# Soil Health & Sustainability in Minnesota

Doug Miller, Minnesota NRCS Soil Health Coordinator

# Soil Health


Think small in size and **big** in numbers…

**Credit and thanks to…**

- Dr. Kristine Nichols – ARS Mandan, ND
- Dr. Elaine Ingham – Oregon State University
- Dr. Rebecca Phillips – ARS Mandan, ND
- Dr. James Nardi – University of Illinois
- Dr. Christine Jones – Australia
- John Stika – Area Resource SS, NRCS, ND
- Actinomycete Photo – Soil Microbiology Slide Set 1976, J.P. Martin, et. al.
- Bacteria Photo – Michael T. Holmes, Oregon State University, Corvallis, OR
- Fungi Photo – USDA Forest Service, PNW Research Sta., Corvallis, OR
- Protozoa Photo – Elaine R. Ingham

# WHAT IS SOIL HEALTH?

The continued capacity of the soil to function as a vital **living system** that sustains plant, animal, and human health.

# Managing for Soil Health puts People, Livestock, Macro and Microorganisms, Crops/Plants Working in Concert to Benefit Each Other, while Building & Protecting Soil

# Managing the Soil as if it is Not Alive, Leaves us with a Woefully Degraded Resource

# What did the Landscape look like Before we Settled and Began to Till the Earth?

# What Functions Do You Expect Your Soil to Perform?

- Take in and Hold Water
- Supply Nutrients
- Maintain Biodiversity
- Filter and Buffering
- Physical/Structural Support

# Is This Soil Functioning?

# Is This Soil Functioning?

# Soil Health Addresses Problems with Soil that IS NOT Functioning

# The 4 Cornerstones to Restore Soil Health & Function Are:

- **Manage More by Disturbing Soil Less**
- **Keep Living Roots in the Soil As Long As Possible**
- **Keep the Soil Covered (Armored) as Much as Possible**
- **Diversify with Crop Diversity**

# Minimize Soil Disturbance
## Soil Microbes Dislike Disturbance – From Tillage or Ag Chemicals

# Keep Living Roots in The Soil as Long as Possible – Late Nov. 2012

# Keep The Soil Covered (Armored)

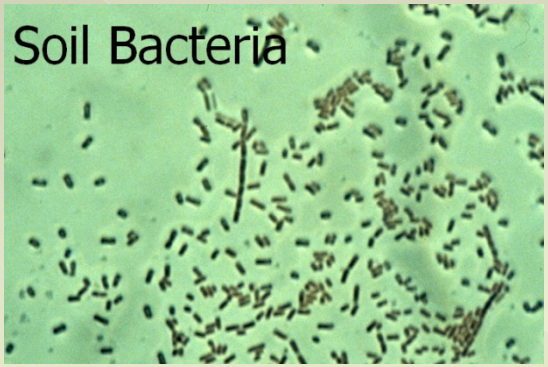
- Topsoil is the most important part of the soil, and the most susceptible to degradation from Wind and Rain

- Cover Protects Soil Microbes from Hot Soil Temperatures

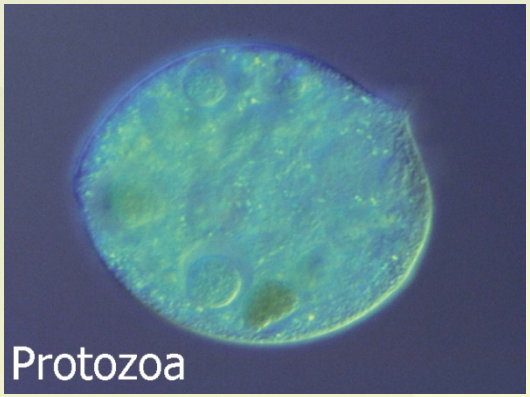
# Topsoil Cracked and Dry – Corn Leaves Rolling From Moisture Stress! Microbes in a Hot Dry Environment – Undesirable!

# Diversify with Plant/Crop Diversity – Cover Crops & Rotations

# Soil Microbial Diversity



# Bacteria & Fungi – The Soil Glue Makers

- Microbes live on plant roots
- Bacteria secrete a type of “Glue” which gives soil Aggregate Stability in Micropores.
- Fungi secrete Glomalin, another glue which give Aggregate Stability in Macropores.
- Soil Microbes and Crops/Plants benefit each other.


