Guidance note to the poster:

Soil fertility management in organic farming

This note provides guidance for using the poster in a training set up. It leads through the different aspects presented on the poster and offers extended information for their presentation, as well as suggestions for the didactical implementation. For further readings, see at the end of the guidance note.

Objectives of the poster

- Provide a basic understanding of soil fertility and the role of soil organic matter
- Outline the 3-step approach to managing soil fertility in organic farming
- Highlight and discuss recommended practices for managing soil fertility in organic farming
- Discuss appropriate measures under local conditions

Introduction

What is organic farming?

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 to synthetic chemical fertilisers.

Exchange on organic farming principles

Ask the participants about their understanding of organic farming. What do organic farmers do with respect to the selection of crop varieties and cultivars, and animal breeds, soil fertility management, pest and disease management, animal husbandry and other aspects?
Inform the participants which methods are acceptable in organic farming and which are prohibited.

What is a fertile soil?

A fertile soil is the foundation for good crop production. It absorbs and holds enough water and nutrients and provides the nutrients to the plants in a balanced way, when they need them. In an organic farmer's perspective, a fertile soil is a living soil containing worms and other soil organisms that decompose plant and animal biomass to make the nutrients more easil available to the crops. Organic farmers may especially be interested in knowing and monitoring the content of soil organic matter.
A practical method to determine aspects of soil fertility is the spade diagnosis. Thereby a soil brick is dug out with a spade and its rooting depth, colour, structure, smell, etc. are analysed based on a defined procedure. A dark, biologically active soil with stable soil aggregates with many pores is an indicator of high fertility.
A buffered soil with a soil acidity (pH) of 5 to 7 ensures the best availability of plant nutrients. The pH can be determined with a simple pH-meter. For detecting deficiencies or toxicities of nutrients such as Phosphorus (P), Potassium (K) or Zinc (Zn), a chemical soil analysis is necessary.

Exchange on the understanding of soil fertility

Invite the participants to share their understanding of soil fertility asking the following questions:

- What do you consider to be the characteristics of fertile soil? – For the discussion, you may provide the following keywords: soil depth, soil structure, soil organic matter, soil organisms, water retention, drainage, soil pH, soil compaction, nutrients, and biological activity.
- Which factors promote soil fertility? Which factors destroy soil fertility?

Determining soil fertility

Present different soil samples to the participants and assess the quality of the soils together.

The role of soil organic matter

The organic matter in the soil, also called soil organic matter, consists of different types of organic material: living biomass of microorganisms, fresh and partially decomposed residues, and well-decomposed organic matter (also called humus). Humus has a special characteristic: when it recombines with mineral soil particles, it forms very stable soil aggregates which contribute to a good structure of the topsoil. Soil organic matter can also retain a lot of water and it buffers soil acidity.

The higher the organic matter content of a soil, the more continuous and balanced the nutrient supply is. Natural soils of humid tropical forests can have 30 % of soil organic matter. Most agricultural soils however have 1 to 3 % of organic matter in the topsoil. In organic farming, a farsighted humus management is of central importance for sustainable cultivation.

Exchange on the role of soil organic matter

Ask the participants whether they have observed any advantages in soils with high soil organic matter content (e.g. forest soils and land after fallow):

- What are the advantages of such soils compared to old agricultural land?

The role of soil organisms

Soils are home to many different organisms. Most of them contribute to the natural nutrient cycles. Two of the most dominant soil organisms are earthworms and termites.

Earthworms remove dead plant material from the soil surface and digest it. During the digestion, they mix organic and mineral soil particles and build stable soil aggregates in their excrements. While soil aggregates improve the soil structure, earthworm tunnels allow easy infiltration of rainwater, thus limiting soil erosion and maximising water collection.

Termites break down and recycle organic matter. This helps to loosen the soil, increase its porosity, improve infiltration of water, and enhance the soil's water-holding capacity.

