Bharathidasan University

Tiruchirappalli – 620 023, Tamil Nadu

6 Yr. Int. **M.Tech. Geological Technology and Geoinformatics**

*Course Code : **MTIGT0707*** *Optional Elective :* **14** *Credits : **3***

GEOINFORMATICS IN SOIL SCIENCE

Unit–4 Soil Quality and Landscape

Prepared by

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Professor, Department of Remote Sensing

Course Objectives:

- ❖ To learn the importance, characters and types of soil and its relation with biotic systems
- ❖ To study the significance of soil nutrients and micronutrients
- ❖ To understand relevant aspects like soil organic matter, water holding property and landscape
- ❖ To learn the application of Geological Technology and Geoinformatics in soil resources mapping and management
- ❖ To learn the application of Geoinformatics in mitigating soil erosion and reservoir siltation.

SEMESTER – VII ELECTIVE PAPER-14 MTIGT0707 GEOINFORMATICS IN SOIL SCIENCE

3 Credits

1. **Introduction to Soil Science :** Nature and Importance of Soil, Soil formation, Soil survey, Physical, chemical and biological characters of soil, Relationship between Soil, plants and animal. **9 Hrs**

2. **Soil Types :** Soil types and classification, Soil genesis, Soil mineralogy and geochemistry of soil types: Laterites, Bauxites, Aridisols, Vertisols, Camborthids. Application of soil micromorphology and landscape evolution. Radiometric age determination of soils. **12 Hrs**

3. **Soil Nutrients and Crop Production :** Elements essential for plants and animals, Soil nutrients - Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and Sulphur in soil and its significance in plant growth, Micronutrients. **9 Hrs**

4. **Soil Quality and Landscape :** Soil and water relations, organic matter in soil, functions of organic matter, organic matter and soil structure, organic matter and essential elements, tillage, cropping systems and fertility and case studies. **12 Hrs**

5. **Soil Management and Conservation :** Introduction, irrigation, drainage and soil management for field crops, gardens, lawns, pastures, rangelands and forests. Problem Soils - Soil surface crusting - Salinity - Erosion - Contamination. Soil conservation factors and implementation methods. **6 Hrs**

6. **Current Contours: (Not for Final Exam; only for Discussion):** Environmentally safe and sustainable methods of mitigating soil erosion and reservoir siltation using Geological Technology and Geoinformatics; Development of suitable and pragmatic methods to protect soil from fertility loss, soil pollution and degradation.

References:

1. Nyle, C. Brady, Ray R. Weil, The Nature and Properties of Soils (13th Edition) Prentice Hall, 2002.
2. Donald, L. Sparks, Environmental Soil Chemistry, 2002.
3. Raymond B. Daniels, Richard D. Hammer., Soil Geomorphology, John Wiley & Sons, 2000.
4. M.E. Sumner, Hand book of soil Science, 1992.
5. Donald Sparks, Donald L. Sparks D, Environmental Geochemistry, Academic Press, 2002.

Course Outcomes:

After the successful completion of this course, the students are able to:

- *Understand the importance and the physical, chemical and biological properties of soils*
- *Know the different types of soils and classification*
- *Differentiate the reflectance properties of soils and mapping them using satellite data*
- *Understand the problems to soils using Remote Sensing, field surveys in GIS platform through modeling.*
- *Suggest pragmatic soil management and conservation practices using Remote Sensing, field surveys in GIS platform through modeling and*
- *Understand the importance of soil nutrients, quality and relation with landscape.*

Unit – 4 Soil Quality and Landscape

Soil and water relations, organic matter in soil, functions of organic matter, organic matter and soil structure, organic matter and essential elements, tillage, cropping systems and fertility and case studies. **12 Hrs.**

Soil water

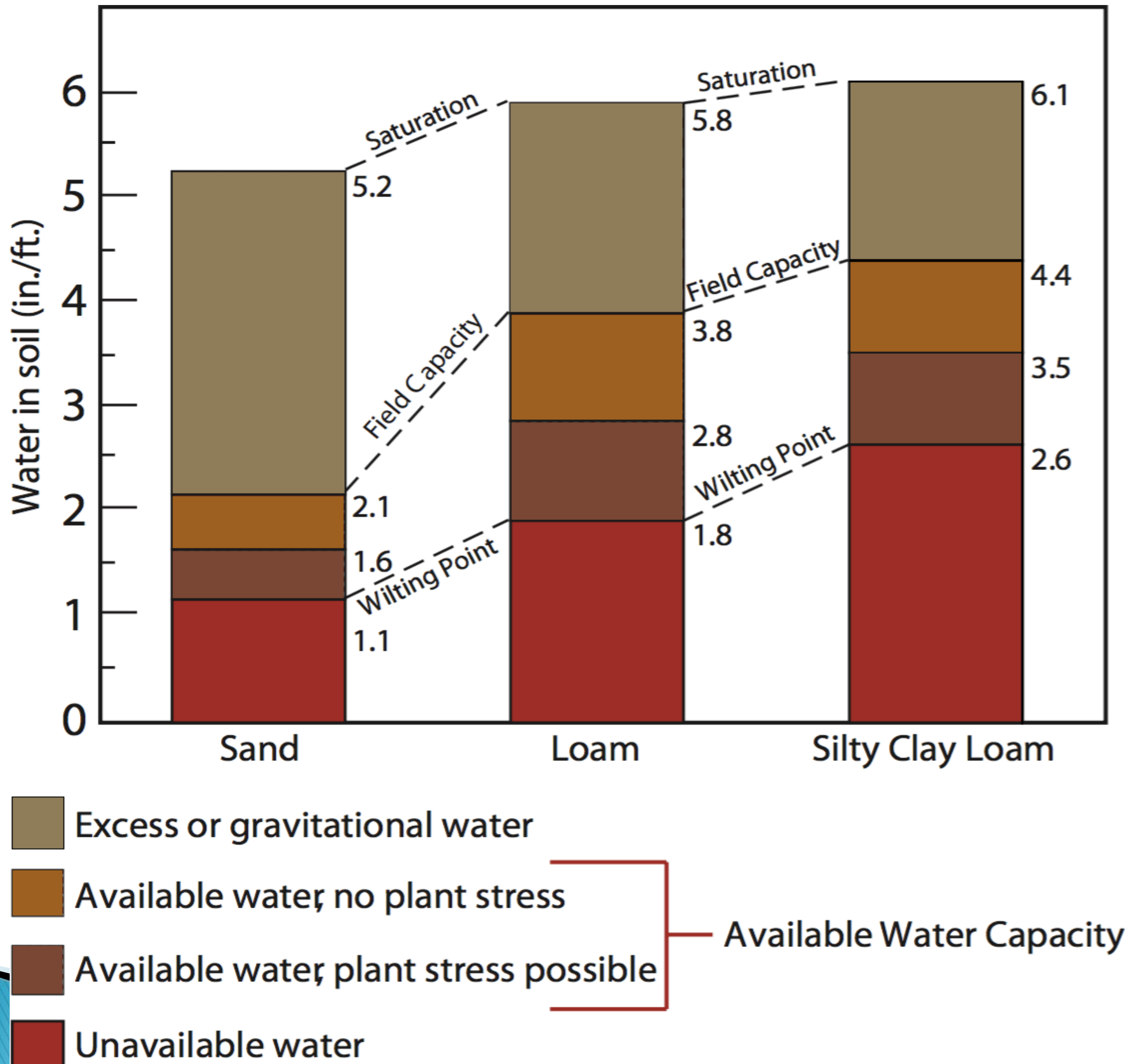
- Water is held in soil by strong cumulative forces of the **H-bonds** that are between the **water** and the **oxygen** atoms of soil mineral surfaces.
- These **adhesive forces** are very strong near the mineral surface; **cohesive forces** (between water molecules) occur throughout the water films.
- Because water held to soil particles has less freedom than free water (potential = 0), it is measured in negative bars.
- The strength with which water is held in the soil is called **water potential of soil.**

