Understanding Soil Basics and How to Build a Great Soil

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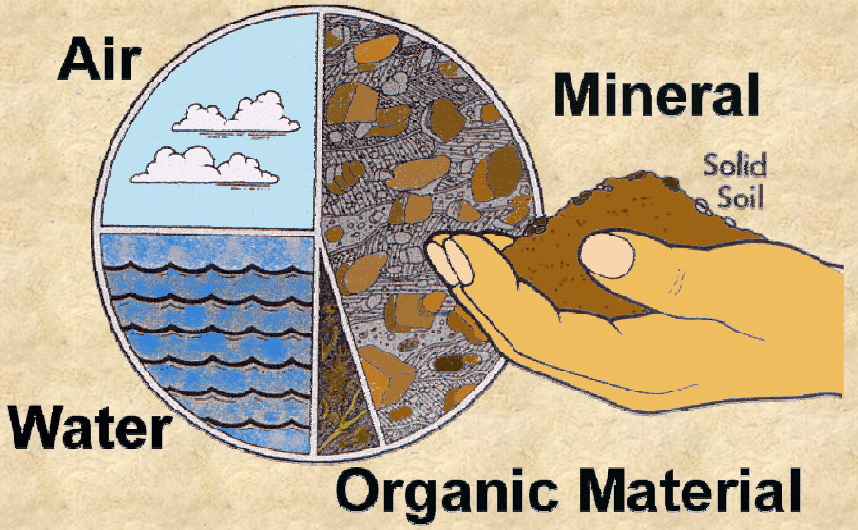
Soil*: it's not just "dirt!"*

- "Man…Despite his very real accomplishments and his artistic pretensions…Owes his existence to 24 inches of topsoil and the fact that it rains!"

Definition of Soil

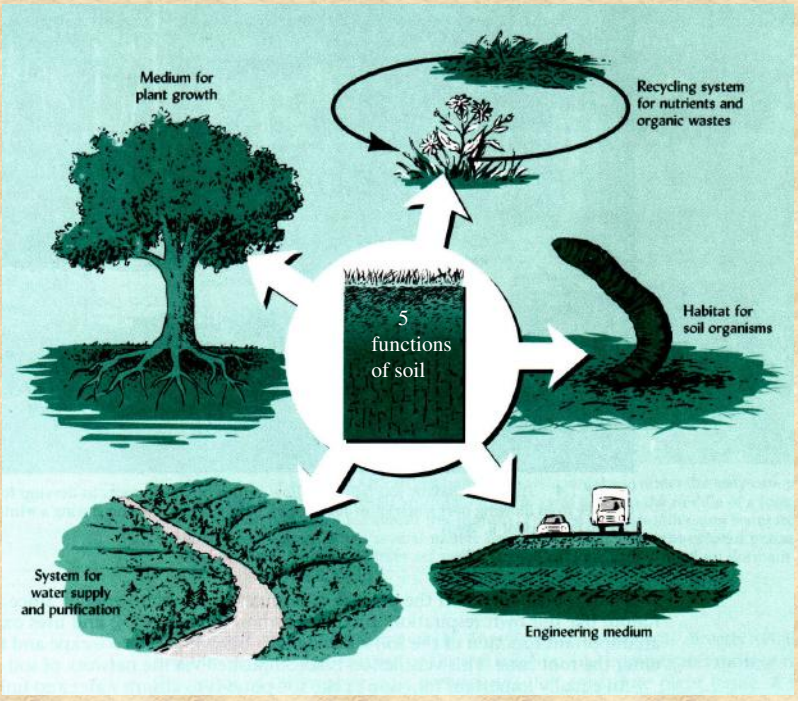
- Soil: a *living*, *dynamic* *system* at the *interface* between air and rock. Soil forms in response to forces of *climate* and *organisms* that act on *parent material* in a specific *landscape* over a long period of *time*.

