Proceedings of the 11th Nutrient Management Conference

Evaluation of Haney Test as a Corn Nitrogen Management Tool

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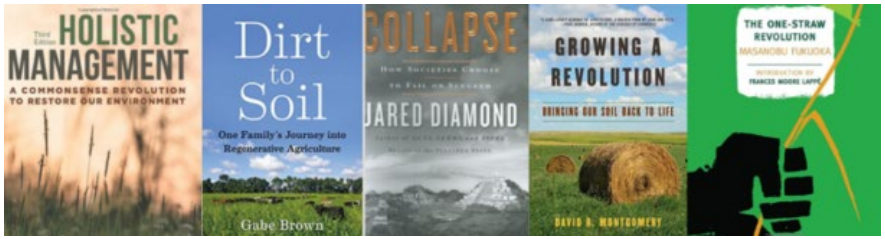
SOIL HEALTH INSTITUTE

SOIL RENAISSANCE



SOIL HEALTH PARTNERSHIP

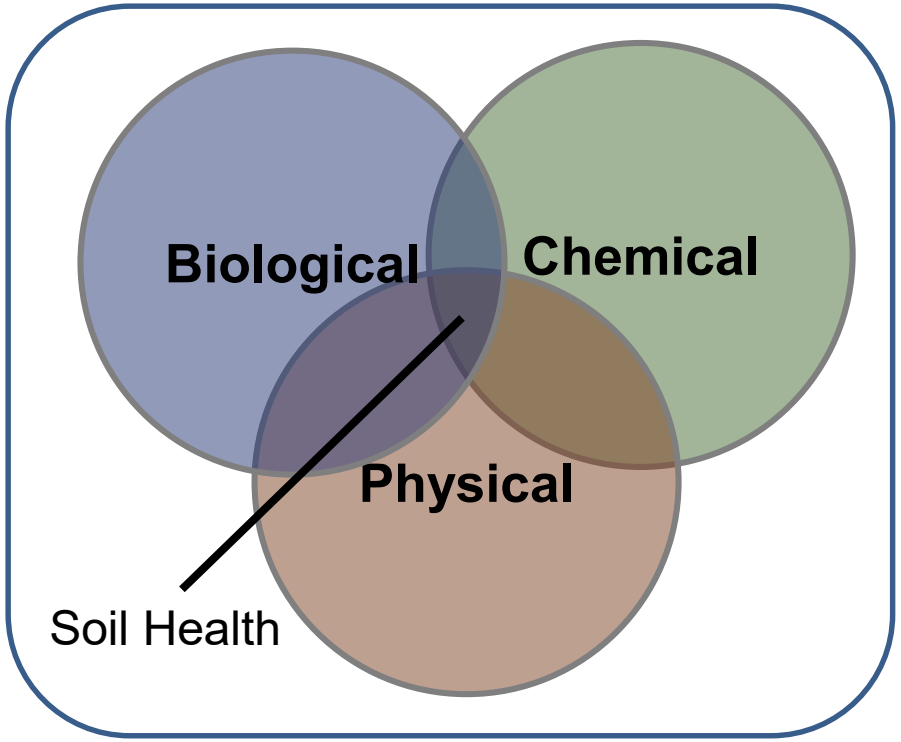
Outline

- Definition/Characteristics
- Measurement
- Improvement
- Utilization

Soil Health Definitions

What is “Soil Health”

“The ability of a soil to support and sustain crop growth while maintaining environmental quality.”

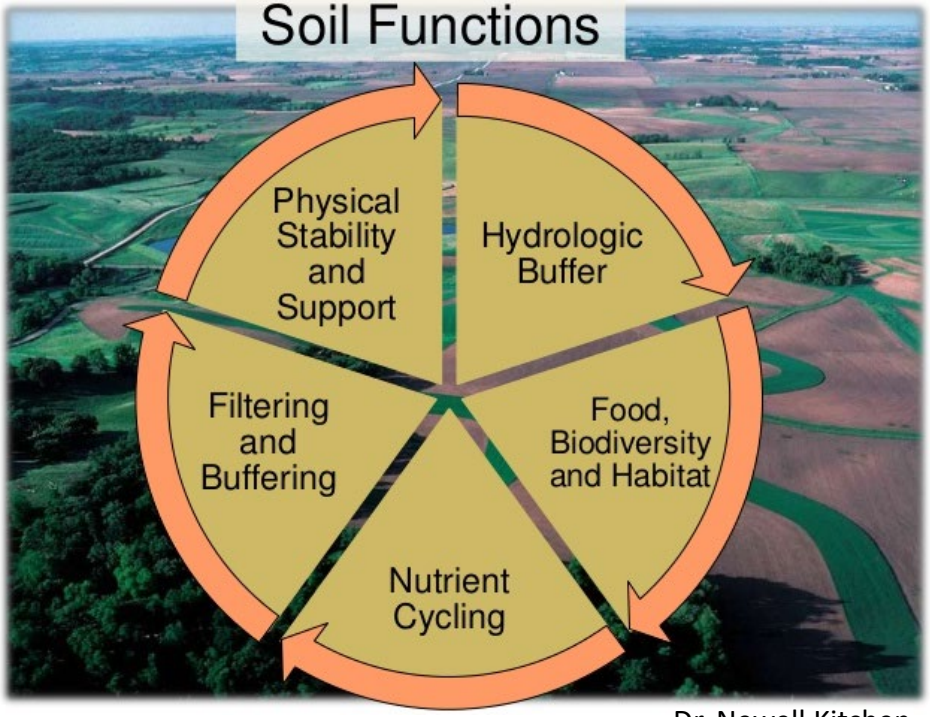


(Magdoff, 2001; Amundson, 2015)

What is “Soil Health”

“the soil's fitness to support crop growth without resulting in soil degradation or otherwise harming the environment.”

(Acton and Gregorich, 1996)



Dr. Newell Kitchen

Characteristics of healthy soils

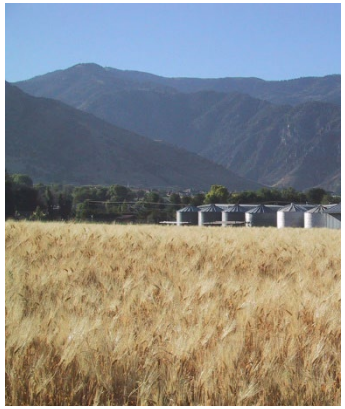
Synergistic Characteristics of Healthy Soils
▪ Sufficient supply of nutrients
▪ Low contaminant toxicity
▪ Low weed pressure
▪ Good soil structure
▪ Low populations of parasites
▪ High populations of plant-health promoting organisms
▪ **Resilience to degradation**

Andrews et al. (2004) and Moebius-Clune et al. (2016).

Characteristics of healthy soils

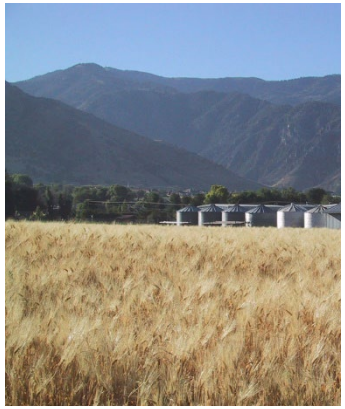
U.S. farmers have noted that healthy soils:

- Are deeper and darker
- Are easier to plow
- Sponge up and hold more water
- Drain better
- Break down crop residues faster
- Have higher organic matter
- Have less erosion
- Have more earthworms
- Have a sweet, fresh smell



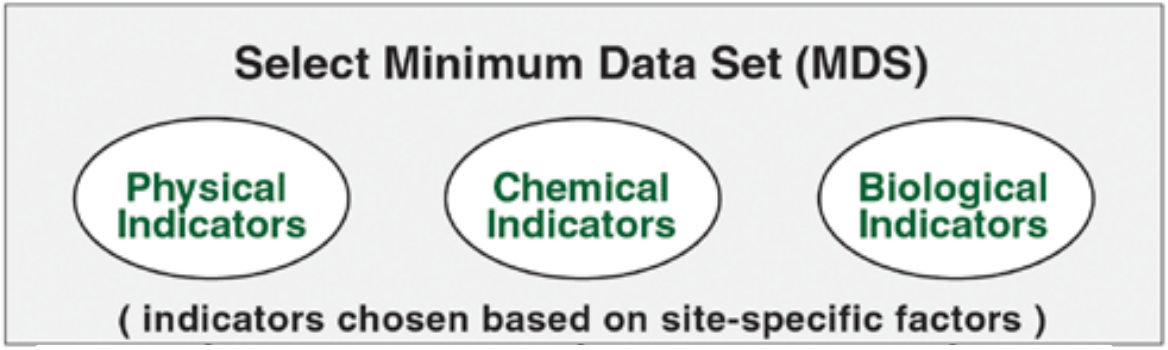
Characteristics of healthy soils

- Lower fuel costs
- Less machinery wear and tear
- Less fertilizer required
- Less disease and insect problems
- Higher crop yields
- Better quality crops – and better animal performance



Soil Health Measurement

Indicators of Soil Health/Quality

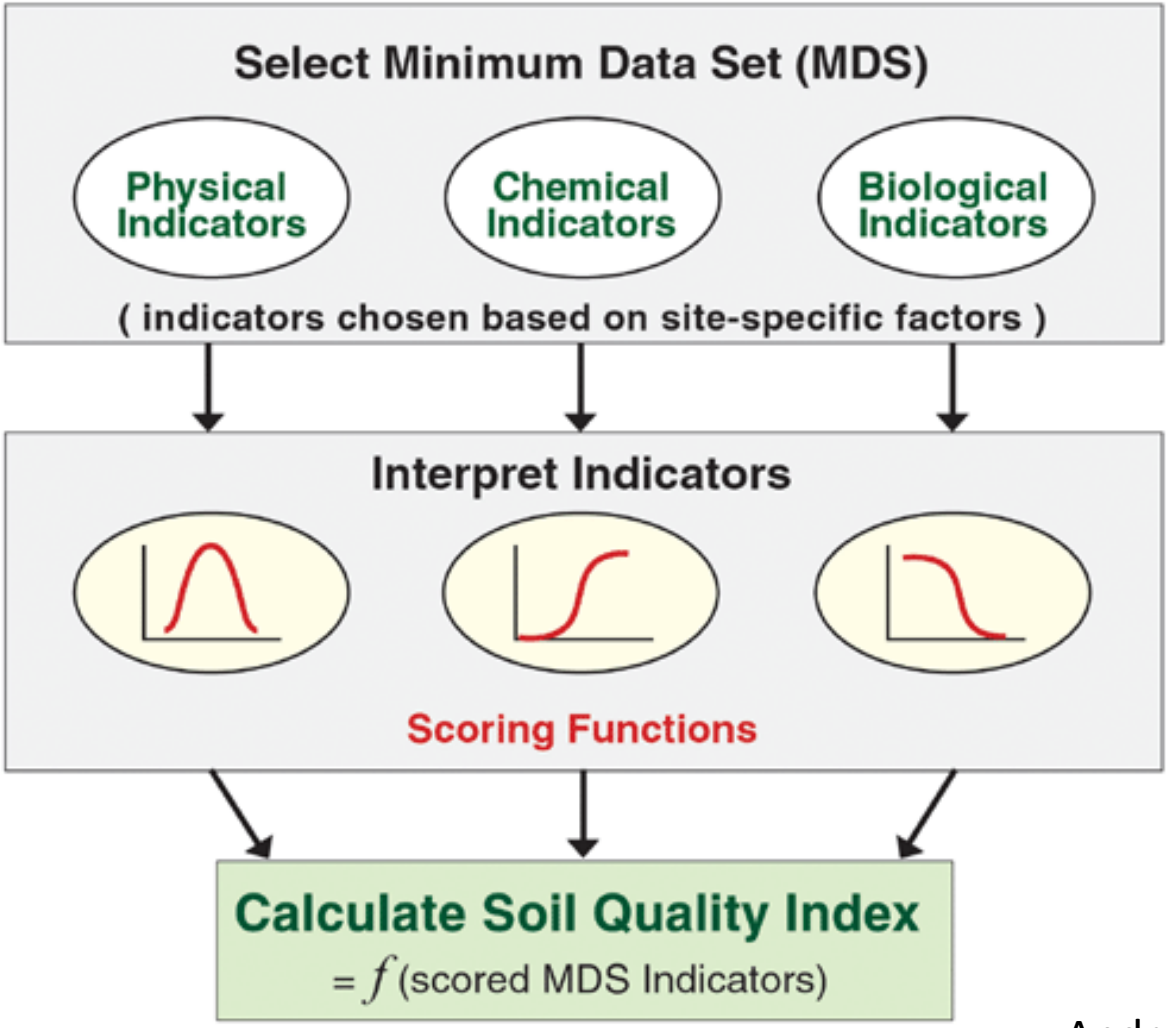


Andrews et al., 2001

Indicators of Soil Health/Quality

Some Major Soil Health Indicators		
Biological	Chemical	Physical
Organic matter	pH	Soil texture
Soil protein	P, K, S, Ca, Mg	Wet aggregate stability
Active Carbon	Fe, Mn, Cu, Zn, B	Water holding capacity
1 day CO_2-C respiration		
Organic C, N		

Interpreting indicators



Andrews et al., 2001

1. Soil Management Assessment Framework (SMAF)

Physical Score
- bulk density
- water-filled pore space
- water-stable aggregates

Chemical Score
- pH
- electrical conductivity
- Extractable P and K

Biological Score
- organic C
- B-glucosidase
- microbial C
- mineralizable N

Veum et al., 2015

2. Comprehensive Assessment of Soil Health (CASH)

Cornell Soil Health Assessment

[redacted]
Agricultural Service Provider:
None
Cedar Basin Crop Consulting
cbcc@earthlink.net

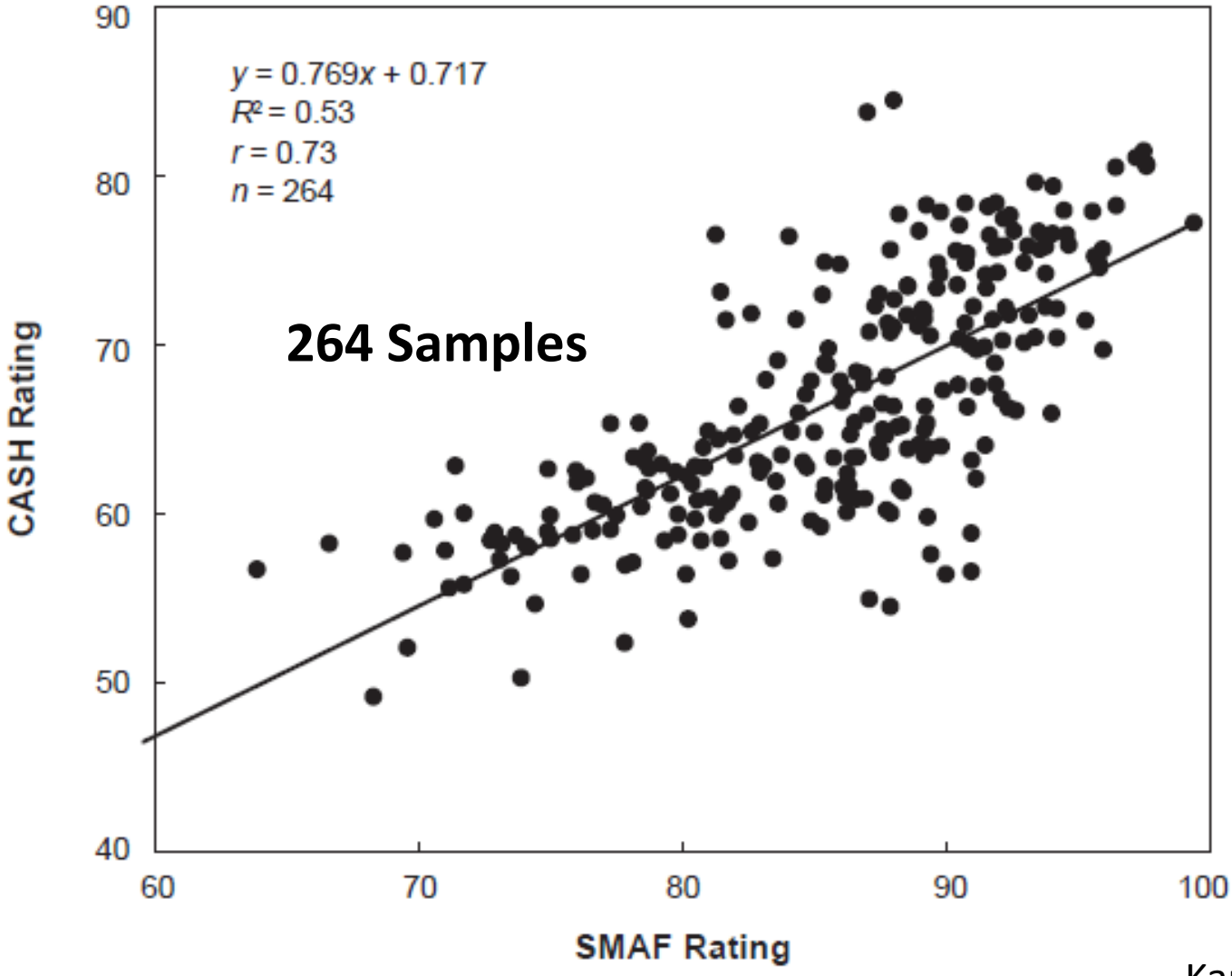
Sample ID: L_555
Field/Treatment: Tenge E
Tillage: 1-7 inches
Crops Crown: COG, COG, SOY
Date Sampled: 12:00:00 AM
Given Soil Type: Muscatine
Given Soil Texture: Silty Clay Loam
Coordinates: [redacted]

