

ENRICHING SOIL, ENHANCING LIFE

Soil Health and Plant Health



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Chief Scientific Officer



SOIL HEALTH
INSTITUTE



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Mission

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

Roles of the Institute

- Identify research & adoption gaps
- Build research/implementation strategies and corresponding networks/synergies
- Obtain funding to strategically address gaps
- Administer accountable, transparent, and technically proficient grants program
- Ensure impact of investments
- Incorporate research results into educational materials
- Enhance partnerships to increase tech transfer and adoption





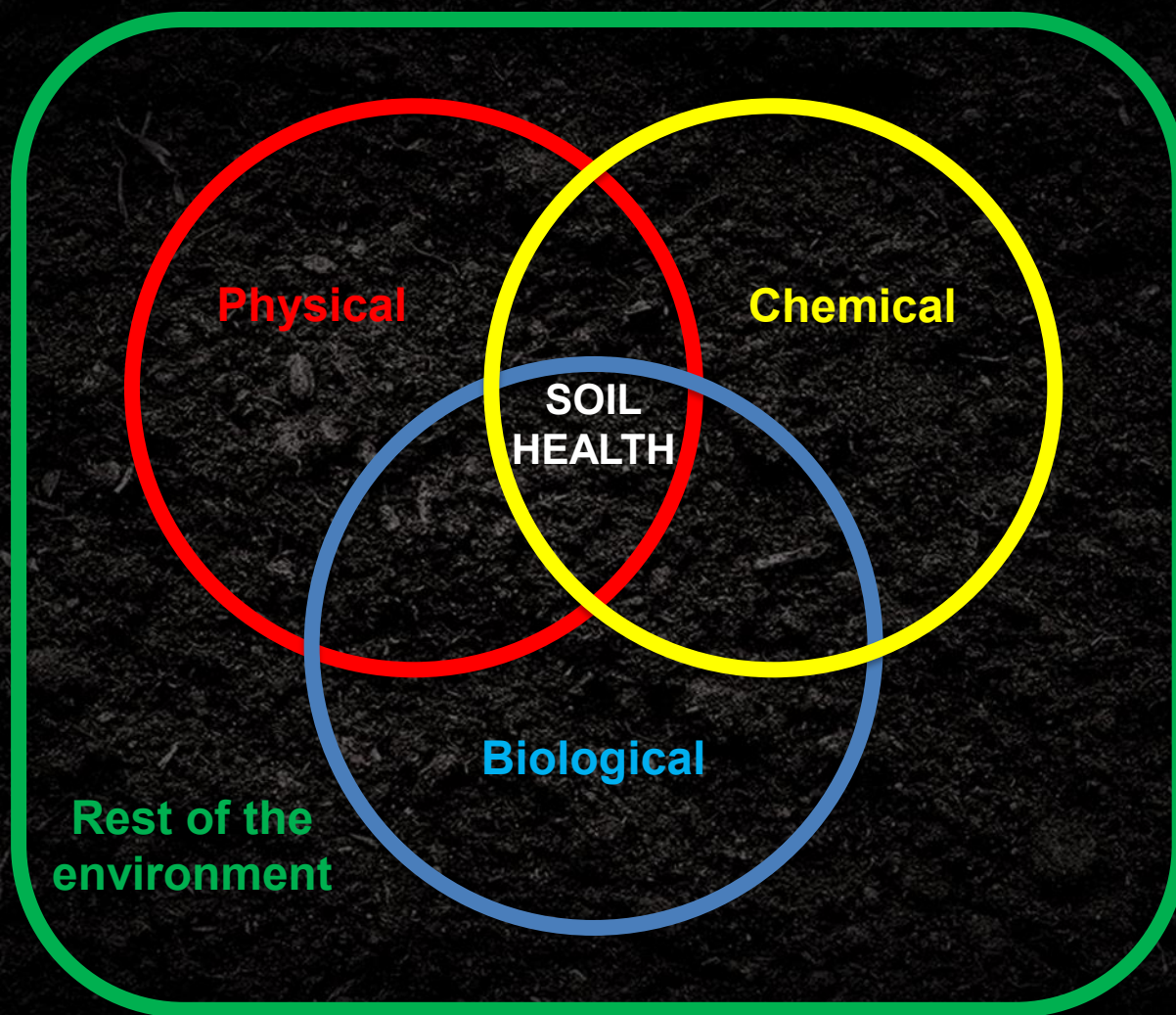
It's Alive!

