

# Measuring and Managing Changes in Soil Health



## PA DEP's Ag Advisory Board

April 15<sup>th</sup>, 2015

DEP South-Central Regional Office, Susquehanna Room A, Harrisburg, PA

Dan Dostie

USDA NRCS


# Presentation Topics

- **NRCS Assistance for Improving Soil Health**
- **How does Soil Health relate to DEP Regs?**
- **What is different about this approach to Ag?**

# **NRCS Assistance for Soil Health**

- **Long Range Soil and Water Conservation District Soil Health Program Development**
- **Planning Assistance**
- **Practice Application Assistance through NRCS programs**

# Many Pennsylvania Partners



[About Us](#)

Penn State **Extension**
Search College


HOME
OUR WORK
VISIT
LEARN
FARM
DO

Plants & Pests
Natural Resources
Community & Business
Food & Health
Youth & Family

Extension
Plants and Pests
Sustainable Agriculture
About Us

## Our Work


Rodale Institute » Our Work » Soil Health



Soil Health

Overview

Soil health is the very foundation on which to champion. From cover crops and no-till, it has found its way into most of the no-till practices.



Pennsylvania  
No-Till  
Alliance

Farmers Improving Soil Health


### Second Annual PA No-Till Alliance Soil Health Field Days

July 29, 30 & 31

Three locations - Same program & speakers at all!

More info at [www.panotill.org](http://www.panotill.org) or (717) 635-2320


Share



July 29

**Oregon View Farm - Jay Landis, host**  
1270 E. Oregon Road, Lititz, PA 17543

Share



July 30

**M & A Farms - Mark Rohrback, host**  
57 Howglen Lane, Catawissa, PA 17820

July 31

**Fabin Brothers Farms - Scott Reinhart, host**  
231 Bethel Church Road, Indiana, PA 15701

Join us for the 24<sup>th</sup> Annual  
**FARMING FOR THE FUTURE CONFERENCE**

WE'RE PLEASED TO ANNOUNCE OUR MAIN SPEAKERS

2019 OCT

**SATURDAY MORNING MAIN SPEAKER**  
**Ray Archuleta** is a Conservation Agronomist at the NCSU's East National Technology Center in North Carolina. Known as "The Soil Guy", Ray shares his infectious enthusiasm for soil health and the principles of agroecology as he teaches around the country. His biological approach looks to the more than 3 billion years of evolutionary knowledge embedded in nature to guide sustainable agricultural practices. He has 25 years of experience with the Natural Resources Conservation Service.



Special thanks to PASAbilities sponsor Kimberlton Whole Foods.



# Capital RC&D

## Area Council

*Supporting Pennsylvania's Heartland*

401 East Louther St., Ste 307 | Carlisle, PA 17013

Phone: 717-241-4361 | Fax: 717-240-0548

Email: [webnotification@capitalrcd.org](mailto:webnotification@capitalrcd.org)

Local solutions for a better environment

### No-till and Soil Health Support



This program is intended to support farm profitability and soil health with peer-to-peer and technical support for no-till systems and other soil health best management practices. [Read more...](#)

### Grass Roots

Prescribed Grazing for  
the 21st Century



Prescribed Grazing is an interactive planning method, done with the operator based on individual goals and needs which can include intensive rotational, rotational, and continuous grazing.

[Read more...](#)

### Park The Plow for Profit



Through the Park the Plow program, Capital RC&D promotes no-till farming as a more profitable and environmentally-friendly alternative to traditional farming methods.

[Read more...](#)

**Dig A Little, Learn A Lot!**

Now is the perfect time for farmers to focus attention DOWN by investigating their soil. If farmers dig a



## Upcoming Soil Health Workshops

Date	Event	Location
March 17	Connect Soils to Profits	USDA Service Center, Mill Hall, PA
March 18	Connect Soils to Profits	Pine Barn Inn, Danville, PA
March 19	Connect Soils to Profits	Wysox Fire Hall, Towanda, PA
July 27-29	PA No-Till Alliance Field Day	Elizabethtown, PA
August 18-20	Ag Progress Days Soils Exhibit	Rock Springs, PA
End of August	Advanced Soil Health Technical Discussion	Ag Progress Days Site, Rock Springs, PA
September	Grazing Pasture Soil Health Field Day	Wilson Farm, Forest County
October 14-16	The Precarious Alliance: Land and its Uses	Del Val College



YouTube



Upload



### International Year of the Soils

by TheUSDANRCS • 5/5 videos

- 1 2015: International Year of Soils (1:53) TheUSDANRCS
- 2 January: To the Heart of the Matter TheUSDANRCS
- 3 February: Soils in the City TheUSDANRCS
- 4 March: Remembering Where Our Food Comes From TheUSDANRCS
- 5 April: Water's Journey to the River TheUSDANRCS

## April: Water's Journey to the River



TheUSDANRCS

Subscribe 1,307

2,032



### The Science of Soil Health: Natural Systems and Weeds

by TheUSDANRCS

2,491 views

3:45



# Conservation NewsBriefs

[Conservation NewsBriefs](#) [Home](#) [About](#) [Join](#) [Conferences](#) [Journal](#) [Calendar](#) [Donate](#) [Contact Us](#)