Measured Soil Textural Class: Silt Loam Sand: 28% Silt: 56% Clay: 16%

Test Report

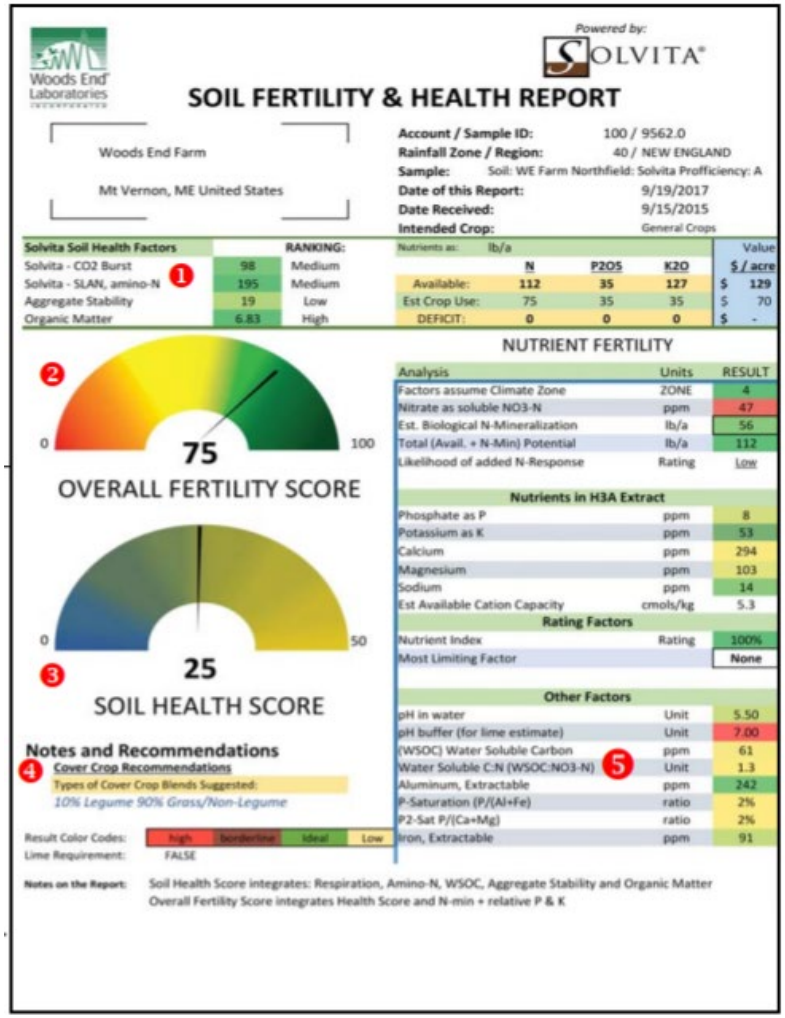
	Indicator	Value	Rating	Constraint
Physical	Available Water Capacity	0.31	100	
Physical	Surface Hardness			Not Rated: No Field Penetrometer Readings Submitted
Physical	Subsurface Hardness			Not Rated: No Field Penetrometer Readings Submitted
Biological	Aggregate Stability	49.5	78	
Biological	Organic Matter	4.6	79	
Biological	ACE Soil Protein Index	5.8	29	Organic Matter Quality, Organic N Storage, N Mineralization
Biological	Root Pathogen Pressure	4.7	54	
Biological	Respiration	0.58	4	Soil Microbial Abundance and Activity
Biological	Active Carbon	744	76	
Chemical	pH	6.0	66	
Chemical	Phosphorus	10.9	100	
Chemical	Potassium	164.5	100	
Chemical	Minor Elements Mg: 456 Fe: 0.8 Mn: 9.2 Zn: 0.4		100	
	Overall Quality Score		71	High

SMAF and CASH related



Karlen et al., 2016

3. Haney Soil Health Test (HSHT)



Powered by: SOLVITA®

Woods End Laboratories

SOIL FERTILITY & HEALTH REPORT

Woods End Farm

Mt Vernon, ME United States

Account / Sample ID: 100 / 9562.0
Rainfall Zone / Region: 40 / NEW ENGLAND
Sample: Soil: WE Farm Northfield: Solvita Profficiency: A
Date of this Report: 9/19/2017
Date Received: 9/15/2015
Intended Crop: General Crops

Solvita Soil Health Factors		RANKING:
Solvita - CO2 Burst	98	Medium
Solvita - SLAN, amino-N	195	Medium
Aggregate Stability	19	Low
Organic Matter	6.83	High

Nutrients as: lb/a	N	P2O5	K2O	Value $ / acre
Available:	112	35	127	$ 129
Est Crop Use:	75	35	35	$ 70
DEFICIT:	0	0	0	$ -

0 — 75 — 100

OVERALL FERTILITY SCORE

0 — 25 — 50

SOIL HEALTH SCORE

NUTRIENT FERTILITY

Analysis	Units	RESULT
Factors assume Climate Zone	ZONE	4
Nitrate as soluble NO3-N	ppm	47
Est. Biological N-Mineralization	lb/a	56
Total (Avail. + N-Min) Potential	lb/a	112
Likelihood of added N-Response	Rating	Low
Nutrients in H3A Extract		
Phosphate as P	ppm	8
Potassium as K	ppm	53
Calcium	ppm	294
Magnesium	ppm	103
Sodium	ppm	14
Est Available Cation Capacity	cmols/kg	5.3
Rating Factors		
Nutrient Index	Rating	100%
Most Limiting Factor		None
Other Factors		
pH in water	Unit	5.50
pH buffer (for lime estimate)	Unit	7.00
(WSOC) Water Soluble Carbon	ppm	61
Water Soluble C:N (WSOC:NO3-N)	Unit	1.3
Aluminum, Extractable	ppm	242
P-Saturation (P/(Al+Fe)	ratio	2%
P2-Sat P/(Ca+Mg)	ratio	2%
Iron, Extractable	ppm	91

Notes and Recommendations

Cover Crop Recommendations

Types of Cover Crop Blends Suggested:

10% Legume 90% Grass/Non-Legume

Result Color Codes: high | borderline | ideal | Low

Lime Requirement: FALSE

Notes on the Report: Soil Health Score integrates: Respiration, Amino-N, WSOC, Aggregate Stability and Organic Matter
Overall Fertility Score integrates Health Score and N-min + relative P & K

REPORT NUMBER
14-123-0020
COMPLETED DATE
May 7, 2014
RECEIVED DATE
May 3, 2014
ACCOUNT

Midwest Laboratories, Inc.
13611 "B" Street • Omaha, Nebraska 68144-3693 • (402) 334-7770 • FAX (402) 334-9121
www.midwestlabs.com

COPY TO

IDENTIFICATION
1 Low

PAGE 3/3
TODAY'S DATE
May 09, 2014

SOIL HEALTH ASSESSMENT

ANALYTICAL LABORATORY FINDINGS

SAMPLE IDENTIFICATION: 1
LABORATORY NUMBER: 26605562

ANALYTE	UNITS	RESULTS	LOW / MEDIUM / OPTIMUM / VERY HIGH
H3A EXTRACTION			
NITRATE-N	ppm	1.0	
AMMONIACAL-N	ppm	2.0	
ORTHOPHOSPHATE-P	ppm	2.0	
PHOSPHORUS	ppm	7	
POTASSIUM	ppm	59	
MAGNESSIUM	ppm	51	
CALCIUM	ppm	147	
SODIUM	ppm	17	
IRON	ppm	46	
ALUMINUM	ppm	83	
WATER SOLUBLE			
NITRATE-N	ppm	1	
AMMONIACAL-N	ppm	2.0	
ORTHOPHOSPHATE-P	ppm	1.0	
CARBON	ppm	370.0	
TKN	ppm	31.0	
1 DAY CO_2C BURST		134.11	
ORGANIC CARBON	ppm	370.0	
ORGANIC NITROGEN	ppm	29.0	
ORGANIC C/N RATIO		12.8	

ADDITIONAL NITROGEN CREDIT IDENTIFIED VIA HANEY TEST: **57 lbs/A**

NITROGEN RECOMMENDATIONS MAY INCLUDE ADDITIONAL NITROGEN CREDITS BASED ON PREVIOUS CROPS AND NITROGEN MINERALIZATION RATES.

The above analytical results apply only to the sample(s) submitted. Samples are retained a maximum of 30 days.

SOIL HEALTH CALCULATION

17.1 (0 — 50)

The **H3A Soil Extractant** was developed by Haney*. This extract is designed to mimic organic acids produced by living plant root systems. These organic acids increase nutrient availability in the root zone.

The **Water Soluble Extract** provides a snapshot of nutrients that are immediately available to the plants.

The **CO_2 Burst** test is very good indicator of soil health. This test measures the amount of CO_2 naturally released from the soil due to the activity of the soil microbes through microbial respiration. This test is very dependant on the amount of carbon that is available to the soil microbes and the form that the carbon is in. As the available carbon increases in your soil the Microbial respiration will increase.

Organic Carbon is the available total water extractable organic carbon from your soil. This pool of carbon is roughly 80 times smaller than the Soil Organic Matter. The organic carbon pool reflects the energy/food source that is driving the soil microbes.

The **Organic Nitrogen** pool is replenished by fresh plant residues, manure, composts, and dying soil microbes.

The **Organic C/N ratio** is a critical component of the nutrient cycle. A soil C/N ratio above 20 generally indicates that Nitrogen will be tied up and not available to plants. The ideal range for the Organic C/N ratio will be from 8:1 to 15:1.

The **Soil Health Calculation** uses the CO_2 Burst, Organic Carbon, Organic Nitrogen, and the C/N ratio to generate the soil health number. This calculation looks at the balance of soil carbon and nitrogen and their relationship to microbial activity. This number represents the overall health of your system. Soil values will range from 0 to 50. A soil with a value below 7 would be considered low. You want to see this number increase as you make changes and adjustments. Keeping track of this number will allow you to gauge the effects of your management practices over time.

*Modifications to the New Soil Extractant H3A-1: A Multinutrient Extractant
R.L. Haney (a); E.B. Haney (b); L.R. Hossner (c); J.G. Arnold (a)

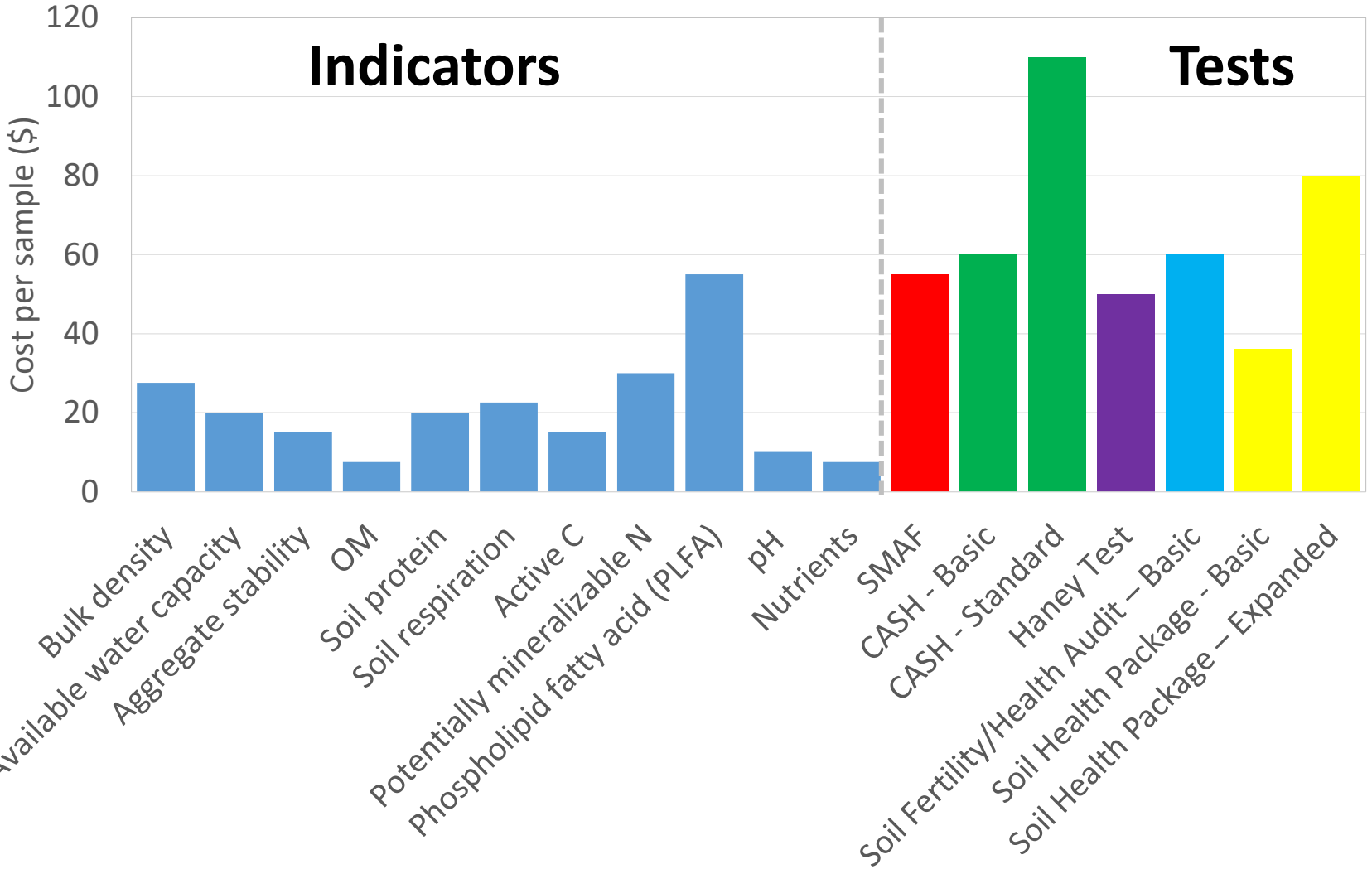
Three major soil health scores

Comprehensive Assessment for Soil Health (CASH)	Soil Management Assessment Framework (SMAF)	Haney Soil Health Test
SHP Scored Indicators • Organic matter • ACE soil protein • Active Carbon • 1-day soil respiration (CO_2-C) • Wet aggregate stability • Water holding capacity (WHC) • pH, P, K (Using SMAF scores)	**SHP Scored Indicators** • Soil Organic Carbon • Wet aggregate stability • pH, P, K	**SHP Scored Indicators** • Wet extractable O, N (WEO/N) • 1 day soil respiration (CO_2 C)
Range of scores: 0 – 100	0 – 100	0-50

4. Other tests

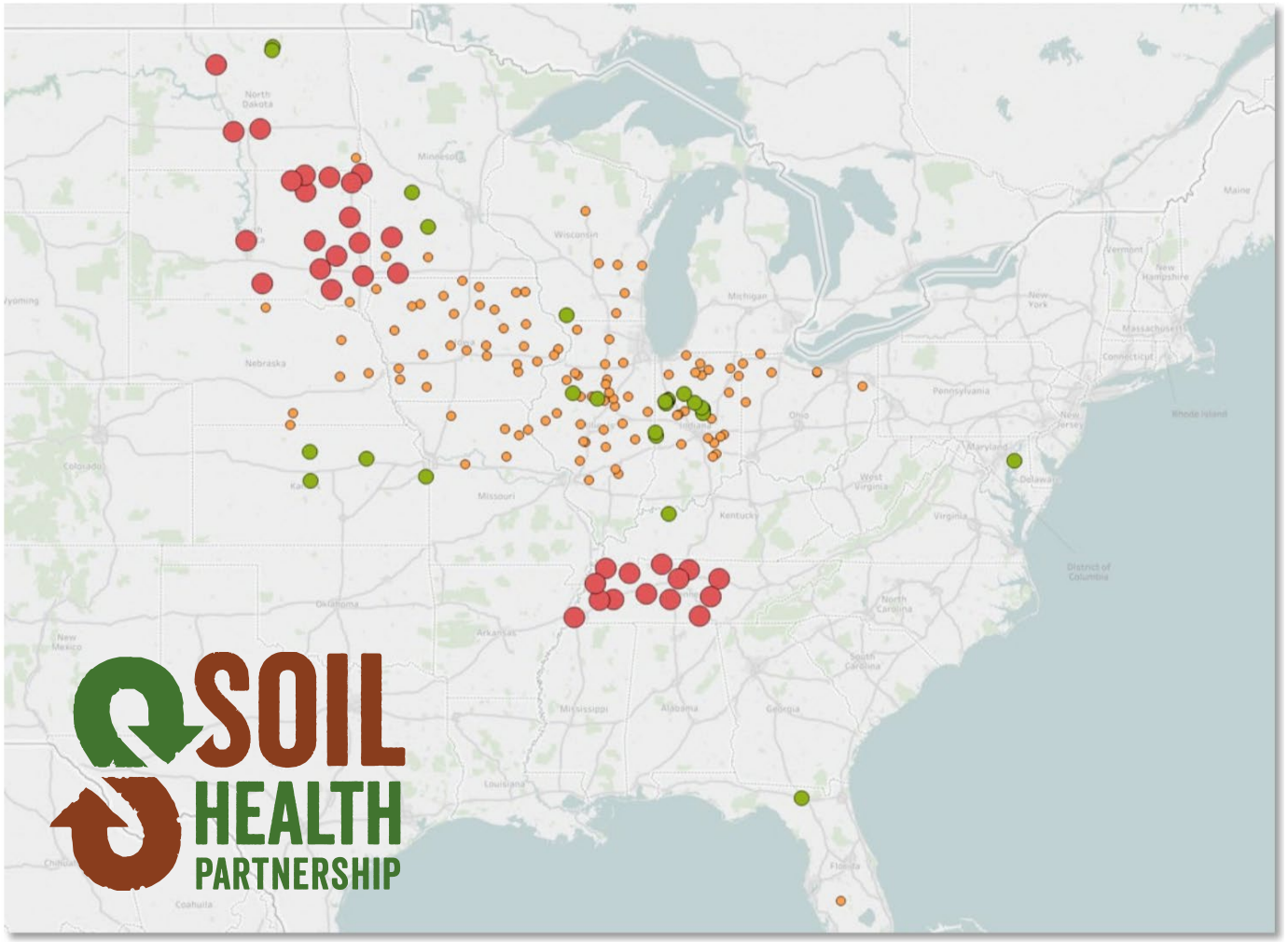
South Dakota State Univ.

Approximate costs of Soil Health tests



***Prices obtained from various lab websites on 12/15/18. Prices do not include processing fees or packages.*

Should I invest in my farm?



Should I invest in my farm?

