Organic Agriculture

2nd lecture for BSc students

Soil Health and Management in organic agriculture

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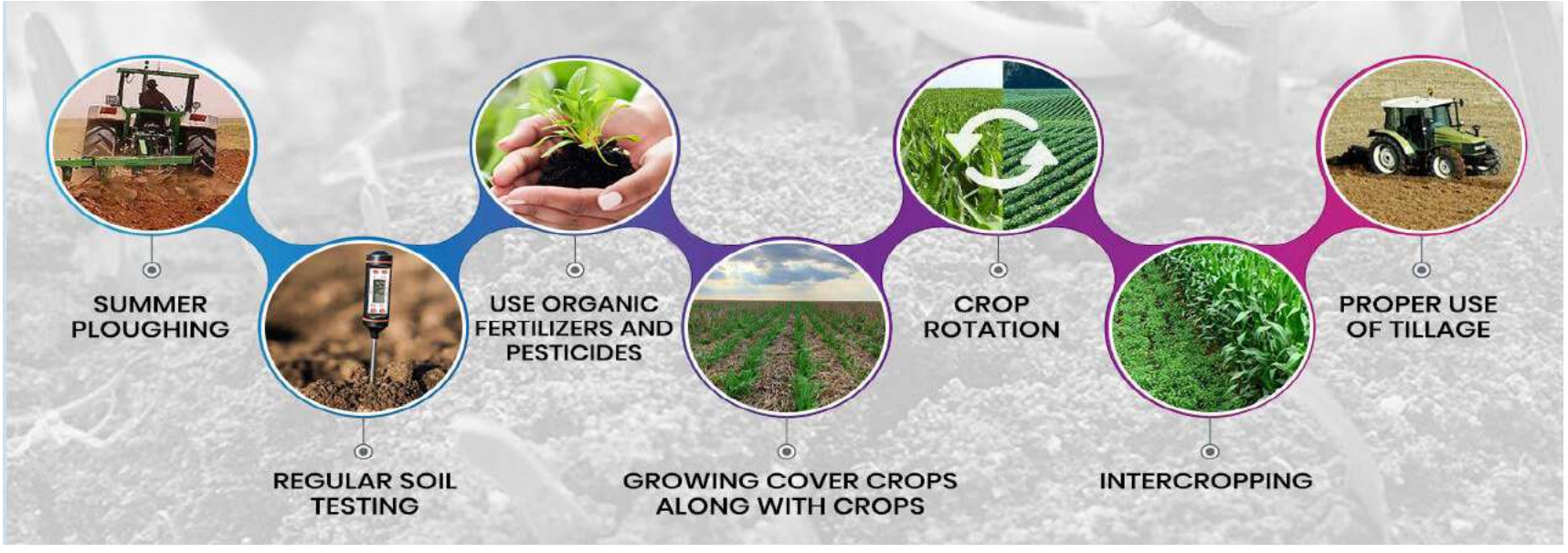
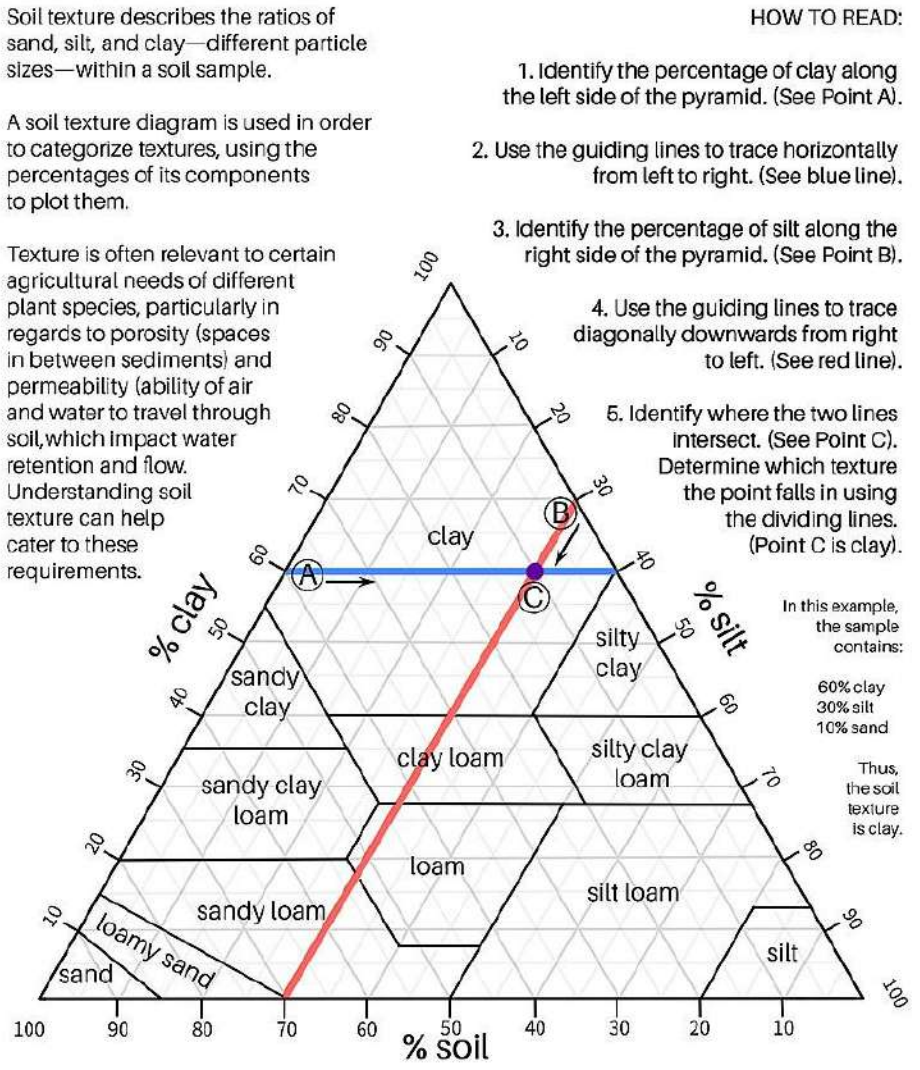


