

unlock the
SECRETS
IN THE
SOIL

NRCS's Soil Health Initiative

*Slides stolen from:
Ray Covino, Jon Stika, Kip Potter,
Ray Archuleta, Tom Akin, and
others, NRCS*



Maggie Payne
Resource Soil Scientist
NRCS
Massachusetts



United States Department of Agriculture
Natural Resources Conservation Service

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Soil Health Benefits

- ✓ Increase soil carbon and reduce CO₂ emissions
- ✓ Save energy and input costs
- ✓ Save water and increase drought tolerance
- ✓ Reduce disease and pests
- **Improve water quality**





What is Soil “Health”

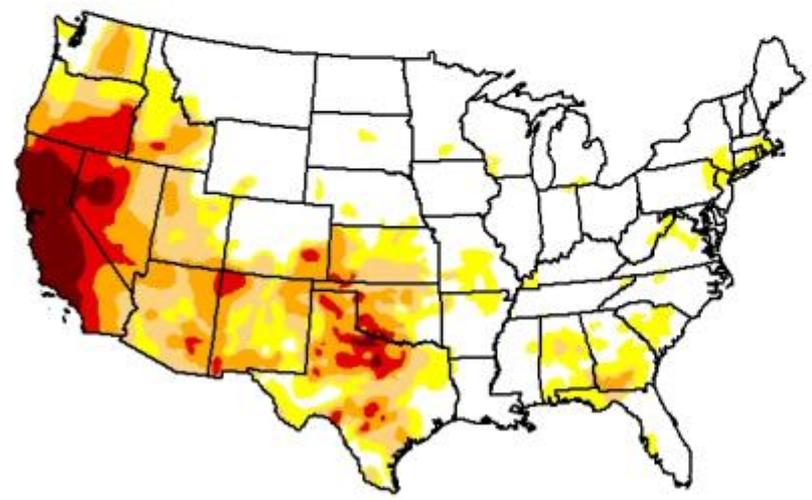
- More than just fertile soils with adequate nutrient levels  soil quality
- Physical structure – good aggregate stability, pore space, and bulk density
- Biology – soil microorganisms provide natural living system, nutrient mineralization, organic glues, etc.
- Vegetative cover – perennial vegetative cover, preferably living plant systems, provide source of carbon, lower soil temperature, etc.
- Increase in organic matter – soil tillage “burns” organic matter



Why a Soil Health push?

- World population is estimated to be 9 billion by 2050, need 70% more food.
- Between 1982-2007, 14 million acres of prime farmland in the U.S. was lost to development.
- Becoming more dependent on expensive and limited petroleum-based fertilizers to maintain production goals
- This is the mission of NRCS/SCS – from the beginning
 - April 27, 1935: "the wastage of soil and moisture resources on farm, grazing, and forest lands . . . is a menace to the national welfare"

Why Should We Care?



Drought Monitor, Sept 18, 2014



Erosion from bare fields into river



Oklahoma October 2012 I-35

Sediment is still the largest water quality pollutant by volume



Lubbock Texas Oct. 17, 2011





2014 Conservation Innovation Grants

B.F. Smith Foundation - Delta F.A.R.M. (MS) \$438,750

*Mississippi's **Soil Health** Initiative: Fostering Awareness, Belief and Understanding through Local Experience and Evaluation*

County of Carlton (MN) \$107,313

*Implementing Whole-Farm Approaches to Improve **Soil Health** and Farm Resiliency in Northeast Minnesota*

Louisiana State University Agriculture Center (LA, MS) \$232,232

***Soil Health** and Pasture Ecosystem Improvement from a Diverse Mixture of Cool-season Species Overseeded on a Warm-season Perennial Grass Pasture*

National Association of Conservation Districts (US) \$750,000

***Soil Health** Advocates - Promoting and Documenting the Benefits of Soil Health Management*

National Corn Growers Association (IA, IL, IN, MN, NE, OH, WI) \$998,000

*Economic and Environmental Benefits of Helping Crop Producers Focus on **Soil Health***

North Carolina Foundation for Soil and Water Conservation, Inc. (NC) \$124,411

Defining Best Management Practices for Multi-Species Cover Crops in the Southeastern USA



