Introduction to Soil Health

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Soil Degradation

What is soil degradation?

- Loss of soil productivity
- Loss of soil's ability to function
- Can be a very gradual and subtle

Soil Degradation

What are the causes soil degradation?

- Erosion
- Loss of organic matter
- Salinization
- Desertification

Do we have soil degradation in Nebraska?


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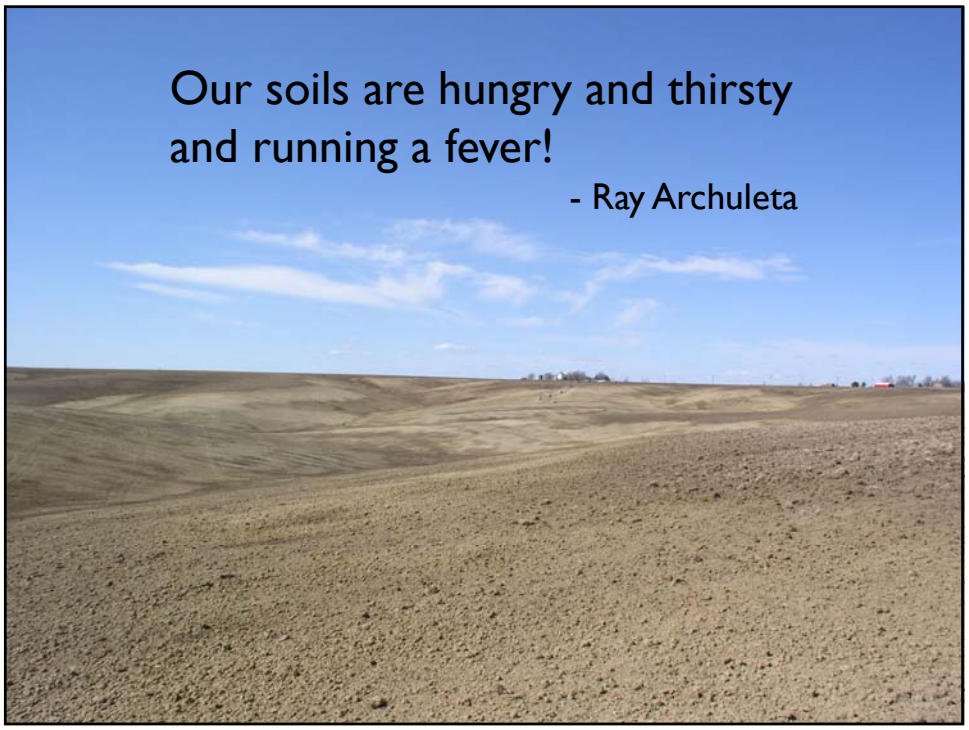

Our soils are hungry and thirsty
and running a fever!
- Ray Archuleta

Soil Health vs. Soil Quality

- The two terms are often used interchangeably.
- Some people use the term *Soil Quality* to refer to *Inherent* Soil Properties such as texture and depth and *Soil Health* to refer to *Dynamic* Soil Properties such as organic matter, bulk density and aggregate stability.
- However, by definition, they both refer to the ability of a soil to function so I will use them interchangeably.

What is soil health?

Soil quality/soil health is "the capacity of a soil to *function*, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."

(Karlen et al., 1997)

Soil quality is…
"the capacity of the soil to function."

(Doran and Parkin, 1993)

Soil Functions

- Physical stability & support
- Partitioning water and solute flow
- Filtering and buffering
- Nutrient cycling
- Habitat for soil organisms
- Maintaining biodiversity

Soil Function …

Physical stability & support

- Soil has the ability to maintain its porous structure to allow passage of air and water, withstand erosive forces, and provide a medium for plant roots.