Soil and Water Relationships

- **Water infiltration** is the movement of water from the soil surface into the soil profile.
- Soil texture, soil structure, and slope have the largest impact on infiltration rate.
- Water moves further below by gravity into the open pore spaces in the soil is known as **Water percolation**, and the size of the soil particles and their spacing determines how much water can flow in.

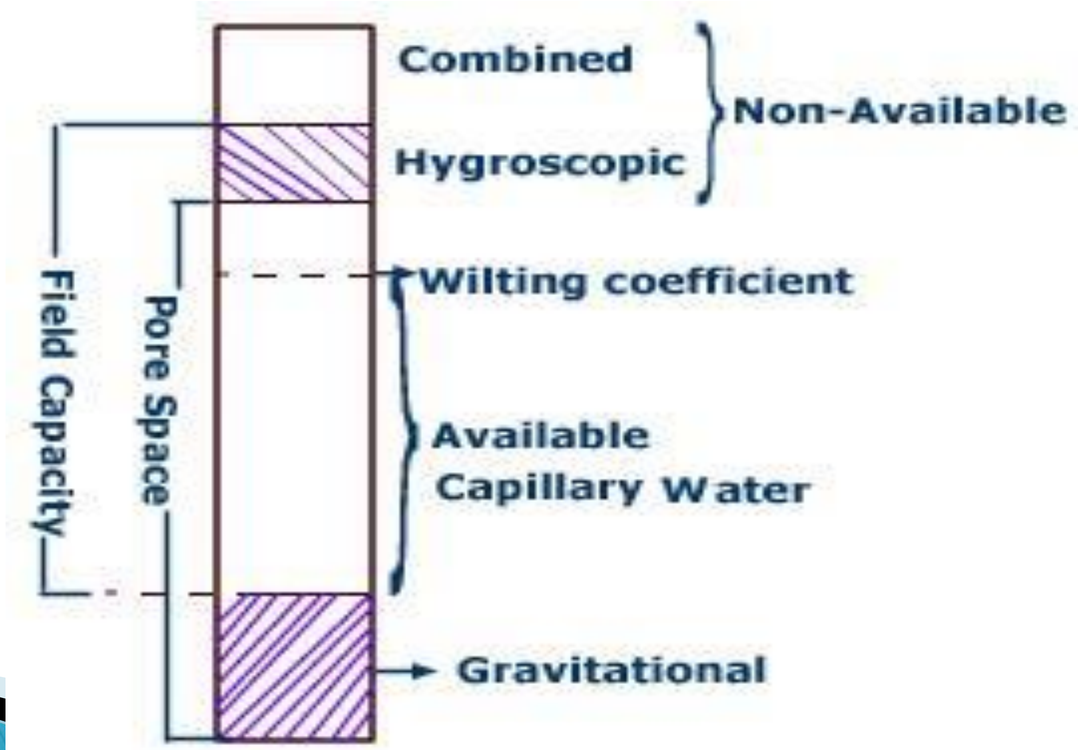
Available Water Capacity by Soil Texture

- **Textural Class based Available Water Capacity (Inches/Foot of Depth); i.e. the capacity of soil to hold water within it.**
- **This involves the capillary rise from the minute pore spaces in soil.**
- **AWC is the maximum amount of available water for plant that can be provided by soil.**
- **AWC ranges in different soils are:**
  - **Coarse sand 0.25–0.75 - Minimum**
  - **Fine sand 0.75–1.00**
  - **Loamy sand 1.10–1.20**
  - **Sandy loam 1.25–1.40**
  - **Fine sandy loam 1.50–2.00**
  - **Silt loam 2.00–2.50 - Maximum**
  - **Silty clay loam 1.80–2.00**
  - **Silty clay 1.50–1.70**
  - **Clay 1.20–1.50**



Water in soil (in./ft.)
0
1
2
3
4
5
6
Saturation
Saturation
Field Capacity
Field Capacity
Wilting Point
Wilting Point
5.2
2.1
1.6
1.1
5.8
3.8
2.8
1.8
6.1
4.4
3.5
2.6
Sand
Loam
Silty Clay Loam
Excess or gravitational water
Available water, no plant stress
Available water, plant stress possible
Unavailable water
Available Water Capacity

- Soil is the major source of water for plants. The plants absorb water through root hairs from the soil.
- The ***total water content*** present in the soil is called '**holard**'. Out of this, the water which can be ***absorbed by plants*** is '**chresard**' and the ***remaining water*** is called '**echard**'.



Inefficient use of rainwater

- Where rainfall lands on the soil surface, a fraction **infiltrates** into the soil to replenish the soil water or flows through/**percolates** deep to recharge the groundwater.
- Another fraction may **run off** as **overland flow** and the remaining fraction **evaporates** back into the atmosphere directly from unprotected soil surfaces and from plant leaves.
- The above-mentioned cyclic processes, totally called as "**Hydrological Cycle**" do not occur at the same moment, but some are ***instantaneous*** (runoff), taking place during a rainfall event, while others are ***continuous*** (evaporation and transpiration).
- Hence, it is possible to efficiently harvest part/full of the instantaneous runoff due to rainfall for various purposes before entering into the ocean.