Experimental Design

Site layout:

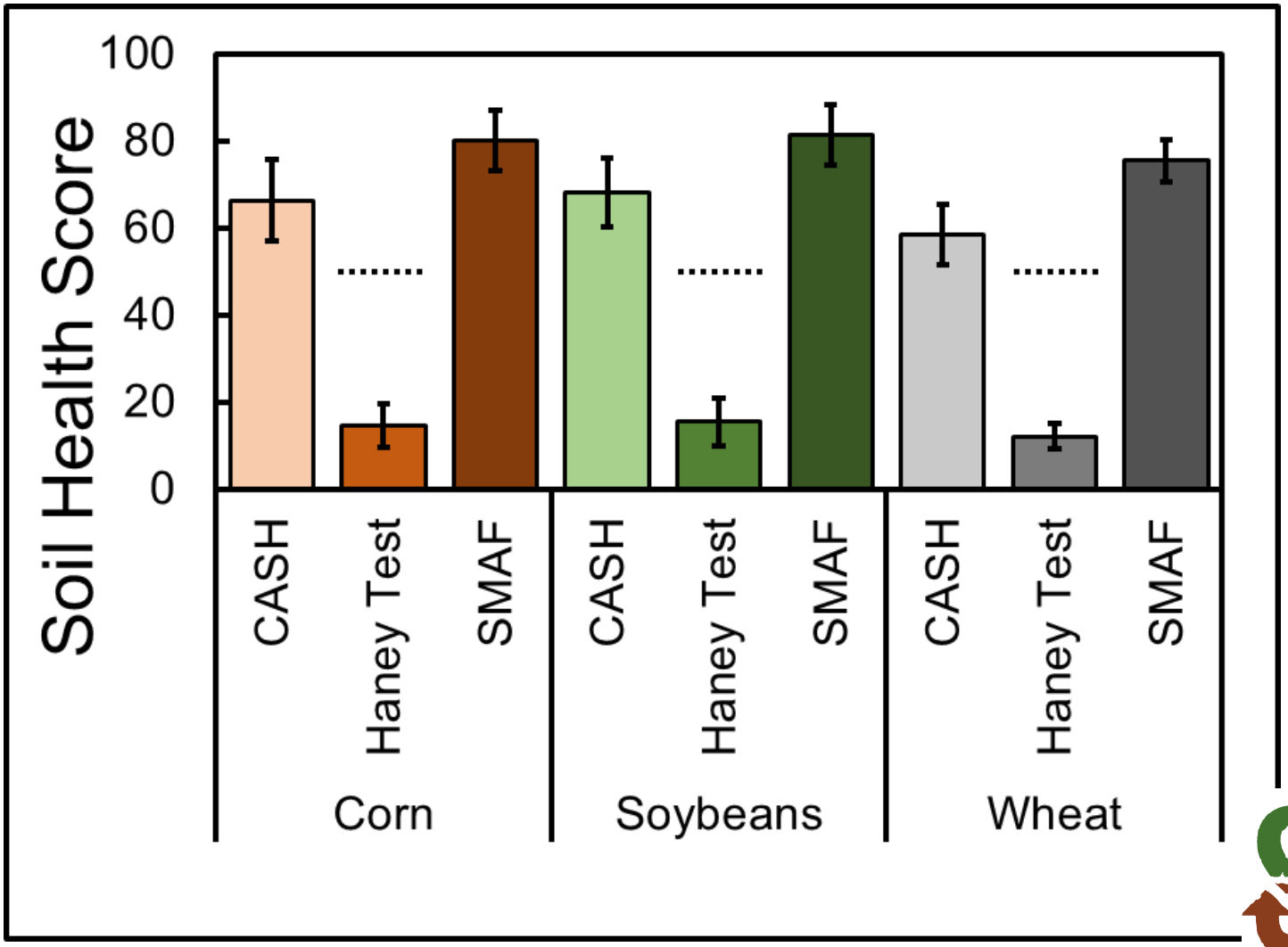
- On-farm strip trials.
- Cover crop vs conventional.
- 4 replications per treatment per site.

Sampling Protocol:

- 0-6 in soil depths.
- Multiple samples per strip for soil nutrients and pH.
- 1 composite sample per strip for CASH, SMAF, and Haney Test.

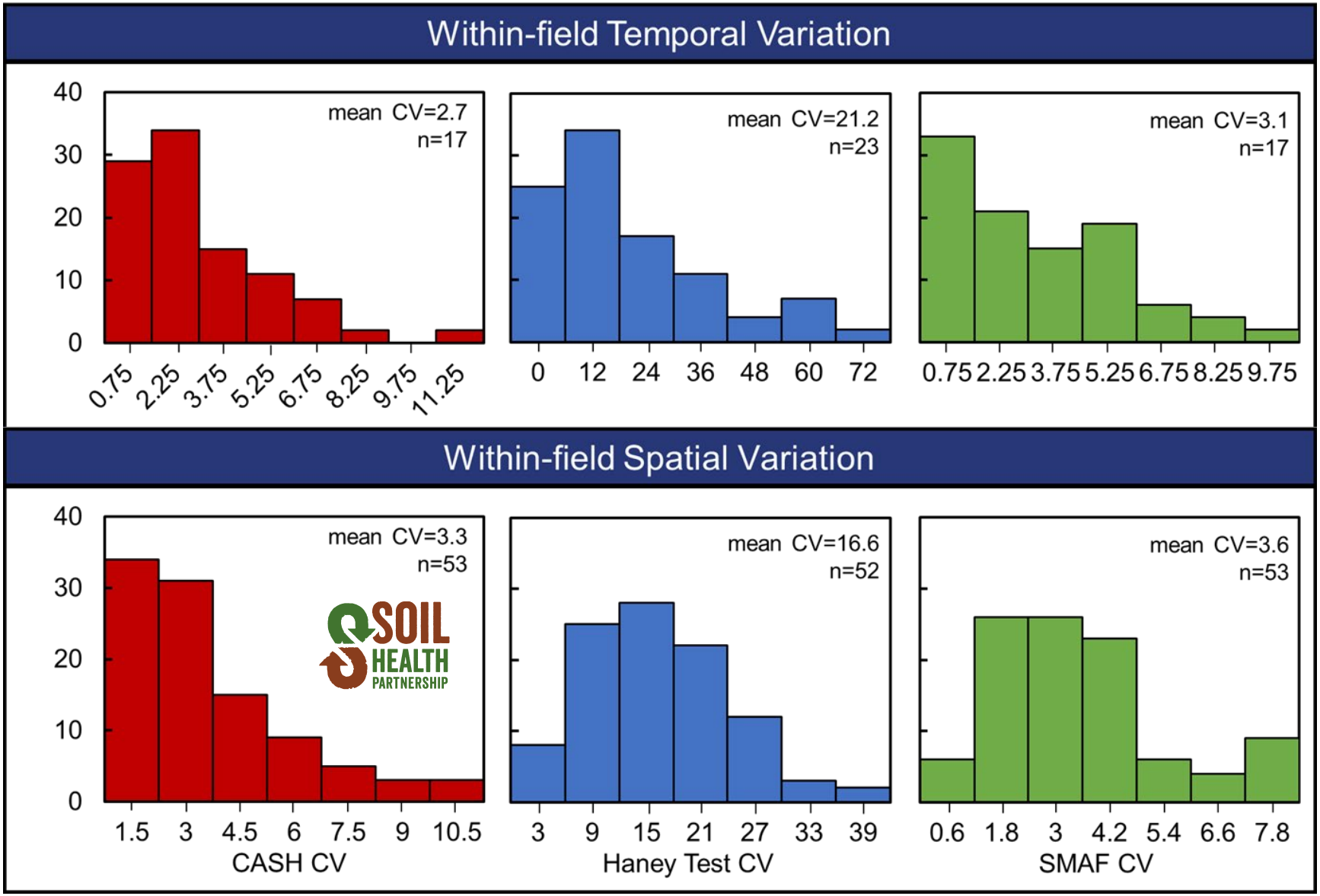
SOIL HEALTH PARTNERSHIP

What values might I expect?

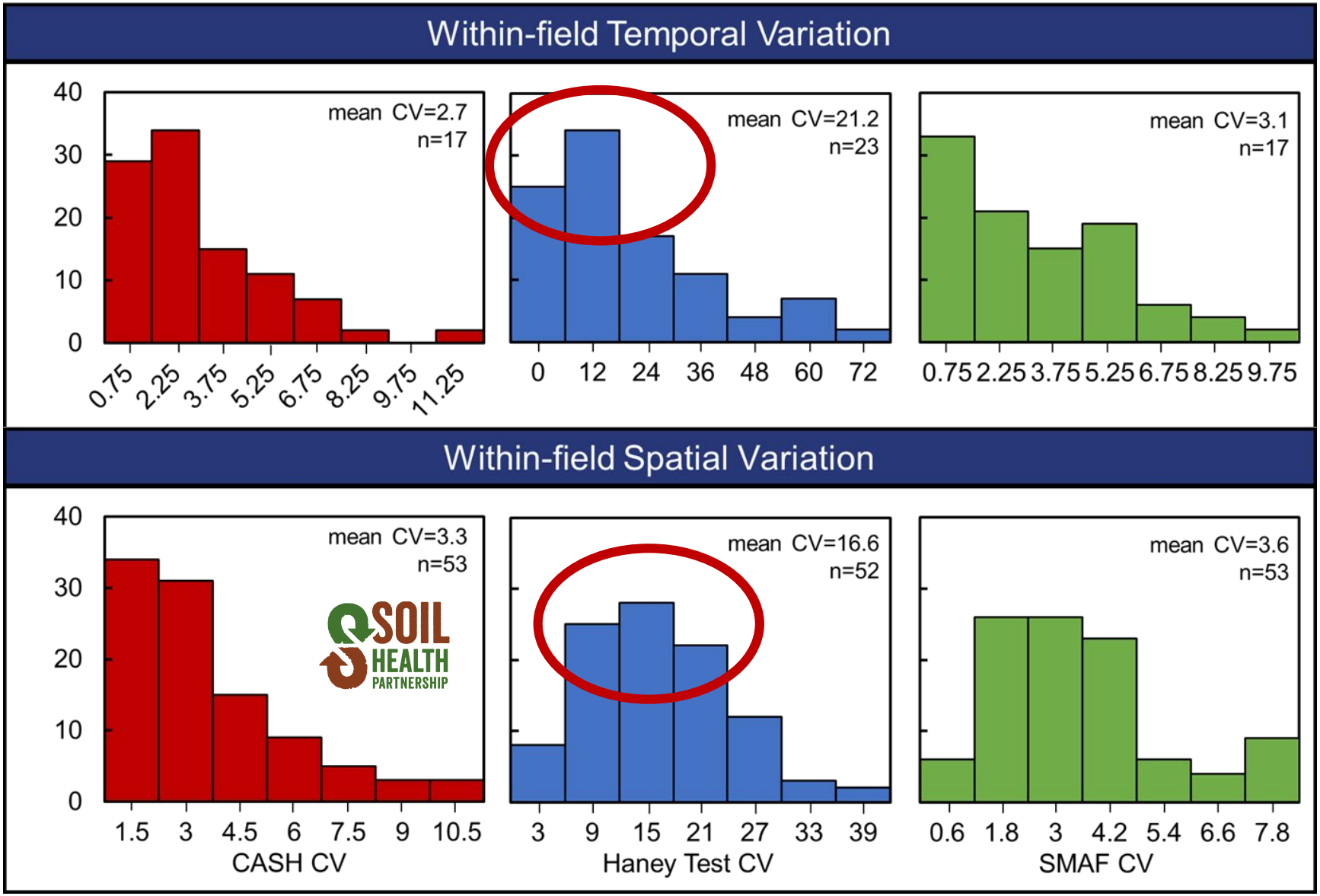


SOIL HEALTH PARTNERSHIP

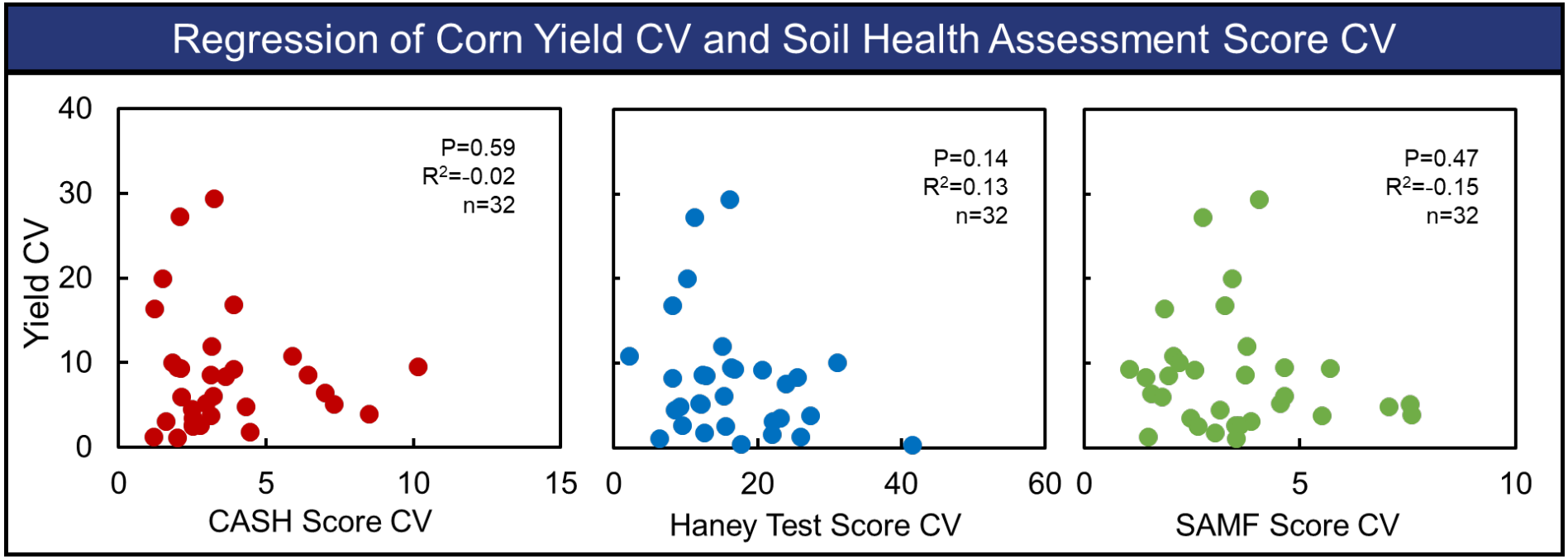
How do they vary in time and space?



How do they vary in time and space?



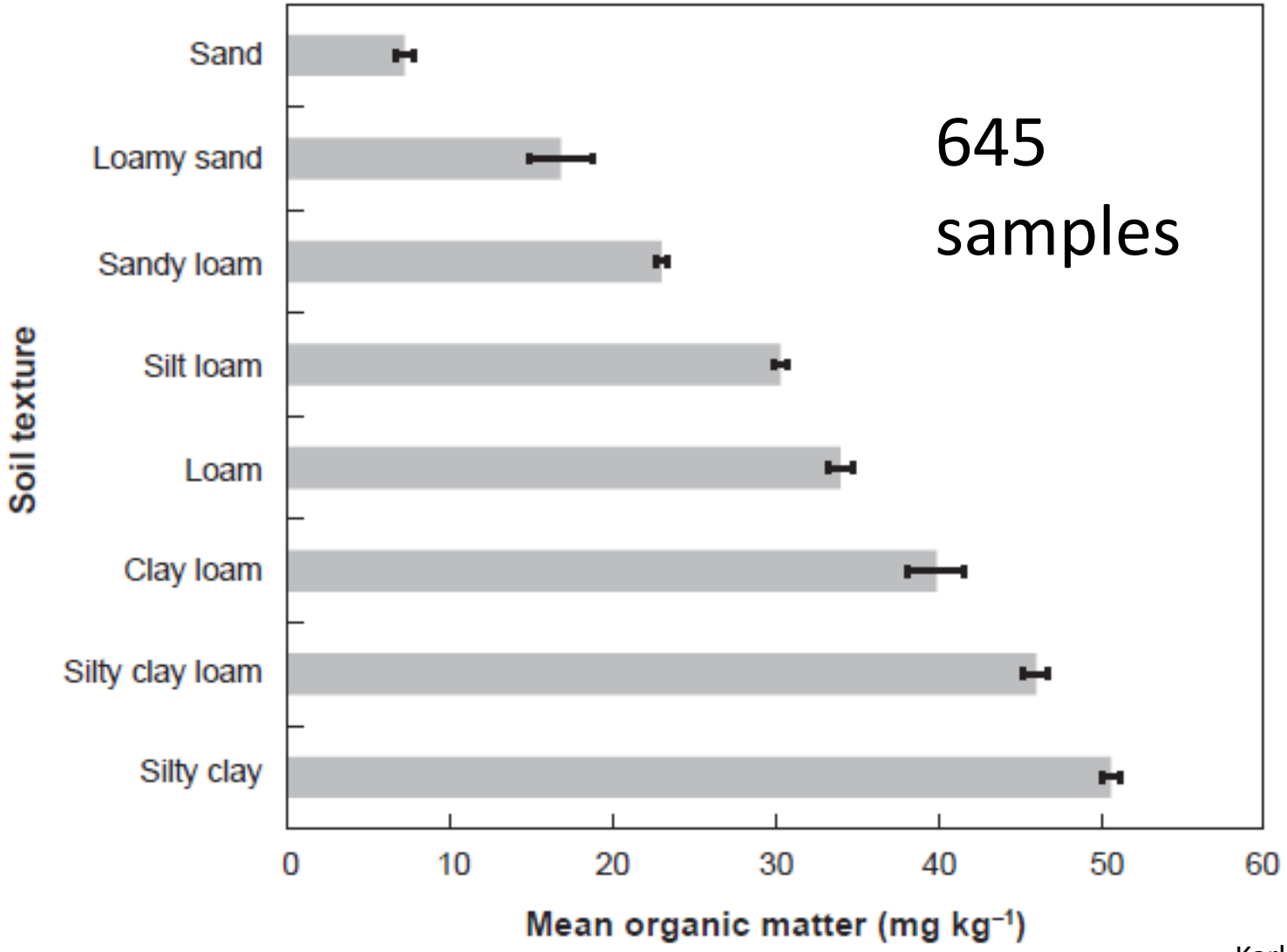
Are SH and yield variation related?



