

EWCE 131
Ecology and Environmental Pollution

Lecture 9

Instructor

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Lecture Outline

Environmental parameters, measurement and impacts on ecology

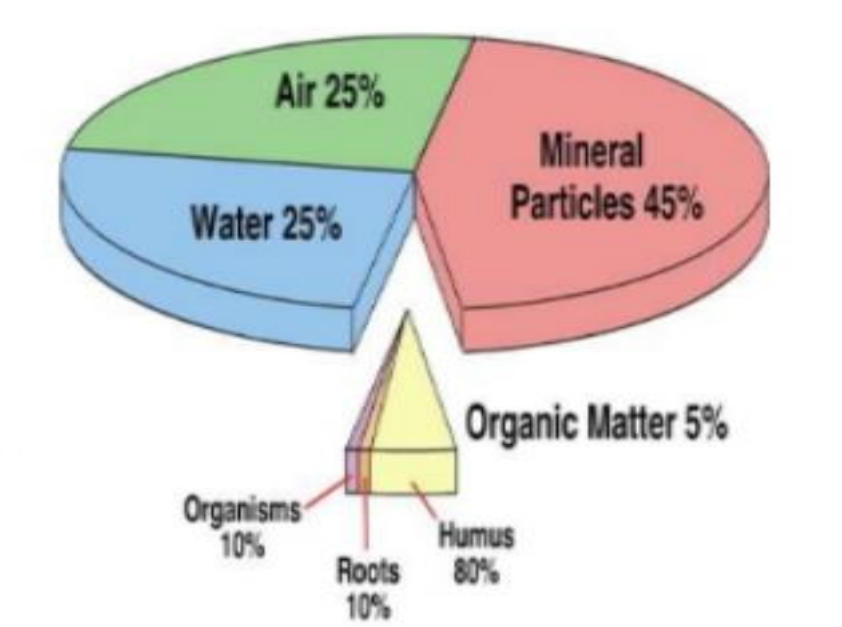
Topics

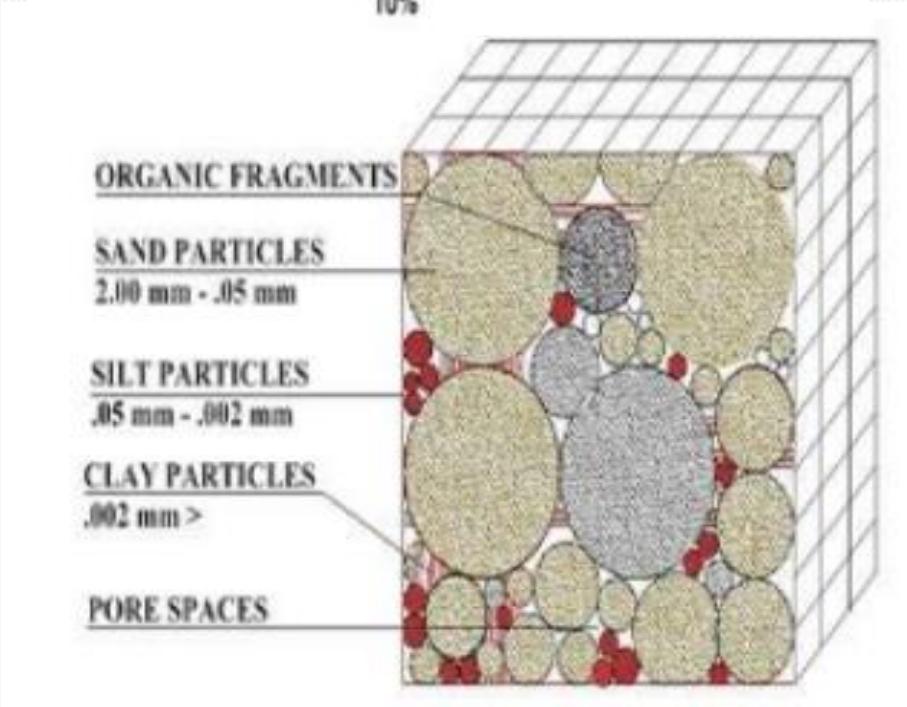
- **Soil parameters**
- **soil texture**
- **soil moisture**
- **water holding capacity**

Soil Parameters

Composition of Soil –

- Mineral matter contains three fractions – sand, silt and clay.
- Organic matter contains significant quantities of N, P and S.
- Air and water occupy the pore spaces in soil.

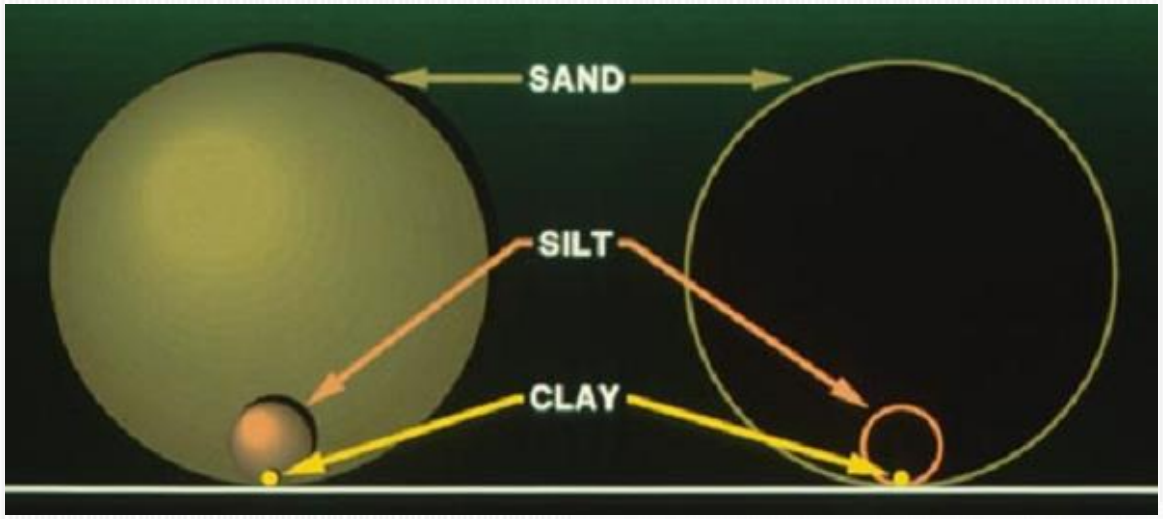




Soil Parameters – **Soil Texture**

- ***Texture*** refers to the size of the particles that make up the soil.
- The terms ***sand, silt***, and ***clay*** refer to relative sizes of the soil particles.
- **Sand**, being the larger size of particles, feels gritty.
- **Silt**, being moderate in size, has a smooth or floury texture.
- **Clay**, being the smaller size of particles, feels sticky.

