# Introduction to Soil Science

## I. Functions of Soil

- Provides physical support, nutrient and water retention, and oxygen exchange for plants.

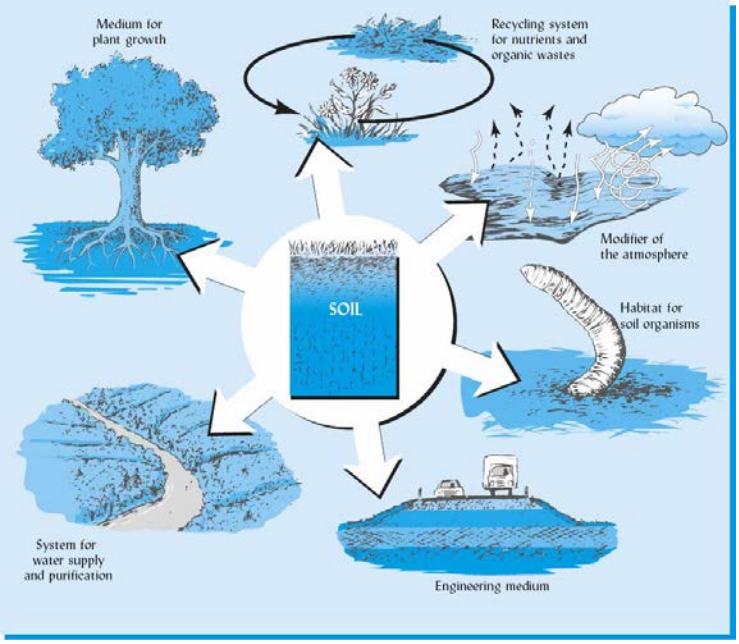
- Recycles nutrients from organic wastes when they decompose.

- Modifies the atmosphere via carbon sequestration, serves as a carbon reservoir.

- Habitat for micro and macro organisms, which are crucial to soil formation & nutrient cycling.

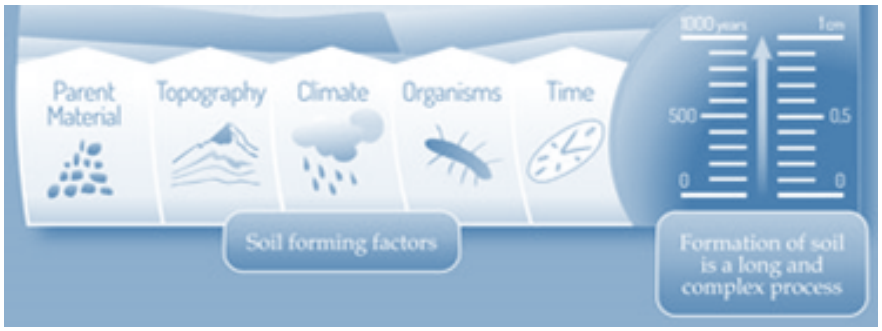
- Stores water in its pores and in aquifers, filters it via ion exchange.

- Engineering medium for buildings, roads, etc.



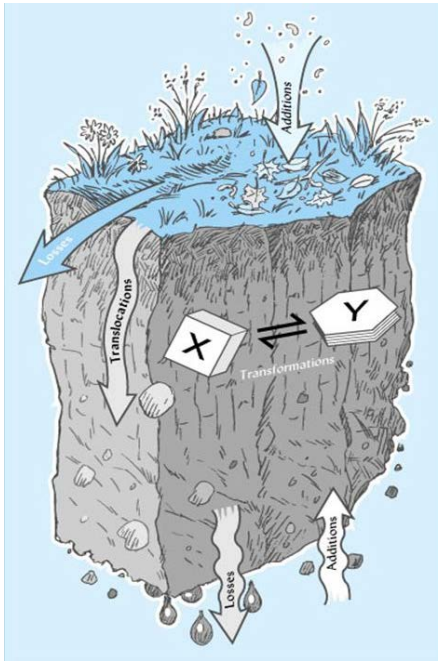

## II. Five Soil Forming Factors

1. Parent Material
   -Underlying bedrock, transported sediments
2. Topography
   -erosion vs. accumulation
3. Climate
   -Moisture and temperature
4. Organisms
   -Micro and macro, humans
5. Time
   -Absolute (geologic) vs. relative ("young" vs. "old")




