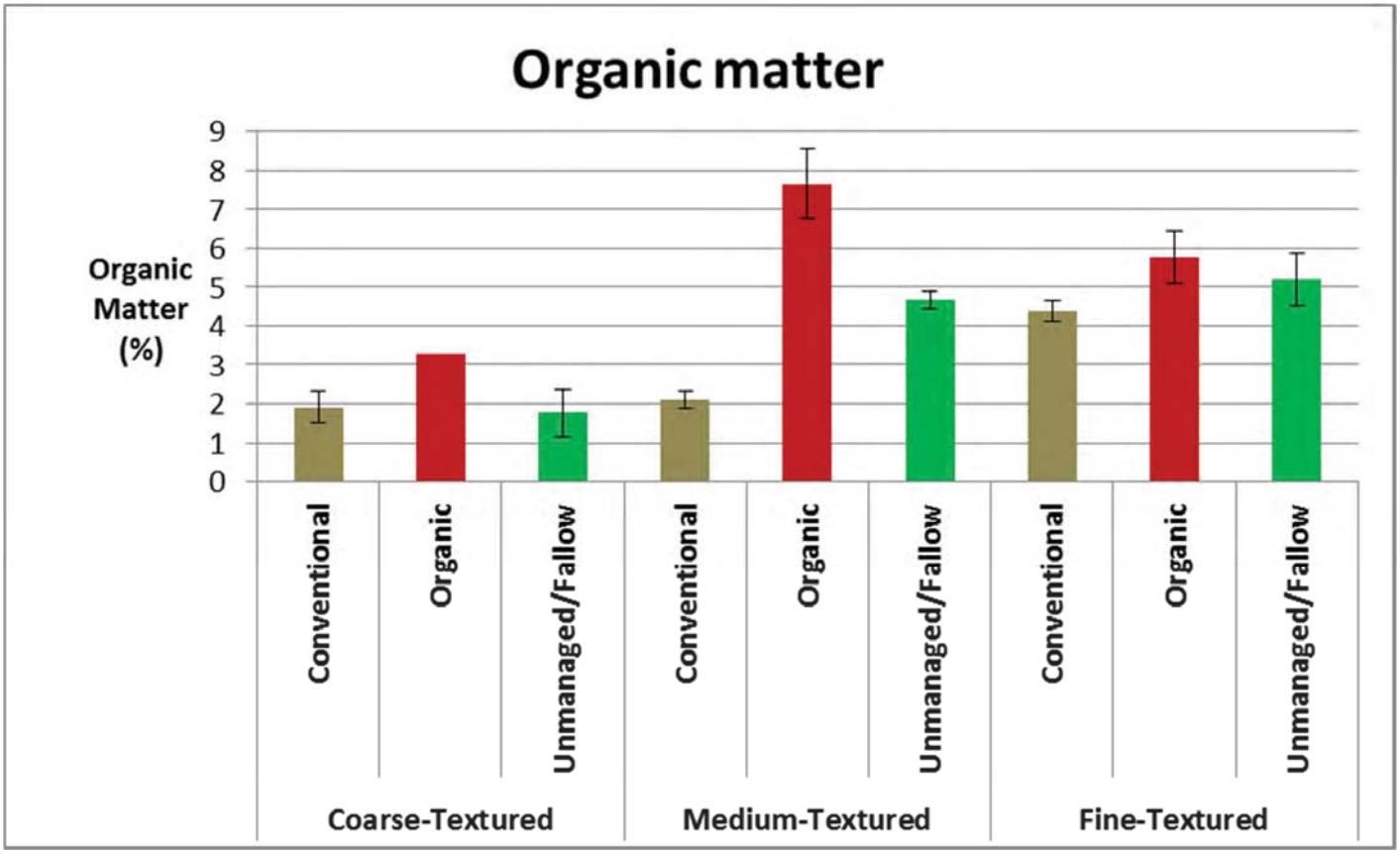
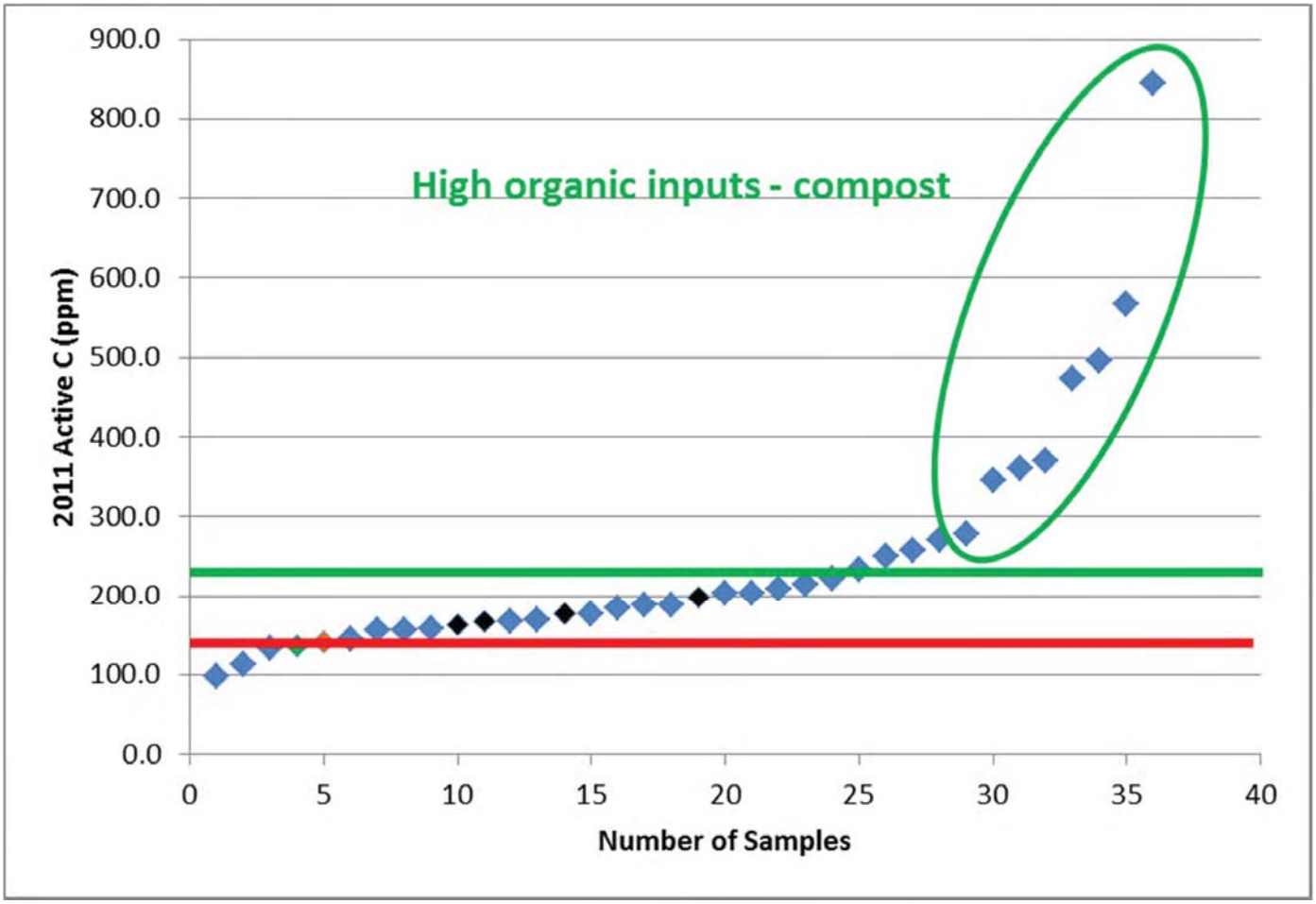
OM vs. Texture vs. Manage



SOIL BIOLOGICAL PROPERTIES:

Active Carbon

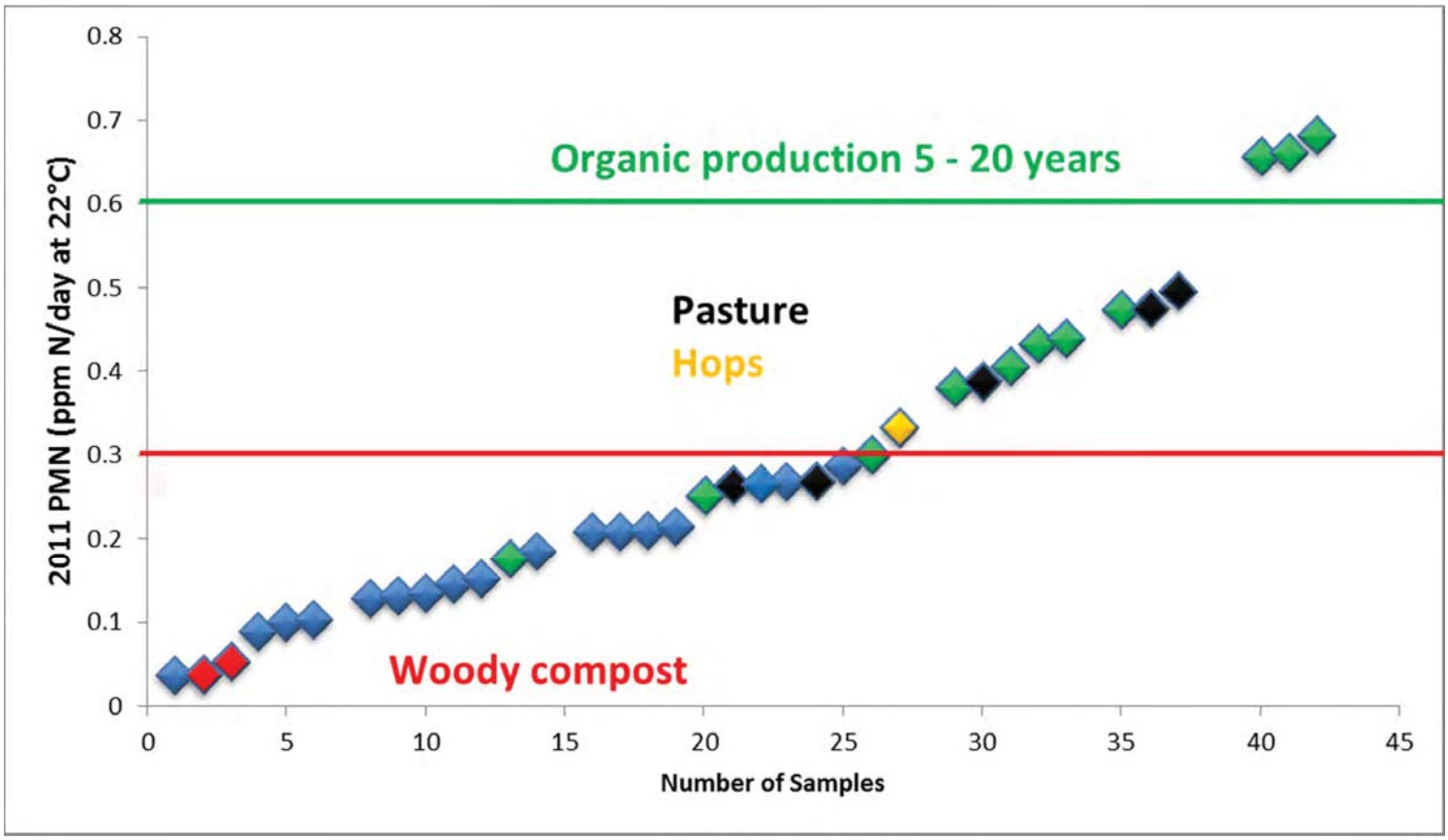


Potentially Mineralizable Nitrogen

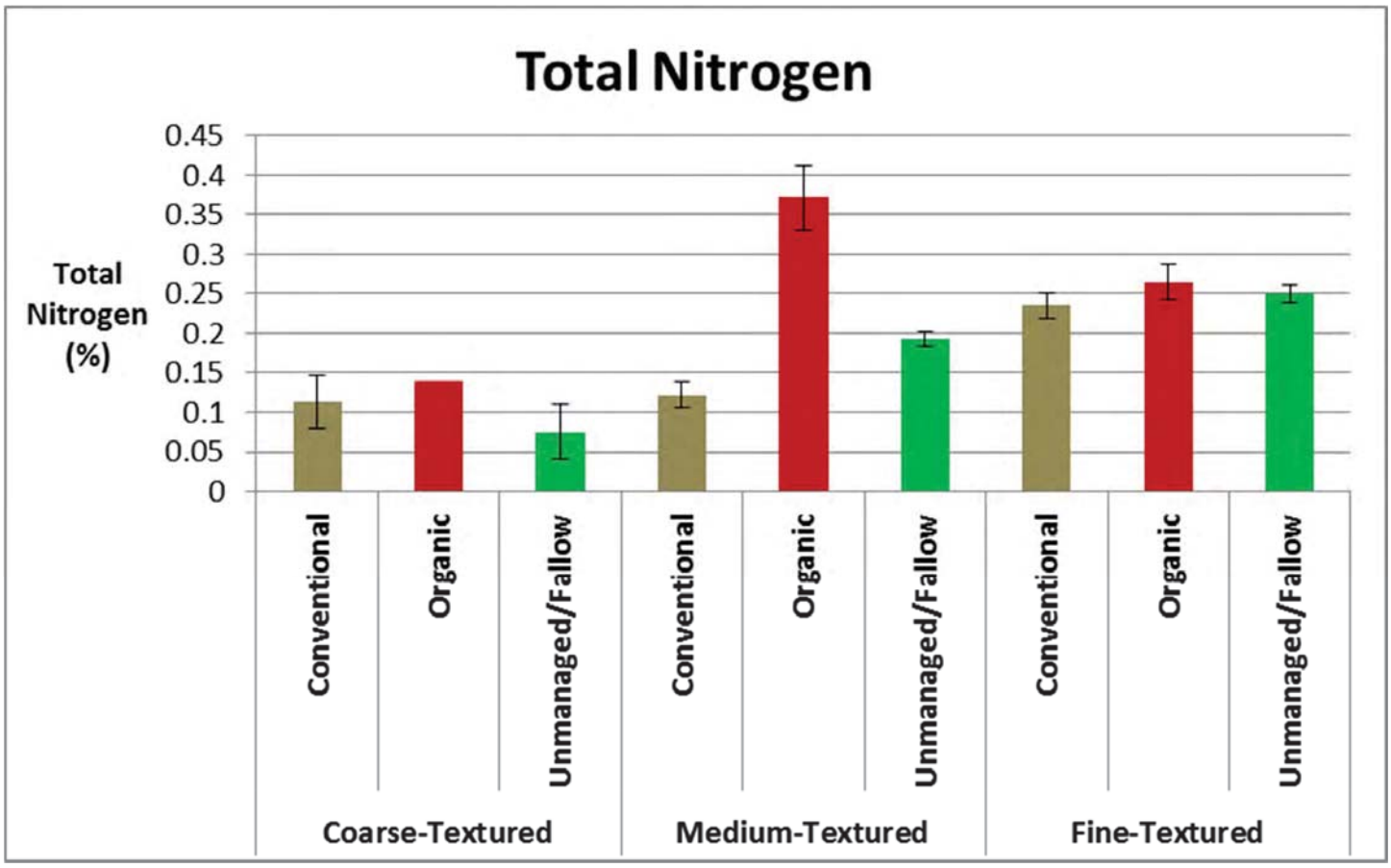
- **Aerobic incubation of field soils, 22°C**
- **Nitrate levels measured at Day 0 and Day 30**
- **Capacity of soil community to convert soil nitrogen into a plant-available form**

SOIL BIOLOGICAL PROPERTIES:

PMN 2011



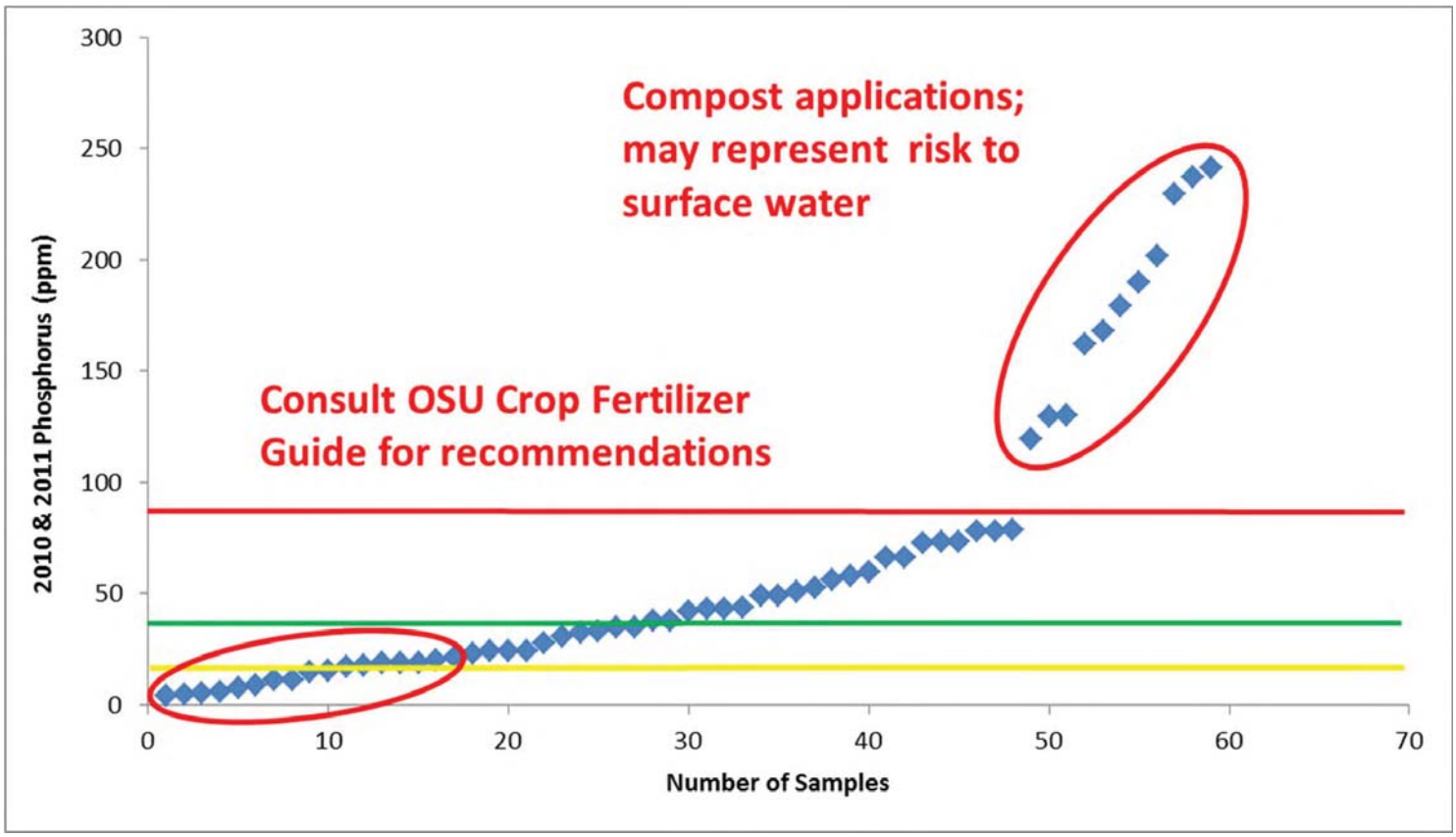
N vs. Texture vs. Manage



SOIL CHEMICAL PROPERTIES:

OSU Soil Test Interpretations Guide: Phosphorus availability
Low <20 ppm
Medium 20-40 ppm
High 40-100 ppm
Excessive >100 ppm