Four Principle Components of Soil



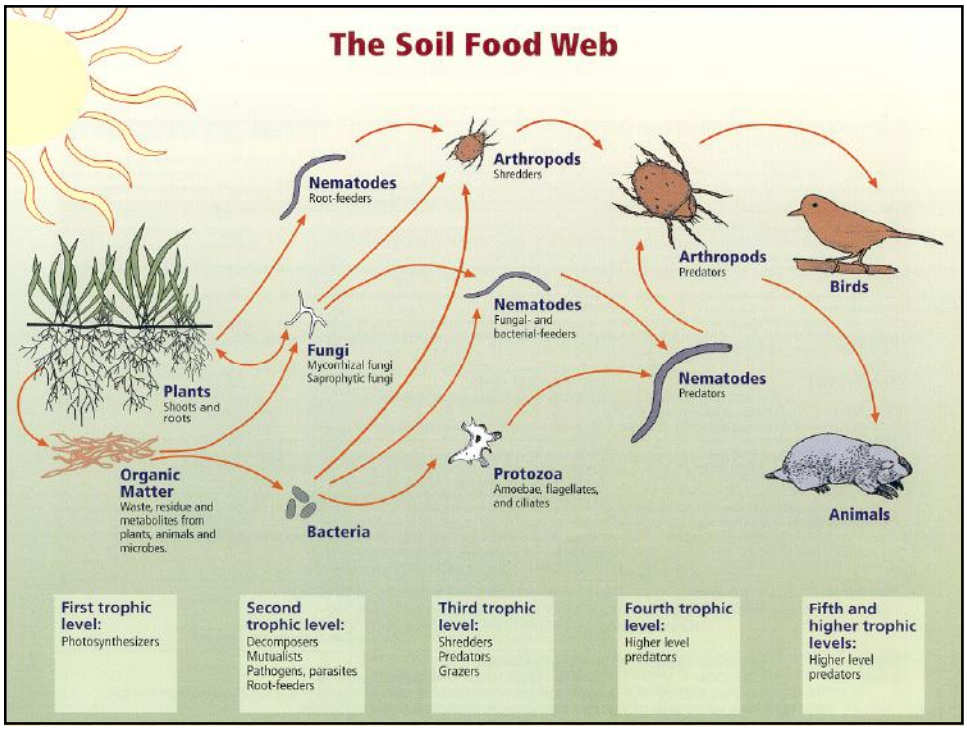
Interface

- Earth's radius ≈ 4,000 miles
- Soil's thickness ≈ 10 feet
- Soil makes up less than 0.00005 % of the Earth's radius!



Factors That Combine to Create Soil

- Climate- weathering
- Organisms- nutrient cycling, good structure
- Parent material- sand, silt, clay (sediments)
- Landscape- slope, exposure
- Time- physical, chemical, biological, geographical



Earthworms – (have gizzards!)

- Probably the most important component of soil fauna (not in acid soils, not in very dry soils)
- Pass as much as 12.5 tons/ac of soil through their bodies (mixing horizons) each year
- Excreted casts higher in N, P, K, Ca, Mg, pH, and CEC
- Promote good soil structure and aeration

est. wt. of worms in US = 10X wt. of entire human population

Soil Organisms

- **Life in the Soil**

- The main function of soil organisms is to break down the remains of plants and other organisms.
- This process releases energy, nutrients, and carbon dioxide, and creates soil organic matter.

Soil Organisms

- **Life in the soil**
- The activity of soil organisms depends on:
- Soil moisture
- Temperature
  - (70f-100f for microorganisms)
  - (50f for earthworms)
- Organic matter

Beneficial Organisms

- Mycorrhizae fungi
- Rhizobia bacteria
- Earthworms
- Moles

O Litter layer

A Mineral surface horizon, dark-colored, granular structure

E Strongly leached horizon, light-colored, platy structure

B Subsoil horizon of maximum development, "brown," blocky structure

C Weathered "parent material," "brown," massive structure

R Hard bedrock

Soil Properties

- Four soil properties:

- Color
- **Texture**
- **Structure**
- Consistency

Describe the characteristics of a soil

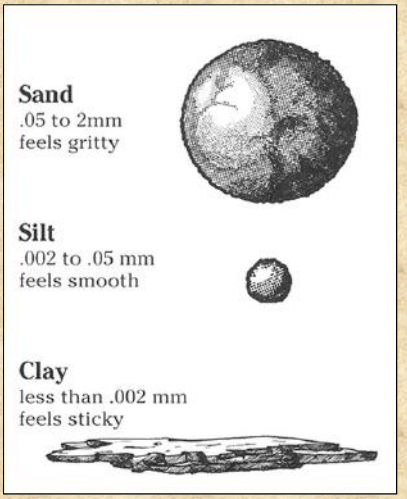
Differences in Soil Properties of Sand-Silt-Clay

