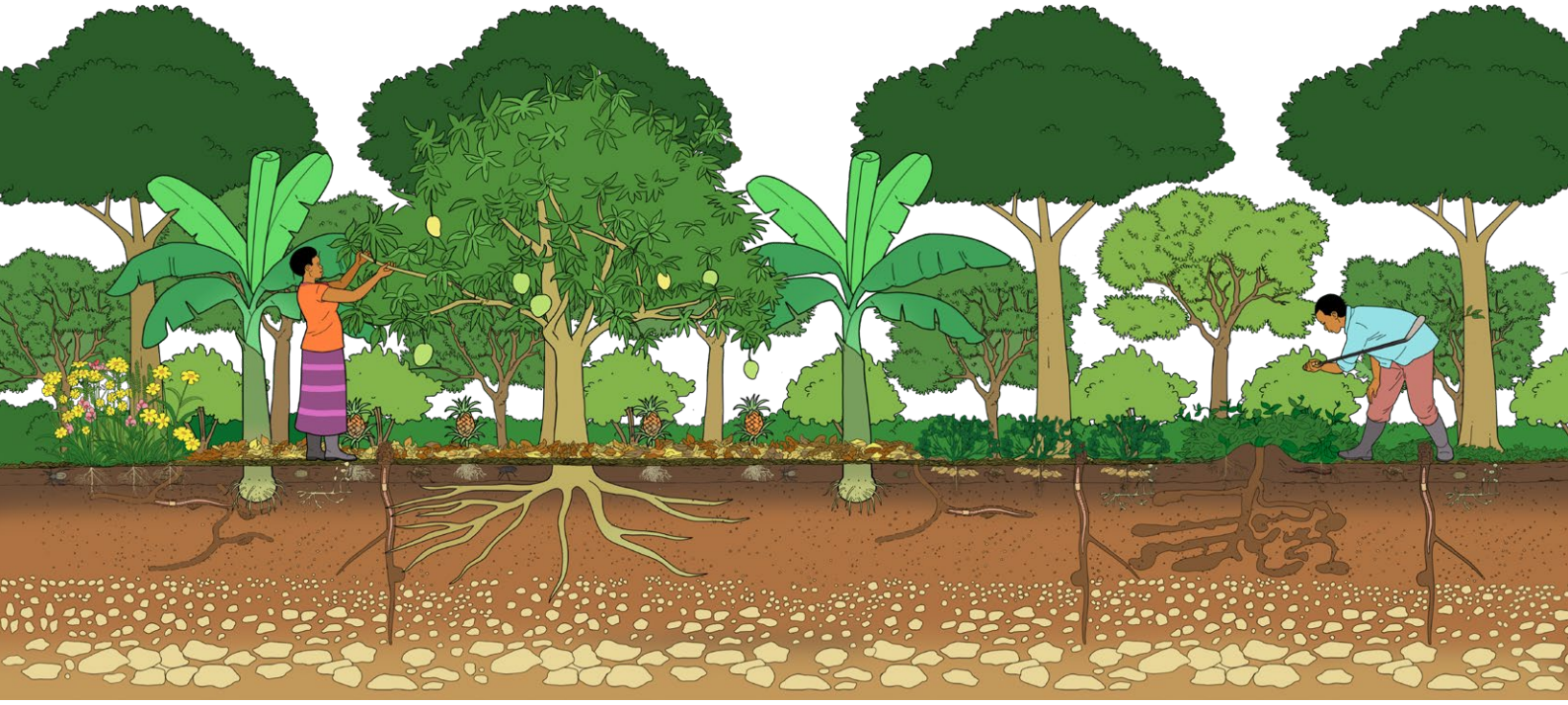
What are the processes and practices on organic farms that promote this improvement in soil fertility?

- **Central importance** is given to the **maintenance and improvement of soil** fertility and health. The activity of soil organisms is stimulated with organic manures and harming them with pesticides (even biorationals) is avoided.
- **Support a balanced soil ecosystem** – fosters beneficial soil organisms that help to: decompose organic materials, release nutrients and build up soil fertility, dig tunnels and encourage deep rooting plants and good aeration, and keep the pest and disease organisms under control.
- Organic **nutrient management** is **based on recycling biodegradable materials**, e.g., plant and animal waste. Nutrient cycles are closed with the help of composting, mulching, green manuring, crop rotations, etc.

