Do Soil Health Tests Match Farmer Experience?

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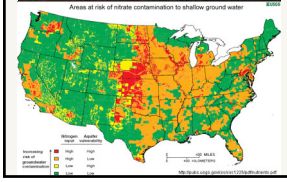
Current paradigm of soil management and testing in Midwest.

New York Times, 2005

Bloomberg, 2014



Earth Observatory, NASA

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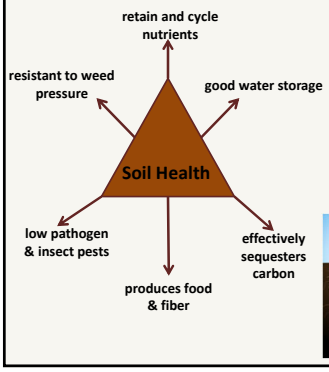
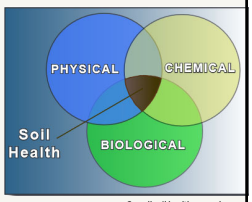
Transitioning toward Soil health paradigm





Cornell soil health manual

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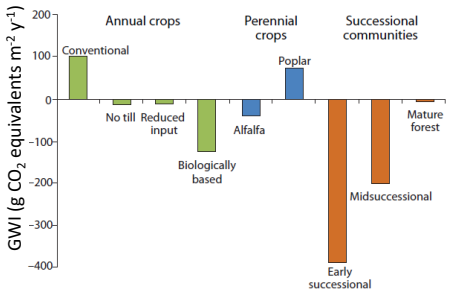
Soil performance across land management gradients experiments (Kellogg Biological Station)



Robertson et al. 2014

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Do soil health tests align with farmer experience of field performance?

1. Quantify variability in on-farm soil health scores across three agricultural regions

2. Evaluate the degree to which soil health parameters align with farmers' assessments of field performance

We hypothesized that physical and biological soil health indicators will better align with farmers' field assessments than will chemical assessments due to a better ability to differentiate among fields that lack measurable nutrient deficiencies

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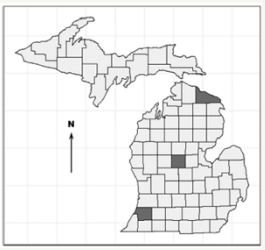
13 farms in 3 Regions: North, Central, South



Soils in the North region experience frigid temperature regimes and greater alkalinity

Central region soils are poorly drained and semiactive in cation exchange.

Soils in the South region are well-drained outwash plains with slight acidity.

O'Neill et al. 2021

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- Each grower selected 4 fields: Best, Worst, non-row crop (NRC), and 'Choice'.
- Follow up interview on detailed to discuss results and management history.

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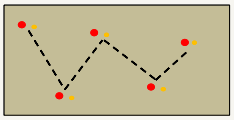
Sampling and field characterization



Isabella County, Michigan (MI073)

Map Unit Symbol	Map Unit Name	Acres in AOI
19	Gilford fine sandy loam	1.3
39A	Londo loam, 0 to 3 percent slopes	15.1
40	Parkhill loam	17.8
50B	Guelph loam, 2 to 6 percent slopes	8.0
Totals for Area of Interest		42.3

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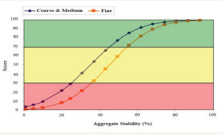
Soil Health metrics tested



Following Cambardella et al. 2004

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How farms chose fields

	Region	North				Central				South				Total
	Farm #	1	2	3	4	5	6	7	8	9	10	11	12	13	
Best Field	High Yield	■	■			■	■	■	■			■	■		10
	How soil 'works'		■			■		■		■		■	■		5
	Takes care of field			■	■		■	■		■					5
	Reliability	■							■	■				■	4
	Drainage/ water					■						■	■	■	4
	Disease pressure		■	■	■									■	4
	Uses as test field							■						■	2
Worst Field	Poor yield		■			■	■	■	■			■	■		9
	How soil 'works'	■	■			■	■	■	■			■	■		9
	Drainage / water	■	■						■	■					4
	Reliability						■	■	■						5
	Compaction		■	■	■					■					4
	Poor Mngt. History			■								■	■		4
	Soil chemistry 'off'										■	■		■	2

O'Neill et al. *SSSAJ* 2021

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Soil management on farms

	Region	North				Central				South			
	Farm #	1	2	3	4	5	6	7	8	9	10	11	12	13
Tillage	No till			■			■	■	■			■	■	
	Chisel	■	■		■						■		■	■
	No till and chisel	■	■	■		■	■	■						
Crop	C-S-W	■				■	■	■	■				■	
	C-S						■	■			■	■		■
	Other (W, S, + hay)		■	■	■						■	■	■	■
	Cover crop use		■	■	■			■	■	■	■	■	■	■
Manure use	Currently	■		■			■	■	■		■			
	In past					■				■				
NRC field	Hay	■	■	■	■	■	■				■	■	■	
	Field margin					■			■					■
	Buffer strip									■				
	CRP/woodlot							■						■

