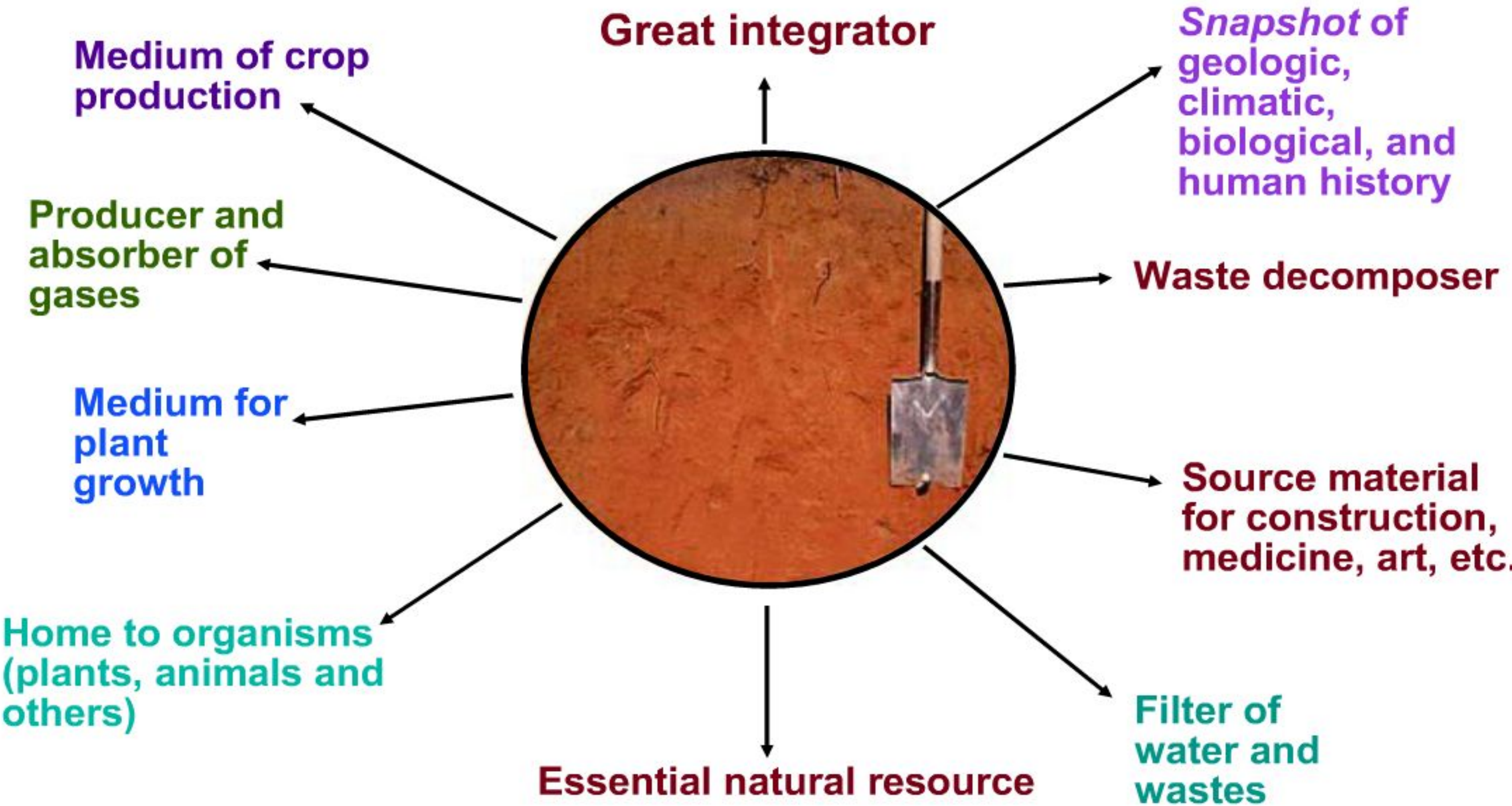
A STUDY OF SOIL SCIENCE

- Historical-Curiosity about soil existed since 70BC
- Philosophic observations have been documented by Indian, German, Russian, French, British and American scientists
- Wilde has written one of the most comprehensive book on Forest Soil

Why are soils important?



Some useful books

- Nature and Properties of Soil by Brady
- Fundamentals of Soil Science by Miller, Turk and Foth
- Forest Soil by Wilde
- Soil :Plant Relationship by C. A. Black
- Soil Conditions and Plant Growth by E.W.Russel

- Soils of India by Ray Chawdhary
- Soils of India by Govindarajan and G.Rao
- Handbook of Agriculture ICAR
- Handbook of Manure & Fertilizer ICAR
- Handbook of Afforestation by R.C.Ghosh
- Forest Types of India by Champion & Seth
- Silvicultural Systems by Champion & Seth

Definitions

- A 3 dimensional heterogeneous body develops naturally by the action of natural forces acting on natural material and under suitable physical,chemical and biological conditions is able to support plant growth.

- Forest soil is that portion of the earth surface which serves as a medium of growth of vegetation.The main constituents of soil are mineral and organic matter which with the passage of time are permeated by varying amounts of water and air and the soil as a whole serves as habitat for organisms.The peculiarities in the soil develops from the influence of pedogenetic factors

- And in the case of forest soil the effect is mainly due to:
- Forest Litter
- Tree Roots and
- Organisms which influence the properties of forest soil

Objectives of Study of Forest Soil

- Maintenance of Nursery Soil Fertility and control of unfavourable factors such as diseases, pestilence and nutrient deficiency etc
- Selection of site for optimising production
- Diagnosis of adverse factors responsible for poor performance of trees and their control
- Effect of silviculture treatments on soil

- Relationship of new/improvised management techniques with the productive potential of soil
- Carbon sequestration by forest soil as a part of mitigation strategy to stabilise climate change
- Management of polluted soil

Range of Forest Soil

- Forest growth is supported by soil ranging from sheer rock outcrops to some of the deepest soils in the world
- Extreme conditions support forest vegetation consisting of struggling stands to a very rich and productive stands

- Root system assumes a very special significance in forest-nutrient mining from various depths, water uptake from deeper layers,anchorage to loftiest trees,creating favourable air:water balance and building up of mycorrhizal fungi association for mineralising nutrients

Forest and Farm Soil

- Forest soil is more naturalised growth medium for vegetation and represents true signature of soil forming factors
- Farm soil is manipulated growth system for a select species of plants
- Forest soil is much less explored and studied than farm soil

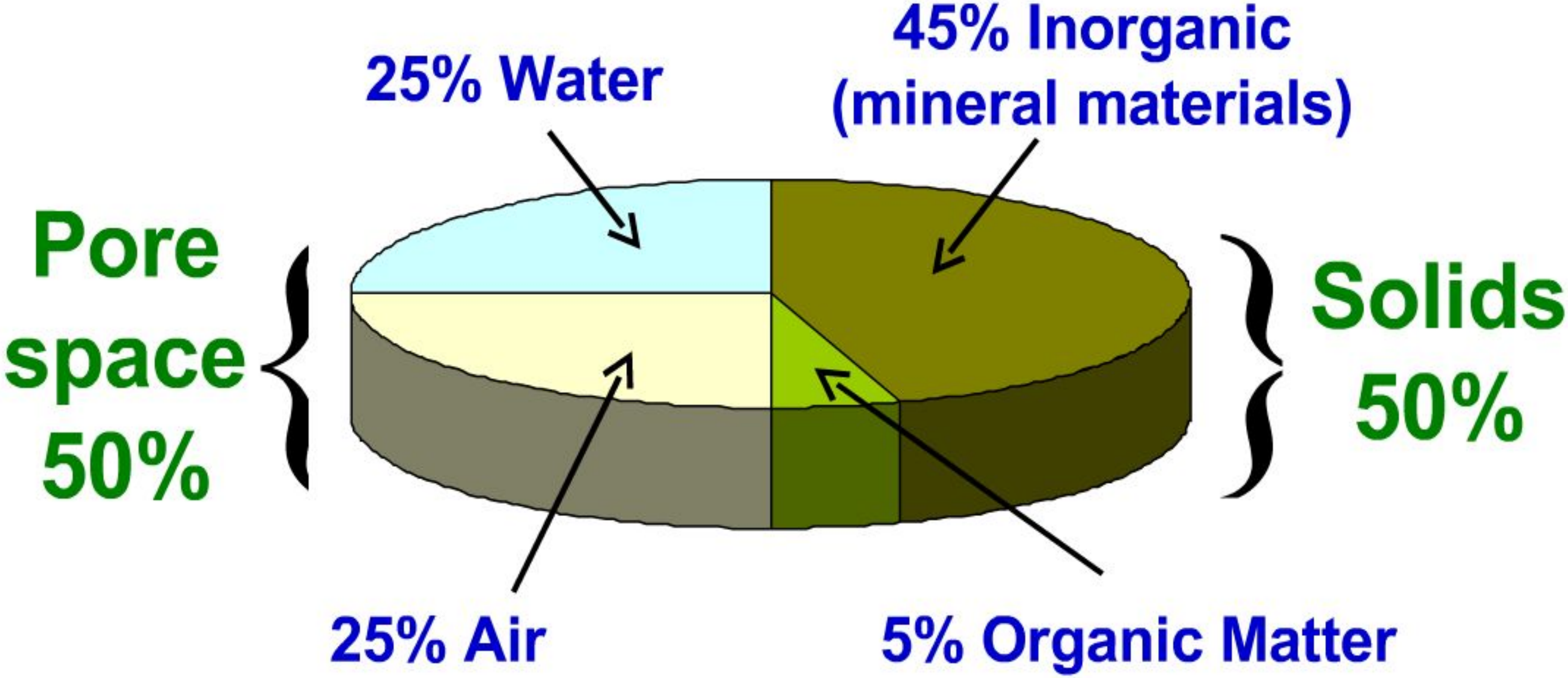
Soil as a part of Site

- Knowledge of a site is crucial for initiating any investment in forestry
- There could be as many as 100 factors of importance to assess a site
- Soil acts as one of the most important factor in site selection because of multidimensional nature and function