*Conservation NewsBriefs is a weekly compilation of news stories of interest to SWCS members and stakeholders. The opinions expressed herein are those of the authors and do not necessarily reflect official policy of the Soil and Water Conservation Society unless so stated.*

## SNF AGRICULTURE

**Polymers for  
Irrigation, Turf &  
Ornamentals, and  
Production  
Agriculture**

SNF FLOBOND®  
and AQUASORB™  
products provide:

- Water Retention
- Enhanced Growth
- Nutrient Retention
- Lower Water Costs
- Lower Energy Costs

## Is selling corn residue worth harming soil?

Futurity

After the corn harvest, farmers still have plant material, called corn residue, left behind. Farmers considering selling that corn residue to produce cellulosic ethanol should consider carefully, according to new research. Mahdi Al-Kaisi, a professor of agronomy at Iowa State University, is urging farmers to consider variables such as topography, tillage system, nitrogen application and the amount of organic matter present in their soil to determine how much corn residue they should part with.

Share this article: [f](#) [t](#) [in](#) [e](#)

[READ MORE](#)



**Cover Crops That Pay™**  
Advanced **genetics**, proven by **research**





# NRCS Program Assistance

## CTA – Haney Test Field Trials with ARS

### Soil Health Nutrient Tool Cropland Data Collection Form

1. Lab ID: \_\_\_\_\_
2. Field Acres: 23079
3. Soil Texture (predominant topsoil texture): (circle one)

Sand

Loam

Silty Clay

Loamy Sand

Silt loam

Clay loam

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Sample ID all lbs per acre	N lbs per acre	P205 lbs per acre	K20 lbs per acre	Nutrient value per acre	Run	Crop	Yield Goal	lbs N needed	lbs P205 needed	lbs K20 needed			
1	MC 01	69.69	69.89	137.80	\$173.41		Wheat							
2	MC 02	78.97	90.20	91.39	\$165.36		Corn							
3	MC 03	85.50	109.00	110.11	\$193.67		Sorghum							
4	MC 04N	67.84	59.43	92.17	\$137.60		Oats							
5	MC 04S	76.76	63.97	89.05	\$144.27		Soybeans							
6	MC 05	95.86	64.42	113.36	\$170.62		Sunflowers							
7	MC 06	82.40	59.34	162.50	\$188.48		Grass							
8	MC 07	88.35	54.87	115.05	\$160.45		Cotton							
9	MC 08	89.02	86.56	79.30	\$161.59									
10	MC 09	61.04	51.18	98.80	\$131.74									
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														

Type in your Yield Goal  
bu/acre  
grass, cotton: bale per acre

Type in your Crop  
Wheat  
Corn  
Sorghum  
Oats  
Soybeans  
Sunflowers  
Grass  
Cotton

Pounds of plant available Nitrogen per acre in your soil

Pounds of plant available P205 per acre in your soil

Pounds of plant available K20 per acre in your soil

Dollar value of nutrients in your soil based on fertilizer prices.

# NRCS Program Assistance

## EQIP Practice Scenarios (No Till, Cover Crops, etc. . . .)

328	EQIP	Conservation Crop Rotation	Standard Rotation	Ac	13
328	EQIP	Conservation Crop Rotation	HU-Standard Rotation	Ac	15
328	EQIP	Conservation Crop Rotation	Specialty Crops Rotation	Ac	31
328	EQIP	Conservation Crop Rotation	HU-Specialty Crops Rotation	Ac	37
328	EQIP	Conservation Crop Rotation	Organic Standard Rotation	Ac	19
328	EQIP	Conservation Crop Rotation	HU-Organic Standard Rotation	Ac	22
328	EQIP	Conservation Crop Rotation	Organic Specialty Crops Rotation	Ac	49
328	EQIP	Conservation Crop Rotation	HU-Organic Specialty Crops Rotation	Ac	59
329	EQIP	Residue and Tillage Management - No-Till	No-Till/Strip-Till	Ac	16
329	EQIP	Residue and Tillage Management - No-Till	HU-No-Till/Strip-Till	Ac	19
329	EQIP	Residue and Tillage Management - No-Till	Organic No-Till/Strip-Till	Ac	16
329	EQIP	Residue and Tillage Management - No-Till	HU-Organic No-Till/Strip-Till	Ac	19
329	EQIP	Residue and Tillage Management - No-Till	No Till Adaptive Management	Ac	285
329	EQIP	Residue and Tillage Management - No-Till	HU-No Till Adaptive Management	Ac	340
330	EQIP	Contour Farming	Contour Farming	Ac	8
330	EQIP	Contour Farming	HU-Contour Farming	Ac	9
340	EQIP	Cover Crop	Small grain or legume	Ac	50
340	EQIP	Cover Crop	HU-Small grain or legume	Ac	70
340	EQIP	Cover Crop	Aerial Seeding	Ac	75
340	EQIP	Cover Crop	HU-Aerial Seeding	Ac	90
340	EQIP	Cover Crop	Multi-species mix	Ac	80
340	EQIP	Cover Crop	HU-Multi-species mix	Ac	95
340	EQIP	Cover Crop	Basic Organic	Ac	80
340	EQIP	Cover Crop	HU-Basic Organic	Ac	95
340	EQIP	Cover Crop	Organic Mix	Ac	110
340	EQIP	Cover Crop	HU-Organic Mix	Ac	130