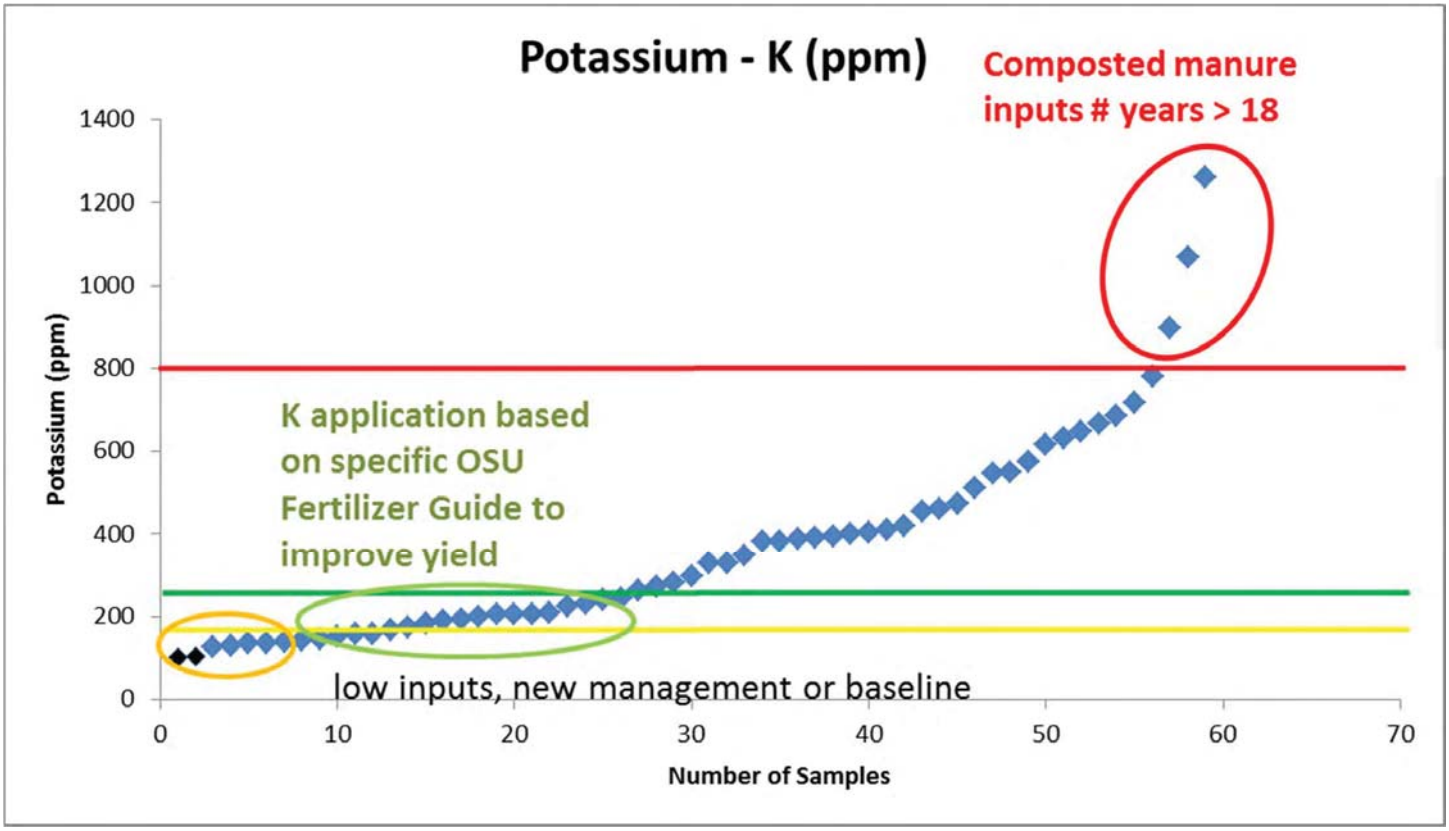
Phosphorus



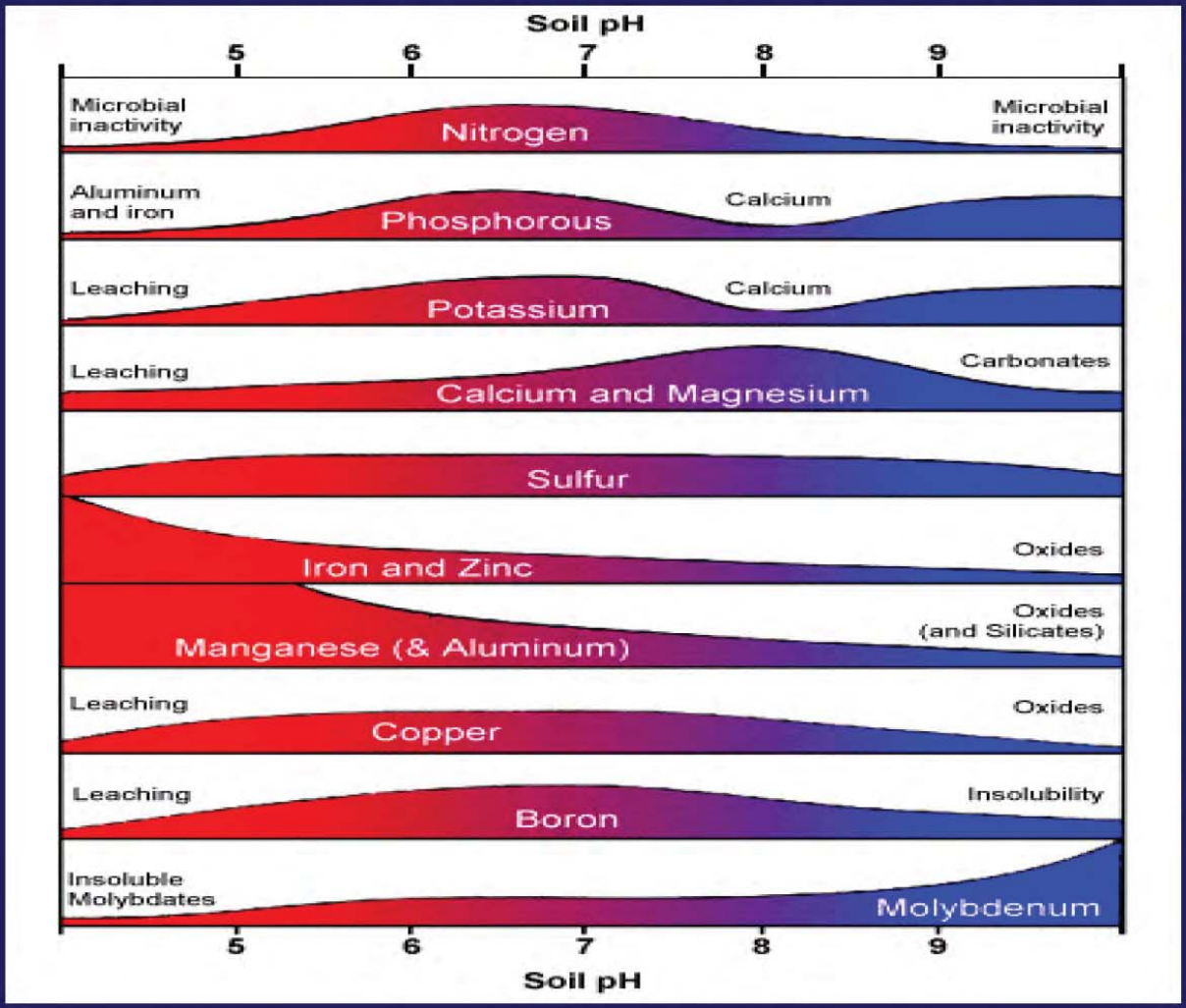
SOIL CHEMICAL PROPERTIES:

OSU Soil Test Interpretations Guide:
Potassium level
Low <150 ppm
Medium 150-250 ppm
High 250-800 ppm
Excessive >800 ppm

Potassium



Nutrient availability vs. pH



Plant nutrients vs. pH

Plant nutrients	pH = 3	pH = 5	pH = 7
Exchangeable Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}	12%	25%	64%

Why we shouldn't till wet soils

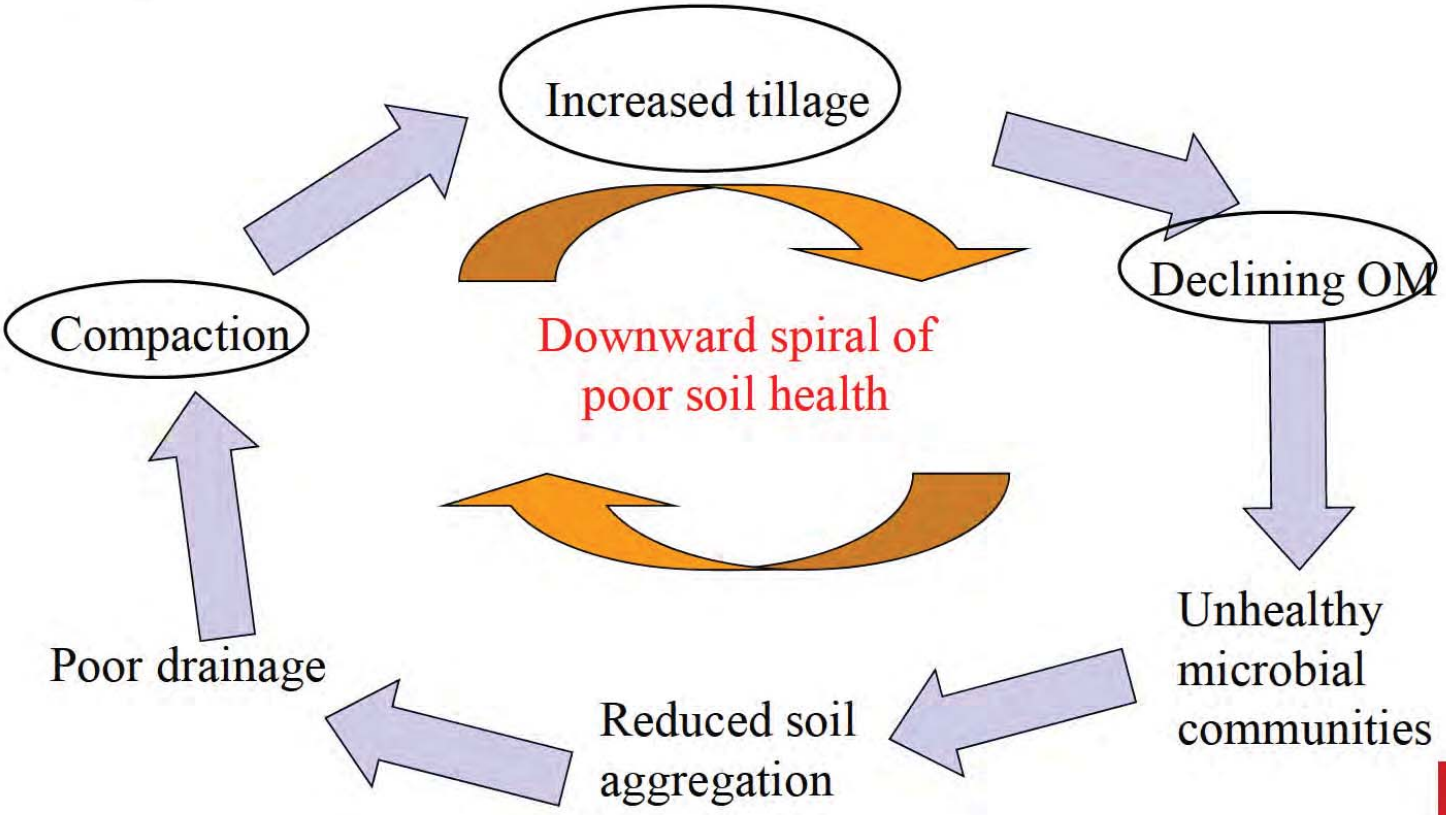
- Aggregate stability lower when wet
- Once aggregates are gone, pores clog
- Crusts can form, preventing seeds from emerging

http://www.oznet.ksu.edu/soybeanscene/may24.htm

Seedlings emerging where crust has been removed

Seedlings struggling to emerge through crust

Tillage Addiction: Downward Spiral in Soil Health




Betsiboka River, Madagascar
Via Space Shuttle
The real voyage of discovery consists not in seeking new landscapes but in having new eyes.
~Marcel Proust

Questions?