Soil Parameters – **Soil Texture**



Comparative size of –

- ✓ sands,
- ✓ silt and
- ✓ clay



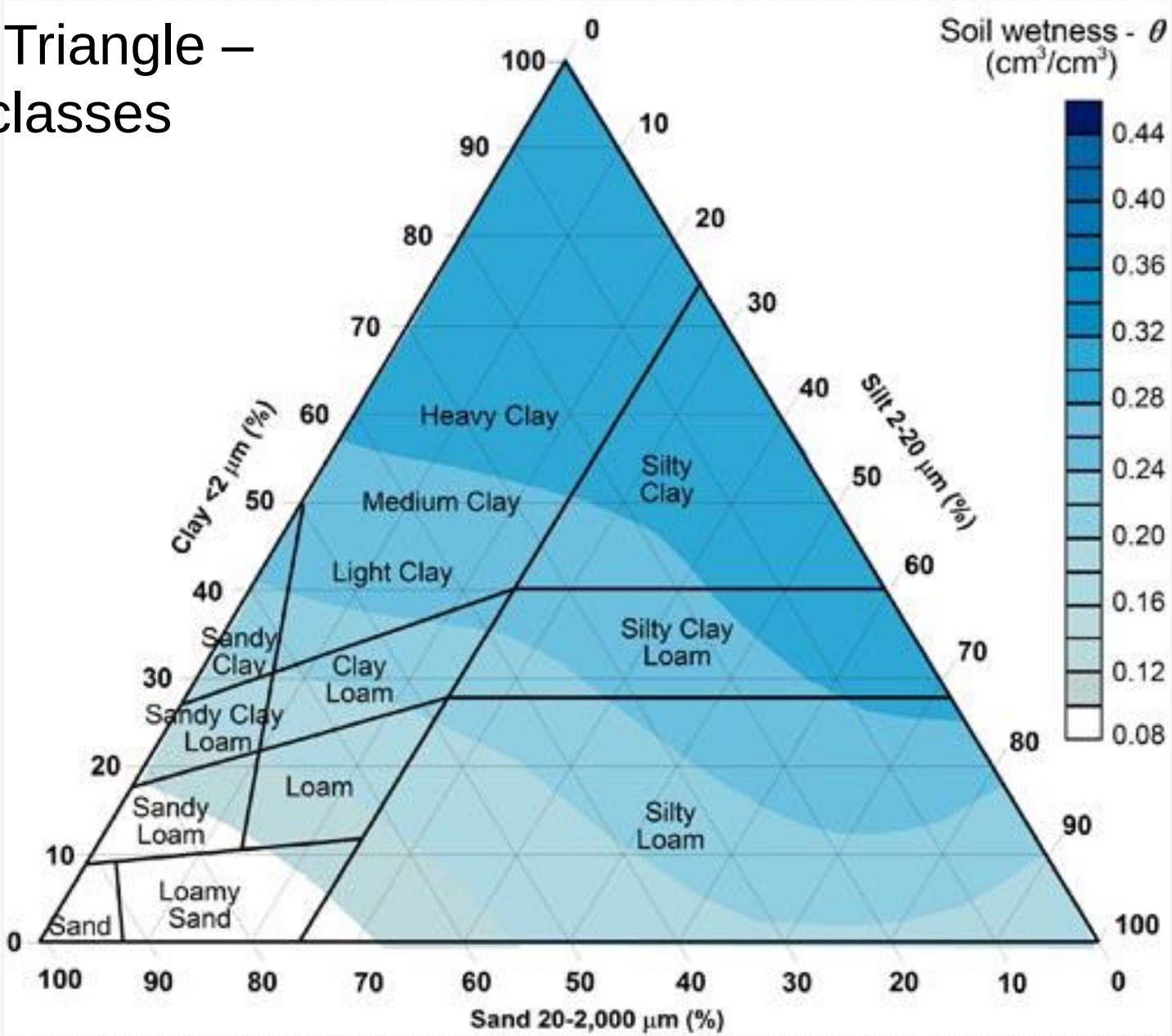
Water Holding Capacity



Infiltration Capacity

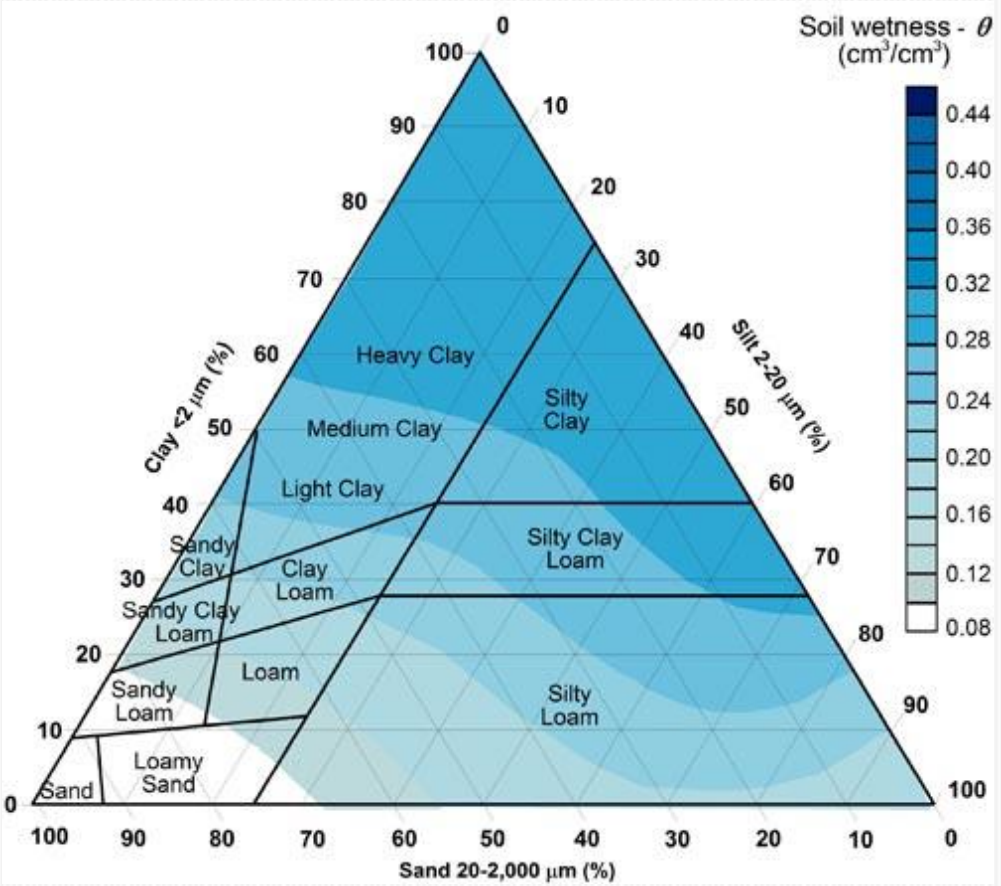
Soil Parameters – **Soil Texture**

Soil Texture Triangle – soil texture classes



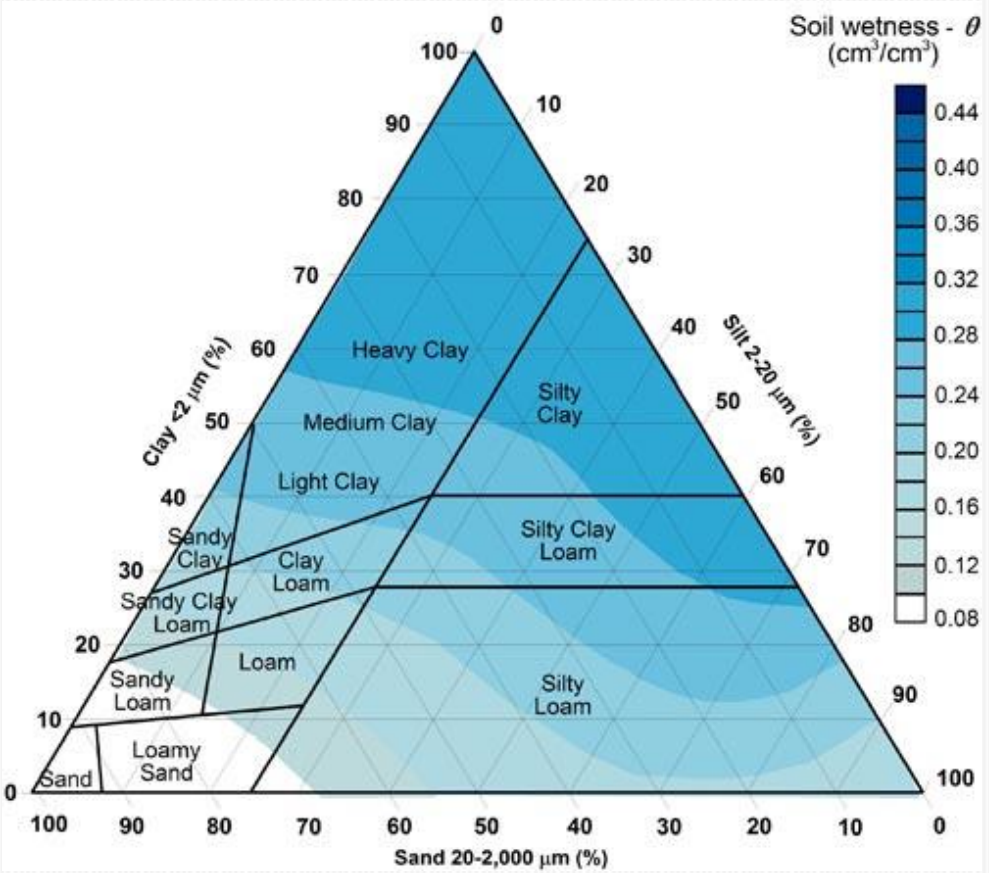
Soil Parameters – **Soil Texture**

- The combined portions of sand, silt, and clay in a soil determine its textural classification.
- A coarse-textured or sandy soil is one comprised primarily of medium to coarse size sand particles.
- A fine-textured or clayey soil is one dominated by tiny clay particles.



Soil Parameters – **Soil Texture**

- Due to the strong physical properties of clay, a soil with only 20% clay particles behaves as sticky, gummy clayey soil.
- The term loam refers to a soil with a combination of sand, silt, and clay sized particles.