Soil Organic Matter (SOM)

SOM - is a Living or dead plant and animal residue which is very active and forms important portion of the soil.

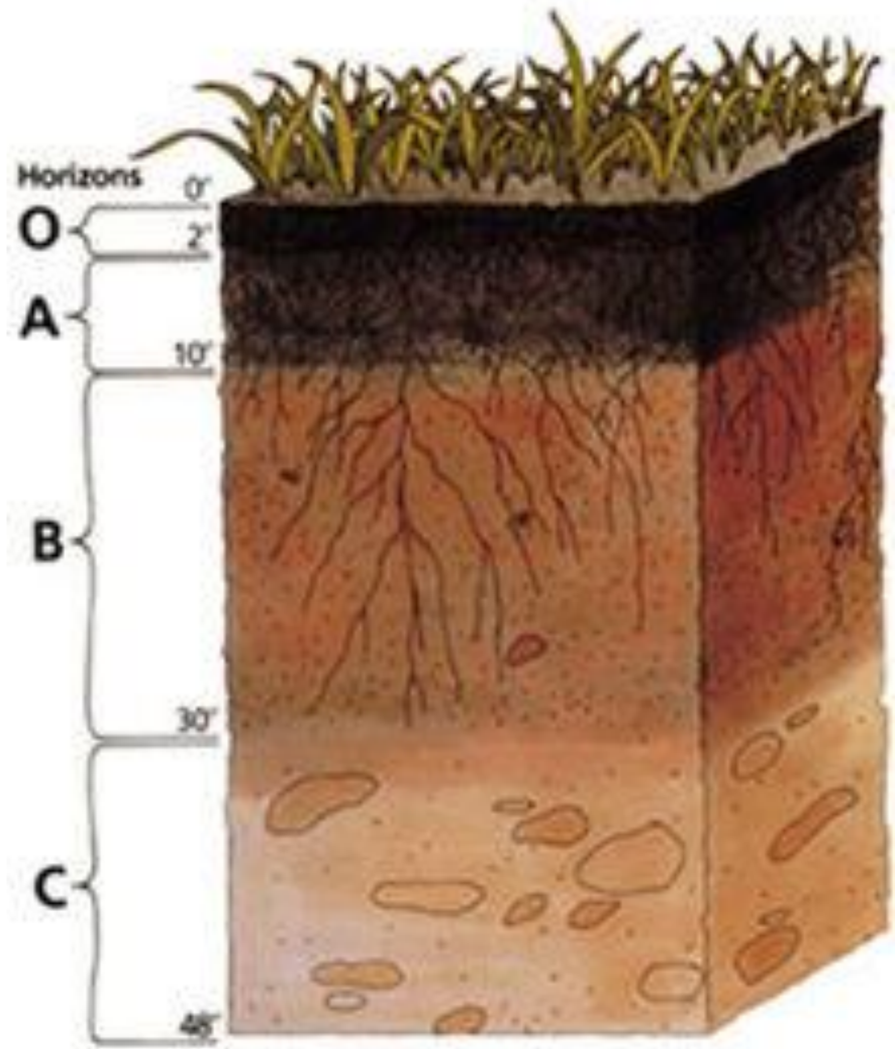
Why Soil Organic Matter (SOM) matters

- ❖ Soil organic matter contributes to a variety of biological, chemical and physical properties of soil and is essential for good soil health.
- ❖ Thus, it is important to understand the
    - Functions of soil organic matter and
    - Optimise the benefits of soil organic matter.

- ✓ Soil health is important to optimise productivity in agricultural systems.
- ✓ Healthy, productive soil is a mixture of water, air, minerals and organic matter.
- ✓ In turn, soil organic matter is composed of plant and animal matter in different stages of decay, making it a complex and varied mix of materials.

Humus

Humus has a characteristic black or dark brown color, due to the accumulation of organic carbon in soil from vegetal matter.



Humin The strong base insoluble fraction.

- The **carbon cycle** describes how carbon is circulated through the **atmosphere, biosphere, pedosphere**, and **hydrosphere**.

- The dead organic matter of the soil is colonized by (micro)organisms, which derive energy for growth from the oxidative **decomposition** of complex organic molecules.

- Decomposition is the biochemical breakdown of mineral and organic materials. During decomposition, **inorganic elements are derived by conversion from the organic compounds**, a process called **mineralization**.

For example, the organic-N and -P are mineralized to NH_4^+ and $H_2PO_4^-$, and C is converted to CO_2.

The amount of organic matter in soil

The amount of carbon (the measure of organic matter) in a soil depends on a range of factors, and reflects the balance between accumulation and breakdown.

- **Climate** – For similar soils under similar management, carbon is greater in areas of higher rainfall, and lower in areas of higher temperature. The rate of decomposition doubles for every 8 or 9^{o}C increase in mean annual temperature.

- **Soil type** – Clay helps protect organic matter from breakdown, either by binding organic matter strongly or by forming a physical barrier which limits microbial access. Clay soils in the same area under similar management will tend to retain more carbon than sandy soils.

- **Vegetative growth** – The more vegetative production the greater are the inputs of carbon. Also, the more woody this vegetation is (greater C:N ratio), the slower it will breakdown. So, the crop system can strongly affect carbon concentrations.