Principles of soil in organic farming

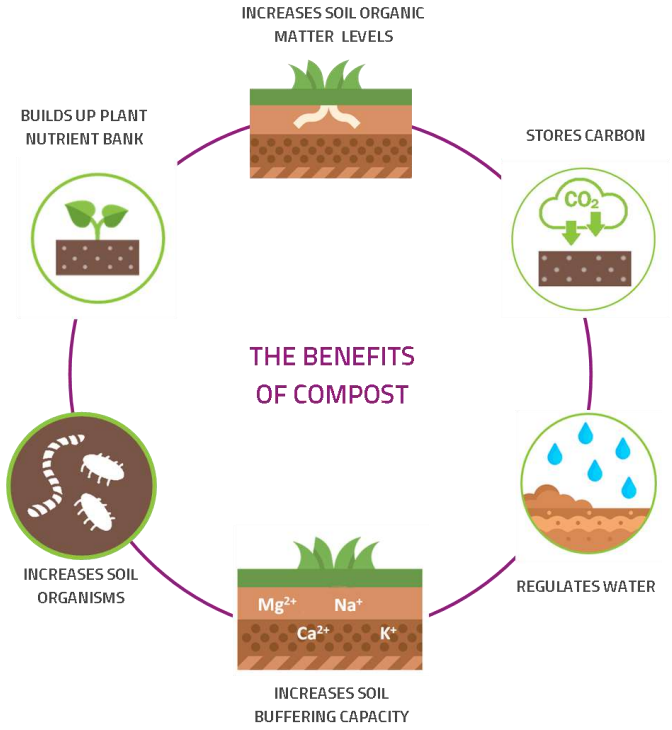
- **What is soil?**

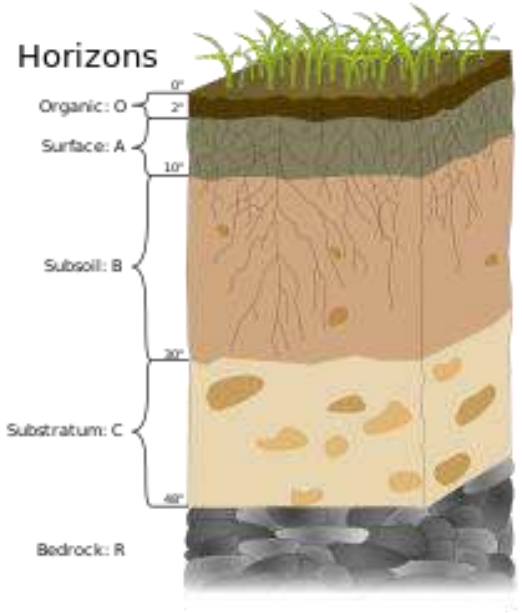
- Soil is the granular surface layer that covers the majority of the earth's surface.
- A normal soil comprises of around 50% solids (45% mineral and 5% organic matter) and 50% spaces (or pores), half of which are occupied by water and the other half by gas.