- For example, a soil with 30% clay, 50% sand, and 20% silt is called a sandy clay loam.



Soil Parameters – **Soil Texture**

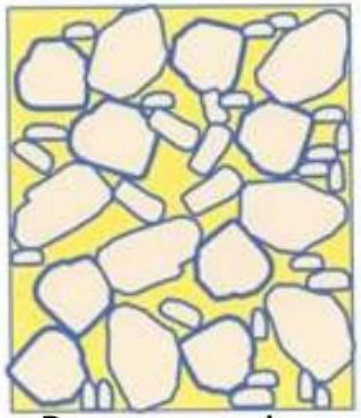
Significance of Soil Texture:

- A clay soil is referred to as a fine-textured soil, whereas a sandy soil is a coarse textured soil.
- Numerous soil properties are influenced by texture including:
  - Drainage
  - Water holding capacity
  - Aeration
  - Susceptibility to erosion
  - Organic matter content
  - Cation exchange capacity (CEC)
  - pH buffering capacity

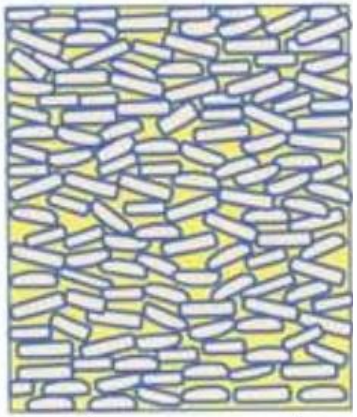
Soil Parameters – **Significance of Soil Texture**

Drainage

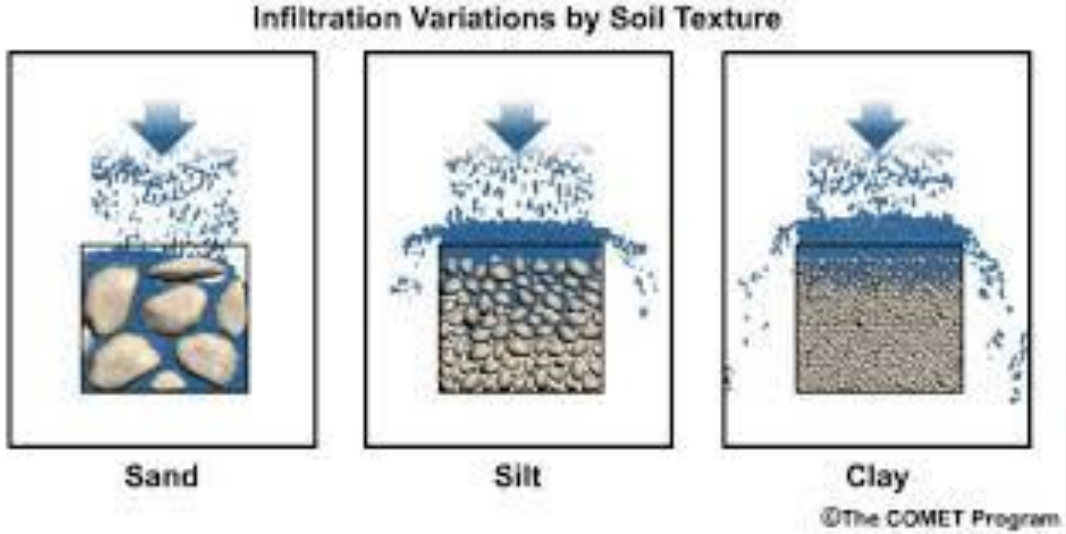
- Soil texture determines the rate at which water drains through a saturated soil.
- Water moves more freely through sandy soils than it does through clayey soils.



