



Session #7

Soil Health Assessment

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September 8, 9, & 10, 2021

**Soil Health Stewards:
Promoting Soil Health on Protected Agricultural Lands**



**Soil
Health:
the
continued
capacity
of the soil
to
function ...**



**These are both
Buxton Silt Loam**

Dorn Cox, 2012

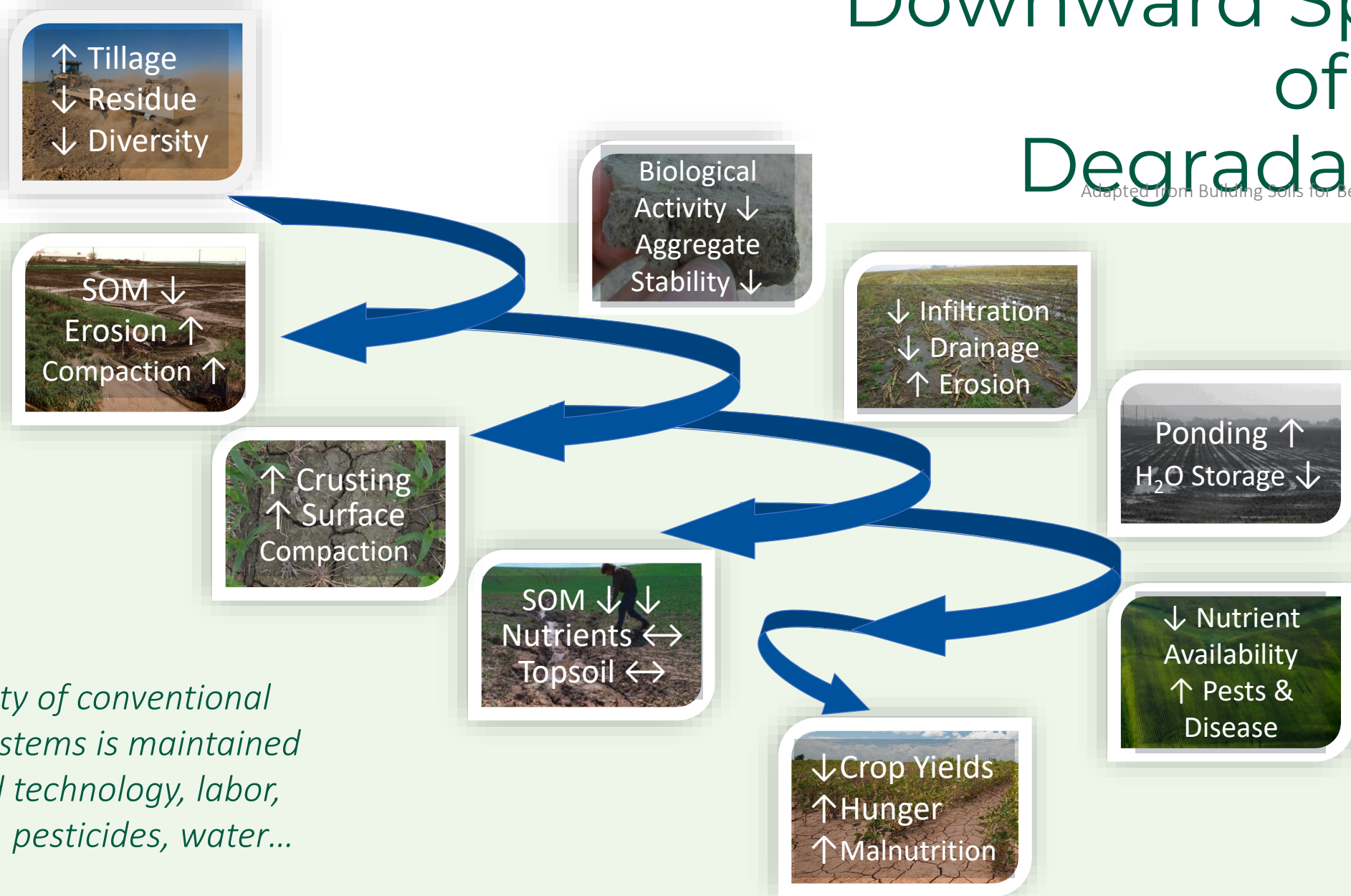


Standard Soil
Test says this
soil is
better!?

Bianca Moebius-Clune, 2012

Downward Spiral of Soil Degradation

Adapted from Building Soils for Better Crops, 3rd ed.



The productivity of conventional agricultural systems is maintained with increased technology, labor, fuel, nutrients, pesticides, water...