Termite activity can also result in accumulation of organic matter and enrichment of nutrients in the soil. Termites prefer dead plant materials and usually do not attack growing plants.

Important **microorganisms** in the soil include bacteria, fungi, algae and protozoa. Soil bacteria such as rhizobia help leguminous plants to fix nitrogen from the air. Mycorrhiza fungi that live in mutually beneficial relationship with plant roots supply water and nutrients to the plants.

Soil organisms are the engine to a fertile and healthy soil. They are promoted through the incorporation of fresh and half-decomposed plant material into the soil, by maintaining the soil covered, and avoiding the use of chemical pesticides.

Discussion on the role and promotion of soil organisms

Ask the participants the following questions:

- Have you made observations in relation to soil organisms? How do you see their role?
- Have you observed conditions or measures that promote or harm soil organisms?
- How can soil organisms be promoted?

Managing soil fertility in organic farms

A three-step approach

Organic soil fertility management can be seen as a three-step approach with a range of tools to manage soil fertility and plant nutrition. Each step of the approach builds the foundation for the next one. The aim is to optimise step 1 (conserving soil and water) and step 2 (building organic matter and nutrients) that encourage natural rejuvenation of the soil, and to complement these measures with appropriate amounts of foreign fertilisers, soil amendments and irrigation water where necessary (step 3). Proper application of steps 1 and 2 saves on costs for fertilisers and other supplements and prevents possible negative impacts on the farm ecosystem.

Step 1: Conserving soil and water

The first step consists of conserving the soil, soil organic matter and soil water. The measures aim at protecting the soil surface from being exposed to the sun and drying out, and from being carried away by wind or washed down by rain.

Protecting the soil

The easiest way to protect the soil from being eroded is to keep it covered with living plants (cover crops) or dead material (mulches and crop residues).
Erosion due to rains is more a problem in annual crops, when soil preparation coincides with rainfall. Covering the soil with crop residues and dry plant material, and tilling it minimally limits erosion during this period. Minimising soil disturbance, avoiding soil compaction and overgrazing by farm animals are other important measures to limit soil erosion. Growing trees in rows (alley cropping) and hedges in or around the fields reduces wind speed and provides shade in dry climates.

Reducing the movement of water

An effective measure to limit soil erosion by water is, among other techniques, making contours along the contour lines of a slope and stabilising the ridges with grass, bushes or trees.

Exchange on soil conservation measures

Discuss with the participants questions related to soil conservation and elaborate appropriate ideas for further improvement of soil conservation.

- Did you realise any loss of soil (of soil fertility) in your fields?
- Do you apply soil and water conservation measures in your fields? Do you know, what contours are?
- Which measures have proved to be effective?
- What difficulties do you face with soil and water conservation?
- Do you see any potential for improvement?

Step 2: Building organic matter and nutrients

The second step consists of improving the organic matter content in the soil and enhancing its biological activity, as this contributes to a more continuous and balanced nutrient supply and better plant health. In aerated and humid soils, organic materials encourage biological activity which improves nutrient mobilisation from organic and mineral sources and the decomposition of toxic substances.
The incorporation of green plant materials, animal manures and compost supply nutrients for the crops, whereas compost also improves the soil's water and nutrient holding capacity, buffers soil acidity and suppresses soil-borne pathogens.
Identifying appropriate organic resources is an essential step to building soil organic matter. Important organic resources include leguminous green manures, cover crops (living mulch), dead mulch, prunings, compost (e. g. with animal manure). Integration of nitrogen fixing plants in the rotation is essential to ensure the nitrogen supply of demanding crops.
Building soil organic matter is a long-term process, but investing into it is highly beneficial to crop or forage production, and contributes to higher and more reliable yields. In this context, burning of crop residues should be avoided, as it destroys soil organic matter.

Exchange on soil organic matter management

Brainstorm with the participants on the following questions:

- Which organic resources are available on the farm that can be used to build soil fertility?
- Are there other organic sources that have remained unused so far (for the trainer: green manures, animal manure, prunings of leguminous trees, nutrients from fish ponds or others)?
- How do you see the burning of crop residues and other plant material in this context?