SOIL HEALTH:

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



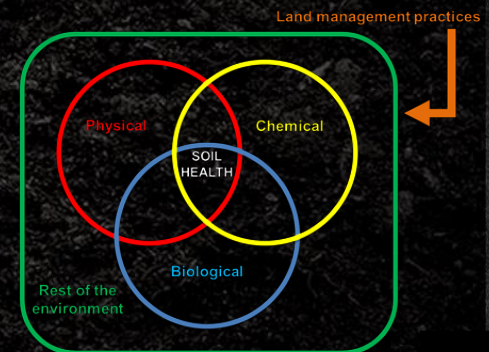
Land management practices



Agricultural Sustainability

is defined by four generally agreed-upon goals:

- Satisfy human food, feed, and fiber needs, and contribute to biofuel needs.
(Produce what we want to produce)
- Enhance environmental quality and the resource base. *(Protect the foundation on which it rests)*
- Sustain the economic viability of agriculture.
(Provide economic incentive to keep doing it)
- Enhance the quality of life for farmers, farm workers, and society as a whole.
(Support the societal framework that enables it)

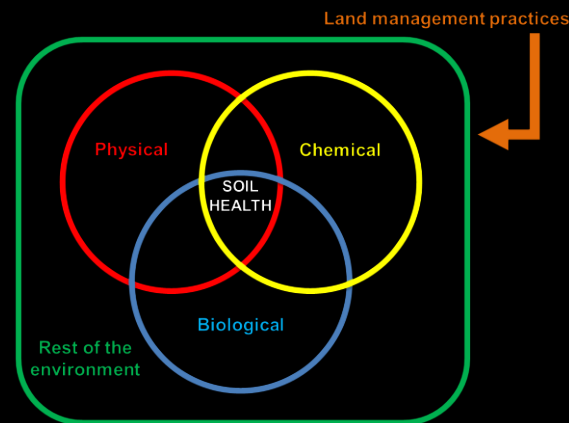


Toward Sustainable Agricultural Systems in the 21st Century.
National Research Council, 2010.



Soil health represents a framework that integrates many aspects of

- Managing soil
- Managing other natural resources
- Advancing sustainability



Soil Health and 4R Nutrient Management

Soil Health Principle	Soil Health Practice	Soil Health Benefits	Right Source	Right Rate	Right Time	Right Place	Supported by Research

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Keep it covered	Reduced tillage	C accum, nutrient return, reduce erosion, water penetration	Complex biological sources utilized and cycled by microbes, made into plant-available forms	Slow release of chemical forms available to plants, unlikely to over-apply forms that can be leached, etc.	Slow release; decomp. rate greatest in spring and summer with actively growing crop	Already in place where the next crop will be grown.	

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Do not disturb	Reduced tillage	C accum, fungal development, AWHC, nutrient retention	Plant/animal residues decomp by insects, microbes, etc., plant-available forms in crop root zone	Slow release from decomposing organic forms	Slow release; decomp. rate greatest in spring and summer with actively growing crop	In place where the next crop will be grown.	

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Keep roots growing	Cover crops, crop rotations, perennial pastures	C accum, microbial growth, water penetration, nutrient input, aeration	Provides organic forms of carbon and nutrients that can be food and nutrient sources for microbes and turned into plant-available forms	Slow accumulation of C and nutrients as roots grow and produce exudates, stimulate soil organisms that induce further turnover	"Application" constant during crop/pasture growth or between crops	On-site development, accum., decomp.	

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Boost biodiversity	Crop rotations, varied sequences, multi-spp cover crops and pasture mixes	Soil biological diversity and resilience (microbes, insects, etc.), disease resistance	Diverse plant spp deposit chem diverse residues as roots, exud., leaves; support different microbes, insects; diverse nutrient forms	Diverse organic matter inputs decompose at different rates, buffer the rate of overall application of plant-available forms	"Application" of plant-available nutrients varies as different-source organic matter decomposes	On-site development, accum., decomp.	