Reasons for Soil Health Assessment



- **Understand constraints or resource concerns** beyond nutrient limitations and excesses
- **Target management practices** to alleviate those constraints
- **Measure** soil improvement or degradation from management
- **Facilitate applied research** to identify success
- **Improve awareness** of Soil Health, its benefits & opportunities
- **Enable valuation** of farmland and producer management

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Soil Health Stewards:

- **Enable assessment of farming system risk**



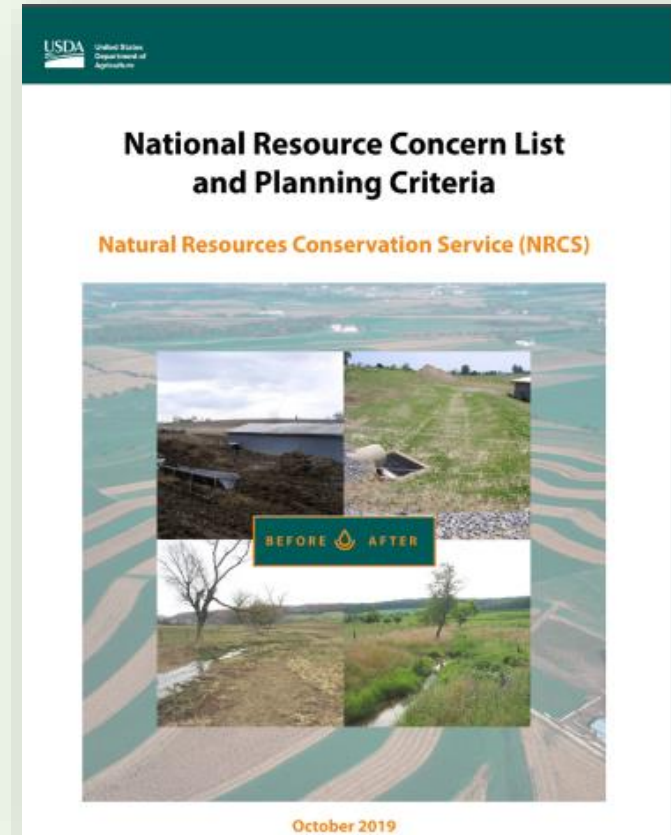
NRCS Soil Health Resource Concerns

Resource Concern: An **existing or expected degradation** of the soil, water, air, plant, or animal resource base to the extent that the **sustainability or intended use** of the resource is impaired.

- Compaction
- Organic matter depletion
- *Soil organism habitat loss or degradation*
- *Aggregate instability*

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Soil Health Stewards:
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Assessing Soil Health using Indicators

A soil health indicator is an assessment of a soil property that provides information about the status of specific important soil processes.

- In field assessment: qualitative or semi-quantitative, rapid, instant conversation
- Laboratory assessment: quantitative, recently more available, longer-term conversation with farmer, better for monitoring



Cropland In Field Soil Health Assessment

Components:

- ***Field visit***
- Farmer interview on management and observations
- Use of web soil survey

Tools of the Trade:

- Conversation
- Soil Survey
- Shovel
- Knives
- Water
- Sink strainers
- Infiltration rings
- Notetaking
- Camera
- Color book



Web Soil Survey for inherent soil type

Provides inherent, non-management-influenced soil properties

Limitations to Soil Health

Interpretations on WSS: represent soil's vulnerability based on inherent properties, but

management is primary driver of whether resource concern is present. Site-specific information on cropping systems essential to properly interpret soil health (e.g.,

crop rotations, cover crops, irrigation, soil stratification, fertility, tillage, grazing, etc.)

The screenshot displays the Web Soil Survey (WSS) interface. The top navigation bar includes links for 'Contact Us', 'Subscribe', 'Archived Soil Surveys', 'Soil Survey Status', 'Glossary', 'Preferences', 'Link', 'Logout', and 'Help'. Below this, there are tabs for 'Area of Interest (AOI)', 'Soil Map', 'Soil Data Explorer', 'Download Soils Data', and 'Shopping Cart (Free)'. The 'Soil Map' tab is active, showing a map of a field with various soil units outlined in orange. The left sidebar contains a 'Search' section with 'Suitabilities and Limitations Ratings' and 'Soil Health' categories. The 'Organic Matter Depletion' section is expanded, showing 'View Description' and 'View Rating' options. The 'View Options' section includes checkboxes for 'Map', 'Table', 'Component Breakdown and Rating Reasons', 'Numeric Values', 'Description of Rating', 'Rating Options', and 'Detailed Description'. The 'Advanced Options' section is also visible. The main content area on the right provides a detailed description of 'Organic Matter Depletion', explaining that soil health is primarily influenced by human soil survey data at this time. It discusses the role of organic matter in soil development and the factors that influence its accumulation and depletion, including annual temperature, rainfall, and soil microbes. The text also mentions that the continental-scale factor is the amount of available rainfall or snowmelt that an area receives in a given year. The ratings are both verbal and numerical, showing the propensity of the individual soil properties to accumulate organic matter. The ratings are shown in decimal fractions, indicating the gradations between the point at which a soil is most likely to allow organic matter to accumulate and the point at which it becomes least likely to allow organic matter to accumulate. The rating class terms indicate the extent to which organic matter is likely to accumulate in the soil. 'Organic matter depletion moderate' and 'Organic matter depletion low' indicate the level of management needed for organic matter accumulation. These soils still maintaining favorable organic matter levels.