# The Rhizosphere…Where Plant Roots Contact the Soil

Zone of concentrated biological activity adjacent to the root…

- Bacteria
- Fungi
- Protozoa
- Nematodes
- Microarthropods
- Earthworms

# Soil Health Toolbox
## Field Management Practices to Improve Soil Health

- No Tillage
- Crop Rotation Diversity
- Cover Crops
- Reduce Fertilizer use
- Reduce Pesticide use
- Livestock
- Compost

# **Soil Aggregate Stability** - Evidence of 2 Contrasting Soil Management Methods!

Minimal Soil Disturbance

Tillage

# EQIP Conservation Practices

- No-Till/Strip Tillage Residue Management (329)
- Conservation Crop Rotation (328)
- Nutrient Management (590)
- Pest Management (595)

And others…

# EQIP Program for Cover Crops

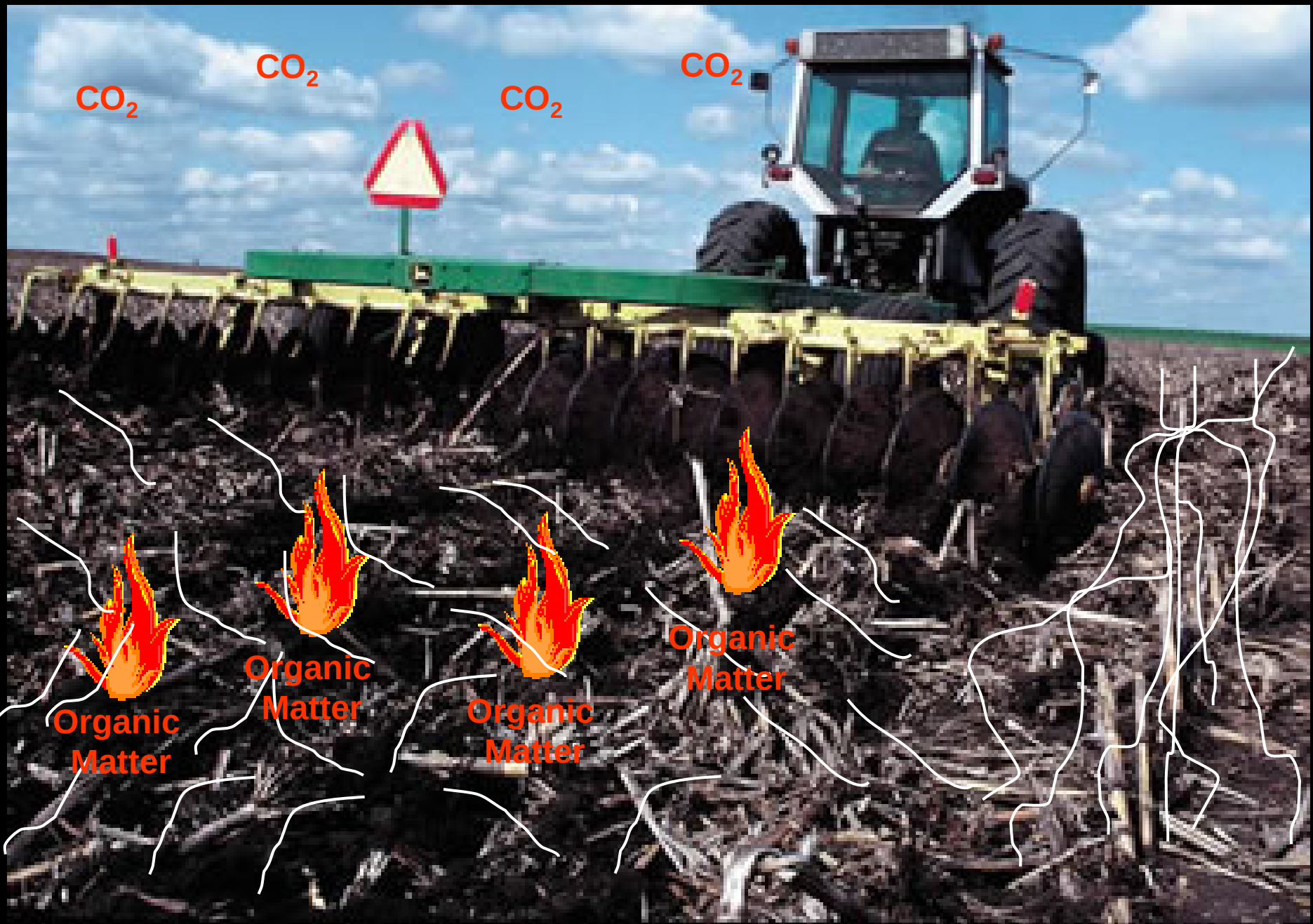
- New Program for Cover Crops
- 5 year duration for up to 40 acres

Check with your local NRCS Field Office!

# CAUTION!

**Do not** make implementation of a Soil Health Practice Your Goal…

**Make Soil Health Your Goal!**


$CO_2$
$CO_2$
$CO_2$
$CO_2$
Organic Matter
Organic Matter
Organic Matter
Organic Matter

# How Does Tillage Affect Soil Health?

- Loose vegetation cover
- The plow destroys micro & macropores
- Soil aggregates are destroyed
- Microbes reduce activity from disruption
- Plowing oxidizes organic matter in the soil (which microbes make available as nutrients to plants)

# Cover Crops Reduce Fertilizer Use

- The Microbes in the soil work together with plants to work the nutrient cycle (make nutrients for crops!)

