3.3 Soil Cultivation and Tillage

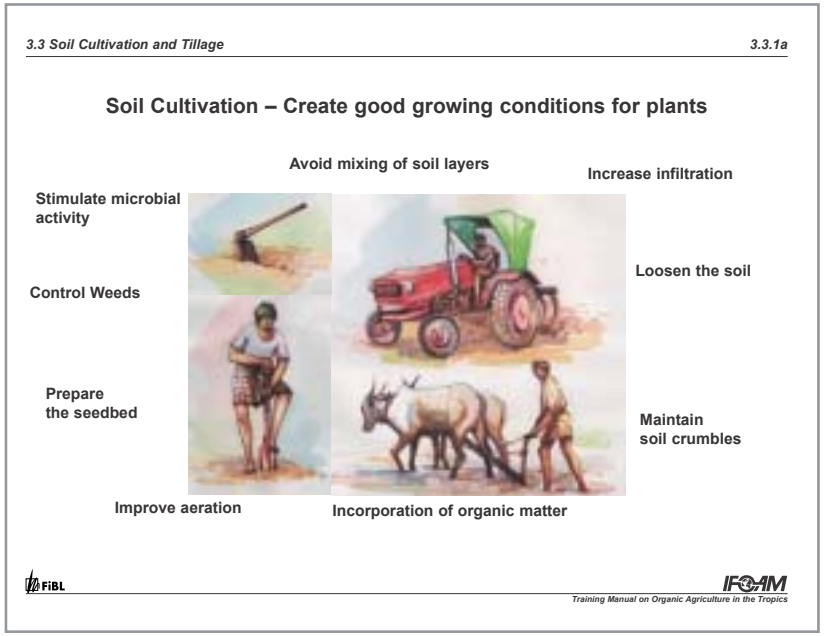
Introduction
Soil cultivation includes all mechanical measures to loosen, turn or mix the soil, such as ploughing, tilling, digging, hoeing, harrowing etc. Careful soil cultivation can improve the soil's capacity to retain water, its aeration, capacity of infiltration, warming up, evaporation etc. But soil cultivation can also harm the soil fertility as it accelerates erosion and the decomposition of humus. There is not one right way to cultivate the soil, but a range of options. Depending on the cropping system and the soil type, appropriate soil cultivation patterns must be developed.

Lessons to be learnt
- *Soil cultivation can have a positive or negative impact on soil fertility.*
- *Frequent tillage can lead to decrease of soil organic matter, nutrient losses and soil erosion.*
- *Soil cultivation should aim on a minimum disturbance of the soil life.*

3.3.1 Aims of Soil Cultivation

Creating good growing conditions for plants
There are many reasons for cultivating the soil. The most important ones are to:
- Loosen the soil to facilitate the penetration of plant roots.
- Improve the aeration (nitrogen and oxygen from the air).
- Encourage the activity of the soil organisms.
- Increase infiltration of water.
- Reduce evaporation.
- Destroy or control weeds and soil pests.
- Incorporate crop residues and manures into the soil.
- Prepare the site for seeds and seedlings.
- Repair soil compaction caused by previous activities.

Discussion: Why to cultivate the soil?
Ask the participants for reasons why farmers cultivate the soil. Note them down at the board. Conclude with the transparency below.

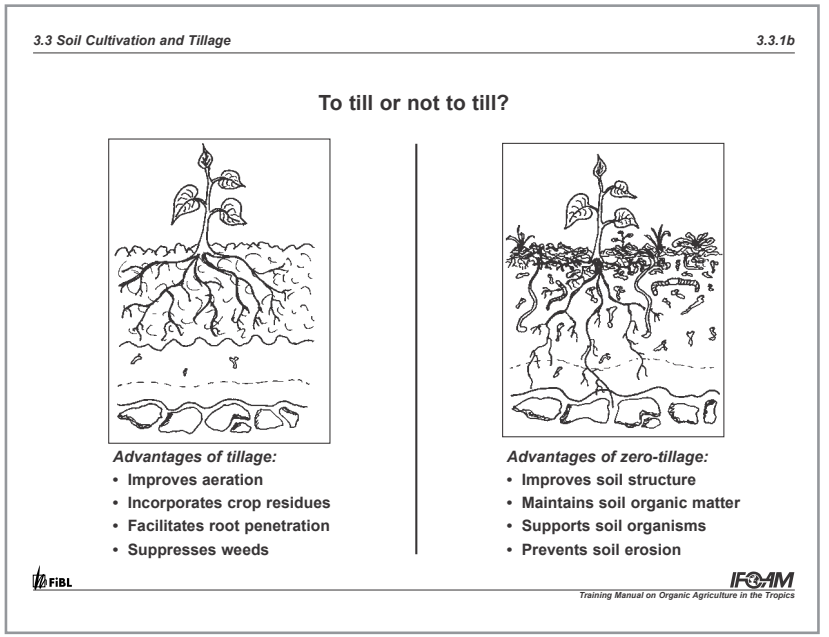


Transparency 3.3.1a: Some methods of soil cultivation, surrounded by the different aims of soil cultivation in organic agriculture.