<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

Cropland In-Field Soil Health Assessment

Farmer Interview

Management History – Interview Cont'd

8. What integrated pest management strategies are used (e.g., crop scouting, selective spraying, treated seeds)?
9. What nutrient management strategies are used (e.g., banding, split application, use of the 4Rs, manure/biochar/compost)?
10. Is the field irrigated? If yes, what type of irrigation system and how many acre-inches are applied for each crop in the rotation described above?
11. Does water pond or run off during or immediately after typical rainfall or irrigation events? Where in the field?
12. Are there problems with crop emergence or early crop growth? Where in the field?
13. Is water management a concern (i.e., field too wet or too dry at planting)?

Other observations not captured in the assessment including plant condition and recent weather and landscape characteristics that may affect assessment results:

Cropland In-Field Soil Health Assessment

11 Indicators to determine if there

Cropland In-Field Soil Health Assessment Worksheet

Soil Health Resource Concerns

CPT = Compaction

SOM = Soil Organic Matter Depletion

AGG = Aggregate Instability

HAB = Soil Organism Habitat Loss or Degradation

Location
Field/CMU
Tract#
Client/Customer
Planner
Date
Soil Map Units
Soil Moisture
Topsoil Texture

Natural Resources
Conservation Service

Indicator Timing and Use Anytime ☀️ After Rain or Irrigation ☁️ With Adequate Moisture 💧 Before a Tillage Event 🚜 Primarily No-till Systems ⚙️ Before Growing Season 🌱 During Growing Season 🌿 Interview 🗣️	Meets Assessment Criteria (Yes/No)
Soil Cover ☀️ SOM, HAB • Surface cover from plants, residue or mulch; cover greater than 75%	<input type="checkbox"/> Y <input type="checkbox"/> N
Residue Breakdown ☁️ ⚙️ 🌱 SOM, HAB • Natural decomposition of crop residues is as expected with crop and conditions	<input type="checkbox"/> Y <input type="checkbox"/> N
Surface Crusts 🚜 🌱 🌿 AGG • Crusting on no more than 5% of the field	<input type="checkbox"/> Y <input type="checkbox"/> N
Ponding ☁️ 🌱 CPT, AGG • No ponding within 24h following typical rainfall or surface irrigation event	<input type="checkbox"/> Y <input type="checkbox"/> N
Penetration Resistance 💧 🚜 🌱 🌿 CPT • Penetrometer rating <150 psi within top 6" depth and <300 psi in the 6-18" depth; • OR Slight or no resistance with wire flag inserted to 12"	<input type="checkbox"/> Y <input type="checkbox"/> N
Water Stable Aggregates ☀️ HAB, AGG • Cylinder: At least 80% remains intact after 5 minutes with little cloudy water; • OR Strainer: soil remains intact with aggregates apparent; • OR Soil Quality Test Kit (SQTK): meets stability class 6	<input type="checkbox"/> Y <input type="checkbox"/> N
Soil Structure ☀️ CPT, SOM, AGG, HAB • Granular soil structure in A horizon and no platy structure in A or B horizons	<input type="checkbox"/> Y <input type="checkbox"/> N
Soil Color 💧 SOM • No color difference between field and fencerow sample; • OR, Value is on the darker range using color chart and soil survey pedon description	<input type="checkbox"/> Y <input type="checkbox"/> N
Plant Roots 🌱 CPT, SOM, HAB • Roots covered in a soil film (rhizosheaths) or are part of soil aggregates; • OR Living roots, if present, are healthy, fully branched and extend into subsoil	<input type="checkbox"/> Y <input type="checkbox"/> N
Biological Diversity 💧 🚜 SOM, HAB • Clearly evident; more than 3 different types of organisms observed without magnification	<input type="checkbox"/> Y <input type="checkbox"/> N
Biopores ☀️ ⚙️ SOM, AGG, HAB • Presence of root or earthworm channels that extend vertically through the soil with some connecting to the surface	<input type="checkbox"/> Y <input type="checkbox"/> N



