A Comprehensive Approach to Soil Health: Merging Science, Economics and Connectivity

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Chief Scientific Officer

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Mission

Safeguard and enhance the vitality and productivity of soil through scientific research and advancement

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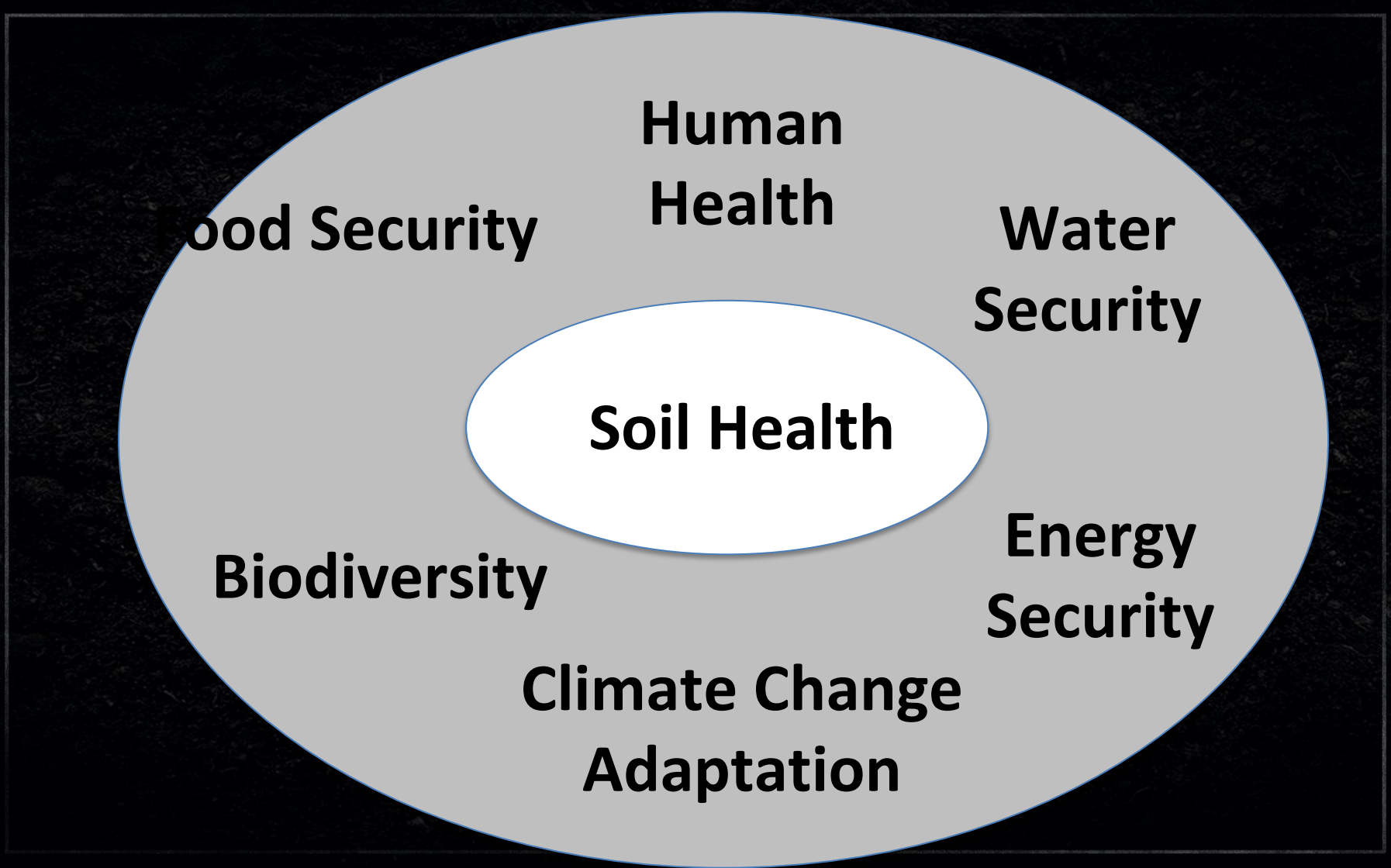
Wayne Honeycutt, CEO
Cristine Morgan, CSO
Sheldon Jones, COO
Byron Rath , Sustainability Specialist

Team of 14 Scientists

Soil Scientists - 5
Biogeochemists – 2
Spatial Scientist - 1
Agronomists - 2
Ag. Economist – 1
Interns - 3







ood Security
Human Health
Water Security
Soil Health
Biodiversity
Energy Security
Climate Change Adaptation


SOIL HEALTH:
The capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans.

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Soil Ecosystem Services

1. Biomass Production – Yield
2. Carbon Cycling – SOC, Short-term Min. C, Permanganate Ox. C, Enzymes, Protein Index, Ester-Linked Fatty Acid Methyl Ester
3. Nutrient Cycling – TN, N Mineralization, P, K, Micronutrients, biological measures above
4. Water Cycling – Saturated Hydraulic Conductivity, Plant-Available Water, Bulk Density

South Dakota

Healthy Soil Cycles Nutrients

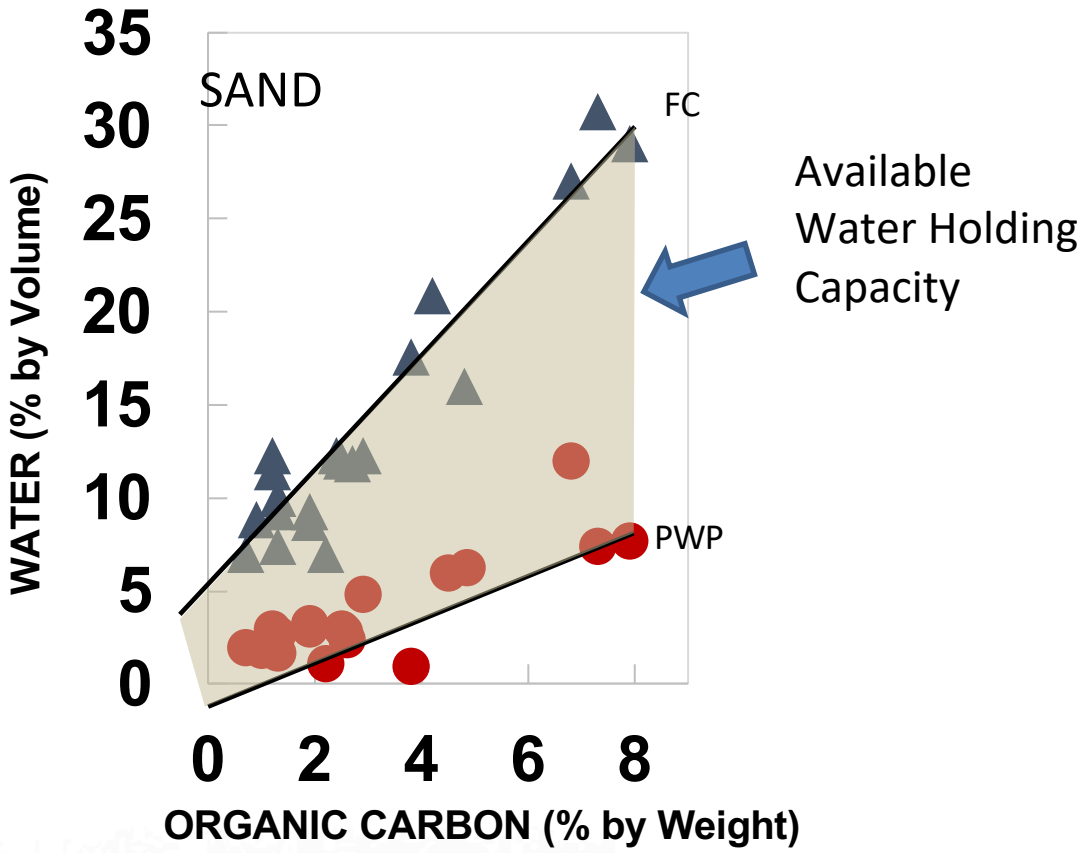
Healthy Soil Cycles Water

Infiltration – Brookings County, SD

Healthy Soil Stays in Place


Healthy Soil Keeps Water Clean

Drought Resilience



Adapted from Hudson (1994)