Minimum disturbance
Any soil cultivation activity has a more or less destructive impact on soil structure. In tropical soils, regular tillage accelerates the decomposition of organic matter which can lead to nutrient losses. The mixing of soil layers can severely harm certain soil organisms. Soil after tillage is very prone to soil erosion if left uncovered before the onset of heavy rains.

Zero-tillage systems on the other side help to build up a natural soil structure with a crumbly top soil rich in organic matter and full of soil organisms. Nutrient losses are reduced to a minimum as there is no sudden decomposition of organic matter and nutrients are caught by a dense network of plant roots. Soil erosion won't be a problem as long as there is a permanent plant cover or sufficient input of organic material. Last but not least, farmers can save a lot of labour.

Thus, each organic farmer will have to assess the soil cultivation practice which is most suitable for his conditions. Zero-tillage can be used only in few crops, mainly perennials. To minimize the negative impacts of soil cultivation while benefiting from its advantages, the organic farmer should aim on reducing the number of interventions to the minimum and choose methods that conserve the natural qualities of the soil.



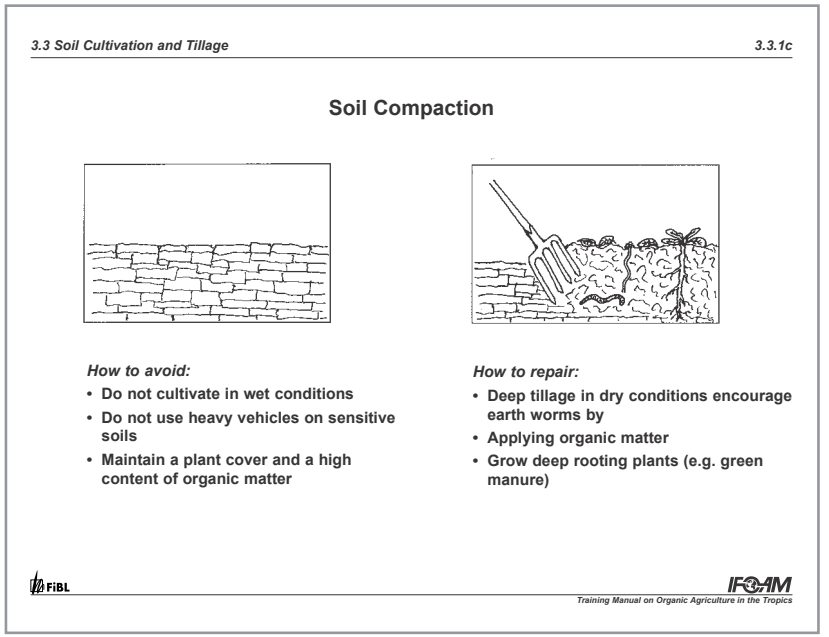
Transparency 3.3.1b: Advantages of soil cultivation and zero-tillage systems

Soil compaction

If soils are cultivated in wet conditions or burdened with heavy machinery, there is a risk of soil compaction which results in suppressed root growth, reduced aeration and water logging.

Where soil compaction is a potential problem, farmers should be aware of the following aspects:

- The risk of soil compaction is highest when the soil structure is disturbed in wet conditions
- Do not drive vehicles on your land soon after rains
- Ploughing of wet soils can lead to a smearing of the plough sole
- Soils rich in sand are less prone to soil compaction than soils rich in clay
- High content of soil organic matter reduce the risk of soil compaction
- It is very difficult to restore a good soil structure once soil compaction took place
- Deep tillage in dry conditions and the cultivation of deep rooted plants can help to repair soil compaction



Transparency 3.3.1c: How to avoid and how to repair soil compaction.

Demonstration: Studying soil profiles

Take the participants to the following three sites: an undisturbed forest soil, a recently tilled field and a foot path. At each site, make a spade examination as described in chapter 3.1.1. Discuss the different soil profiles, their structure, mixture of layers, relevance for soil organisms etc. This demonstration can be done during a break if suitable sites are available nearby, or during an excursion.

3.3.2 Methods to Cultivate the Soil

Types of soil cultivation
Depending on the aim of the soil cultivation, different cultivation practices are implemented during different stages of the cropping cycle: after harvesting, before sowing or planting or while the crop stands.

Post-harvest
In order to accelerate decomposition, the residues of the previous crop are incorporated into the soil before preparing the seedbed for the next crop. Crop residues, green manure crops and farmyard manure should be worked only into the topsoil layer (15 to 20 cm), as decomposition in deeper soil layers is incomplete, producing growth inhibiting substances which can harm the next crop.

Primary tillage
In annual crops or new plantations, primary tillage is usually done with a plough or a similar instrument. As a principle, soil cultivation should achieve a flat turning of the top soil and a loosening of the medium deep soil. Deep turning soil cultivation mixes the soil layers, harms soil organisms and disturbs the natural structure of the soil.