Role of Organic Matter in Soil Fertility

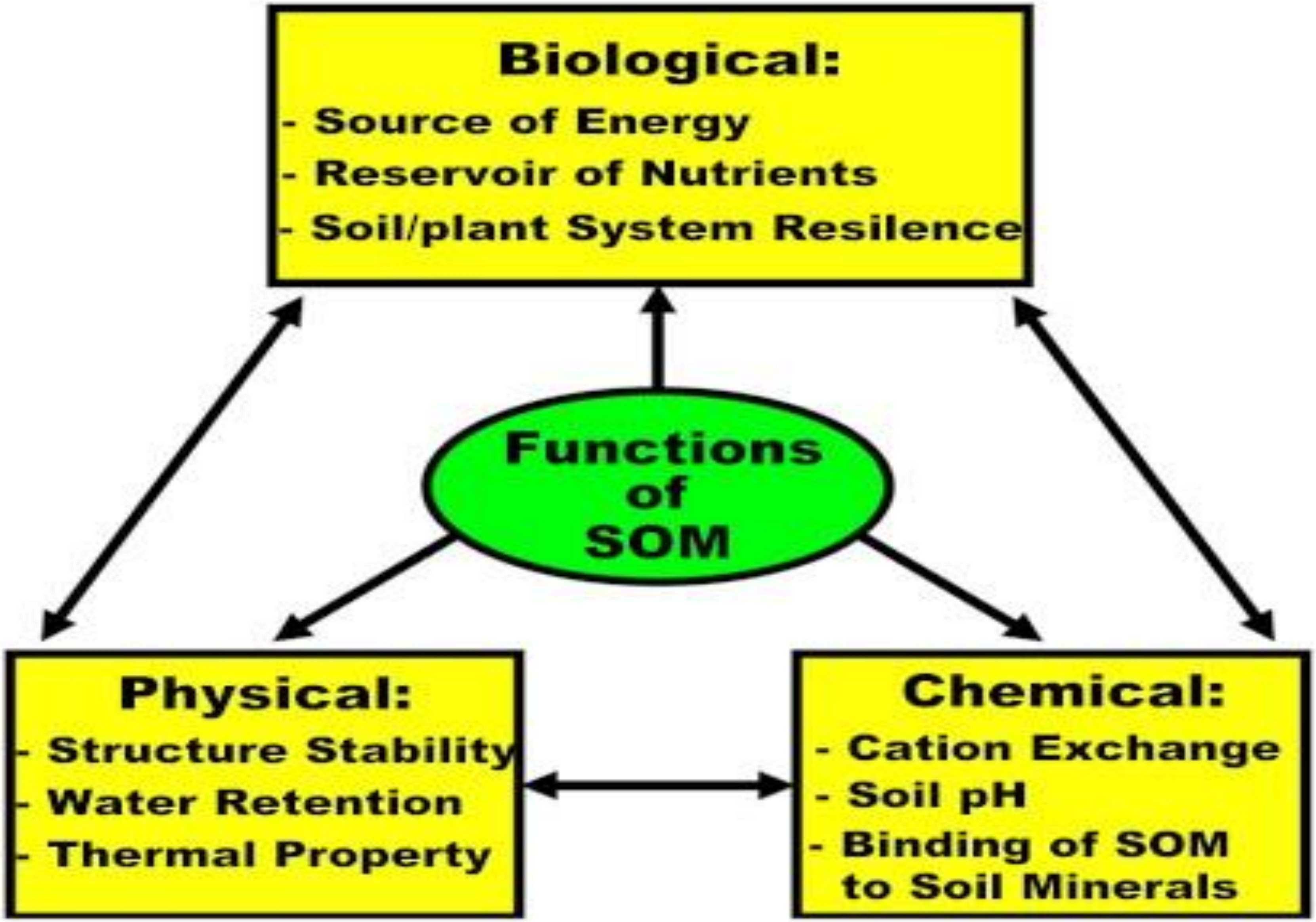
✓Organic matter forms a very small but an important portion and it is obtained from dead plant roots, crop residues, various organic manures like farmyard manure, compost and green manure, fungi, bacteria, worms and insects.

Measuring soil organic matter

It is the non-living organic matter to be measured as 'soil organic matter'.

The most common methods for measuring soil organic matter in current use is actually the measure of amount of carbon in the soil by **oxidising the carbon** and measuring either the **amount of oxidant used** (wet oxidation, usually using dichromate) or the **CO_2 given off in the process** (combustion method with specific detection).

Functions and interrelations of SOM:



- SOM
  - Biomass (living organisms)
  - Detritus (identifiable dead tissue)
  - Humus (non-living and non-tissue)
    - Humic
      - 60-80% SOM
      - Large and complex
      - Aromatic and polyphenols
      - Resistant
      - Colloidal
    - Non-humic
      - 20 to 30% of SOM
      - $C_n(H_2O)_m$
      - Polysaccharides
      - Less complex
      - Structure and nutrients

Essential functions performed by different members of soil organisms (biota)

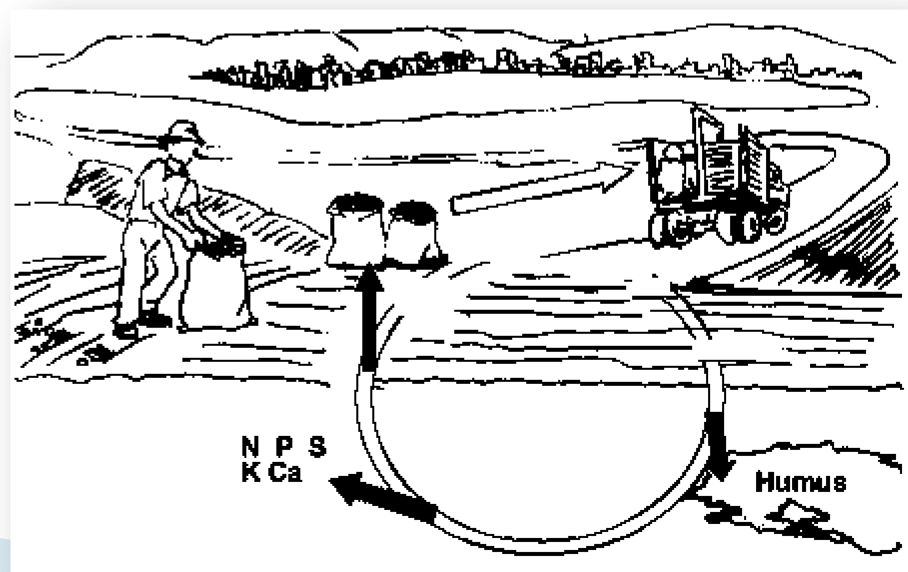
Functions	Organisms involved
Maintenance of soil structure	Bioturbating invertebrates and plant roots, mycorrhizae and some other micro-organisms
Regulation of soil hydrological processes	Most bioturbating invertebrates and plant roots
Gas exchange and carbon sequestration (accumulation in soil)	Mostly micro-organisms and plant roots, some C protected in large compact biogenic invertebrate aggregates
Soil detoxification	Mostly micro-organisms
Nutrient cycling	Mostly micro-organisms and plant roots, some soil- and litter-feeding invertebrates
Decomposition of organic matter	Various saprophytic and litter-feeding invertebrates (detritivores), fungi, bacteria, actinomycetes and other micro-organisms
Suppression of pests, parasites and diseases	Plants, mycorrhizae and other fungi, nematodes, bacteria and various other micro-organisms, collembola, earthworms, various predators
Sources of food and medicines	Plant roots, various insects (crickets, beetle larvae, ants, termites), earthworms, vertebrates, micro-organisms and their by-products
Symbiotic and asymbiotic relationships with plants and their roots	Rhizobia, mycorrhizae, actinomycetes, diazotrophic bacteria and various other rhizosphere micro-organisms, ants
Plant growth control (positive and negative)	Direct effects: plant roots, rhizobia, mycorrhizae, actinomycetes, pathogens, phytoparasitic nematodes, rhizophagous insects, plant-growth promoting rhizosphere micro-organisms, biocontrol agents Indirect effects: most soil biota