SOIL HEALTH PARTNERSHIP

Soil Health Improvement

Some things we cannot change



Karlen et al., 2017

Others we can, and quite rapidly

Soil Health goals

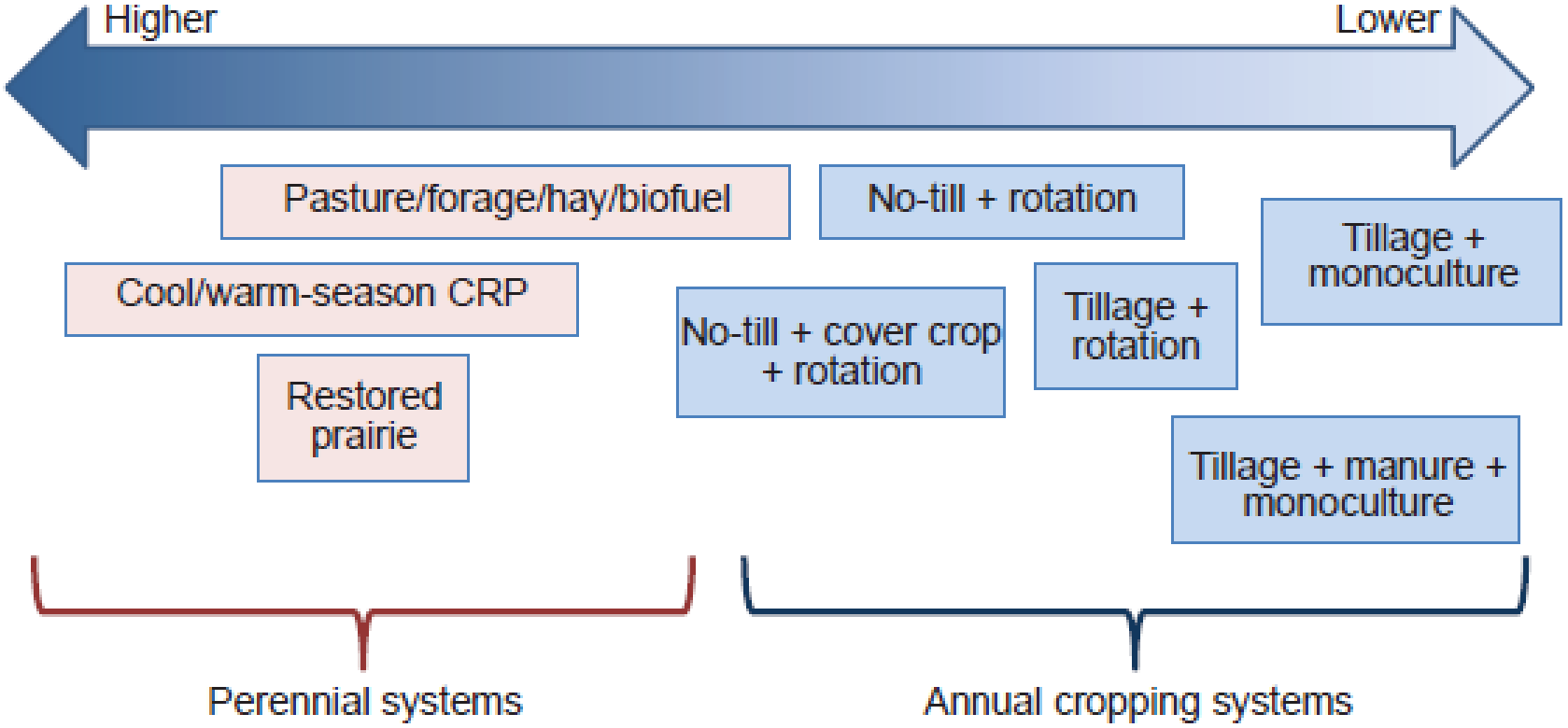
- Protect soil surface from erosion (wind and water)
- Add OM
  - Retain more water and nutrients
  - Build soil structure/tilth
  - Soil aggregates further resistant to erosion
  - Promote aeration and infiltration
  - Promote microbial activity and diversity
- Add diversity
- Refine inputs
- Reduce negative environmental impacts

Practices with potential

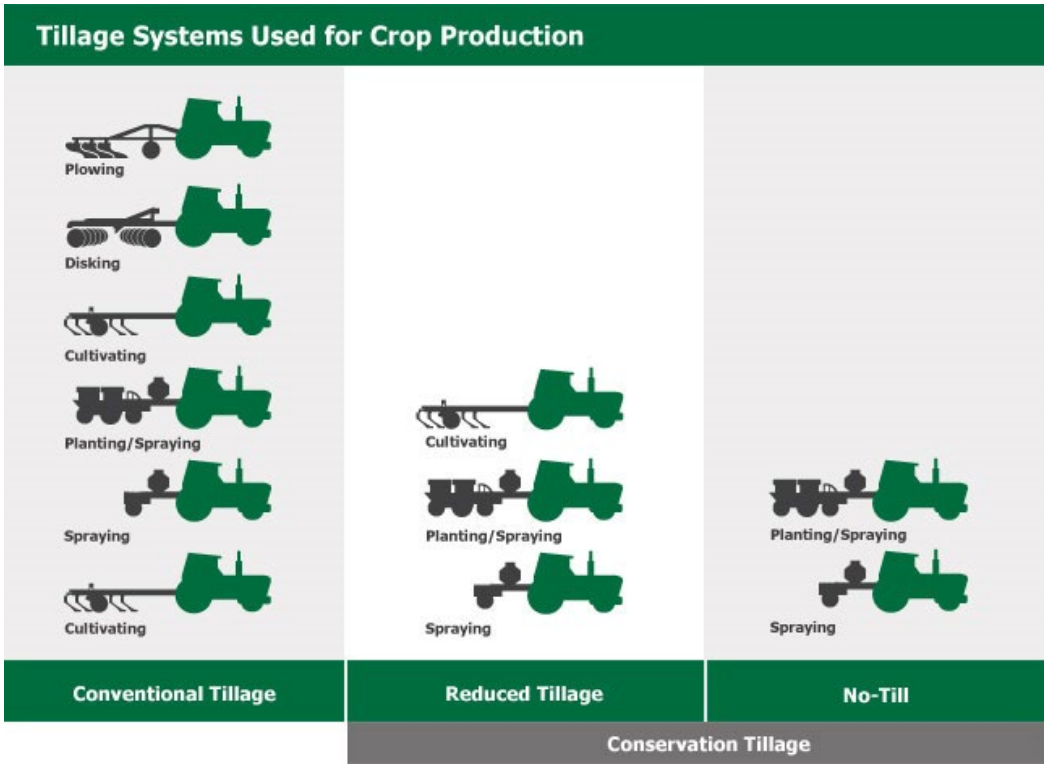
No single practice, but many

Figure 3

Continuum of soil health based on Veum et al. (2014, 2015). CRP is Conservation Reserve Program.



Less or no-tillage and cover crops are great options

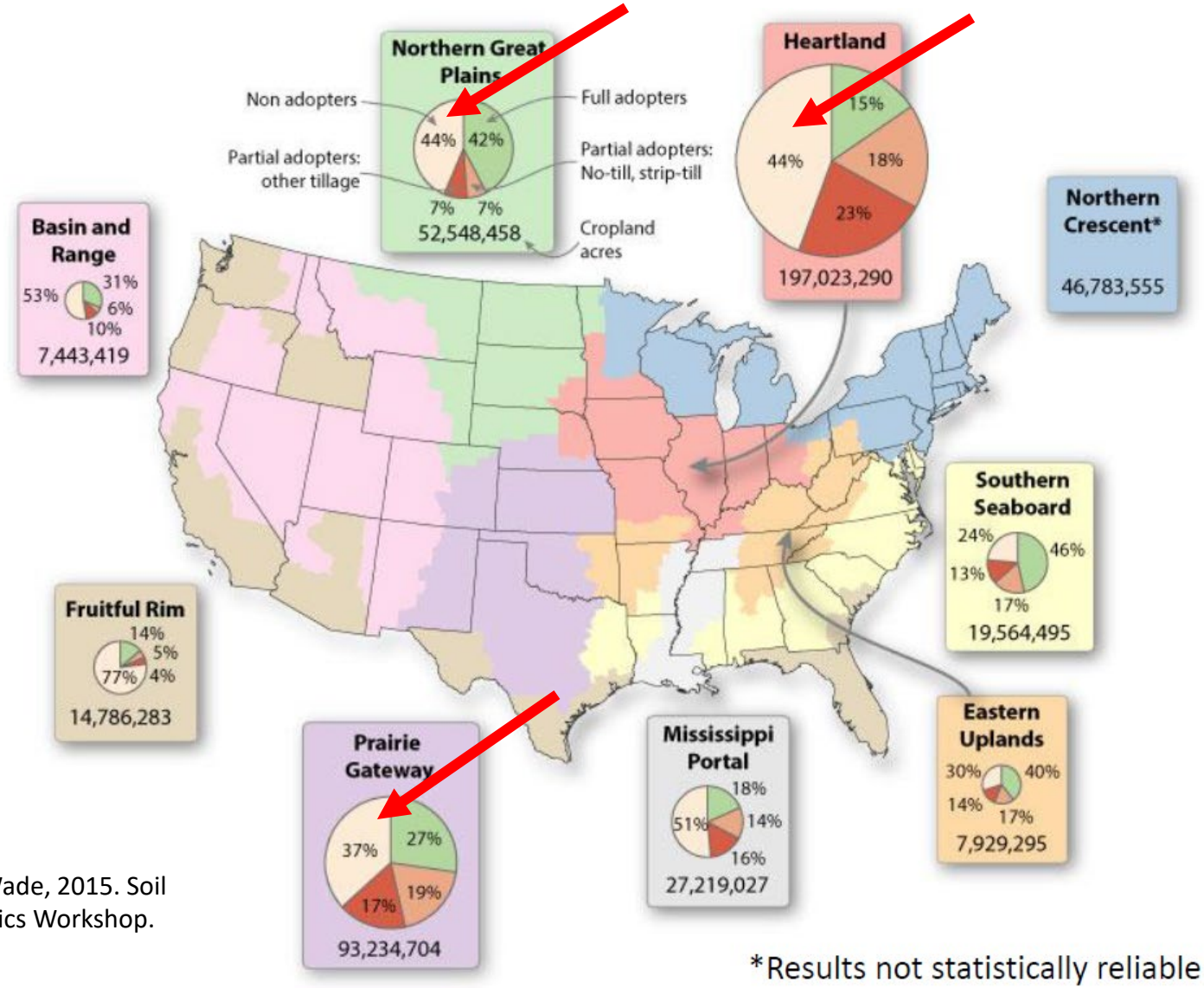


www.advancefarming.com

Iowa State Ext.