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Pop Quiz

Define and list Soil Ecosystem Services

SHI's Comprehensive Strategy to Improve Soil Health

Premise…

THE MOST CRITICAL INGREDIENT:

Comprehensive Strategy to Increase Adoption of Soil Health Management Systems

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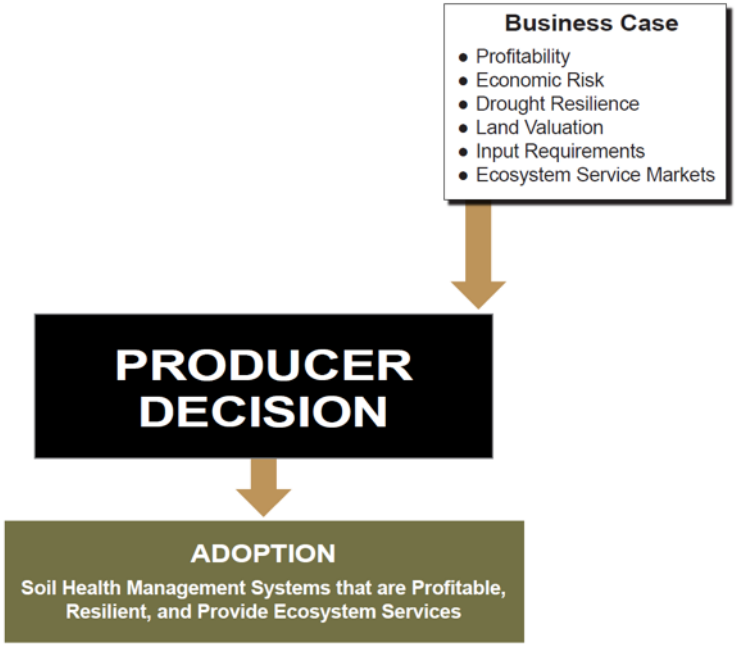
UNIFY ■ RESTORE ■ PROTECT

Comprehensive Strategy to Increase Adoption of Soil Health Management Systems



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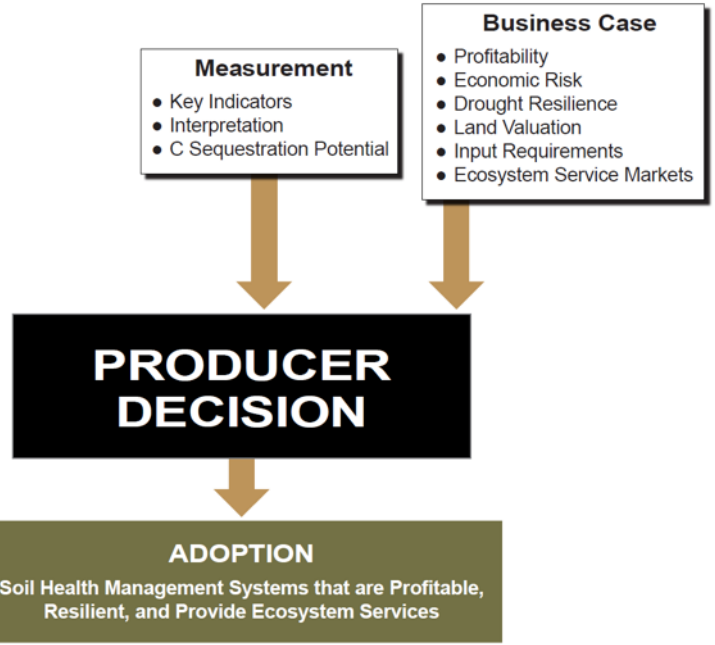

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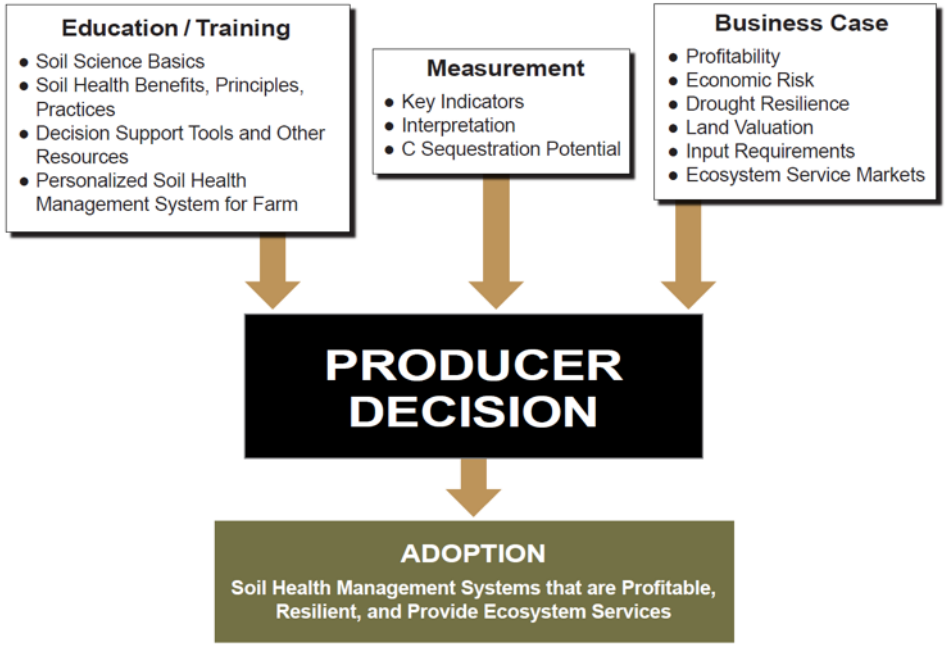
Comprehensive Strategy to Increase Adoption of Soil Health Management Systems