Bioturbation - physical movement of soil by fauna or plant roots; **Saprophytes**- obtaining food by absorbing dissolved organic material

Human interventions that influence soil organic matter

- ❖ Various types of human activity decrease soil organic matter contents and biological activity. However, 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.

- ❖ Soil organic matter levels can be maintained with less organic residue in fine textured soils in cold temperate and moist-wet regions with restricted aeration. If SOM in soil is not maintained properly, then this may:
  - ✓ decrease in biomass production
  - ✓ decrease in organic matter supply and
  - ✓ increase decomposition rates.

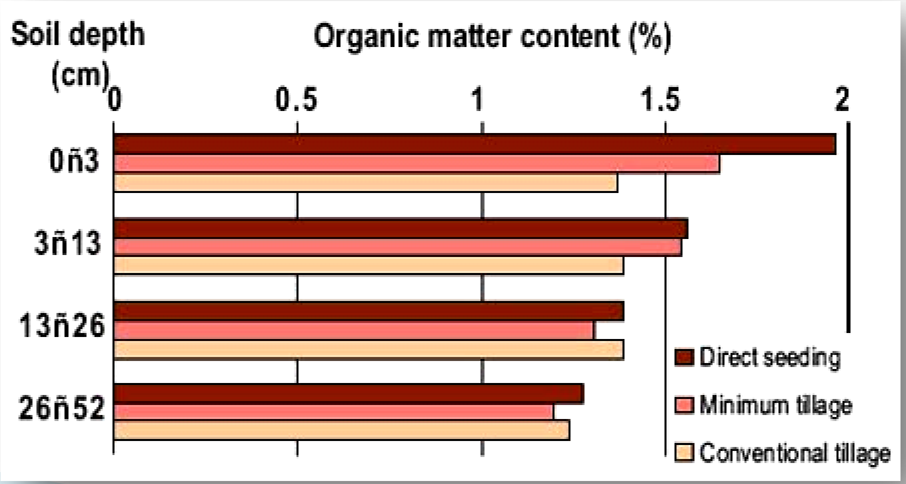


Effect of soil organic matter on soil properties

- Organic matter affects both the chemical and physical properties of the soil and its overall health. Properties influenced by organic matter include:
  - soil structure; moisture holding capacity; diversity and activity of soil organisms, both those that are beneficial and harmful to crop production; and nutrient availability.

Organic matter deposition

- The reduction of soil disturbance through zero-tillage, the use of cover crops and the preservation of crop residues on the soil surface result in increased activity of the soil and in the accumulation of **soil organic matter**, mainly in the topsoil.
- conservation of agriculture is feasible in the humid and subhumid tropics and the generation of sufficient biomass in semi-arid regions is the limiting factor.

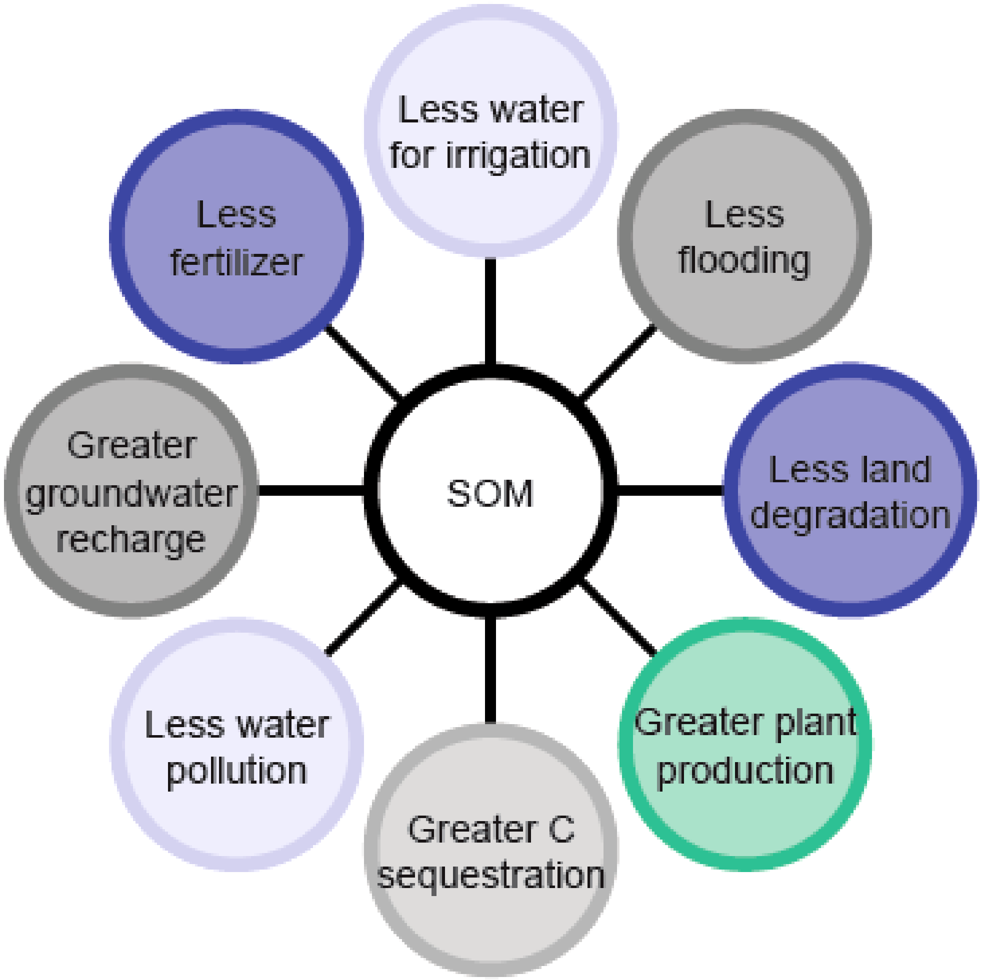


SOM and soil quality

1. Cation exchange capacity
2. Infiltration and water holding capacity (4 to 5 times silicate clays)
3. Aggregate formation and stabilization
4. Slow nutrient (NPS) release
5. Microorganism C and energy supply
6. Direct plant growth stimulation (e.g., DON, growth regulators, and allelopathic compounds)

Note: **NPS** – Nitrogen, Phosphorous, Sulphur; **DON** – Dissolved Organic Nitrogen; **Allelopathy** - biological phenomenon by which an organism produces one or more biochemicals that influence the germination, growth, survival, and reproduction of other organisms.

