



REDUCED OR ZERO TILLAGE

- ▶ Reduced mineralization of organic matter because less soil disturbance means less oxygen is available for organic matter decomposition.
- ▶ Increased movement of soil fauna, such as earthworms, which are responsible for the incorporation of organic matter in the soil and whose burrows aid circulation of air and water in the soil.

ROTATIONS AND COVER CROPS

- ▶ Prevent erosion by anchoring soil and reducing the impact of raindrops.
- ▶ Add organic matter to the soil.
- ▶ Provide habitats for a diverse range of beneficial soil fauna.
- ▶ The varied root systems use nutrients from different layers, reducing losses caused by leaching.

RESTRICTED IN-FIELD TRAFFIC

- ▶ Restricting the location of human, animal and machinery traffic.
- ▶ Between the tracks, where combined with zero or reduced tillage, soil porosity and water infiltration are maximized, earthworms and other soil animals prosper, organic matter is not lost and becomes bound and integrated more closely with the soil.

The efficiency of the system comes from the **SYNERGY** of the four practices. The system is not prescriptive and there is no one recipe to suit all conditions.

In conclusion, conservation agriculture protects and enhances the nutrient cycling system, resulting in greater fertility and more structurally stable soils that will help farmers achieve sustainable livelihoods and food security.

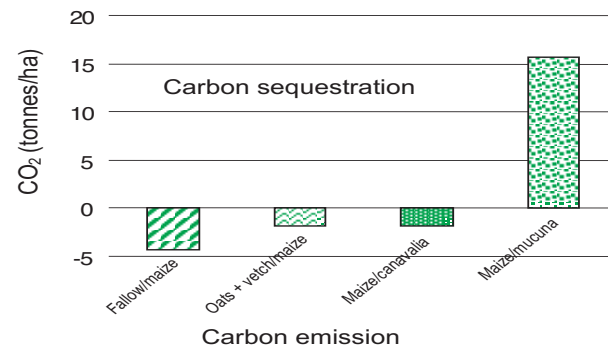


CARBON SEQUESTRATION

an additional benefit

Agricultural lands play a key role in the storage and release of carbon within the terrestrial carbon cycle.

Estimation of emission and sequestration of CO₂ (total over eight years) under different maize production systems with cover crops under direct sowing compared to natural vegetation in southern Brazil (T.J.C. Amado, C. Bayer, F.L.F. Eltz & A.C.R. de Brum, 2001).



The vegetation takes up CO₂ from the atmosphere through the process of photosynthesis. Part of the carbon fixed is respired (plant respiration) and part is transferred to the soil where it is decomposed by soil organisms (soil respiration).

Only a small fraction is stored in soils as organic matter. This natural cycle is broken in conventional agriculture as plant biomass is removed and the release of CO₂ is enhanced by tillage.

Conversely, conservation agriculture practices involving large crop residue retention or addition, crop rotations and no tillage tend to accumulate carbon in the soil.

Improved soil management may cause soils to act as carbon **SINKS**, preventing carbon emissions to the atmosphere.

FOR MORE INFORMATION:

Land and Plant Nutrition Management Service

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Viale delle Terme di Caracalla - 00100 Rome, Italy
<http://www.fao.org/landandwater>

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CONSERVATION of natural resources for sustainable AGRICULTURE

Organic matter

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Improving soil
fertility and
structure



BETTER MANAGEMENT, BETTER SOILS

One objective of long-term sustainable agriculture is the **conservation of soil organic matter (SOM)**. Management of SOM in agro-ecosystems should mimic natural ecosystems by maximizing retention and recycling of organic matter and plant nutrients, and should minimize losses of these soil components caused by leaching, runoff and erosion.

Adequate organic matter management will then lead to:

- Improved soil fertility
- Improved soil structure
- Increased soil biodiversity

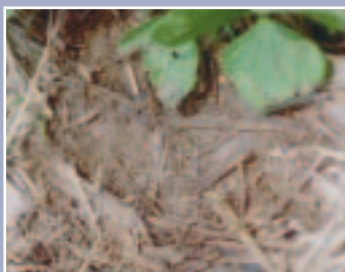
As soil is an essential resource for farmers, its improvement and protection is a necessary step for achieving cost-effective agriculture and increased and more assured productivity.