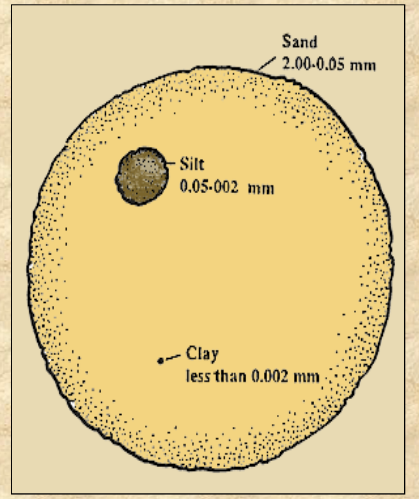
Property/Behavior	Sand	Silt	Clay
Ability to hold water	Low	Medium	High
Aeration	Good	Medium	Poor
Drainage	High	Medium	Very Slow
Organic Matter level	Low	Medium	High
Decomposition of Organic Matter	Rapid	Moderate	Slow
Warm-up in spring	Rapid	Moderate	Slow
Compactability	Low	Medium	High
Shrink/swell potential *	Very Low	Low	High
Ability to store plant nutrients	Poor	Medium	High
Resistance to pH change	Low	Medium	High

Texture

- Texture refers to the sizes and relative amounts of the constituent particles in a soil.
- For the most part, soil particles can be classified as either **sand, silt** or **clay**.

Texture describes how coarse or fine a soil is

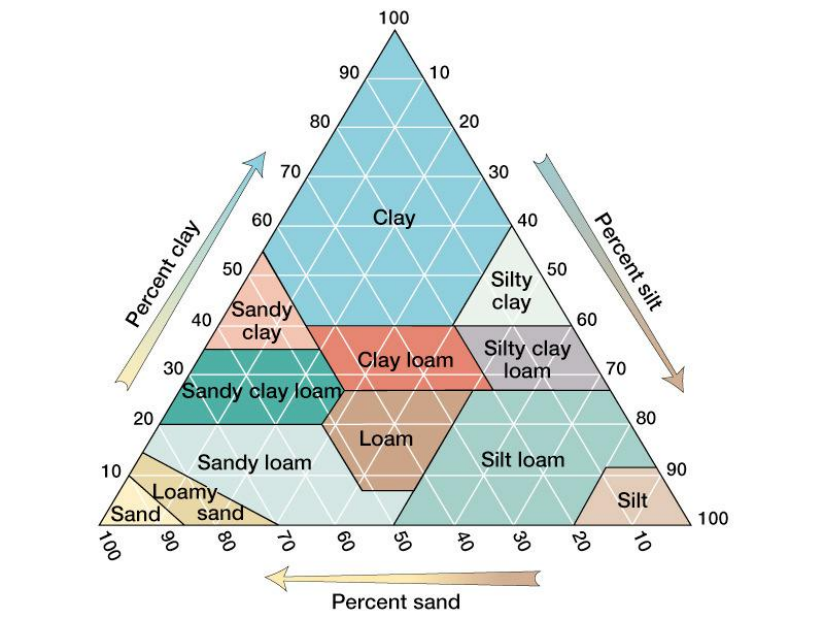




Loam is not topsoil!

- Topsoil is another name for the A horizon, where the bulk of biological activity in the soil occurs.
- Loam is a near-equal mixture of sand, silt and clay.
  - Thus sandy loam, silt loam and clay loam are all loam, each with a slightly different composition.

