PRODUZIONE DI CIBO APPROPRIATO: sufficiente, sicuro, sostenibile

# SOIL ORGANIC MATTER

*Soil organic matter* is any material produced originally by living organisms, plant or animal, that is returned to the soil and goes through the decomposition process. At any given time, it consists of a range of materials from the intact original tissues to the substantially decomposed mixture of materials known as *humus* (fig. 1). Soil organic matter is more important because it releases nutrients in a plant-available form upon decomposition. In order to maintain this nutrient cycling system, the rate of organic matter addition from crop residues, manure and any other sources must equal the rate of decomposition, and take into account the rate of uptake by plants and losses by leaching and erosion. Where the rate of addition is less than the rate of decomposition, soil organic matter declines. Conversely, where the rate of addition is higher than the rate of decomposition, soil organic matter increases. The term “steady state” describes a condition where the rate of addition is equal to the rate of decomposition. Increasing the organic matter content of soils or even maintaining good levels requires a sustained effort that includes returning organic materials to soils and rotations with high-residue crops and deep- or dense-rooting crops. It is especially difficult to raise the organic matter content of soils that are well aerated, such as coarse sands, and soils in warm-hot and arid regions because the added materials decompose rapidly.

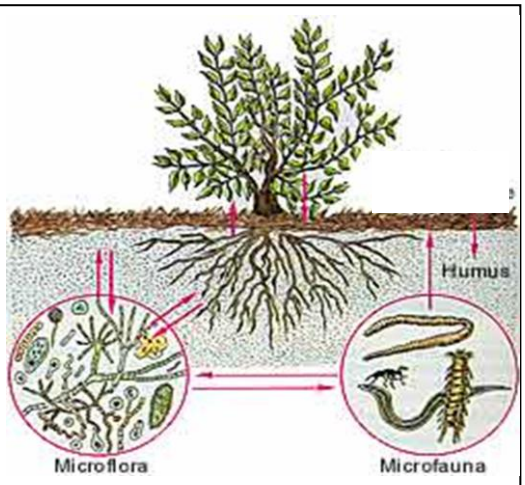


**Figure 1. Soil organic matter cycle.**

## PRACTICES TO INCREASE SOIL ORGANIC MATTER

Several cases have demonstrated that it is possible to restore organic matter levels in the soil. Activities that promote the accumulation and supply of organic matter, such as the use of cover crops and refraining from burning, and those that reduce decomposition rates, such as reduced and zero tillage, lead to an increase in the organic matter content in the soil creating a new equilibrium in the agro-ecosystem.

### 1- Compost

*Composting* is a way for recycling organic materials in order to achieve enhanced agricultural production. Biological aerobic degradation accelerates the rate of decomposition and transform organic materials into *humus* (fig. 2). Composting proceeds under controlled conditions in

compost heaps and pits and can complement certain crop rotations and agroforestry systems. It can be used efficiently in planting pits and nurseries. Compost is very similar in composition to soil organic matter: it breaks down slowly and it is very good to improve physical, chemical and biological soil properties. Well-made compost contains all the nutrients needed by plants, so it can be used to maintain and improve soil fertility as well as to regenerate degraded soils.

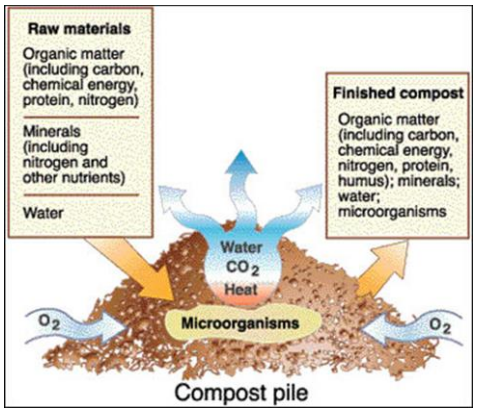


**Figure 2. Compost composition and realization.**

## 2- Cover crops/green manure crops

Growing *cover crop* is one of the best practices for improving organic matter levels and, hence, soil quality. The benefits of growing cover crops include:

- to prevent erosion by anchoring soil and lessening the impact of raindrops,
- to add plant material to the soil for organic matter replenishment,
- to bind excess nutrients in the soil and prevent leaching.

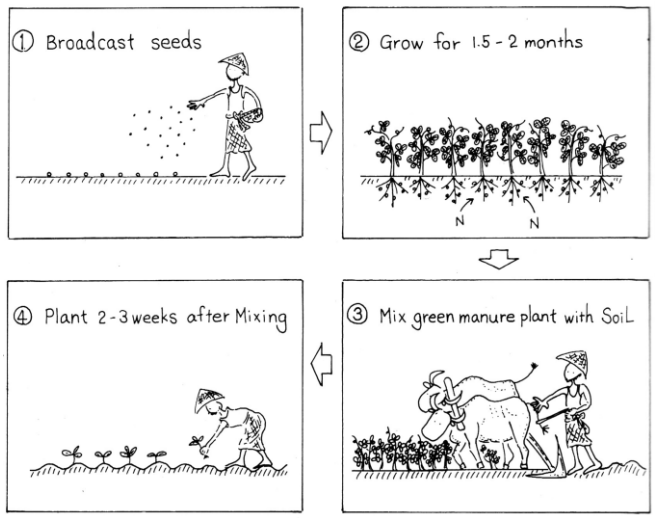


**Figure 3. Green manure realization.**

Different crops can be used as vegetative cover: grains, legumes and oil crops.
All have the potential to provide great benefit to the soil. Grasses and cereals are most appropriate to improve soil structure because of their intensive rooting system, while leguminous enrich the soil with nitrogen and their residues decompose rapidly.
The term *green manure* is often used to indicate the same plant species that are used as cover crops. However, green manure refers specifically to a crop in rotation grown to incorporate the non-decomposed vegetative matter in the soil (fig. 3).

