Soil Quality -- Why it Matters

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Sustainable Cropping Systems

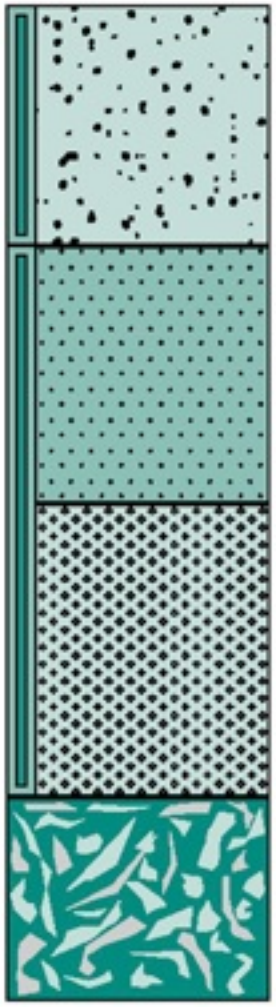
WHAT IS SOIL?

- **A portion of the earth's crust**
- **Formed from the decomposition of rocks and minerals**
- **Formed through physical, chemical, and biotic forces**
- **Is complex and dynamic**

FACTORS AFFECTING SOIL DEVELOPMENT

- **Chemical Weathering**
  - **Carbonation, Hydration, Hydrolysis, Oxidation**
- **Physical Weathering**
  - **Temperature changes, Glacial movement, Moving water**
- **Climate**
- **Organic Fraction**
- **Topography**
- **Time**
- **HUMANS**

Soil Development



Topsoil

Subsoil

A-horizon (High in organic matter; highly weathered soil)

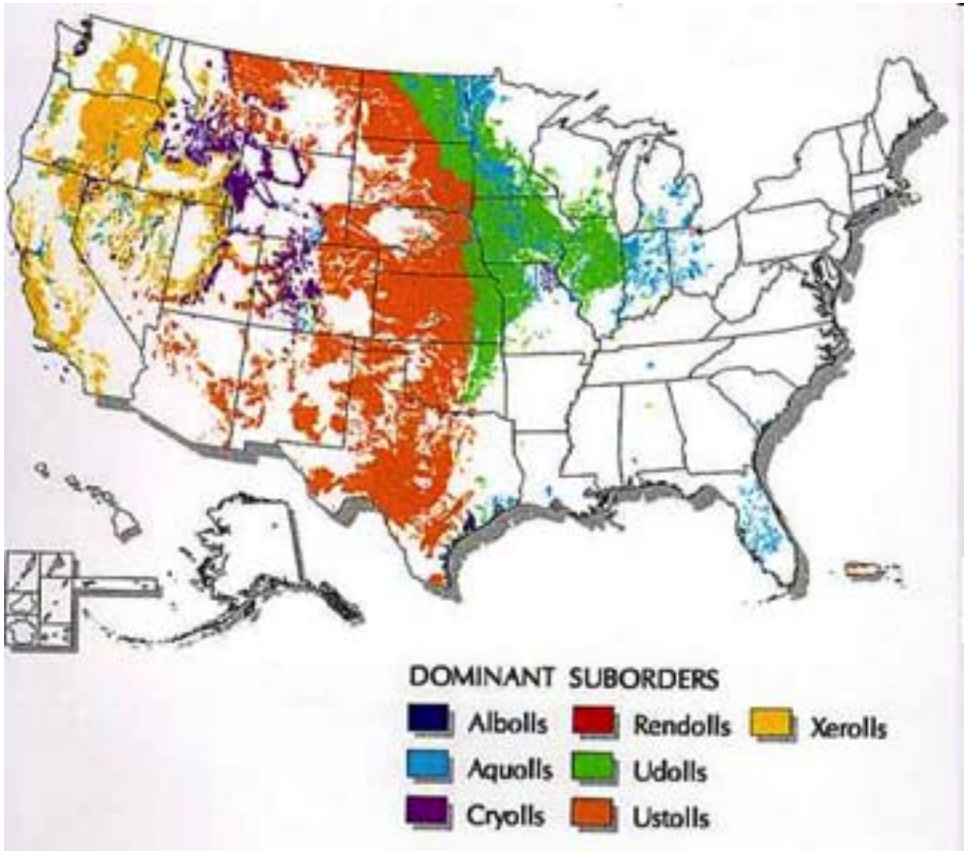
B-horizon (Leached materials from A accumulate here; soil less weathered)

C-horizon (Weathering just starting)

Parent material (Material from which soil is formed)