## III. Soil Forming Processes

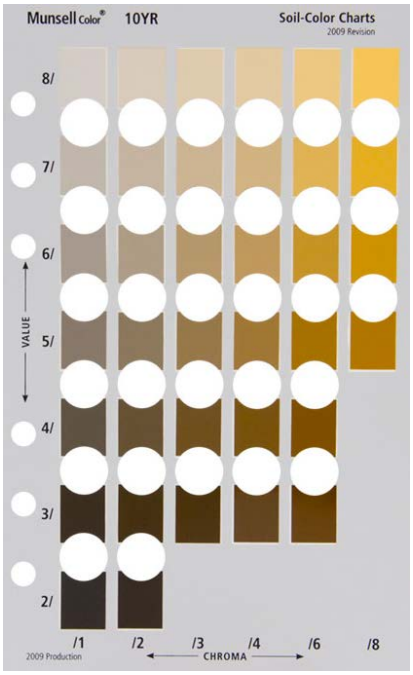
1. Additions: organic matter, soil deposited by wind
2. Losses: leaching, erosion
3. Transformations: weathering of primary particles
4. Translocations: movement of inorganic and organic material



## IV. Physical Properties of Soil

*Used to classify soils and determine soil suitability for agricultural and environmental projects.

*1. Color*




-Doesn't affect behavior, but infers information about other soil properties and conditions and helps classify soils.

-Colors determined using *moist* soil samples and Munsell color charts arranged according to three components of how we see color:

a. Hue: In soils, typically redness or yellowness

b. Value: Lightness or darkness, a value of 0 being black

c. Chroma: Intensity of brightness, a chroma of 0 being neutral gray.

-Factors influencing soil color:

a. organic matter content

b. water content

c. presence and oxidation states of Fe and Mn oxides

*2. Texture*

-Size distribution of soil particles (sand, silt, clay)

-Important in understanding soil behavior and management

-Sand

-2.00-0.05 mm, feels gritty, particles visible to naked eye

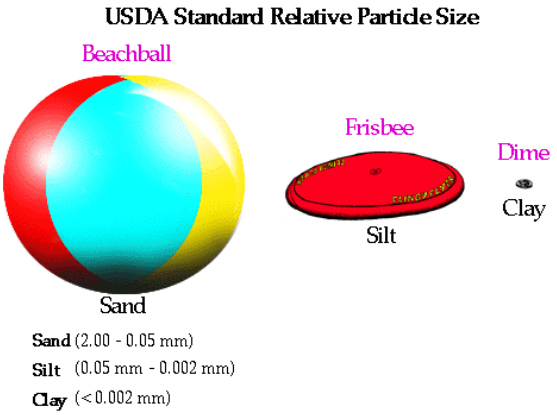
-Large pores between particles due to size, does not hold water or nutrients well. Well drained soils.

-Silt

-0.05-0.002 mm, feels smooth/silky like flour, particles not visible to naked eye. Smaller and more numerous pores, holds more water and nutrients than sand.

-Clay

<0.002 mm, feels sticky, has plasticity. Tremendous capacity to hold water and nutrients due to very large specific surface area due to small particle size. Poorly drained.




Texture class can be determined fairly well in the field by feeling the sand particles and estimating silt and clay content by flexibility and stickiness. There is no field mechanical-analysis procedure that is as accurate as the fingers of an experienced scientist.

Soil Textural Class Names Developed by the USDA

| *Common name* | *Texture* | *Basic soil textural class name* |
|---|---|---|
| Sandy soils | Coarse ⟶ | Sandy<br>Loamy sands<br>Sandy loam |
| | Moderately coarse ⟶ | Fine sandy loam<br>Very fine sandy loam |
| Loamy soils | Medium ⟶ | Loam<br>Silt loam<br>Silt |
| | Moderately fine ⟶ | Clay loam<br>Sandy clay loam<br>Silty clay loam |
| Clayey soils | Fine ⟶ | Sandy clay<br>Silty clay<br>Clay |

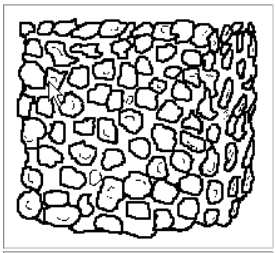
## IV. Physical Properties of Soil (continued)

*3. Structure*

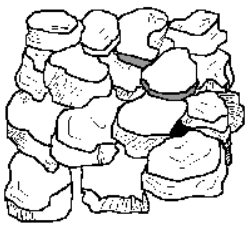
-The arrangement of sand, silt, clay and organic particles in soils. --Particles become aggregated together due to various forces and at different scales to form distinct structural units called *peds* or *aggregates*.

