United States Department of Agriculture

Pennsylvania
Natural Resources Conservation Service

Connections Between Soil Health and Human Health

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Today's Talk

1. What is NRCS and what do we do?

2. What is Soil Health?

3. What do soils (healthy & fully-functional soils) provide to us?

4. Emerging connections between healthy soils and "nutrient dense" food

5. What can farmers do to have healthy soils?

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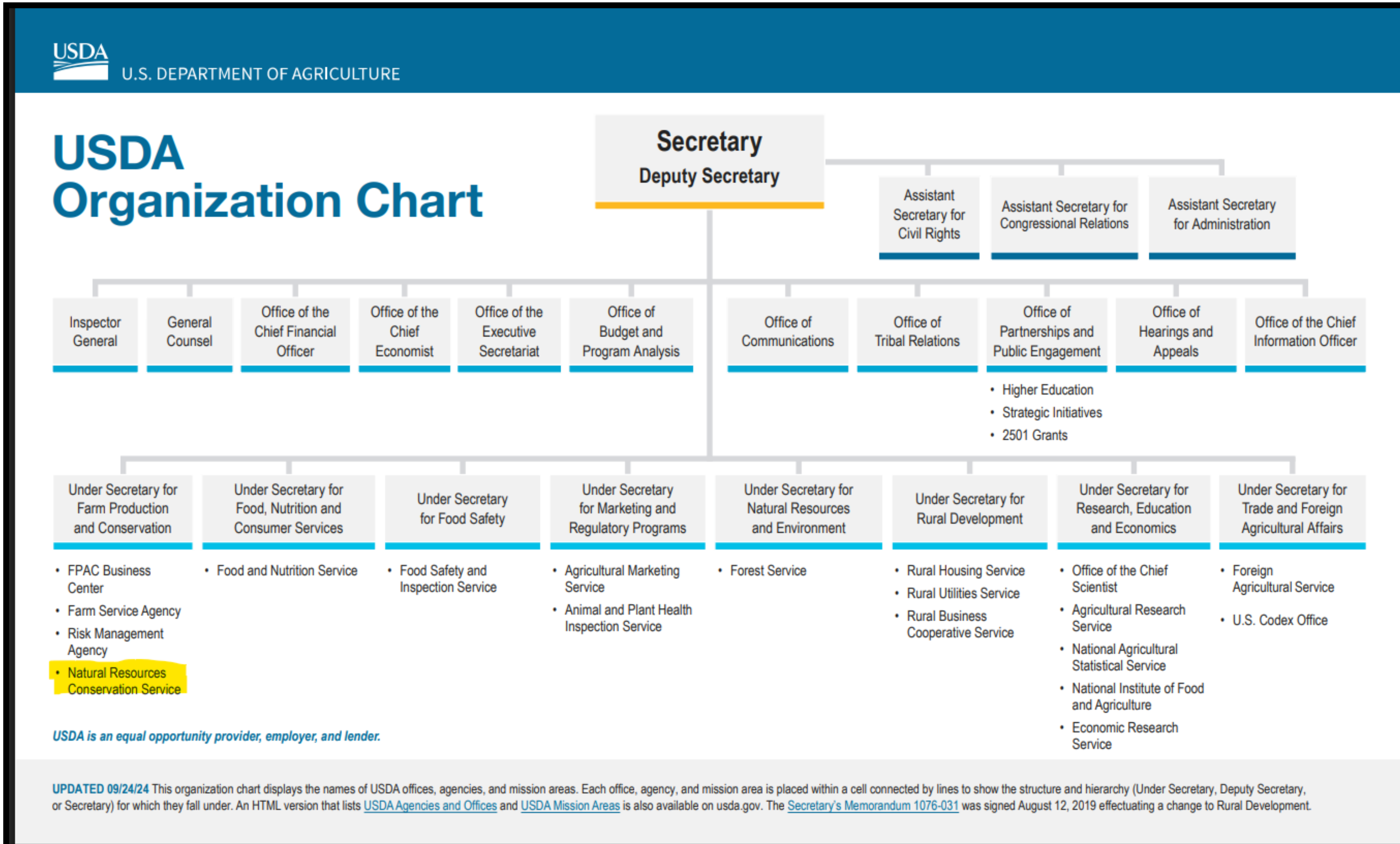


The Natural Resources Conservation Service (NRCS)

An agency committed to “helping people help the land”—our **mission** is to provide **resources** to farmers and landowners to aid them with conservation.