Main Constituents of Soil

- Mineral fraction consisting of primary and secondary minerals at various stages of disintegration and physico-chemical and electrical behaviour,and
- Organic fraction consisting of material derived from faunal and floral sources ,in various stages of decomposition ,size fraction determining its physical-chemical and electrical behaviour
- This is called ‘clay-humus complex’ or ‘colloidal complex’

Average Soil Composition



Development of Soil

- Development of a soil profile
- Profile helps understanding of morphological development and classification
- It helps in assessment of soil potential for biomass productivity
- Constant impact of soil forming factors and capacity of soil to restitute

Soil Profile

- Weathering and soil forming factors are always impacting soil development
- Permeation of water and air over a long passage of time creates horizontal layering in a column of soil material(called horizons)
- Horizons are created due to movement of particulate matter down the depth
- Differentiation in physico-chemical and biological behaviour and function occurs down the depth

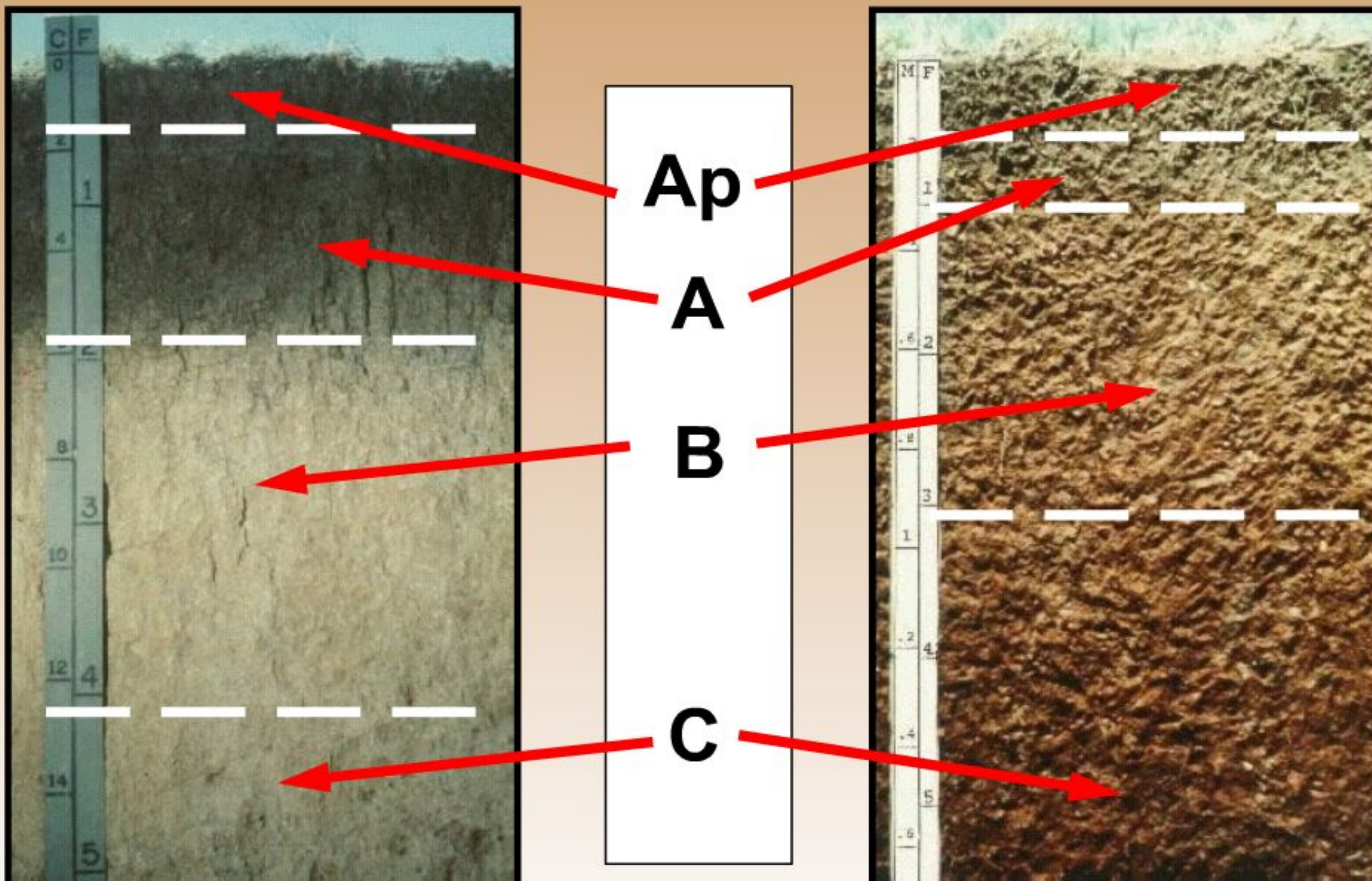
- Most of the chemical,biochemical and microbiological activities occur in response to the oxygen status of soil profile
- Though anaerobic activities are also in evidence,they are less preponderant and less efficient for tree nutrition
- Swamps and mangrove forest show submerged profile features

Soil Profile

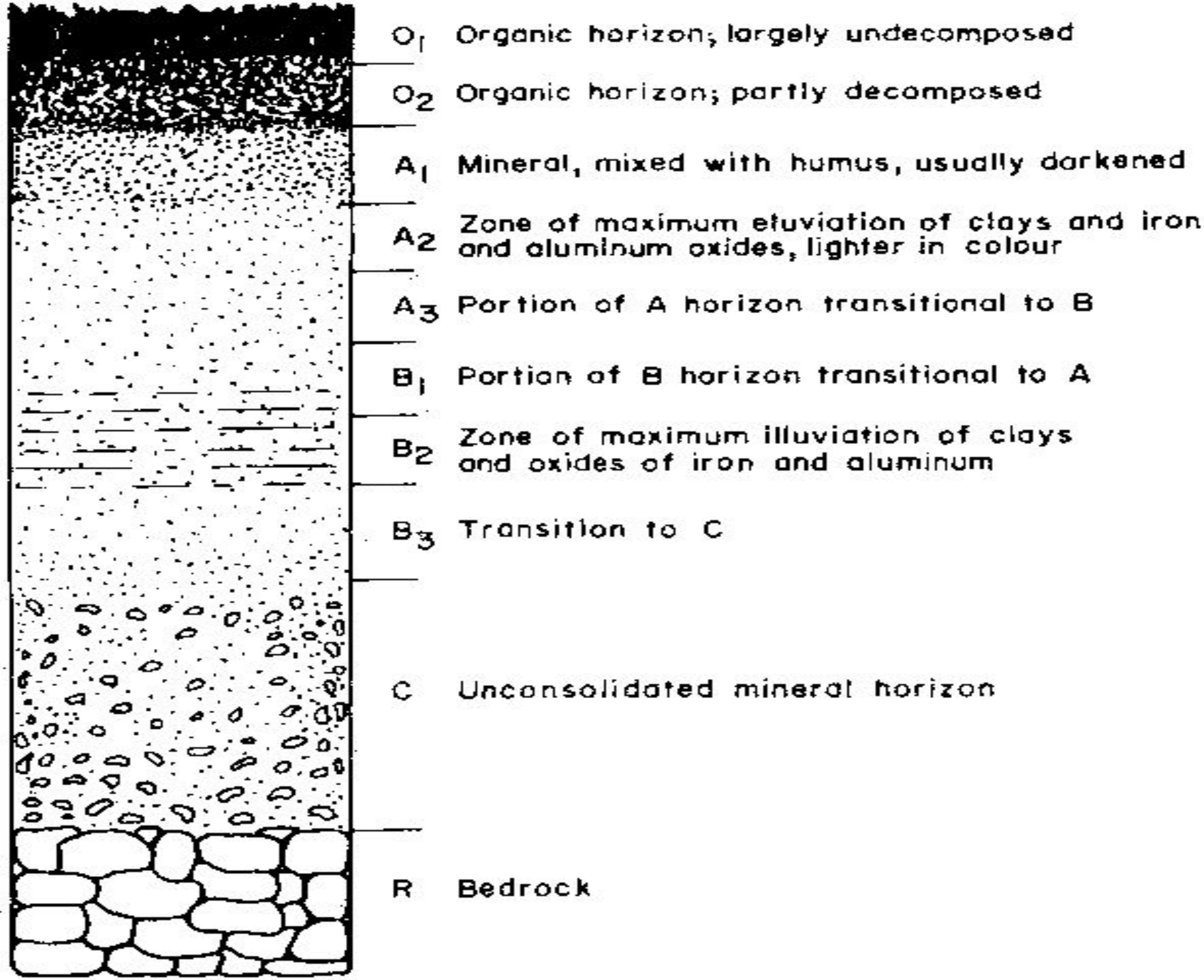
What do we see?

- organic matter - surface soil is darker due to organic matter
- iron oxides - subsoil has brighter browns and tans due to iron oxides
- drainage
- horizons - layers of different color or texture; formed from the top down

. . . more on Soil Horizons



Mollisol **Alfisol**



O1 Organic horizon; largely undecomposed
O2 Organic horizon; partly decomposed
A1 Mineral, mixed with humus, usually darkened
A2 Zone of maximum eluviation of clays and iron and aluminum oxides, lighter in colour
A3 Portion of A horizon transitional to B
B1 Portion of B horizon transitional to A
B2 Zone of maximum illuviation of clays and oxides of iron and aluminum
B3 Transition to C
C Unconsolidated mineral horizon
R Bedrock

Physical properties of soil

- Soil is composed of solid, liquid and gas
- Size fractions of solids impart a specific behavioural pattern
- Movement and retention of water in the soil regulates moisture and temperature in the soil profile
- The voids vacated by water are filled with gases

- The soil gases are in constant exchange with atmospheric gases
- Composition of soil air is different from atmospheric air
- Presence of microorganisms in soil and root respiration influences soil air composition

- Basic soil particle size classes are sand ,silt and clay
- Distribution of these size classes in a given soil determines its Texture
- Relative abundance of these mechanical seperates in a soil can be put in a separate textural class

Sand

- Feels gritty
- Considered non-cohesive – does not stick together in a mass unless it is very wet.