Soils as the Substance of Organic Farming

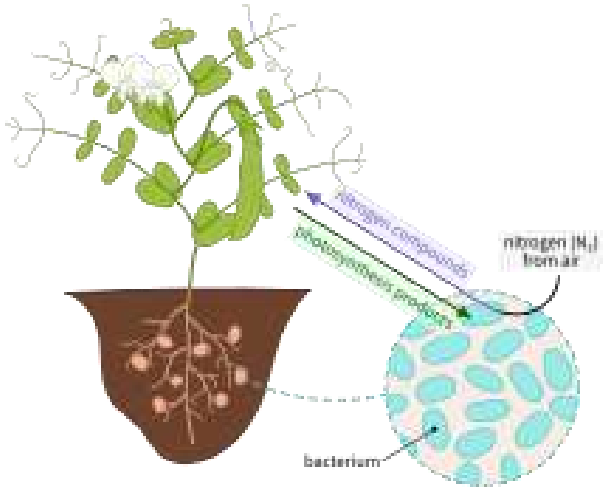
- Organic farming systems are built on soil health. Fertile soil supplies critical nutrients to plants while also maintaining a diversified and active biotic population that aids in the soil's resistance to environmental degradation.

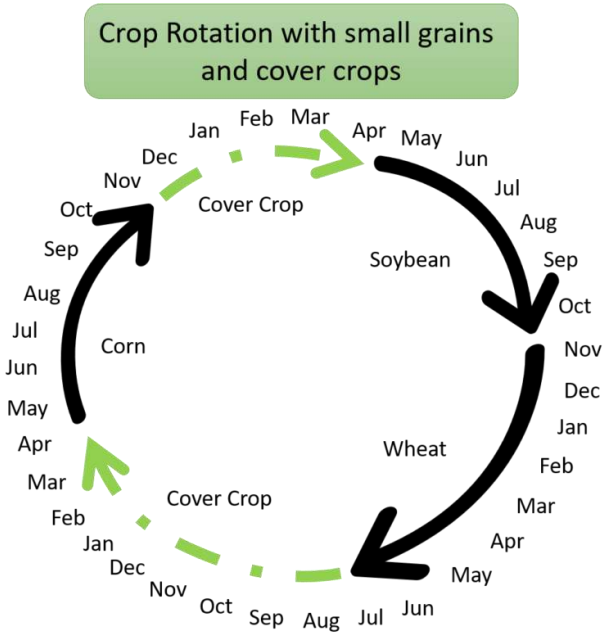




Techniques for improving soil fertility

- Organic farmers use crop rotations, animal and green manures, and cover crops to "build the soil" or improve its intrinsic fertility.





Methods Used to Build Soils

- **Bare fallow**

Bare fallow is practiced in the period between harvested crops.

Aims:

1. Retain water to the soil.
2. Control weeds
3. Enhance soil nutrient content

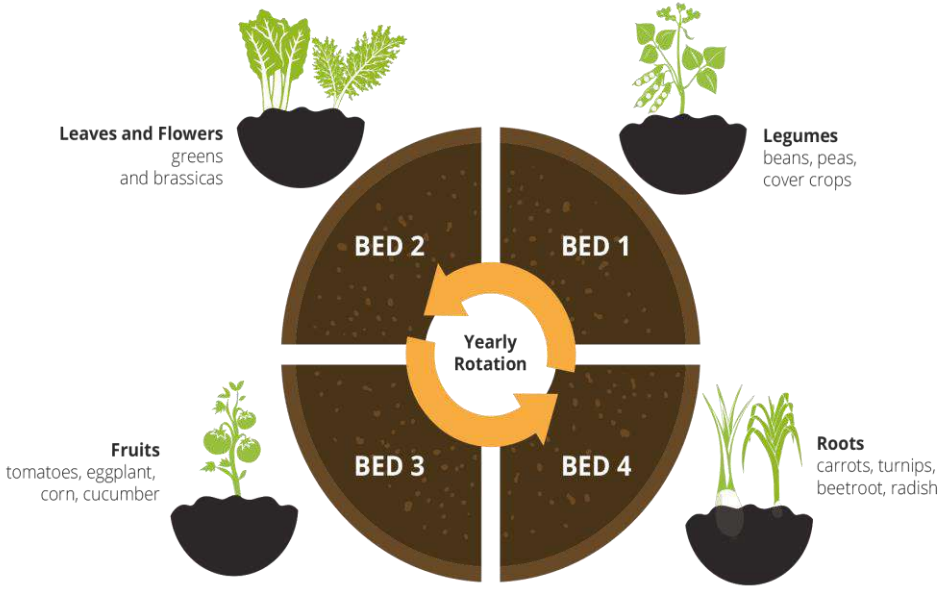
It is necessary to stop soil erosion when using bare fallow.