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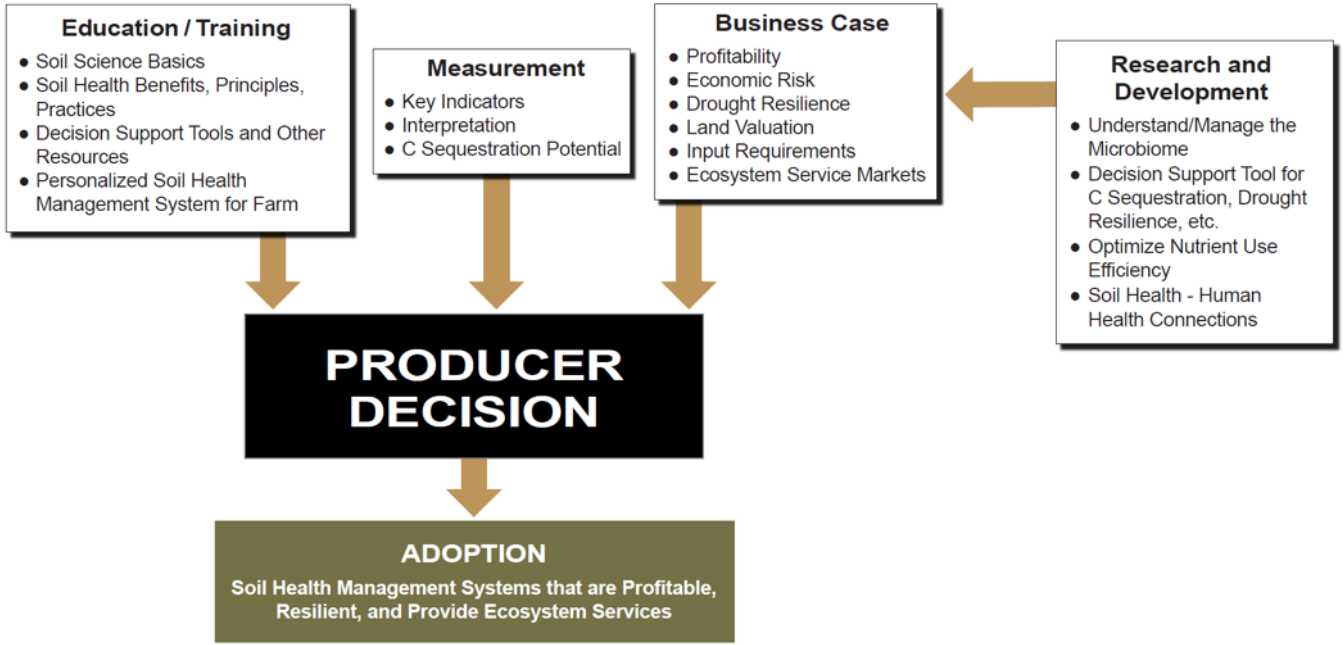

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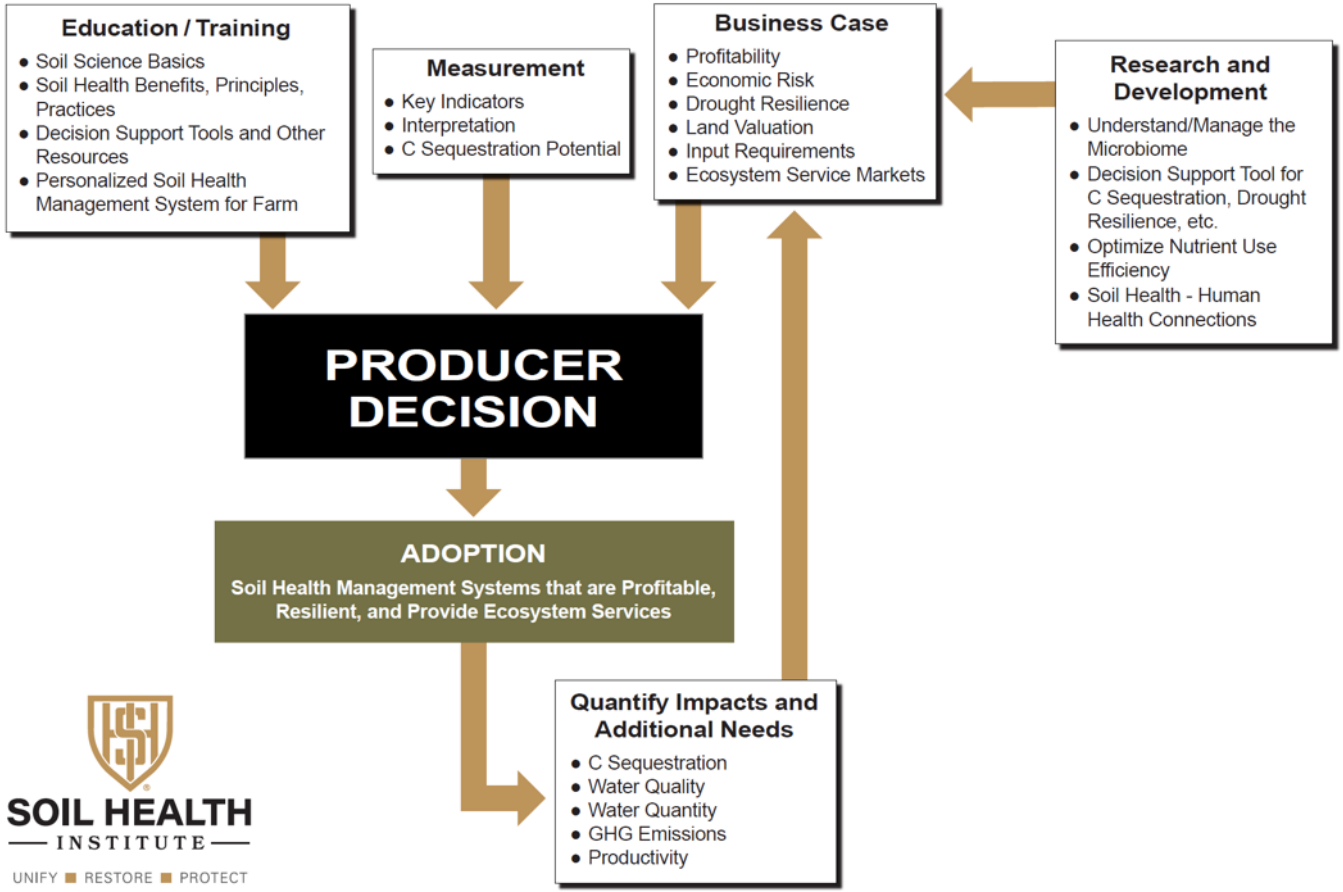
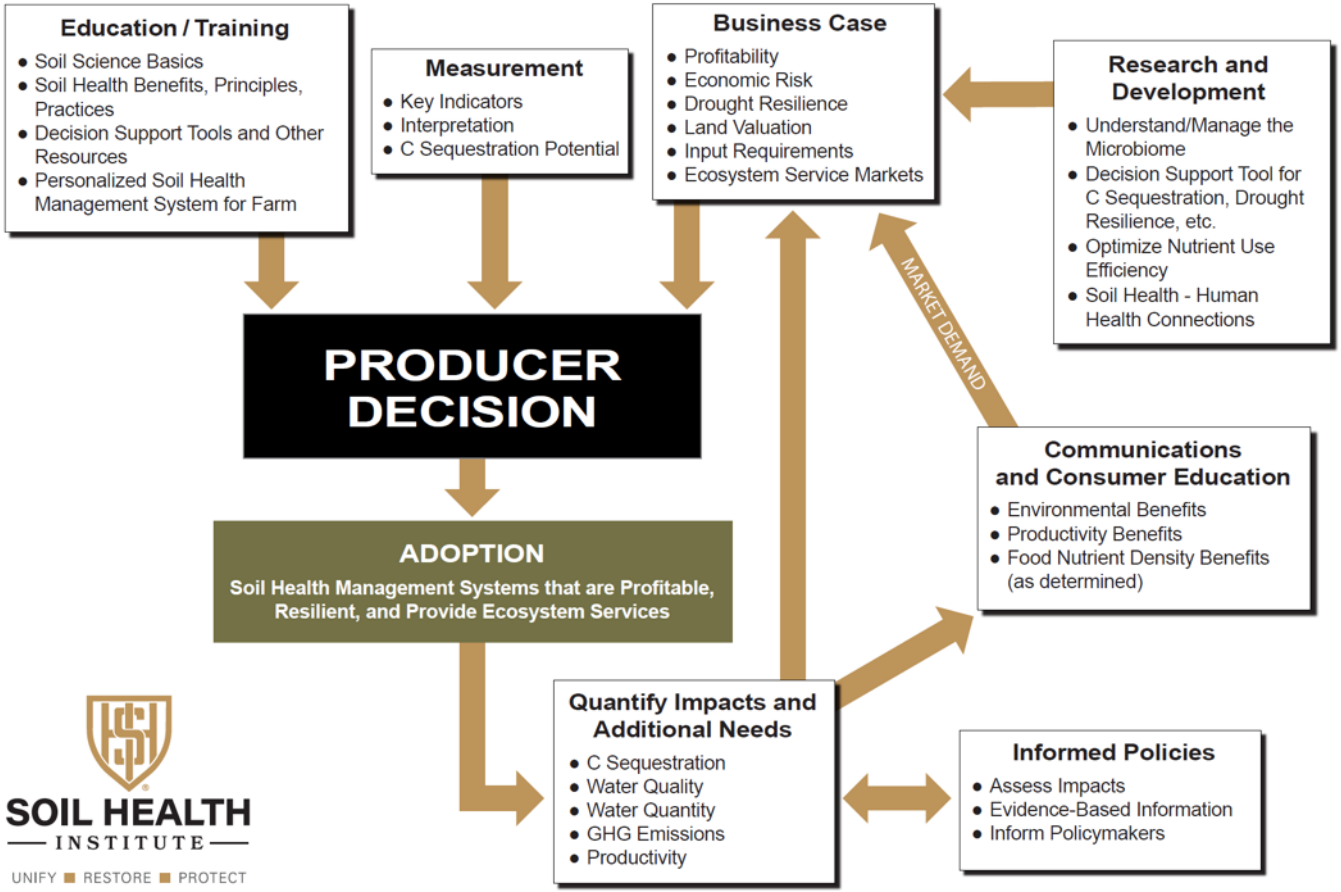