North Carolina State University (NC, GA) \$995,710

Soil Health in Diverse Forage Systems on Beef Farms

Okanogan Conservation District (WA) \$306,453

Cover Crops in the Low-Rainfall, Wheat-Fallow Region of Eastern Washington

Oklahoma State University (OK, KS, TX) \$872,044

On Farm Soil Health Management Systems Demonstration Program for the Southern Plains

Purdue University (IN) \$252,978

Documenting Soil Health Assessment Methods and Jump Starting Carbon and Nutrient Cycles for the Sustainable Restoration of Soil Health

Regents of the University of Minnesota (MN) \$190,231

Optimizing Soil Health in Season Extension Environments through Innovative Cover Crop Management

Texas A&M AgriLife Research (TX) \$361,135

Demonstrating Soil Health Promoting Practices to Increase Water Holding Capacity and Yield in Deficit-Irrigated Agriculture

The Curators of the University of Missouri (MO, IA) \$463,167

Building Soil Health through Innovative Cover Crop Practices while Enhancing Pollinator and Wildlife Habitat

The National Grazing Lands Coalition (TX, LA, SC, NY, ND) \$279,720

Utilizing Outreach and Grazing to Improve Conservation and Soil Health



University of Hawaii (HI) \$474,043

*Promoting the use of Cover Crop Calculator for the Tropics as Nitrogen Management Tool and the use of Cover Crops for **Soil Health** Management Guideline*

University of Vermont and State Agricultural College (VT, NY) \$174,691

Demonstrating Effects of Compaction Best Management Practices on Soil Properties and Water Movement

University of Vermont and State Agricultural College (VT, NY) \$483,484

Innovative Strategies for Broad Scale Adoption of Cover Cropping in Northern Climates

Virginia Polytechnic Institute and State University (VA) \$381,761

*Quantifying **Soil Health**: Measuring the Impacts of Tillage and Cover Crop Practices on Nutrient Retention and Soil Physical, Biological and Chemical Properties*

West Virginia Conservation Agency (WV) \$15,000

*Using In-Season Cover Crops to Improve **Soil Health** and Reduce Nitrogen Fertilizer use in the Chesapeake Bay Drainage*

Winrock International Institute of Agricultural Development (MN, IA) \$395,930

*Demonstrating Economic and **Soil Health** Benefits of Livestock Grazing on Cover Crops*

> \$8 million



Paradigm Shift

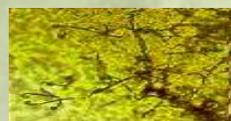
- Treating the soil like an ecosystem instead of a purely physical body

“Feed the subterranean herd”