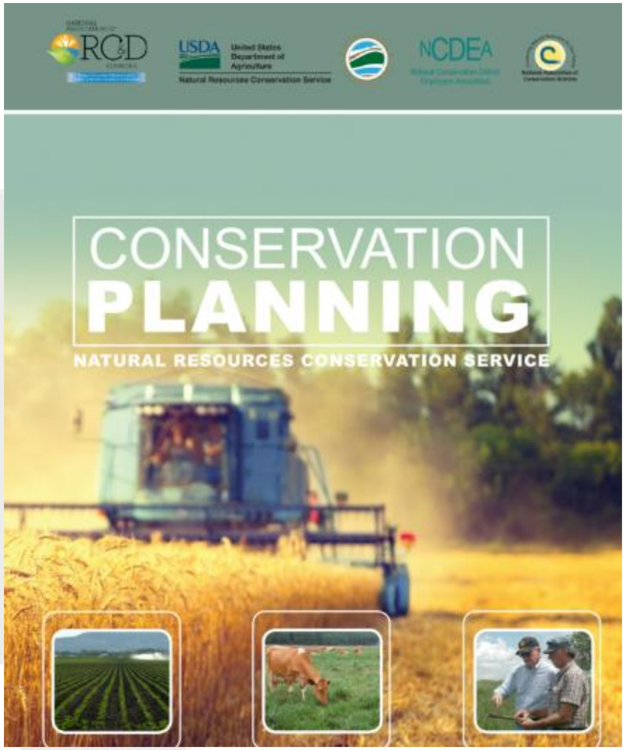
Ensuring productive lands in harmony with a healthy environment is our priority.

NRCS provides leadership in a partnership effort to help people conserve, maintain and improve our natural resources and environment.

What does NRCS do at the Local Level?

A conservation plan is a document that describes the schedule of implementation for practices needed to solve identified natural resource concerns associated with soil, water, air, plants, livestock, energy, and wildlife.

Management decisions in the plan are made by you, for your land or farming operation, with assistance from NRCS. Your social and economic interests, as well as federal, state, tribal, and local requirements are considered during the planning process.



Connections Between
Soil Health and Human Health

But First -- How Do We Define Soil Health and Human Health?

How do doctors define Human Health?

Human health refers to a state of complete physical, mental, and social well-being, extending beyond the mere absence of disease or infirmity.

How does NRCS define Soil Health?

Soil health is the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animal and humans

"We often consider how soil health supports human health in the context of feeding a growing world population. This is certainly a very noble goal by itself, but the potential does not end there"

Dr. Wayne Honeycutt, President and CEO of Soil Health Institute.

What do Healthy Soils Provide to Us?

- Food production and food security
- Filtering contaminants from water
- Impacting our gut microbiome through the food we eat
- Source of beneficial microorganisms

https://www.nature.com/scitable/knowledge/library/the-influence-of-soils-on-human-health-127878980/

What do Healthy Soils Provide to Us?

Food production and food security:

- Production of sufficient amounts of food, adequate nutrient content in the food products, and the exclusion of potentially toxic compounds from the food products (Hubert *et al*. 2010).
  - Soils play a major role in all of these areas of quality food production and security.
  - Healthy soils with diverse microbial communities can produce more nutrient-dense crops.

What do Healthy Soils Provide to Us?

Food production and food security:

- In particular, soils that have well-developed structure, sufficient organic matter, and other physical and chemical properties conducive to promoting crop growth lead to strong yields and are thus important for food security (Reicosky *et al*. 2011; Brevik 2009b).
  - Soil degradation, which includes soil erosion and loss of soil structure and nutrient content, decreases crop production and threatens food security (Brevik 2013b; Pimentel & Burgess 2013; Lal 2009) (Figure 1)

What do Healthy Soils Provide to Us?