Pore space in sandy soils

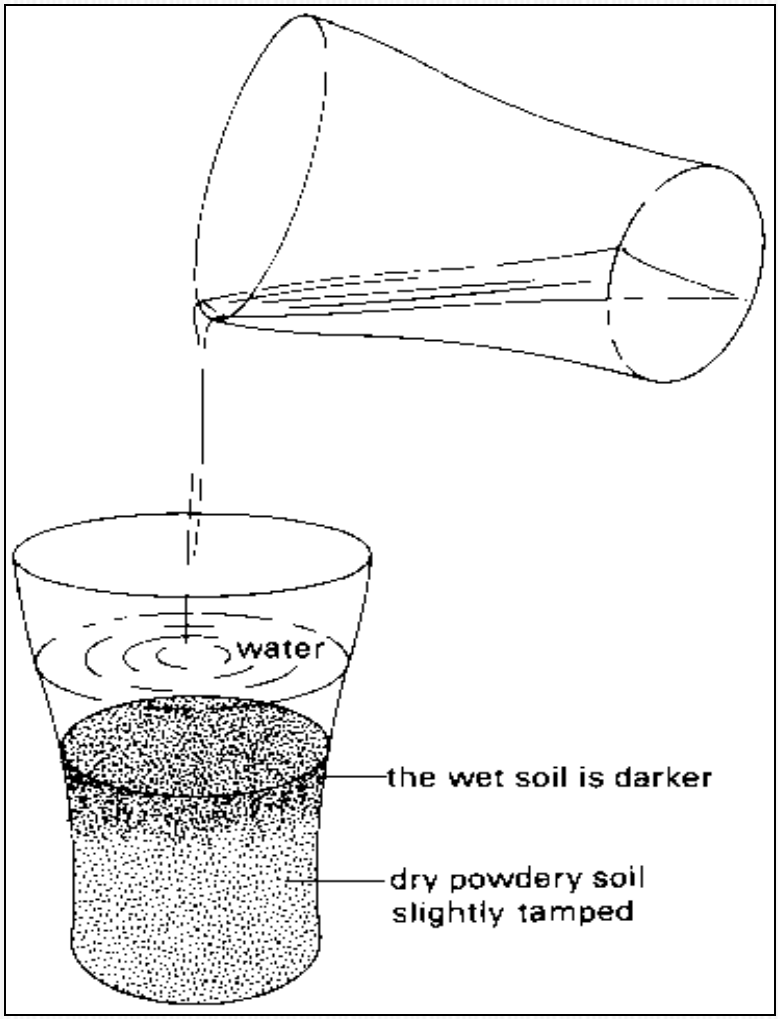


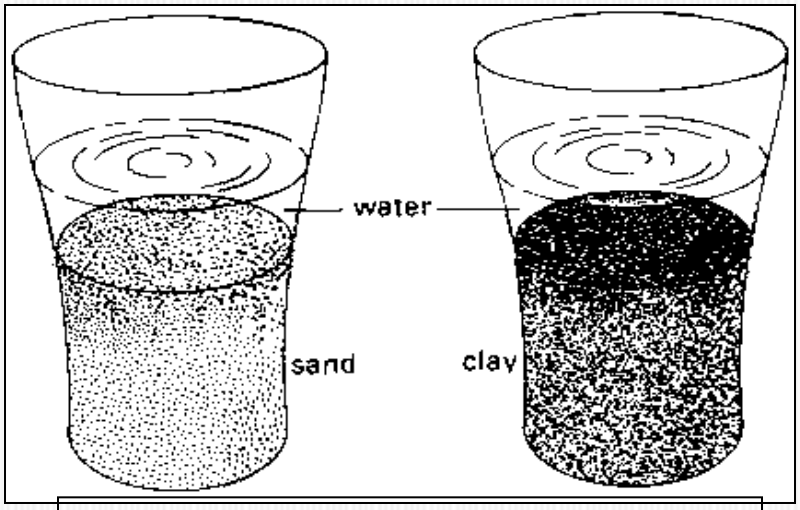
Pore space in clay soils



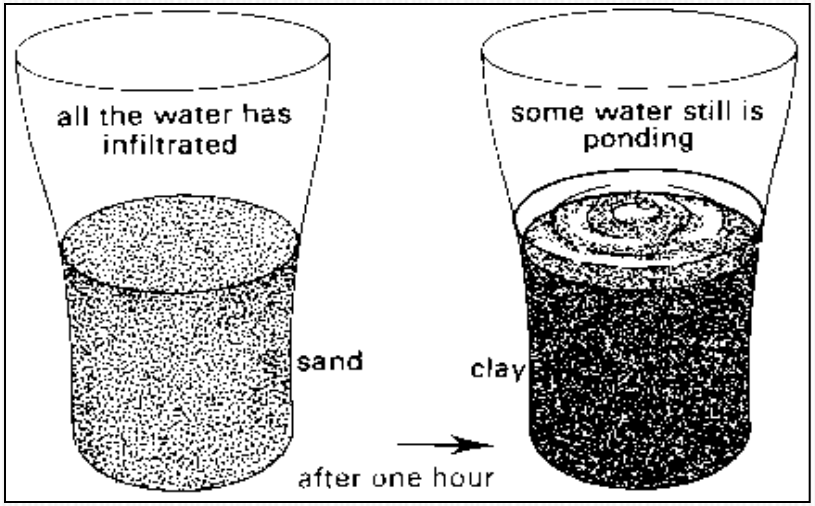
Soil Parameters – Significance of Soil Texture

Drainage





The same amount of water is supplied to each glass



After one hour the water has infiltrated in the sand, while some water is still ponding on the clay

Soil Parameters – **Significance of Soil Texture**

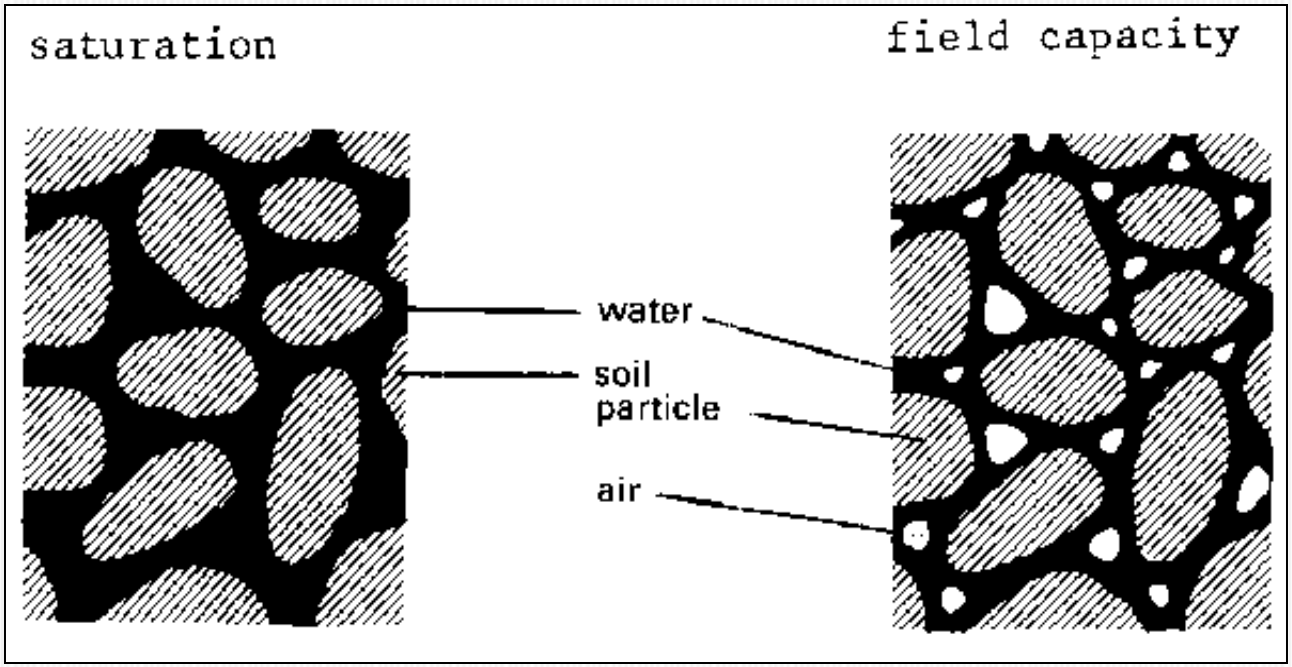
Water Holding Capacity

- Once field capacity is reached, soil texture also influences how much water is available to the plant.