Laura Greiner, NRCS

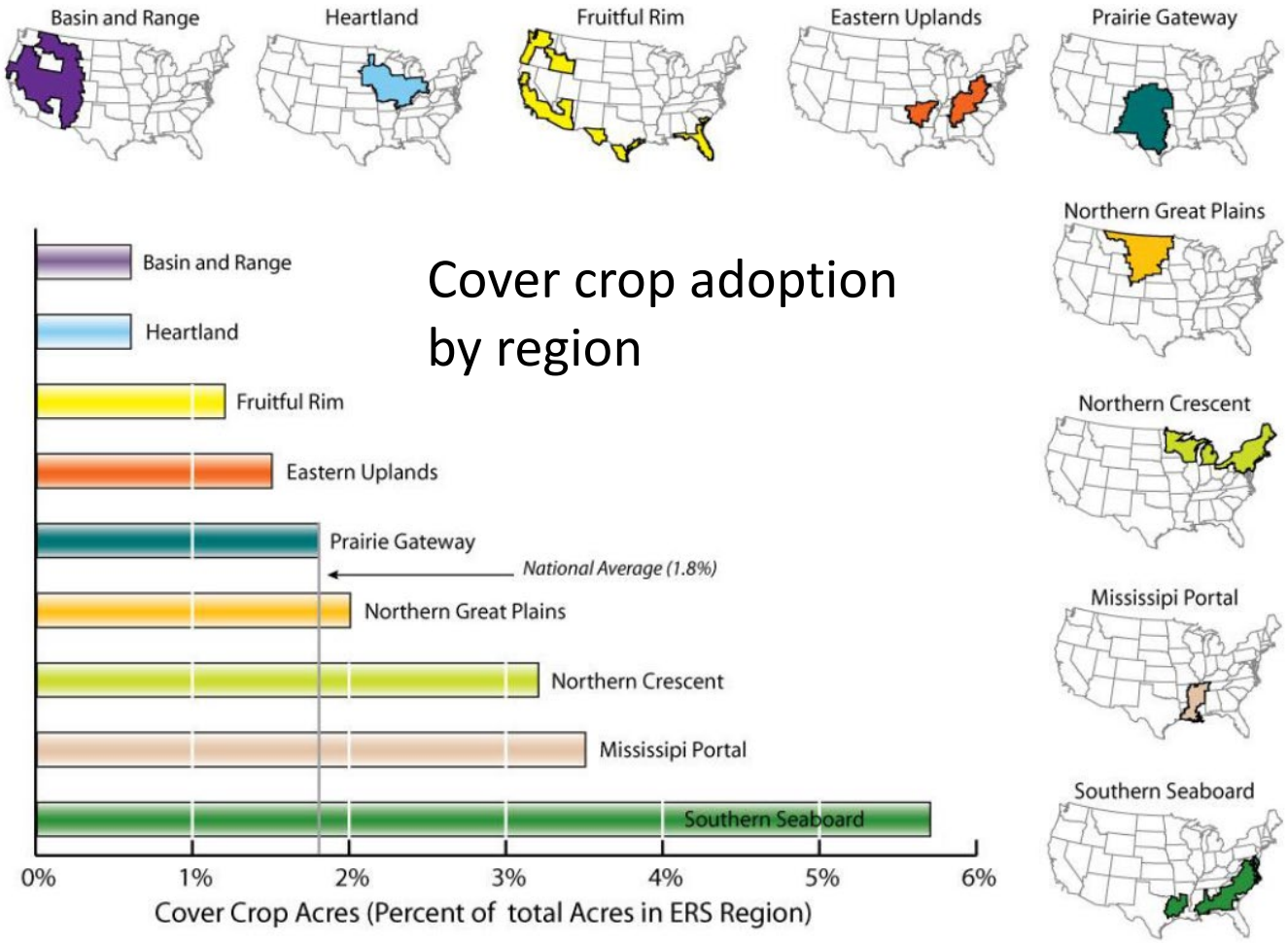
Yet.. adoption of no-till still low



Claassen and Wade, 2015. Soil Health Economics Workshop. ARMS survey

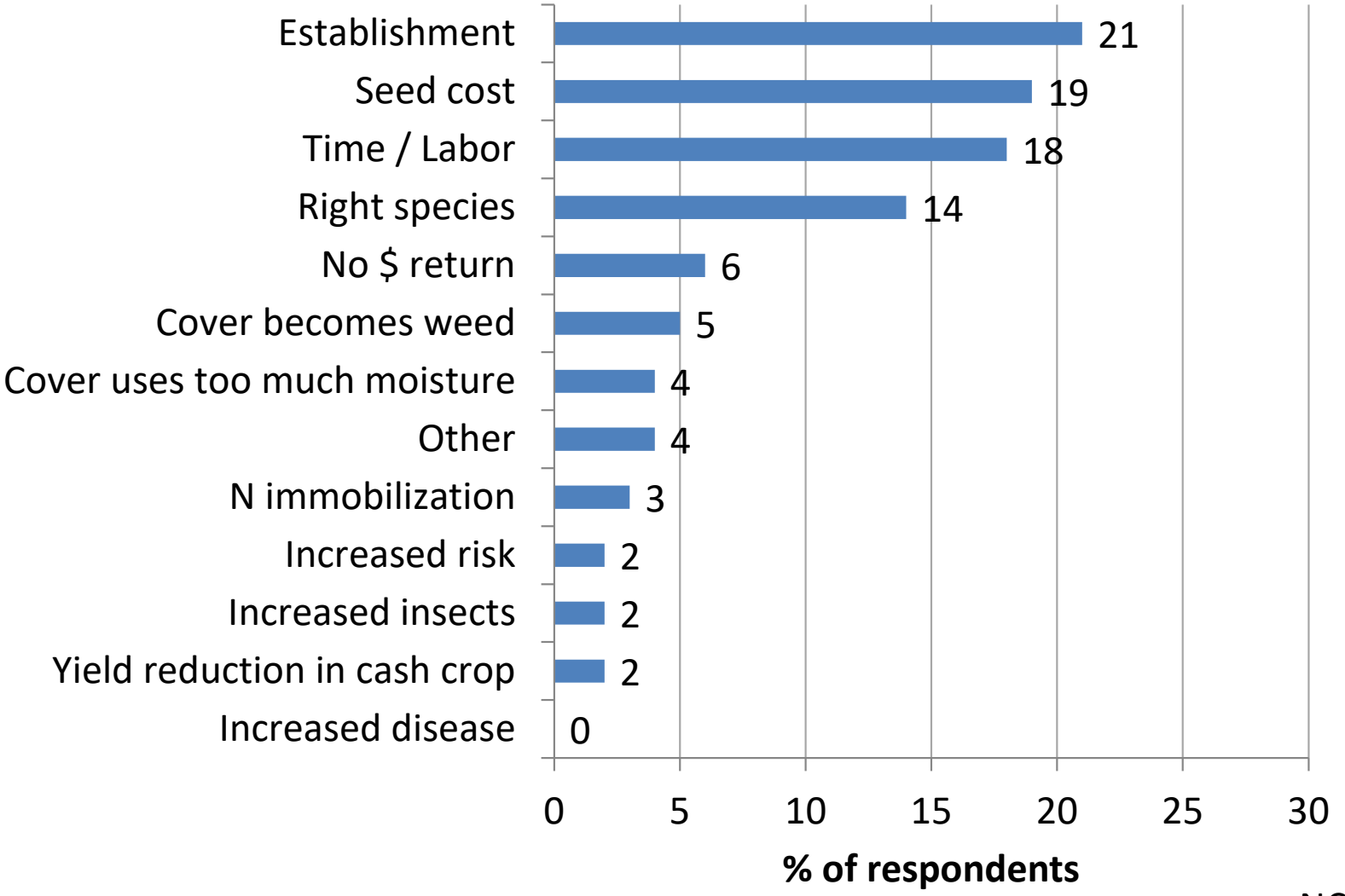
*Results not statistically reliable

And… even lower for cover crops



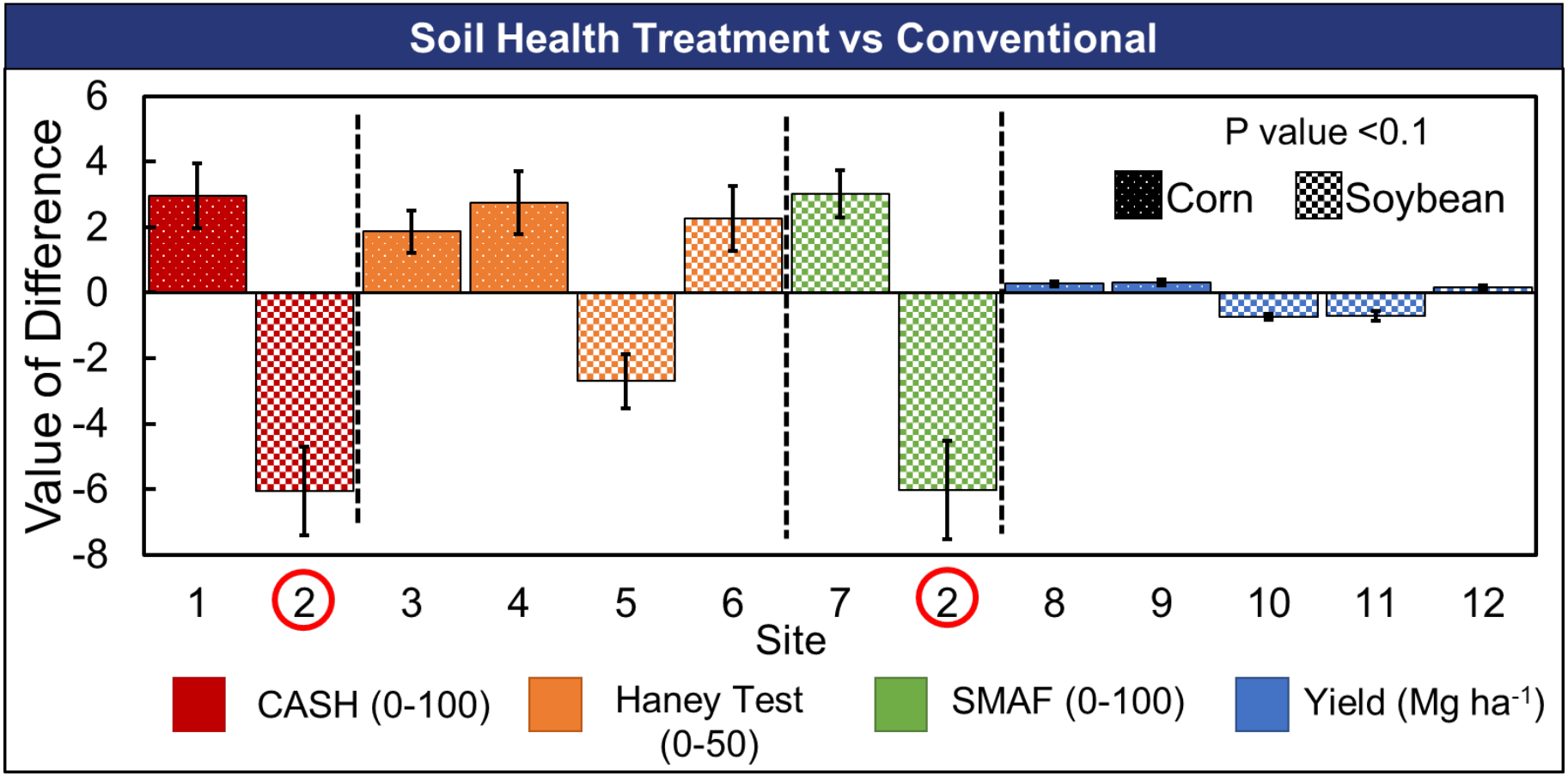
Claassen and Wade, 2015. Soil Health Economics Workshop. ARMS survey

Many short-term challenges



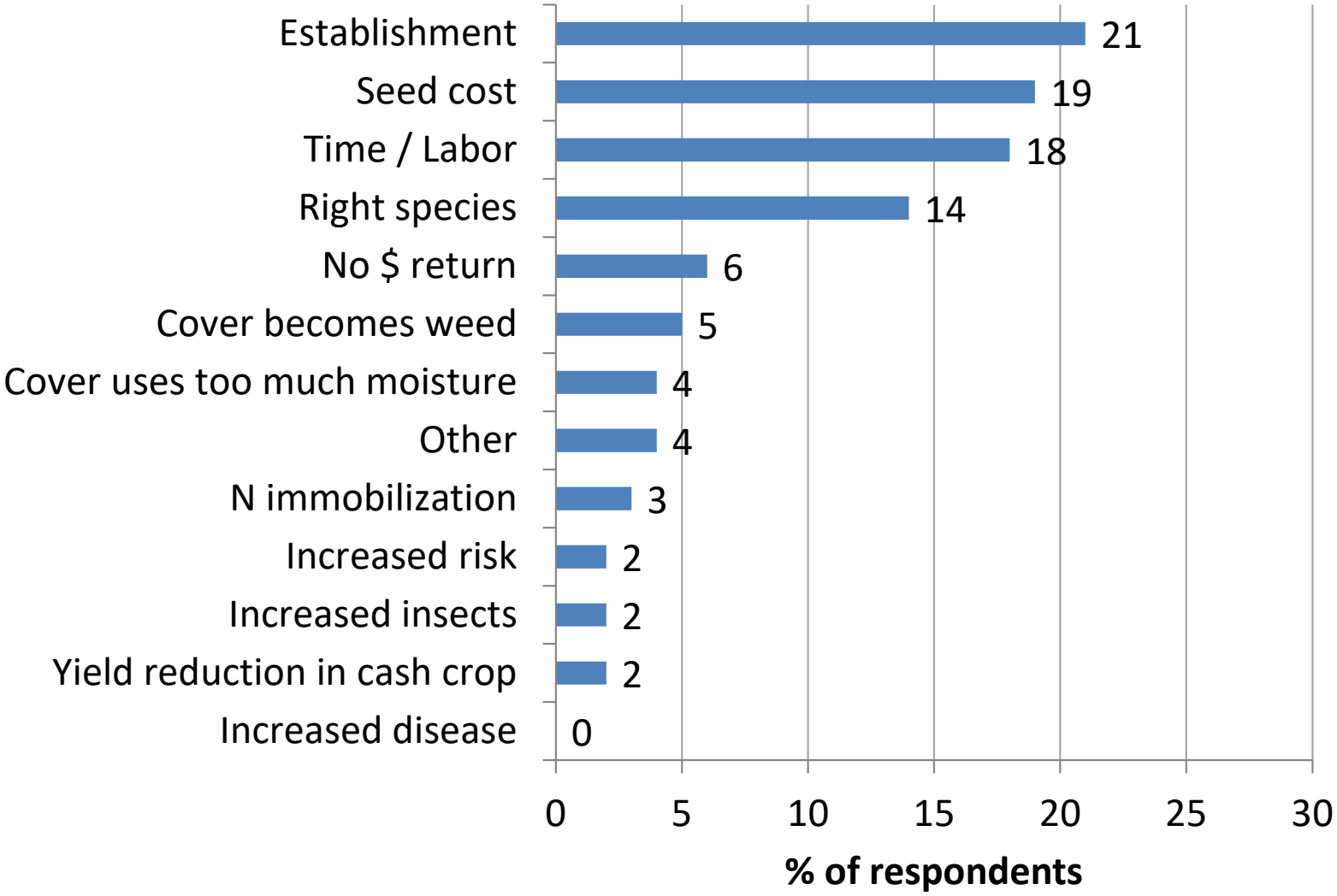
NCR-SARE, 2015

SHP – few short-term differences



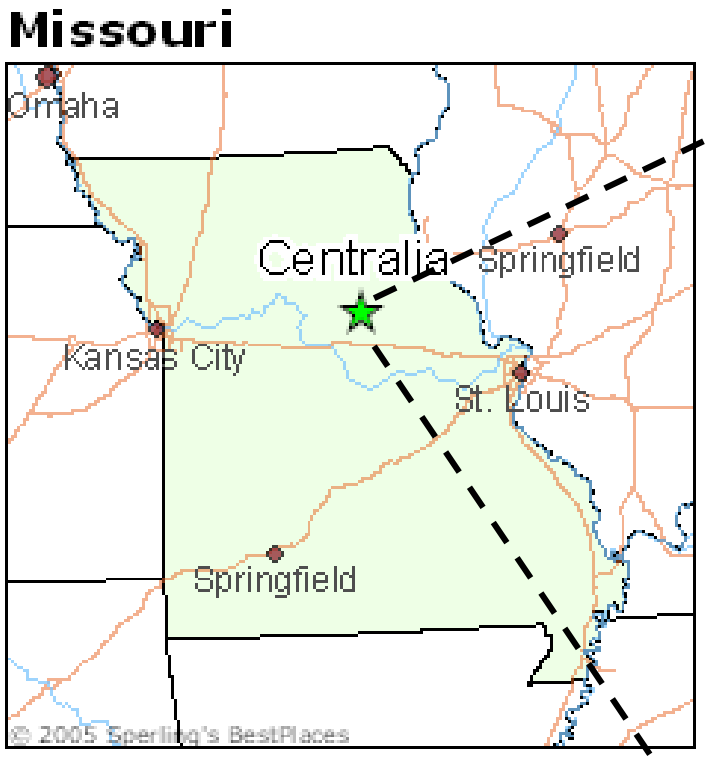
Different time scales for yield and soil health indicator changes??

What about long-term success?

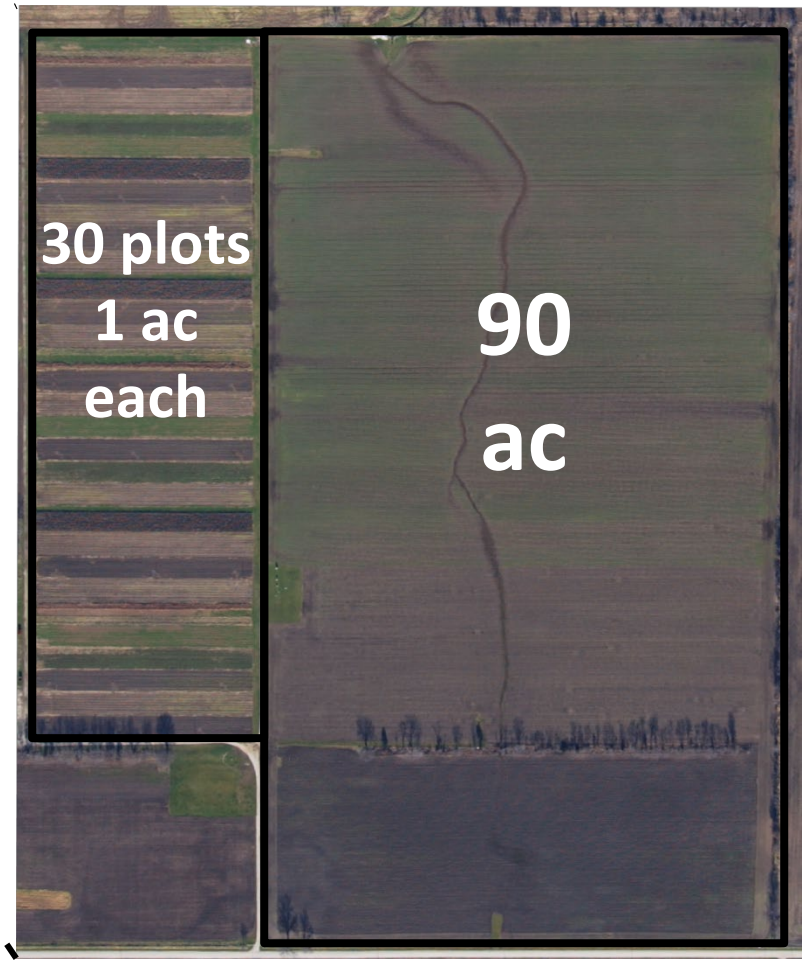


NCR-SARE, 2015

Long-term plot and field research



1991 - Present



Plots - Three cropping systems

Conventional:

Till, corn-soybean

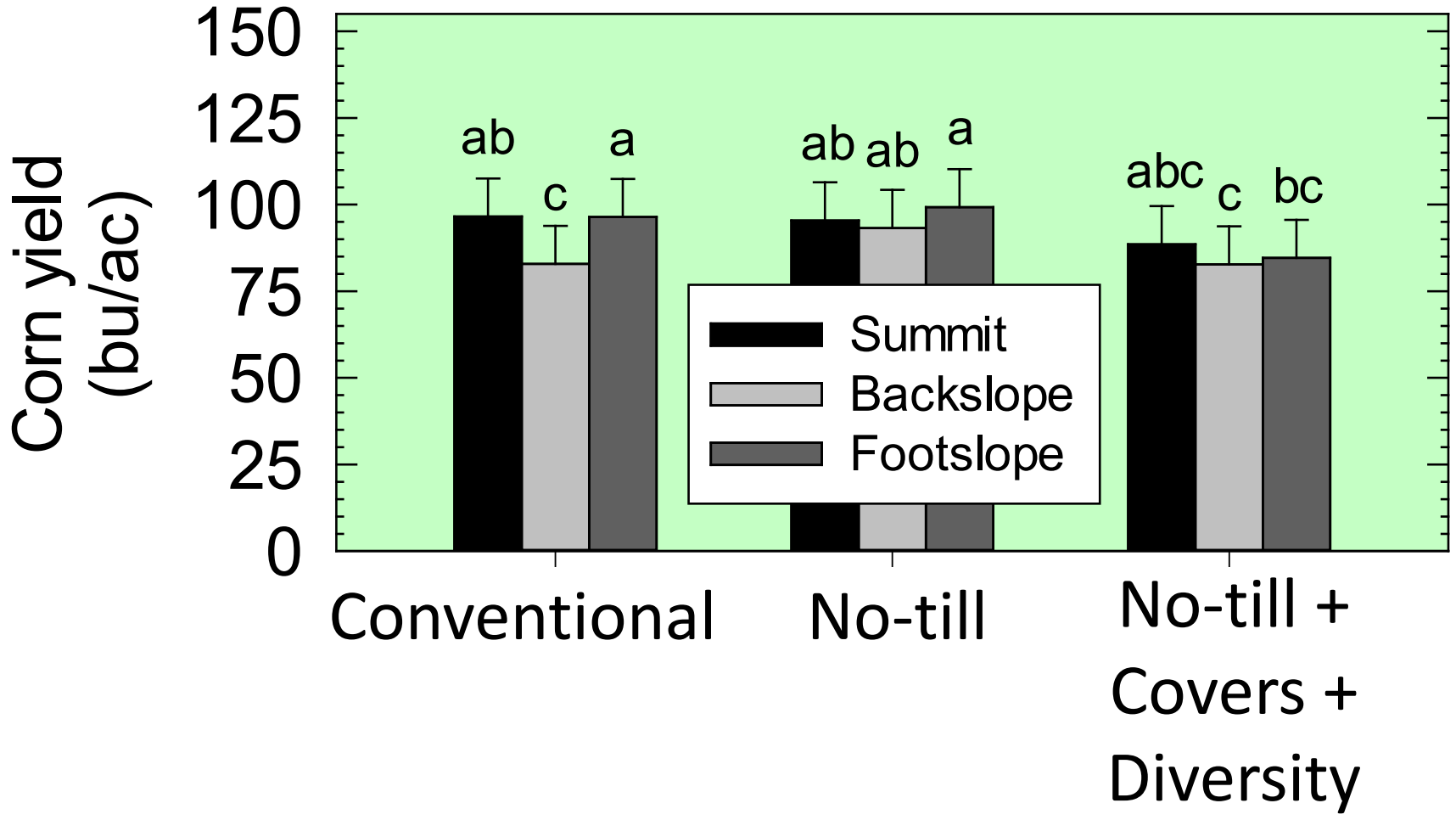
No-till:

No-till, corn-soybean

No-till + cover + diversified:

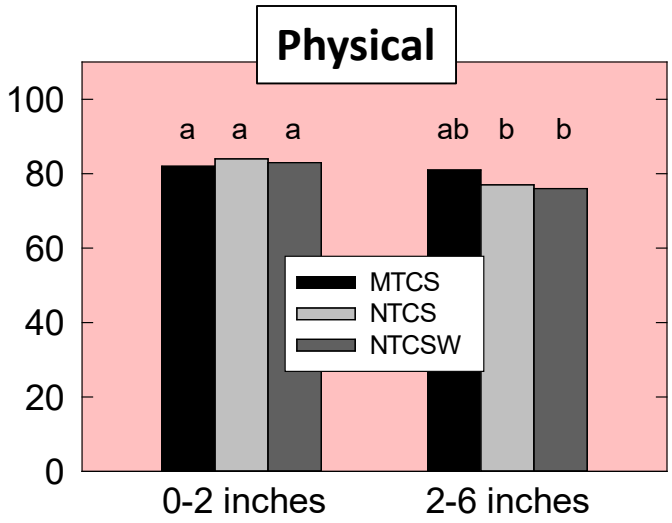
no-till corn-soybean-wheat-cover crop (red clover, hairy vetch) + less total herbicides (atrazine, metolachlor, and glyphosate).