Comprehensive Strategy to Increase Adoption of Soil Health Management Systems



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Fundamentals of Soil Health Management Systems

1. Keep soil armored
2. Minimize disturbance
3. Increase biodiversity
4. Maintain living roots
5. Incorporate grazing into row cropping

Measurements

North American Project to Evaluate Soil Health Measurements

GOAL: Identify most effective indicators of soil health

APPROACH: Evaluate soil health indicators on long-term agricultural research sites

Funders:

General Mills

FFAR

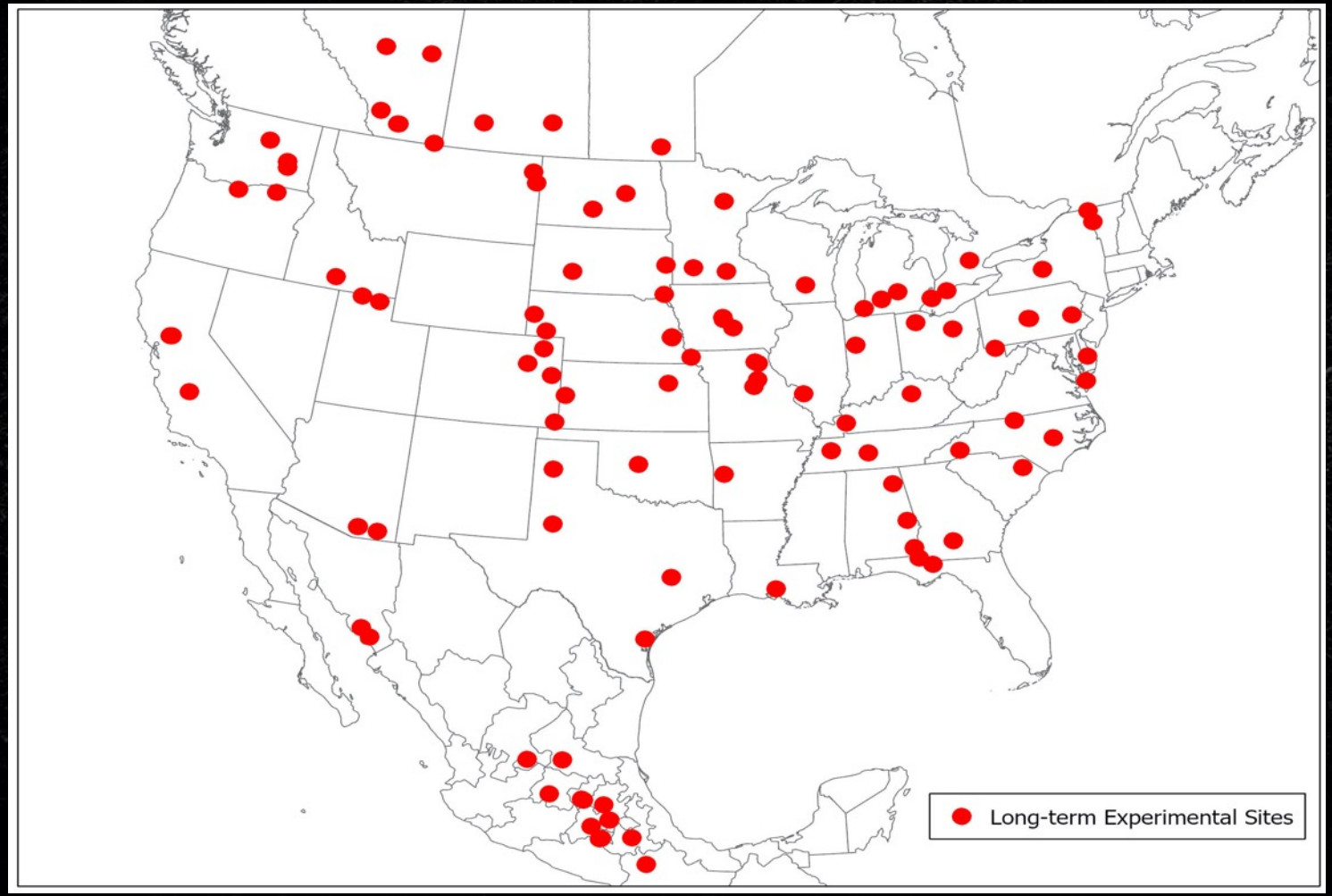
Partners:

SOIL HEALTH PARTNERSHIP

The Nature Conservancy

Many universities, USDA, AAFC, CIMMYT

Long-Term Agricultural Research Sites (120)



Tier 1 Soil Health Indicators

Chemical/Biological Lab

pH
Electrical Conductivity
Cation Exchange Capacity
Percent Base Saturation

Organic Carbon
Short-Term C Mineralization
Total Nitrogen
Nitrogen Mineralization
Extractable P and K
Sec./Micro. (Ca, Mg, S, Fe, Zn, Cu, Mn)

Physical Lab/Field

Particle Size

Bulk Density
Water Stable Aggregation
Available Water Holding Capacity
Hydraulic Conductivity Surface
Crop Yield

