Soil Health

Key Concepts and Why it Matters for Water Quality

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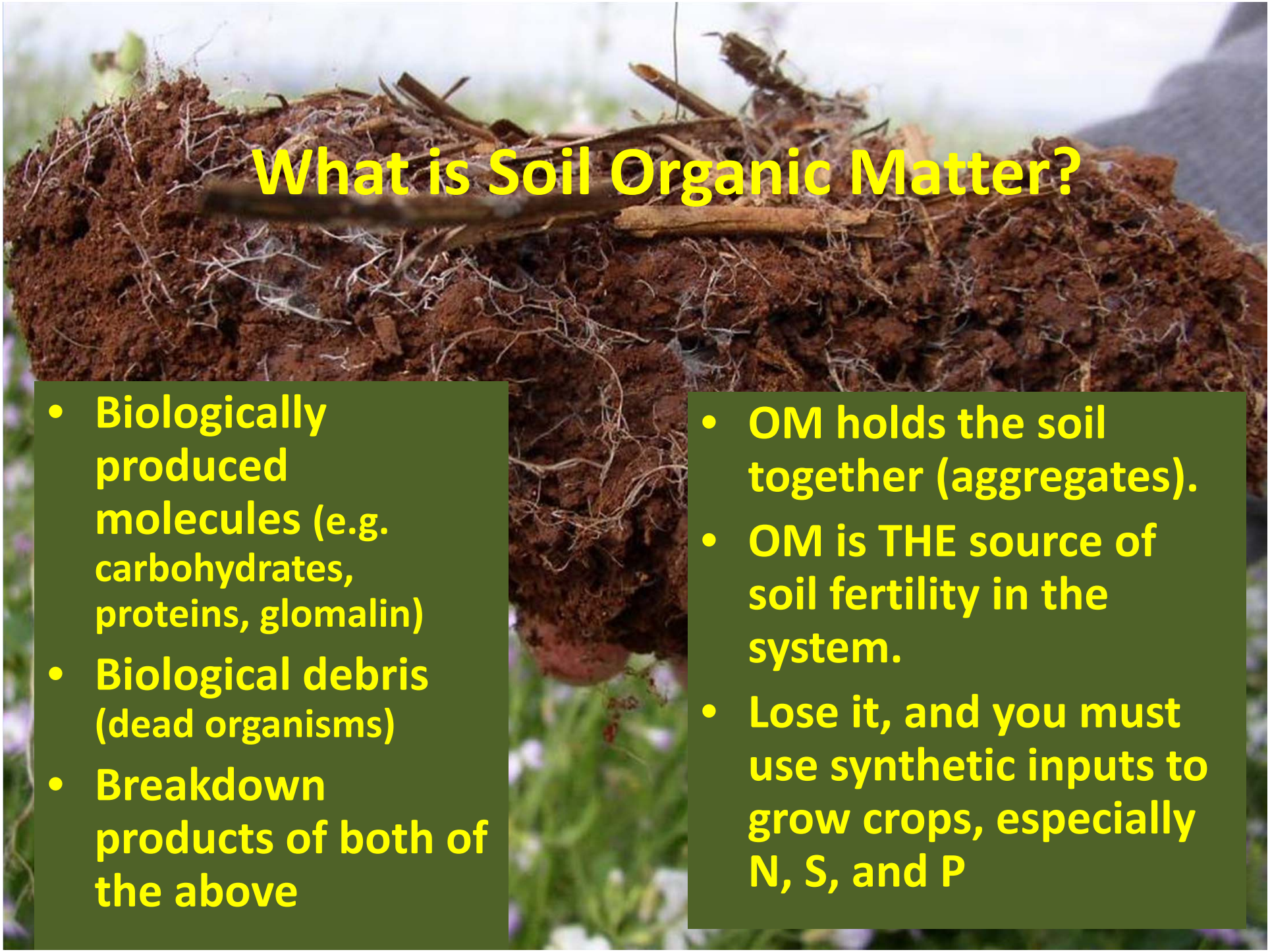
What is Soil Health?