There are 10 soil orders – depends on parent material and soil forming factors

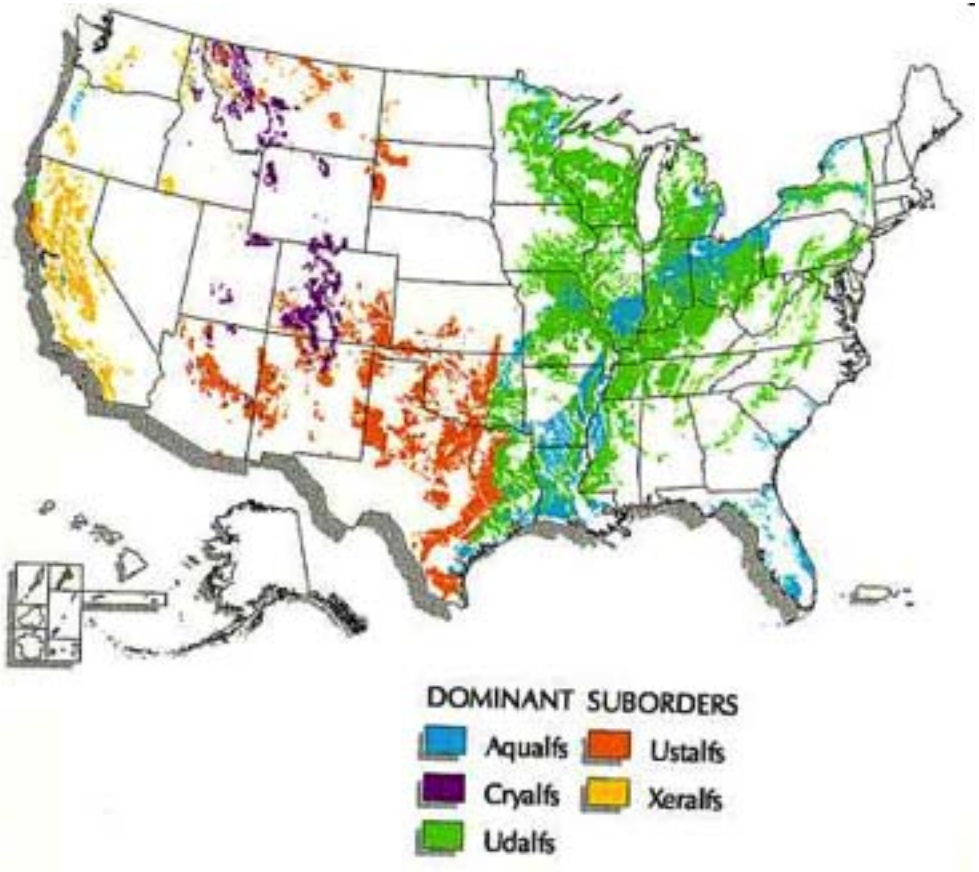
- Mollisols - grasslands



There are 10 soil orders – depends on parent material and soil forming factors

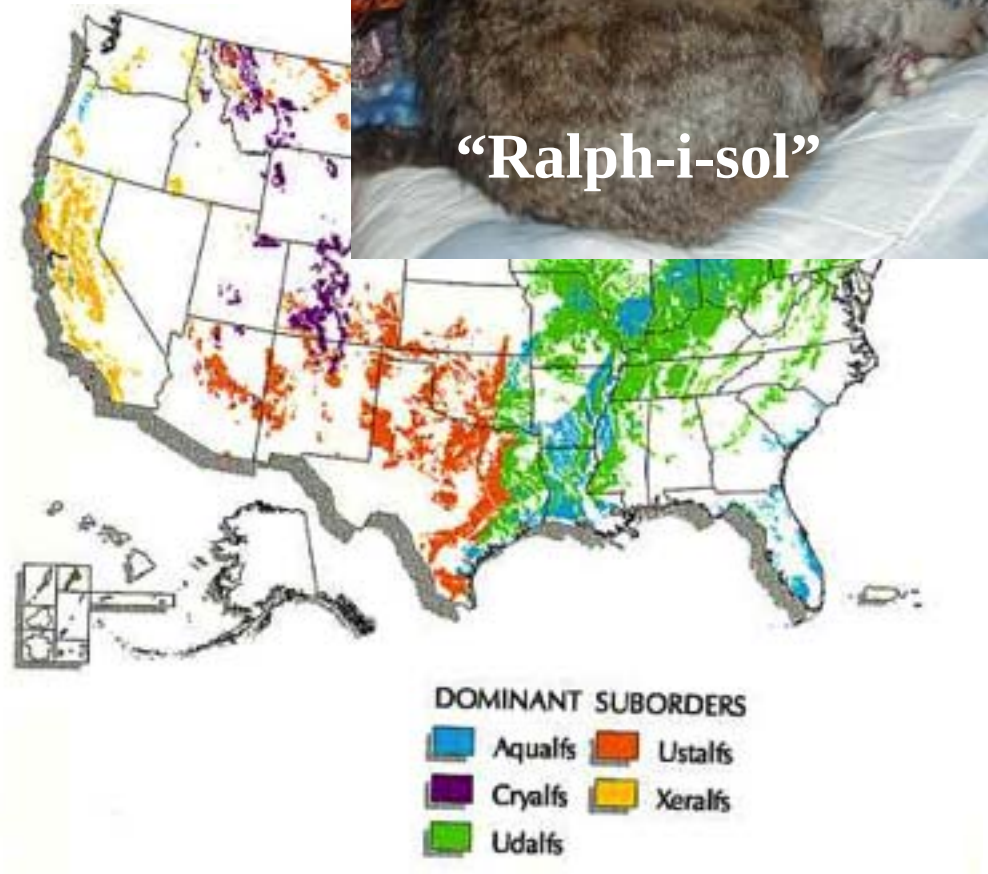
- Mollisols

- Alfisol – deciduous woodland



- Alfisol

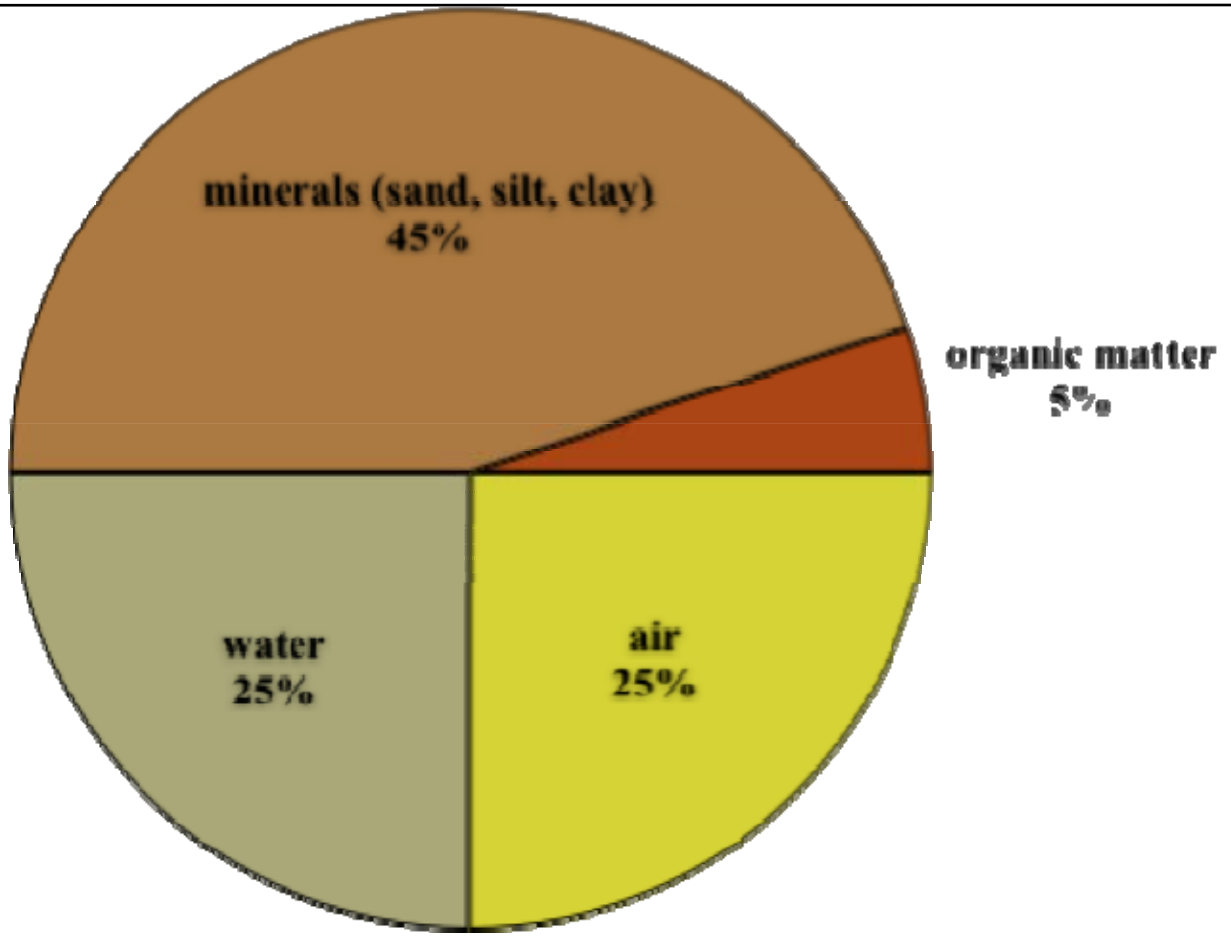

“Ralph-i-sol”


DOMINANT SUBORDERS
Aqualfs
Ustalfs
Cryalfs
Xeralfs
Udalfs

Soil is *not* Dirt

“Dirt” the Movie:

http://www.youtube.com/watch?v=TKPcuwOOGqY



Soil Tests for Quality: physical, chemical, & biological

Definition of Soil Quality

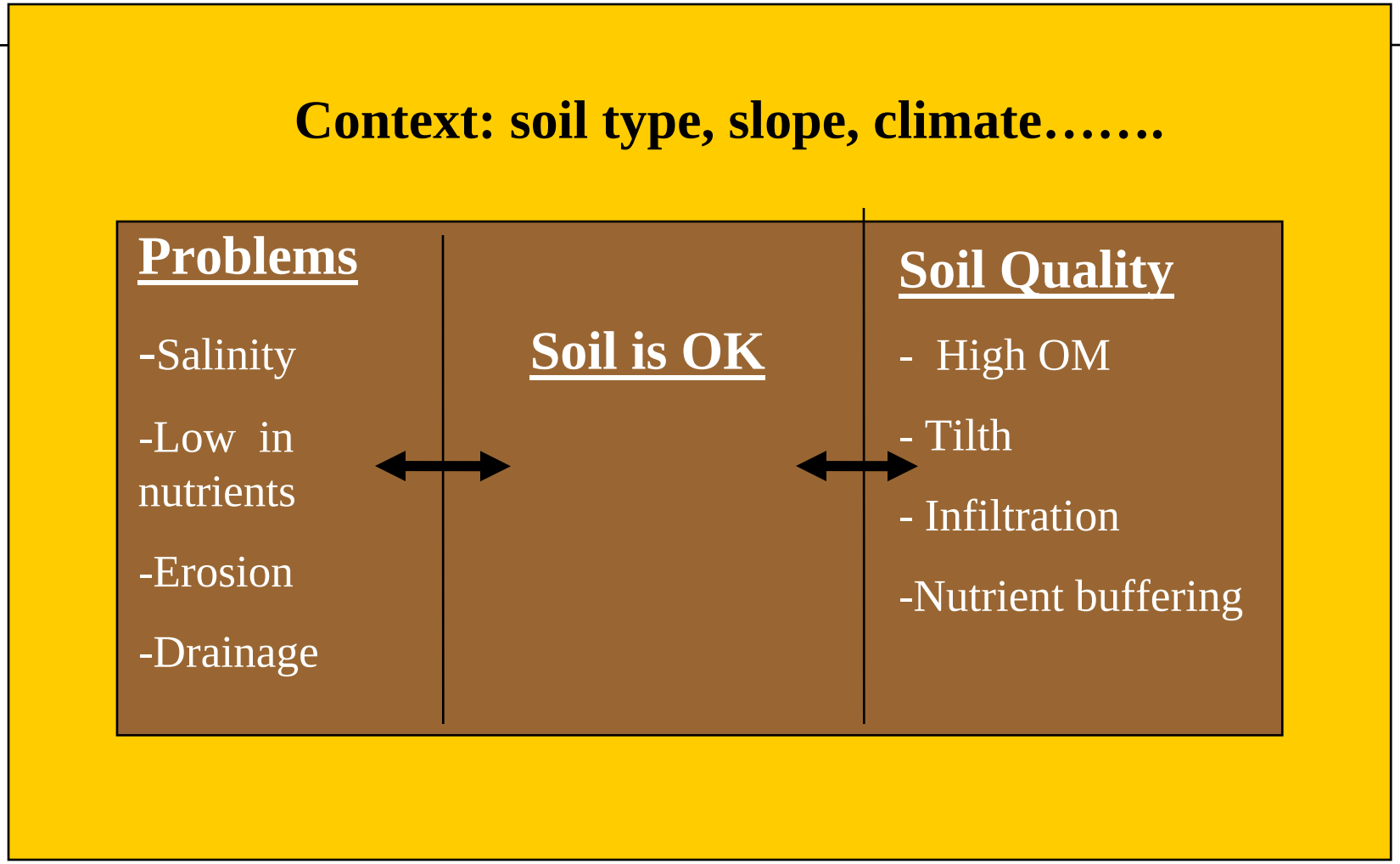
Soil Fertility

Physical Properties

Biological Activity

“The ability of soil to function; to supply plants with adequate nutrients, have good drainage and aeration, promote root growth and biological activity.”

A Definition of Soil Quality



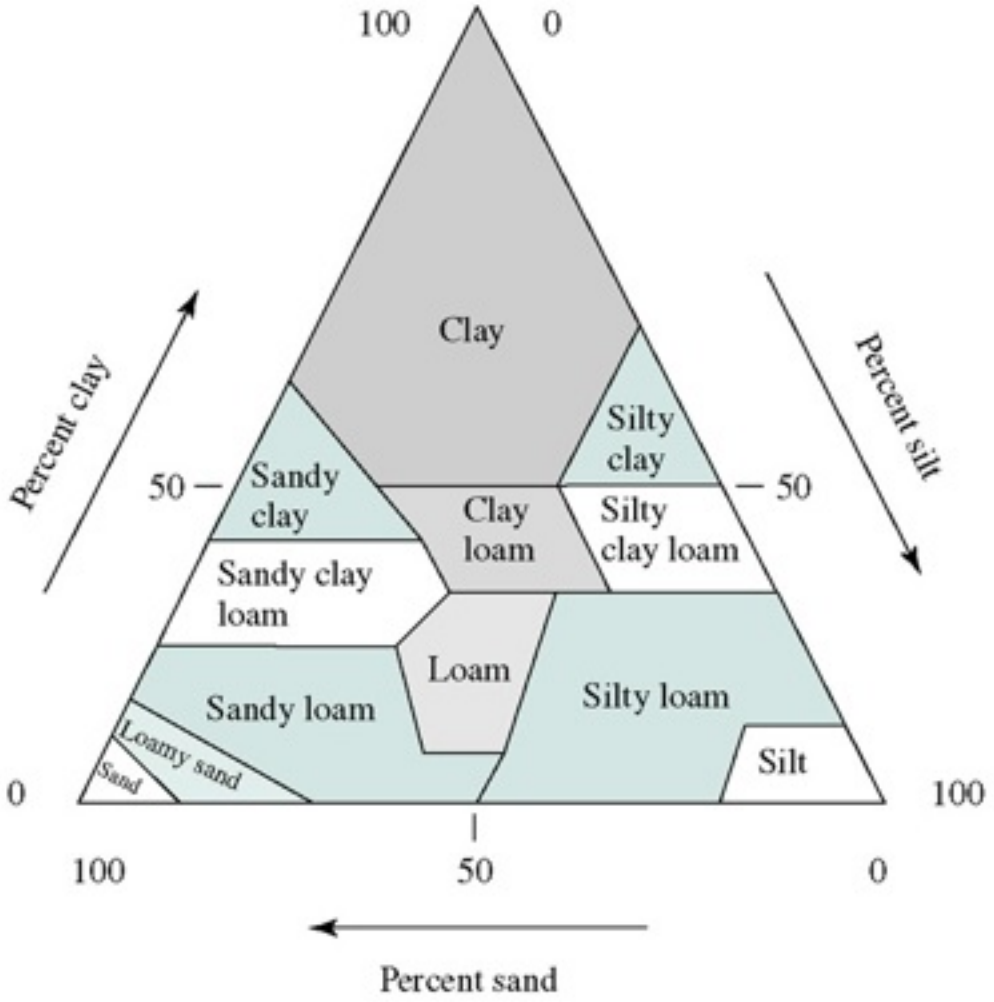
Physical Tests -- Soil Texture

- Fill a jar 2/3 with soil.
- Fill the same jar about 7/8 full of water. Add detergent (optional) to break up aggregates.
- Shake well.
- Measure height of settling at 30 seconds, 30 minutes, and 24 hours – or -- look at particle size differences – sand, silt, and clay layers.

Soil Texture

- Estimate by rolling slightly moist soil in fingers
  - Firm ball, smooth and becomes sticky when moistened → mostly clay
  - Won't stay together and feels gritty → a mix/silt
  - Won't stay together and feels very coarse → sandy