Tier 2 & 3 Soil Health Indicators Identified

Sodium Adsorption Ratio

Enzymes: B-Glucosidase, B-Glucosaminidase, Phosphatase, Arylsulfatase

Soil Protein Index – Autoclave Citrate Extractable

Active Carbon – Permanganate Oxidizable C

Phospholipid Fatty Acid (PLFA)

Ester-Linked Fatty Acid Methyl Ester (EL-FAME)

Genomics

Reflectance

Soil Health Index Programs to be Evaluated

SMAF – Soil Management Assessment Framework

CASH – Cornell's Comprehensive Assessment of Soil Health

Haney Test

Soils sampled in 2019; Management/Yield data collection in process
Analyses and report writing in 2019-2020

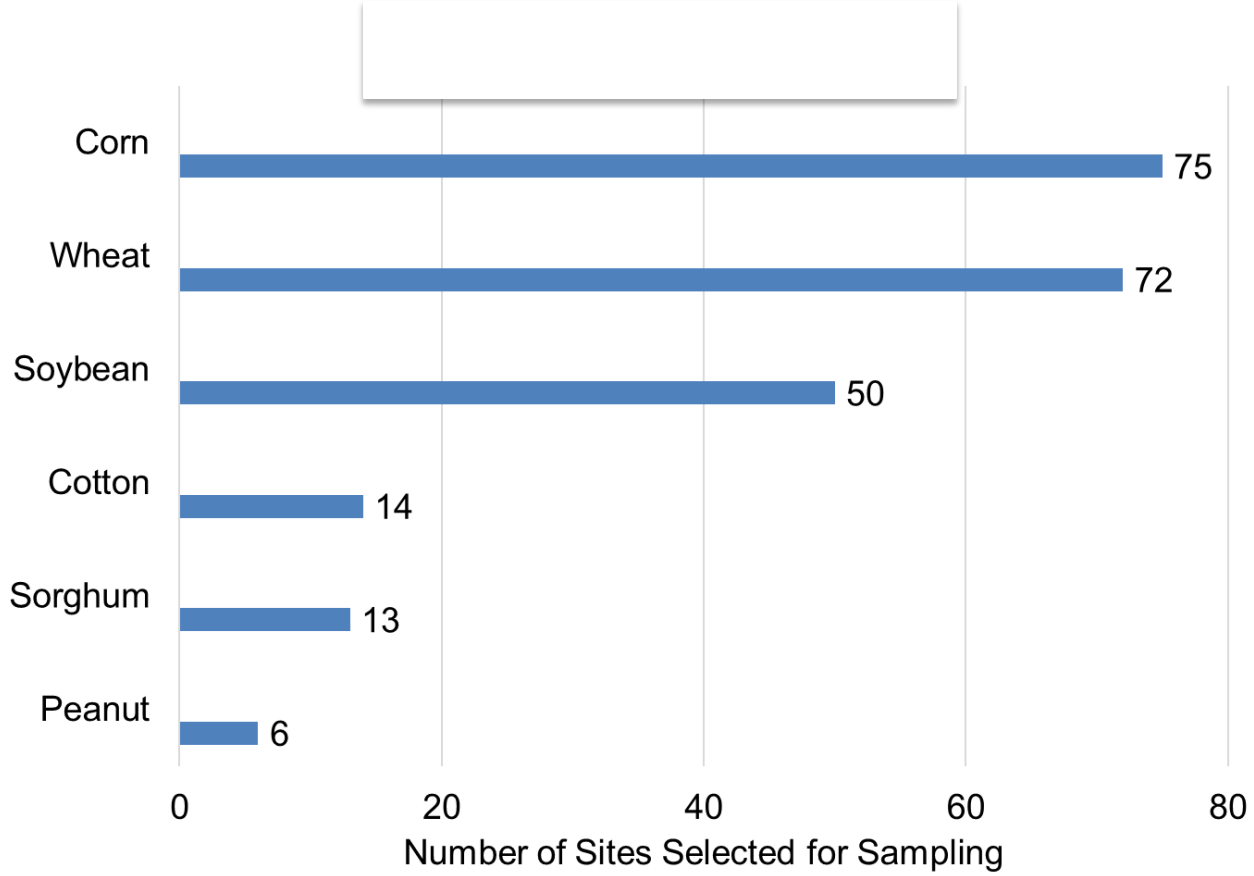
Sampling in April-July 2019:
2057 plots 100 % complete

Lab analyses 95 % Complete

QA/QC – 20% complete

Management profiles – 60% complete

Agronomic Crops



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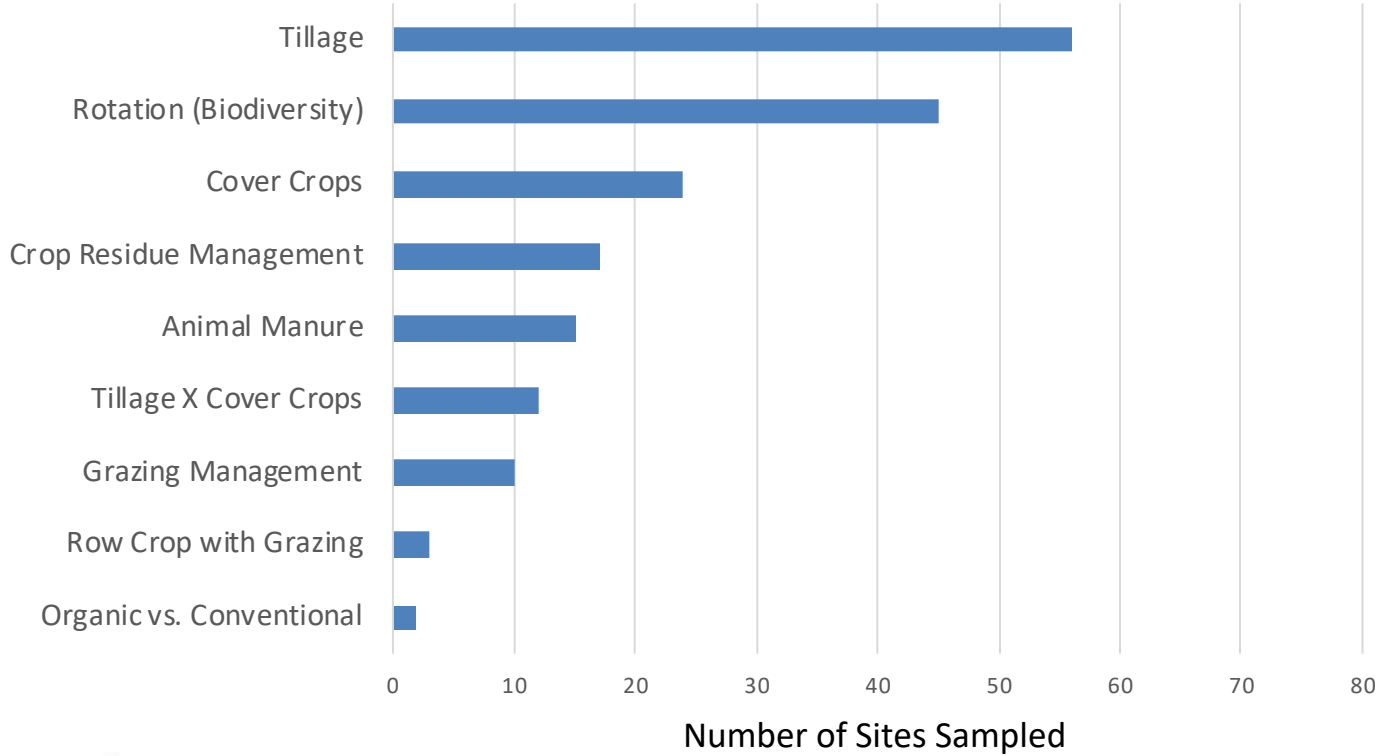
Soil Health Managemnt Practices



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Pop Quiz

What are the fundamental soil health practices?