-When you take a mass of soil and gently break it apart it tends to break along natural zones of weakness into peds.

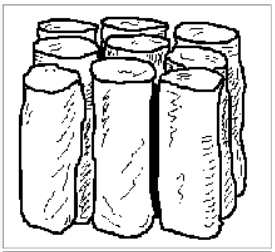
-Networks of pores within and between aggregates are a key aspect of soil structure.



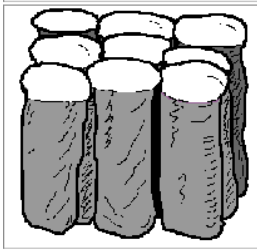
**Granular**: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.



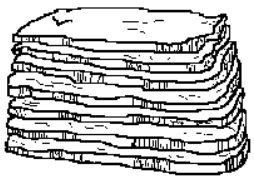
**Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.



**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.



**Columnar**: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.



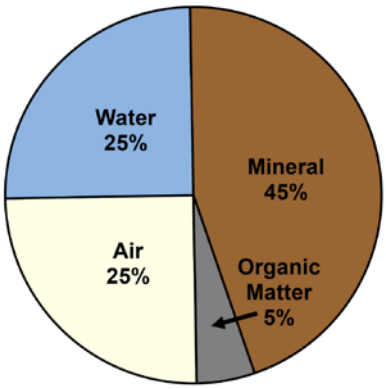
**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.

**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

## V. Volume Composition of an Ideal Surface Soil

50% Solids
- 45% Mineral Soil
- 5% Organic Matter

50% Pore Space
- 25% Air
- 25% Water




## VI. Soil Taxonomy

-Provides a hierarchical grouping of natural soil bodies based on soil properties that can be objectively observed or measured.