Indicator: Adequate Soil Cover

Description	Soil cover is the percent of the soil surface that is covered by plant residue, organic mulch and/or live plants.	
Resource Concerns Addressed	<ul style="list-style-type: none"> • Aggregate instability • Soil organic matter depletion • Soil organism habitat loss or degradation • Surface compaction 	
In-field measurement	<ol style="list-style-type: none"> 1. Farmer interview 2. Photo estimation method or state approved method, OR 3. Line intercept: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022074.pdf 	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Cover > 75% after planting	Cover ≤ 75% after planting



Indicator: Surface Crusts		
Description	Crusts form after rain or irrigation on soils with weak aggregate stability.	
Resource Concerns Addressed	<ul style="list-style-type: none"> Aggregate instability Soil organism habitat loss or degradation Soil organic matter depletion Surface compaction 	
In-field measurement	<p>Evaluated by visual observation after rainfall/irrigation and drying:</p> <ul style="list-style-type: none"> Note whether crusts are throughout the field or only in patches. Near surface will be dense, show layered sediment deposits Poor crop emergence uneven stand 	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Evidence of surface crust \leq 5% of field	Evidence of surface crust $>$ 5% of field



Surface Crusts



Indicator: Ponding



Indicator: Ponding		
Description	Areas of the field that collect and hold runoff water from other parts of the field.	
Resource Concerns Addressed	<ul style="list-style-type: none"> • Aggregate instability • Surface compaction 	
In-field measurement	Farmer interview or visual observation after rainfall/irrigation: <ul style="list-style-type: none"> • Note evidence of crop residue deposits • Evidence of ponding from observation or on recent aerial photos • Poor crop conditions (yellowing) 	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Evidence of ponding 24 hours or less after a typical rain event	Evidence of ponding more than 24 hours after a rain event



Indicator: Penetration Resistance

Description	Management induced reduction of large pores and degraded structure (i.e., platy) that results in decreased rooting depth, plant growth and soil biological habitat and activity.	
Resource Concerns Addressed	<ul style="list-style-type: none"> Aggregate instability Soil organism habitat loss or degradation Soil organic matter depletion Surface compaction 	
In-field measurement	Conduct with soil moisture near field capacity: <ul style="list-style-type: none"> Evaluate multiple representative locations in the field Record depths of restrictive layer(s) & PSI readings (penetrometer) Evaluate root development and distribution Look for platy structure 	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Granular structure, appropriate PSI reading, vertical channels or roots.	Evidence of platy structure, unacceptable PSI, root restriction, surface ponding, horizontal or abnormal root architecture.



Bianca Moebius-Clune

Penetration Resistance



UW- Extension

https://www.youtube.com/watch?v=Zq_785JqRq8



Roots and Platy Structure to show Compaction?

Healthy Roots

- Root growth not restricted
- Many fine roots



Unhealthy Roots

- Restricted root growth
- Few fine roots
- Short thick roots
- Discolored & Lesions (root pathogens present)



Indicator: Aggregate Stability

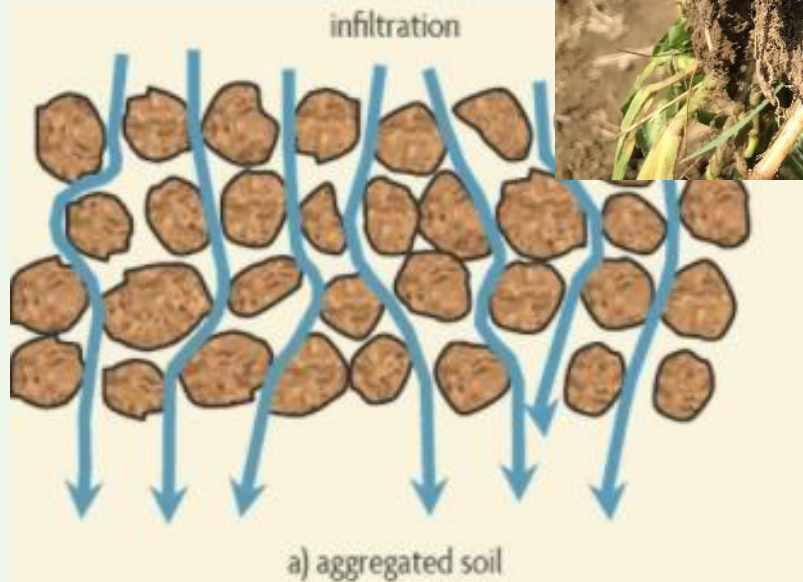
Description	Soil aggregate stability is related to soil porosity and how well a soil can resist raindrop impact and erosion.	
Resource Concerns Addressed	<ul style="list-style-type: none"> • Aggregate instability • Soil organic matter depletion • Soil organism habitat loss or degradation • Surface compaction 	
In-field measurement	Choose one of the following three methods: <ul style="list-style-type: none"> • Slake test (ensure samples are completely dry) • Strainer test • Jornada soil aggregate stability test (stability kit) 	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Aggregate remains intact <ul style="list-style-type: none"> • $\geq 80\%$ for slake test • “stands up” for strainer test, runoff water is translucent • Jornada criteria 	Aggregate disintegrates <ul style="list-style-type: none"> • $< 80\%$ remaining (slake) • Soil “slumps” into a puddle, runoff is not translucent • Jornada criteria