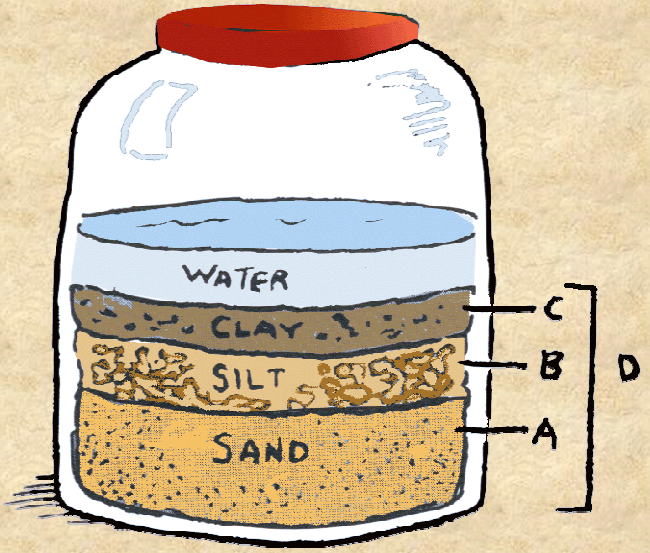
Soil Triangle



Soil Fractional Analysis

A= 20 min.
B= 2 hrs.
C= 24 hrs.
D= total

Quart jar
2/3 full water
1 cup dry soil
2 tsp calgon

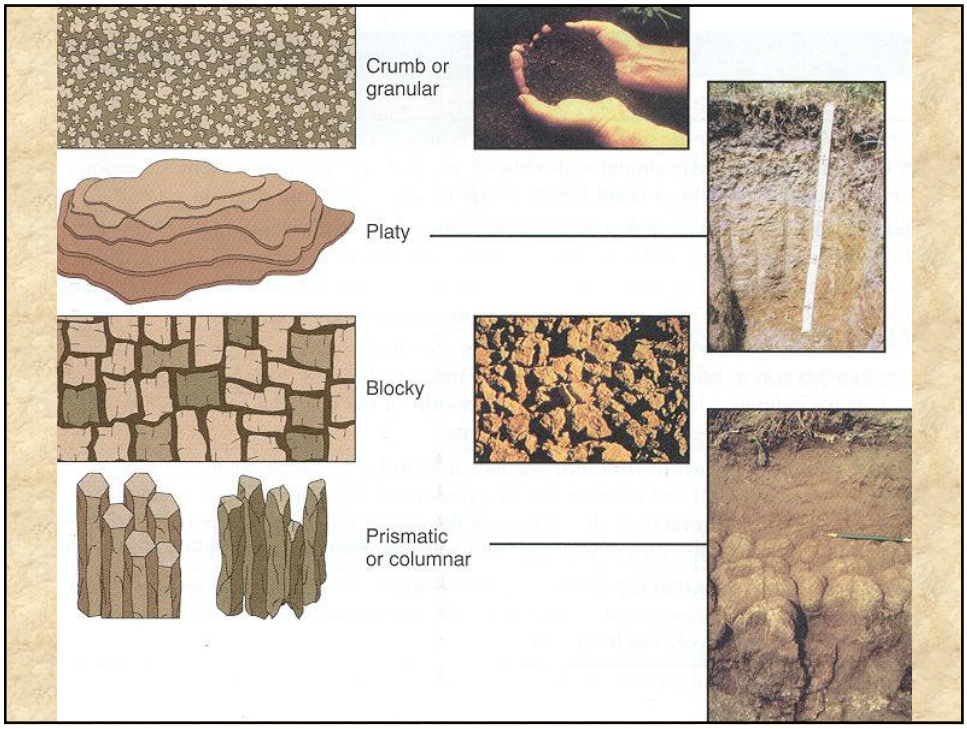


Altering soil textural properties

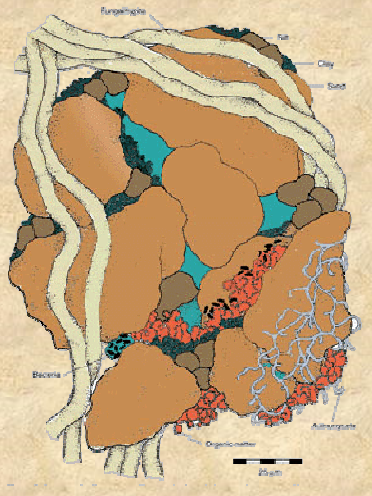
- Just accept it…this is virtually impossible!
- One acre of soil just 1 mm thick can weigh over five tons!
- Many clays, when combined with sand, form a low-grade concrete!
- **OM is the closest thing to a cure-all you'll ever find!**

Structure

- Soil structure refers to the way individual particles of sand, silt and clay are bound together into larger units called **peds**.
- Binding agents are provided by soil organisms such as bacteria and plant roots (exudates), OM (humus) and clay particles.



Soil and Water



Soil structure

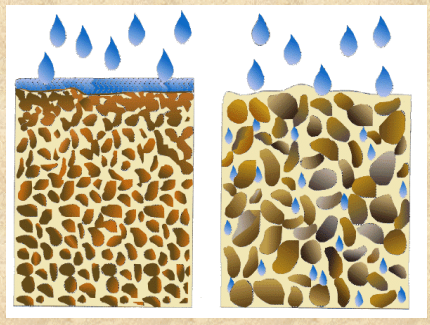
- Aggregation is a natural process caused largely by biological activity.
- Soil organic matter is an important binding agent for soil structure

Good Porosity & Permeability Resolve Many Garden Problems

- **Porosity:** amount of space (pore space) between particles in a soil.
- **Permeability:** ability of water to move through that pore space.
- Good structure is associated with large pores (**macropores**).
- OM is essential to the formation and maintenance of good soil structure (tilth).