Relative Amount of Microbes in Handful of Soil



Bacteria up to 50 billion



Actinomycetes up to 2 billion



Fungus up to 100 million



Protozoa up to 50 million



Nematodes 10,000



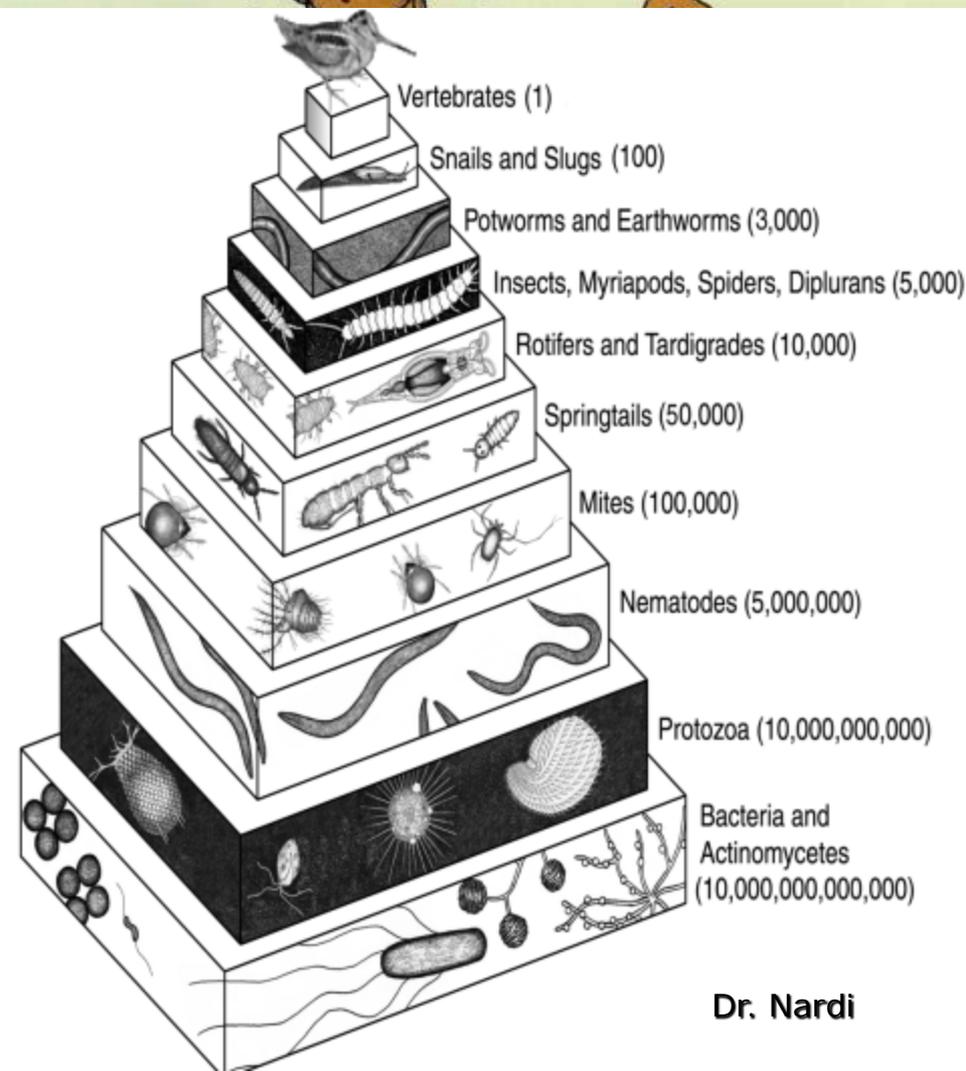
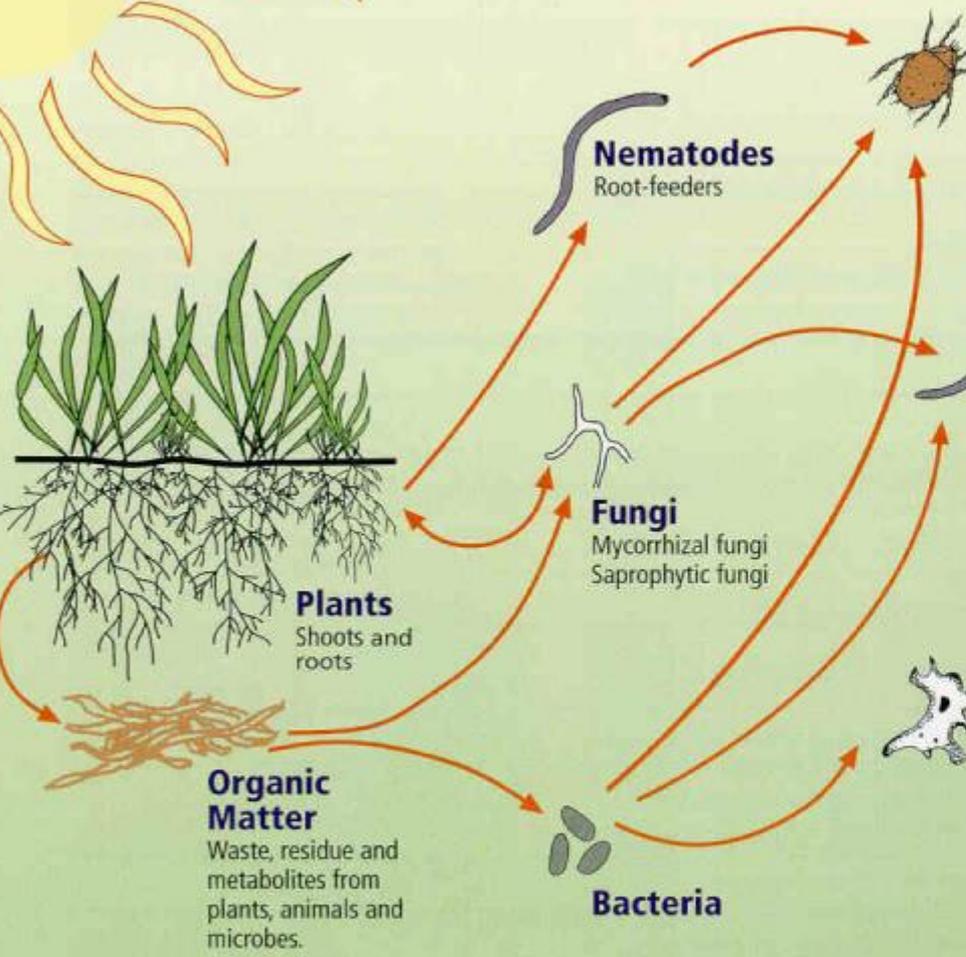
Arthropodes 1000