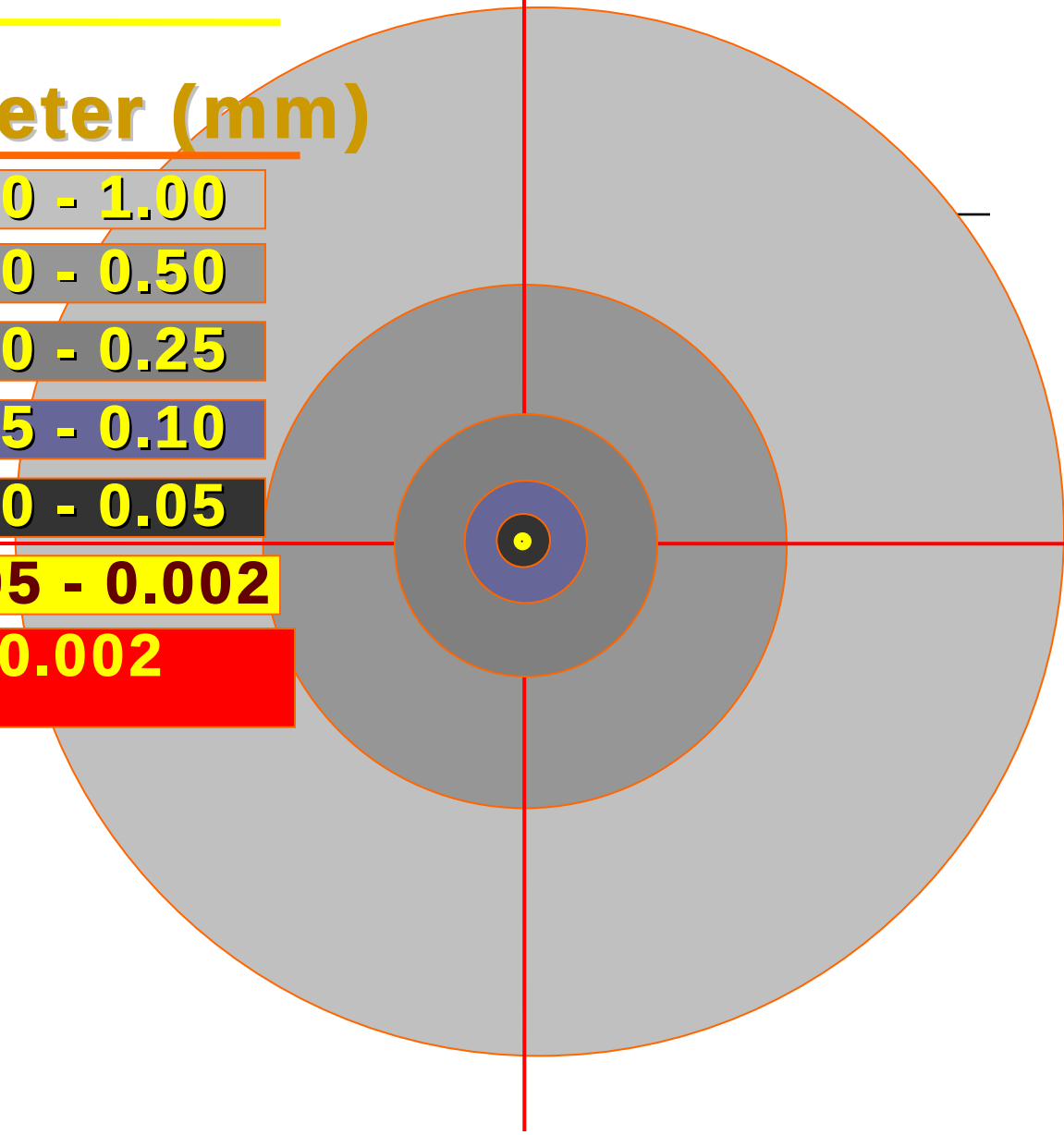
SOIL TEXTURE



Soil Texture

100 X

Separate	Diameter (mm)
Very Coarse Sand	2.00 - 1.00
Coarse Sand	1.00 - 0.50
Medium Sand	0.50 - 0.25
Fine Sand	0.25 - 0.10
Very Fine Sand	0.10 - 0.05
Silt	0.05 - 0.002
Clay	<0.002

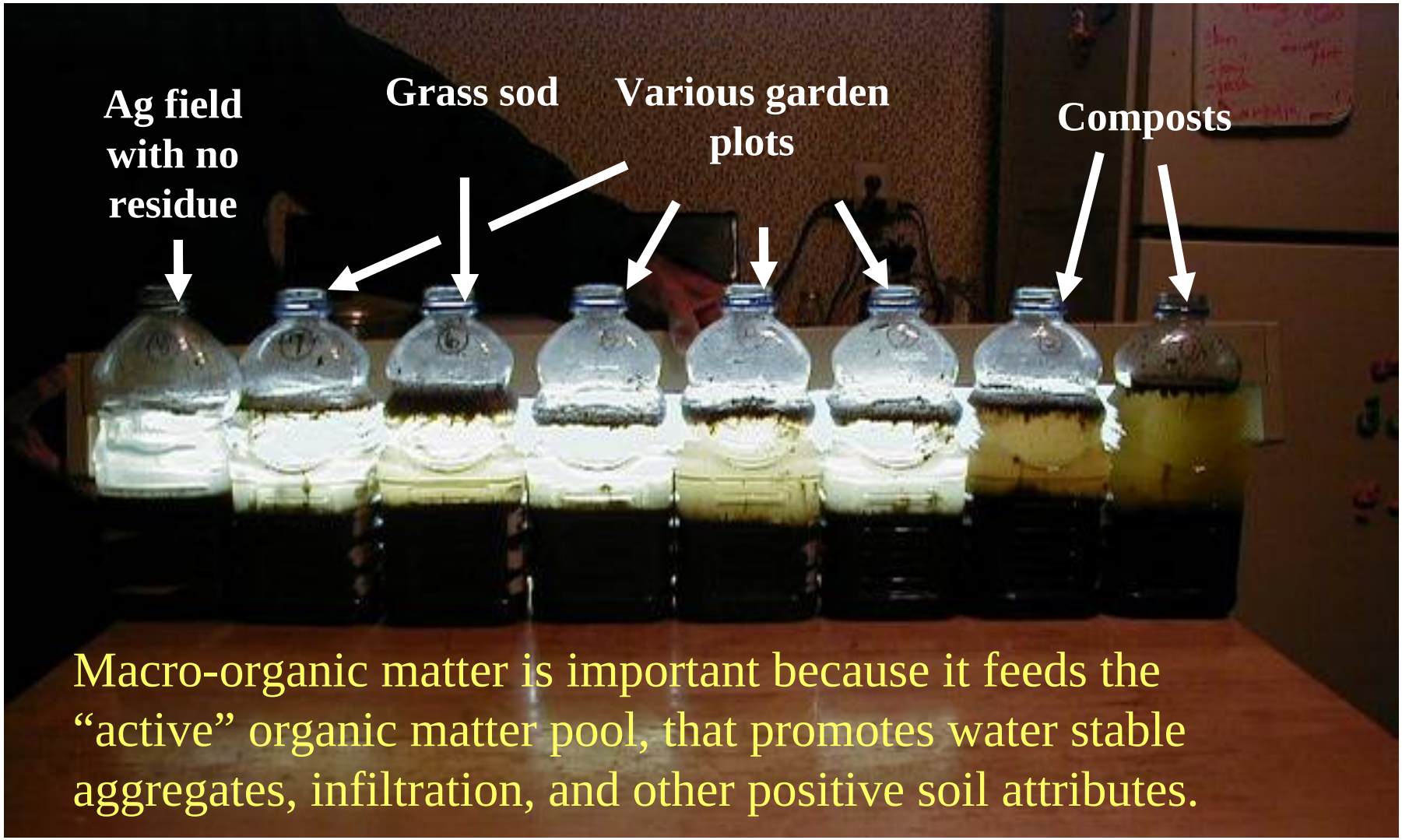


Texture largely determined by parent material of soil, past erosion, and new deposits (such as topsoil addition)

- **Sandy soil** – good drainage, but doesn't hold water or nutrients well. (particles 0.05 to 2 mm)
- **Silt** – moderate drainage, moderate nutrient and water holding capacity. (0.002 – 0.05 mm)
- **Clay** – poor drainage, can supply K mineral, shrink/swell with water (<0.002 mm)