Silt

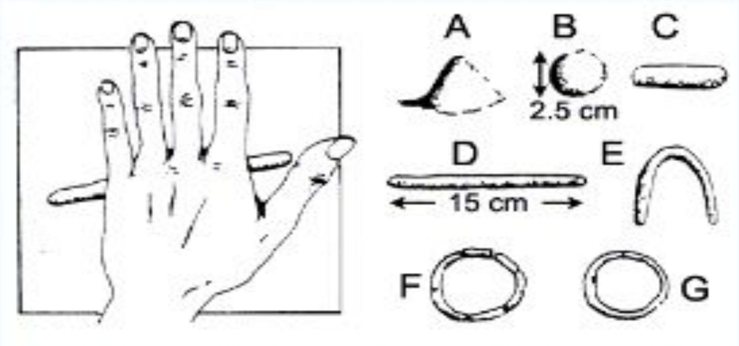
- Does not feel gritty
- Floury feel -smooth like silly putty

Clay

- Wet clay is very sticky and is plastic or it can be molded readily into a shape or rod.
- Easily formed into long ribbons

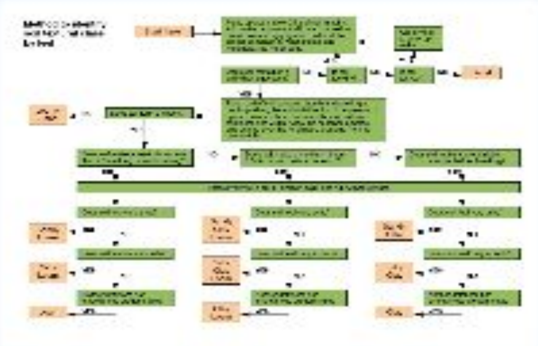
Sand (A)*	Soil remains loose and single-grained; can only be heaped into a pyramid.
Loamy sand (B)	The soil contains sufficient silt and clay to become somewhat cohesive; can be shaped into a ball that easily falls apart.
Silt loam (C)	Same as for loamy sand but can be shaped by rolling into a short, thick cylinder.
Loam (D)	About equal sand, silt, and clay means the soil can be rolled into a cylinder about 15 cm long that breaks when bent.
Clay loam (E)	As for loam, although soil can be bent into a U, but no further, without being broken.
Light clay (F)	Soil can be bent into a circle that shows cracks.
Heavy clay (G)	Soil can be bent into a circle without showing cracks.
	* The letter in brackets refers to the corresponding image in Figure 1 below.

Figure 1. Determining soil textural class by forming shapes with the soil.

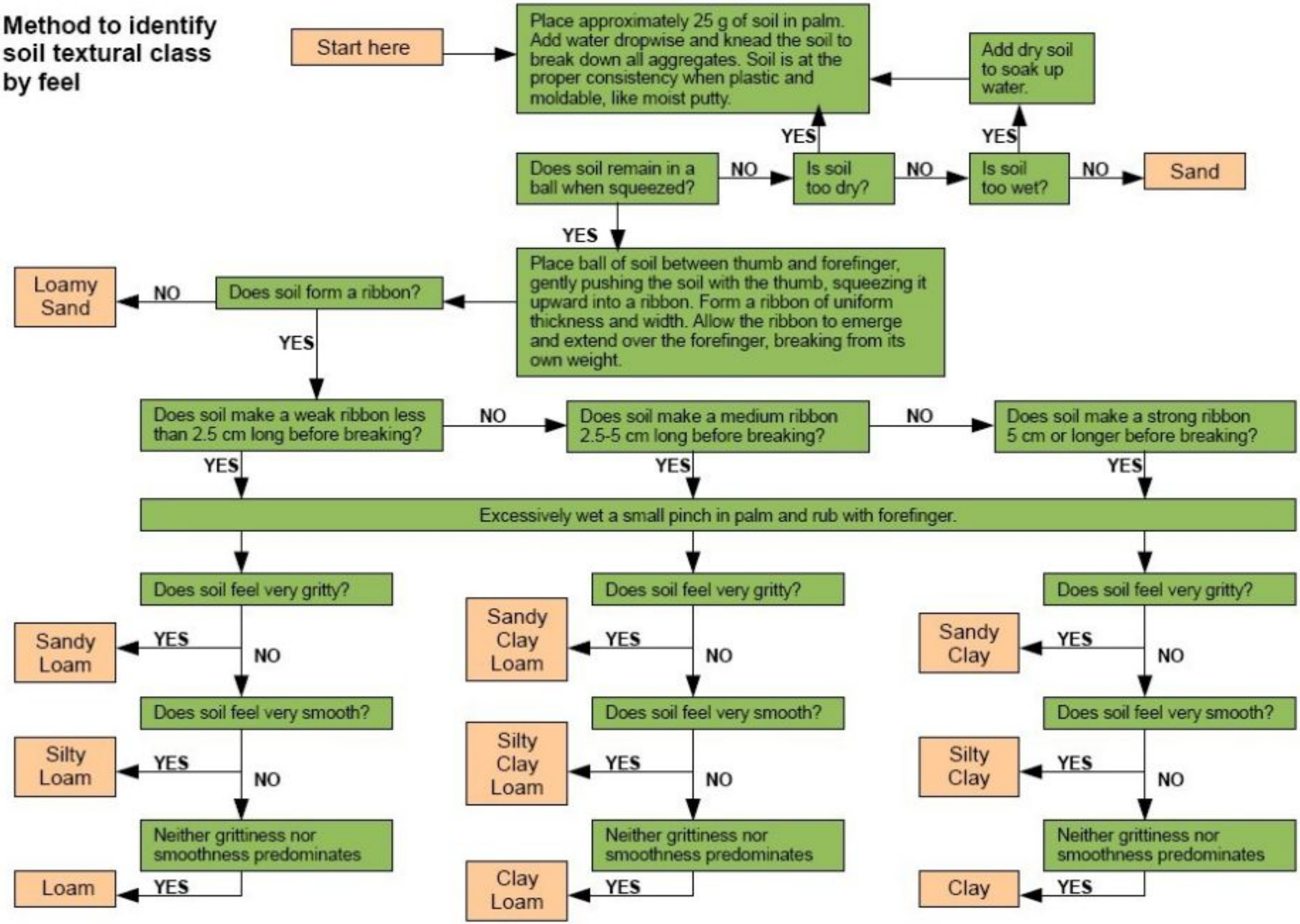


(Method and drawings after Ilaco (1985))

Figure 2. Method to identify soil textural class based upon feel.



Method to identify soil textural class by feel



Soil Texture

- **Determined by the relative proportion of sand, silt and clay**

	Surface Area	Charge
Sand	50 cm^2/g	none
Silt	500 cm^2/g	none
Clay	5,000,000 cm^2/g	negative

Relative Size Comparison of Soil Particles

barrel

Sand
- feels gritty
(2.00 - 0.05 mm)

plate

Silt
- feels floury
(0.05 - 0.002 mm)

coin

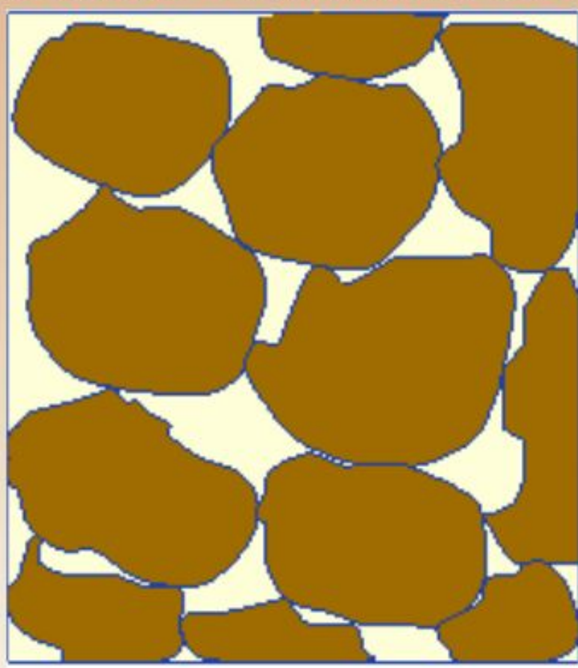
Clay
- feels sticky
(< 0.002 mm)

USDA system for determining soil separates

Texture and Pore Space

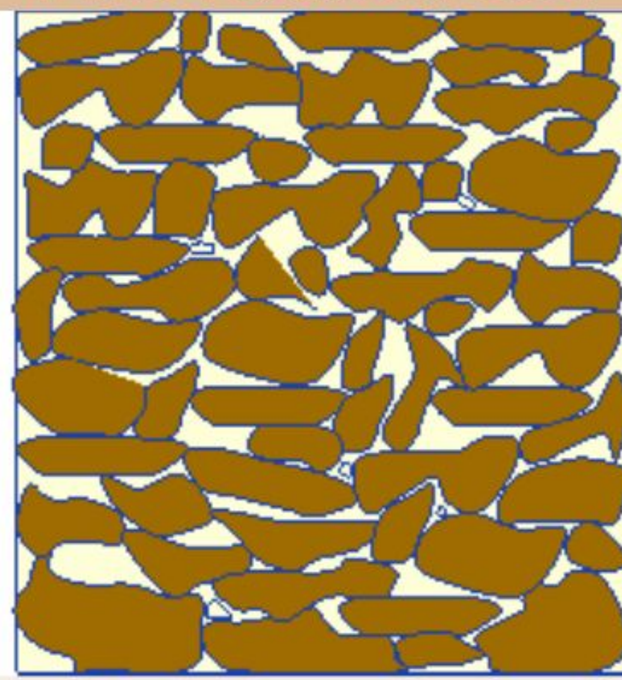
Comparison of Coarse Textured and Fine Textured Soils