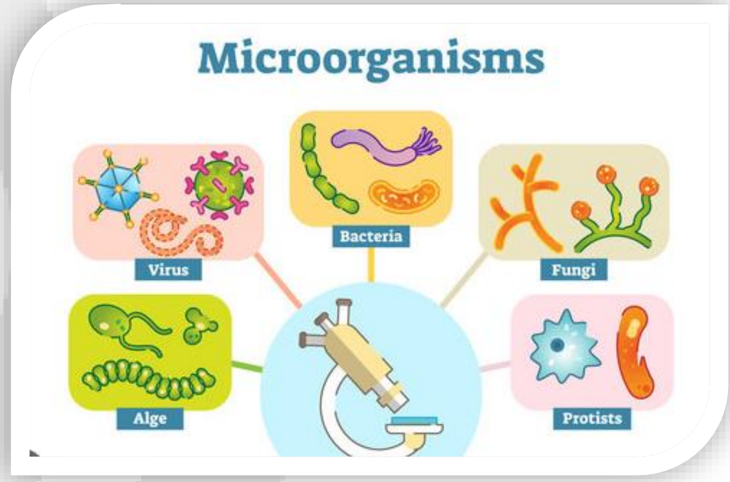
Filtering contaminants from water:

- Contaminants are removed by soil through multiple ways
  - physical capture as the water moves through pore spaces
  - chemical sorption to solid surfaces
  - biodegradation carried out by microorganisms living in the soil (Helmke & Losco 2013).

What do Healthy Soils Provide to Us?

Soil Microbiome and Gut Microbiome:

- The soil microbiome, a diverse community of microorganisms, plays a vital role in nutrient cycling and plant health, ultimately impacting the nutritional value of the food we consume.
- There's growing evidence suggesting a link between the soil microbiome and the human gut microbiome, which plays a crucial role in digestion, immunity, and overall health



Beneficial Microorganisms:

- Exposure to beneficial microorganisms in the soil may contribute to a healthy gut-brain axis and overall well-being.