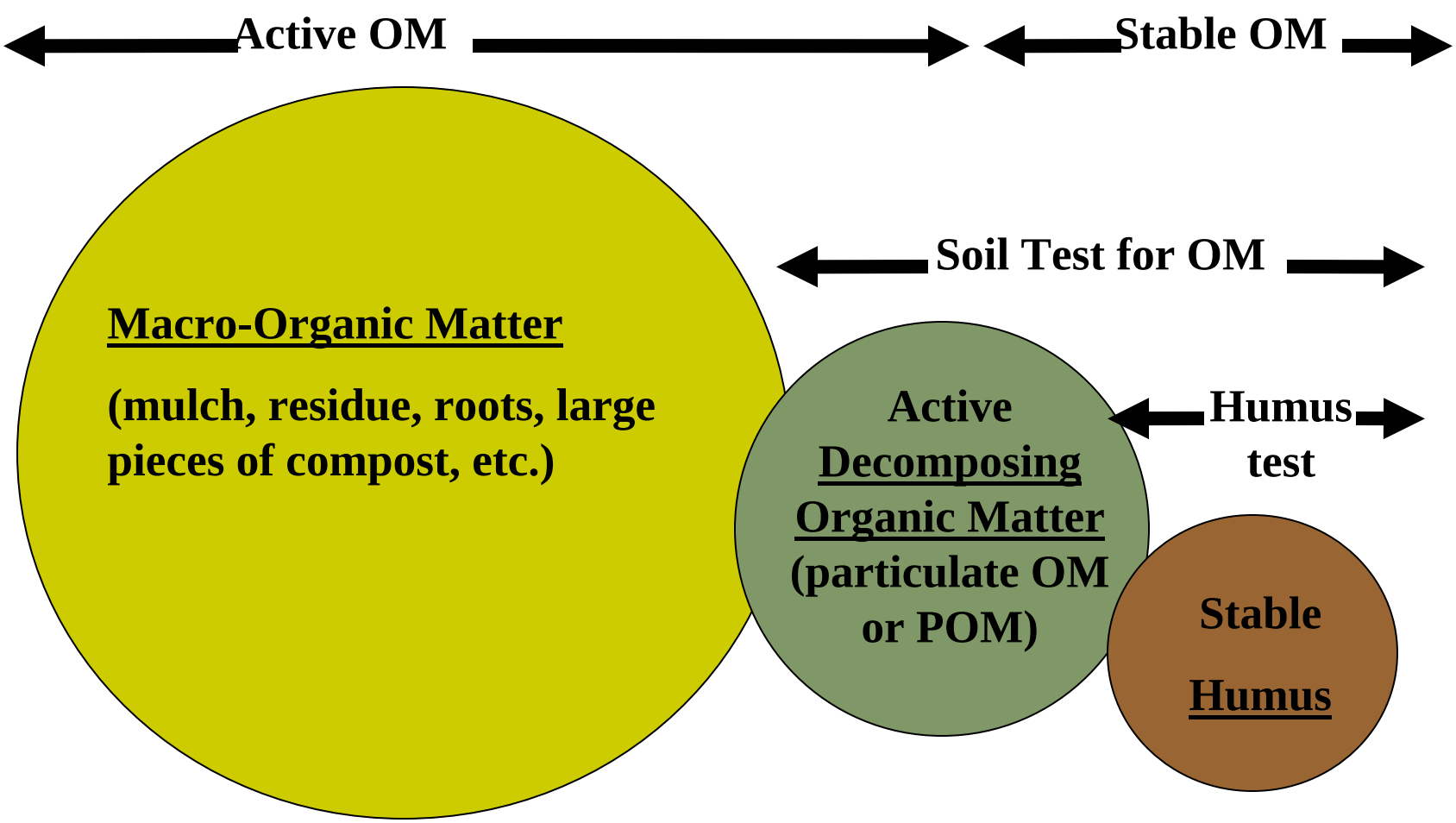
- **All of these characteristics are helped with the addition of organic matter, especially composts.**

Can also examine “macro-organic matter flotation” at home.

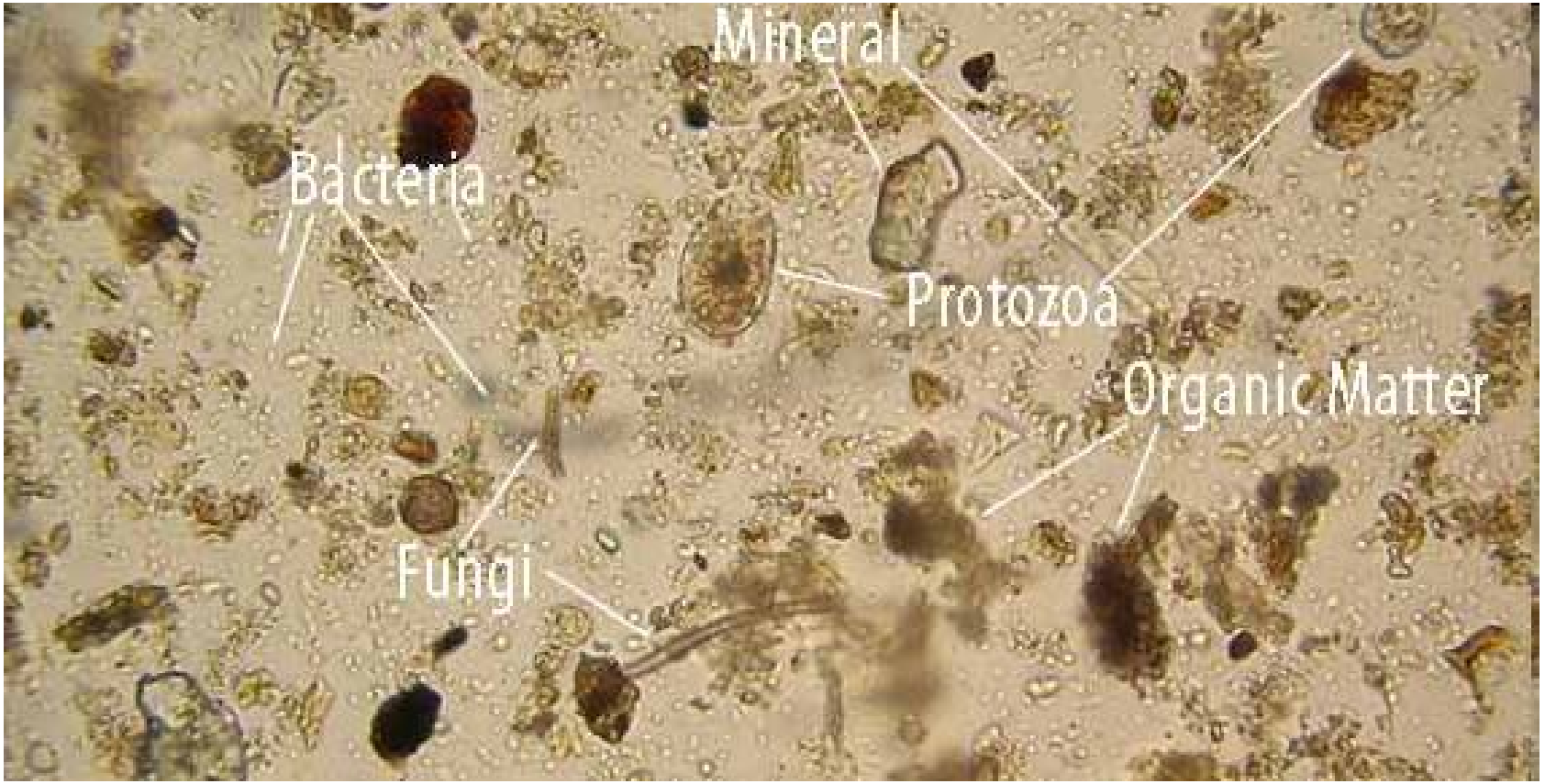


Macro-organic matter is important because it feeds the “active” organic matter pool, that promotes water stable aggregates, infiltration, and other positive soil attributes.