# **NRCS Program Assistance**

## **CSP Enhancements:**

**SQL18–Soil health crop rotation**

**SQL15 - Utilize the soil health nutrient tool to assess soil nutrient pools**

**ENR10 – Using nitrogen provided by legumes, animal manure and compost to supply 90 to 100 percent of the nitrogen needs**

**ENR12 – Use of legume cover crops as a nitrogen source**

**PLT20 – High residue cover crop or mixtures for weed suppression\soil health**

**SOE05 – Intensive no-till (organic or non-organic systems)**

**SQL08 – Intercropping to improve soil quality and increase biodiversity**

**SQL12 – Intensive cover cropping for annual crops**

**SQL16 - High species diversity grazing land**

# Planning Assistance: Measuring Soil Property Indicators of Quality

## Biological Health

Community Populations  
Species Diversity

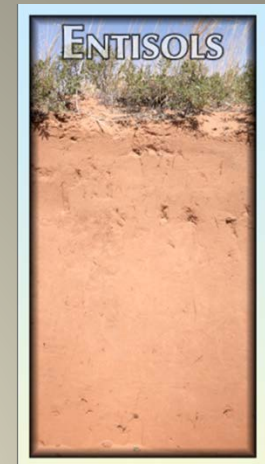
## Chemical Properties

Nutrient Availability  
pH & CEC

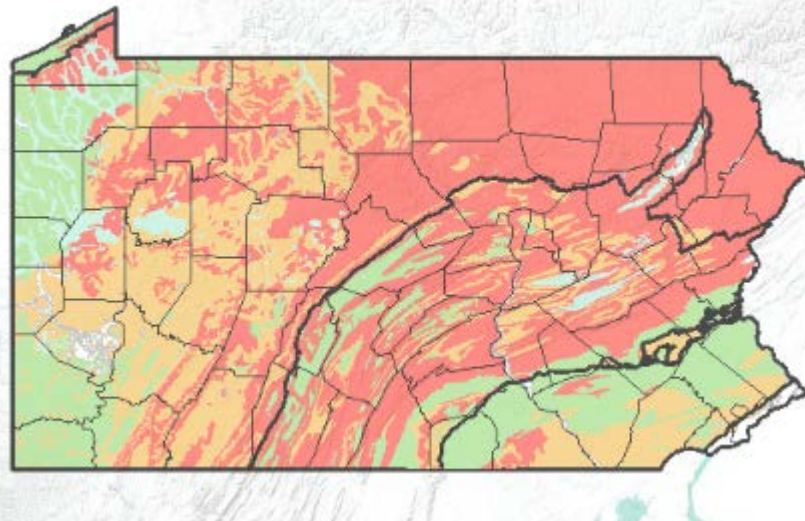
## Physical Structure

Rainfall Infiltration & Runoff  
Aggregate Stability & Slaking









<http://mapmaker.millersville.edu/PAmaps/Soils/>



### Credits

Data source for Soil Orders: [US Natural Resources Conservation Service](http://www.nrcs.usda.gov/).  
Data source for Populated Places: [Esri, Inc.](http://www.esri.com/)  
Map and webpage created by: [Dr. Geiger](http://www.millersville.edu/~geiger/), 2012.

# Soil Orders

 <b>Alfisol</b> High Nutrients	 <b>Inceptisol</b> Young Soils
 <b>Ultisol</b> Low Nutrients	 <b>Entisol</b> New Soils