- Excessive nitrogen fertilizer…
  - Short-circuits microbes
  - Depresses activity of natural N fixers
  - Stimulates bacterial decomposition of SOM
  - N at risk for leaching or denitrification and
  - Applying of Anhydrous Ammonia is a chemical disturbance to microbes
  - Synthetic fertilizers are salts (salinity)

# Livestock – Cover Crops – Soil Health

- Livestock in Field – Mob Grazing
- Add and Distribute Biology to the Soil
- Cycle residues
- Put Plant Residues in Contact with Soil

# Compost

- Aerobic compost – lots of microbes
- Increase Soil Food Web diversity
- Low application rate
- Can be applied as a liquid “tea”
- Compost or Compost Tea is often used to “jumpstart” microbial activity in a field new to Soil Health Practices

# Benefits of Managing for Soil Health

- Improved Nutrient Cycling

- Improved soil aggregation
  - Increased water infiltration and storage
  - Better root growth into more soil (along macro & micropores)

- Fewer weeds and diseases
  - Less soil disturbance means fewer weed seeds will be brought to the surface

# How Will We Know if Soil Health is Improving?

- Increased soil aggregate stability
- Water infiltration increases
- Organic matter increases
- Crop response
- Reduced input costs
- Soil Food Web analysis

# Use A Simple Soil Test
# Dig a Hole – Use Your Senses

**If the soil…**

- Looks healthy with lots of roots and a dark brown to black color (high organic matter), and visible earthworms & other organisms
- Feels healthy (moist, crumbly, friable)
- Smells healthy (fresh, earthy)

**Then, you are on your way!**

# Resources

- NRCS Soil Health Website

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1048859

- Managing Cover Crops Profitably

www.sare.org/publications/covercrops.htm

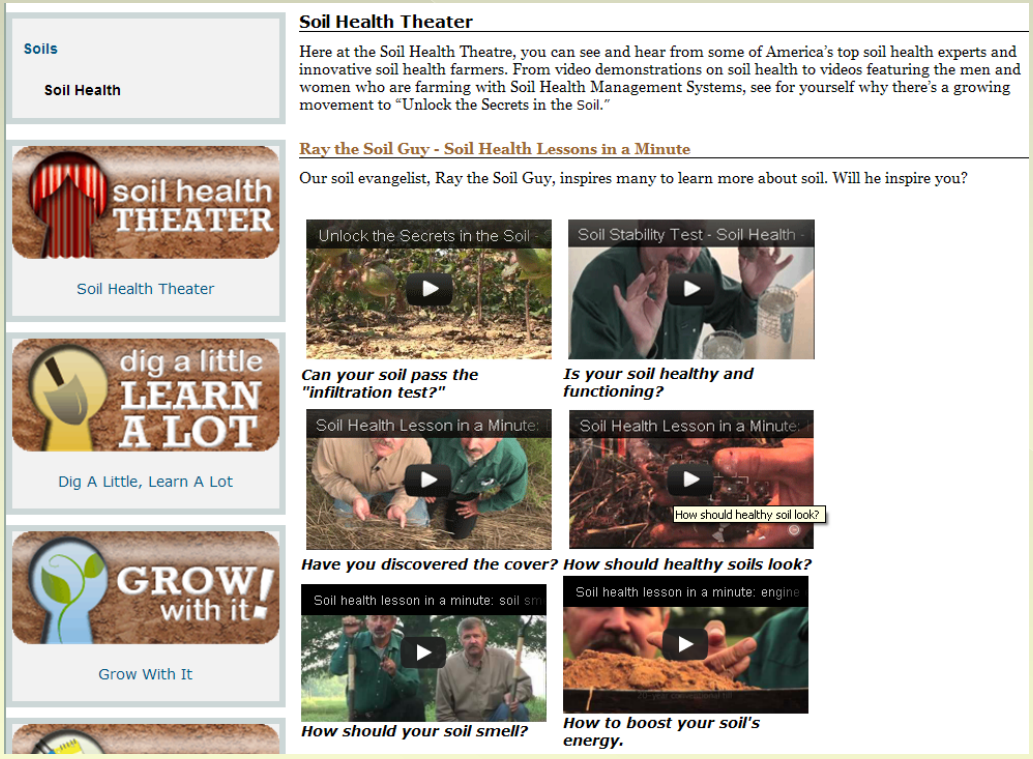
- Burleigh County Soil Conservation District

http://www.bcscd.com/?id=23

- Your County NRCS/SWCD  Field Office

# ...Or Just Google

- NRCS Soil Health
- NRCS Soil Health Theater
- Burleigh Co. ND Soil Health



# Now is the Time to Begin

NRCS is an Equal Opportunity Provider and Employer