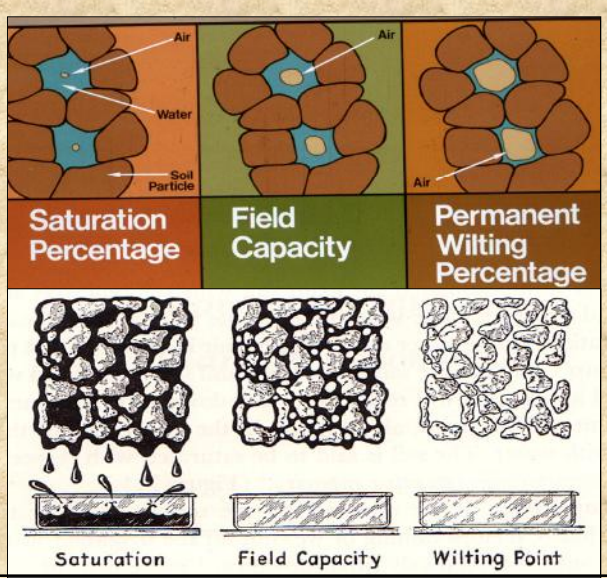
Soil and Water

A productive soil is permeable to water and is able to supply water to plants.

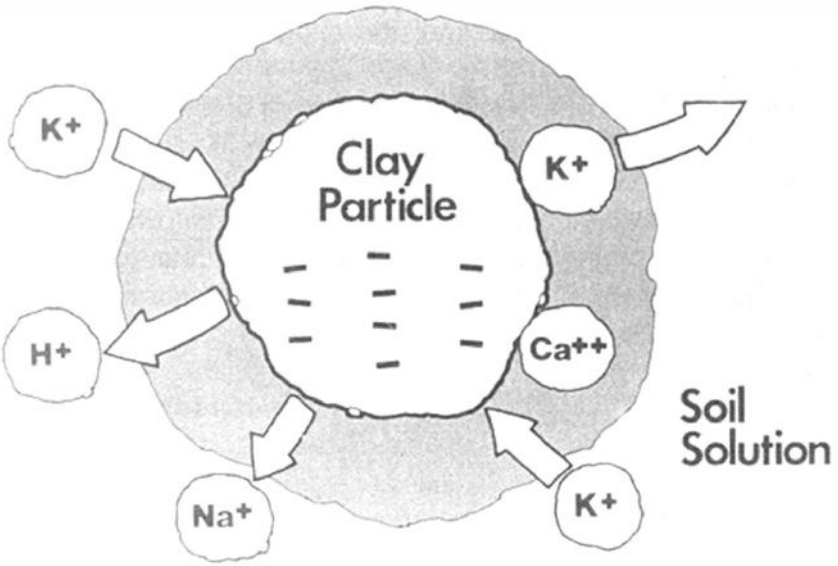


Poor infiltration Good infiltration

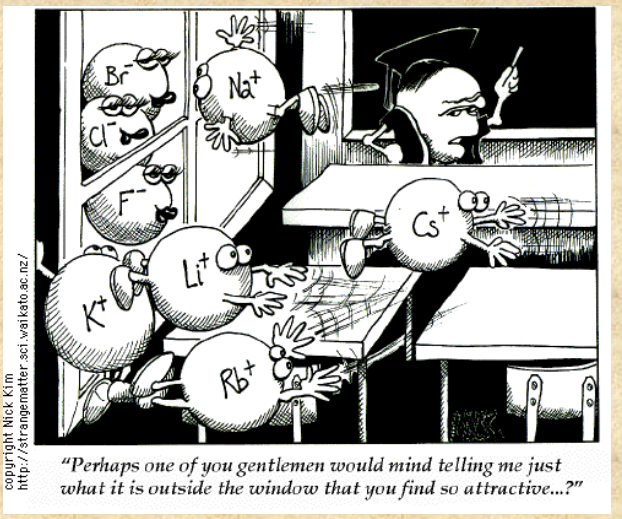
Available Water Capacity



Cation Exchange Capacity (CEC)