Coarse Textured Soil



Less porespace but more macropores

Fine Textured Soil



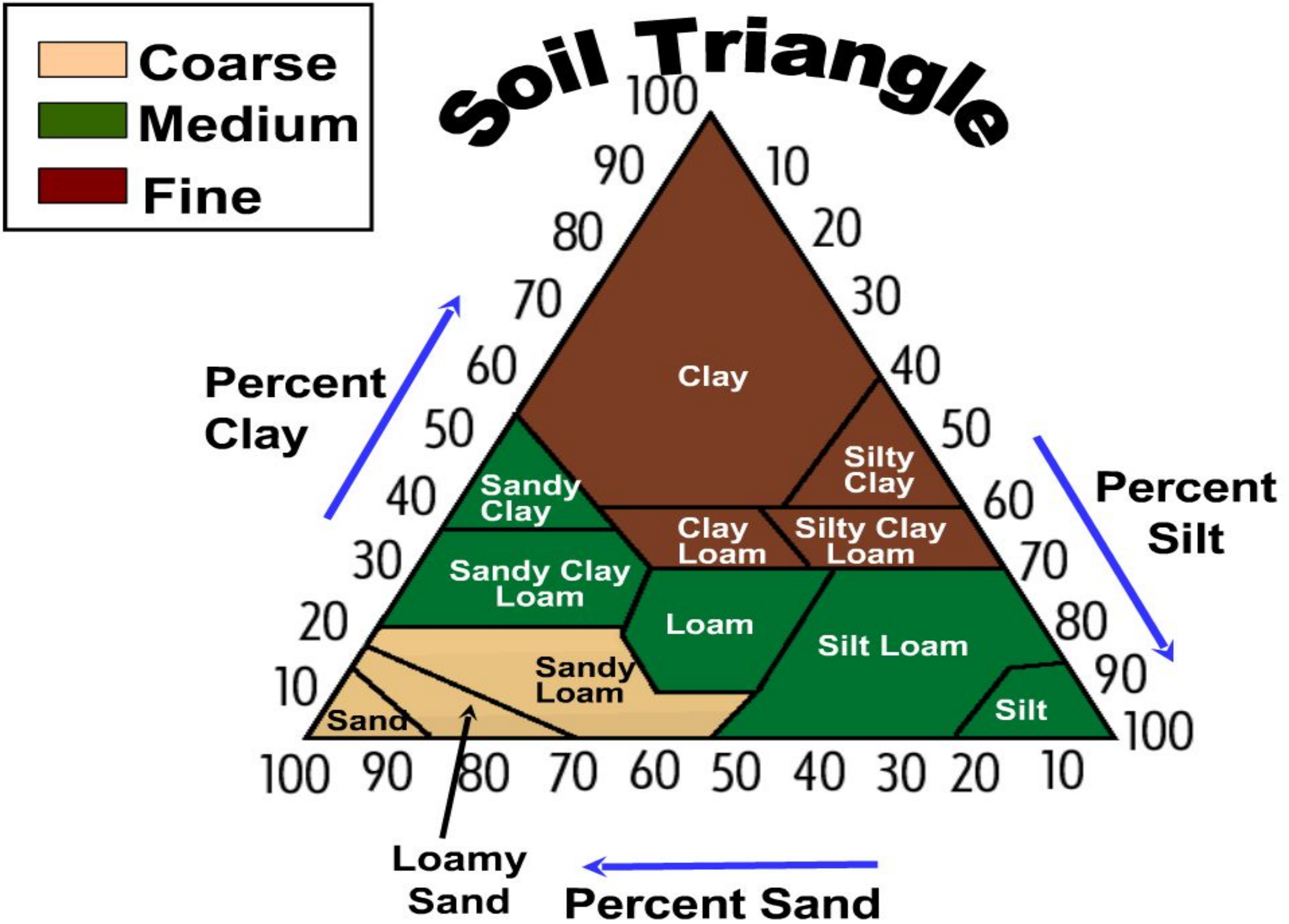
More total porespace

Table 3.1: The International Soil Science Society (ISSS) Classification of Soil particles

separate	Particle diameter	
	mm	µm
Coarse sand	2.0-0.2	2000-200
Fine sand	0.2-0.02	200-20
Silt	0.02-0.002	20-2
Clay	<0.002	< 2

Table 3.2: The USDA Classification System of Soil Particle

Separate	**Particle Diameter**	
	mm	**µm**
Very coarse sand	2.0-1.0	2000-1000
Coarse sand	1.0-0.5	1000-500
Medium sand	0.5-0.25	500-250
Fine sand	0.25-0.10	250-100
Very fine sand	0.10-0.05	100-50
Silt	0.05-0.002	50-2
Clay	<0.002	<2



Soil Triangle
Coarse
Medium
Fine
Percent Clay
Percent Silt
Percent Sand
Clay
Silty Clay
Sandy Clay
Clay Loam
Silty Clay Loam
Sandy Clay Loam
Loam
Silt Loam
Sandy Loam
Silt
Sand
Loamy Sand
100
90
80
70
60
50
40
30
20
10

- There are seven textural classes showing relative abundance of sand, silt and clay
- Knowledge of soil textural classes is essential to anticipate the likely behaviour of soil for a successful establishment of plant
- Generally, fine textured soil are more suitable for raising heavy timber species

- Light or loose texture soils are more suitable for short rotation soft /hard wood species
- Medium texture soils are suitable for a wide range of species
- Soil texture must be tested before launching any planned land use

- Arrangement of soil particles in a given soil gives it a typical Structure
- Activities of microbes,organic matter,roots,clay,soluble salts,iron and calcium play important role in determining structure
- Wetting and drying cycle are crucial apart from above factors

- Soil seperates aggregate due to the effect of these factors and arrangement of these aggregates defines structure
- Structure can be water stable or unstable
- Proportion of water stable aggregates in a soil decides stability of structure

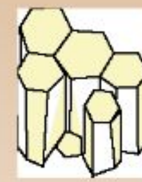
- Vertical,horizontal and three dimensional orientation of aggregates determines pattern of structure
- Typical soil structure patterns are Platy,Prismatic,Blocky,Spheroidal
- Aggregate orientation is more on horizontal axis in platy structure
- It is flaky when thin and platy when thick

Common Types of Soil Structure

Granular — Plow layer

Platy

Prismatic



Columnar

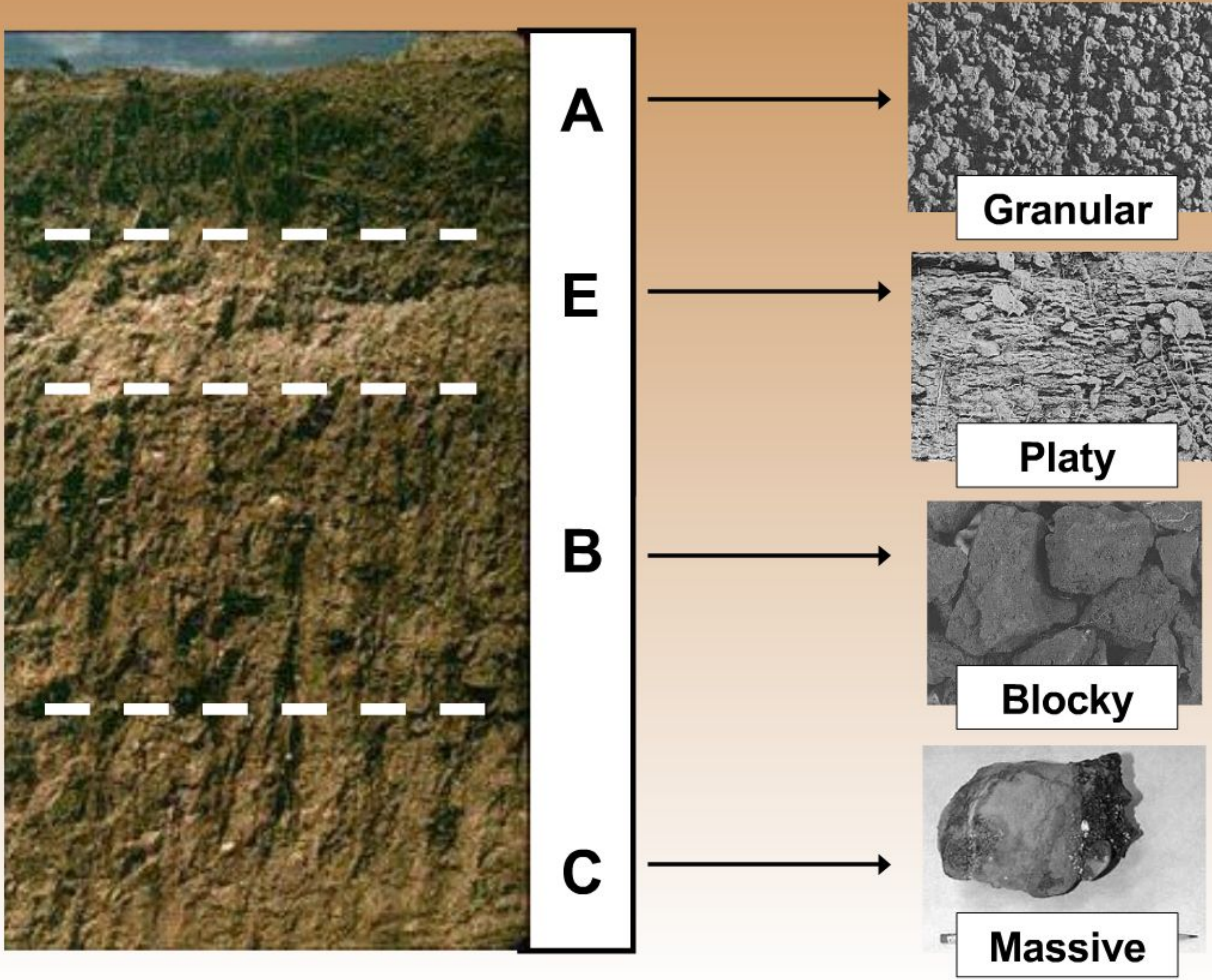
Blocky — Common to Ohio soils just below Ap (> 8")

Single Grain — Sand

Massive — Deeper in profile (>3-4')


GRANULAR


BLOCKY


A
E
B
C
Granular
Platy
Blocky
Massive

- This structure does not allow free flow of water down the profile and causes drainage problems
- Aggregate orientation is more on vertical axis in columner structure
- Columns with round tops are called columner and columns with flat tops, forming honey comb, are called prismatic structure
- This structure is found in arid and semiarid areas

- When orientation is more or less equal on both axes,it gives rise to blocky structure
- This structure is found in humid areas in soils rich in clay
- When edges are sharp,it is called angular blocky.When edges are blunt,it is called sb-angular blocky

- Spheroidal structure has aggregate orientation, more or less the same, in all the three axes
- This structure is called granular in normal conditions and crumb when the soil is ploughed to obtain a good tilth
- Spheroidal structure is ideal for good germination and growth of plants