What is soil organic carbon?

Soil organic carbon (SOC), also called humus, is a measure of soil organic matter present in the soil. This is the part of the soil resulting from the decomposition of biomass (plant materials, biodegradable). SOC is vital for successful crop growth, because it holds nutrients and moisture in the soil and makes them available to plants, creates good soil structure, helps degrade pollutants and fixes carbon from the atmosphere into the soil.

Refer to the 'Biodiversity and adaptation' factsheet to learn more about the SOC and soil life plays in climate change adaptation and water management > Link.

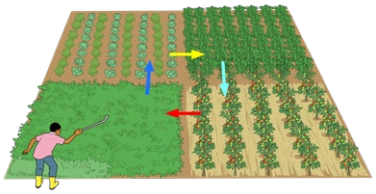


What farming practices contribute to soil fertility and health?

Results from SysCom Kenya, show that active organic farming effectively protects, restores and builds soil fertility and health at a faster rate, and can better support sustainable agricultural land management and crop production in sub-Saharan Africa compared to both high and low-input conventional production systems. These improvements are due to on-farm practices implemented over time. Here, these practices are explained:

Crop rotations

Growing a series of different crops sequentially in the same area.



Different crops have different nutrient demands and are susceptible to specific pests and diseases – crop rotations allow farmers to work with plants to balance nutrients and interrupt disease cycles.

Composting

A controlled natural process of recycling organic wastes into a nutrient-rich organic fertiliser.

Composting crop residues and animal wastes increase their value as a fertiliser. Composts enrich the soil, foster beneficial organisms, feed the crops, and can improve the availability of nutrient in acidic soils.

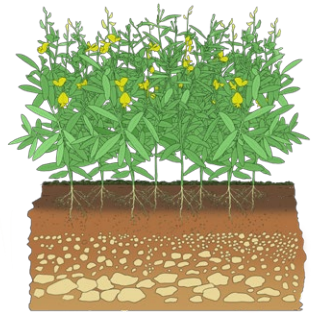
Intercropping

Growing two or more crops on the same plot, at the same time.

Crops often have different nutrient requirements and their roots different growth patterns. Through intercropping, you can avoid the depletion of single nutrients and access different nutrient pools.

Cover crops, green manures

Crops grown to protect and enrich the soil.



Covering the soil with fast growing, nitrogen-fixing plants is important to avoid direct exposure of soil to sunlight and rainfall. This can increase water evaporation and risk of erosion. Cover crops can also reduce weed pressure.

Mulching

Using dead plant material to cover the soil between crops.

This practice can increase SOC content, water penetration, and reduce water evaporation, erosion and weed pressure – in agroforestry systems, prunings from trees can be used as mulch and can replace external input.

Agroforestry

The integration of agriculture and trees, including the agricultural use of trees.

Agroforestry provides many benefits for soils. SysCom Bolivia found agroforestry systems were more efficient in adding SOC to the soil, had lower soil temperature and higher microbial carbon biomass in the soil.

How to meet the nutrient requirements of my crops?

After switching to organic agriculture, farmers often encounter the challenge meeting the nutrient requirements of their crops. Compared to conventional agriculture, nutrients in organic fertiliser are not standardised and have a different behaviour in the soil. Availability of sufficient nutrients such as nitrogen (N), phosphorus (P) and potassium (K) is crucial for crop productivity, particularly during critical growth stages.

A sufficient nutrient supply is an important factor influencing crop productivity. It is essential to understand nutrient dynamics and current nutrient amounts in your soils. This is often done in lab analysis of soil samples but observing nutrient deficiency symptoms can also be an easy and accessible way for farmers to ensure that the nutrient requirements of their plants are met.

Research findings highlight the role of biological processes fuelled by regular inputs of organic matter via compost, green manures, mulching, etc., in ensuring nutrient supply to crops. In the following section we highlight common challenges and solutions for nutrient supply in organic farming:

Use high-quality fertilisers

Produce self-made composts using a diversity of locally available biodegradable materials. Although production is labour-intensive (see factsheet 'Profitability' to go deeper > Link), research has shown that they can provide sufficient nutrients to crops.