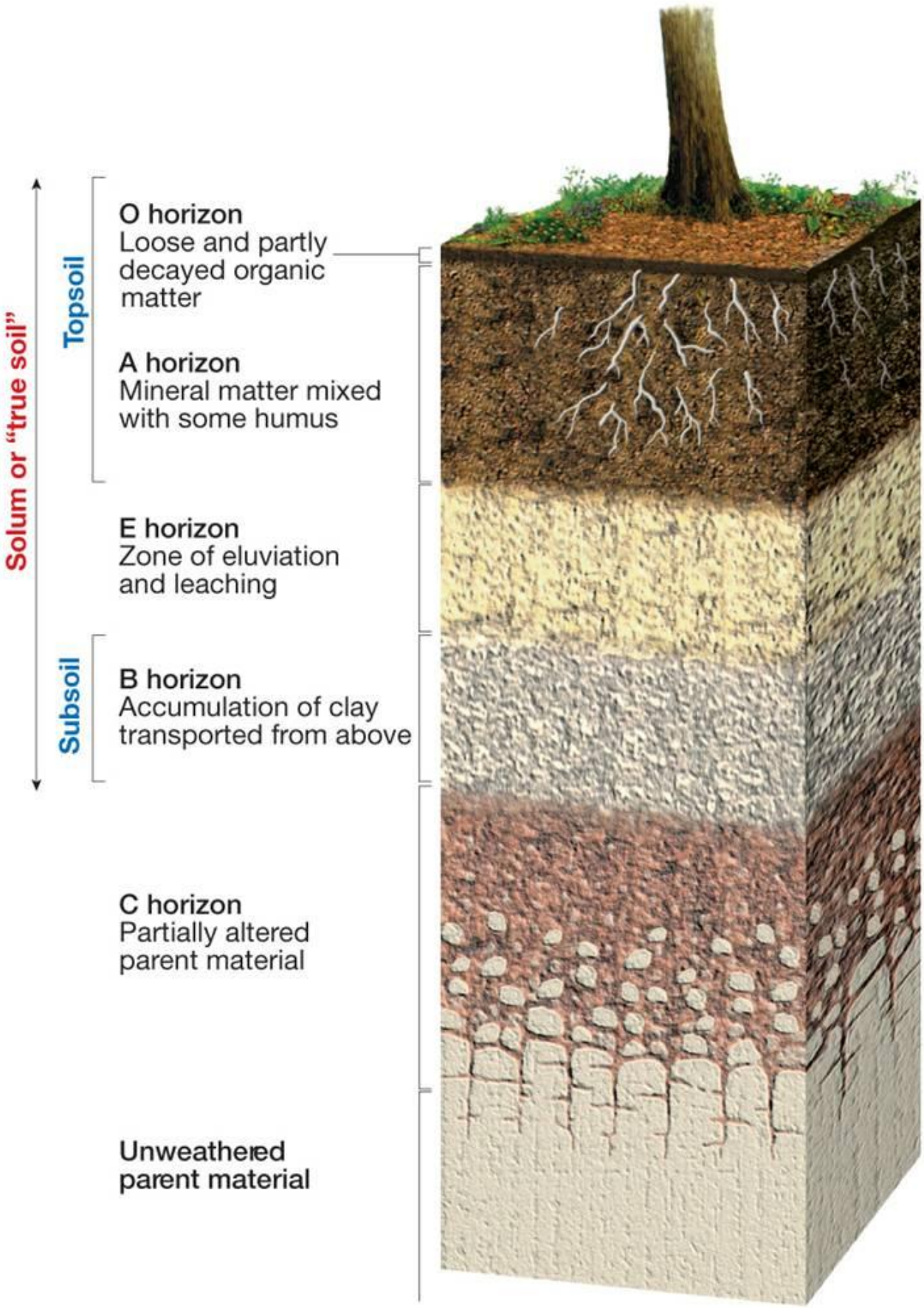
-12 Soil Orders

**NAMES OF SOIL ORDERS IN *SOIL TAXONOMY* WITH THEIR DERIVATION AND MAJOR CHARACTERISTICS**

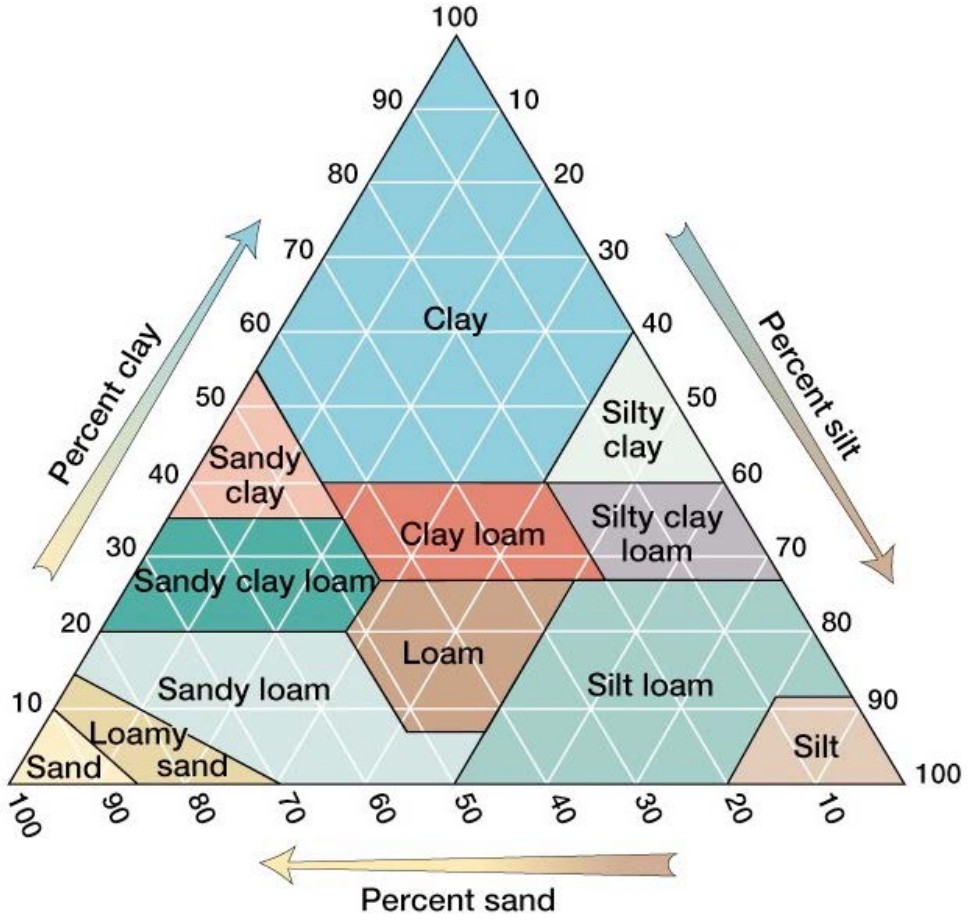
*The bold letters in the order names indicate the formative element used as the ending for suborders and lower taxa within that order.*