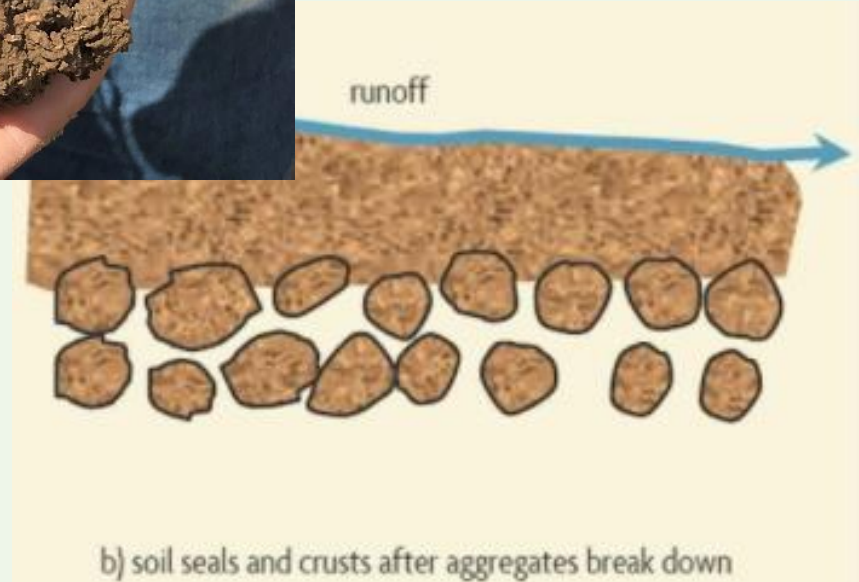
Manage for Water Stable Aggregates



You want this...



NOT this!



Slump Test



“We feel that we have some soil health problems”
Dave Degolyer, Western NY Crop Management
Association





Slide courtesy of D. DeGolyer

4 8 5005



Indicator: Plant Roots and Biopores (continuity)

Description	Roots influence the soil immediately adjacent to them through exudates, growing and leaving soil organic matter as they die.	
Resource Concerns Addressed	<ul style="list-style-type: none"> • Aggregate instability • Soil organism habitat loss or degradation • Soil organic matter depletion 	
In-field measurement	Observe evidence of dark, root channels or biopores left by previous plants or earthworms.	
Rating Criteria	Meets Criteria	Does Not Meet Criteria
	Presence of dark, root channels or biopores left by previous plants or earthworms	Roots are stressed and do not follow previous root channels, no pores evident from earthworms

Roots and Biopores



Rye Root, Soybean root and earthworm sharing the same biopore

There's an app for that



Log in to view your data

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LANDPKS IN THE FIELD

Mobile App

Discover the value and potential of your land. Use this information to plan and track management actions. Monitor soil health and vegetation indicators over time.



<https://landpotential.org/knowledge/intro-to-the-landpks-soilhealth-module/>

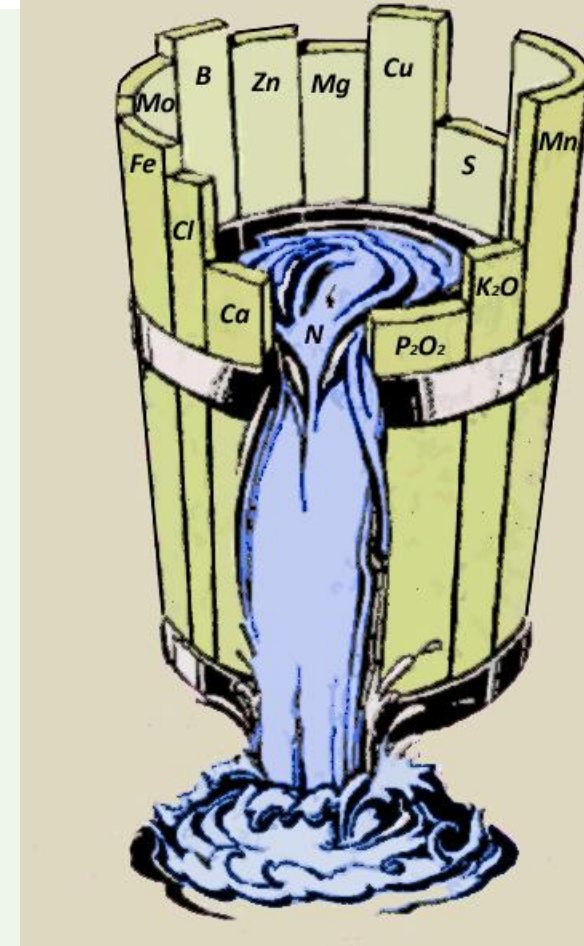
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**Soil Health Stewards:
Promoting Soil Health on Protected Agricultural Lands**