Cations + and Anions -



Building Soil Fast

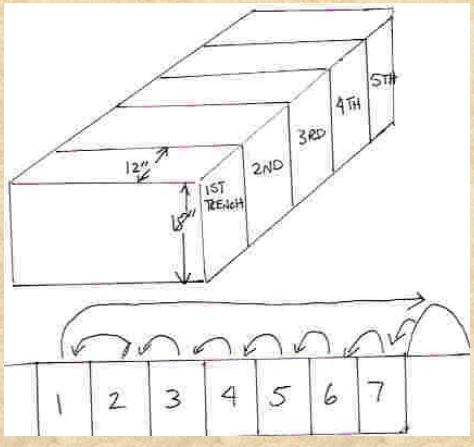
- Test the pH, adjust to make it 6-7
- Add other deficient macro nutrients K,P,Mg,S to enhance plant growth
- Annually add inches of compost, or other organic materials (manures, wood chips, livestock bedding etc.)
- Cover crop and till when soil is not wet

Double Digging

- Intensive method, 1.5-2 ft deep
- Dig first trench, remove soil with shovel
- Add lime or other minerals to trench
- Take garden fork and dig in first trench to loosen
- Dig second trench next to first, put soil in first trench
- Loosens soil gets nutrients deep in root zone

Double Digging Trench

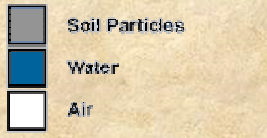
Double Digging Method

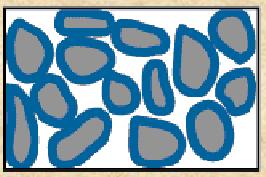


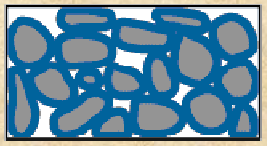
Soil Tillage

Compaction and loss of structure

- Tilling when soil is too wet damages soil structure.







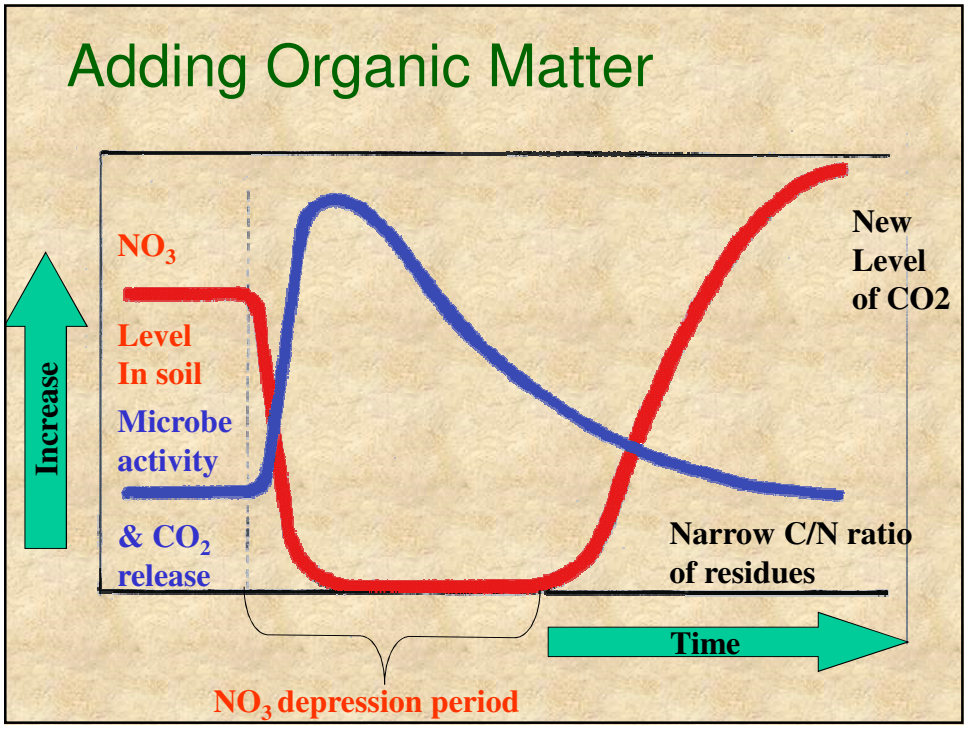
Non-compacted

Compacted

Minimize Tillage for Slower Soil Building

No Till Soil Building

- Ruth Stout method from 50's and 60's
- Layering organic matter over your garden
  - Manure, grass clippings, kitchen waste, compost, wood shavings, shredded newspaper
- Lasagne Gardening
- Sheet composting
- Slow process but effective



Adding Organic Matter

Compost

- **Compost is an excellent source of organic matter for garden soils.**
- **Composting also closes the recycling loop by turning waste materials into a soil amendment.**
- **You can make compost at home or buy commercially prepared compost.**

Benefits of Soil Organic Matter

- Soil aggregation
- Aeration and water penetration
- Moisture holding capacity
- Cation exchange capacity
- pH buffer
- Micronutrient chelation
- Plant nutrient source

Add How Much Organic Matter?