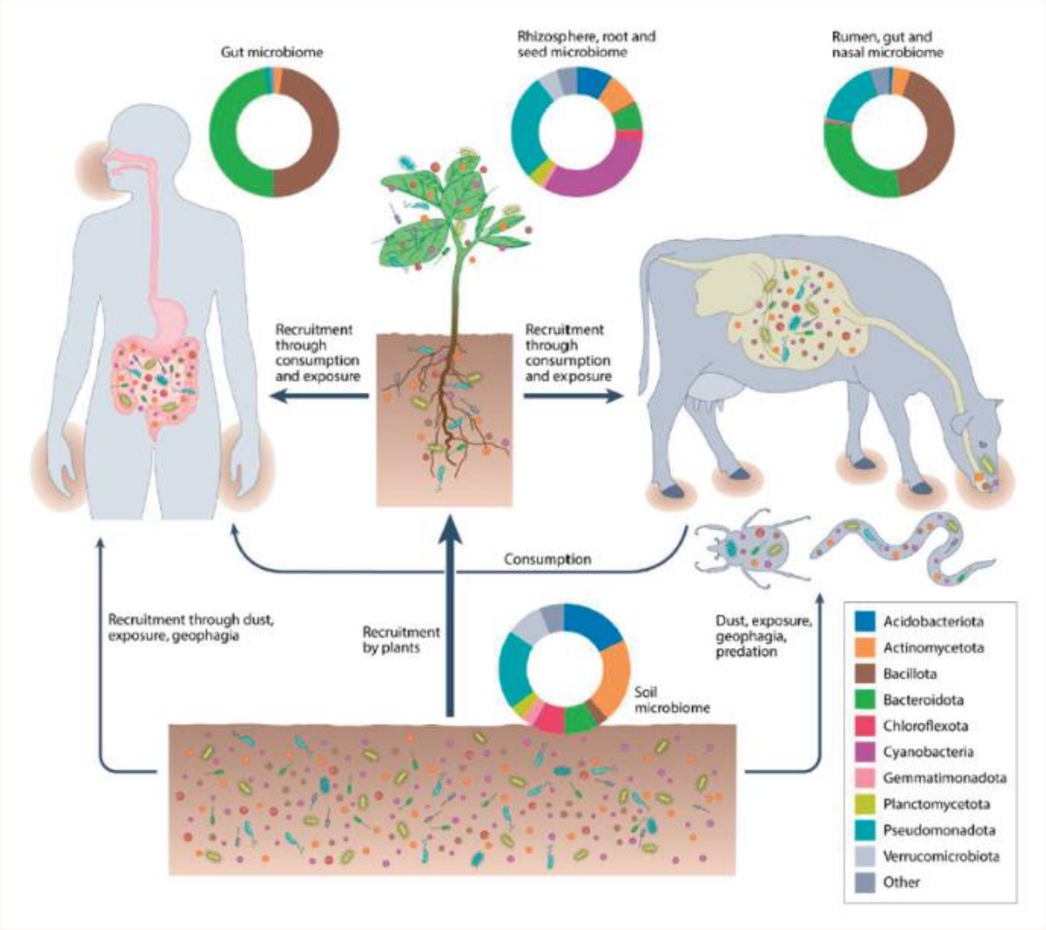


FIGURE 2-9 Soil as a microbial reservoir for plant, animal, and human microbiomes.
SOURCE: Used with permission of Springer Nature BV, from "Soil Microbiomes and One Health", Banerjee and van der Heijden, *Nature Reviews Microbiology* 21 (1), 2023; permission conveyed through Copyright Clearance Center, Inc.

Emerging Connections Between Healthy Soils and "Nutrient Dense" Food

Therefore, soils that provide a healthy, nutrient-rich growth medium for plants will result in plant tissues that contain most of the elements required for human life when the plants are consumed.

Combs 2005; Committee on Minerals and Toxic Substances in Diets and Water for Animals, National Research Council, 2005

Emerging Connections Between Healthy Soils and "Nutrient Dense" Food

Healthier soils with more soil life are producing more nutrient-rich crops.

Degraded soil undermines both phytochemical production and micronutrient acquisition, leaving crops more vulnerable to pests and pathogens

- David Montgomery

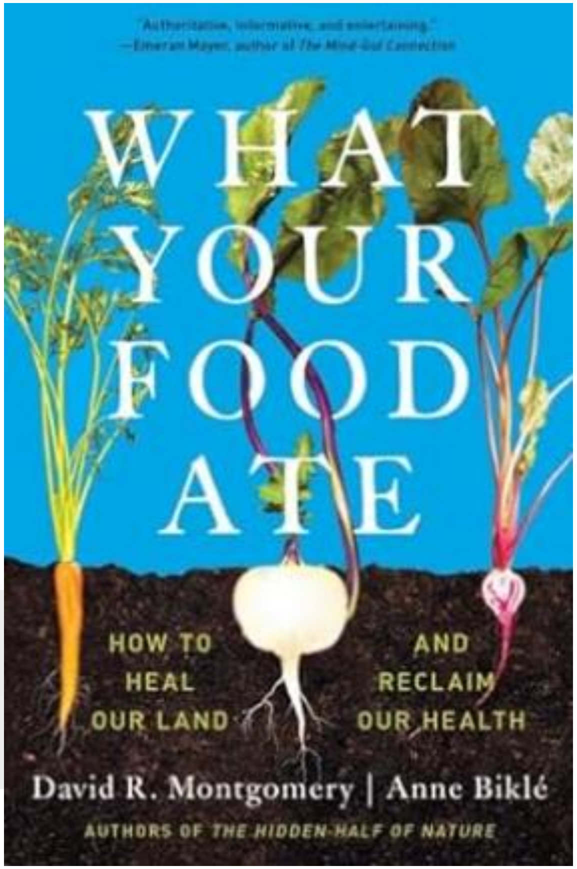
Emerging Connections Between Healthy Soils and "Nutrient Dense" Food

In terms of nutrient density, when averaged across all the paired farms, the crops from regenerative farms had a third more vitamin K, 15% more vitamin E, and 14% more vitamin B1. The crops from the regenerative farms also had 15-22% more total phenolics, phytosterols, carotenoids as well as 11% more calcium , 16% more phosphorus and 27% more copper.

Healthier soil with more soil organic matter and the life it sustains enhanced the nutrient density of crops.

Farmers using regenerative practices focus on building up soils organic matter.

"What Your Food Ate" by David Montgomery



Emerging Connections Between Healthy Soils and "Nutrient Dense" Food

As the science on nutrient density is developing, it is becoming clear that when we compare apples to apples, or any fruits, vegetables or meat for that matter, there is actually significant variation in levels of essential nutrients.

The science is pointing to the soil as the differentiating factor.