Earthworm 0 to 2

The Soil Food Web

All sources of soil carbon:



First trophic level:
Photosynthesizers

Second trophic level:
Decomposers
Mutualists
Pathogens, parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

A photograph of a soil profile, showing a cross-section of dark brown soil with numerous roots and organic matter like twigs and sticks. The soil is rich and appears to be in a natural setting. The background is slightly blurred, showing green foliage.

Soil is a Living Factory

- **Macroscopic and microscopic organisms**

- Food
- Water
- Shelter
- Habitat
- Powered by sunlight

- **Management activities improve or degrade soil health**

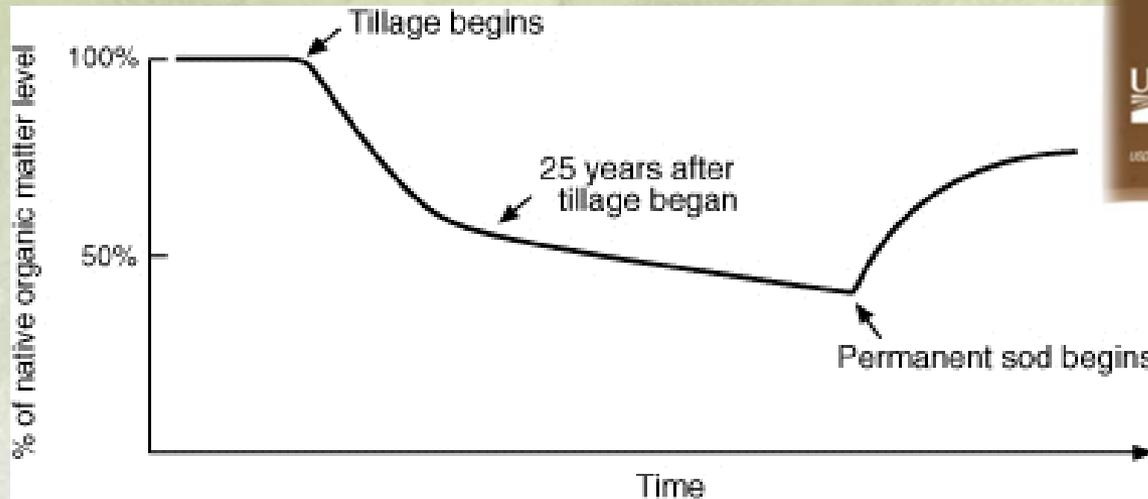
- Tillage
- Fertilizer
- Pesticides
- Grazing
- Plant Diversity



Dynamic Soil Properties

- Inherent vs Dynamic Soil Properties
- Soil function can be restored (with proper management) in a dog's lifetime.

Soil Organic Matter over Time:



USDA-NRCS SOIL HEALTH INFOGRAPHIC SERIES #002

what's underneath

unlock the SECRETS IN THE SOIL

healthy soil has amazing water-retention capacity.



Every

1%

increase in organic matter results in as much as



25,000

gal of available soil water per acre.