Discuss with the participants the potentials and constraints to increasing the supply of organic materials from farm-own resources.

Step 3: Applying other approved fertilisers

The third step consists of completing the crops' nutrient requirements with approved organic and mineral fertilisers as well as improving the growing conditions by applying some soil amendments, where necessary.
Nutrient deficiencies can be due to an unbalanced soil pH, dry soil conditions, insuffient release of nutrients from an organic source, or high nutrient requirements of a crop. Before choosing a specific fertiliser, one should know the reason for the deficiency. Using the wrong fertiliser can be a waste of money, create a nutrient imbalance in the soil, or pollute groundwater and water bodies.
Liquid manures help overcome temporary nutrient shortages and stimulate plant growth. They are made from animal manure, compost or nitrogen-rich green plant material.
Approved commercial organic fertilisers such as by-products from agro-processing (e. g. seed oil cakes), pelleted chicken manure, bone meal, feather meal, fish meal, horn and hoof meal, as well as commercially produced composts are valuable fertilisers with different nutrient properties.

Exchange on commercial fertilisers

Clarify as to what level the participants have the ability or interest of purchasing commercial organic and mineral fertilisers.
Invite them to share their experiences with the use of commercial fertilisers.

- What differences did they observe?
- Were the costs outweighed by higher revenues or a higher product quality?

Calculation exercise

Calculate the costs of compost and liquid fertiser together with the farmers. Remember to include the following key components:

- Time taken and number of people required to collect materials and prepare the fertiliser
- Costs of containers and other tools required
- Transport requirements
- Cost of water, if applicable
- Cost of application
- Think of other key requirements

Natural fertilisers that provide the necessary minerals to the crops in organic farming are based on ground natural sources and include lime, stone powder, rock phosphate, gypsum, potassium magnesium sulphate, sodium nitrate, vermiculite and other natural reserves like bat guano.
Soil amendments include lime to correct soil pH, and microbial fertilisers to enhance nitrogen fixation and plant nutrient uptake. **Lime** can be added to acid soils to balance its acidity level (pH), a soil pH of 6 to 7 being ideal for nutrient availability to plants, and for the soil organisms. **Microbial fertilisers** (also called biofertilisers) such as symbiotic rhizobia are essential when growing leguminous crops in new fields to ensure nitrogen fixation. Mycorrhiza can be of high value in dry climates and phosphorus deficient soils where they can improve phosphorus and water uptake of the crops. The value of other biofertilisers, however, is much discussed and in many cases has not been proven. Most bacteria, fungi and other microorganism are naturally present in the soils and can be enhanced with the application of good compost. Microbial fertilisers cannot substitute appropriate soil management practices on the farm.
Water supply to the soil is often neglected. Water is essential for biological activity in the soil and nutrient uptake by the plants. Using irrigation to supplement soil water requirements can have similar effects as fertilisers in dry soil conditions.

The amounts and types of fertilisers to apply depend on the following factors:

- Soil nutrient levels
- Quality of the nutrient sources
- Crop nutrient demand (medium or high)
- Growing stage of the crop (early stage with low nutrient demand or leaf-building stage with high demand)
- Experience and advice

General assessment of the local soil fertility situation

Brainstorm with the participants, how the presented practices apply to the local situation. Identify 2 to 4 farmers to share their experiences of applying the step 1, 2 and 3 practices.

- What are the similarities and differences in the experiences?
- Which step 1 and 2 practices are critical in the local context?

Discuss how farmers can be supported or support each other to maximise on the step 1 and 2 practices before resorting to step 3.

Further readings

Organic farming definition

- www.ifoam.bio › Why Organic?
- www.organic-africa.net › Training manual › Module 1

Soil fertility

- www.organic-africa.net › Training manual › Module 2

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