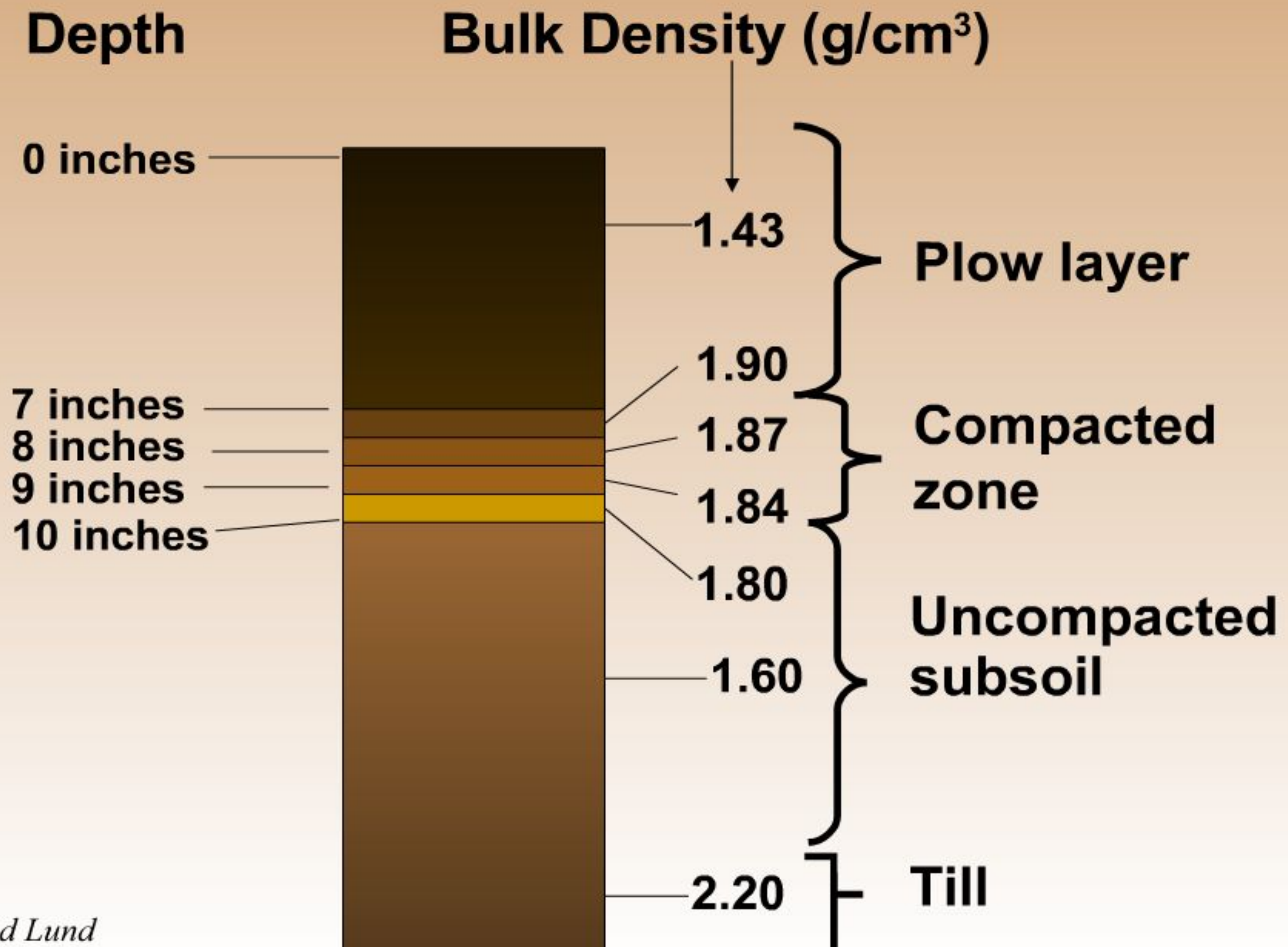
- Granular structure is porous and Crumb structure is very porous

- Soil density is its mass per unit volume
- There are two terms-particle density and bulk density
- Particle density refers to soil solids and is accumulative densities of individual organic and inorganic particles

Some Common Bulk Densities

- **Uncultivated/undisturbed woodlots**
  - **1.0 to 1.2 g/cm^3**
- **Cultivated clay and silt loams**
  - **1.1 to 1.5 g/cm^3**
- **Cultivated sandy loams**
  - **1.3 to 1.7 g/cm^3**
- **Compacted glacial till**
  - **1.9 to 2.2 g/cm^3**
- **Concrete**
  - **2.4 g/cm^3**

Bulk Density and Compaction



Data from Camp and Lund

- Generally we assume a particle density of 2.65 g/cc for normal soils
- Oven dry mass per unit volume of soil inclusive of pore space is called Bulk Density
- Bulk density is less than particle density
- 1.7g/cc is a typical value of a soil well supplied with organic matter

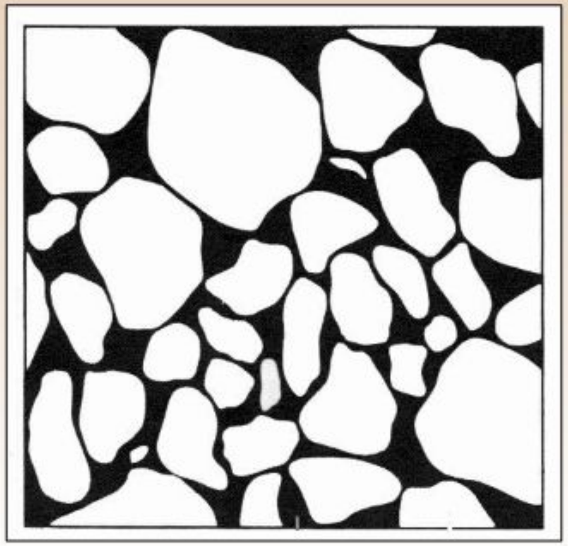
- Bulk density can be as low as 0.5g/cc in organic soils

- Packing of soil particles leave voids which are filled with either air or water
- The volume occupied by voids or pores expressed as percentage is called porosity
- Pore space increases with fineness of soil

- Thus,sandy soil has less pore space than clay soil
- There are two types of pores- macropores and micropores
- These pores regulate air and water movement in soil
- Any working with the soil which reduces aggregation or organic matter reduces porosity

Influences of Soil Texture, Soil Structure and Density

1) Water movement
2) Water retention
3) Soil temperature
4) Gas exchange
5) Erosion potential
6) Fertility



- Soil Consistence is the physical condition of the soil at various moisture contents as evidenced by their mechanical behaviour
- The consistence can be loose, friable, firm ,soft, harsh, plastic and sticky
- Swelling & Shrinkage is a property more frquently shown by clay soils
- There is an increase in volume on addition of moisture and a decrease when soil dries up

Chemical Properties of Soil

- Colloids present in soil govern the chemical behaviour in a major way
- Soil colloids also demonstrate all the typical properties of colloids
- These properties are,

1. Adsorption
2. Electrical charge
3. Coagulation
4. Tyndal effect

5. Brownian movement
6. Dialysis

Mineral colloids are derived from transformation of primary minerals to secondary minerals such as ‘clays’

Organic colloids are derived from fully decomposed organic matter called ‘humus’

- Clay and Humus in the soil are present as a complex called ‘Clay:Humus Complex”
- This complex mainly regulates ‘ion exchange’ in the soil through which soil fertility is maintained

- Soil develops colour due to different factors
- Many soils are associated with their colour e.g. black soil, red and yellow soil ,grey hydromorphs
- Parent material, organic matter, iron compounds, silica, lime,influence soil colour

Soil Color

Color is the most obvious characteristic of soil.

Soil color is influenced by the oxidation state of iron and manganese.

What are some colors encouraged by well aerated conditions?

RED BROWN YELLOW

What are some colors encouraged by poorly aerated conditions?

GRAY BLUE

Soil Color, Soil Aeration or Drainage, and the Oxidation State of Iron

POOR AERATION

1. Iron is reduced
2. Fe^{++}
3. dull colors (grays, blue)
4. poorly drained

GOOD AERATION

1. Iron is oxidized
2. Fe^{+++}
3. bright colors (yellows, browns)
4. well drained

Soil Color Tells A Story

Drainage on this farm?

Well Drained | **Poorly Drained**

- Soil colour can be studies by evaluation of * Hue-indicates its relation to red, yellow, green, blue and purple
- * Value-indicate its lightness,
- * Chroma- indicates its strength
- There is a soil colour chart developed by Munsel Colour Co.,USA.Thus a chart reading of Red=2.5YR5/6 shows 2.5YR is Hue,5 is Value and 6 is Chroma

- Soil Temperature is the measure of heat retained in the soil.It is measured by thermometer or a probe.
- The primary source of heat is the Sun. Heat produced during microbial or root activity is very marginal and can be neglected.
- Heat produced from inner core of earth is episodic, localised and does impact soil properties

- There is a daily movement of heat in the soil profile
- Soil heat is affected by soil colour, moisture, organic matter
- Soil Water is one of the most important phenomenon in soil: plant relationship whether it is natural or artificially developed culture

- Water plays a variety of functions in soil and plant life
- It acts as a solvent and carrier of nutrient elements in soil
- Water can trigger soil erosion
- There are few terms associatd with soil:water phenomena

- Infiltration-downward entry of water from above ground into the soil
- Percolation-Movement of water through soil profile under saturated or near saturated condition
- Permeability-Relative ease with which water moves in the soil

- Soil texture and structure influence movement of water
- Water is held by soil particles on its surface in the form of a film
- The thickness of this film depends on amount of water and fineness of particle
- Retention and release of water is crucial to availability of water to plants