Laboratory Soil Tests: Beyond Standard Soil Nutrient Testing & Management

- Nutrient management foundational to ag success
- Identifies nutrient deficiency/excess
- Critical New Component: apply principle to assess constraints in essential biological and physical functioning



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→ **Soil Health Testing!**

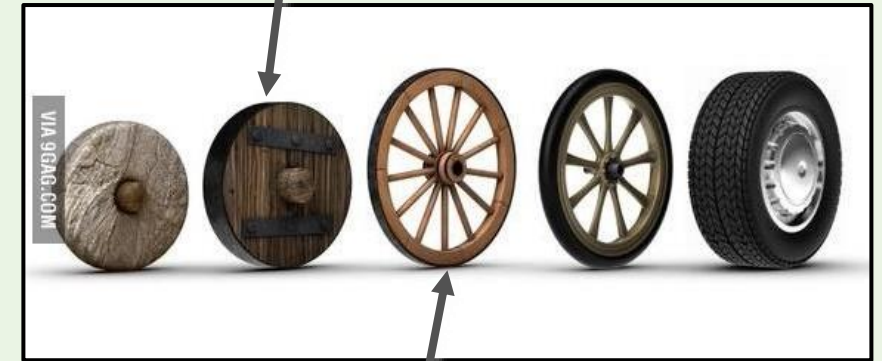
Soil Health Stewards:

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Lab Indicators for Soil Health Assessment

- USDA consensus on standard current best available laboratory methods (NRCS Technical Note 450-03)
- Criteria:
 - Standardized
 - Scientific/agronomic relevance
 - Represent diverse processes
 - Easy & inexpensive to measure
 - Sensitive to agricultural management but robust
 - Interpretations accessible to public
- Regional calibration iterative, now available for most indicators through **NRCS Soil Testing Conservation Activity 216**