- The continued capacity of the soil to function as a complex, living ecosystem
  - Habitat sustaining soil organisms, plants, animals, people
  - Physical Stability (resistance to erosion)
  - Nutrient and energy cycling
  - Water (infiltration & availability)

Healthy Soils:

- **Have a high content of Organic Matter (OM)**
- Sequester carbon
- Are high performing (cycle nutrients, healthy crops)
- Can biodegrade pesticides (microbes break down)
- Are more resistant to erosion, reducing sediment runoff and nutrient loading
- Hold more water and have less runoff
  - -- 1% increase can hold 27,000 gallons per acre
  - -- increase from 1 - 4.5% doubles AWC
- **Protect natural resources on- and off-farm**



What is Soil Organic Matter?

- Biologically produced molecules (e.g. carbohydrates, proteins, glomalin)
- Biological debris (dead organisms)
- Breakdown products of both of the above

- OM holds the soil together (aggregates).
- OM is THE source of soil fertility in the system.
- Lose it, and you must use synthetic inputs to grow crops, especially N, S, and P

Soil Aggregates

soilquality.org

Managing for Soil Health

- Diversify as much as possible
- Keep plants (living roots) growing in the soil throughout the year
- Keep the soil covered at all times with plants and plant residues
- Disturb the soil as little as possible

- MIMIC NATURE--create the most favorable habitat possible for soil organisms

How do these Ecosystem flourish without human inputs?

unlock the SECRETS IN THE SOIL

Prairie

Forest

Managing for Soil Health

- **MAXIMIZE inputs** = more PLANTS, animals if possible
- **MINIMIZE losses** = reduce TILLAGE

INPUTS: Plants

- Roots deliver carbohydrate and nutrients to the rhizosphere, fueling the entire soil ecosystem and building Organic Matter.
- Biodiversity is the key.
- Introducing diversity aboveground promotes diversity below ground.
- Use crop rotation and multi-species cover crop mixes, herbivores if possible

The Rhizosphere

- Zone in the soil < 5mm from the plant roots
- 20-50% of a plant's photosynthate ends up released through roots
- Higher population of microorganisms (>10X) than in bulk soil
- Nutrient cycling (immobilization; mineralization by decomposers)
- Symbiosis (mycorrhizal fungi, rhizobia)
- We want to keep the action going year round!

Mycorrhizal fungi

- Mutualistic symbiosis between plant and fungus (80% of plants have mycorrhizae)
- Plant provides food for fungus

  -up to 20% of plant's carbohydrate
- Fungus extends root system, providing water and nutrients to plant
- Nutrient transfer BETWEEN plants
- Hyphae produce glomalin, aggregate "glue"

Mycorrhizae on Roots

Cover Crops: What they do

- Roots deliver carbohydrate and nutrients to the rhizosphere year-round
- Protect soil surface from the action of water and wind
- Suppress weed growth through competition

Diverse cover crop mixes

Crop Rotation: What it does

- Diversify plant inputs
- Break weed, disease, and pest cycles, as each crop has specific problems associated with it.
- Each crop has a different physiology--therefore roots put slightly different compounds into the soil, encouraging different microbial communities and symbioses.

INPUTS: Grazing Animals

- Herbivores eat and trample plants
- Plant stress increases in root exudates
- Manure/urine deposition provides nutrients