Soil Structure

key physical indicator of soil hydrologic, biological

a measure of the effects of soil management practices

Healthy Soil Cycles Water

Infiltration – Brookings County, SD

aggregate stability: a soil health indicator

- aggregate stability tells us on how management effects soil condition:
  - influences infiltration, aeration, and resistivity to erosion
  - influenced by manageable factors such as OM and biological activity
- multiple ways to measure
  - wet sieving
  - Cornell wet aggregate stability
  - aggregate size fractions
  - Smart phone (SLAKES)

soil aggregates

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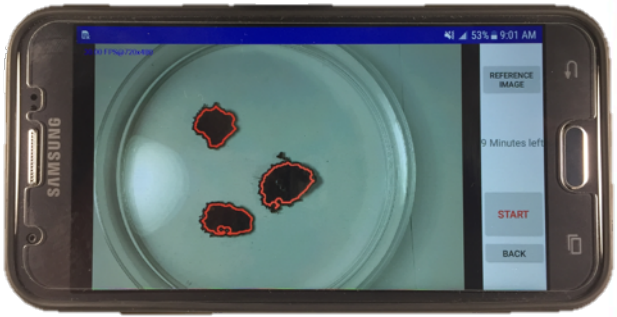
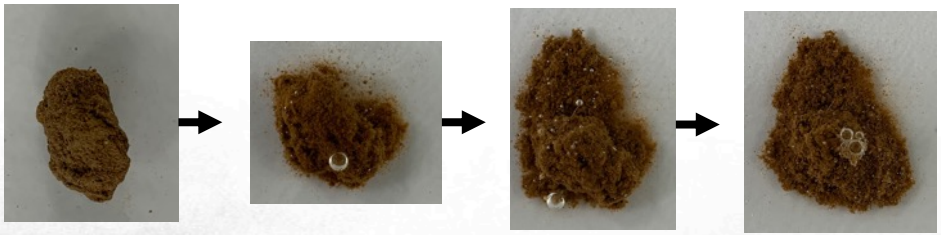
SLAKES: an app for aggregate stability

- developed at the University of Sydney, Australia
  - based on methodology in Fajardo et al., 2016
- stability at 10 min
  - *stab-10*= $\frac{initial\ area}{final\ area}$
  - larger stab-10 = more stable
  - smaller stab-10 = less stable





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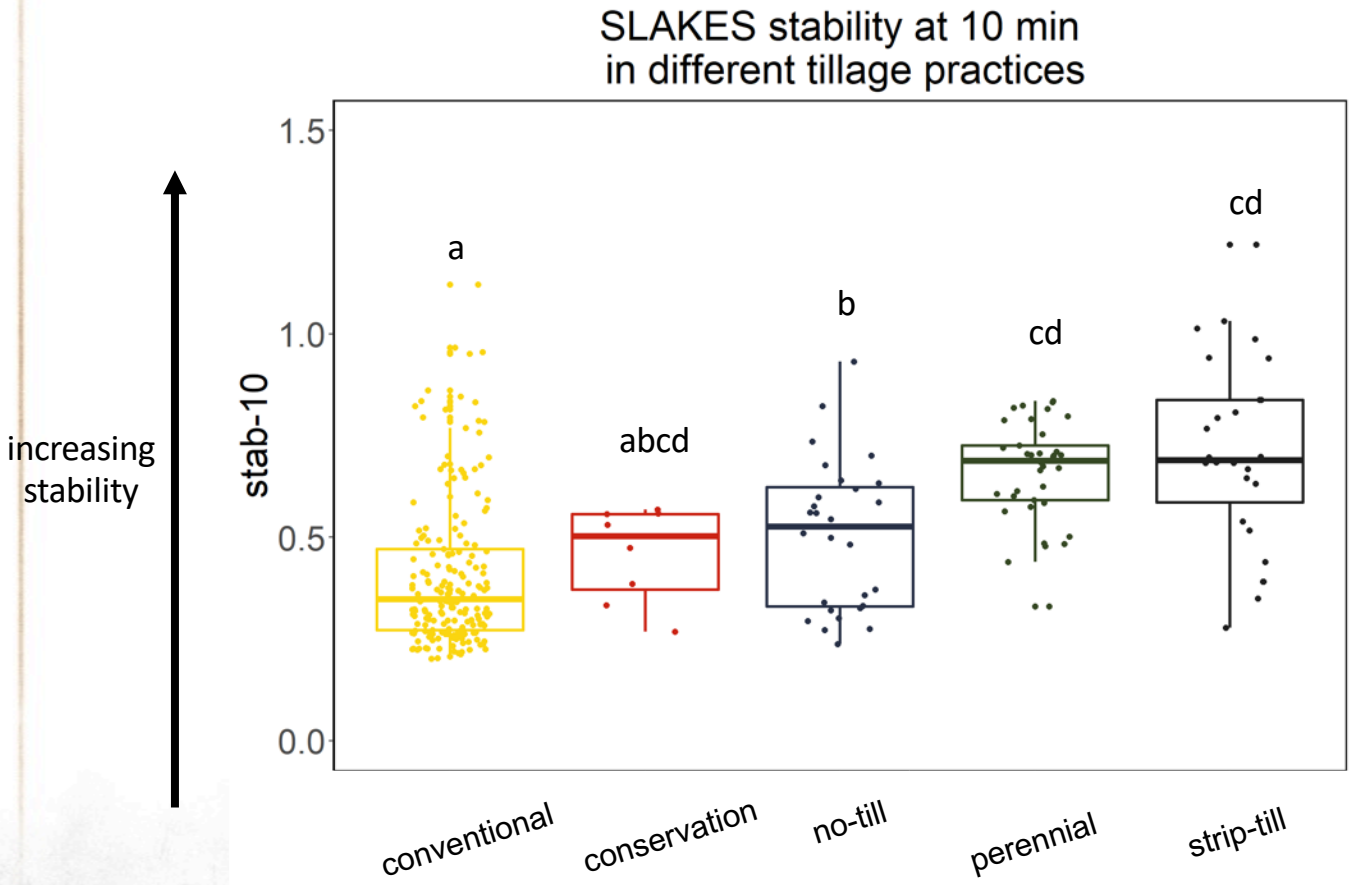

- lowest stability in conventional
- highest stability in perennial grass and strip-till
- tillage, cover crop as fixed effect; location as random effect