Environmental effects of SOM



Effect of soil organic matter on soil properties

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- Properties influenced by organic matter include:
  - soil structure;
  - moisture holding capacity;
  - diversity and activity of soil organisms, both those that are beneficial and harmful to crop production; and
  - nutrient availability.

Reduced soil erosion and improved water quality

- The less the soil is covered with vegetation, mulches, crop residues, etc., the more the soil is exposed to the impact of raindrops.

- When a raindrop hits bare soil, the energy of the rain drop at a greater velocity detaches individual soil particles from soil clods. These particles can clog surface pores and form many thin, rather impermeable layers of sediment at the surface, referred to as **surface crusts**.

- They can range from a few millimetres to 1 cm or more; and they are usually made up of sandy or silty particles. These surface crusts hinder the passage of rainwater into the profile, with the consequence that runoff increases.

- This breaking down of soil aggregates by raindrops into smaller particles depends on the stability of the aggregates, which largely depends on the organic matter content.

Benefits of soil organic matter

- ✓ Organic matter can be considered a **pivotal component of the soil** because of its role in physical, chemical and biological processes.

- ✓ Many of these functions interact. For example, the **high cation exchange properties** of organic matter are a major means by which organic matter is able to bind soil particles together in a more stable structure.

- ✓ The **reactive regions** present in humus are numerous, and give these molecules a capacity to **bind** to each other and to **mineral soil particles**,

- ✓ It supplies major soil aggregate-forming cements, particularly long sugar chains called **Polysaccharides** and

- ✓ Also to **react with cations** (positive charge, e.g. Ca^{2+}, K^+) in the soil solution.

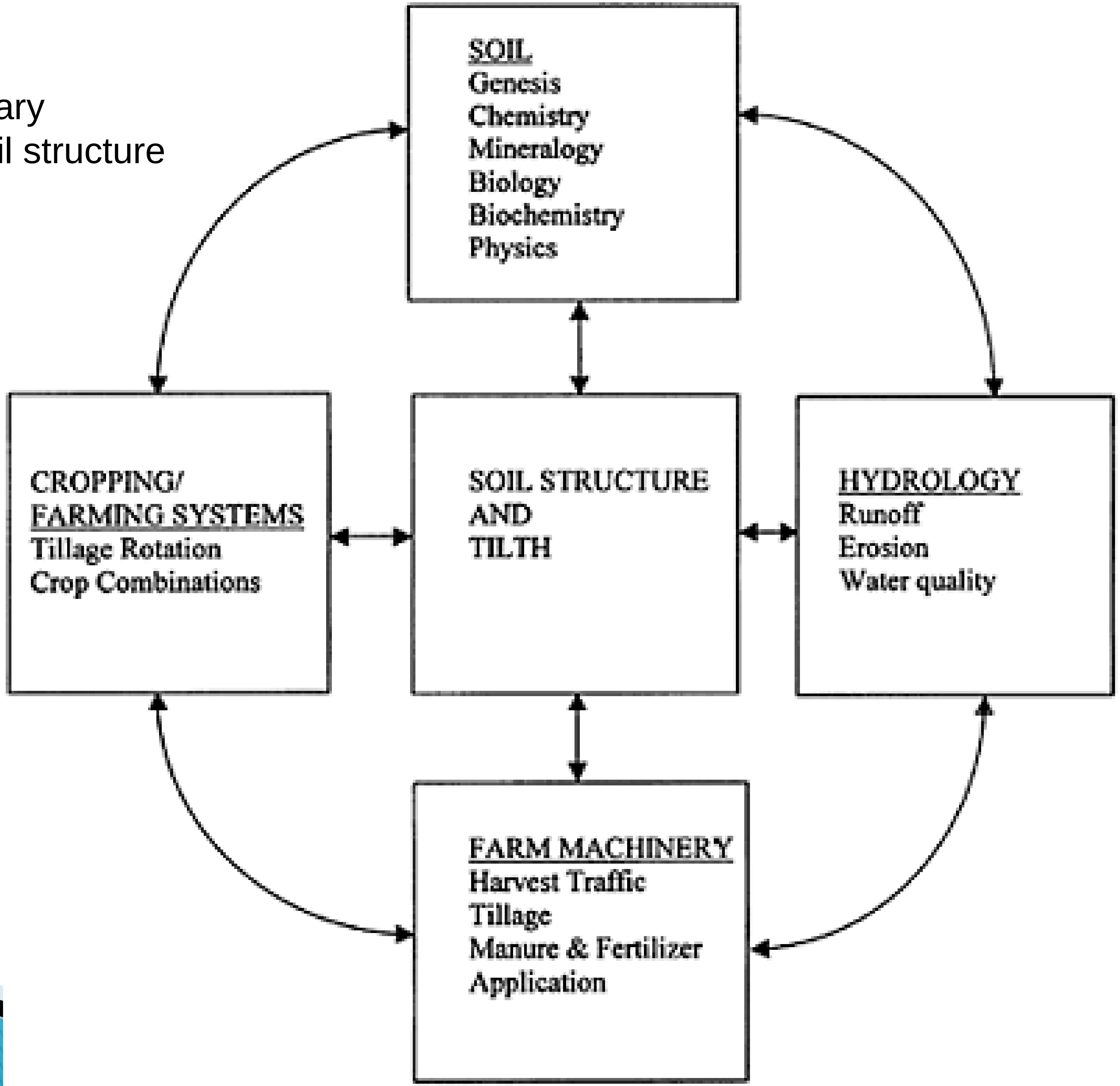
- ✓ The density of cation exchange capacity (**CEC**) of organic matter is greater than clay minerals.
- ✓ While a **high CEC** is an important attribute of soil organic matter, to note that organic matter does not have an **anion (negative) exchange capacity**, and is therefore **not able to bind anions** like phosphate and sulphate.
- ✓ SOM is the source of **90-95% of nitrogen** in unfertilized soils.
- ✓ SOM is the major source of both available **phosphorous** and available **sulphur**, if soil humus is present.
- ✓ It **increases** water contents at **field capacity.**
- ✓ When left on top of soil as a **mulch**, it **reduces soil erosion**, keeps the **soil cooler** in very hot weather and **warmer** in winter.
- ✓ Organic matter is a **carbon supplying material** for many microbes**.**

Organic mater and soil structure

- Organic materials, especially microbial cells and waste products, act to cement aggregates and thus to **increase their strength**.