Note:

✓Saturation – all soil pores are filled with water.

✓ Field capacity – soil pores are filled with water and air



Soil Parameters – **Significance of Soil Texture**

Water Holding Capacity

- Clay soils have a greater water holding capacity than sandy soils.

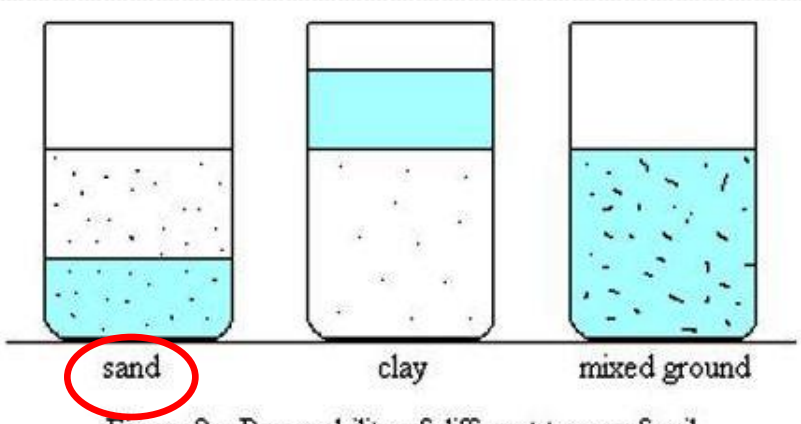
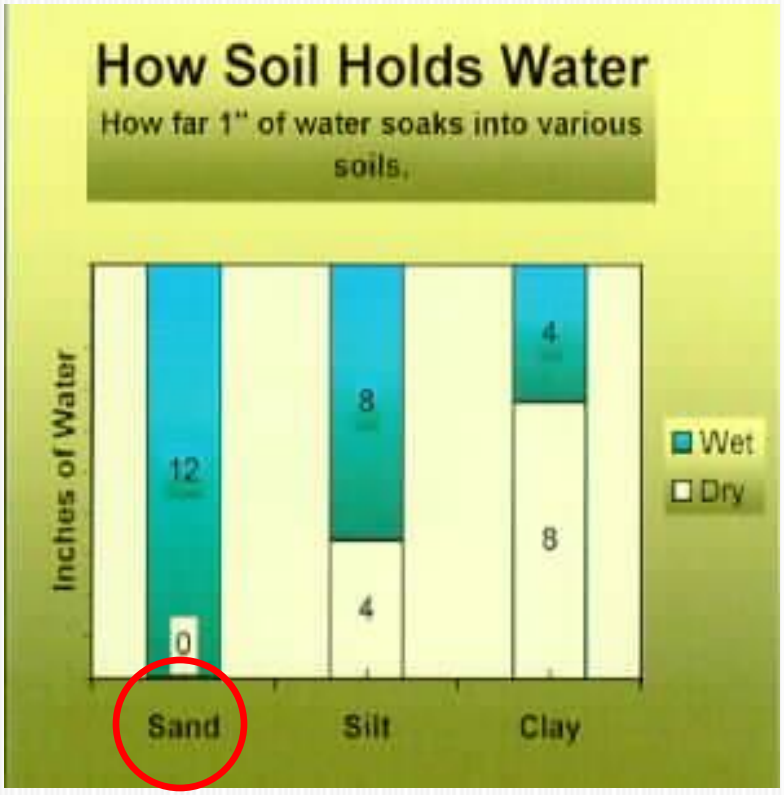


Figure 2 - Permeability of different types of soil components. In blue the distribution of water.

- If 1" of water is applied to **sandy soil**, the water will quickly proceed downward for at least 12 " leaving very little water held in the top several inches.



Soil Parameters – **Significance of Soil Texture**

Water Holding Capacity

- The same amount of water applied to **silt soil** will drain downward more slowly reaching down to 8 or 9 inches. Some water will be retained by the **silt soil** in the top layers.

- One inch of water applied to **heavy clay soil** will drain slowly to a depth of 4 or 5 inches. The water is retained entirely within the root zone of plants.

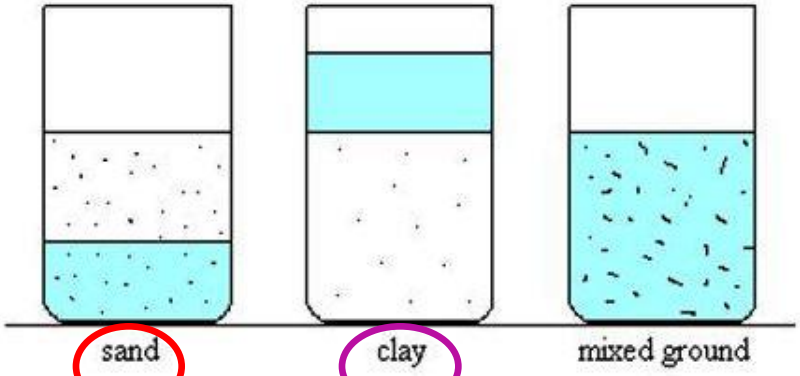
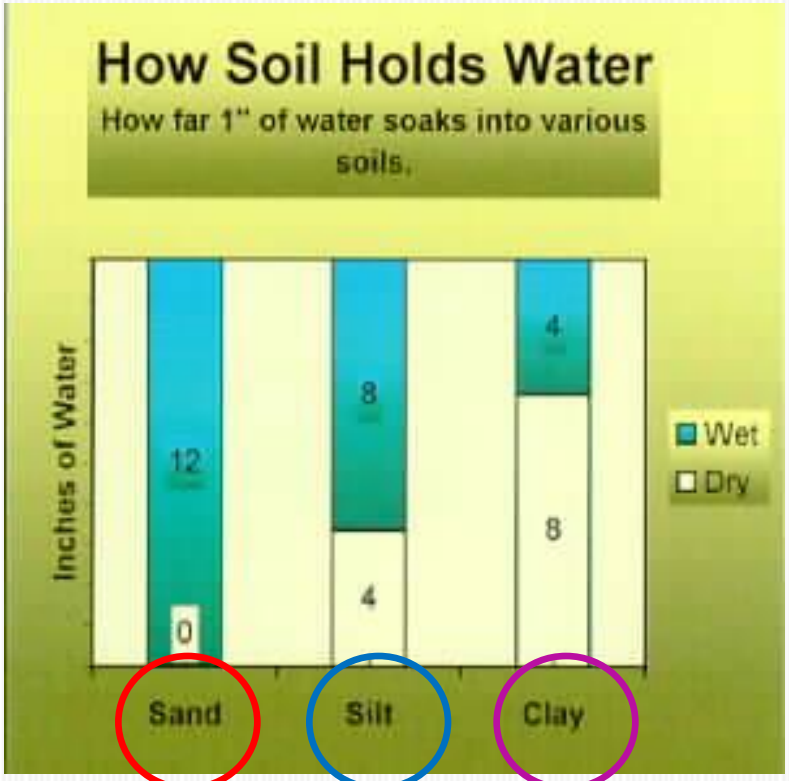


Figure 2 - Permeability of different types of soil components. In blue the distribution of water.