# Key principles to improve soil health

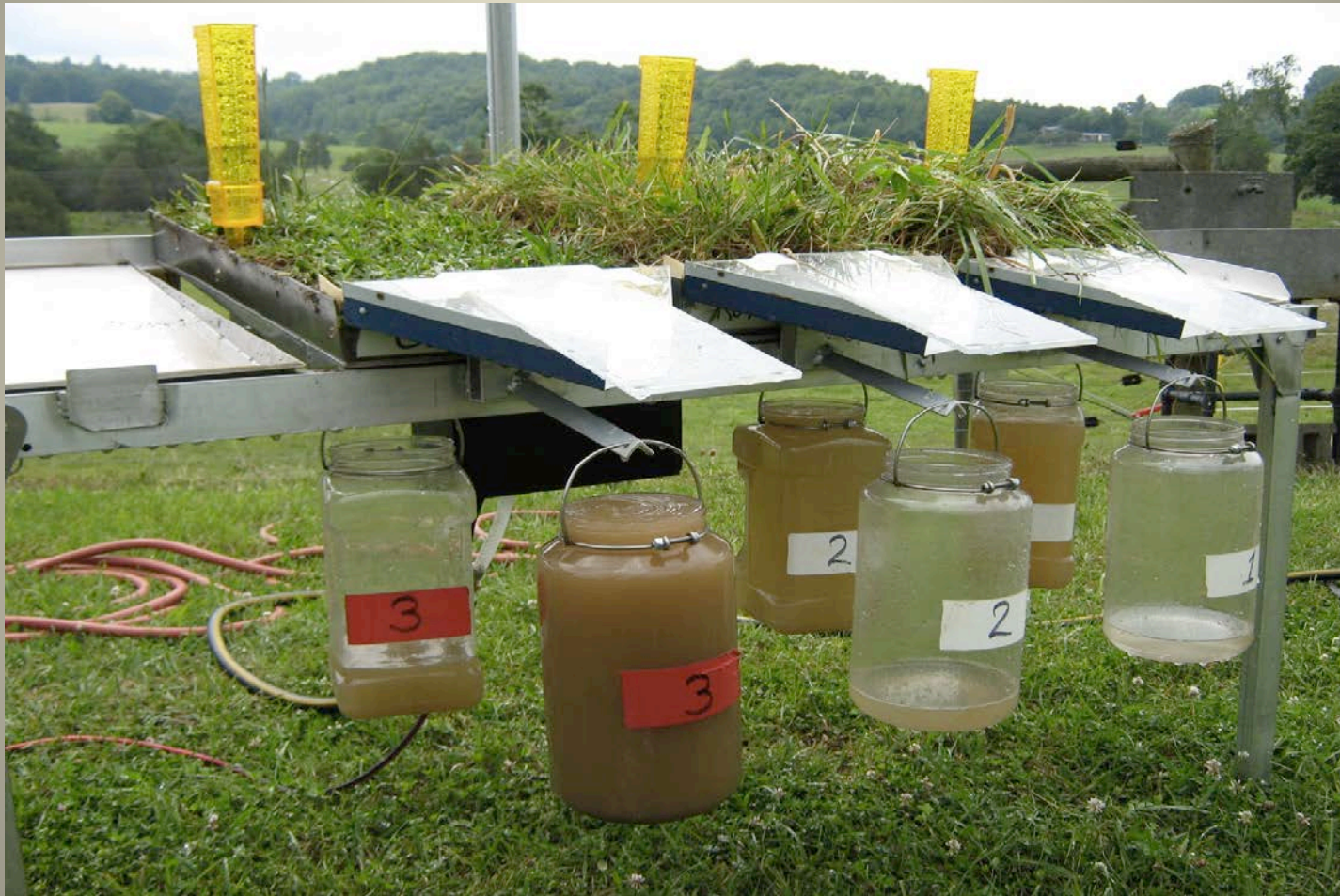
- Minimize soil disturbance
- Keep the soil covered
- Grow a living root year round
- Diversify the kinds of plants
- Integrate animals where possible