- **Crop Rotation**

Crop rotation varies plant species in time and space

Aims:

1. Goals are to keep the soil surface covered with a growing crop for most of the year
2. The breaking of disease and pest cycles
3. Maintain or increase soil organic matter content and nutrient availability



- **Cover Crops**

Herbaceous plants, either pure or mixed, that are annual, biennial, or perennial can be used as cover crops.

Aims:

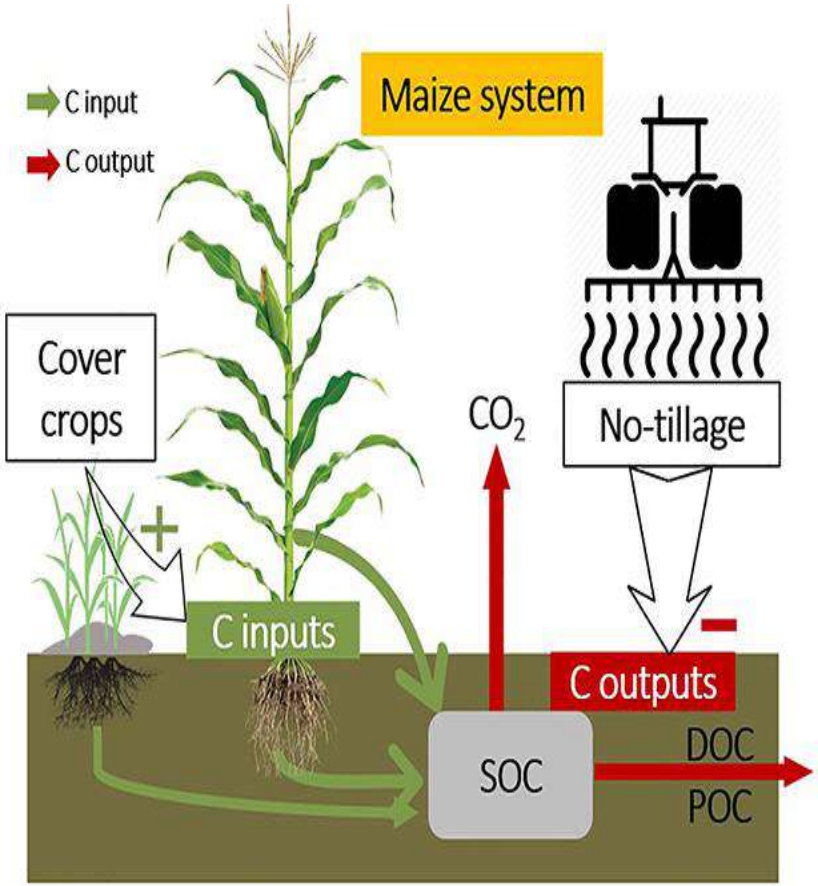
1. Providing soil cover
2. Can help loosen compacted soil
3. Improved water filtration
4. Build up or improve nutrients to the soil

- **Careful Use of Tillage**

Current organic systems usually require tillage prior to planting and cultivation after planting. However, tillage destroys the organic matter that is critical in improving soil fertility and soil water-holding capacity.

- **Aims**:

1. Control weeds
2. Improve soil quality
3. Provide beneficial insect habitat
4. In some cases reduce pest damage.



- **Organic Amendments**

Application should be made based on soil testing and/or use of budgets

- Manures and composts are the most common organic resources where livestock is in the vicinity
- **Aims**:

1. Providing nutrients to the soil
2. Protect soil from degradation and erosion

- **Problems Associated with Nutrient Over-Addition**

(over-fertilization)

Over-addition of N and P in organic systems can occur in situations where **leaching is restricted** (eg., in greenhouses) or after N rich cover crops or manures are applied.

1. The notion that N surplus **promotes microbial activity** and works against organic matter storage and destroys plant-microbe associations.
2. Excess nutrients can also **increase plant susceptibility** to pathogens and arthropod pests and can also lead to increased weed competition.
3. Tendency toward nutrient leaching and ability to **hold and retain nutrients** varies with soils and **climatic conditions**.
4. **Texture and CEC** are related to this, with nutrient storage capacity increasing with soil clay and silt contents and cation exchange capacities.

Soil conservation methods

All strategies and activities that protect soil from degradation and erosion are referred to as soil conservation.