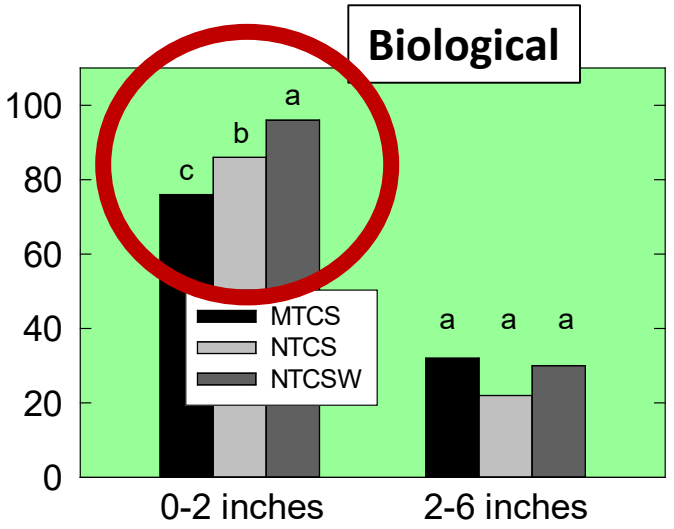
Conservation systems maintained corn yield and profit

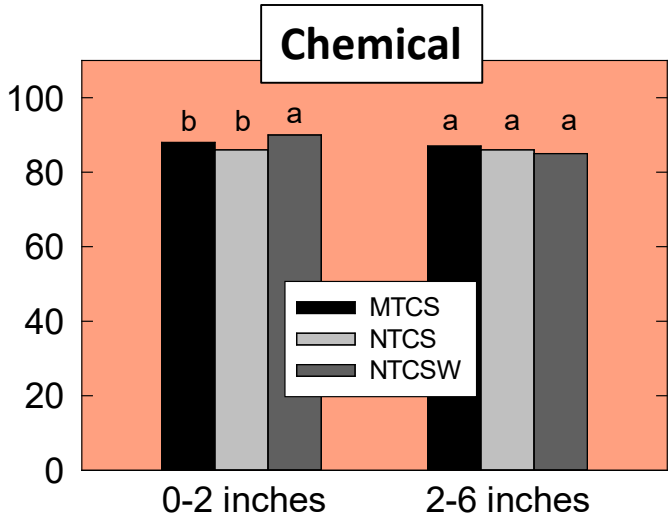


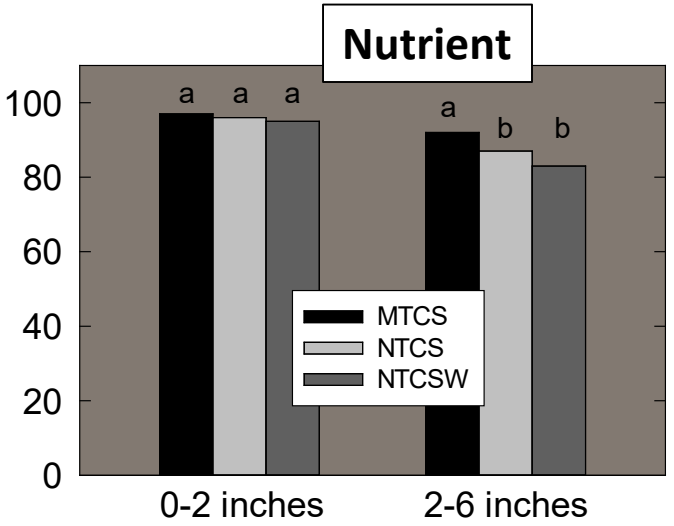
Yost et al., 2016

Conservation systems improved biological, chemical, and total SMAF scores





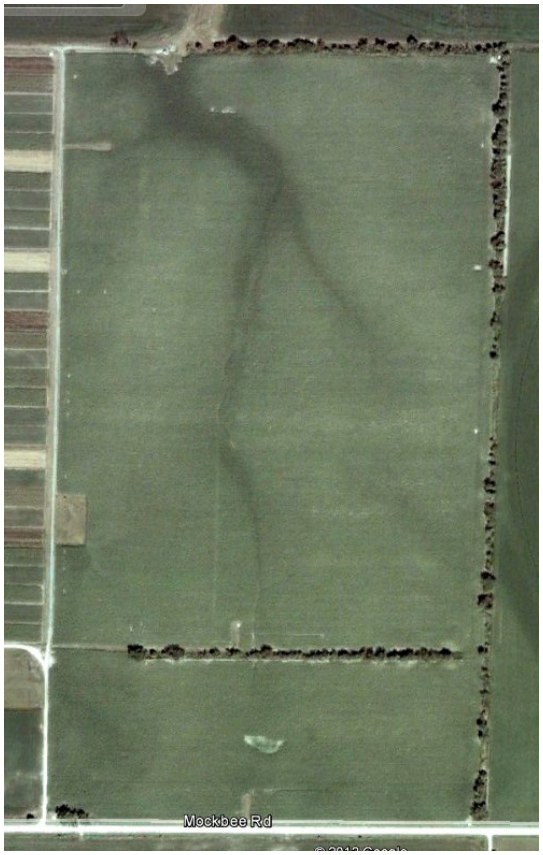




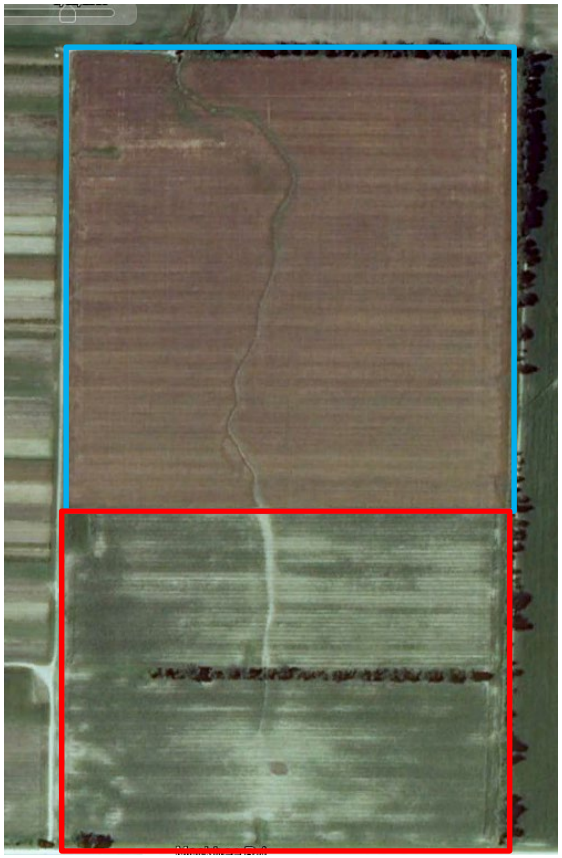
Veum et al., 2015

Field Study

1991-2003: Pre-PAS
MTCS



2004-2014: PAS
Soybean-wheat (north)
Soybean-corn (south)
No-till + cover crop



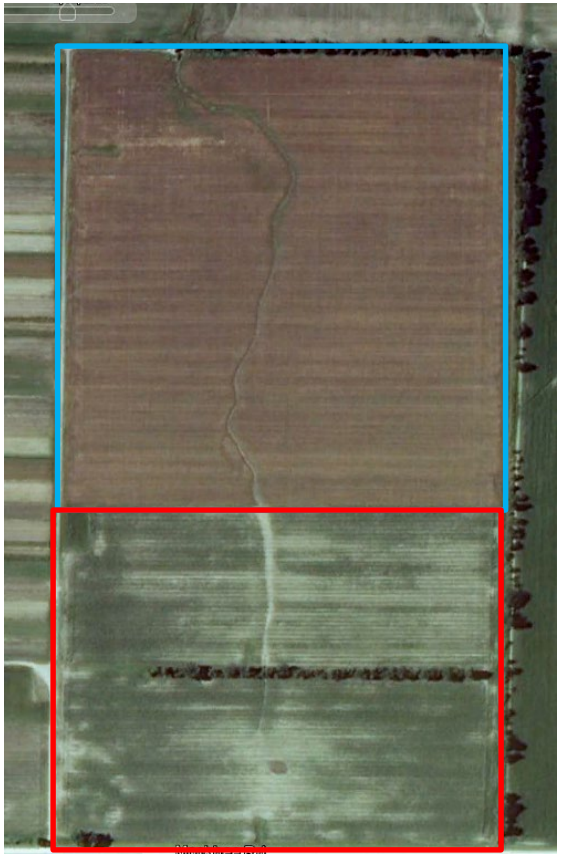
Cover Crops

Summer cover after Wheat

- Vetch / Clover / Winter peas
- Radish / Turnip / Cabbage
- Millet / Oat / Sudangrass / cereal rye

After Corn:

- Cereal Rye
- Cereal Rye / turnip / radish / oats



Cover Crops

Summer cover after Wheat

- Vetch / Clover / Winter peas

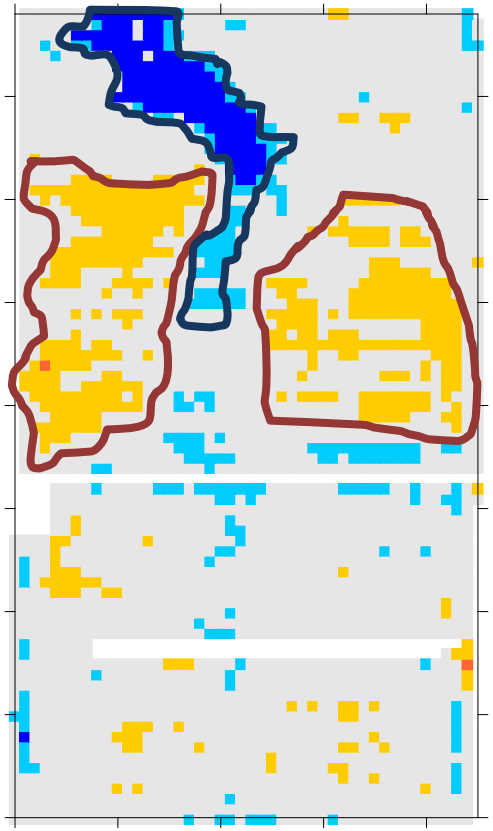
+$40 / acre cover crop

-$39 / acre with no-till

- Cereal Rye
- Cereal Rye / turnip / radish / oats

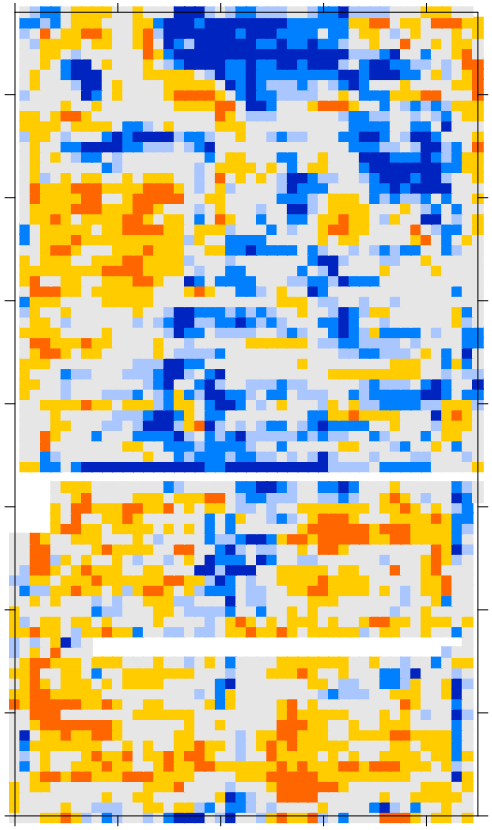
Soil Health practices maintained yield and profit

Relative yield



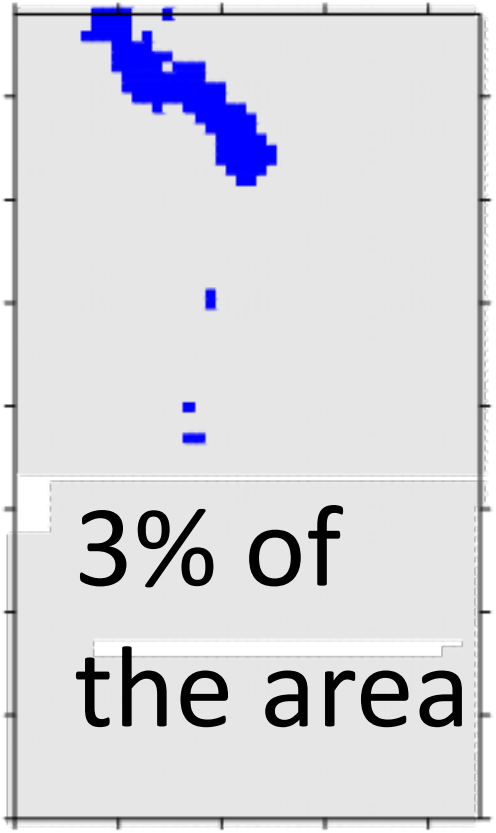
Blue = Lower yield
Orange = Higher yield

Temporal variation



Blue = More variable
Orange = Less variable

Profit

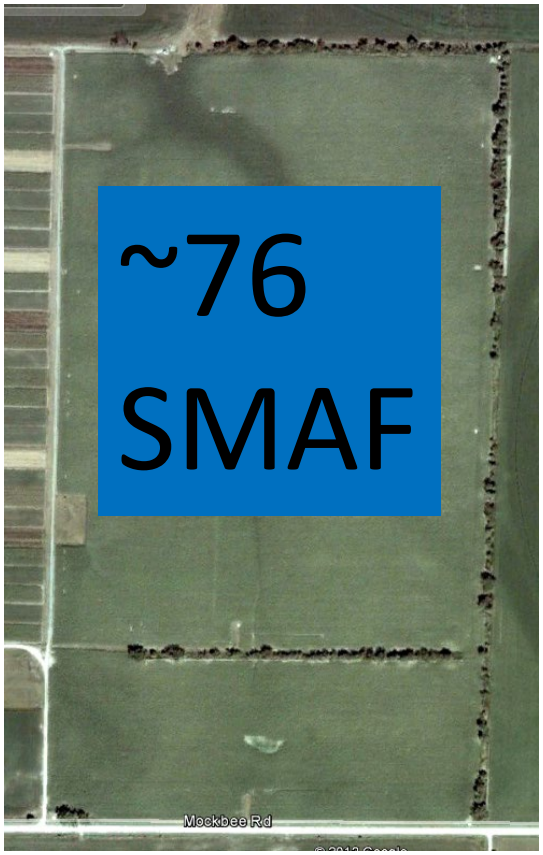


Blue = Less profit

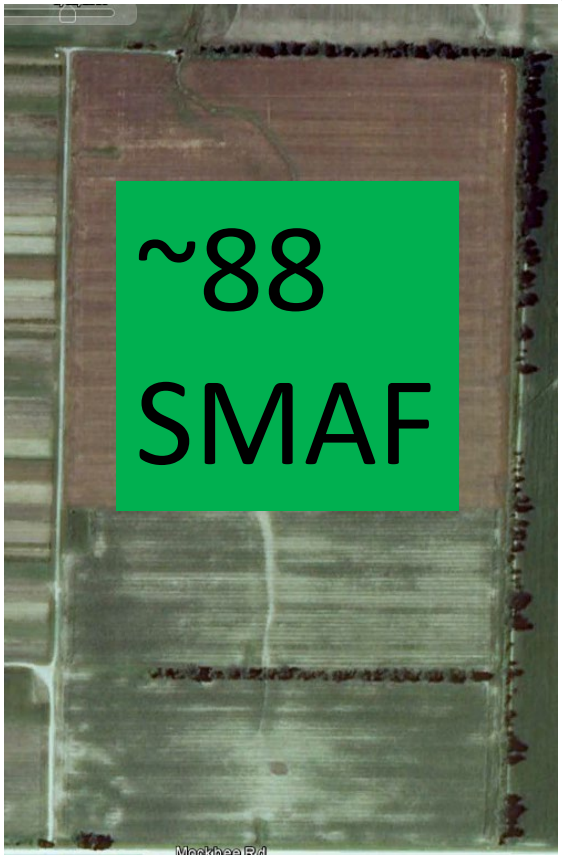
Yost et al., 2017

Improved Soil Health score by 12%

1991-2003
MTCS



2004-present
Soybean-Wheat (N)
Soybean-Corn (S)
No-Till + Cover Crop



Field & Plots Summary

10 – 17 years of precision + conservation:

- Increased crop yields on shallow soils
- Decreased crop yields in wet waterways
- Decreased yield variability in southern part of the field
- Improved soil health by about 12%
- Maintained profit – without subsidies

Soil Health Utilization

Soil Health

Fertilizer Management

Haney Test For Fertilizer Guidelines

SF Successful Farming

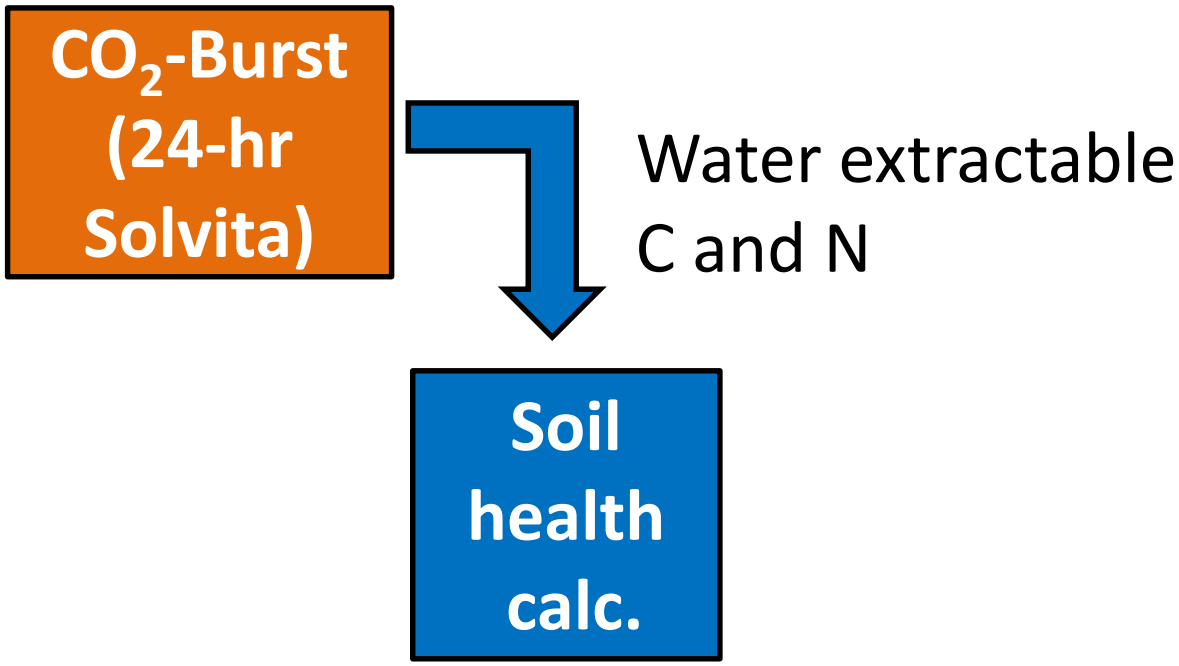
SOIL HEALTH TOOL SHOWS NUTRIENT AVAILABILITY AND SOIL RESPIRATION

By Raylene Nickel
11/26/2014

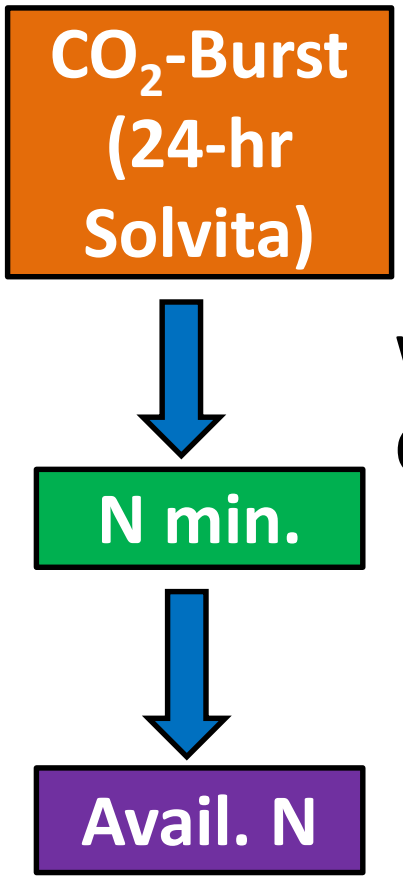
Components/recommendations of Haney soil health test