Adjust the timing of fertilisation

Some organic fertilisers, like compost or mulching, supply nutrients (e.g., N and P) slowly over time. During key crop stages, you can supplement with fast-releasing fertilisers (i.e., liquid manure) to provide more readily-available nutrients.

Provide sufficient nutrients

Organic farming does not mean low input – on the contrary! Our research has shown that in low input organic management, the productivity and soil fertility will decrease over time. Organic crops need sufficient amounts of nutrients, too – organic farmers must provide high-quality organic fertilisers and follow organic best practices to meet crop needs. Refer to the 'Productivity' factsheet for more details on organic best practices > Link.

Monitor your crops often

Keep an eye out for signs of nutrient deficiencies – next to N and P, other nutrients are often sufficiently available in organic fertilisers. However, sole cropping or the use of only one type of fertiliser can lead to nutrient depletion.

Making nutrients more plant-available: Acidulation of phosphorus

P is a crucial nutrient for successful plant growth and exports from the fields through harvests need to be replenished. Most soils in the tropics are deficient in plant-available P.

P fertilization can be tricky in organic farming – there are limited supplies and most commercially produced P fertilisers are not allowed. Organic materials, e.g., bone meal and rock phosphates, are permitted in organic production, but have limited efficiency.

Acidulation is a promising solution. Our on-farm SysCom trials showed that mixing rock phosphate with acidic materials (e.g., lemon juice or buttermilk) can release over two-thirds of the available P, making it readily available for crops. In addition, the combined application of this dissolved phosphate rock and compost at planting increased P efficiency and crop yields.

Further information

- Complimentary knowledge products, e.g., a poster, powerpoint, video about the ecological approach to soil fertility and health > Link
- Further knowledge products, e.g., posters, videos and more, in the series cover topics such as: the ecological approach, pest and disease, productivity, profitability and biodiversity > 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 comparisonsin 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
- Leaflet series: 'Preparation and Application of self-made organic pest control products' leaflet 8. Buttermilk, Mandloi, L. et al. (2014) > Link
- Organic Africa Manual Module 2: Soil Fertility Management, Weidmann, G. et al. (2011): The module describes the relevance of the different soil components for soil fertility > Link
- Soil and Climate factsheet, Maeder et al. (2022): This factsheet takes a closer look at the multifaceted role of agriculture in climate change. Various scientific findings are presented that show the potential of organic farming to mitigate climate change > Link
- Ecological Organic Agriculture videos series from ESAFF Uganda TV features a video on mulching > Link and cover cropping > Link Two small scale farmers share their experiences with these two soil benefiting practices
- Farmers' perception on soil fertility in West Africa (ORM4Soil project) – in this video local farmers (In Mali and Ghana) talk about soil fertility of their land > 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.

Publisher
Research Institute of Organic Agriculture FiBL, Switzerland
Ackerstrasse 113 , Postfach 219, CH-5070 Frick
Tel. +41 (0)62 865 72 72
info.suisse@fibl.org, www.fibl.org

Authors: David Bautze, Lauren Dietemann (all FiBL)

Contact: beate.huber@fibl.org

Contributors: Noah Adamtey, Laura Armengot, Eva Goldmann, Elsa Kanner, Sophie Thanner, Gilles Weidmann (all FiBL)

Editor: Lauren Dietemann (FiBL)

Layout: Brigitta Maurer (FiBL)

Photos: Joost Bastmeijer (Biovision) page 1, 2, 3.

Illustrations: Deogratius G Okudi (Uganda)

FiBL ordering no.: 1474

Permalink: orgprints.org

Knowledge product funders

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

KCOA Knowledge Centre for Organic Agriculture in Africa

Projects involved

SysCom

ProEco Africa

Project funders

biovision

This project is supported by the Coop Sustainability Fund. coop

STIFTUNG MERCATOR SCHWEIZ

LED LIECHTENSTEIN DEVELOPMENT SERVICE

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Hivos people unlimited