■ Best
■ Worst

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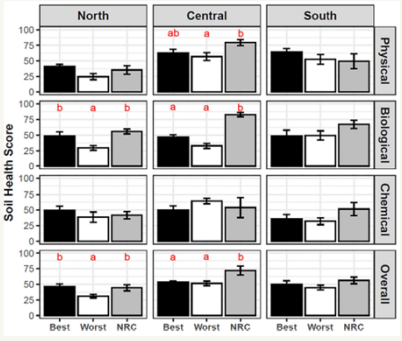
Overall soil health by region



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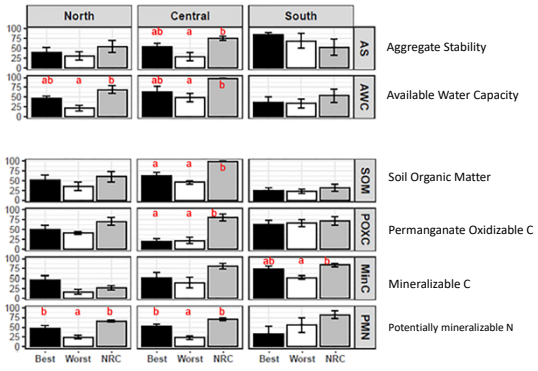
Key Metrics: Physical and Biological



Aggregate Stability

Available Water Capacity

Soil Organic Matter

Permanganate Oxidizable C

Mineralizable C

Potentially mineralizable N

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Pairwise comparisons by field type across farms

Parameter[a]	Field comparison Best vs. Worst	Best vs. NRC	Worst vs. NRC
AS	17.7*	1.5	−17.1
AWC	34.3**	−23.5*	−39.5**
SR	8.8	18.3*	8.8
SSR	3.3	16.4	7.3
SOM	11.8**	−15.1*	−27.9**
POXC	0.6	−30.2*	−34.0**
MinC	20.4*	−3.8	−25.5**
PMN	11.0	−30.2*	−38.5**
pH	4.0	3.9	3.9
P	−10.2	−5.2	6.6
K	−2.9	−12.5	−8.1
CEC	4.4	−8.5	−15.2*
Physical	10.9**	3.2	−10.7
Biological	11.0*	−19.8***	−31.5***
Chemical	−1.2	−5.6	−3.2
Overall health	6.9*	−7.4	−14.9***

[a]AS, aggregate stability; AWC, available water capacity; SR, surface resistance; SSR, subsurface resistance; SOM, soil organic matter; POXC, permanganate oxidizable carbon; MinC, mineralizable carbon; PMN, potentially mineralizable nitrogen CEC; cation exchange capacity.
*Significant at the .05 probability level.
**Significant at the .01 probability level.
***Significant at the .001 probability level.

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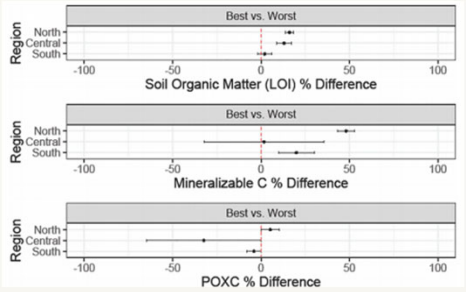
Three types of carbon measures



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Results summary

- Overall SH score was higher for 'Best' fields
- These results were not driven by traditional soil testing (i.e. NPK)
- Testing 'paired' fields proved a much more effective approach to elucidating SH metrics.

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Take home

- Farmer knowledge can boost how we test soil in fields and understand results.
- For soil carbon, the capacity for soil to 'flux' carbon – measured as CO_2 was highest on 'Best' fields
- The most 'accurate' measures differed by region – but differed based on farmer input.
- Many type of knowledge needed to make soil health testing work – farmer knowledge, fine-scale carbon accumulation in soil, and scaling to landscapes.

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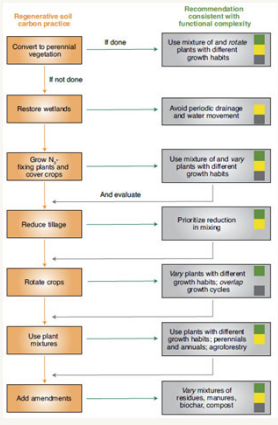

Importance of linking on-farm testing when evaluating practices to build soil health on-farm testing

(Lehmann et al. 2020)

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Thanks to

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A special thanks to the farmers,
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G.P. Robertson, Kim Chung, John Kerr,
Alessandra Zuniga, Andrew Galimberti

KBS LTER Kellogg Biological Station Long-term Ecological Research

SARE Sustainable Agriculture Research & Education

CRFS MSU CENTER *for* REGIONAL FOOD SYSTEMS

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Questions…

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