1. **Physical Soil Conservation Methods**
2. **Biological Soil Conservation Methods**
3. **Chemical and organic Soil Conservation Methods**

1. Physical Soil Conservation Methods

- **Contour farming**, for example, adapts the soil structure to the landscape, slowing water flow and limiting erosion.
- Another option is **terracing**, which includes turning the terrain into a sequence of steps to control water runoff and soil erosion.
- **Windbreaks** and shelterbelts are tree lines planted to prevent wind from blowing away valuable topsoil.

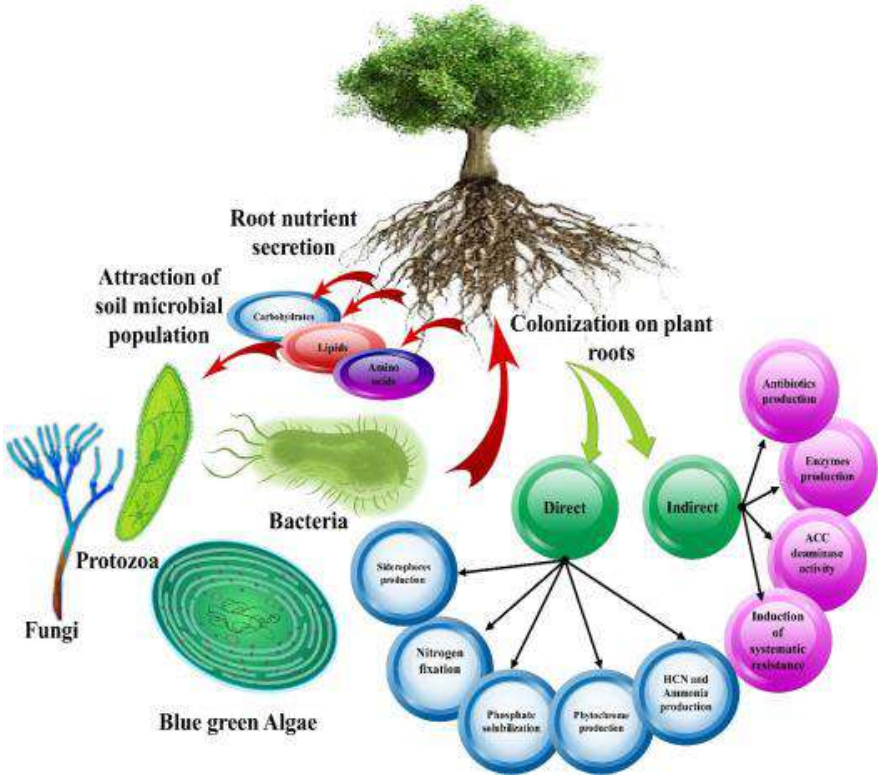
2. Biological Soil Conservation Methods

- **Crop rotation** is alternating different types of crops in a given region, which helps to prevent nutrient depletion in the soil.
- **Cover cropping** requires planting specific crops that protect the soil from erosion while also improving its structure.
- **Agroforestry** is a system that mixes trees, crops, and livestock to improve soil fertility and water retention.

Chemical and Organic Soil Conservation Methods

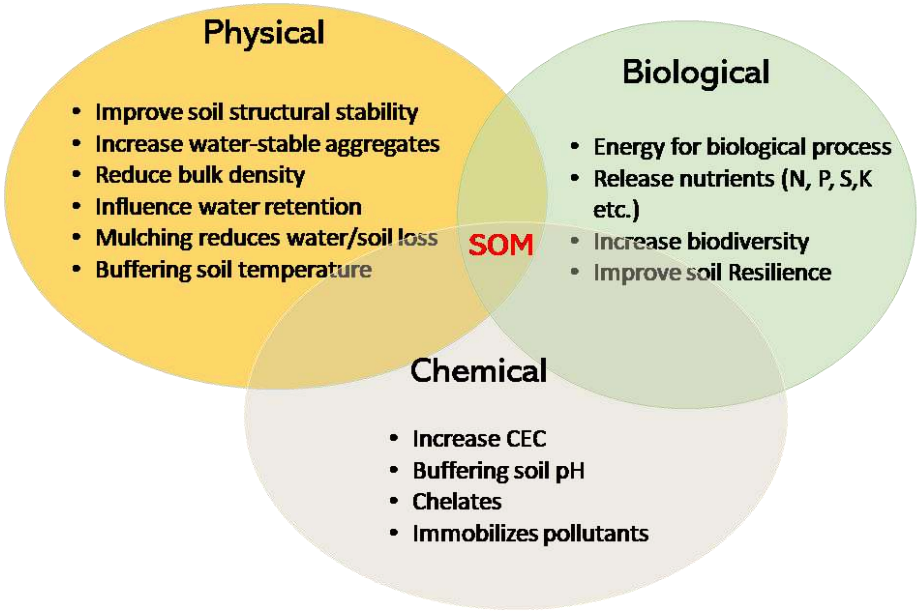
- **Chemical** approaches emphasize the use of chemicals to improve soil health. Fertilizers are frequently used to replenish lost nutrients and boost soil fertility.