Teresa Matteson
Benton SWCD
541-753-7208
tmattson@bentonswcd.org

Willsboro Farm
Kingsbury clay loam
Long-term Tillage Research Plots

REPORT (COMPREHENSIVE)

Sample ID: F133

No till 13 years
Continuous corn

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	59	78	
	Available Water Capacity (m/m)	0.18	50	
	Surface Hardness (psi)	45	93	
	Subsurface Hardness (psi)	114	99	
BIOLOGICAL	Organic Matter (%)	4.9	73	
	Active Carbon (ppm) [Permanganate Oxidizable]	670	36	
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	11.6	75	
	Root Health Rating (1-9)	2.3	88	
CHEMICAL	*pH	5.9	56	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	3.5	100	
	*Extractable Potassium (ppm)	80	100	
	*Minor Elements		100	
OVERALL QUALITY SCORE (OUT OF 100):			79.0	High

Measured Soil Textural Class:==> silt loam
SAND (%): 24.0 *SILT (%): 52.0* *CLAY (%): 24.0*

Location (GPS): Latitude=> Longitude=>

CORNELL SOIL HEALTH T

Plow till 13 years
Continuous corn

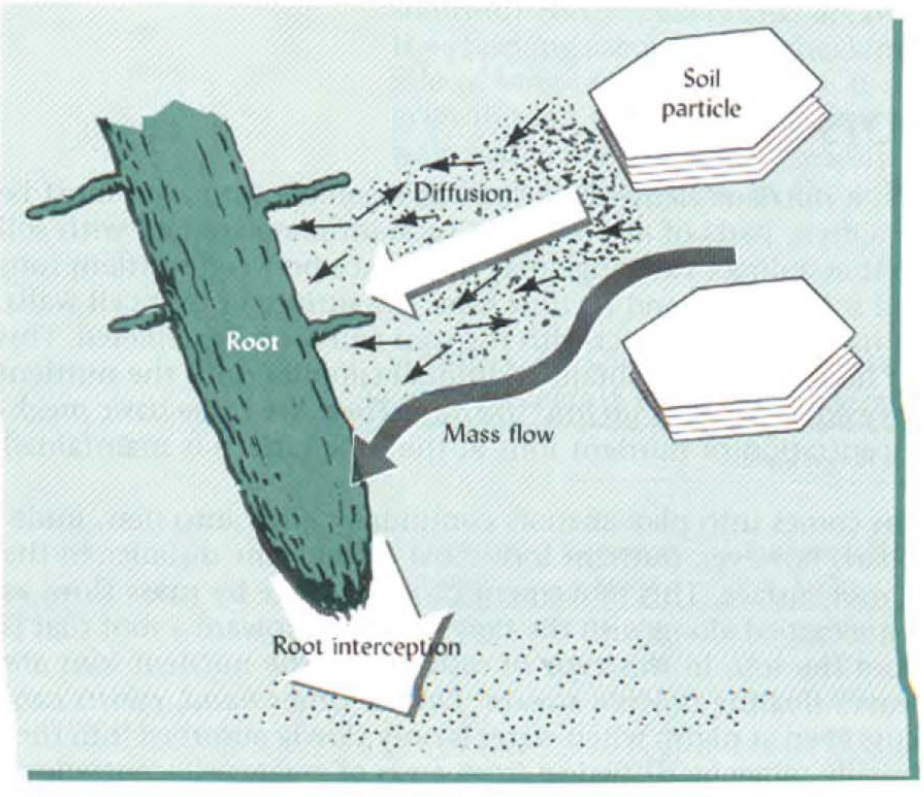
	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	12	3	aeration, infiltration, rooting
	Available Water Capacity (m/m)	0.17	43	
	Surface Hardness (psi)	57	91	
	Subsurface Hardness (psi)	200	82	
BIOLOGICAL	Organic Matter (%)	3.3	25	nergy storage, C sequestration, water retention
	Active Carbon (ppm) [Permanganate Oxidizable]	559	20	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	4.8	0	N Supply Capacity
	Root Health Rating (1-9)	2.5	88	
CHEMICAL	*pH	6.1	67	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	2.5	44	
	*Extractable Potassium (ppm)	83	100	
	*Minor Elements		100	
OVERALL QUALITY SCORE (OUT OF 100):			55.3	Medium

Measured Soil Textural Class:==> silty clay loam
SAND (%): 16.0 *SILT (%): 47.0* *CLAY (%): 37.0*

Location (GPS): Latitude=> Longitude=>

* See Cornell Nutrient Analysis Laboratory report for recommendations

Root uptake of nutrients

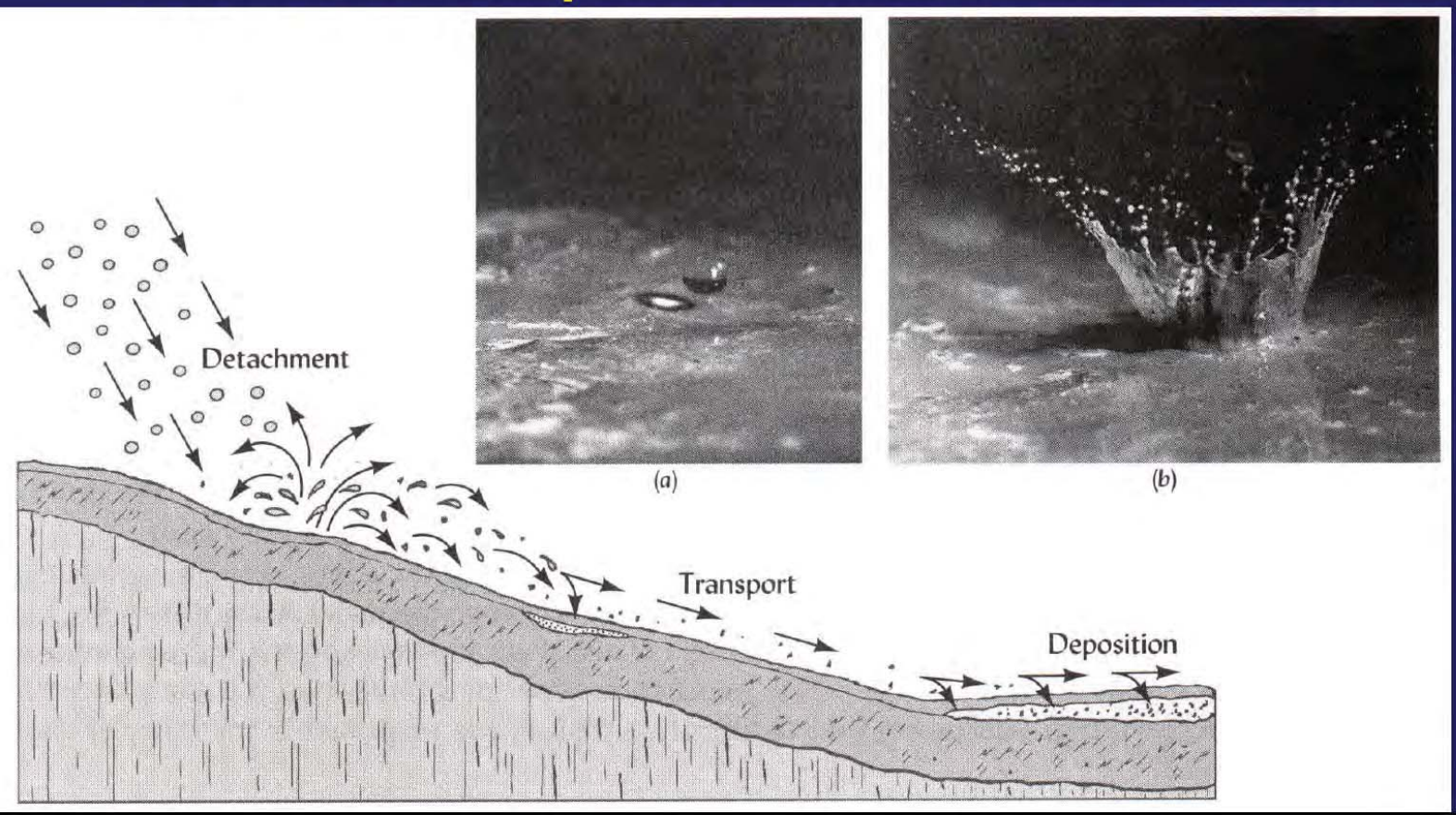


- Mass flow
- Diffusion
- Interception

Common soil constraints

- Soil compaction
- Poor aggregation and crusting
- High populations of soilborne pathogens and root diseases
- Low water and nutrient retention

Three steps of water erosion



Most erosion is initiated by the impact of raindrops, NOT by the flow of running water

Characteristics of a healthy soil

- Good soil structure (tilth)
- Sufficient depth
- Sufficient but not excess supply of nutrients
- Small population of plant pathogens and insect pests
  - Large population of beneficial organisms
- Resistant to degradation
  - Resilience when unfavorable conditions occur

Soil Health Can Be Diagnosed in the Field

General Signs of Poor Soil Health Are:

- Declining yields
- Rapid onset of stress or stunted growth during dry or wet periods
- Plowing up cloddy soil and poor seedbeds
- Soil crusting
- Signs of runoff and erosion
- Hard soil (at planting, etc.)

Build Healthy Soils

Organic matter management

- ✓ Add supplies of organic residues (manure, compost etc).
- ✓ Include high residue producing crops in rotation (eg, grass, legume, forage, cover crops).
- ✓ Use different types of organic materials.
- ✓ Reduce organic matter losses (reduced tillage intensity).
- ✓ Keep soil surface covered with living vegetation and/or residues.