- Crop residue mulch, in situ or brought in, also improves soils structure by **eliminating the raindrop impact** and enhancing activity of soil macrofauna. (The pen points to earthworm casts beneath the mulch layer.)

A multidisciplinary approach to soil structure



Structural Resilience

- The ability of soil structure to recover following a major disruption in the aggregation process is known as **Structural Resilience.**

- The **disruption** may be caused by **alterations** in land use, cultivation, or soil management practices that change the composition of cations on the exchange complex, decrease quantity and quality of the humus fraction, and reduce effectiveness of the biotic factors. Numerous soils exhibit **self mulching** properties.

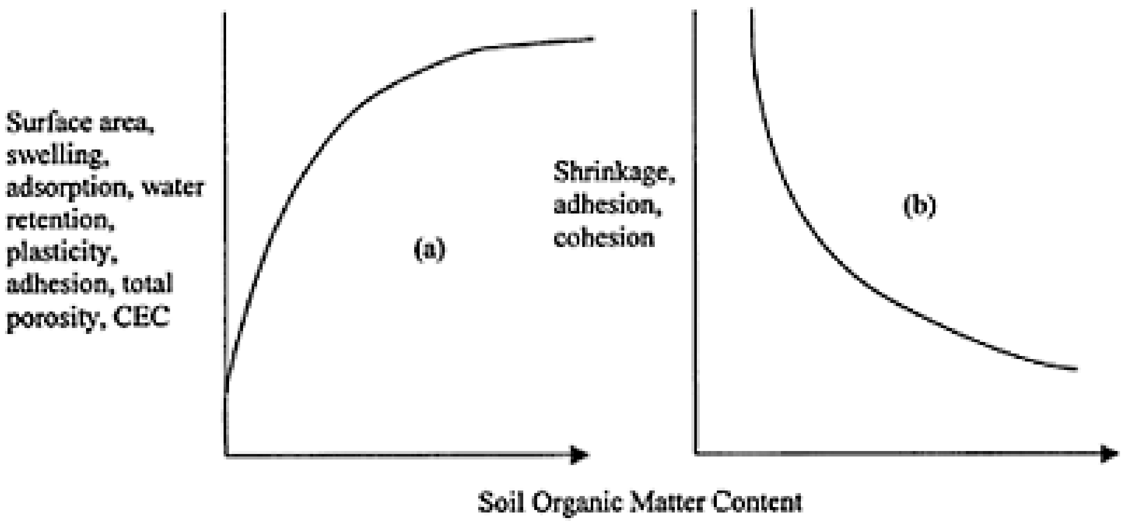
- Surface layer of some **Vertisols** and **Andisols** have **self mulching** characteristics with fine- to medium-crumb structure.

- In other soils, aggregation is restored only when taken out of cultivation and put under a restorative **fallow**.
- Inevitably, soils with structural resiliency are better suited for intensive management under different land uses than those that do not possess these characteristics.
- Structural resiliency depends on numerous factors including soil organic matter content, clay mineralogy, wettability characteristics, and biotic factors.
- **Root systems** and **canopy cover** have an important influence of soil structure.
- Grasses with their dense and fibrous root system and legumes with their deep tap roots have a profound effect on **aggregation** characteristics.
- It is because of these and other differences in legumes and cereals that crop rotations and farming systems have a profound effect on soil structure.
- **Crops** affect structural properties through their impacts on root biomass, amount and rate of water extraction from different depths, total biomass produced, and C:N ratio of the biomass that affects its persistence.
- From a long-term study in Ohio, Lal et al. (1990) observed that **relative aggregation** for different **crop rotations** was 1.00:1.66:2.1 for corn-oats-meadow, continuous corn, and corn-soybean.
- **Perennial forages / fodderings**, both legumes and grasses, improve soil structure (Wilson et al., 1947; Low, 1972; Lal et al., 1979; Lal, 1991).

Soil Organic Matter and essential elements, tillage, cropping systems and fertility

Relation of soil organic matter content with soil properties

Consequently, the organic fraction affects timing and nature of tillage, rate and type of fertilizers to be used, fate of pesticides, and transport of water and pollutants into the soil



***Tillage** is the agricultural preparation of soil by mechanical agitation of various types, such as digging, stirring, and overturning. Examples of human-powered tilling methods using hand tools include shoveling, picking, mattock work, hoeing, and raking. Depending upon the purpose or necessity, different types of tillage are carried out. They are **deep ploughing, subsoiling** and **year-round tillage**.*

Beneficial effects of organic fraction on plant growth and yield are also related to improvement in soil quality and decrease in susceptibility to degradative processes. With a strong interaction with texture and clay minerals, the organic fraction affects soil's susceptibility to erosion, compaction, and other degradative processes

Texture influences soil compaction through its effect on aggregation and porosity, absorption of water and other organic/inorganic compounds by altering surface area, water and nutrient storage through charge properties, transport of solute and gaseous exchange through porosity, etc.

Soil Properties and Processes Affected by Soil Organic Component

Soil properties	**Processes**
1. Color	-Heat absorption, warming
2. Surface area	-Adsorption, aggregation
3. Charge density	-Cation exchange, chelation, aggregation, buffering capacity
4. Porosity and pore size distribution	-Transport of solute and solids, leaching
5. Bulk density, particle density	-Compaction, erosion, bearing capacity
6. Gaseous composition of soil air	-Soil respiration, gaseous emission to the atmosphere
7. Microbial biomass and activity	-Mineralization, aggregation, soil respiration, nutrient immobilization

Tillage

- Structural effects of tillage depend on the type, frequency, and timing of tillage operation.
- The antecedent soil moisture content is an important parameter that affects structural properties, because it influences dispersibility of clay.
- Conservation tillage and mulch farming techniques are beneficial to aggregation and soil structure formation (Lal, 1989; Carter, 1994).
- Lal et al., (1994) reported that in Ohio, tillage effects on total aggregation and MWD were in the order of no tillage > chisel plowing > moldboard plowing.