- **Organic** additives like as compost can also help to enhance the soil



Nature and composition OF soil organic matter (SOM)

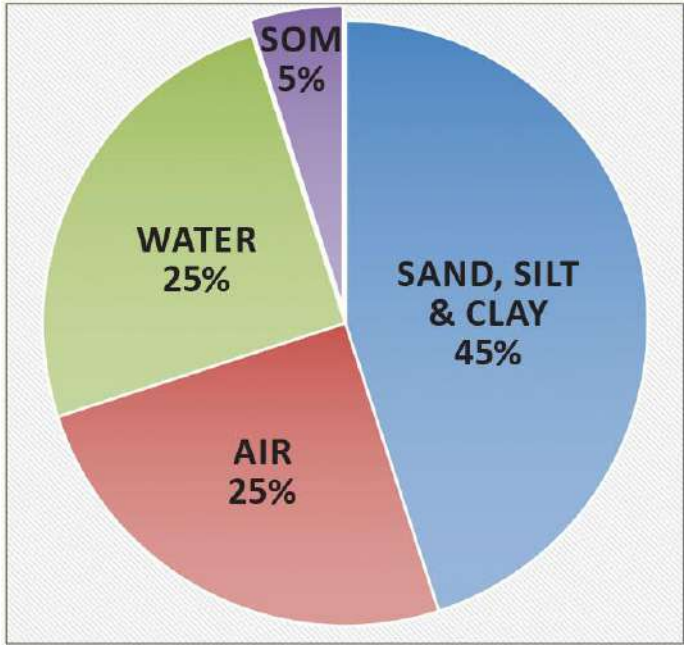
- **Humic compounds, saccharides and peptides**, and products formed from **recalcitrant** materials are all examples of SOM.
- SOM is ordinarily estimated to contain **58% C**, and "soil organic carbon" (SOC) is often used as a synonym for SOM.



Soil organic matter (SOM)

- The content of organic matter in soils ranges from OM **2 g/kg** in some **desert** soils to more that **800 g/kg** in some **Histosols**; however, cultivated mineral soils usually contain **10 to 40 g/kg** in the A horizon

- For most highland soils, the concentration of SOM in soils ranges from 1% to 6% of the total mass of **topsoil**. Soils with upper layers containing less than 1% organic matter are generally found in deserts, whereas soils in low-lying, wet locations can contain up to 90% SOM. **Organic soils** are those that have a SOC content of **12% to 18%.**



ORGANIC MATTER BREAKDOWN

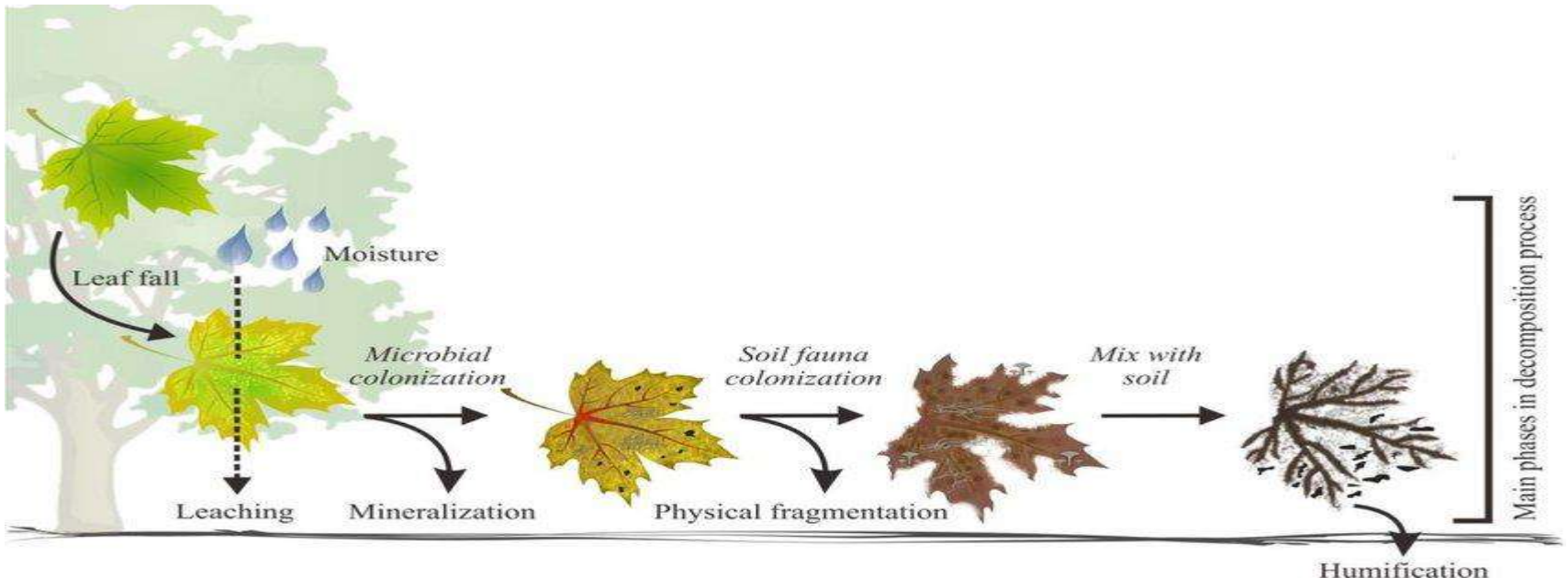
Plant and animal organic material that reaches the soil is subject to the action of many agents, including microorganisms and invertebrates, that promote decomposition. Some plant and animal residues are decomposed rapidly by microorganisms; however, much of the organic matter, particularly the tougher plant leaves, stems, and root material, breaks down much more readily after being fragmented by soil-inhabiting invertebrates, which facilitates microbial and enzymatic activity in the invertebrates' intestines. In many soils, earthworms are probably the most important macroinvertebrates involved in the initial stages of recycling of organic matter and release of nutrients for plant growth.