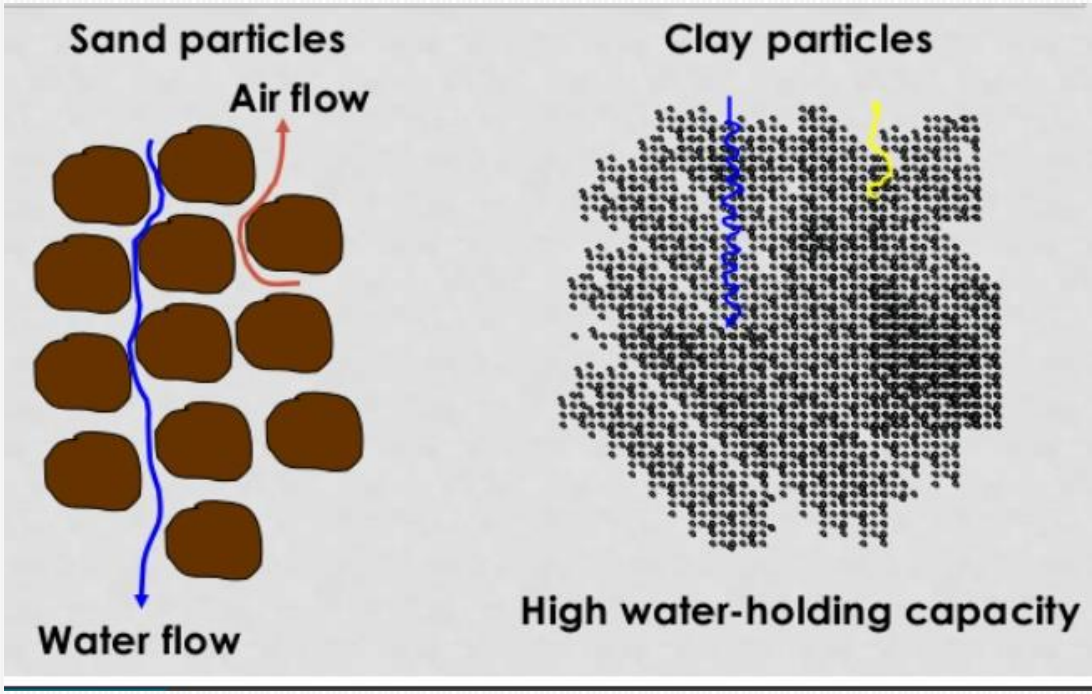


Soil Parameters – **Significance of Soil Texture**

Aeration

- Well drained soils (sandy soils) typically have good soil aeration.

- This type of soil (sandy soil) contains air that is similar to atmospheric air, which is conducive to healthy root growth, and thus a healthy crop.



Soil Parameters – **Significance of Soil Texture**

Erodibility - Susceptibility to erosion



- An indicator of a soil's susceptibility to raindrop impact, runoff, and other erosive processes.



- Soils also differ in their susceptibility to erosion (erodibility) based on texture.
- Sandy soil - less cohesive and easy to detached.



- Clay soil - resistant to erosion, but once detached, the particle is ready to remove by water run-off.

Soil Parameters – **Significance of Soil Texture**

Organic matter content

- Organic matter breaks down faster in sandy soils than in fine-textured soils (clay), given similar environmental conditions, tillage and fertility management, because of a higher amount of oxygen available for decomposition in light textured sandy soils.

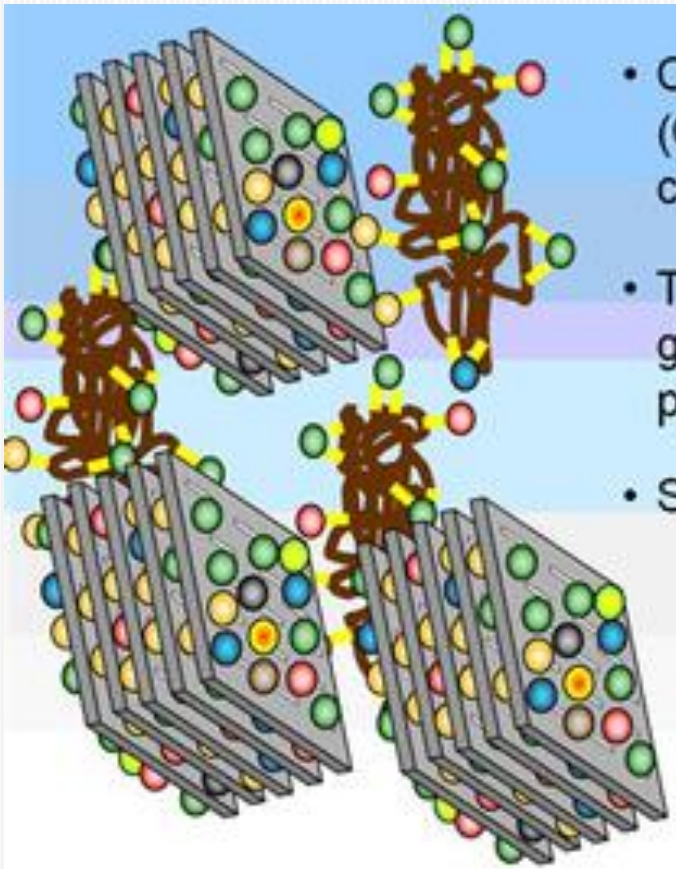
- Organic matter gives a clay soil some of the good characteristics of a sandy soil, such as better aeration and a faster water infiltration.

- Again it acts as a sponge in a sandy soil to make it able to hold water and nutrients.

Soil Parameters – **Significance of Soil Texture**

Cation Exchange Capacity (CEC)

- *Cation exchange capacity,* or *CEC* is the net ability of a soil to hold, retain, and exchange *cations*, such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), sodium (Na^{+}), ammonium (NH_4^{+}), aluminum (Al^{3+}), and hydrogen (H^{+}).



- The higher the soil CEC, the greater ability it has to store plant nutrients.

- The cation exchange capacity of the soil increases with-

✓ Increase of percent clay and organic matter

✓ Increase of pH

Soil Parameters – **Significance of Soil Texture**

Cation Exchange Capacity (CEC)

- A soil with *a* ***low CEC value*** (1-10 meq/100 g) may have some, or all, of the following characteristics:
  - high sand and low clay content
  - low organic matter content
  - low water-holding capacity
  - low soil pH
  - will not easily resist changes in pH or other chemical changes
  - enhanced leaching potential of plant nutrients such as Ca^{2+}, NH_4^+, K^+
  - low productivity

Soil Parameters – **Significance of Soil Texture**

Cation Exchange Capacity (CEC)

- A soil with *a* ***higher CEC value*** (11-50 meq/100g) may have some or all of the following characteristics:
  - low sand and higher silt + clay content
  - moderate to high organic matter content
  - high water-holding capacity
  - ability to resist changes in pH or other properties
  - less nutrient losses to leaching than low CEC soils

Soil Parameters – **Significance of Soil Texture**

pH buffering capacity

- The resistance of soils to changes in pH of the soil solution is termed buffering capacity.