ORGANIC MATTER

what it is and what it does

Soil organic matter is a complex mixture of carbon compounds, consisting of decomposing plant and animal tissue.

Decomposition: physical and biochemical transformation of complex organic molecules into simpler organic and inorganic molecules by micro- and macro-organisms.



A. BOT

Decomposition is determined by three major factors:

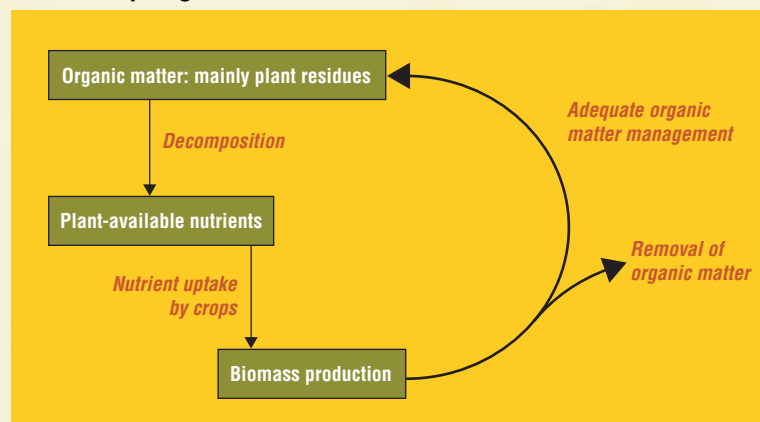
- ▶ **Soil organisms:** micro-organisms, macro-organisms and plants.
- ▶ **Physical environment:** soil texture, temperature, moisture and oxygen levels.
- ▶ **Quality of organic matter:** Carbon-nitrogen ratio, lignin content, phenolic acids and biochemical decomposition.

At any given time, organic matter comprises tissues and residues of plants and animals, partially decomposed residues, humus (resistant or stable organic matter) and soil biota. These components are in a dynamic equilibrium in undisturbed soils.

Soil organic matter has several important functions, including

- ▶ **Improvement of soil structure:** the soil fauna and some of the resistant soil organic components are involved in binding soil particles into larger aggregates. Aggregation is important for better soil structure, aeration, water infiltration and resistance to erosion and crusting.

- ▶ **A recycling nutrient fund:**



In order to maintain this nutrient cycling system, the rate of organic matter addition from crop residues, manure and other sources must equal the rate of decomposition.

In equilibrium, the almost closed-cycle transfer of nutrients between soil and vegetation adapted to the local site conditions results in better structure and soil water conditions for plant growth.



S. VANEPH

CONSERVATION AGRICULTURE

closing the cycle

The following common practices are not successful in developing healthier soils:

Tillage	Damages the soil through compaction and causes decline of fertility by losses in organic matter and decreased biological activity
Burning of residues	Leads to loss of soil biota and organic matter
Incorporation of residues under the surface	This mechanical disturbance of soil can cause fast release of nutrients, most of which will be lost before the following crop can absorb them

Agricultural practices should aim to increase biomass addition in order to build active organic matter. Active organic matter provides habitat and food for beneficial soil organisms that: (i) help build soil structure and porosity; (ii) make nutrients available to plants; and, (iii) compete with soil pathogens.

Conservation agriculture can serve as a valid tool to help farmers achieve increased organic matter levels. Conservation agriculture is based on:

Permanent soil cover

Reduced or zero tillage

Rotations and cover crops

Restricted in-field traffic

The conservation agriculture practices relevant to SOM content are:

PERMANENT SOIL COVER

- ▶ The plant residues left on the surface and materials added to the soil surface are incorporated slowly into the soil by soil fauna. The slow release of nutrients makes them available for subsequent crops.