Standard Nutrient Test
Macro, Micro, SOM, CEC



Upgraded: Biological,
C&N, Physical

NRCS Technical Note 450-03

<https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=43637>

Lab Indicators For Soil Health

Soil Structural Stability
& Water Partitioning

- **Aggregate stability**
- Infiltration, available water capacity

Soil Organic Matter
Cycling

- **Soil organic C**
- C cycling, sequestration

Carbon Food Source

- **Permanganate oxidizable C (Active C)**
- Organism food source

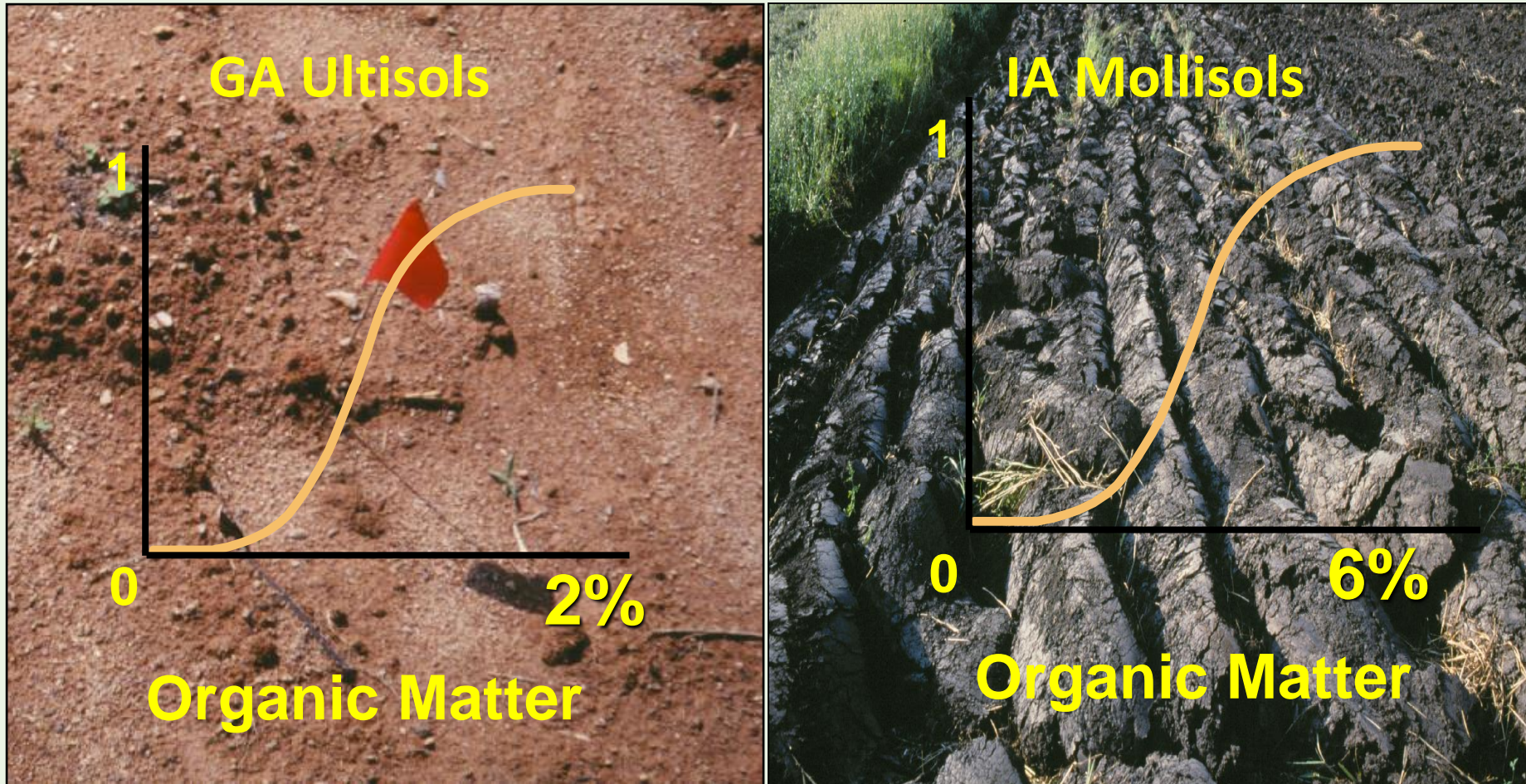
Microbial Activity

- **Short-term C mineralization (respiration)**
- Organism activity

Bioavailable N

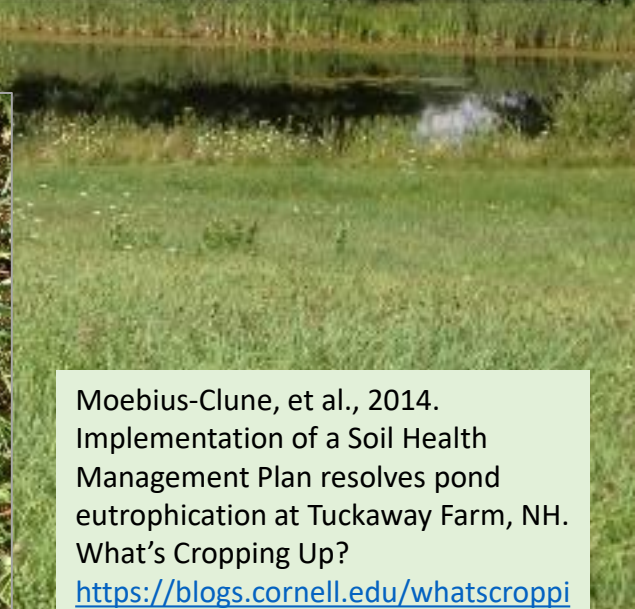
- **Acid Citrate Extractable protein**
- Organically bound environmentally stable soil N pool

Indicator Interpretation via soil-type-based scoring functions being iteratively developed