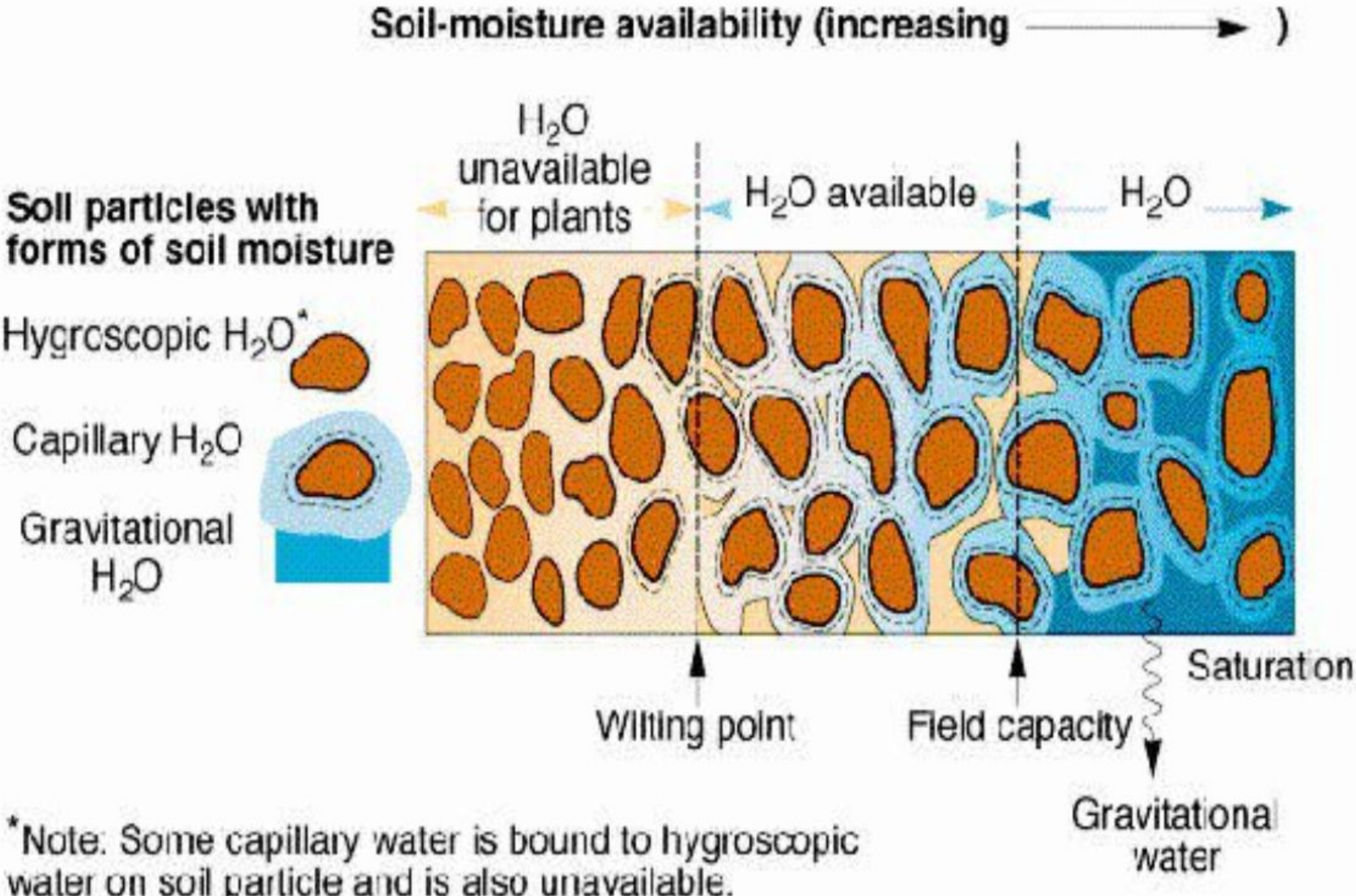
- Soil is saturated when macro- and micro-pores are filled with water and the soil is at its ‘maximum water holding capacity’
- When macro-pores loose all their water under the force of gravity, the soil is at its’field capacity’.The tension measured at this point is 1/3rd atm.
- Plants prefer this level of moisture for best growth performance

Available Water Holding Capacity

Texture	Storage capacity (in./ft.)
Silty clay loam	1.8
Clay loam	1.8
Silt loam	2.0
Silty clay	1.6
Sandy loam	1.4

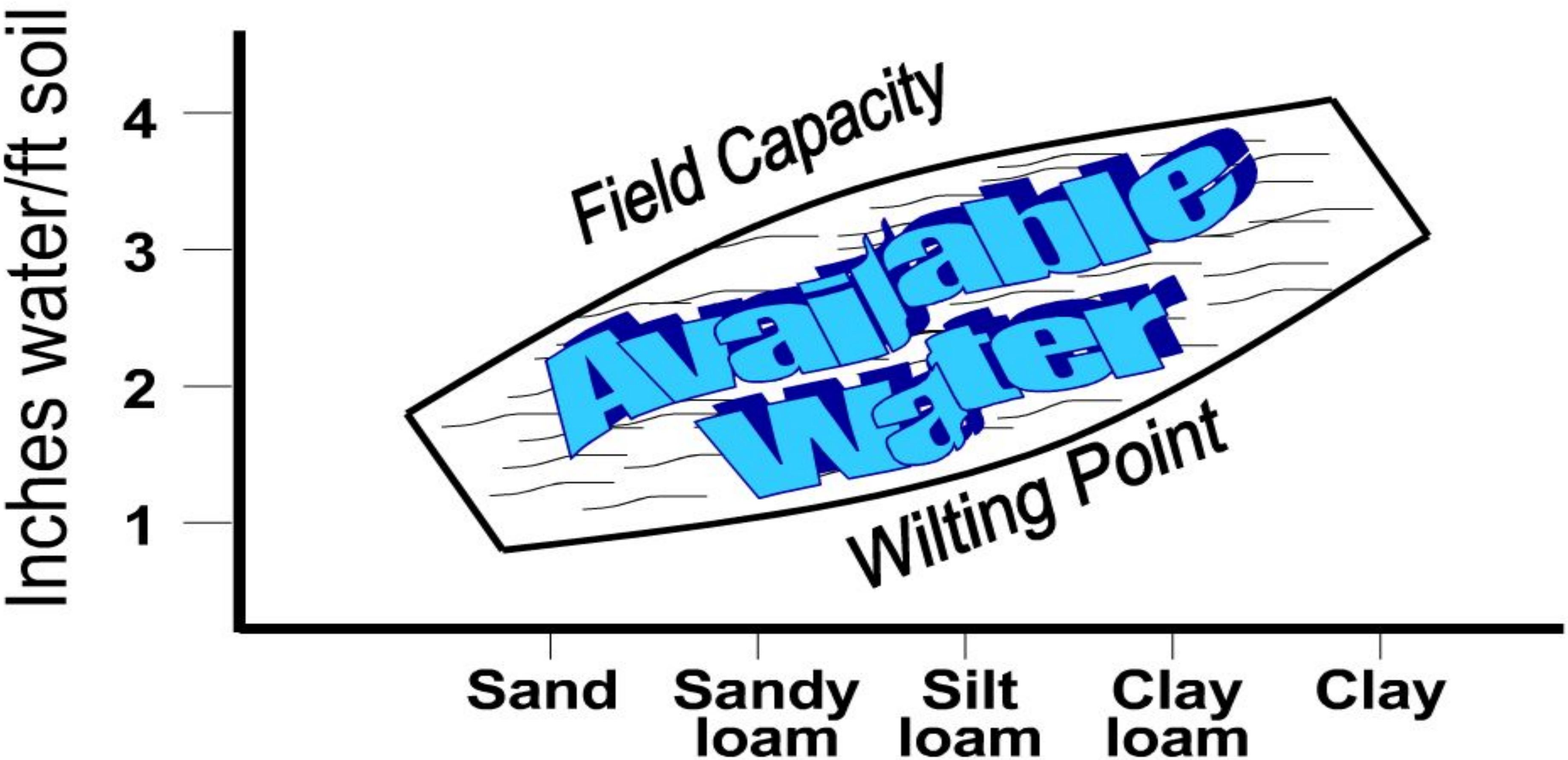
- Soil moisture level at which plants show symptoms of permanent wilting is known as ‘wilting point’ moisture. Moisture in soil is held at 15 atms. at this point
- The moisture content in soil between field capacity and wilting point is called ’Available Water Capacity’
- In terms of tension it is the moisture between 1/3rd and 15 atms.

- Classes of soil moisture-it is based on tension with which water is held by soil particles
- Almost ‘no’ tension-Max. Water Holding Capacity
- !/3rd atm.-Field Capacity
- 15atms.-Wilting Point
- 31atms.-Hygroscopic moisture



Soil-moisture availability (increasing)
Soil particles with forms of soil moisture
Hygroscopic H_2O*
Capillary H_2O
Gravitational H_2O
H_2O unavailable for plants
H_2O available
H_2O
Wilting point
Field capacity
Saturation
Gravitational water
*Note: Some capillary water is bound to hygroscopic water on soil particle and is also unavailable.

Plant Available Water



- 1000atms.-Air dry soil
- 10,000atms.Oven dry soil
- Measurement of Soil Moisture:

1. Gravimetric
2. Equillibrium tension-use of tensiometers
3. Pressure plate method-can measure upto 15atms.

4. Electrical Conductivity-Gypsum blocks set up
5. Heat Conductivity-flow of heat as a function of moisture
6. Neutron Scattering Probe-Attenuation of neutrons by protons or ‘H’ in soil
7. Multi Channel moisture probe

Chemical Properties of Soil(contd.)