What is the C:N ratio of organic matter and why is it important?

- The C:N ratio of organic matter means the amount of carbon relative to the amount of nitrogen present. There is always more carbon than nitrogen in organic matter. It is usually written as C:N and is a single number, because it expresses how much more carbon than nitrogen there is. For example if the ratio is 20, this means that there are 20 grams of carbon for each gram of nitrogen in that kind of organic matter.

Why do stems and leaves decompose at different rates?

- Stems and leaves decompose at different rates because they are made up of different kinds of molecules that require different enzymes for their degradation. Leaves generally have more cellulose than lignin. Stems generally have more lignin than leaves. Cellulose is a simpler molecule which is able to be decomposed by microorganisms more quickly than lignin.



Earthworms and microorganisms in soil

- Earthworms (*Lumbricus terrestris)* impact the physical and chemical composition of soil and contribute to organic and mineral soil transfers.
- Earthworms have adversely affected bacterial wealth in the gut and casts. *Eudrilus spa. L. rubellus* the intestines and casts

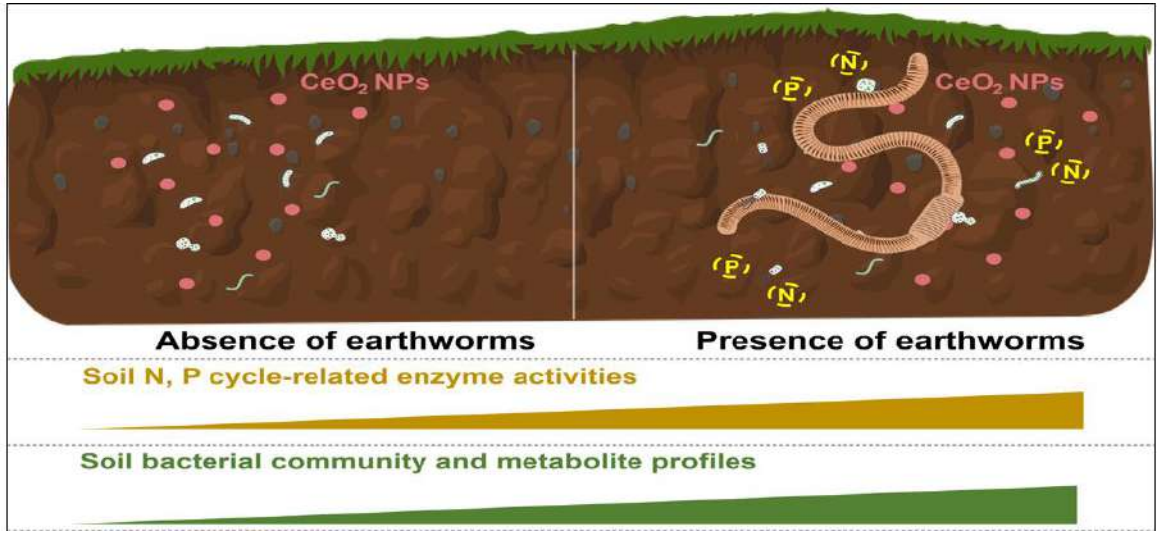
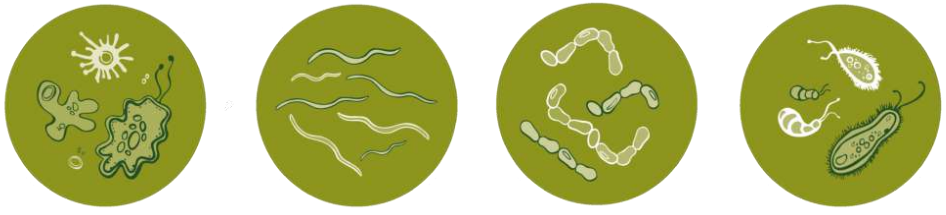
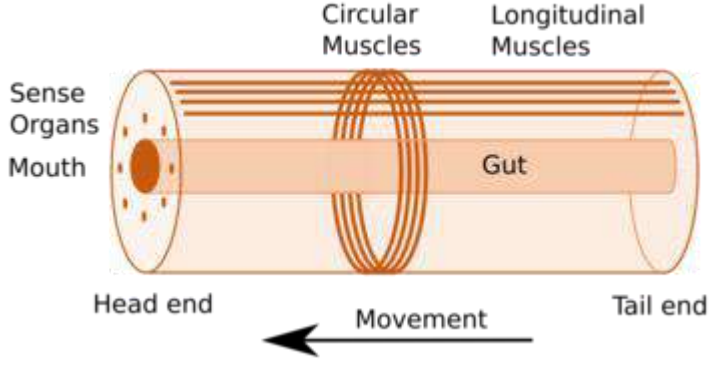