Seedbed preparation
Before sowing or planting, secondary soil cultivation is done to crush and smoothen the ploughed surface. Seedbed preparation has the purpose to provide enough loose soil of appropriate clod size. If weed pressure is high, seedbeds can be prepared early thus allowing weed seeds to germinate before the crop is sown. Shallow soil cultivation after some days is sufficient to eliminate the young weed seedlings. Where water logging is a problem, seedbeds can be established as mounds or ridges.

In-between the crop
Once the crop is established, shallow soil cultivation e.g. by hoeing helps to suppress weeds. It also enhances the aeration of the soil and at the same time reduces the evaporation of soil moisture from the deeper soil layers. When crops are temporarily lacking nutrients, shallow soil cultivation can stimulate the decomposition of organic matter thus making nutrients available.

Experience sharing: Indigenous soil cultivation practices
Many traditional farming systems have a rich knowledge on the appropriate kind and timing of soil cultivation practices. It may be worth collecting and studying the different traditional methods and practices. Either ask the participants to share their knowledge and experience, or gather such practises by visiting traditional farmers in the area. To which extent do these practices comply with the principles of organic farming? How could they be further developed?

Example: Minimum and zero-tillage in Honduras
(Adapted from: «Manual de agricultura biologica», Kolmans, E. & Vasquez, D.)

Farmers in the coastal region of Honduras are practising the following minimum tillage system:

- First, the vegetation is cut down to the soil level.
- Then the soil is opened along contour lines at plant row distance.
- Organic manure is applied into the rows.
- The crop is sown into these rows.
- The vegetation in between is cut regularly and used as a mulch.
- This system can be combined with leguminous plants which act as cover crops.

In the same region, also a zero tillage system is practised by sowing maize and corn directly into the residues of the previous crop:

- Corn is sown into the mulch layer
- 1–2 months later the beans are sown.
- After the corn is harvested, the residues are left on the field and the beans grow over them.
- The beans offer suitable conditions for a direct sowing of the following corn crop.
- With this method, two corn crops and two bean crops per year are grown with satisfying yields

With both methods, farmers observe higher total yields, less soil erosion, less weeds and a great reduction of the work load.

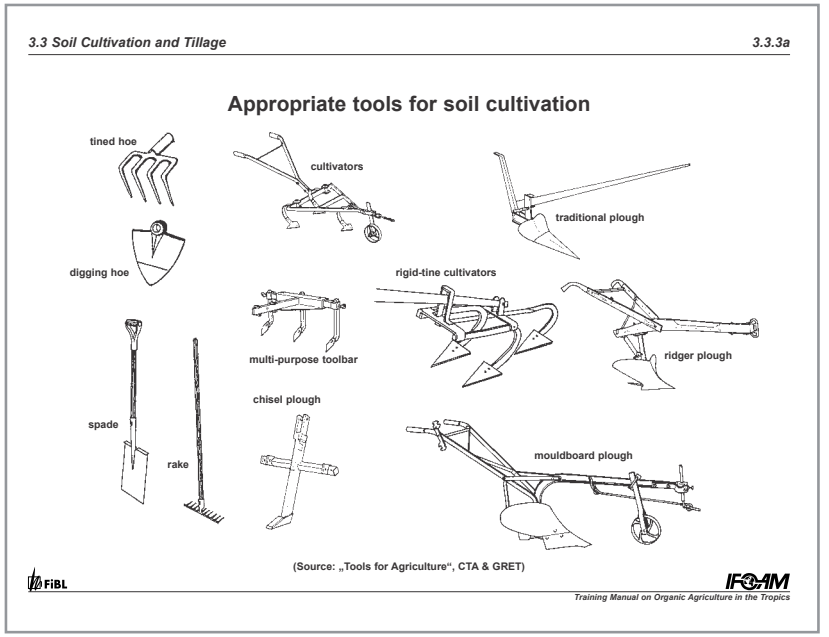
Experience sharing: Low- and no-tillage methods
Some participants may have their own experience with low- or zero-tillage systems. Find out and ask them to share it with the group, giving a short presentation on their system and the results. Or invite an innovative farmer of the region to share his experience.

3.3.3 Appropriate Tools for Soil Cultivation

The tools for soil cultivation can be grouped in four types:

- Tools for primary cultivation: pole plough, mouldboard plough, digging fork, spade
- Tools for secondary cultivation: cultivators, harrows, rakes
- Tools for inter-row cultivation: inter-row cultivators, hoes
- Tools for land forming: ridgers, hoes

Tools should be chosen considering the soil cultivation purpose, the soil type, the crop and the available power source. Therefore, it is difficult to make general recommendations.



Transparency 3.3.3a: Some examples of soil cultivation tools.

Experience sharing: Local tools for soil cultivation
Which tools are used in the region? Show tools or pictures, discuss their advantages and disadvantages.

Recommended Readings

- *«Manual de Agricultura Ecologica», Kolmans, E. & Vasquez, D.*
- *«Tools for Agriculture», CTA/GRET.*