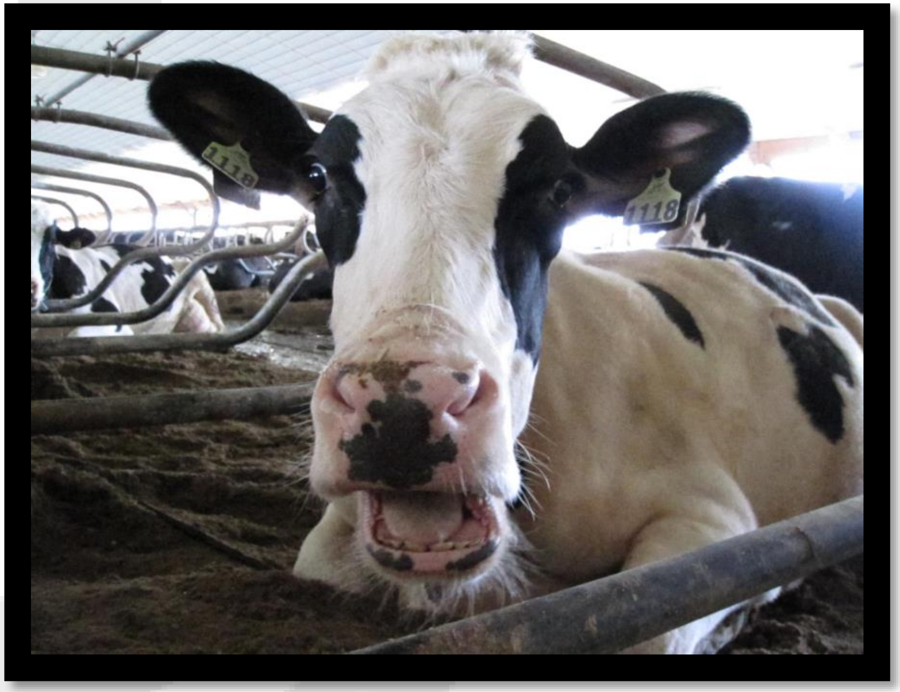
Sophie Waechter-Cass, Green Cover Seed

The Keys to Soil Health

C – Cover the soil with residue and living plants and roots

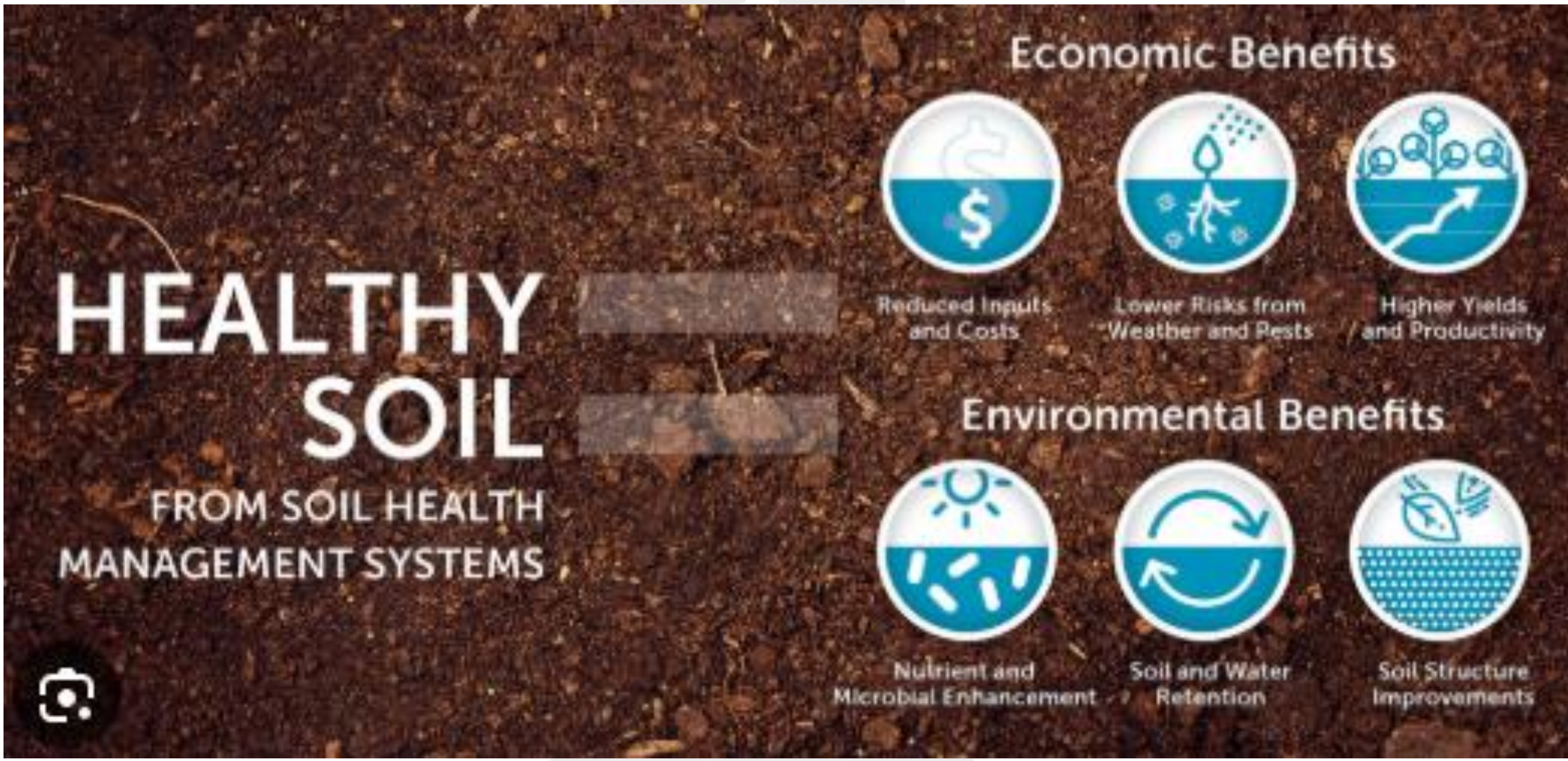
U - Undisturbed, minimize tillage

D - Diversity



The Keys to Soil Health

The Keys to Soil Health



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SLAKE DEMONSTRATION

an indicator of soil health......

What does it tell us?

Tilled soil, no cover crops, vegetable grower, and uses chemical fertilizer