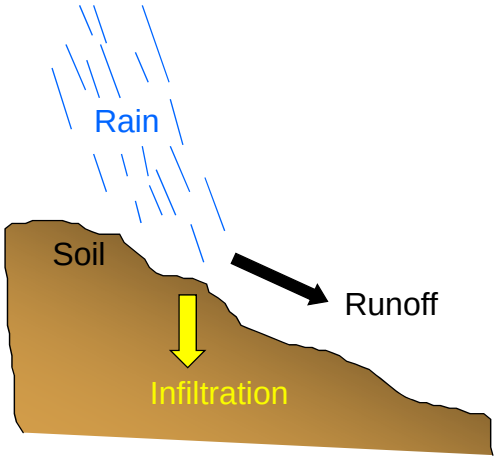
Soil Function …

Physical stability & support

- Soils also provide support for human structures such as buildings and roads.

Soil Function…

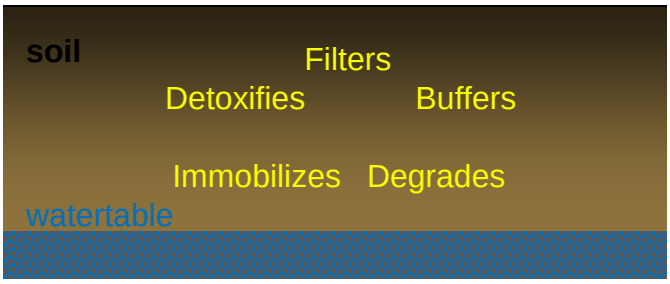
Partitioning Water and Solute Flow



Soil Function…

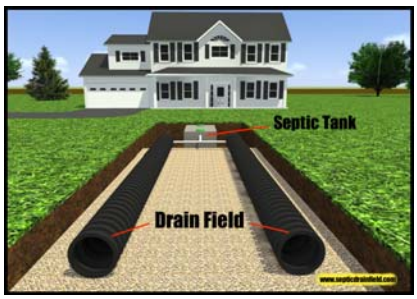
Filtering and Buffering

Organic & Inorganic materials



Soil Function…

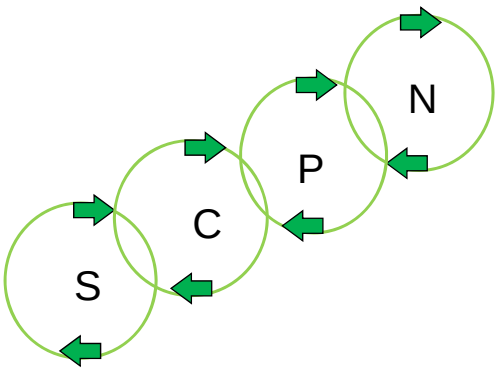
Filtering and Buffering



Septic systems use soils to safely dispose of wastewater

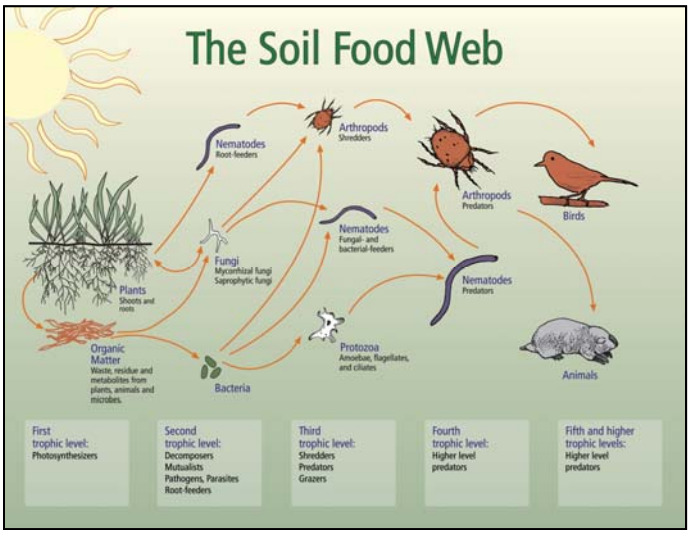
Soil Function…

Storing and Cycling Nutrients



Soil Function …

Habitat for Soil Organisms



Soil Function …

Maintaining Biodiversity

- Most soil organisms cannot grow outside of soil, so it is necessary to preserve healthy and diverse soil ecosystems if we want to preserve beneficial microorganisms.
- Estimated numbers of soil species include 30,000 bacteria; 1,500,000 fungi; 60,000 algae; 10,000 protozoa; 500,000 nematodes; and 3,000 earthworms (Pankhurst, 1997).