Organic Matter Pools

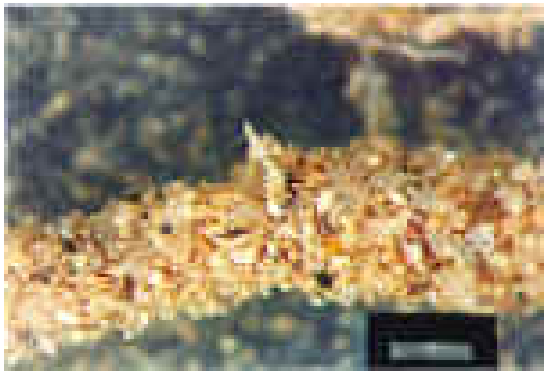


Healthy Soil photo



Water Stable Aggregates

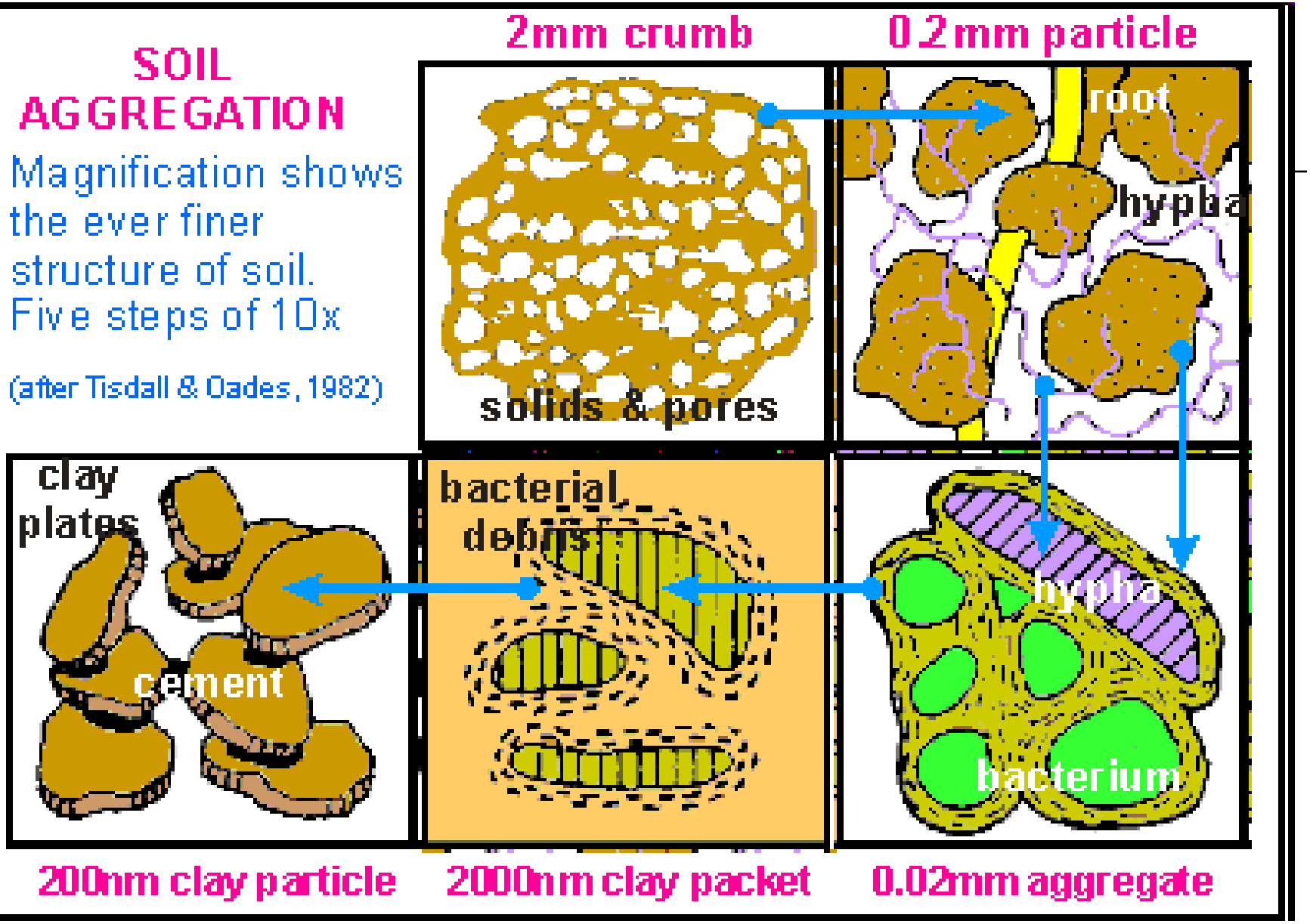
- Formed by the aggregation of clay (smallest particles), followed by gluing together of macro-aggregates with bacterial secretions, fungal hyphae, and root hair bonding.



SOIL AGGREGATION

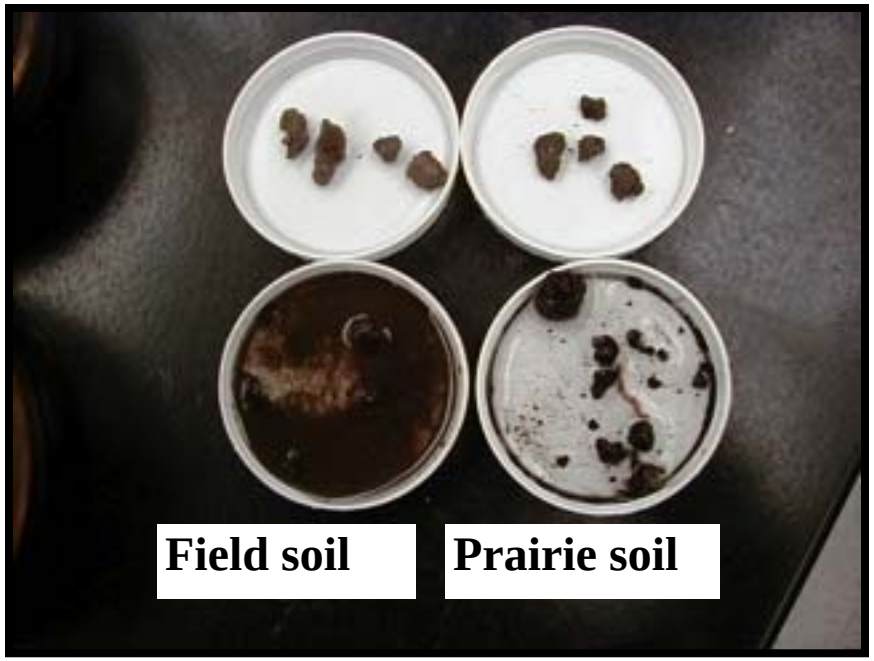
Magnification shows the ever finer structure of soil. Five steps of 10x

(after Tisdall & Oades, 1982)



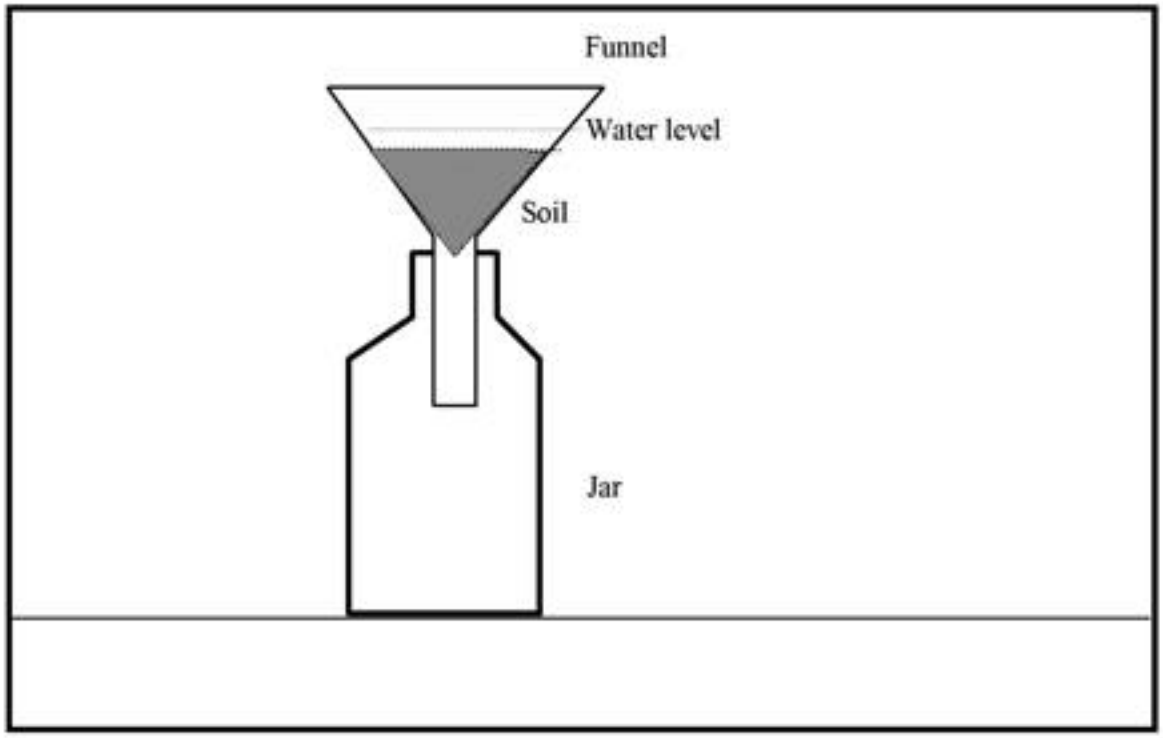
To measure water stable aggregates:

- Use a stack of sieves under water.
- Demonstrate with a few aggregates in a shallow dish.