Indicators:

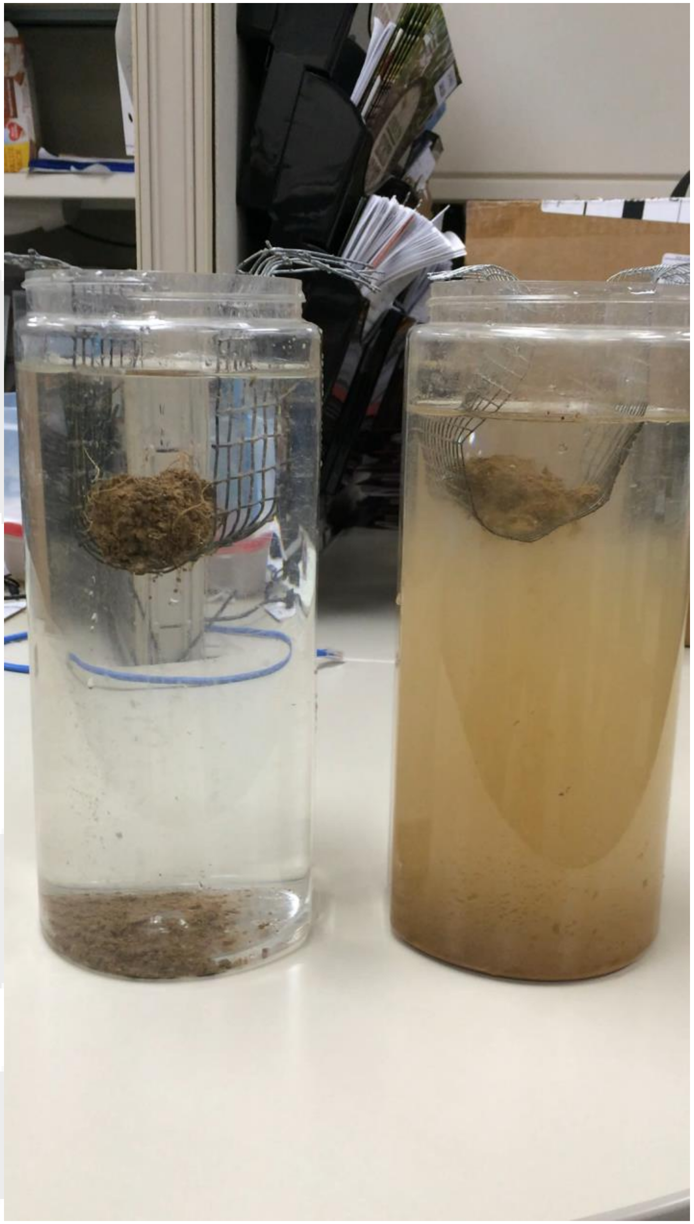
- Low organic matter, less carbon
- High wind and water erosion
- Low infiltration, poor drainage
- High crusting, increased runoff
- Low water holding capacity, droughty
- Low biodiversity below/above the soil
- Inefficient nutrient cycling
- High nutrient loss-decreased plant uptake
- Increased weed and pest populations
- Increased susceptibility to disease
- High fossil fuel dependency