- Buffering capacity increases with the amount of clay and organic matter.

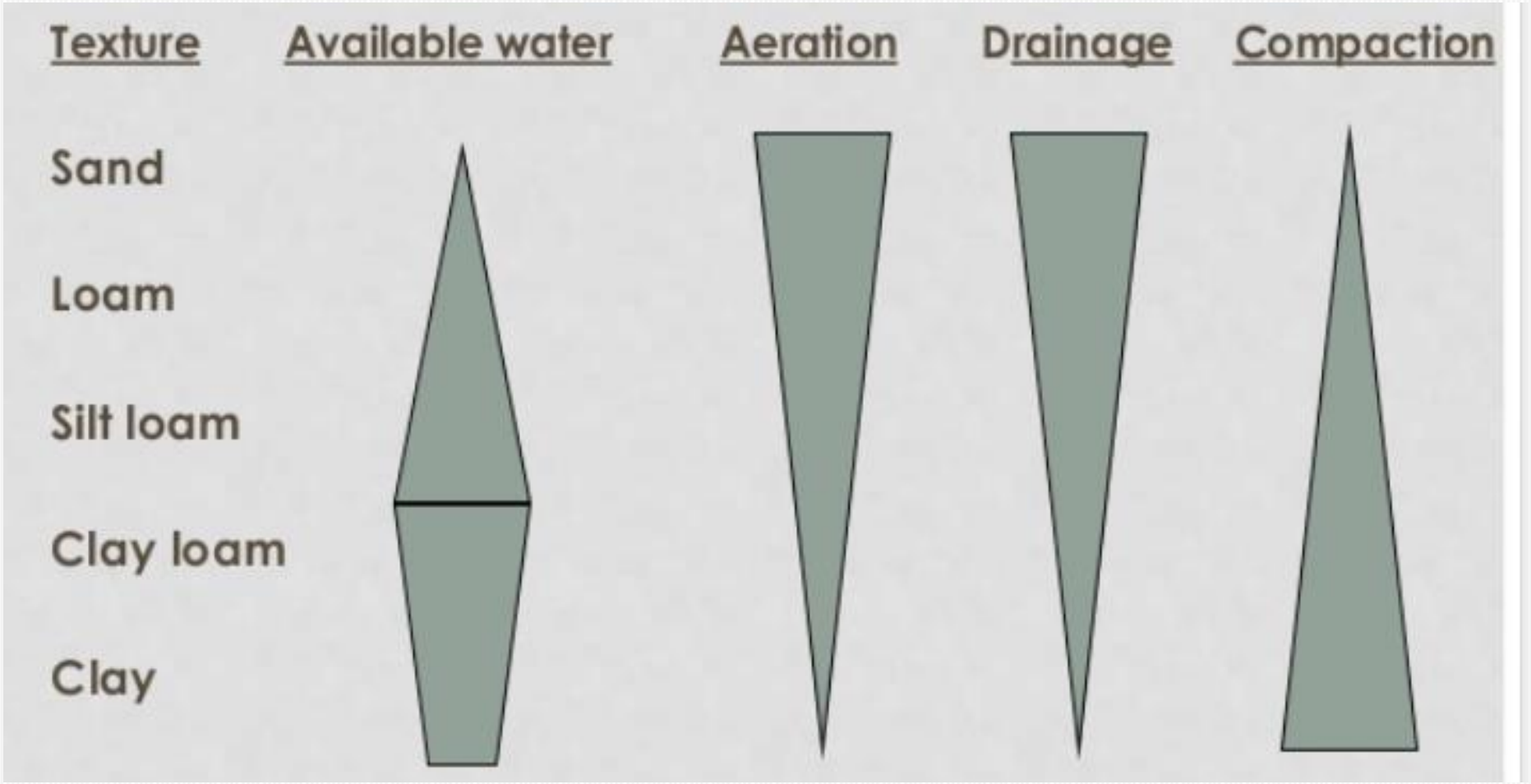
Soil Parameters – **Significance of Soil Texture**

pH buffering capacity

- Soils become acidic when basic cations (such as calcium, Ca^{2+}) held by soil colloids are leached from the soil, and are replaced by aluminum ions (Al^{3+}), which then hydrolyze to form aluminum hydroxide [$Al(OH)_3$] solids and H^+ ions in solution.

- Soils with high clay and organic matter content (high buffer capacity) require more lime to increase pH than sandy soils with low amounts of organic matter (low, or weak, buffer capacity).

Soil Parameters – **Significance of Soil Texture**



Soil Parameters – **Soil Texture**

Significance of Soil Texture:

- Sandy soils tend to be characterized by –
  - ✓ low strength
  - ✓ with a greater susceptibility to wind erosion
  - ✓ less water available to plants than soils of other textures.

- In addition, trenches and banks in sandy soil are highly susceptible to caving, which may pose a safety hazard.

- Water may pipe through terraces and other water impoundments.

Soil Parameters – **Soil Texture**

Significance of Soil Texture:

- Clayey soils generally have more available water than sandy soils.
- Generally, the cation-exchange capacity increases with increases in content of clay and organic matter.
- Soils that have large amounts of clay fix more phosphorus than soils that have less clay.

Soil Parameters – **Soil Texture**

Significance of Soil Texture Assessment:

- Choosing comparable sites for the measurement of –

  ✓ Soil microbial processes,

  ✓ Soil invertebrate activity,

  ✓ Pesticide residues in soil

Soil Parameters – **Soil Texture**

Identifying Soil Texture



- **Sand** –

✓ feels gritty

✓ does not stick together in a mass unless it is very wet.



- **Silt** –

✓ feels floury powdery and smooth.

✓ wet silt does not stick together and cannot mold it into different shapes.

Soil Parameters – **Soil Texture**

Identifying Soil Texture

- **Clay** –

✓ clay is very powdery when dry

✓ very sticky and slippery when wet.

✓ Wet clay be molded readily into any shape or a rod.



Soil Parameters – **Soil Texture**

Identifying Soil Texture – Jar Test

- Fill a clear glass jar halfway with soil sample.
- Fill the remaining half with water, leaving 1" of air.
- Attach the lid, then shake the jar vigorously until you have broken up any clumps of soil.
- Set the jar aside to rest, undisturbed, overnight.