- Inorganic and Organic soil colloids mainly contribute to chemical behaviour of soil
- Clay forms inorganic and Humus forms organic colloids in the soil
- The two are complexed and called ‘clay:Humus Complex’
- Some hydroxides of Fe,Mn,Al etc.are also present in soil besides clay

- Soil clay are crystalline and mainly composed of Si and Al in the form of lattices
- There are Si:Al or 1:1 type and Si:Al:Si or 2:1 type of clays
- These play distinctively different role in soil chemical behaviour

Cation Exchange Capacity (CEC)

- ✓ **Ability of a soil to hold and exchange cations**
  - Ions are atoms with an electrical charge

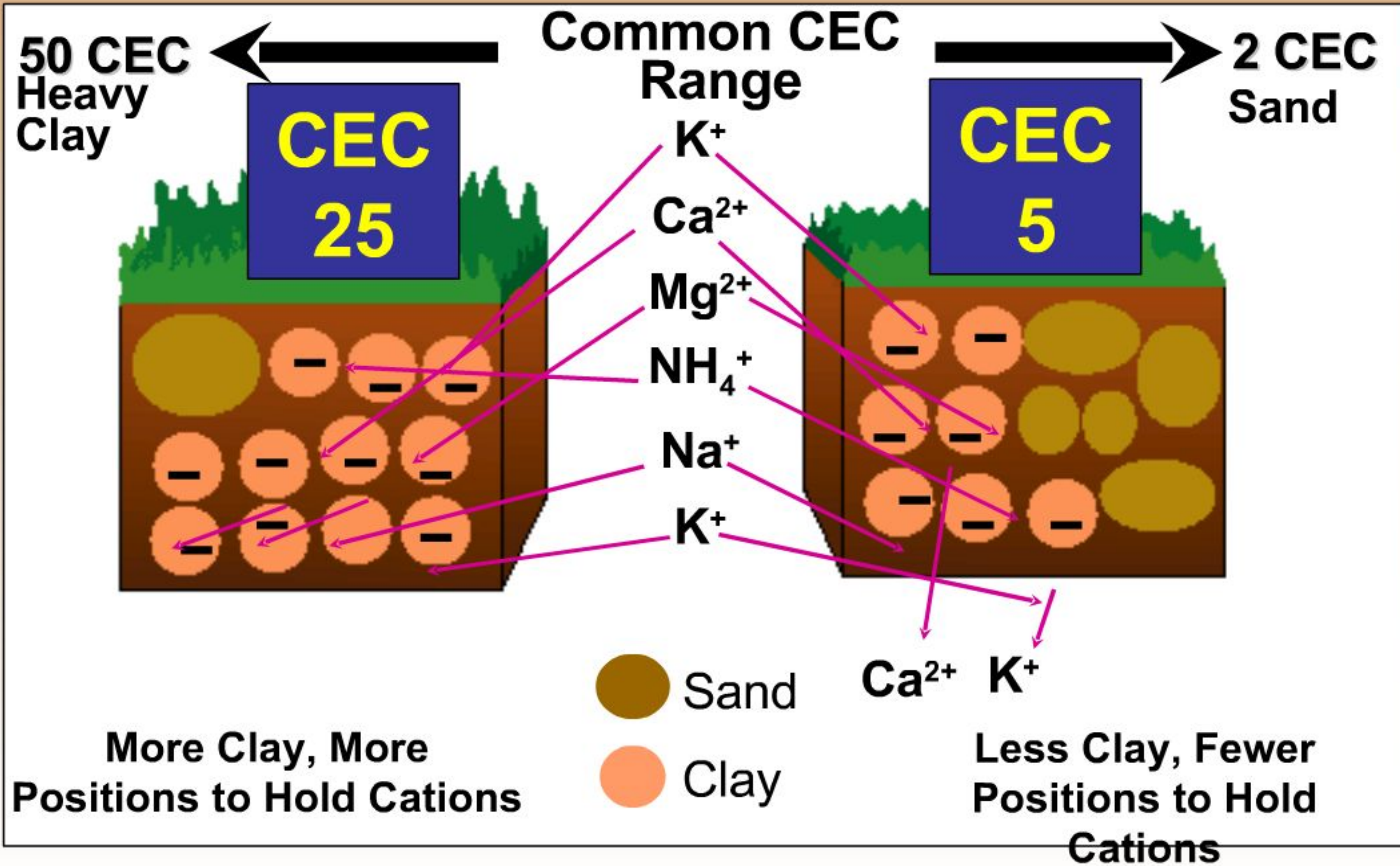
Cations	**Anions**
Ca^{2+}, Mg^{2+}	SO_4^{2-}, PO_4^{3-}
Na^{+}, K^{+}	Cl^{-}, NO_3^{-}

- ✓ **Negatively charged colloids (organic matter and clay) attract and hold cations**

CEC of a soil is due to:

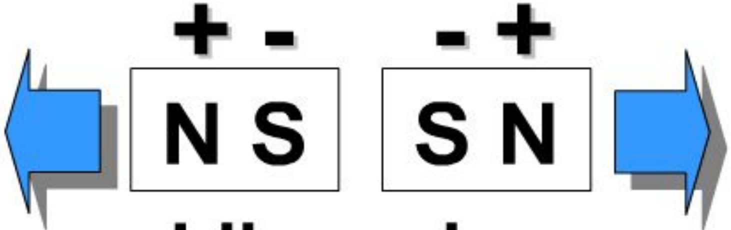
1) **Organic Matter Content**
2) **Clay Content**
3) **Type of Clay**
    1) Montmorillonite → high CEC
    2) Illite → mod. CEC
    3) Kaolinite → low CEC

Another Schematic Look at CEC

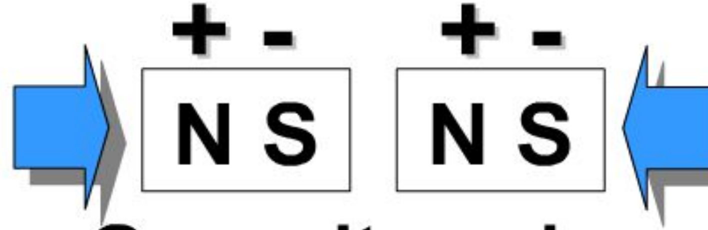


Some practical applications

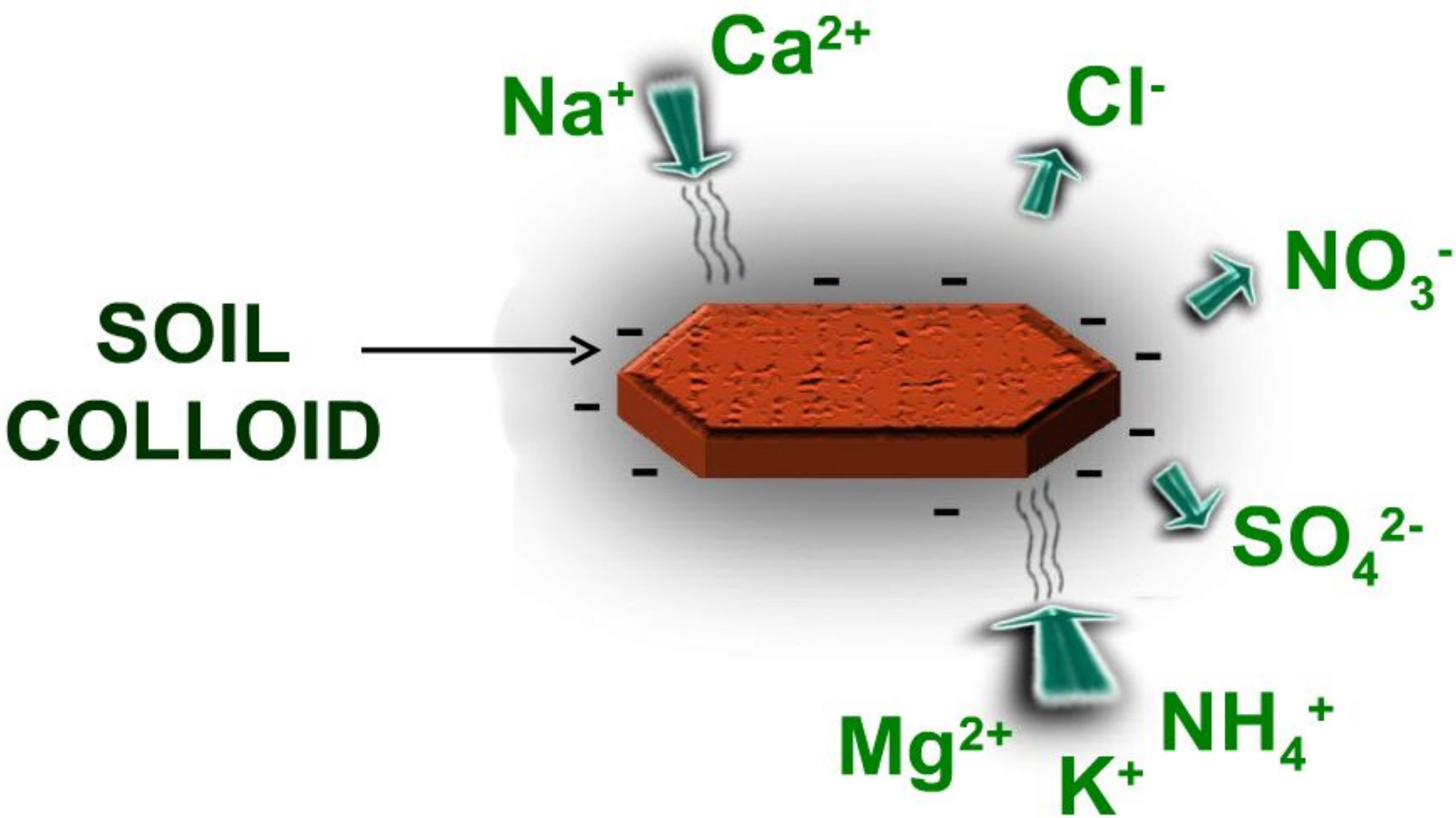
Soil CEC 11-50		Soil CEC 1-10
Higher clay content	Clay content	Lower clay content
Requires more lime to correct a given pH	Lime relationship	Requires less lime to correct a given pH
Greater capacity to hold nutrients	Nutrient relationship	Leaching more likely
Higher water holding capacity	Water Holding Capacity	Lower water holding capacity



Like poles (charges) repel



Opposite poles (charges) attract



- Humus is amorphous and is brownish black in colour
- Though it is derived from odorous material,it is free from odours
- Humus has considerable ion exchange capacity
- Clay:Humus complex is the seat of ion exchange in the soil

- Most of the ion exchange in soil takes place in the soil:water matrix which we term as soil solution
- Plant roots are present in this matrix and ion exchange between root surface and colloidal complex takes place continually
- The efficiency of this exchange depends upon the ion concentration,temperature,moisture etc.