CO_2-Burst (24-hr Solvita)

Components/recommendations of Haney soil health test



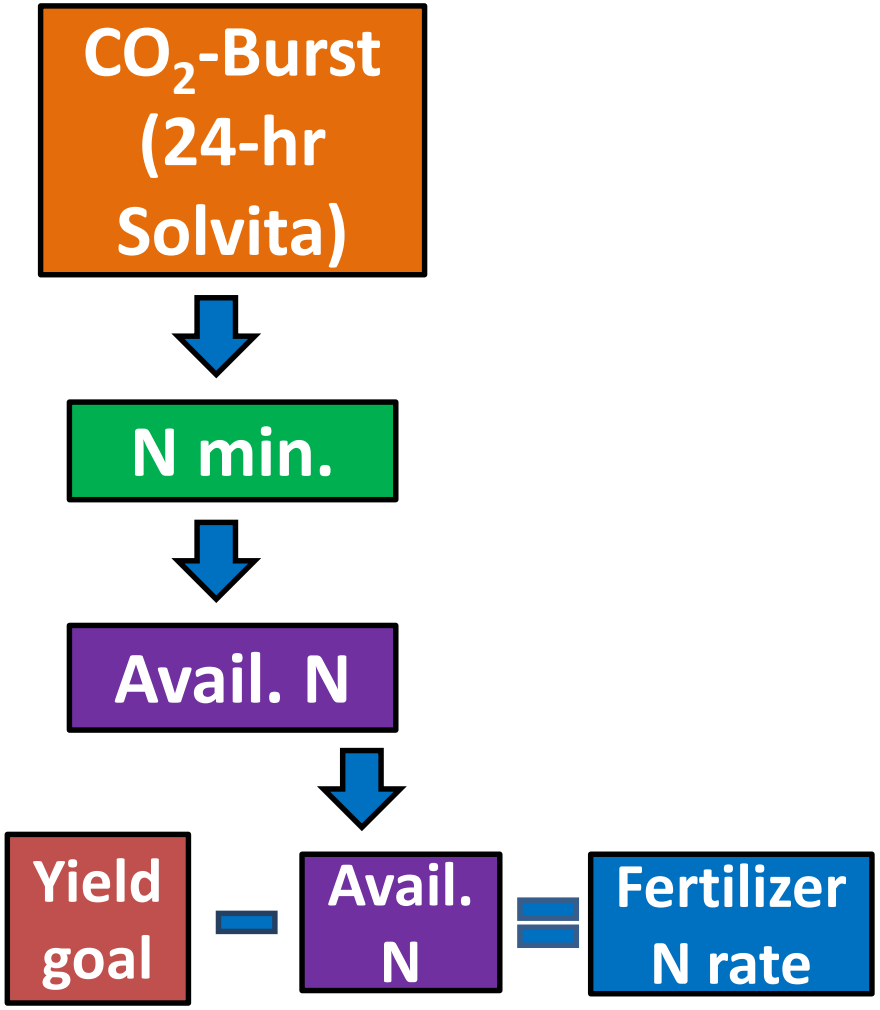
Components/recommendations of Haney soil health test



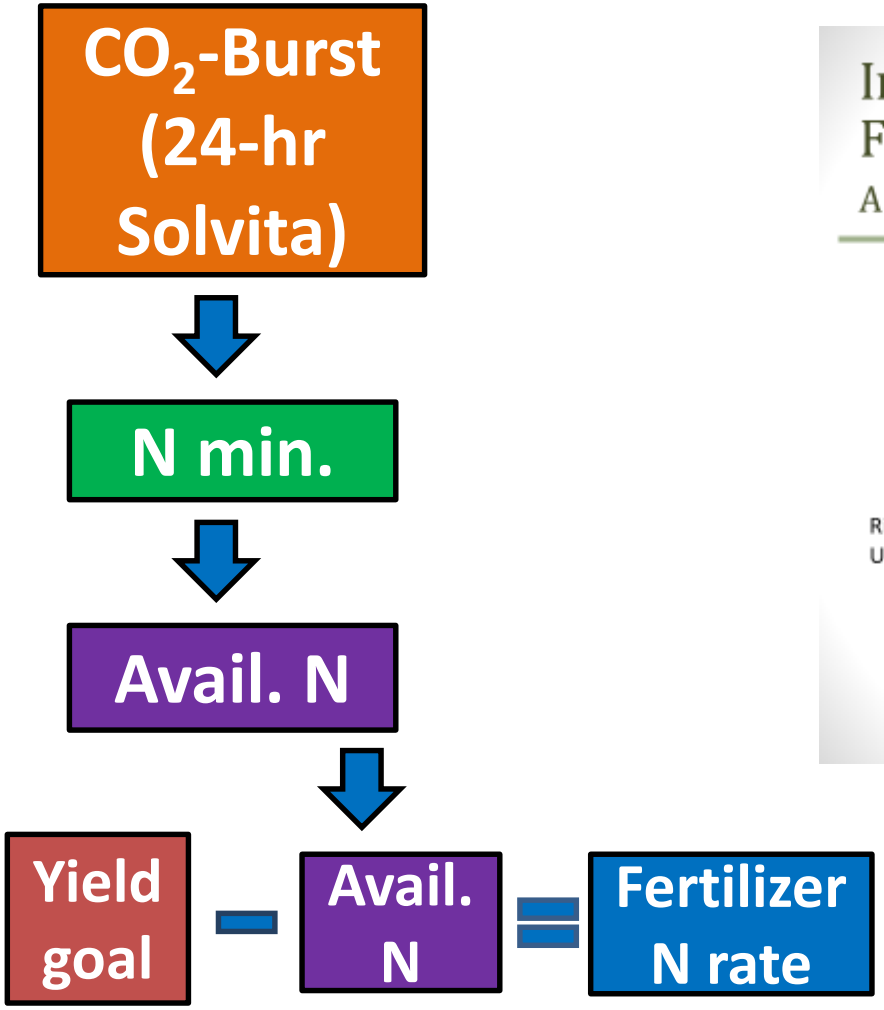
Water extractable C and N

Organic N release
Inorganic N

Components/recommendations of Haney soil health test



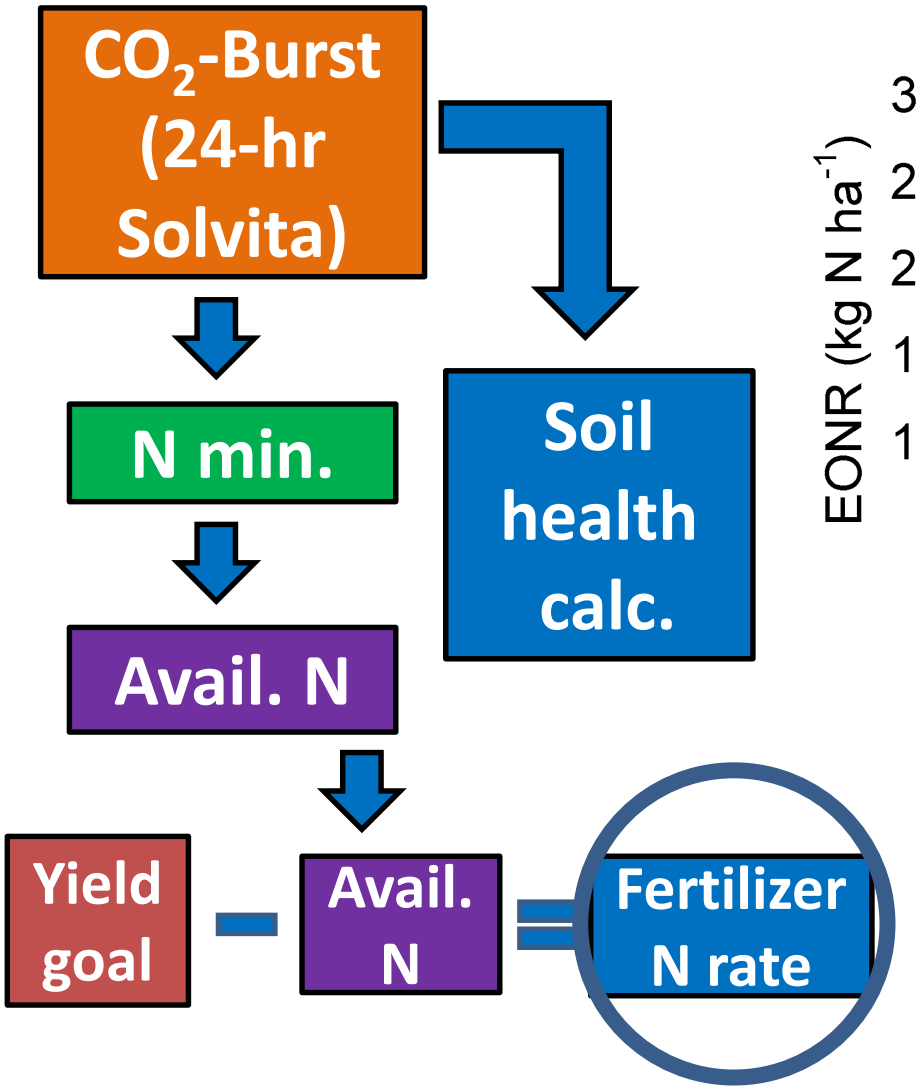
Components/recommendations of Haney soil health test

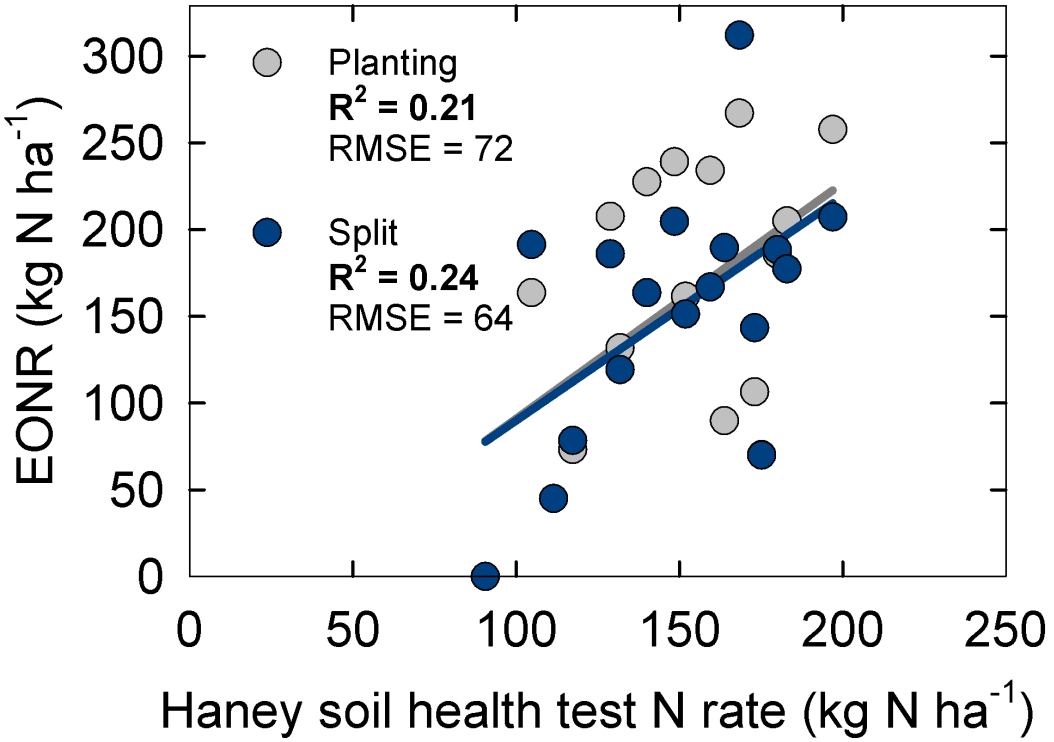


17 sites in 2016

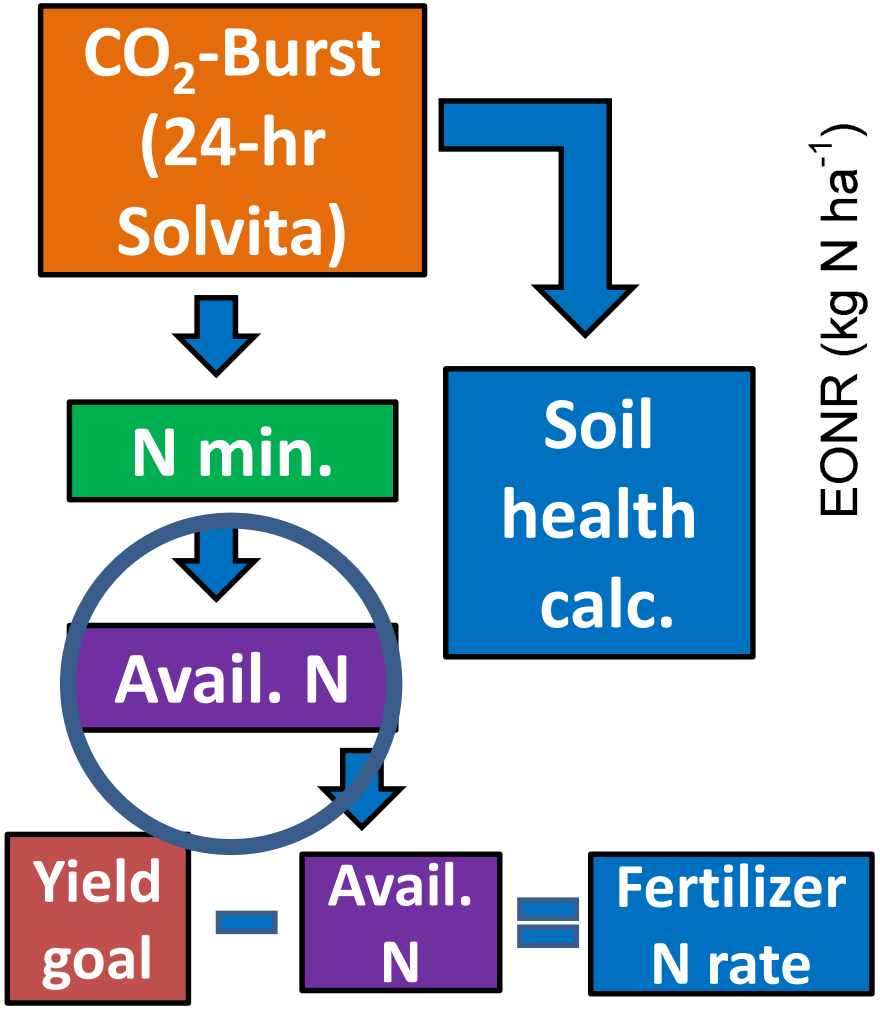
8 Midwest states

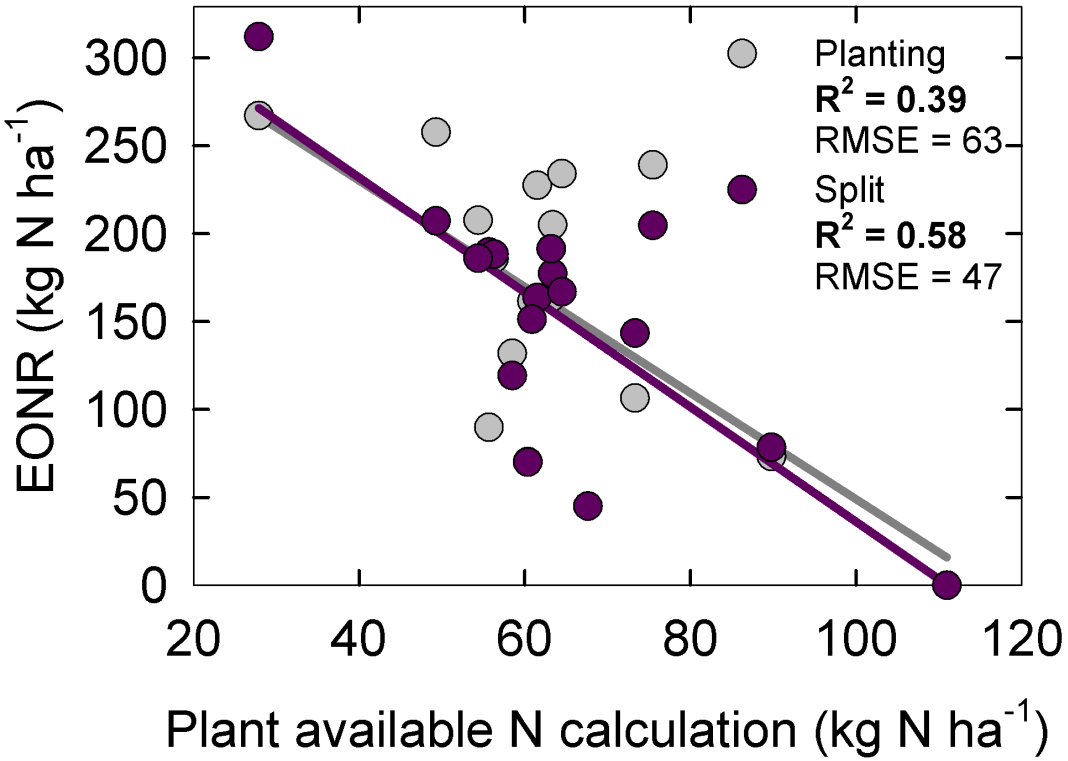
Haney N recommendation did not relate well to EONR