Productivity

Health

Resiliency

# Field Scale Rainfall Simulator Infiltration & Runoff Demonstration



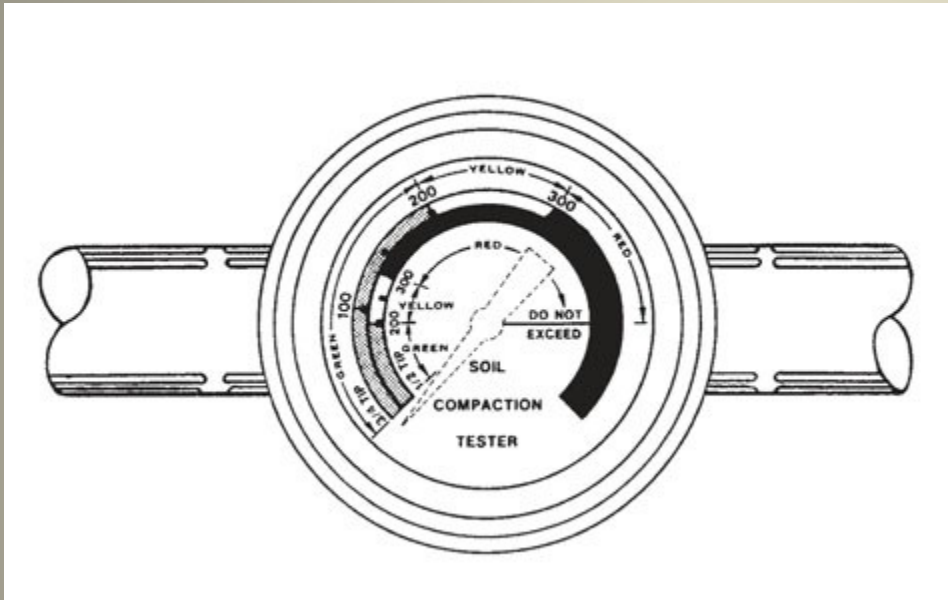
# Demonstrating Infiltration Properties



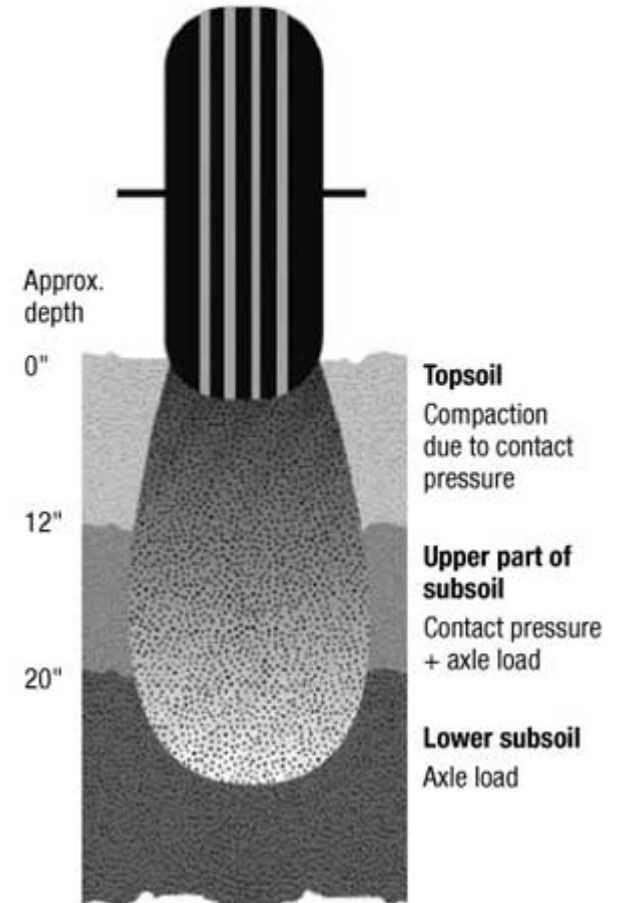
*A one inch layer of water is added to a six inch diameter ring to measure infiltration rate.*



# Diagnosing Soil Compaction



**Figure 1.1-5. Topsoil compaction is caused by contact pressure, whereas lower subsoil compaction is caused by axle load.**



# Key #1 : Limit Soil Disturbance

- Agricultural disturbance destroys soil organic matter
- Destroys habitat for soil organisms and creates a hostile environment
- Types of disturbance
  - Physical (tillage)
  - Chemical (over application)
  - Biological (over grazing)



# How does Soil Health relate to DEP?

Regs?

Chapter 102.4(a)?

Chapter 102.4(b)?

Chapter 91?



... None of the above ... More a Growing Greener

# What is different about this approach?

Holistic  
Functioning

Stewardship

Principles not  
Practices

## Ecological Architecture:



“As to methods, there maybe a million and then some, but principles are few. The man who grasps principles can successfully select his own method”

- Ralph Waldo Emerson

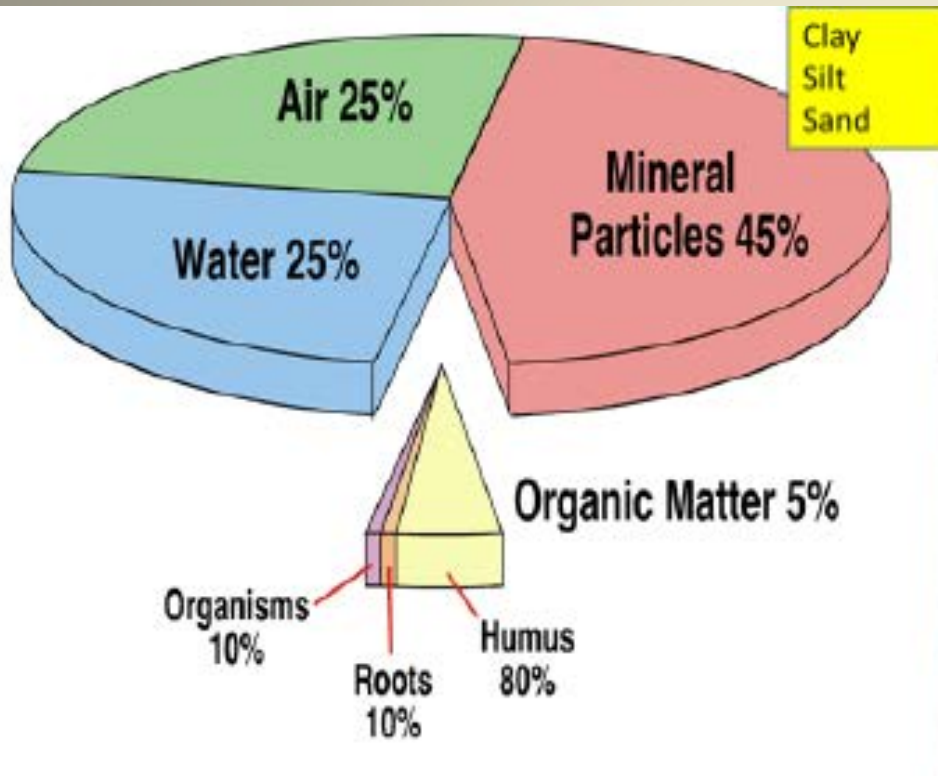
# What is different about this approach?