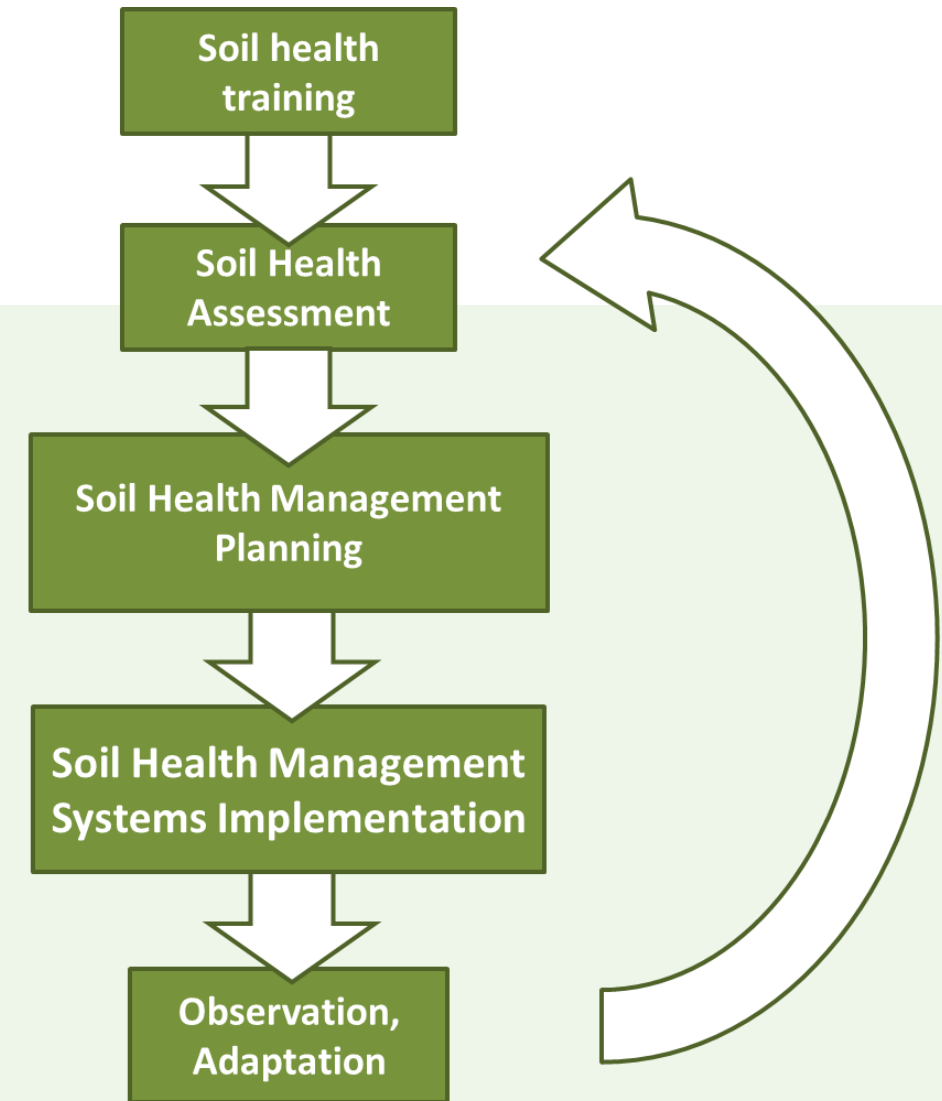
What to do based on Soil Health Assessments

Management Suggestions for Physical and Biological Constraints		
Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Aggregate Stability Low	<ul style="list-style-type: none"> • Incorporate fresh organic materials • Use shallow-rooted cover/rotation crops • Add manure, green manure, mulch 	<ul style="list-style-type: none"> • Reduce tillage • Use a surface mulch • Rotate with sod crops and mycorrhizal hosts
Organic Matter Low	<ul style="list-style-type: none"> • Add stable organic materials, mulch • Add compost and biochar • Incorporate high biomass cover crop 	<ul style="list-style-type: none"> • Reduce tillage/mechanical cultivation • Rotate with sod crop • Incorporate high biomass cover crop
Soil Protein Low	<ul style="list-style-type: none"> • Add N-rich organic matter (low C:N source like manure, high N well-finished compost) • Incorporate young, green, cover crop biomass • Plant legumes and grass-legume mixtures • Inoculate legume seed with Rhizobia & check for nodulation 	<ul style="list-style-type: none"> • Reduce tillage • Rotate with forage legume sod crop • Cover crop and add fresh manure • Keep pH at 6.2-6.5 (helps N fixation) • Monitor C:N ratio of inputs
Respiration Low	<ul style="list-style-type: none"> • Maintain plant cover throughout season • Add fresh organic materials • Add manure, green manure • Consider reducing biocide usage 	<ul style="list-style-type: none"> • Reduce tillage/mechanical cultivation • Increase rotational diversity • Maintain plant cover throughout season • Cover crop with symbiotic host plants
Active Carbon Low	<ul style="list-style-type: none"> • Add fresh organic materials • Use shallow-rooted cover/rotation crops • Add manure, green manure, mulch 	<ul style="list-style-type: none"> • Reduce tillage/mechanical cultivation • Rotate with sod crop • Cover crop whenever possible



Photos: Bianca Moebius-Clune and Dorn Cox, 2012

Moebius-Clune, et al., 2014.
Implementation of a Soil Health
Management Plan resolves pond
eutrophication at Tuckaway Farm, NH.
What's Cropping Up?
<https://blogs.cornell.edu/whatscroppinngup/category/soil-health/>



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Soil Health Stewards: Promoting Soil Health on Protected Agricultural Lands

Polls (S#7), Q&A and Discussion



Taking it back to your Day to Day:

1. What did you learn about assessing soil health that is particularly relevant to you?
2. How will you use what you learned in your action plan?
3. What key messages may particularly inspire 'a-ha!' moments with those you work with?

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What's next?

- 10:30 to 10:45 – Break
- 10:45 – Go back to the platform, click on links to sessions, and find the link for Session #8—Advancing SH through Conservation Easements and referenced Plans.