- Sandy soil, warm climate:1-1.5 tons/1000sqft
- Clay soil, cooler climate: 200 lbs/1000sq ft

Cover Crops

What is a Cover Crop?

1. Farming practice that imitates nature
2. Soil armor
3. Conservation practice
4. Green manure
5. Beneficial insect habitat
6. All of the above

Benefits of Cover Crops to Soil Fertility

- Nutrient cycling
- Nitrogen additions by legumes
- Enhanced phosphorus availability
- pH buffering
- Energy and food source for soil biota

Benefits of Cover Crops to Environmental Quality

- Reduce erosion
- Reduce nitrogen leaching
- Reduce surface water runoff
- Some species accumulate metals

Benefits of Cover Crops to Soil Structure

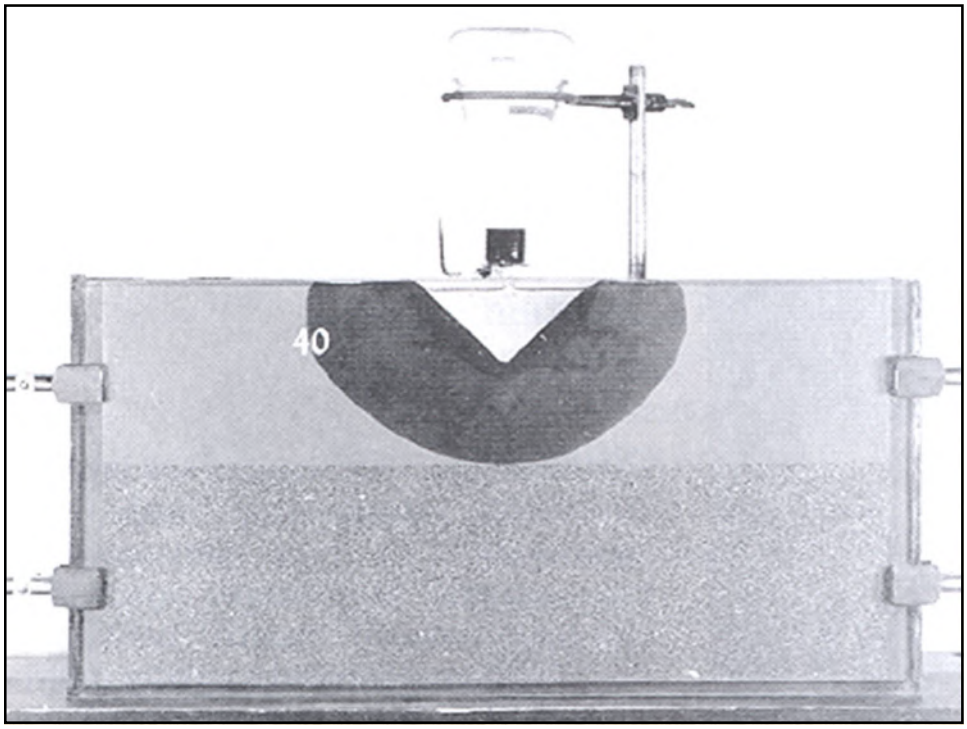
- Increase soil organic matter content
- Better soil aggregation
- Better water infiltration
- Improved water-holding capacity
- Improved aeration
- Reduced soil erosion
- Reduced soil crusting and compaction

Benefits of Cover Crops to Soil Temperature

- Soil bacteria die at 140F
- Bare soil temperature can go over 140F during summer
- 100% of soil moisture loss due to evaporation at 130F
- At 100F 15% of soil moisture used for growth and 85% evaporation and transpiration
- At 70F nearly 100% of moisture used for growth