Build Healthy Soils

Prevent Soil Compaction

- ✓ No traffic on wet soil
- ✓ Reduce equipment weight
- ✓ Spread equipment weight
- ✓ Minimize traffic
- ✓ Limit traffic to controlled lanes

Build Healthy Soils

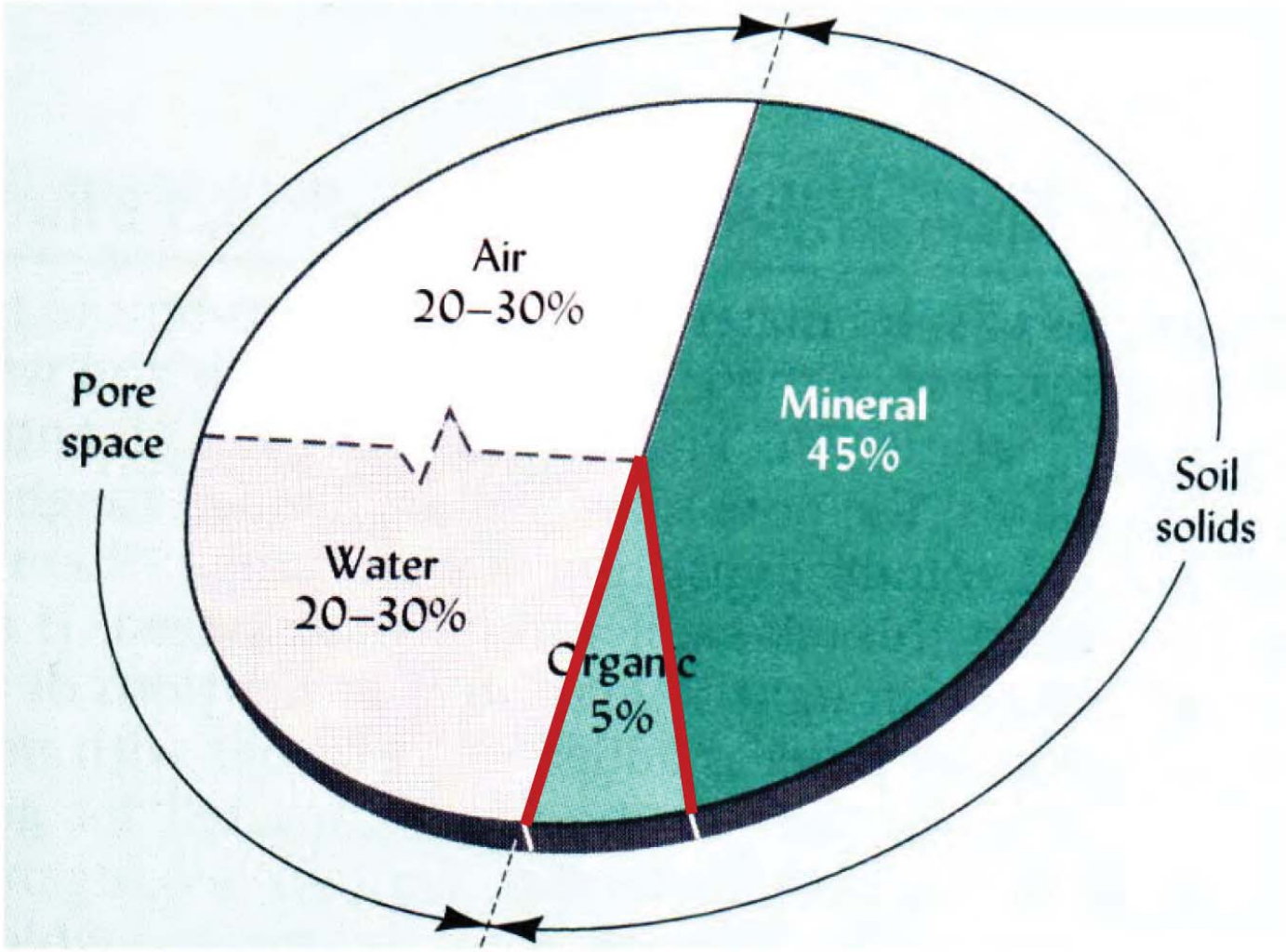
Improved Tillage

- ✓ Minimize tillage intensity
- ✓ Optimize timing.
- ✓ Maximize surface cover.
- ✓ Reduce water quality impact.
- ✓ Maximize economic return.

Dynamic Soil Properties

- Biology
- Fertility
- Structure

The four components of soil:

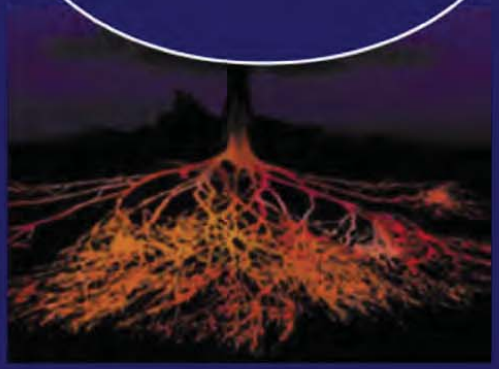


What is Soil Organic Matter?

organic = carbon-based

SOIL ORGANIC MATTER

The Living: BIOMASS



The Dead: DECOMPOSING MATERIAL

The Really Dead: HUMUS

Five Roles of Organic Matter in Soil Health

1. Food for the many beneficial organisms in soil

2. Store for nutrient cycling

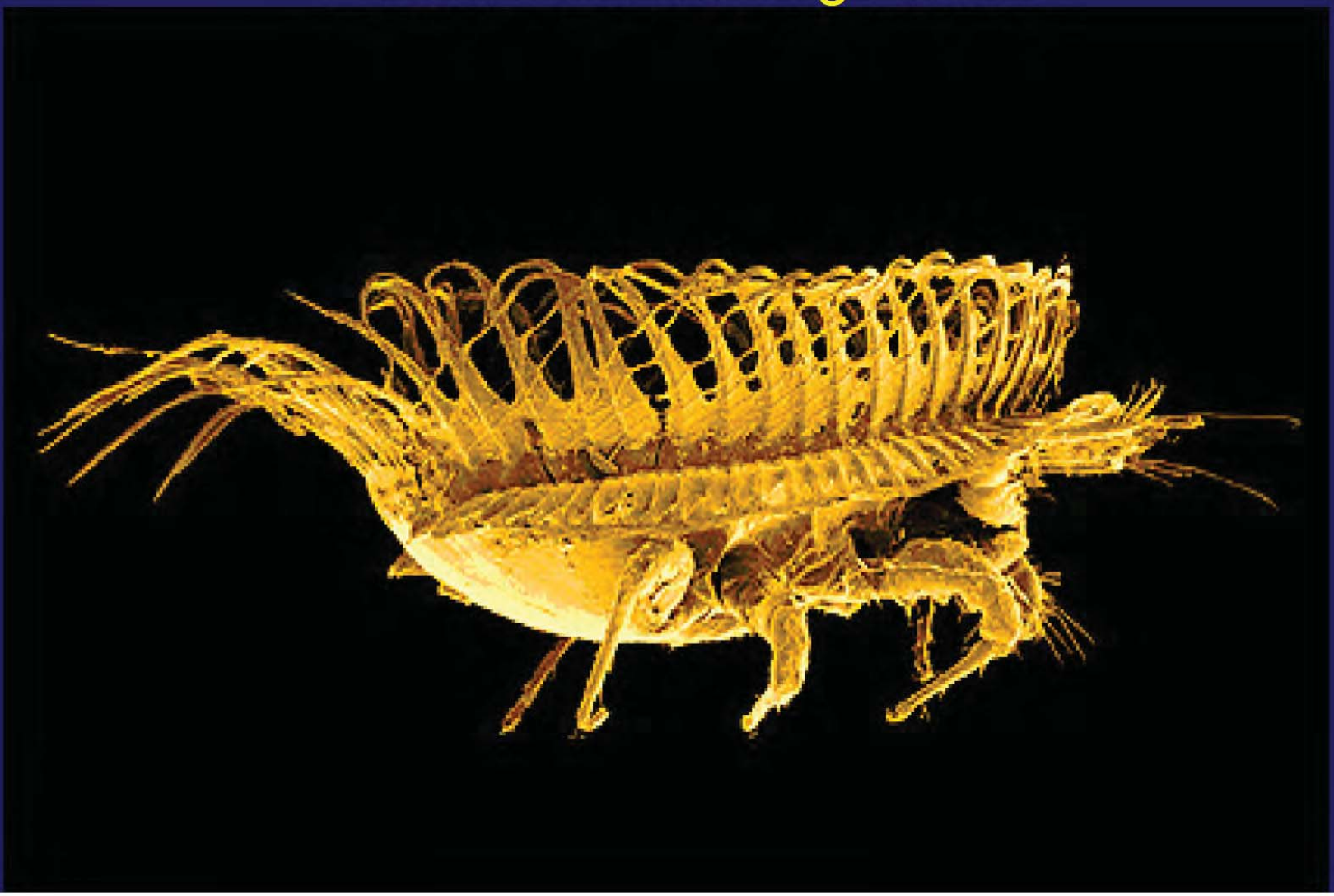
Five Roles of Organic Matter in Soil Health