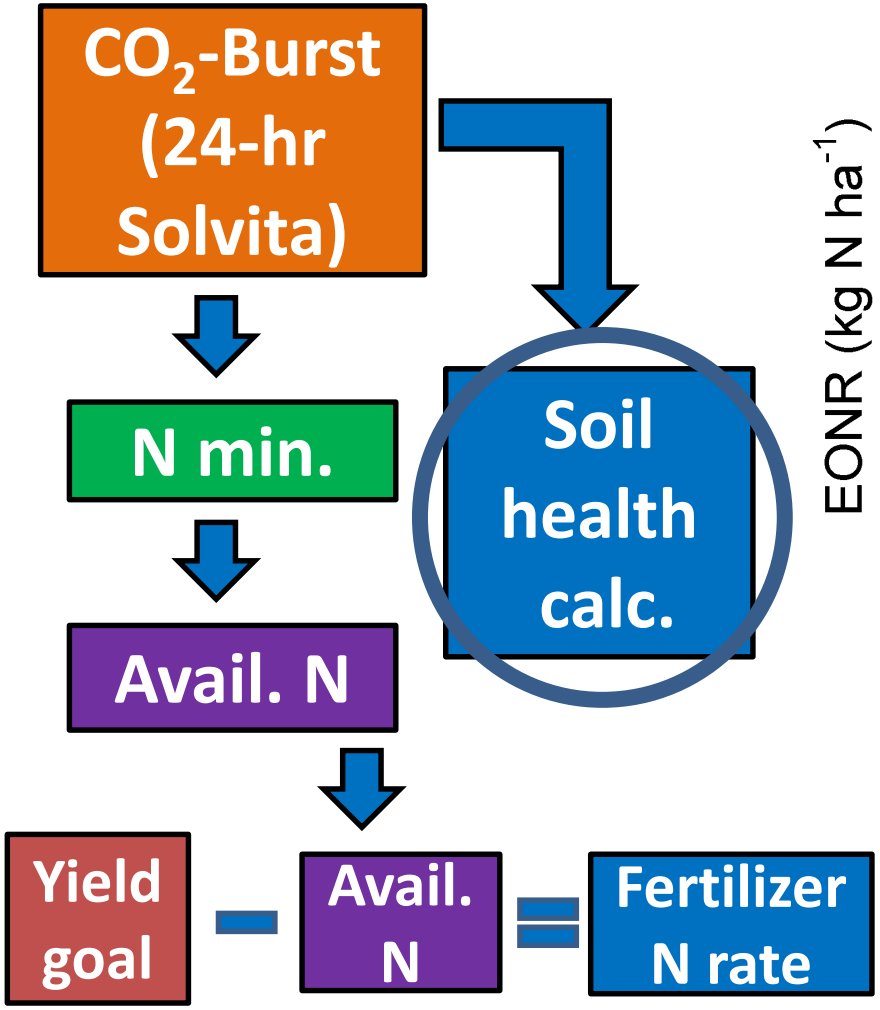


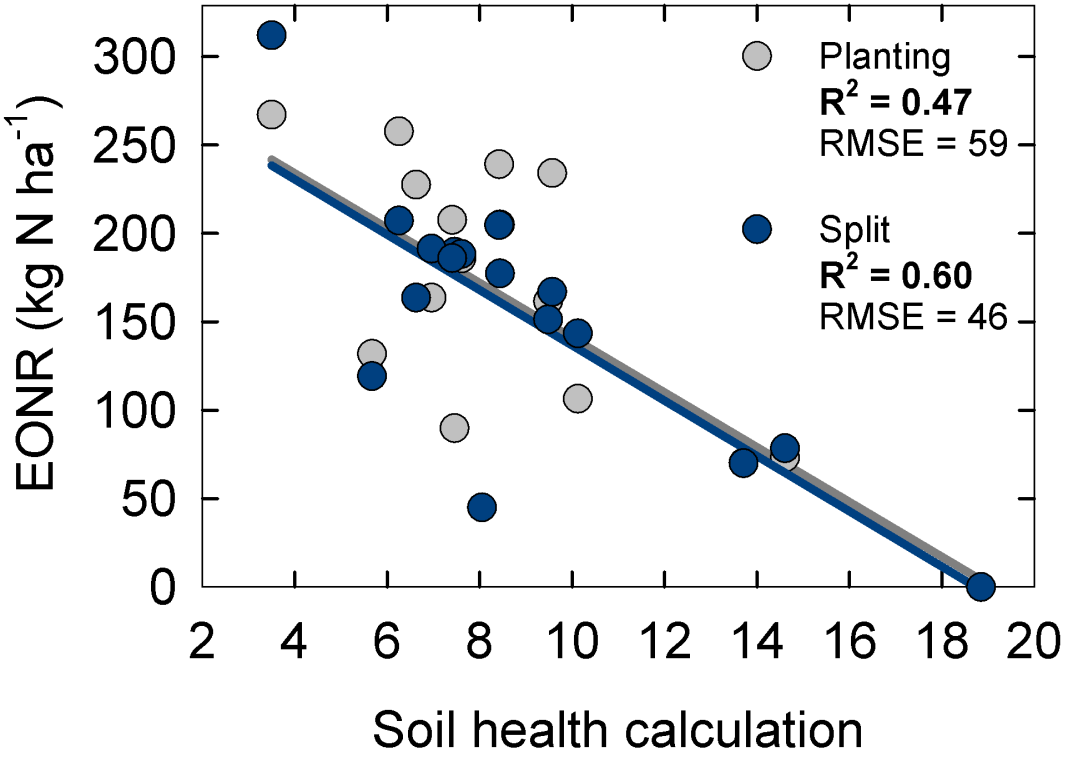
Available N explained more variation in EONR



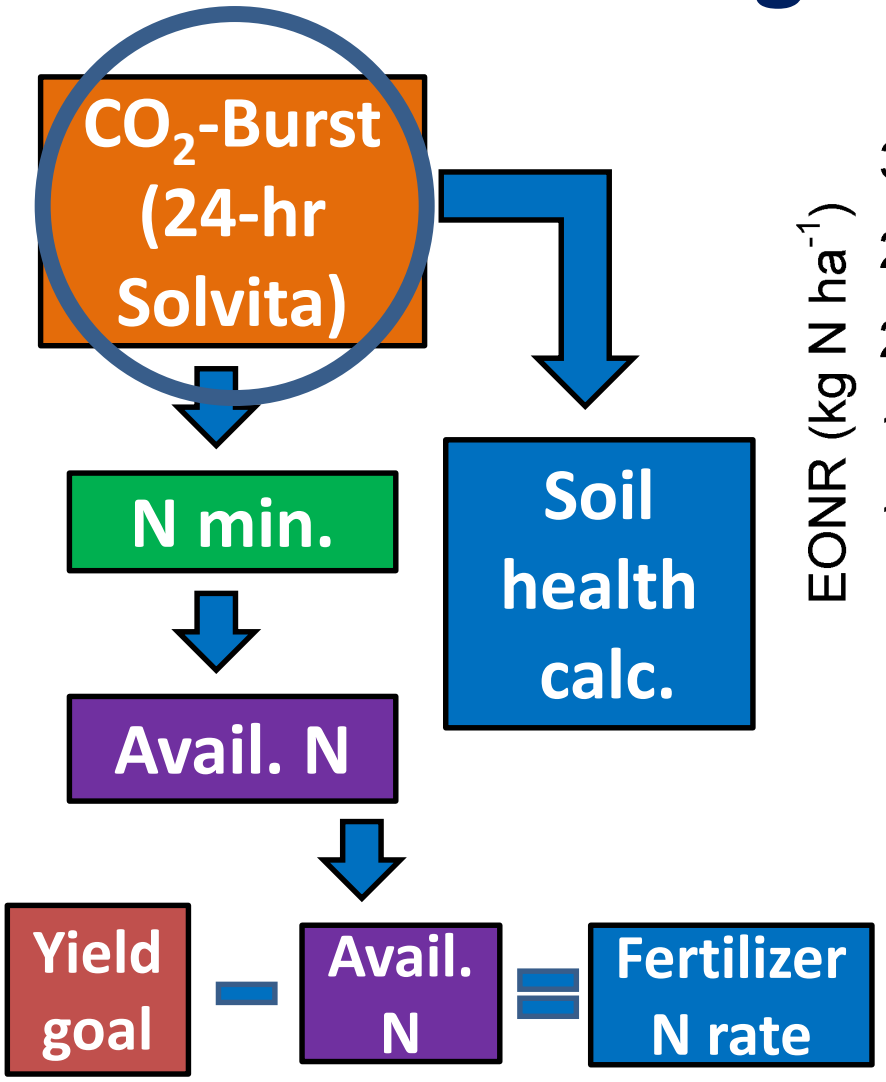


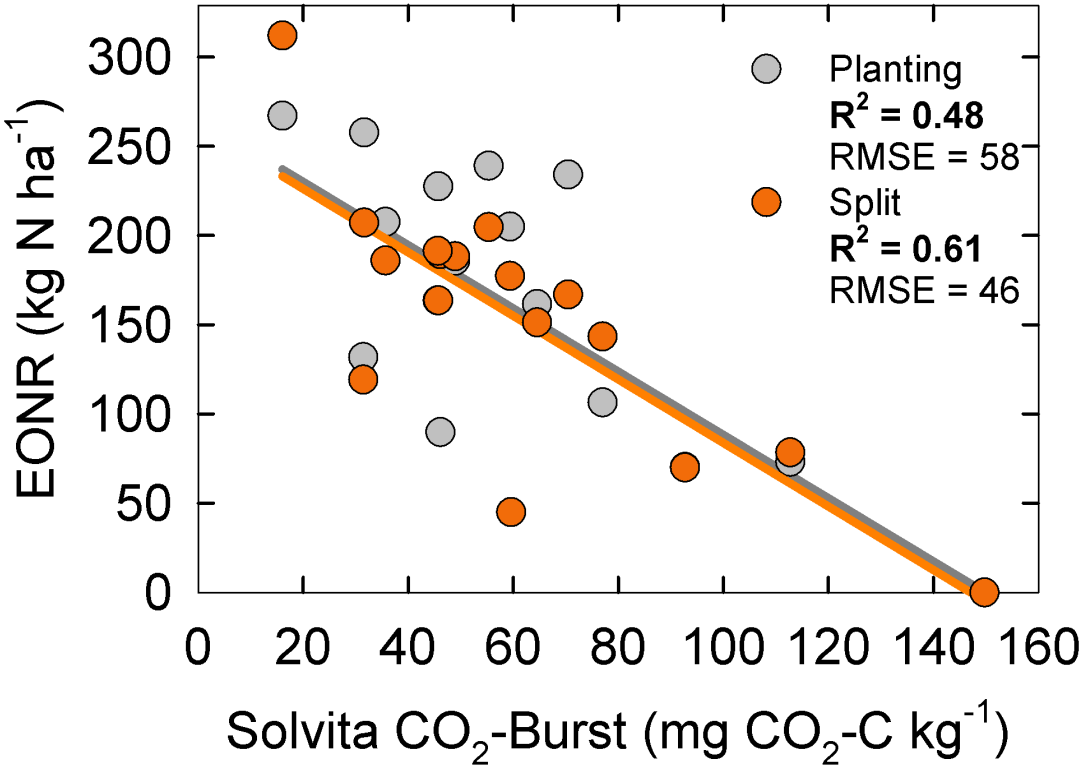
The soil health calculation explained even more





The CO_2-Burst explained slightly more

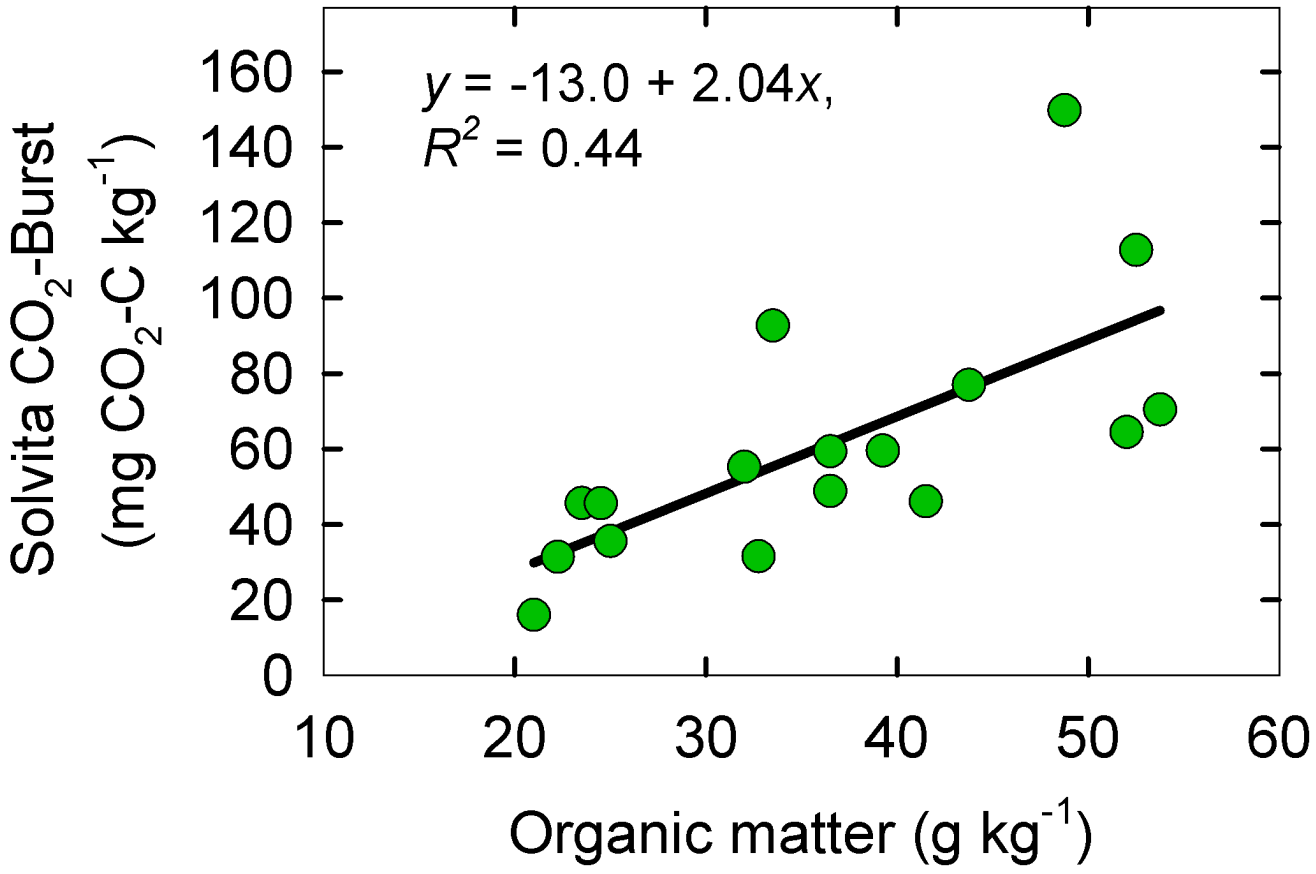




The CO_2-Burst related to OM

CO_2-Burst (24-hr Solvita)

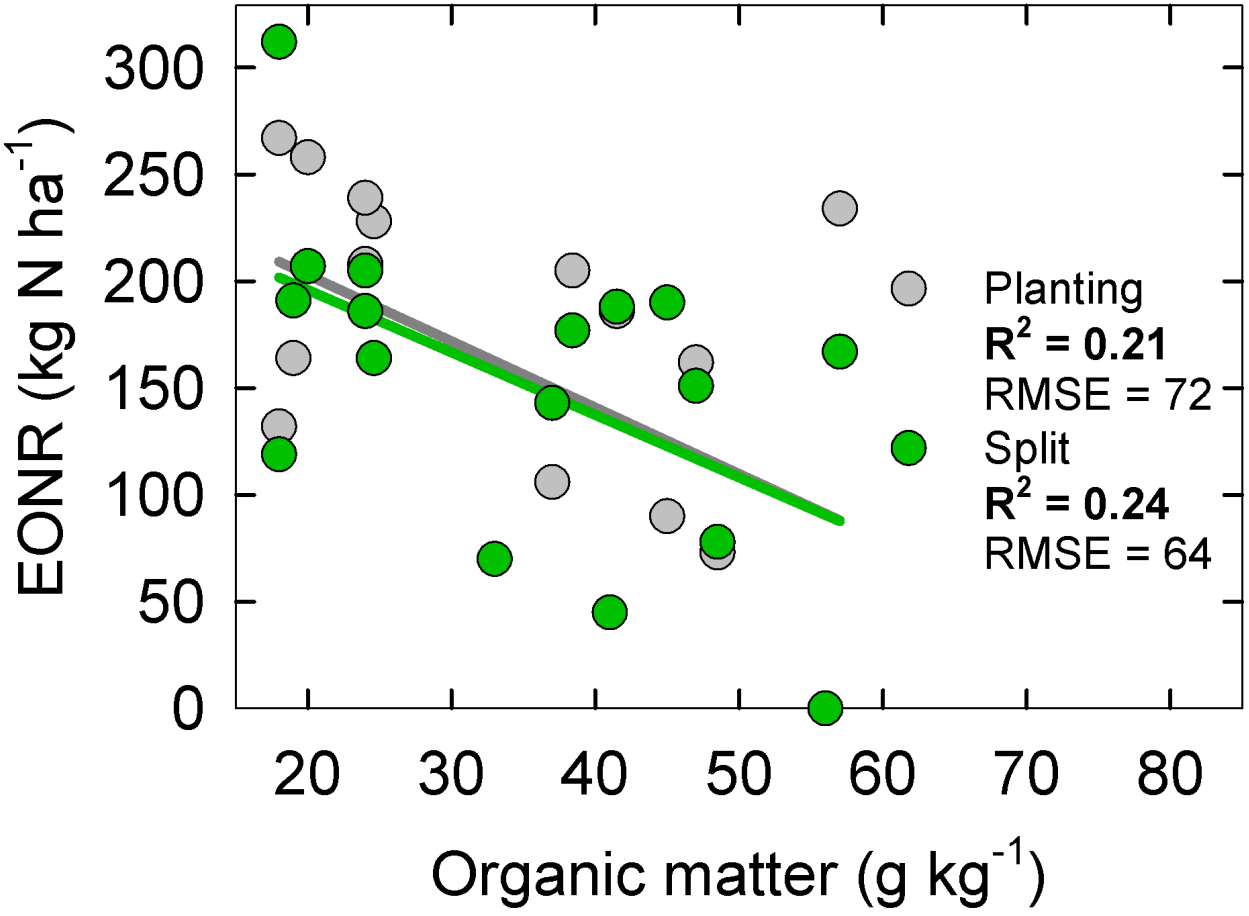
Soil organic matter



But OM not as related to EONR

CO_2-Burst (24-hr Solvita)

Soil organic matter



Take home messages

- It may take 10-20 years to see changes in yield, profit, and soil health. *Be patient, it's a long-term investment.*
- Soil health and yield/profit likely change on different time scales.
- Start small, but try something (indicators for $10-20 then tests for $50-150/sample) on your farm and don't give up.

Take home messages

- The Sol-vita/CO_2 respiration may help predict N requirements for corn, but more testing is needed.
- Greater understanding and incorporation of soil health needed in nutrient management.

Thank you

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