| Name | Formative element | Derivation | Pronunciation | Major characteristics |
|---|---|---|---|---|
| Alfisols | alf | Nonsense symbol, Aluminum Al, iron Fe | Pedalfer | Argillic, natric, or kandic horizon; high-to-medium base saturation |
| Andisols | and | Jap. *ando*, "black soil" | Andesite | From volcanic ejecta, dominated by allophane or Al-humic complexes |
| Aridisols | id | L. *aridus*, "dry" | Arid | Dry soil, ochric epipedon, sometimes argillic or natric horizon |
| Entisols | ent | Nonsense symbol | Recent | Little profile development, ochric epipedon common |
| Gelisols | el | Gk. *gelid*, "very cold" | Jelly | Permafrost, often with cryoturbation (frost churning) |
| Histosols | ist | Gk. *histos*, "tissue" | Histology | Peat or bog; >20% organic matter |
| Inceptisols | ept | L. *inceptum*, "beginning" | Inception | Embryonic soils with few diagnostic features, ochric or umbric epipedon, cambic horizon |
| Mollisols | oll | L. *mollis*, "soft" | Mollify | Mollic epipedon, high base saturation, dark soils, some with argillic or natric horizons |
| Oxisols | ox | Fr. *oxide*, "oxide" | Oxide | Oxic horizon, no argillic horizon, highly weathered |
| Spodosols | od | Gk. *spodos*, "wood ash" | Podzol; odd | Spodic horizon commonly with Fe, Al oxides and humus accumulation |
| Ultisols | ult | L. *ultimus*, "last" | Ultimate | Argillic or kandic horizon, low base saturation |
| Vertisols | ert | L. *verto*, "turn" | Invert | High in swelling clays; deep cracks when soil is dry |

## VII. Soil Profiles & Soil Horizons

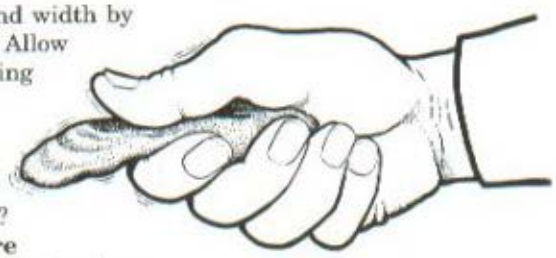


# Soil Textural Triangle




**Start:** Take approximately 1 tablespoon of soil and wet by adding water in small amounts. Knead to break down all aggregates until soil is plastic and moldable, like moist putty.

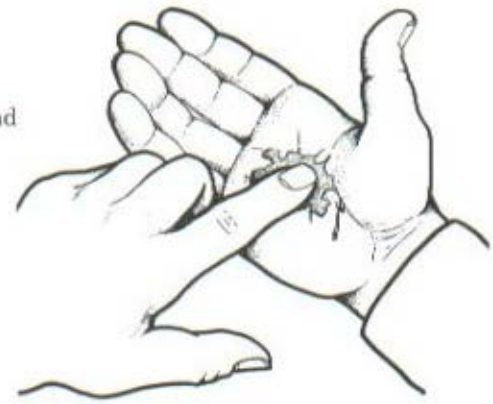
**Step 1:** Try to form a ribbon of uniform thickness and width by gently pushing the soil between thumb and forefinger. Allow the ribbon to emerge and extend over the finger, breaking from its own weight.