3. **Essential for good aggregate stability**

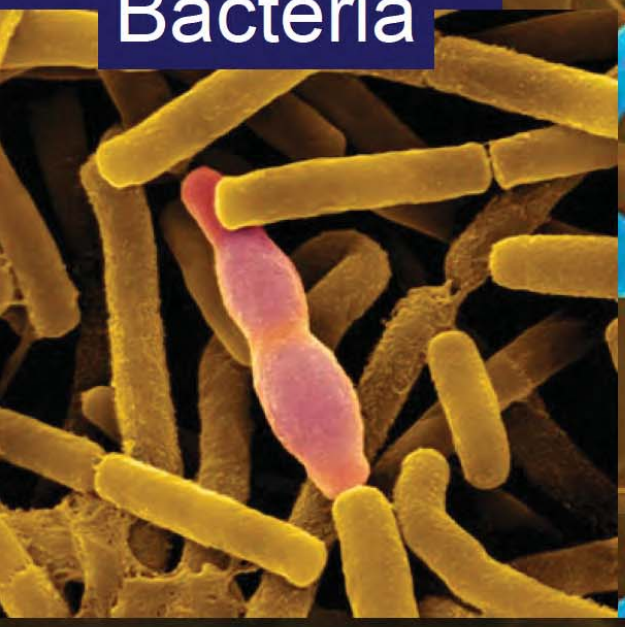
4. **Increases nutrient holding capacity**

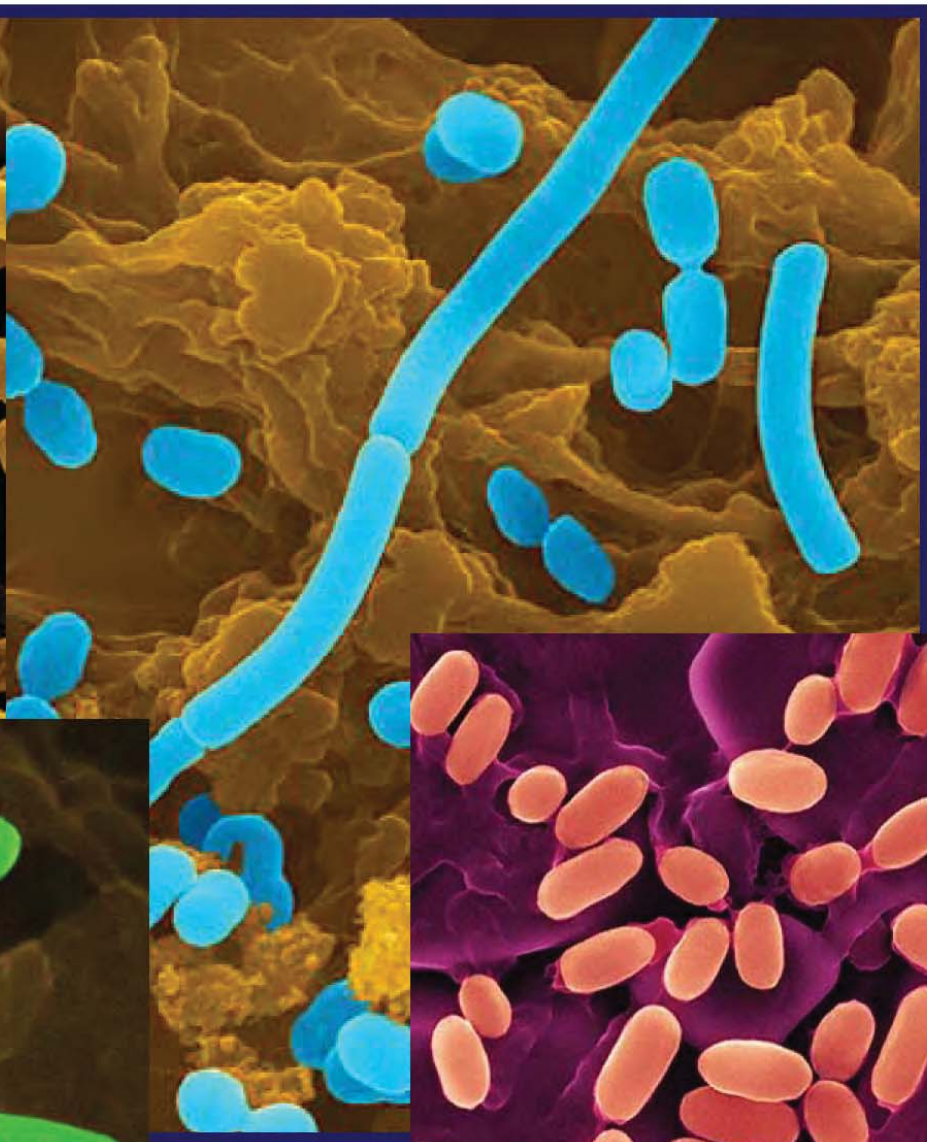
5. **Protects soils from short-term water and nutrient shortages, and soil compaction**