To measure the *effect* of water stable aggregates:

Figure 15. Lab Infiltration Test with Funnel.



Results:

Notice the lack of soil structure on the left (field soil) and the presence of water stable aggregates on the right (prairie soil)

First scoop:

Field = 38 seconds

Prairie = 20 seconds.

Second Scoop:

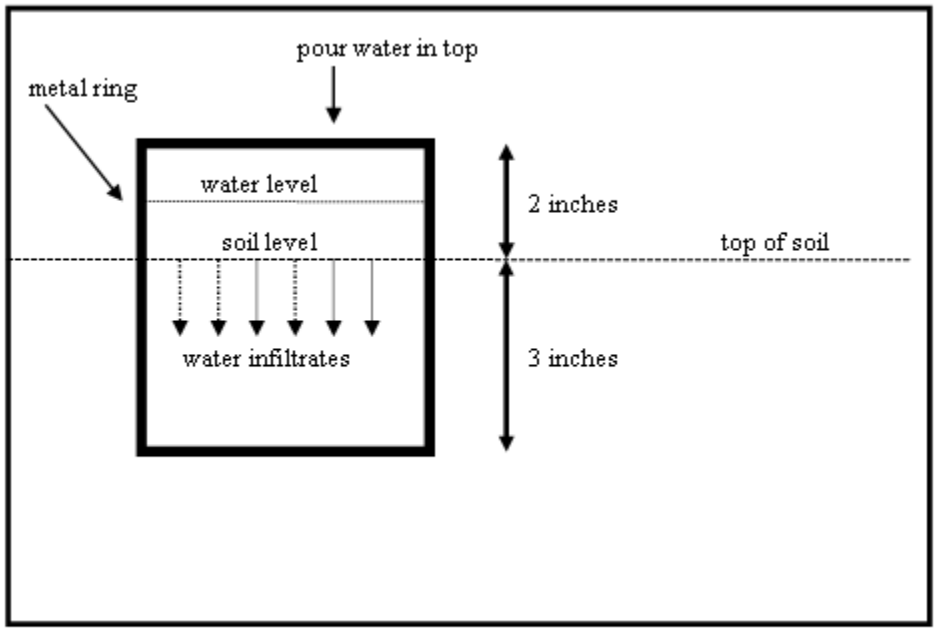
Field = 2:06 minutes.

Prairie= 1:15 minutes.

Faster infiltration means that more rainfall will soak in to your soil.

A similar test can be run in the field. Use a section of irrigation pipe or coffee can to create an “infiltrometer.”

Figure 14. Illustration of an infiltrometer



In a 6 inch diameter ring, pour 1 7/8 cup water. Measure amount of time to soak in. Repeat measurement.

What are the four ways to improve water infiltration?

Four Ways to Improve Infiltration:

- Adding organic matter
- Adding organic matter
- Adding organic matter
- Don’t work the soil when wet!!!

Good cover crops for the garden - plant in the fall

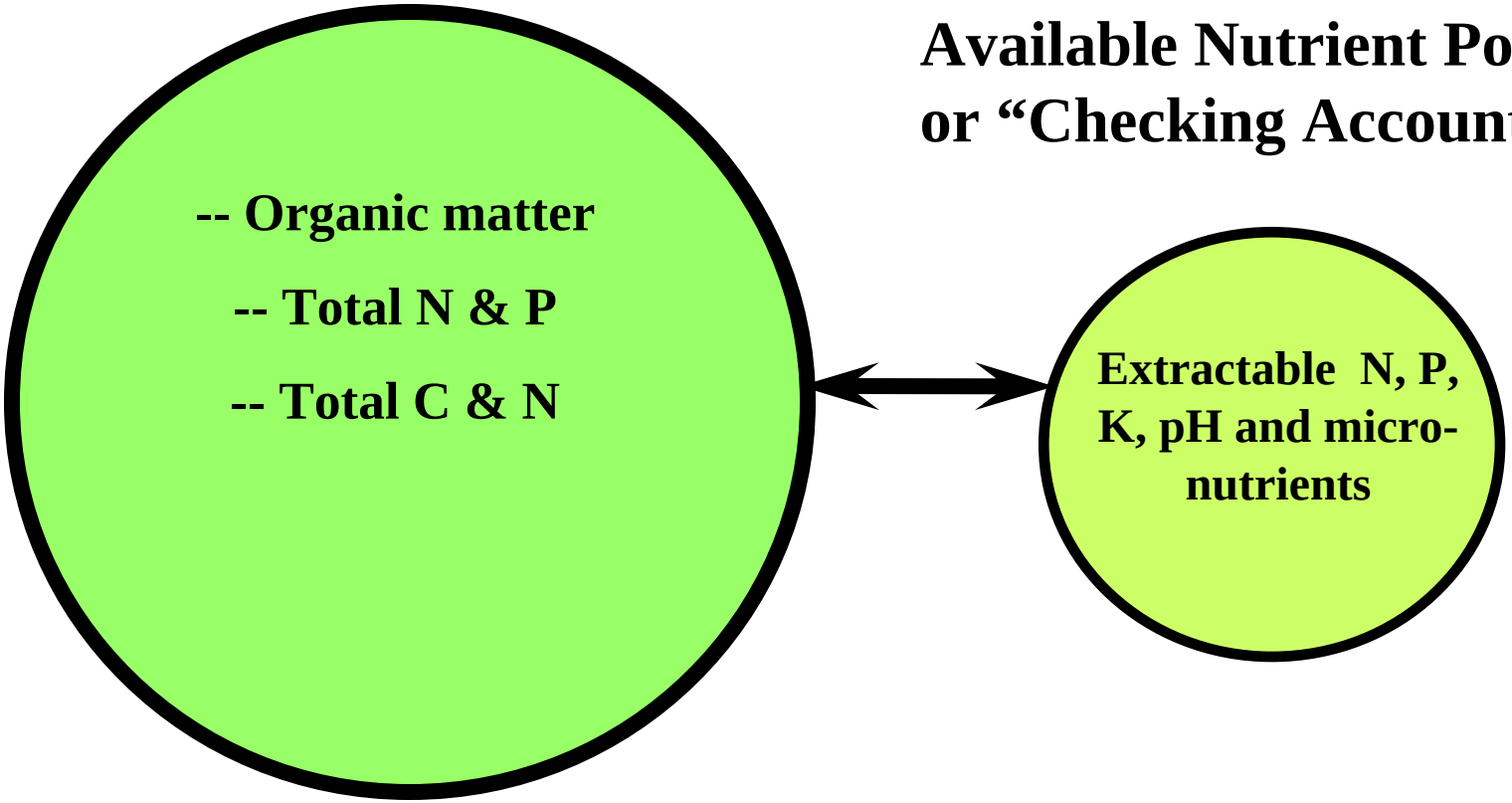
Bins can be used for worm composting.

NOP has strict rules for definition of “compost.” Difficult at small scale.

Lab soil fertility tests available:

Organic Matter Pool, or "Savings Account"

Available Nutrient Pool, or "Checking Account"



Prairie Soil vs. “Ag” Soil

N and P in the organic matter pools.

	Organic Matter	NO_3 (ppm)	Total N (ppm)	Soluble P (ppm)	Total P (ppm)
Ag	3.0 %	22.1	1363	58	412
Prairie	7.6 %	26.4	2828	34	652

"Banking" on Soil Nutrient Levels

Your Savings Account

-- Organic matter content, total N, total P, *clay* release of K.