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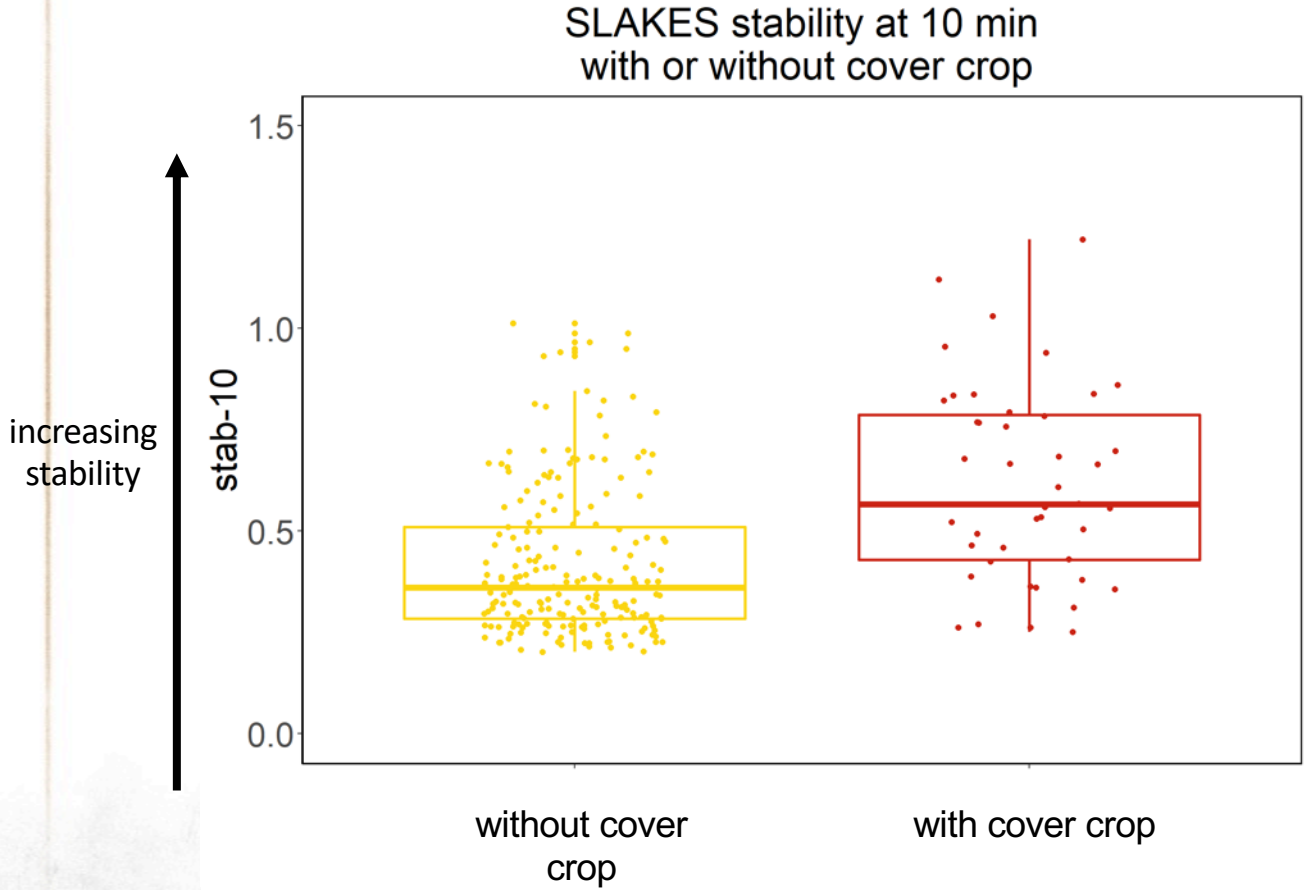

- lower stability in without cover crop
- higher stability with cover crop

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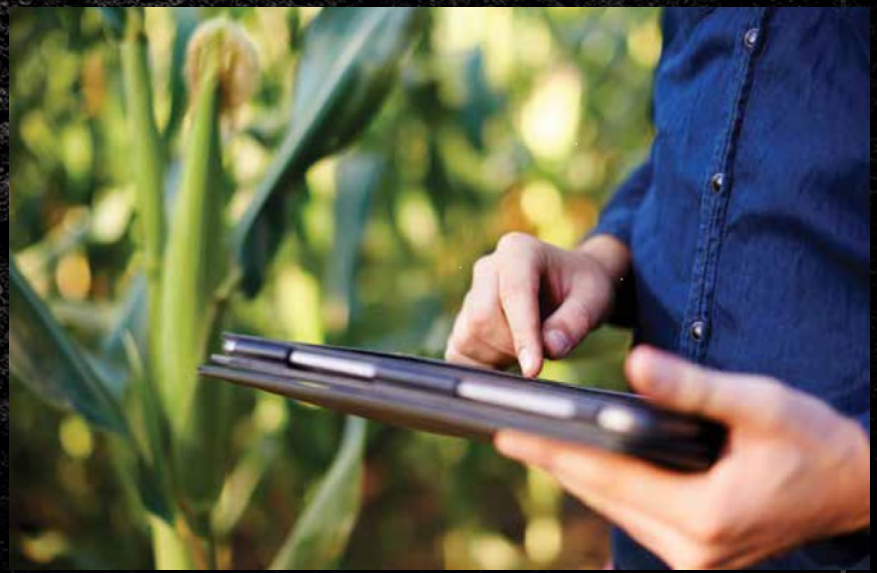
Pop Quiz

1. What are we managing when we manage for soil heath?

Business Case

GOAL: Assess Profitability of Soil Health Systems

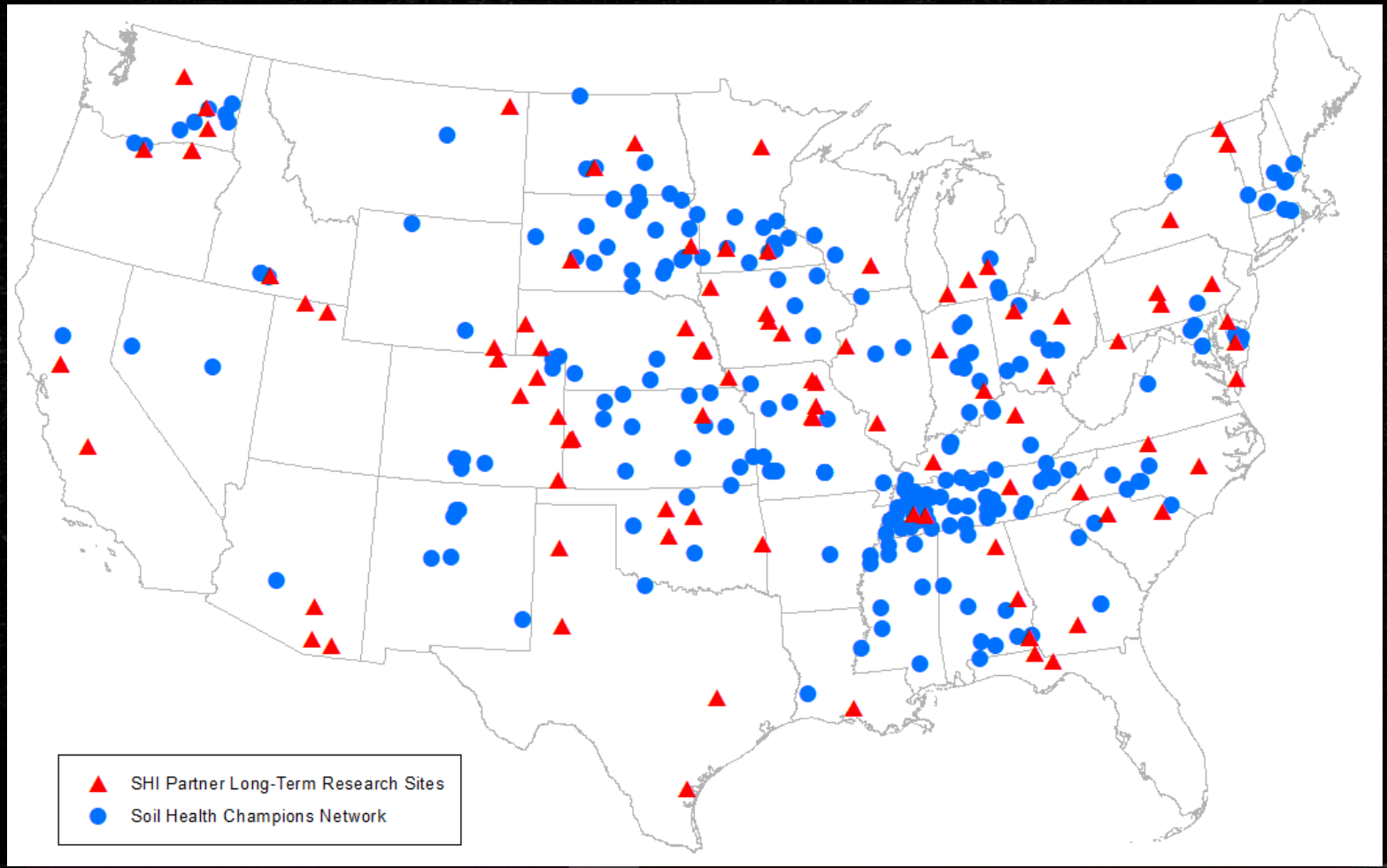
APPROACH: Calculate & Integrate Enterprise Budgets from On-Farm and Experimental Settings