- Agricultural practices that enhance biomass production have also favorable effects on aggregation and soil structural development.
- Use of **organic manures, compost**, and **mulches** improve **aggregation** (soil structure) more than chemical fertilizers (Tisdall et al., 1978).
- Decrease in soil pH due to chemical fertilizers may adversely affect aggregation, especially in soils of low activity clays.
- Otherwise, use of chemical fertilizers has beneficial effects on aggregation (Emmond, 1971; Hamblin, 1985).

Importance of Soil Organic Matter - case studies

Organic Matter and Soil Structure in the Everglades Agricultural Area[1]

A.L. Wright and E.A. Hanlon[2]

Introduction

This publication pertains to management of organic soils (Histosols) in the Everglades Agricultural Area (EAA). These former wetland soils are a major resource for efficient agricultural production and are important globally for their high organic matter content. Recognition of global warming has led to considerable interest in soils as a repository for carbon. Soils rich in organic matter essentially sequester or retain carbon in the profile and can contribute directly to keeping that sequestered carbon from entering the atmosphere. Identification and utilization of management practices that minimize the loss of carbon from organic soils to the atmosphere can minimize effects on global warming and increase the longevity of subsiding histosols for agricultural use. While farming is likely to continue within the EAA for several more decades (Snyder, 2005), some lands will likely be converted from intensive agriculture to other land uses, such as Stormwater Treatment Area wetlands. Understanding and predicting how these muck soils will respond to current and changing land uses will help to manage carbon loss to the atmosphere.

The objectives of this document are to:

a) Discuss organic soil oxidation relative to storing or releasing carbon and nitrogen
b) Evaluate effects of cultivation (compare structure for sugarcane vs. uncultivated soil)

c) Use this information to predict long-term outcomes for agricultural production and reclamation

The intended audience for this publication includes growers within the EAA, state and federal personnel dealing with organic soils in southern Florida, researchers working in soils and reclamation, and Certified Crop Advisers or other consultants making agricultural or environmental recommendations.

Organic matter in Histosols: origins and fate

The muck soils found throughout the EAA and southward through the Everglades formed under flooded conditions, primarily as wetlands dominated by sawgrass (*Cladium sp*). These wet condition preclude the decomposition of organic

Soil Conservation And Protection for Europe

Importance of soil organic matter for soil functions

Claire Chenu[1] and Michel Robert[2]

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[2] Ministère du développement Durable / INRA, Paris, France.
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Abstract

Soil organic matter (SOM) benefits, since a long time, of a positive perception. It is clearly associated with the concept of soil fertility and recently of soil quality. Organic matter, although it is a minor component of soil in quantitative terms, influences many soil properties, which in turn affects several soil functions.

Soil organic matter affects soil chemical properties, through its charge and diverse functional groups which can be involved in the retention of elements such as cations or substances, such as pesticides. The hydrophobicity of its humic substances explains the retention of apolar organic pollutants by SOM. Soil organic matter influences many soil physical properties: increases water retention, increases interparticle cohesion and thus aggregate stability, decreases compaction upon mechanical stresses, often increases soil aeration, protects soil surface from erosion, modifies soil albedo. It also has a major role on soil biological properties, being the source of elements and energy for all soil heterotrophs. Its decomposition and mineralisation sustains food webs, maintains biodiversity in soils, and ensures the recycling of C, N and other elements in terrestrial ecosystems. The heterogeneous and complex nature of SOM implies that different SOM fractions and constituents have different roles in soil.

Through their influence on soil properties, soil organic matter affects soil major functions: to sustain plant growth and food production (agronomical functions) as well as soil environmental functions which can be summarized as the maintenance of natural resources: ability to sustain very different organisms and indirectly to affect the habitats of soil organisms, also influences soils ecological functions.

Soil organic matter is thus a key constituent of soils. Although its importance has been recognised for a long time, it is not yet rationally managed in soils for its agronomic, environmental or ecological functions. Several milestones are needed for that which are far from being attained for all the roles of SOM. Quantitative relationships are needed between soil organic carbon contents of soils and the properties of interest (aggregate stability, CEC, N mineralisation, retention of

THE IMPORTANCE OF SOIL ORGANIC MATTER IN THE FERTILITY OF ORGANIC PRODUCTION SYSTEMS

William R. Horwath
Department of Land, Air and Water Resources
One Shields Ave., University of California, Davis, CA

ABSTRACT

The management of soil organic matter is critical to maintaining a productive organic farming system. Nutrient management in organic agriculture is an important consideration that impacts both yield and quality. Nutrient management is dependent on primarily organic amendments and biological N fixation. The greatest challenge to organic growers is to synchronize nutrient availability from diverse fertility sources to that of crop demand. This challenge can be met through organic matter management but requires an understanding of factors affecting soil organic matter maintenance and decomposition of the organic amendments. The successful management of soil fertility can often produce crop yields and quality equivalent to conventional agriculture. Examples of the influence of organic amendments on soil fertility in organic agriculture are taken from the Sustainable Agriculture Farming System project at the University of California Davis.

INTRODUCTION

The management of nutrients to maintain productivity and quality in organic farming systems is a challenge that must be met through a combination of organic amendments and management of soil organic matter (SOM). The management strategies often use N-fixing cover crops and organic amendments such as compost and manures. The optimal nutrient management strategy is to synchronize the release of nutrients with patterns of plant uptake and consequently minimize wastefulness and or non-synchronized nutrient release. In organic systems, it is often the case that no one source of nutrients suffices to maintain productivity and quality control. In addition, the inputs to supplement nutrient availability are often not uniform presenting additional challenges in meeting the nutrient requirement of crops in organic systems. For these reasons, organic agriculture can be substantially more challenging than conventionally based

NRCS Natural Resources Conservation Service

Importance of Soil Organic Matter
Soil Quality = S. O.M.

Agricultural and Environmental perspective

Ben Schmidt

Assistant Director - Operations

Pacific Islands Area