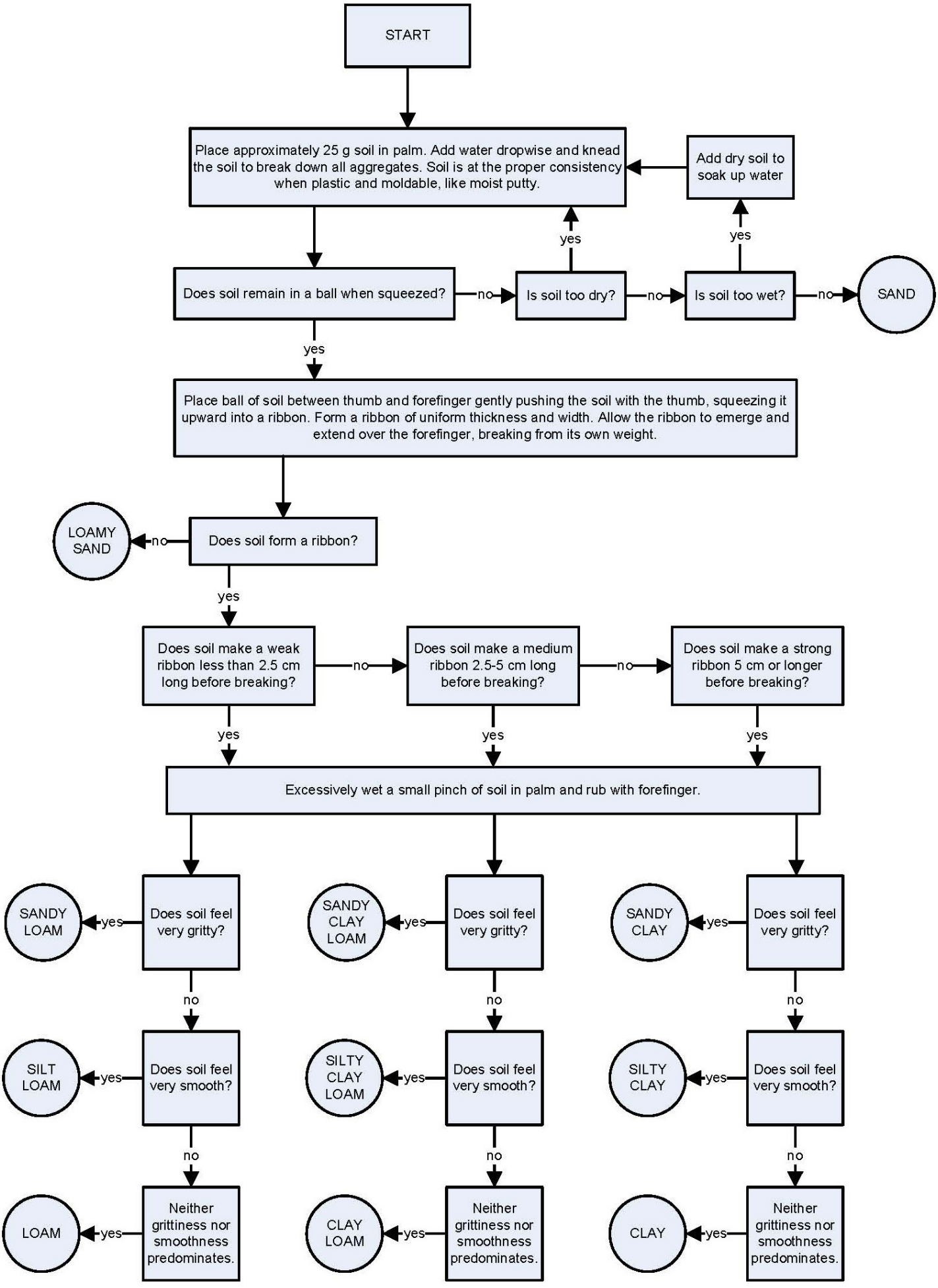
**A:** Soil does not ribbon — **coarse texture**

**B:** Soil does ribbon — What is the length of the ribbon?
- **B1:** If the ribbon is over 2 inches long: **fine texture**
- **B2:** If the ribbon is 1 to 2 inches long: **moderately fine texture**
- **B3:** If the ribbon is less than 1 inch long: **Go to Step 2**

**Step 2:** Excessively wet a small pinch of soil in your palm and rub with forefinger.



**C:** Is the soil gritty?
- **C1:** The soil is not gritty—**medium texture**
- **C2:** The soil is gritty—**moderately coarse texture**


START
Place approximately 25 g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.
Add dry soil to soak up water
yes
yes
Does soil remain in a ball when squeezed?
no
Is soil too dry?
no
Is soil too wet?
no
SAND
yes
Place ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.
LOAMY SAND
no
Does soil form a ribbon?
yes
Does soil make a weak ribbon less than 2.5 cm long before breaking?
no
Does soil make a medium ribbon 2.5-5 cm long before breaking?
no
Does soil make a strong ribbon 5 cm or longer before breaking?
yes
yes
yes
Excessively wet a small pinch of soil in palm and rub with forefinger.
SANDY LOAM
yes
Does soil feel very gritty?
SANDY CLAY LOAM
yes
Does soil feel very gritty?
SANDY CLAY
yes
Does soil feel very gritty?
no
no
no
SILT LOAM
yes
Does soil feel very smooth?
SILTY CLAY LOAM
yes
Does soil feel very smooth?
SILTY CLAY
yes
Does soil feel very smooth?
no
no
no
LOAM
yes
Neither grittiness nor smoothness predominates.
CLAY LOAM
yes
Neither grittiness nor smoothness predominates.
CLAY
yes
Neither grittiness nor smoothness predominates.