-- These are slowly available, but can accumulate over time to be available later.

-- This is sometimes called nutrient "buffering."

Your Checking Account

-- Mineral N, available P and K

-- This is an indication of what will be available that growing season

-- Soil pH will influence the availability of these and micro-nutrients

How to build up your soil “savings” account.

Local, on-farm sources:

- cover crops, annuals *and* perennials.
- hay mulch
- compost
- raw manure (use with caution, not on leafy crops)
- wood chips, ash (also use with care)

Purchased products:

- alfalfa and soybean meal (N)
- bone meal, rock phosphate (P)

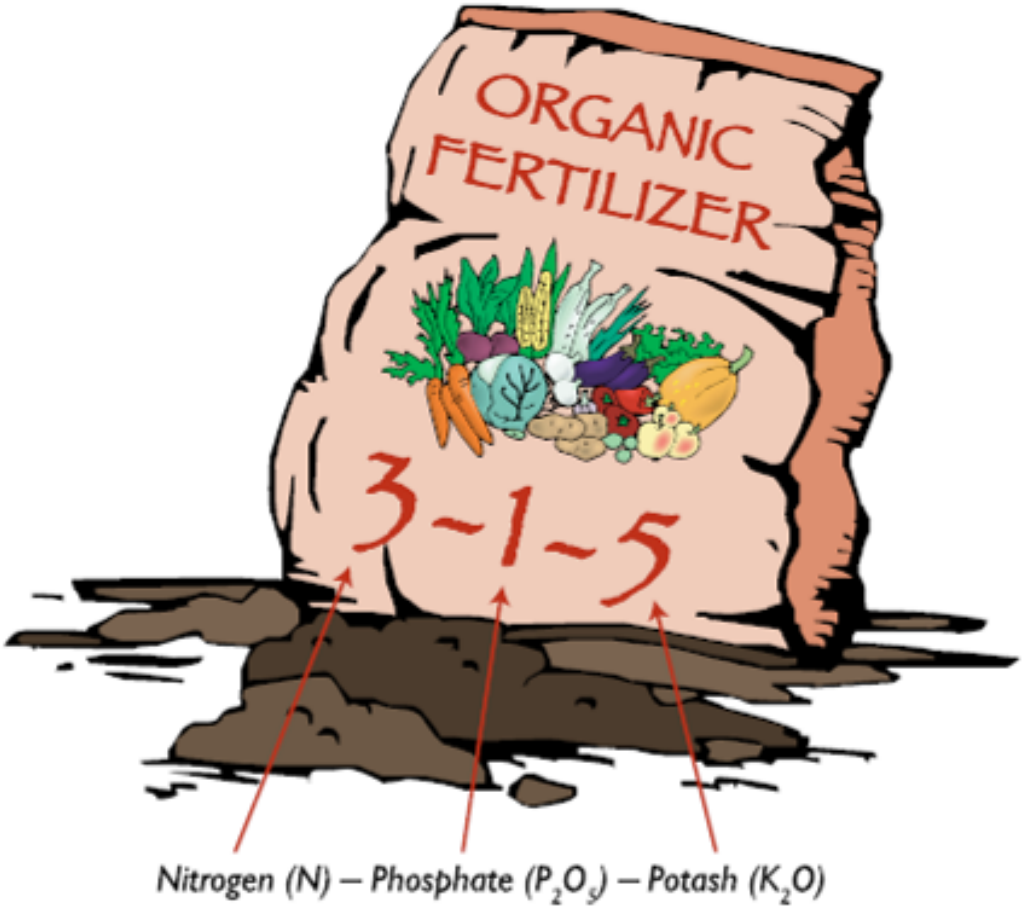
Practices that deplete your soil “savings” account.

- Too much tillage.
- Bare ground (no mulch on top).
- No living crops (no roots in the soil).
- Soluble fertilizers without concurrent addition of carbon rich mulches or composts.

Interpretation of chemical tests

- How much is “just right?”
- How do you know if there is not enough?
- When is there too much?

Nutrient levels – a story about Goldilocks and the three bears…..

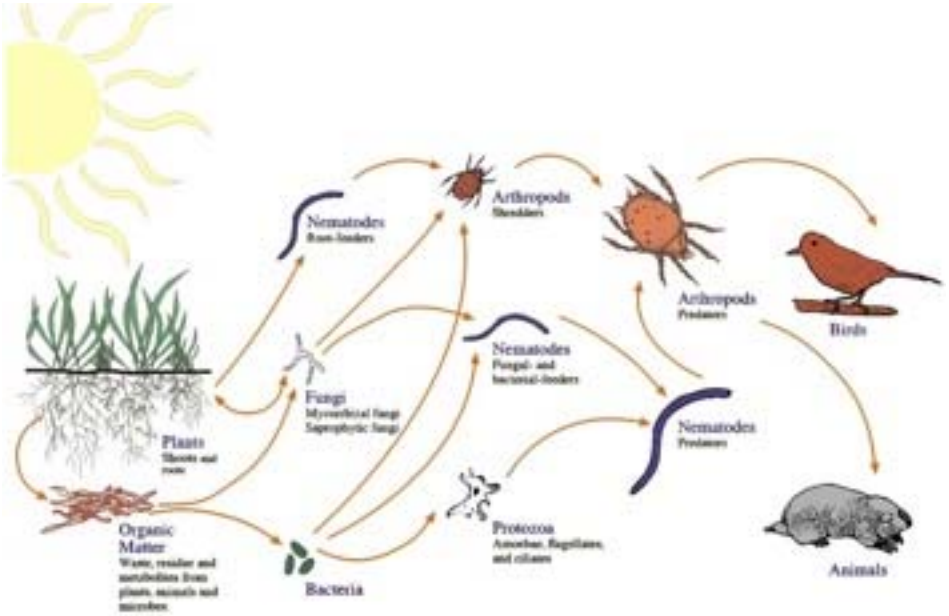


Levels of major plant nutrients are printed on fertilizer bags.

Ways to save money

- Only put on what you need
- Keep your nutrients in balance – don't let any one get too high or too low
- Compost applications supplemented with other N sources (fertilizer, fish emulsion, alfalfa pellets, blood meal, manures) will grow a VERY healthy garden.
- Too much N can damage crops too – examples include fruit trees, and perennials that need to prepare for winter dormancy.

Soil Biology Cont…….



Soil biological tests include earthworm counts (by hand), extraction of soil insects with light above and funnel below into a jar.

No accurate tests yet for microbial species diversity.
Soil respiration rate tests also available, but difficult to interpret.

The “will it rot?” soil test.

- Wet filter paper.
- Place in bottom of flat covered dish.
- Fill dish with moist soil.
- Add a little more water
- if needed.
- Incubate and watch.
- Observe the amount of decomposition after certain length of time.
- Examples (see photos) incubated for 1 week at 95^{o} F.

Canvas fabric and rubber bands

Ready to go to the field.

Sweet potato bed fresh dug soil

Buried fabric/canvas

Ready to bury in worm compost & leaves (old oyster mushroom bag of spawn on left)

Buried canvas in worm compost/leaves

Good Roots Need Good Soil

- Many “sick” plants don’t have a disease, they just need better roots/soil.
- Good soil conditions can also help plants fight off disease and insect pests (like a healthy immune system in a person).
- Try to improve the subsoil and also the topsoil. Limit compaction, and keep adding organic matter over a period of years.

For more information:

- **http://www.oznet.ksu.edu/ (to get to all KSU publications, soil test lab info, etc.)**
- **http://www.oznet.ksu.edu/kswater (for "Citizens Guide to Soil and Water Testing")**
- **http://soils.usda.gov/sqi/index.html (fact sheets and other info on soil quality)**
- **http://www.woodsend.org/ (copies of other soil quality publications, compost testing)**
- **http://www.amazon.com or other book seller (for copies of "Soul of the Soil.")**