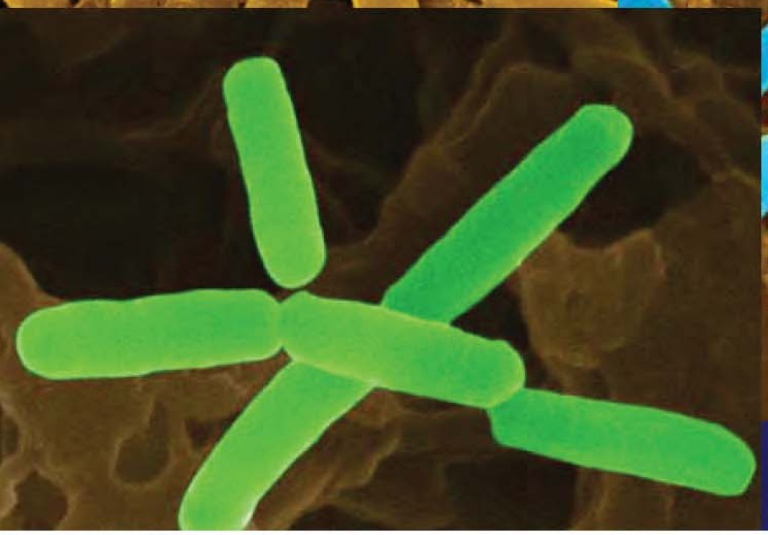
Function of soil organisms



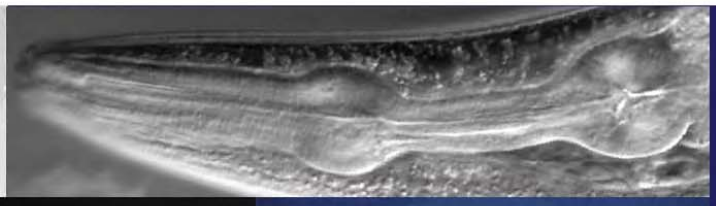
Bacteria



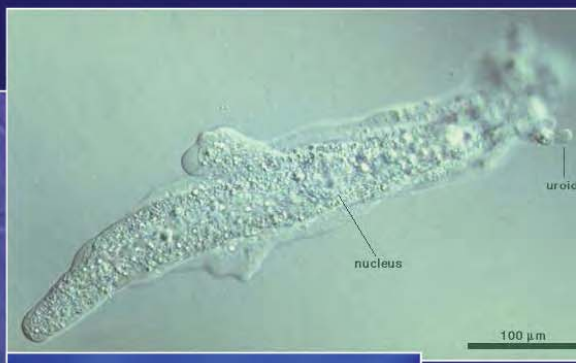


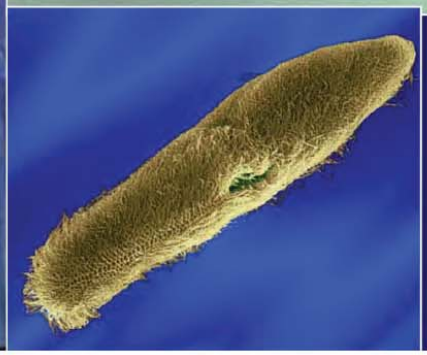


Nematodes



Protozoa





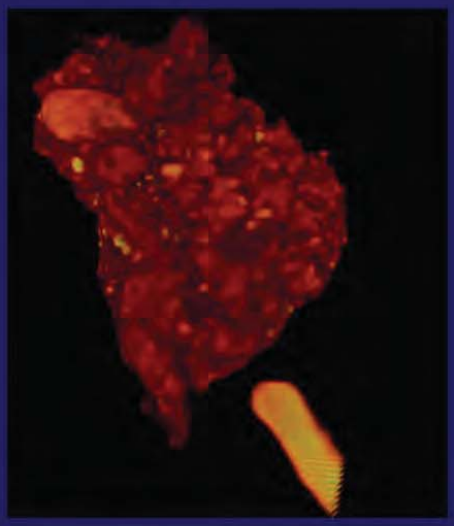
Other invertebrates

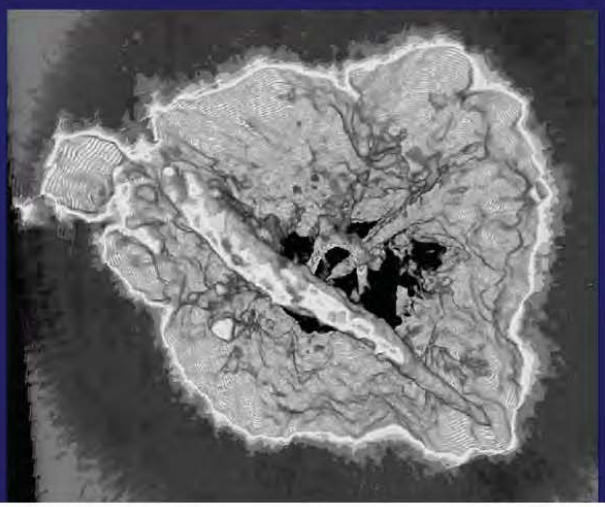
Macrofauna

- shred plant material
- feed on bacteria and fungi associated with organic matter

Why Are Aggregates Important?

- Increase porosity
- Increase water infiltration, drainage, decrease runoff
- Increase water holding capacity



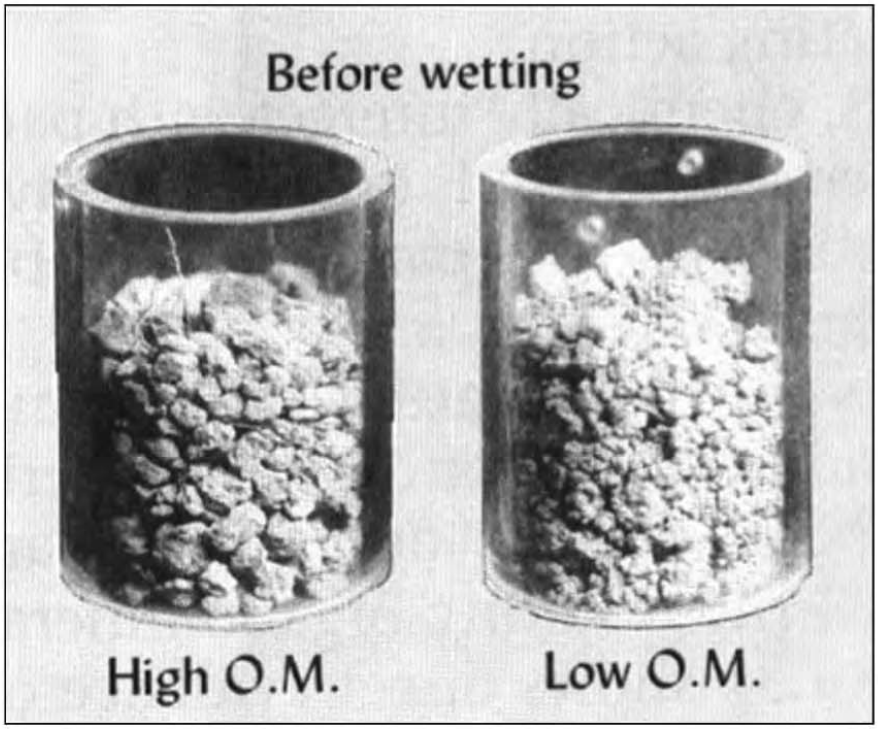


http://www-unix.mcs.anl.gov/~insley/XRAY/SOIL/

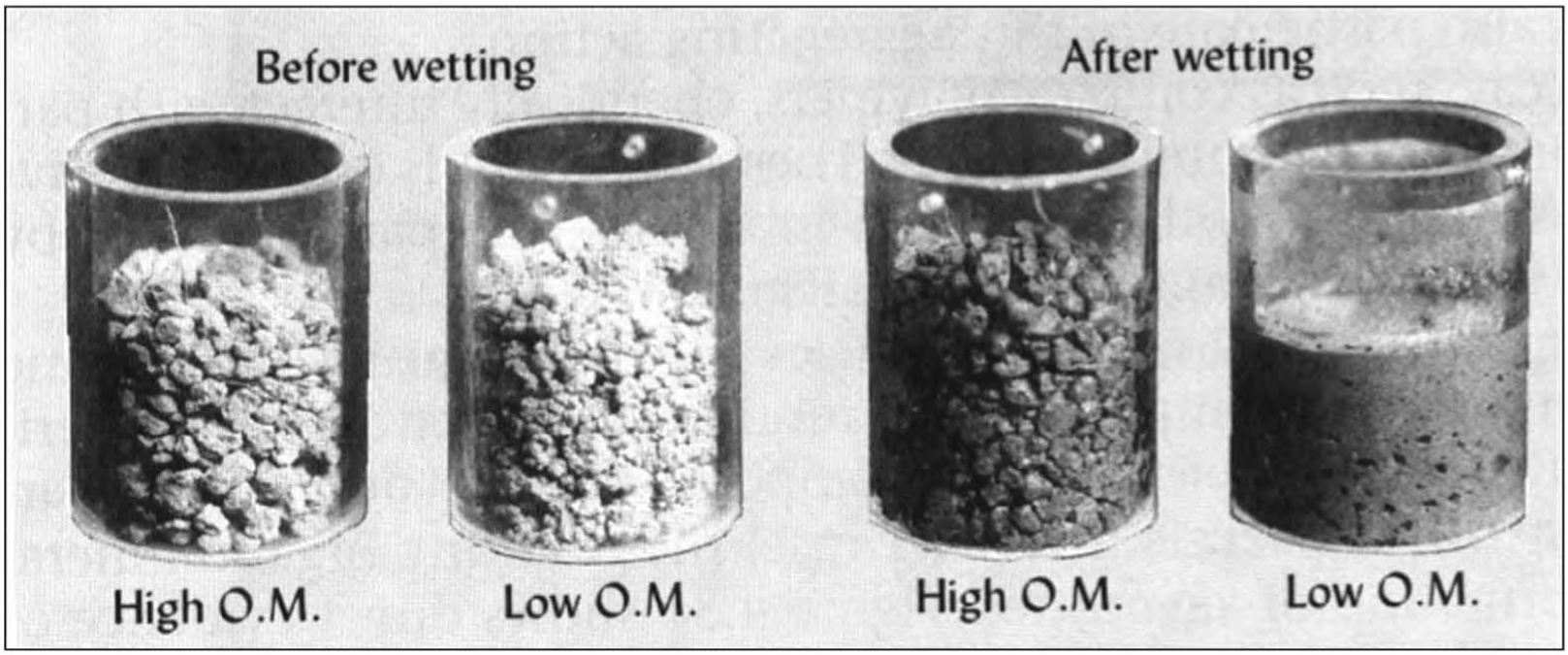
Ways to Improve Soil Structure

- Reduce disturbance
- Work soil when dry
- Mulch soil surface
- Add organic materials (crop residues, compost, manure)
- Use cover crops

Effect of OM on aggregate stability



Effect of OM on aggregate stability



Soil Water

- Infiltration
- Plant available
- Purification

Water terminology