Funders: USDA Natural Resources Conservation Service; Cargill

Partners: Cargill; USDA Natural Resources Conservation Service

Long-term Research Sites and NACD On-farm Sites



	Corn			Soybean		
	Production Practice			Production Practice		
	Revenue and Expense Increase: No-Till, Cover Crop	Expense Decrease: Conventional	**Net Income Change due to Soil Health Management System**	Revenue and Expense Increase: No-Till, Cover Crop	Expense Decrease: Conventional	**Net Income Change due to Soil Health Management System**
	per Acre			*per Acre*		
Revenue						
Yield (bu.)	20.0		20.0	5.0		5.0
Price ($/bu.)	4.40		0.00	10.50		0.00
Other Revenue[1]	0.00		0.00	0.00		0.00
Total Revenue	**88.00**		**88.00**	**52.50**		**52.50**
Expense						
Seed	45.00	0.00	45.00	28.00	0.00	28.00
Fertilizer & Nutrients	0.00	29.25	-29.25	0.00	0.00	0.00
Chemicals	17.23	2.75	14.48	17.99	15.80	2.18
Diesel Fuel	3.28	5.90	-2.62	3.28	4.11	-0.83
Input Costs	**65.51**	**37.90**	**27.61**	**49.27**	**19.92**	**29.35**
Repairs & Maintenance	3.28	4.01	-0.73	3.28	3.33	-0.06
Labor, Field Activities and Repairs	4.35	6.72	-2.37	4.35	4.94	-0.60
Production Expenses	**73.13**	**48.63**	**24.51**	**56.89**	**28.19**	**28.70**
Interest	1.76	1.17	0.59	1.37	0.68	0.69
Post-harvest Expenses	9.00	0.00	9.00	1.61	0.00	1.61
Custom Harvest	0.00	0.00	0.00	0.00	0.00	0.00
Total Operating Expenses	**83.89**	**49.79**	**34.10**	**59.87**	**28.87**	**31.00**
Returns to Operating Expenses	**4.11**	**49.79**	**53.90**	**-7.37**	**28.87**	**21.50**
Capital Recovery & Fixed Costs	19.30	26.35	-7.04	19.30	21.06	-1.76
Total Specified Expenses	**103.19**	**76.14**	**27.05**	**79.17**	**49.93**	**29.24**
Returns to Specified Expenses	**-15.19**	**76.14**	**60.95**	**-26.67**	**49.93**	**23.26**

[1]

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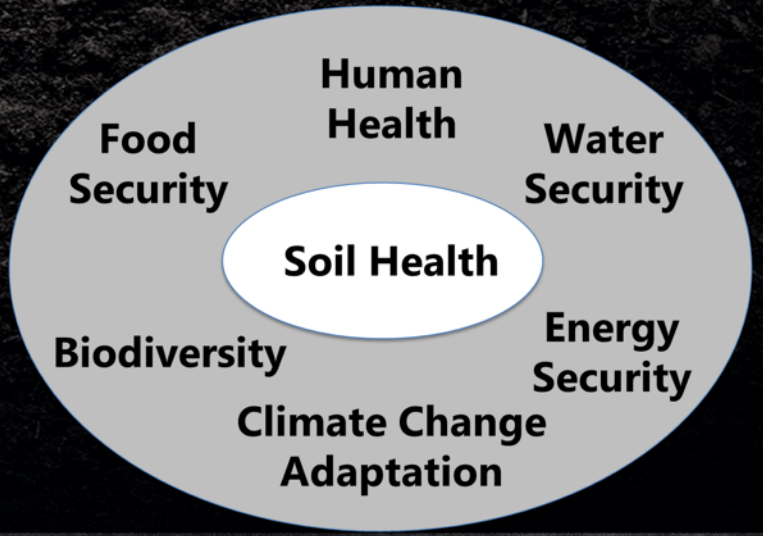
How can Agriculture address our grand existential challenges?



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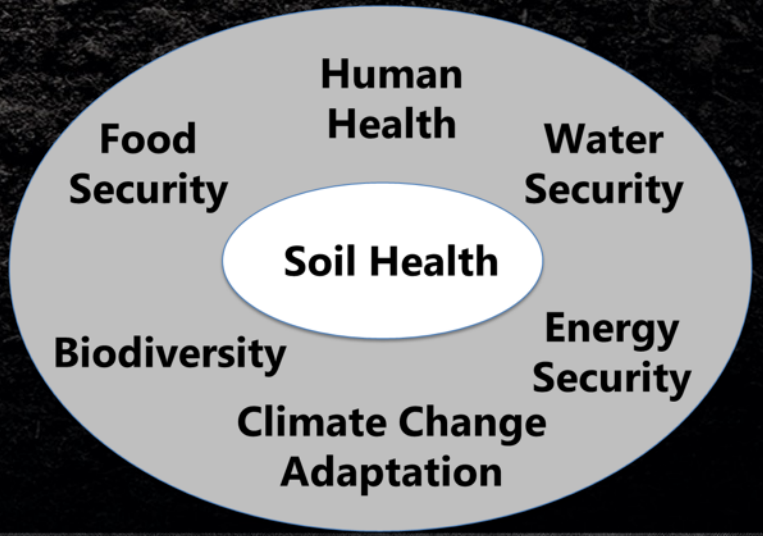
Pop Quiz

How can Agriculture address our grand existential challenges?

- Nutrient management
- Cover crops
- Reduced till
- Grazing



Soil Health Documentary “Living Soil”

https://vimeo.com/294093065/65b2bb191a

Thank You!

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