## Principles More than Practices



# What is a Healthy Soil?

A holistic portrait of the soil integrating physical, chemical, biological properties to grow desired plants



# A Healthy Soil Works (functions) for You, All

(So You don't have to work for dirt! Or muddy your neighbors . . . )

- Provide physical support to plants
- Create structural habitat, space for soil life (house)
- Regulate water flow
- Regulate air flow below ground
- Release and recycle nutrients (food)
- Filter and adsorb toxins
- Buffer against extreme changes

# Desired Soil Qualities to Grow Plants

- Good soil tilth, sufficient depth for roots
- Good soil drainage
- Large population of beneficial organisms
- Small population of pathogens, weed & insect pests
- Sufficient, but not excessive, nutrient supply
- No chemicals or toxins that may harm the crop
- Resilience to degradation and unfavorable conditions



# Benefits of Soils Working Well

## Soil health matters because:

1. Healthy soils are high-performing, productive soils.
2. Healthy soils reduce production costs—and improve profits.
3. Healthy soils protect natural resources on **and** off the farm.
4. Franklin Roosevelt's statement, "The nation that destroys its soil destroys itself," is as true today as it was 75 years ago.
5. Healthy soils can reduce nutrient loading and sediment runoff, increase efficiencies, and sustain wildlife habitat.

## What are the benefits of healthy soil?

1. Healthy soil holds more water (by binding it to organic matter), and loses less water to runoff and evaporation.
2. Organic matter builds as tillage declines and plants and residue cover the soil. Organic matter holds 18-20 times its weight in water and recycles nutrients for plants to use.
3. One percent of organic matter in the top six inches of soil would hold approximately 27,000 gallons of water per acre!
4. Most farmers can increase their soil organic matter in **three to 10 years** if they are motivated about adopting conservation practices to achieve this goal.

# Soil Biology Respiration Measures

## NEW TECHNOLOGY FOR MEASURING SOIL C AND N MINERALIZATION POTENTIAL

Solvita® - Innovative rapid test for 24 hour CO<sub>2</sub> burst.

- No extra lab equipment
- No wet chemistry
- Streamline tests
- High volume per day
- Reduce costs
- Field and lab use



Soil studies have shown the utility of testing CO<sub>2</sub> respiration as a means to gauge active soil carbon and potential release of nitrogen.<sup>(1)</sup> Recent research shows that the CO<sub>2</sub> burst from short-term drying-rewetting accurately predicts N+P mineralization, and is superior to current estimates of N-Min potential from soil organic matter.<sup>(2,3)</sup> The Solvita® procedure combines these findings with modern technology in a reliable, simple-to-use process which can be performed fairly rapidly at a significantly reduced cost compared to traditional lab respirometry.

### Simple, accurate procedure:

Weigh in dry soil

Place in jar

Add H<sub>2</sub>O

Insert CO<sub>2</sub> sensor

Incubate at 25°C

Read CO<sub>2</sub> ppm at 24hr



# Solvita Basal Respiration Test

- Field measure of background CO<sub>2</sub> evolution from soil microbial activity
- Soils with a carbon source and adequate microbial activity will respire more than soils without
- Measurement is a **proxy for available nitrogen** – 10 parts C released = 1 part N