What does a healthy soil look like?

Soil Quality Indicators

Soil quality indicators are physical, chemical and biological properties, processes, and characteristics that can be measured to monitor changes in the soil health.

Soil Quality Indicators

Chemical indicators include:

- Soil Reaction (pH)
- Electrical Conductivity
- Cation Exchange Capacity
- Nutrient content (N, P, K & micros)

Soil Quality Indicators

Physical indicators include:

- Aggregate Stability
- Available Water Capacity
- Bulk Density
- Infiltration Rate
- Soil Crusts
- Soil Structure and Macropores

Soil Quality Indicators

Biological indicators include:

- Organic Matter
- Earthworms and other soil organisms
- Respiration
- Microbial biomass assessment (PLFA)
- Soil Enzymes

Keys to Improving Soil Health

- Keep the soil covered as much as possible
- Disturb the soil as little as possible
- Keep plants growing throughout the year to feed the soil
- Diversify as much as possible using crop rotation and cover crops

Keep the Soil Covered

Types of Soil Cover:

Passive – Crop Residue

Active – Cover Crops

Benefits of Crop Residue & Cover Crops

- Protect the Soil Surface
- Improve Infiltration/Reduce Runoff
- Reduce Evaporation
- Moderate soil temperature

Protect the Soil Surface

Raindrop impact destroys soil aggregates and disperses soil particles …

Creating soil crusts …

Protect the Soil Surface

Resulting in increased runoff and soil erosion.

Rainfall Simulator Demonstration

Set-up

Operation

Rainfall Simulator Demonstration

Runoff and Erosion Results

Rainfall Simulator Demonstration

Infiltration Results

Reduce Evaporation

- Crop residue improves infiltration and reduces soil evaporation. Maintaining adequate residue cover takes the "E" out of ET.
- A study in Kansas found that leaving crop residue in place resulted in a savings of 3.5" of soil water. That is equivalent to an extra 40 bu/ac dryland corn or an irrigation savings of $25 to $35 per acre.

Moderate Soil Temperature

Soil temperature without cover

Soil temperature with cover

When soil temperature reaches

140 F Soil bacteria die

130 F 100% moisture is lost through evaporation and transpiration

113 F Some bacteria species start dying

100 F 15% moisture is used for growth
85% moisture lost through evaporation and transpiration

95 F

70 F 100% moisture is used for growth

J.J. McEntire, WUC, USDA SCS, Kernville TX, 3-58 4-R-12198. 1956

Disturb the Soil as Little as Possible

Intensive tillage destroys the biological and ecological integrity of the soil system.

Before Primary Tillage

After Primary Tillage

After Secondary Tillage

Disturb the Soil as Little as Possible

Tillage creates twin problems:

- Accelerated soil degradation
- Destruction of habitat for soil organisms

"For soil organisms tillage is a catastrophic event."

- Dwayne Beck

Disturb the Soil as Little as Possible

- Under reduced tillage and direct seeding systems soil biota can build and maintain soil pore networks.
- Creating a stable soil habitat is the first step towards having your soil function to your advantage.
- Crop rotation is the next step

Keep Plants Growing All Year

Benefits of Cover Crops:

- Reduce erosion from wind and water.
- Increase soil organic matter content.
- Capture & recycle or redistribute nutrients in the soil profile.
- Promote biological nitrogen fixation and reduce energy use.
- Increase biodiversity.
- Suppress weeds.
- Manage soil moisture.
- Minimize and reduce soil compaction.

Keys to Improving Soil Health

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Practices to Improve Soil Health

- Conservation Crop Rotation
- Continuous no-till
- Cover Crops
- Nutrient Management
- Pest Management

National Resources

- Soil Health Website
  http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/
- Includes links for:
  - Soil Health Theater (1 minute videos on soil health)
  - Dig a Little, Learn a Lot (a link to the soil biology primer)
  - Grow With It (a productive soils checklist for growers)
  - Links to Soil Health Fact Sheets


but in the soil.

Questions?


LOST
CONFUSED
UNSURE
UNCLEAR
PERPLEXED
DISORIENTED
BEWILDERED