= INCREASE in biological activity

Nutrient Cycling

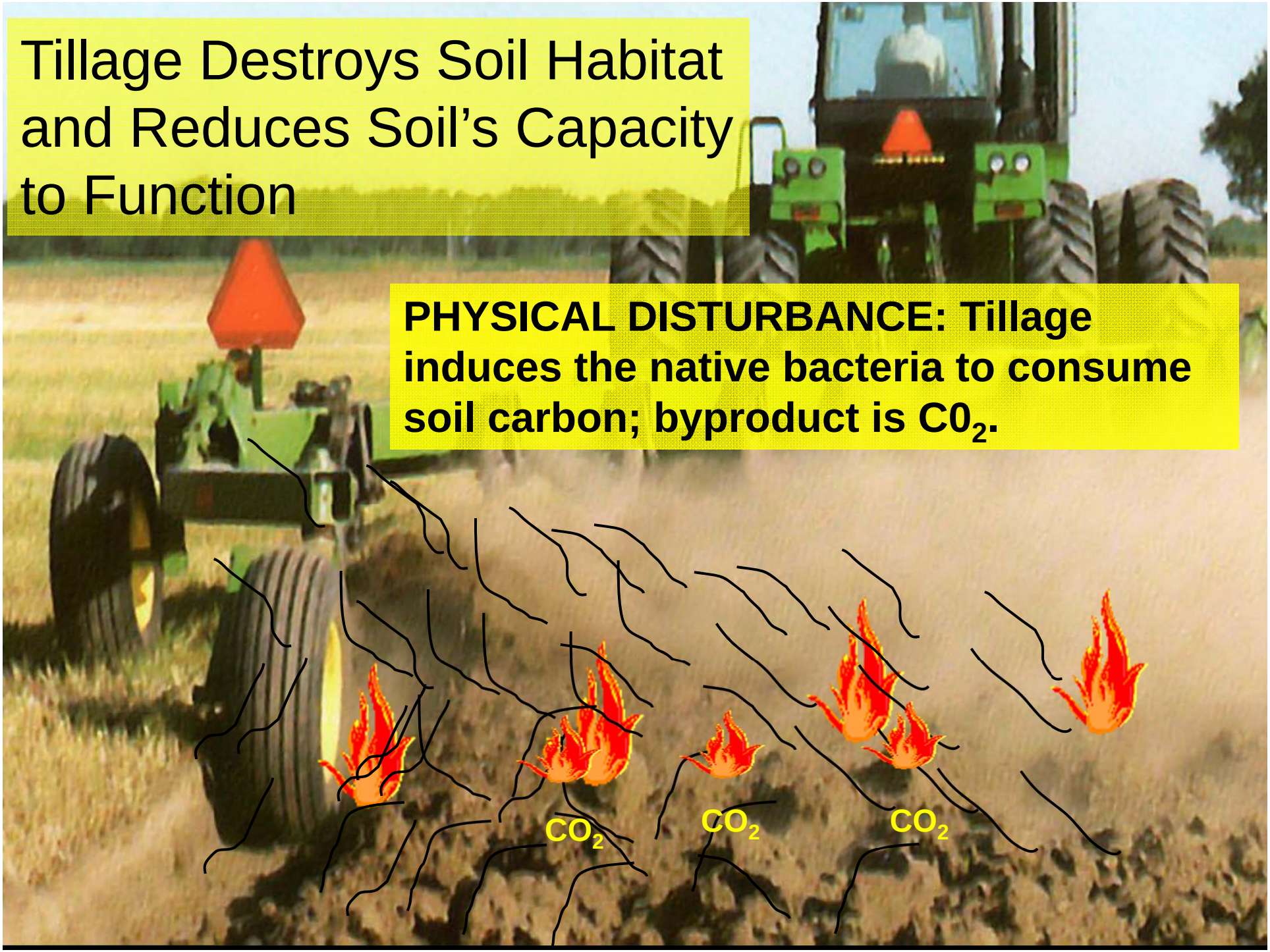
- Healthy soil's OM will cycle and release nutrients for plants during growing season
- Less inputs = less loss to surface and ground water

North Dakota soil test guide—5 yr No-Till gets 50# N credit. Assumption is that 50# N is released to the crop during season via cycling.

LOSSES: Tillage

- Destroys aggregates
- Disrupts mycorrhizal fungal networks
- Accelerates decomposition of OM
- Disrupts soil pore continuity
- Reduces habitat and food for soil organisms
- Plants weed seeds
- Compacts the soil