# **Integrating Tests into Holistic Soil Health Assessments**

# Cornell Soil Health Assessment

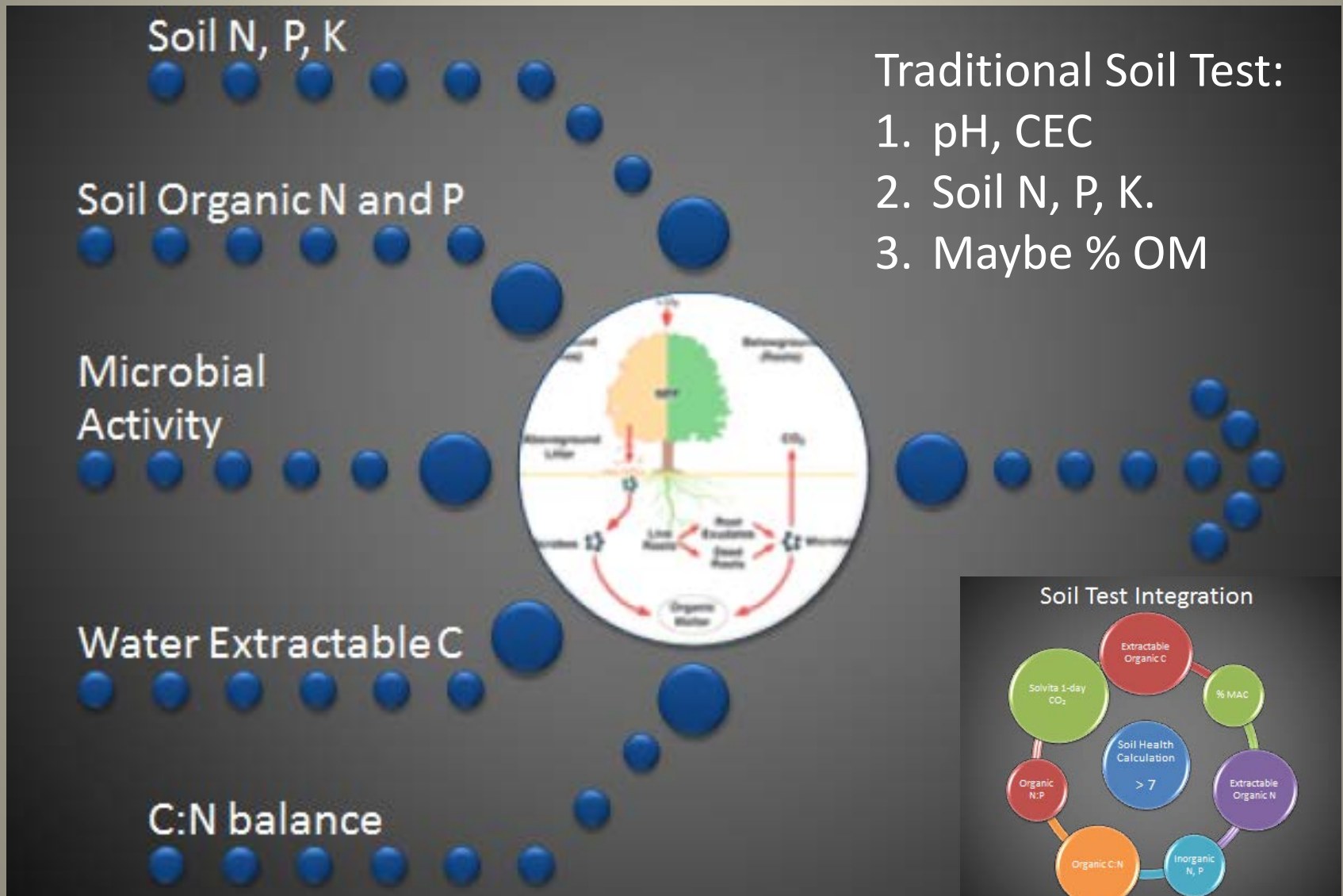
The Cornell soil health assessment protocol emphasizes the integration of soil biological measurements with soil physical and chemical measurements. These measurements include soil texture and stone content, wet aggregate stability, available water capacity, field penetrometer resistance, potentially mineralizable nitrogen, active carbon, organic matter content, root health assessment, and macro- and micro-nutrient level assessment. These measurements were selected from 39 potential soil health indicators (page 10, Table 1) that were evaluated for their:

- sensitivity to changes in soil management practices
- relevance to soil processes and functions
- consistency and reproducibility
- ease and cost of sampling
- cost of analysis.

Soil Health Testing	Page
Scoring function.....	16
Soil sampling protocol.....	18
Individual indicators	
Soil texture.....	22
Aggregate stability.....	24
Available water capacity.....	26
Field penetration resistance.....	28
Organic matter.....	30
Active carbon.....	32
Potentially mineralizable nitrogen.....	34
Root health assessment.....	36
Chemical analyses.....	38
Soil health assessment report.....	40

The results of these measurements have been synthesized into a grower-friendly soil health report that can initially be used by the grower as a baseline assessment. Subsequent