## 3- Mulch

*Mulches* are materials placed on the soil surface to protect it against raindrop impact and erosion. Crop residue mulching is one tool to maintain a protective soil cover by using straw, maize stalks, palm fronds and stubble (fig. 4).

**Figure 4. Organic mulch.**

There are two principal mulching systems:

- *in situ* mulching systems: plant residues remain where they fall on the ground;
- cut-and-carry mulching systems: plant residues are brought from elsewhere and used as mulch where it is necessary.

Crop residue mulching has numerous positive effects on crop production. However, it may require a change in existing cropping practices. For example, farmers may conventionally burn crop residues instead of returning them to the soil. So, *in situ* mulching depends on the design of appropriate cropping systems and crop rotations, which have to be integrated with the farming system. Moreover, the residues from cuttings of cover crop can be used as mulch where it is not possible the burial of residues.

**4- Crop rotation**

*Crop rotation* is the alternation of subsistence, cash and green manure/cover crops with different characteristics, cultivated on the same field during successive years, and following a previously established sequence. The principal objective of crop rotation is to contribute to the achievement of a production that is profitable and sustainable, maintaining soil fertility and health. Specifically, its several advantages are:

• to achieve a more abundant and lasting soil cover,

• to maintain and/or increase soil organic matter content,

• to stabilize the extraction of nutrients, favoring equilibrium in the soil profile, by alternating root systems with different characteristics (tap, fascicular) and depths (fig. 5).

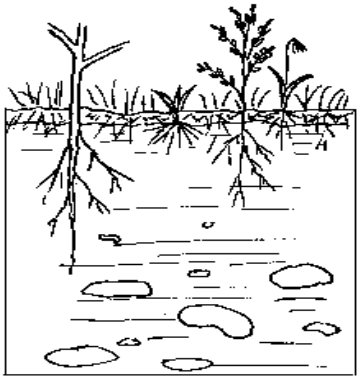

**Figure 5. Plant with different type of roots.**

**5- Perennial forage crops/grazing**

Benefits of *forages* on soil health (soil structure, nutrient status), salinity control, pest management, crop yield are well-recognized.

One of the most important reasons to incorporate perennial forages into a rotation is the nitrogen credit for the following crop. Generally, legume crops fix substantial amounts of nitrogen which can reduce fertilizer-nitrogen inputs to succeeding crops. Organic matter from this crops helps increase aggregate stability because soil microorganisms produce stabilizing compounds as byproducts of decomposition which help to improve soil structure and productivity thanks an high return of nutrients to the land (70 to 90%). Removal of the residues from the field can lead to a considerable loss of organic matter where animal manure is not returned to the field.

By controlled *grazing*, the animal manure is returned in the field without a high labour input. Timing and length of grazing may significantly affect soil physical properties due to compaction and mixing of feces and residues into the soil. Any application of animal manure, slurry or other carbon-rich wastes improves the organic matter content of the soil.

**6- Reduced or *no-till* farming system**

**Figure 6. No-till seed drills.**

Repetitive tillage degrades the soil structure and its potential to hold moisture, reduces the amount of organic matter in the soil, breaks up aggregates, and reduces the population of soil fauna such as earthworms that contribute to nutrient cycling and soil structure.

*No-tillage* farming practices required to implement those principles:

- *minimize soil disturbance by avoiding mechanical tillage* in order to maintain soil organic matter, soil structure and overall soil health;
- *enhance and maintain a protective organic cover* on the soil surface, using cover crop or crop residues, in order to protect the soil surface, conserve water and nutrients, promote soil biological activity and contribute to integrated weed and pest management;
- *cultivate a wider range of plant species* – both annuals and perennials – in associations, sequences and rotations in order to enhance crop nutrition and improve system resilience.

In no-tillage systems, the crop is sown into a soil left undisturbed since the harvest of the previous crop (fig 6). Crop residue mulch is maintained and anchored firmly to the ground. The additional benefit of the increased soil organic matter and burrowing is the creation of a stable and porous soil structure without expensive, time-consuming and potentially degrading cultivations.

In this agricultural system, the action of soil macrofauna gradually incorporate cover crop and weed residues from the soil surface down into the soil.

In many situations, a conflict exists between leaving crop residues on the surface or feeding them to livestock in the dry season when there is a shortage of fodder. In this case it is appropriate to establish what is the priority: feeding the livestock or adding organic material to the soil to increase agricultural productivity.

**7- Agroforestry**

*Agroforestry* is a collective name for land-use systems where woody perennials plants (trees, shrubs, palms, etc.) are integrated in the farming system. It covers a wide range of systems combining food crops, forestry and pasture species in different ways (agrosilviculture, silvipasture, agrosilvipasture and multipurpose forest production). There are two different approaches to agroforestry. One uses agricultural crops or pasture as a transitional means of utilizing the land until forest plantations are fully established. The other is to integrate trees and shrubs permanently into the crop or animal production system, to the benefit of both crop production and land resource protection. The integration of trees and woody shrubs implies to create a system in which the distances between trees and herbaceous crops are major than a specialized system. But adding organic matter, perennial trees and shrubs to the system is a way to recycle plant nutrients from deeper soil layers through their rooting system.