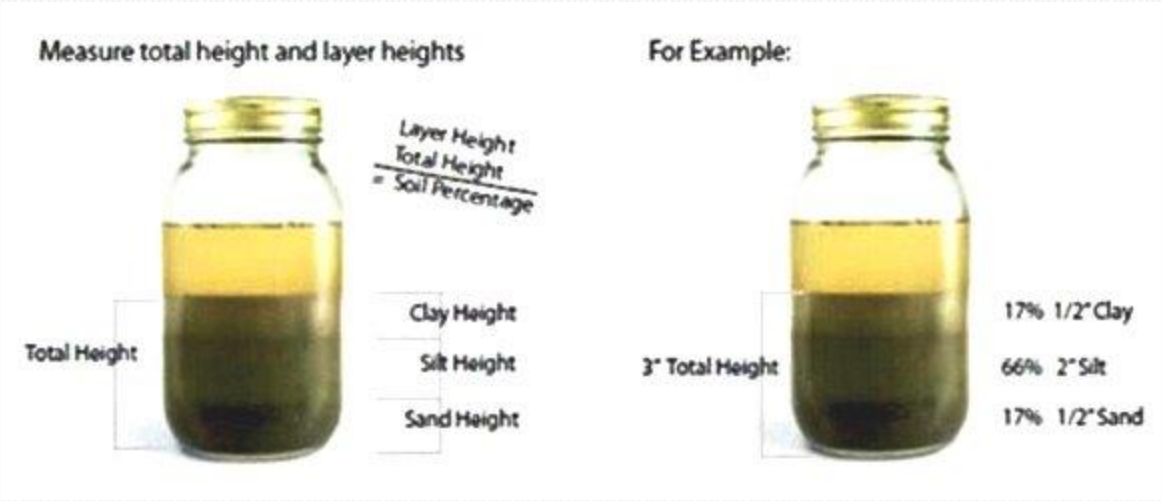


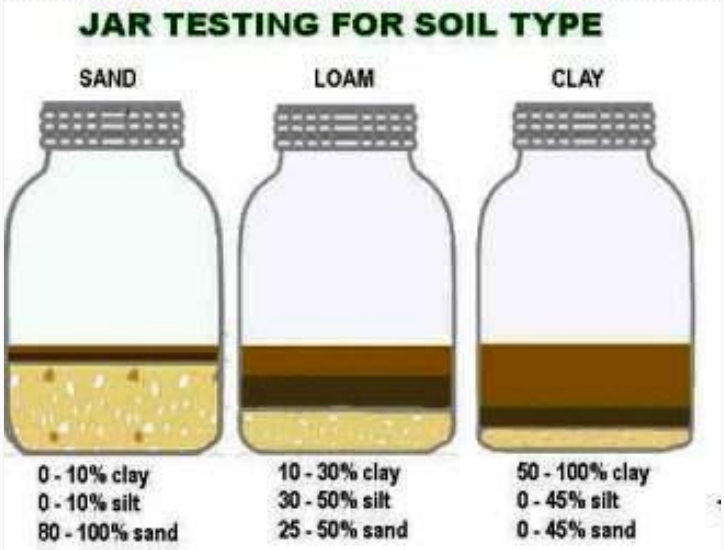
Soil Parameters – **Soil Texture**

Identifying Soil Texture – Jar Test

- After 24 hours, the jar contents will settle into distinct layers of sand, silt and clay.

- By examining the proportion of these layers, you can gain a sense of what type of soil you have.

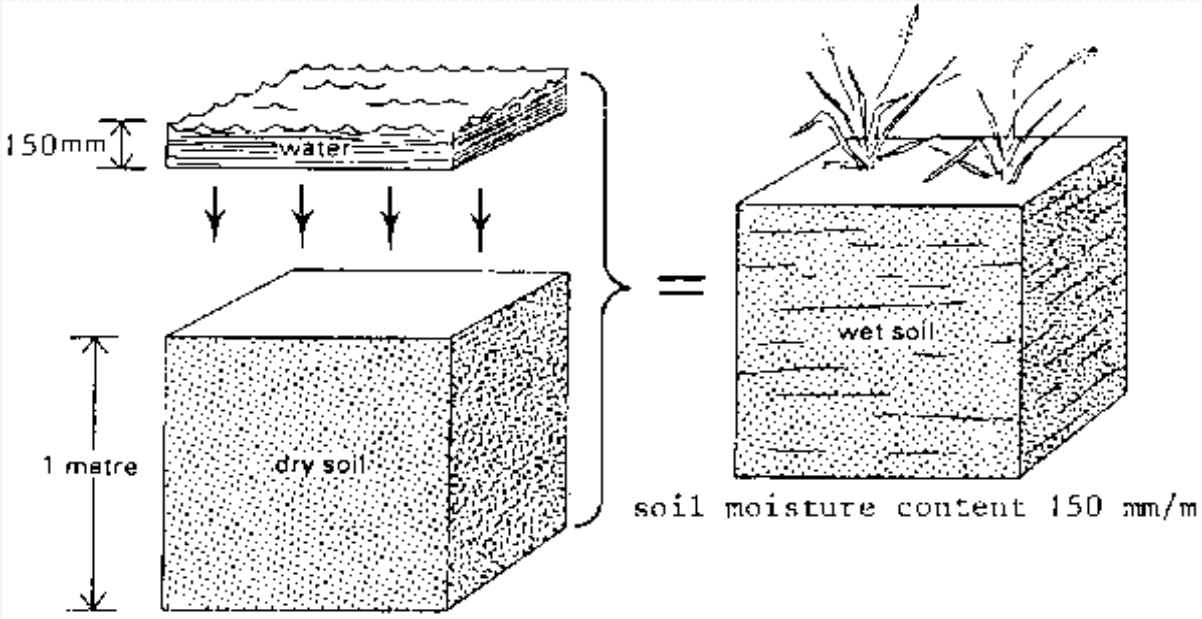




Soil Parameters – **Soil Moisture**

- The soil moisture content indicates the amount of water present in the soil.
- It is commonly expressed as the amount of water (in mm of water depth) present in a depth of one meter of soil.

For example: when 150 mm water is present in a depth of one meter of soil, the soil moisture content is 150 mm/m.



A soil moisture content of 150 mm/m

Soil Parameters – **Soil Moisture**

- The soil moisture content can also be expressed in percent of volume.

- In the example above, 1 m^3 of soil (e.g. with a depth of 1 m, and a surface area of 1 m^2) contains 0.150 m^3 of water (e.g. with a depth of 150 mm = 0.150 m and a surface area of 1 m^2).

- This results in a soil moisture content in volume percent of:

$$\frac{0.150\,m^3}{1\,m^3} \times 100\% = 15\%$$

- Thus, a moisture content of 100 mm/m corresponds to a moisture content of 10% by volume.

Soil Parameters – **Soil Moisture**

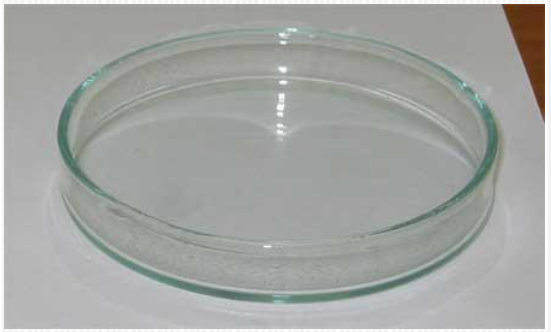
Measurement of Soil Moisture:

- Soil moisture is determined by weighing freshly dug soil before and after drying and expressing the difference as a percentage of dry soil weight.

- **Conventional Equipment**: Portable balance and 2 mm sieve if determining in the field, polythene bags and Petri dishes.







Soil Parameters – **Soil Moisture**

Measurement of Soil Moisture:

- **Potable Equipment – Soil Moisture Meter**