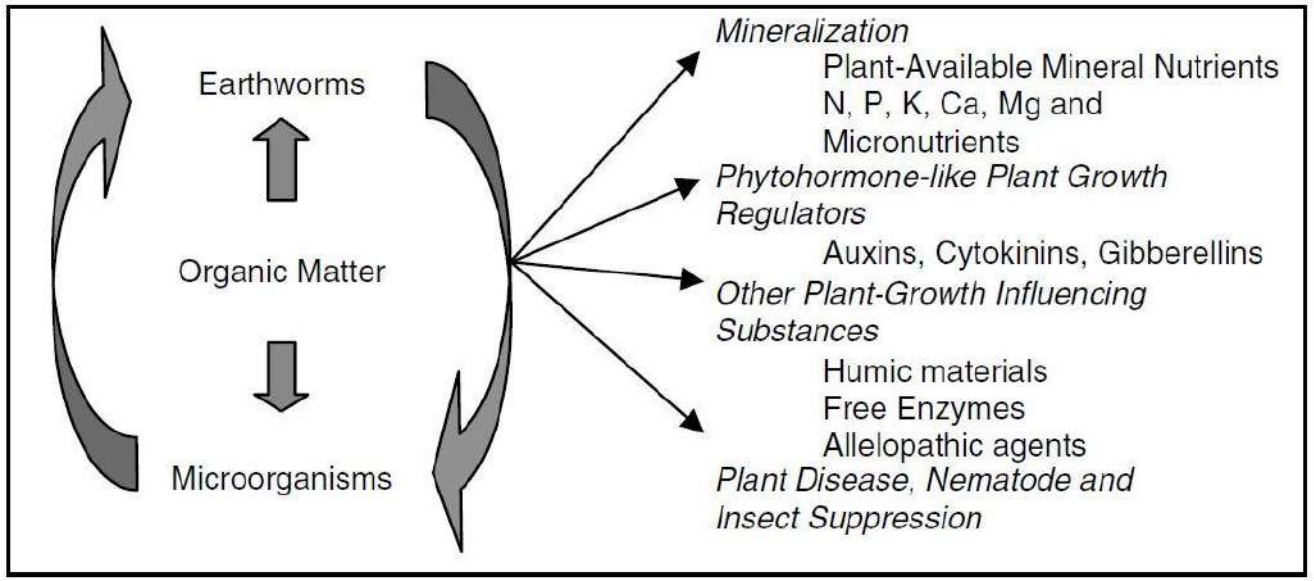
Figure 1. Soil Microorganisms





Understanding soil microbiology and promoting beneficial organisms

- Interactions between earthworms and microorganisms
- There is a great increase in the total numbers of bacteria, fungi, and actinomycetes occurring in the earthworm gut compared with those in the surrounding soil.
- Although many species of microorganisms can survive passage through the earthworm gut, not all emerge in a viable form.



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Thank you

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