Tillage Destroys Soil Habitat and Reduces Soil's Capacity to Function

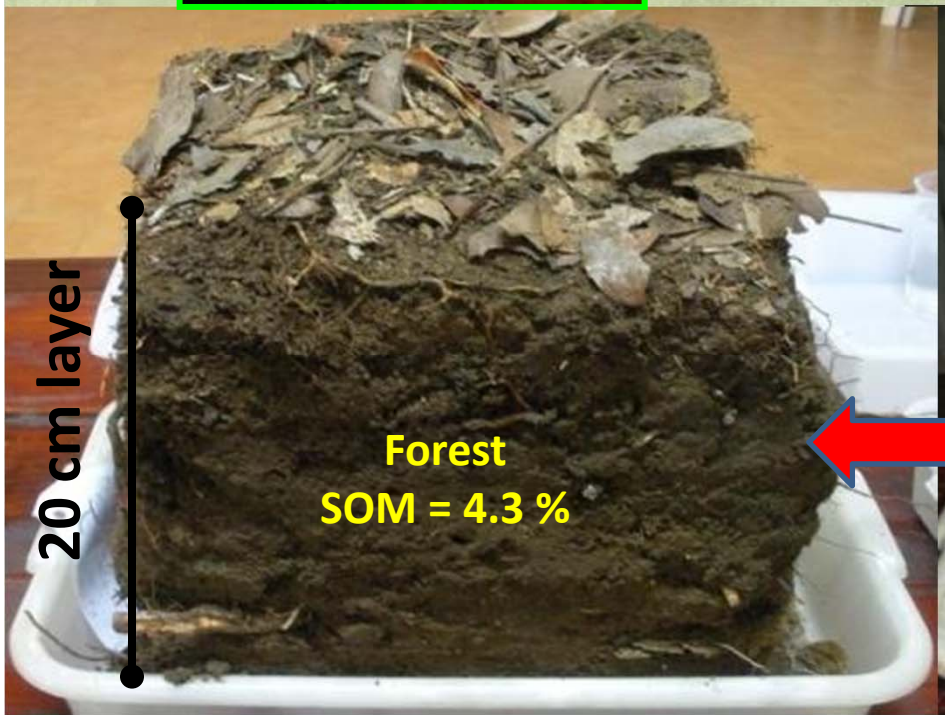


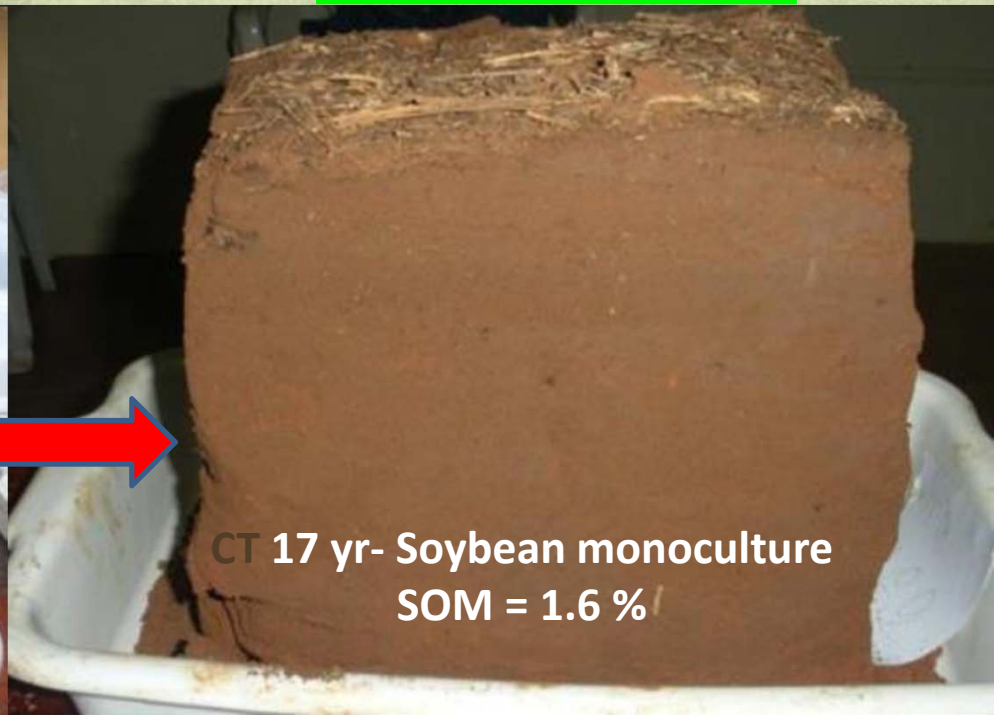

Agricultural soils do not have a water erosion/runoff problem, they have a water infiltration and storage problem.

Management Changes Soil Properties & Capacity of Soil to Function

unlock the SECRETS IN THE SOIL

62.8% loss of SOM after 17 yr intensive tillage





Minimizing Losses: No Till

- Maintains aggregates and pores
- Maintains/increases water holding capacity
- Limits excess O_2 in the system; maintains/builds OM
- Requires banded or seed placed nutrients, rather than broadcast/incorporated

Paradigm Shifts

- **Paradigm shift #1** Stop treating the **symptoms** of dysfunctional soil. Solve the **problem** of dysfunctional soil.
- **Paradigm shift #2** Conservation practices do not restore soil health. Understanding soil function restores soil health.
- **Paradigm shift #3** Restoring soil function can be accomplished without going broke.
  - Apply basic principles of ecology to create quality habitat.
  - How will this work in the Treasure Valley?
  - How will producers minimize risk?