- Ions are held at the soil surface at different tenacity
- Soils of arid,semi-arid and humid regions have different ionic composition at the exchange complex
- At the soil-water interface,transport(to and from),Adsorption-Desorption,Reaction are the mechanisms at play

- There is a dynamic equillibrium at work which controls the nutrient movement between soil and water interface
- This DE exists between reserved ions-exchangeable ions and available ions
- The direction of movement depends upon the ionic concentration,root demand etc.
- Available nutrient concentration is a measure of soil fertility

- Balance between nutrient inflows and outflows in the soil:plant nutrient system defines the trend of soil fertility
- A measure of ‘available nutrient store’in the soil at different points of time can give us an idea of fertilisation schedule for a plantation
- This information combined with soil moisture regime data can enable us to manage the field operations fairly efficiently

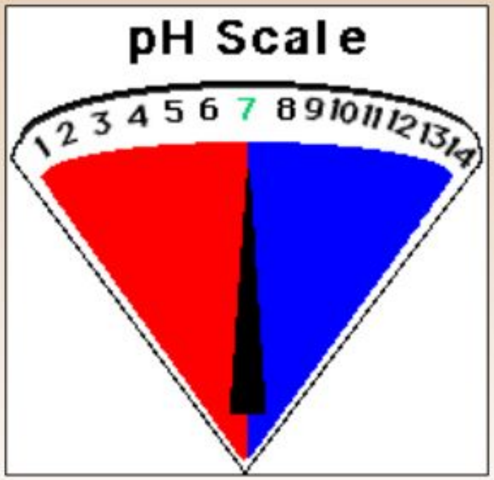
Soil pH - a "master variable"

- A measure of the hydrogen (H^+) ion activity

- One pH unit change = a ten fold change in acidity or alkalinity

Why called "master variable"?

- **soil pH controls:**
  1) *soil microbe activity*
  2) *nutrient exchanges*
  3) *nutrient availability*
  4) *gaseous exchanges*
  5) *chemical degradation*
  6) *CEC*



Factors Affecting Soil pH

- Parent Soil Material
- Precipitation
- Nitrogen Applications
- Cropping Sequence
- Organic Matter Breakdown

Press Esc to exit full screen mode.

- Soil pH is an extremely important property and gives us an understanding of soil behaviour
- A pH range of 6.5 to 7.5 is the most favourable for most of the plants
- It is very difficult to change soil pH due to buffering capacity in soil
- Some temporary change change be achieved by fertilisation and amendments

- Low soil pH is typical of humid areas and high soil pH is typical of arid and semi-arid areas
- Acid soils are improved by liming and high pH soils are improved by application of gypsum or other acidifying material

Mineral Nutrition of Plants

- There are 16 nutrients which fulfill the essentiality criteria
- They are C,H,O,N,P,K, (Macro), Ca,Mg,S (Secondary) and Fe,Zn,Cu,Mn,Mo,Cl and B (Micro)
- There are a few more elements which play important role in plant nutrition such as Na,Vn,Co,I,Si

- These nutrient elements have a specific role in the plant metabolism
- Absence of any of these nutrients produce deficiency symptoms in plant and growth suffers irreversibly if deficiency is not detected early
- Soil test for available nutrients,pH etc is very helpful to manage soil fertility for optimising biomass production

Soil-Vegetation Nutrient System

- Soil solution nutrient store has nutrients in a constant flux
- There are several factors which influence the S-V nutrient system
- Some factors are +ve and some are –ve
- Positive factors add to the nutrient store and negative factors deplete it

- The response of plant growth at any site is proportional to the enrichment of this store
- Therefore,if we log this soil solution nutrient store or say available nutrient store at different points of time,we can work out the system’s efficiency for biomass production
- Economic viability and ecological compatibility of a production system can be determined in a real life scenario

- Factors which enrich the S-V system are weathering of rocks and minerals,fertilisers and manures,additions from atmosphere,
- Factors which deplete the S-V system are Biomass harvest(removals),surface run off losses,Leaching losses,gaseous losses from soil(in odd conditions)

- Plants and animals thriving on the site enrich as well as deplete the S-V system
- In the long run,if we find the soil solution nutrient store is increasing,we term the system as agrading
- If the soil solution nutrient store is decreasing,we term it degrading
- If there is no change,we term it steady state

- Steady state in the soil solution nutrient store is much less likely in nature
- Steady state can be obtained only in a sophisticated laboratory set up of constant nutrient flow cultures

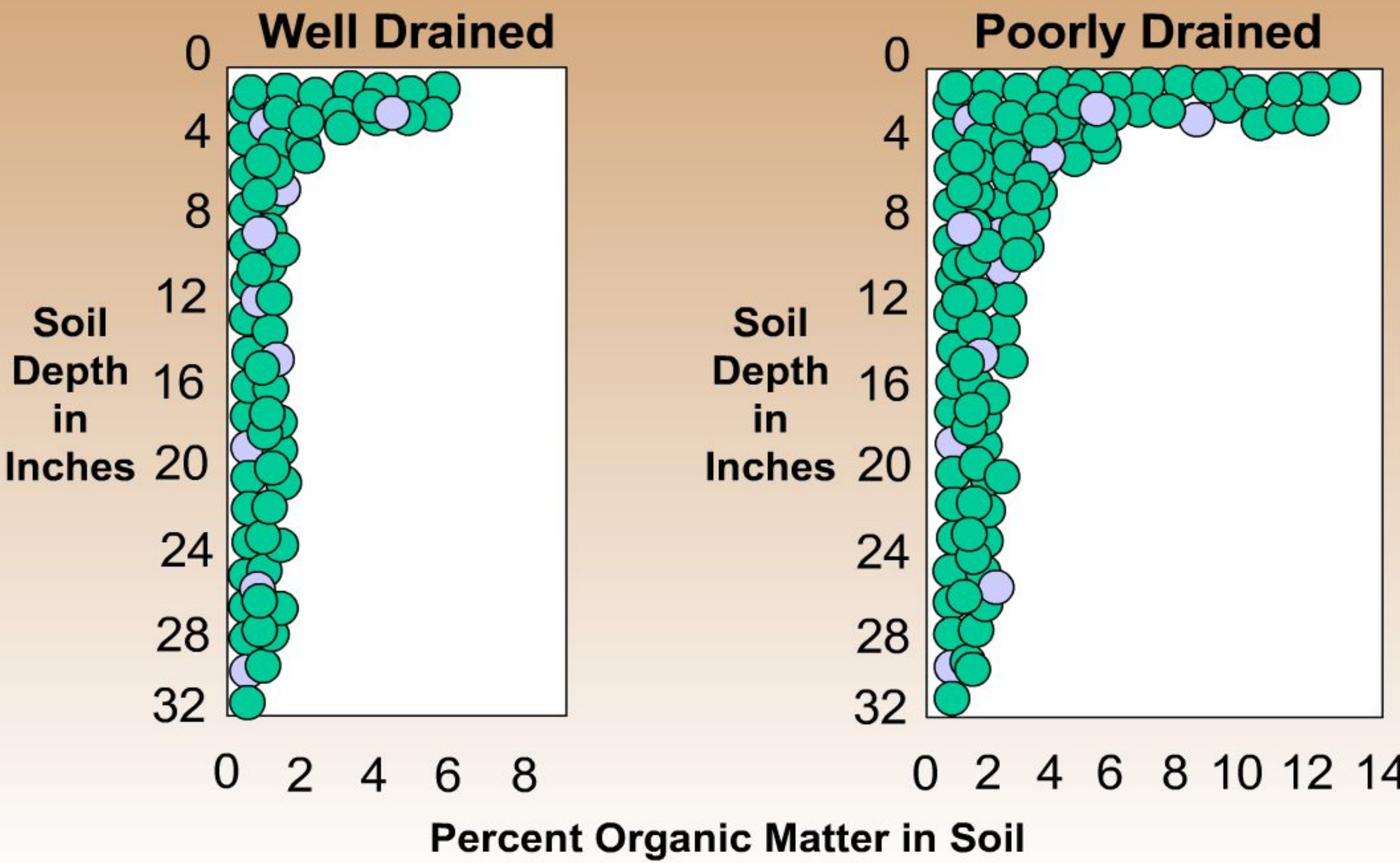
Biological Properties of Soil

- Biological properties of soil develop due to the action of a large variety of plants animals,micro-organisms
- Availability of nutrients like N,P,S depends largely on biologically/biochemically mediated functions in a soil
- Organic matter in the soil is the principal product/substrate which determines biological properties of soil

Factors Influencing Organic Matter Accumulation

1) Topography
2) Native Vegetation
3) Climate
4) Time
5) Organisms

Forest Soil



Well Drained
Poorly Drained
Soil Depth in Inches
0
4
8
12
16
20
24
28
32
0 2 4 6 8
0 2 4 6 8 10 12 14
Percent Organic Matter in Soil

- Organic matter is derived from both animals and plants(including microbes)
- Humus is the terminal product of organic matter decomposition
- There are several functions of o.m.in a soil such as, reducing the impact of falling rain drops by coarse o.m. on the soil surface;helps in structure build up;air:water regulation by roots;

increases water holding capacity;reservoir of nutrients;dissolves minerals by producing acids during decomposition;improves buffering in the soil;source of energy for the microbes;fresh matter is food for several detritivorous spp;checks evaporative losses;reduces wind erosion;insulates soil from rapid changes in soil temperature;influences availabilty of N,P,K;

improves alkalinity in the soil.

Carbon to Nitrogen ratio(C:N ratio)in the soil is a measure of decomposition of organic matter.

In the beginning of decomposition the ratio is wide(say 50:1) and it starts reducing as the process advances.A steady ratio(say 10:1)is achieved when decomposition is complete and we can see humus formation.

- General decomposers are active in the beginning of decomposition
- Organic-N is changed to ammonium by non specialised decomposers
- Ammonium is converted to nitrites by nitrosomonas
- Nitrites are converted to nitrates by nitrobacter
- Nitrate is the form which plant absorb easily

- There are a few terms associated with soil nitrogen
- Ammonification-is the process by which N in organic form is converted to Ammonium form
- Nitrification-is the process by which ammonium N is converted to nitrite and nitrate
- Nitrogen Mineralisation-is conversion of N from original organic form to nitrate form

- Nitrogen immobilisation-During the decomposition process,there is a temporary arrest of nitrogen supply to the plants as microbes out compete roots in absorbing the nitrates.This is nitrogen immobilisation
- Denitrification-is the process by which nitrogen is lost from soil as gas in submerged(anaerobic) conditions

- Nitrogen is an enigmatic nutrient element and many factors apart from fertilisation govern its level in the soil
- Land levelling, fertilizer management, irrigation, combination of other nutrients, soil pH,o.m.level etc.influence N availability to plants