# ARS Dr. Haney: Testing in Nature's Image



# How can we measure soil health?

Treat the soil as a living integrated system

Use new indicators of soil health and function

Better information leads to better efficiency

Measure biological activity

Measure microbial food and not just the house



Nature



Biology

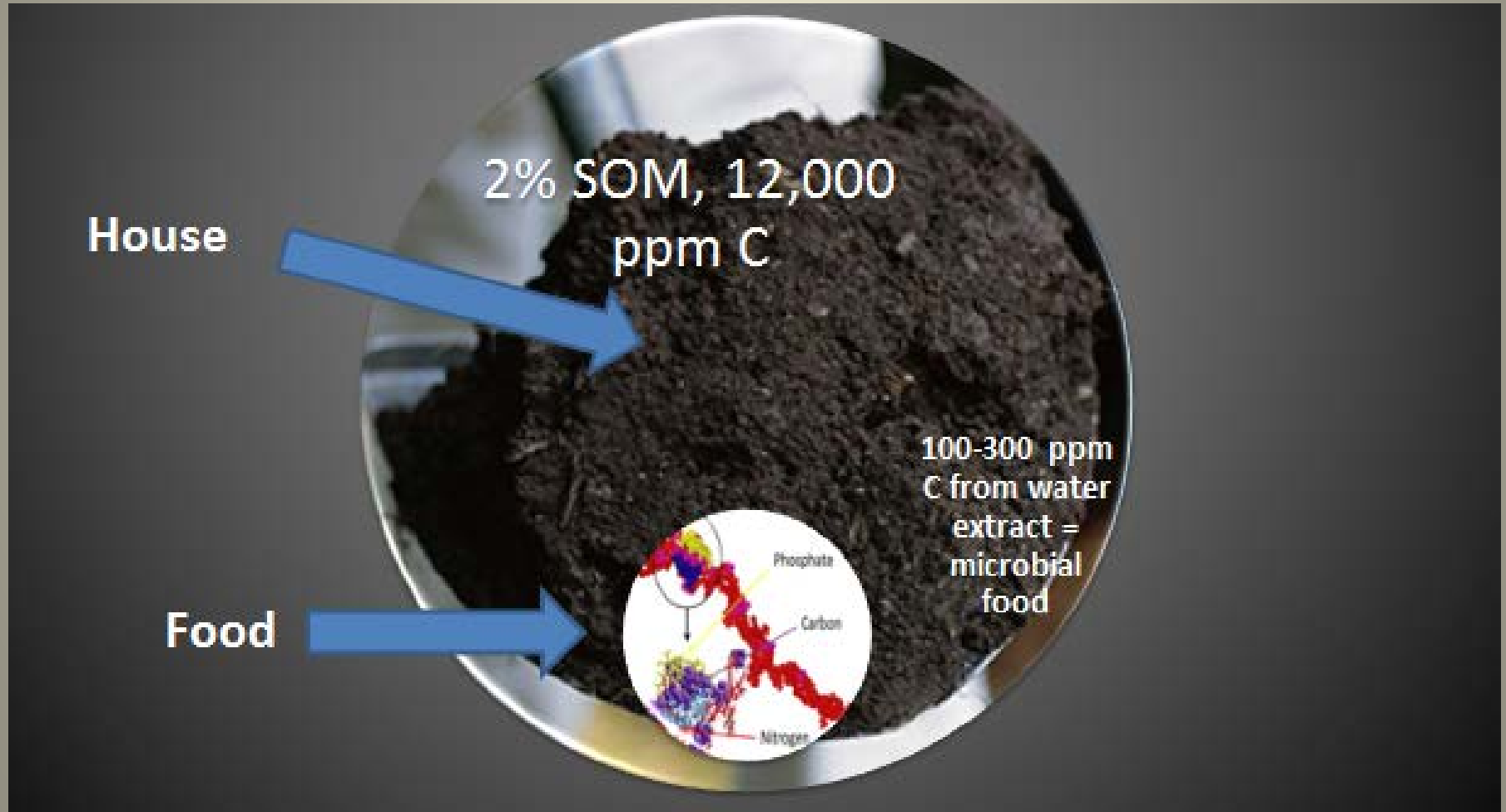


Chemistry

Use soil extracts that are naturally occurring

Integrate the data to form a more complete picture of biology and chemistry

# Haney Test: measures the food!





# NRCS\ARS begin 5 yr field trial project

Measure soil health by **asking** our soil the right questions:

- What is your condition?
- Are you in balance?
- What can we do to help?

## Soil Testing for Soil Health and NPK

Rick Haney PhD, USDA-ARS, Temple, TX



# Commercial Soil Health Tests for plant available nutrients

Haney Test ..... \$49.50

The Haney Test is a dual extraction procedure that allows the producer to assess overall soil health. The test is used to track changes in soil health based on management decisions. This test examines total organic carbon and total organic nitrogen to determine a C:N ratio used to make general cover crop recommendations. This test also includes the Solvita CO<sub>2</sub> Burst Test to look at microbial activity and potentially mineralizable nitrogen. The weak acid (H3A) extraction represents some available plant nutrients.

<http://www.wardlab.com>

Ward Lab, Kearney, Nebraska\*

<http://www.blinc.com/soils.htm>

Brookside Lab, New Bremen, Ohio

<http://www.solvita.com>

Woods End Lab, Mt Vernon, Maine

\*Also provides a biology presence test of microbial functional groups identified by phospholipid fatty acid markers

# Led by Pennsylvania Farmers & Conservation Districts !

## Clinton County Director Testifies on Soil Health in Washington DC by Lisa Blazure, Clinton County Conservation District

Jim Harbach, Clinton County Conservation District Director, [testified](#) September 18 at a Congressional Agricultural Sub Committee hearing in Washington DC.

Mr. Harbach was one of four panel members invited to speak about the benefits of promoting soil health in agriculture and rural America. NRCS Chief Jason Weller also testified at the hearing.



Photo of Jim Harbach providing testimony to a Congressional Agricultural Sub Committee hearing courtesy of Clinton County Conservation District.

# Where to go for more information?

NRCS's "Unlock the Secrets in Soil Health" communications website

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/>

NRCS's Science & Technology Training Library:

<http://www.conservationwebinars.net/webinars>

Cornell's Soil Health Assessment Manual

<http://soilhealth.cals.cornell.edu/extension/manual.htm>

ARS Grassland Soil and Water Research Lab Dr. Rick Haney

<http://research.brc.tamus.edu/snap/>