Soil Water

- Water will fill like soils before moving into new soil types, regardless of soil texture!
  - This is the principle of dissimilar soils.
  - Plant roots will often do the same thing!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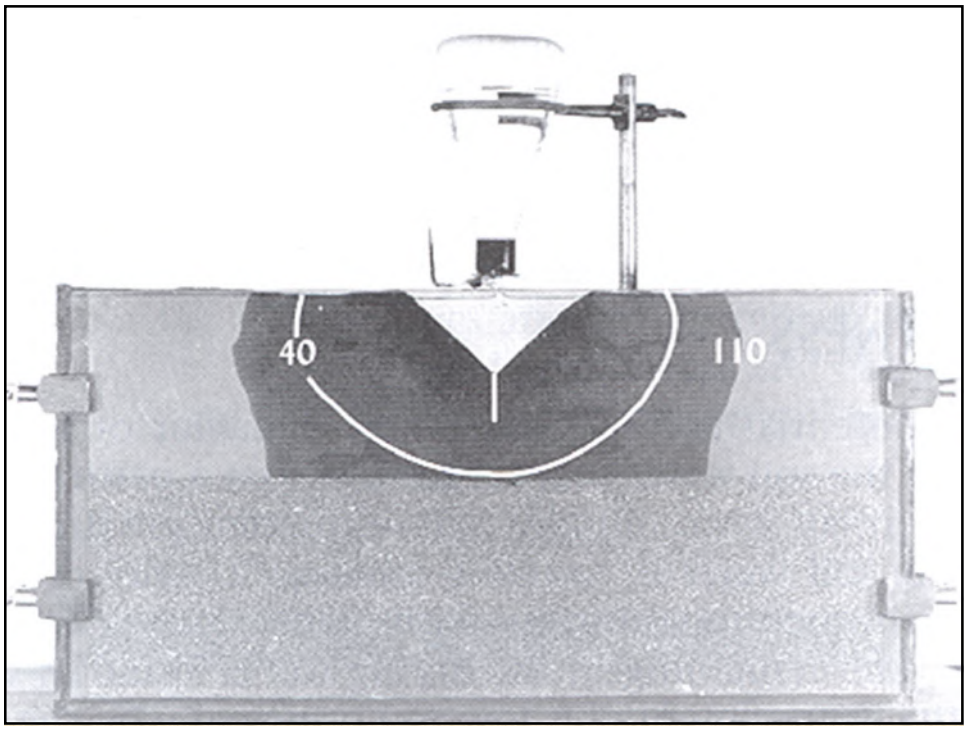
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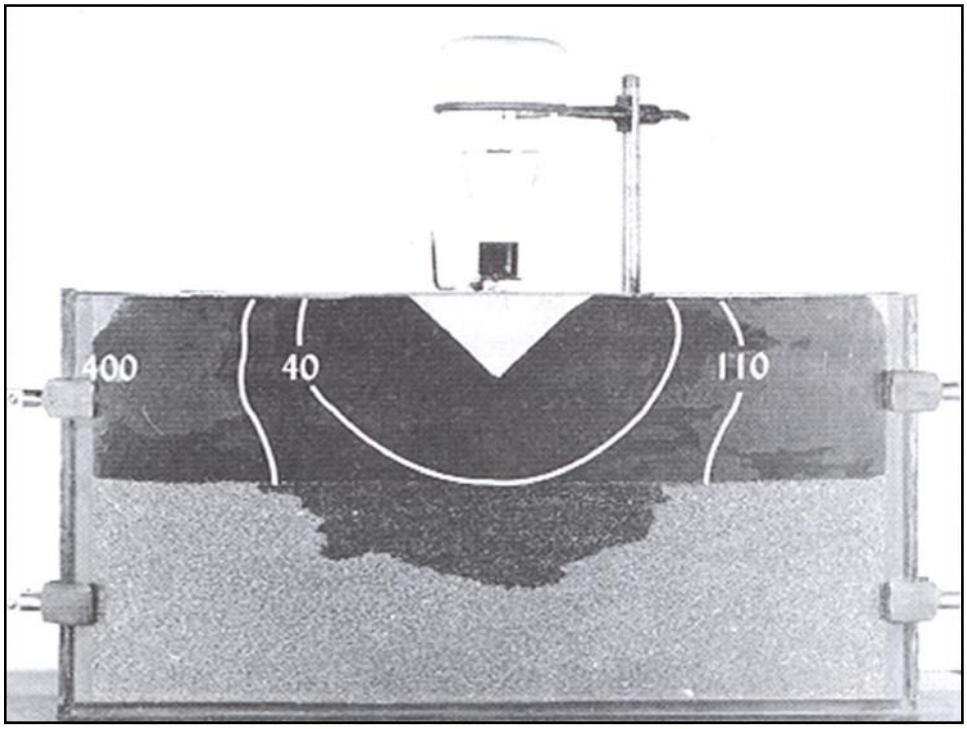
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