Source: Kansas State Extension Agronomy e-Updates, Number 357, July 6, 2012



United States Department of Agriculture

Want more soil secrets?
Check out www.nrcs.usda.gov

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Principles of Managing for Soil Health



- Minimize **Disturbance of the soil**
- Maximize **Diversity of plants in rotation**
- Keep **Living Roots in the soil as much as possible**
- Keep the soil covered **with plants and plant residues**
- **Create the most favorable habitat possible for the soil food web**



Soil Health Toolbox

- (No) Tillage
- Crop Rotation Diversity
- Cover Crops
- Degree of Fertilizer use
- Degree of Pesticide use
- Livestock



How do we know if soil health is improving?



- Indicators of soil health – what we see:
 - Soil aggregate stability increases
 - Water infiltration increases
 - Organic matter increases
 - Crop response
 - Reduced input costs
 - Soil Food Web analysis

Indicators of Soil Health – what we can measure



- Infiltration



Indicators of Soil Health – what we can measure



Respiration



Indicators of Soil Health – what we can measure



Compaction/Bulk Density



Indicators of Soil Health – what we can measure



- Organic matter
- Surface cover
- Structure
- Erosion
- Root growth
- pH
- EC



Photo: Matthew Havens, Soil Scientist, NRCS New York.

Measuring Soil Health

- Soil Health Card
- Soil Health Kit
- Cornell Soil Health Assessment
- Haney Test

INDICATOR	Excellent (8-10)
	Surface cover 
Soil structure (0–3 inches)  	Soil aggregates crumb, don't disintegrate in water; soil tilth excellent; good weight-bearing capacity; no crusting and sealing
Organic matter (0–3 inches) 	Soil dark color; visible organic matter at surface; organic matter content high (>4% in top 2 inches); approaching level under native vegetation
Soil erosion  	No visual evidence of rills or soil movement and deposition in the field; few to no rock fragments visible at surface
Soil compaction  	Soil not very resistant to penetration with soil compaction tester; no evidence of plow pan; low penetration resistance in subsoil
Water infiltration 	Water drains well after heavy rain; ponding largely absent; low runoff
Soil biodiversity 	Much evidence of earthworm activity; many nightcrawler mounds; spiders and ground beetles visible under residue
Plant and root growth 	Seedling emergence even and fast; plant growth vigorous and even; plants resist drought stress; root growth vigorous; roots fibrous; roots explore soil profile

Cornell Soil Health Assessment Training Manual



Local Advocates



- **Ward's Berry Farm** – 150 acres sweet corn, pumpkins, vegetables and small fruit – no till, diverse cover crop, nutrient management
- **Woodstock Orchards** – 100 acres apples, 20 acres veggies – conversion to no till, crimper roller, diverse cover crops

It's all about water quality at Ward's Berry Farm

Jim Ward, owner | Ward's Berry Farm | Sharon, Massachusetts

Farming in a suburban town 25 miles south of Boston has both benefits and challenges. Those benefits and challenges result from the same thing, lots of neighbors.

Lots of neighbors mean lots of customers for Ward's Berry Farm's retail farm stand and pick-your-own operation in Sharon, Massachusetts. They also mean competition for water resources and stricter state regulations to protect public drinking water supplies.



Tom Akin, NRCS Conservation Agronomist, and Jim Ward examine healthy soil in the no-till sweet corn field.

"We never saw the no-till corn or pumpkins wilt, while a few feet away in bare ground, corn at the same stage was curling at the ends."

Local Advocates



- **Elm Farm** – 160 cow dairy, 300 acres – min till, nutrient management, diverse cover crop
- **Valleyside Farm** – 220 cow dairy, 560 acres, no till, nutrient management, diverse cover
- **Fairholm Farm** – 300 cow dairy, 600 acres, no till, nutrient mngmt, diverse cover crop
- **May Hill Farm** – 180 cow dairy, 280 acres, no till, nutrient mngmt, diverse cover
- **Fairvue Farm** – 1000 cow dairy, 2,000 acres, combination of no and min till, nutrient mngmt, diverse cover

Questions / Discussion