40 yr. no-tilled soil, diverse cover crops/rotations, manure, and no chemical fertilizer

Indicators:

- High organic matter, high carbon
- Low wind and water erosion
- High infiltration, increased drainage
- Low crusting, decreased runoff
- High water holding capacity, resilient against drought
- High biodiversity below/above the soil
- Efficient nutrient cycling
- Low nutrient loss-increased plant uptake
- Less weed and pest populations
- Decreased susceptibility to disease
- Low fossil fuel dependency

Soil Photos: Same soil types, PbB2 Poplar Forest Sandy Clay Loam, Reidsville, NC



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SOIL ANALYSIS

Client :	Grower :	
[redacted] Richfield PA 17086	[redacted]	Report No: [redacted] Cust No: [redacted] Date Printed: 03/26/2025 Date Received: 03/25/2025 PO: Page : 1 of 10

Lab No: 02017 **Field:** **Sample ID:** CS 1

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: 9.6 meq/100g

Test	Method	Results
Soil pH	1:1	6.5
Buffer pH		
Phosphorus (P)	M3	285 ppm
Potassium (K)	M3	176 ppm
Calcium (Ca)	M3	1288 ppm
Magnesium (Mg)	M3	208 ppm
Sulfur (S)	M3	10 ppm
Boron (B)		
Copper (Cu)		
Iron (Fe)		
Manganese (Mn)		
Zinc (Zn)	M3	8.4 ppm
Sodium (Na)		
Soluble Salts		
Organic Matter	LOI	4.4%
Estimated N Release		132 lbs/acre
Nitrate Nitrogen		

SOIL FERTILITY GUIDELINES Prev

Crop : Soybeans- No till **Yield Goal :** 50 bu/ac

(lbs) LIME	(tons)	N	P_2O_5	K_2O	Mg	S
0	0	0	0	40	0	15

Crop : Corn- No till **Yield Goal :** 160 bu/ac

(lbs) LIME	(tons)	N	P_2O_5	K_2O	Mg	S
0	0	195	0	40	0	11

Comments :

Soybeans- No till

· Nitrogen is optional on soybeans.
· For soybeans on soils with a pH of 6.2 or less, apply limestone as recommended
molybdenum. Apply 1-2 oz of sodium molybdate (0.4-0.8 oz of elemental molybden

Corn- No till

· Greater N efficiency for corn may be achieved by splitting the N application. App
planting and the remainder as sidedress when corn is 8-24 inches high.
· For early planted corn or no till corn, apply a starter fertilizer at least 2 inches fro
N/Acre and 30-60 lbs P2O5/Acre.
· If N is supplied to corn through the irrigation system, make 3-4 equal application
6th leaf stage.

Table 3. Ratings and peer comparisons for the Cornell Soil Health Test Indicators. This table shows ratings for your fields, compared to the 10th, 50th (median), and 90th percentiles for fields from peer row crops & grain farms in the study.

	Your Fields			Peer Fields		
Soil Health Indicator	**2598**	**2850**	**3356**	**10th**	**Med**	**90th**
Available Water Capacity	97	93	97	64	88	95
Aggregate Stability	76	86	89	16	40	77
Organic Matter	88	92	96	20	71	98
Soil Protein Index	52	58	65	21	37	61
Respiration Index	68	46	72	19	42	78
Active Carbon	86	90	94	21	65	92
pH	61	79	100	62	100	100
Phosphorous	100	100	100	10	100	100
Potassium	100	100	100	95	100	100
Minor Elements (Mg, Fe, Mn, Zn)	100	100	100	88	100	100
Overall Score	83	84	91	56	70	84

OPTIMAL (80-100)	EXCELLENT (60-80)	AVERAGE (40-60)	LOW-LEVEL (20-40)	CONSTRAINED (0-20)