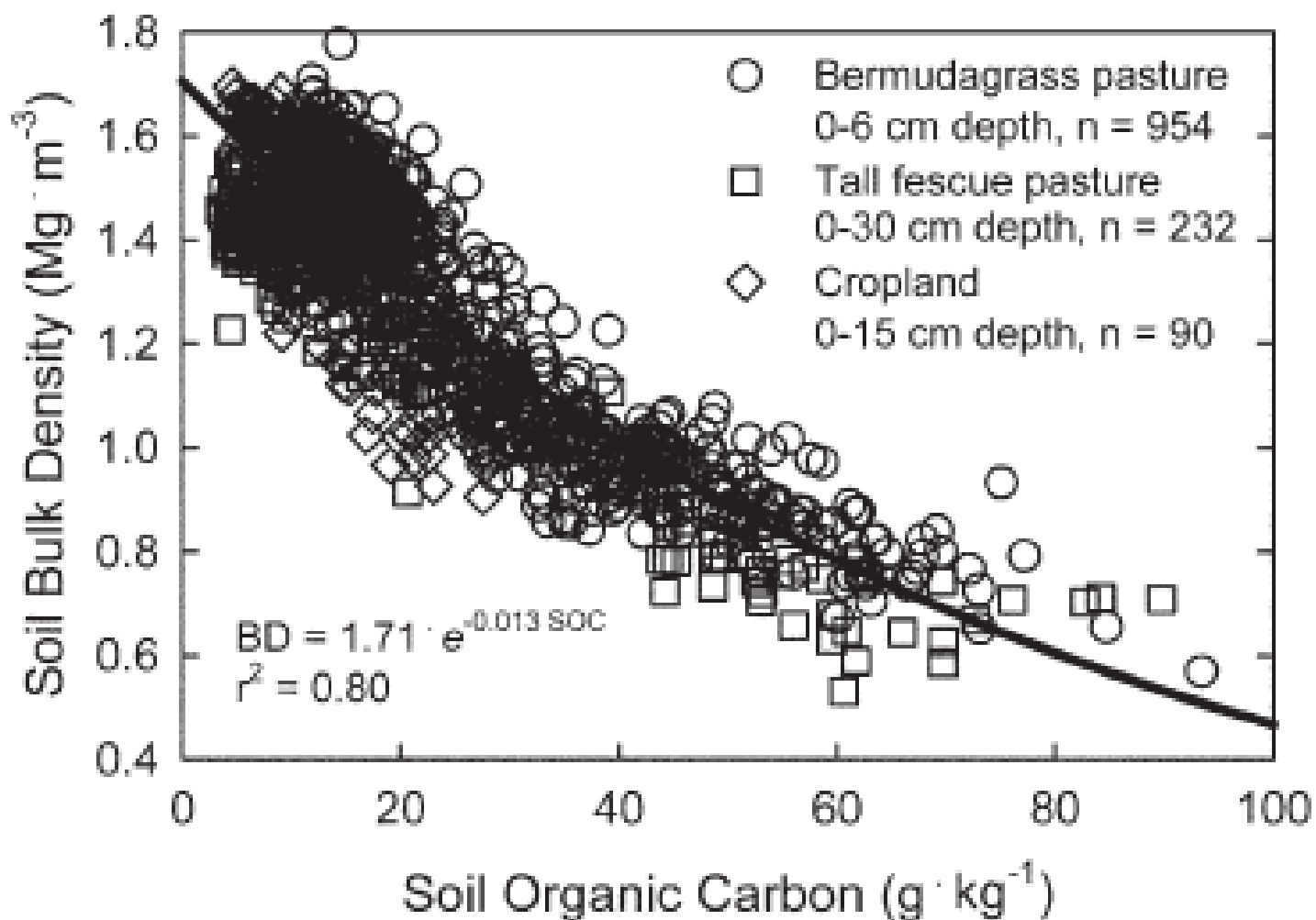
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Involve animals	Graze livestock, apply manures	C and nutrient inputs, root death and regrowth, nutrient cycling, soil biological diversity	Additional diverse, complex organic forms that decompose and release plant-available forms	Diverse OM inputs decompose at different rates, buffer the rate of overall application of plant-available forms	"Application" of plant-available nutrients varies as different-source organic matter decomposes	"Application" of plant-available nutrients varies as different-source OM decomp; avoid contam surface waters, fresh-harv crops	

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Involve animals	Graze livestock, apply manures	C and nutrient inputs, root death and regrowth, nutrient cycling, soil biological diversity	✓	✓	✓	✓	✓

Soil Organic C (Mg/ha)

State	Years	Conventional Tillage	No Tillage
IA	15	60.3	71.1
IL	6	45.4	51.3
IN	11	60.0	73.0
KY	5	45.9	52.8





Georgia studies – Typic Kanhapludults
Franzluebbers (2010) SSSAJ 74:347–357



Tillage & Cover Crop Impacts On Water Infiltration Rate

Location	Years	Tillage & Crop	Impact on Infiltration Rate	Reference
KS	15	NT Winter Wheat-Sorghum	182% Increase with Cover Crop	Blanco-Canqui et al. (2011)
MD	11	NT Corn	164-462% Increase with Cover Crop (different sites & years)	Steele et al. (2012)
KS	11	NT Wheat-Sorghum-Fallow	132-194% Increase with No-Till	Stone and Schlegel (2010)
Malawi	3	NT Corn	165% Increase in No-Till	TerAvest et al. (2015)



Northern Mixed Grass Prairie

Cheyenne, WY; 1982-2003

Treatment	Soil C, 0-5 cm (Mg/ha)	Soil N, 0-5 cm (Mg/ha)
No Grazing	10.8 b	0.94 b
Light Grazing	13.8 a	1.23 a
Heavy Grazing	10.9 b	0.94 b

Ganjugunte et al. (2005)

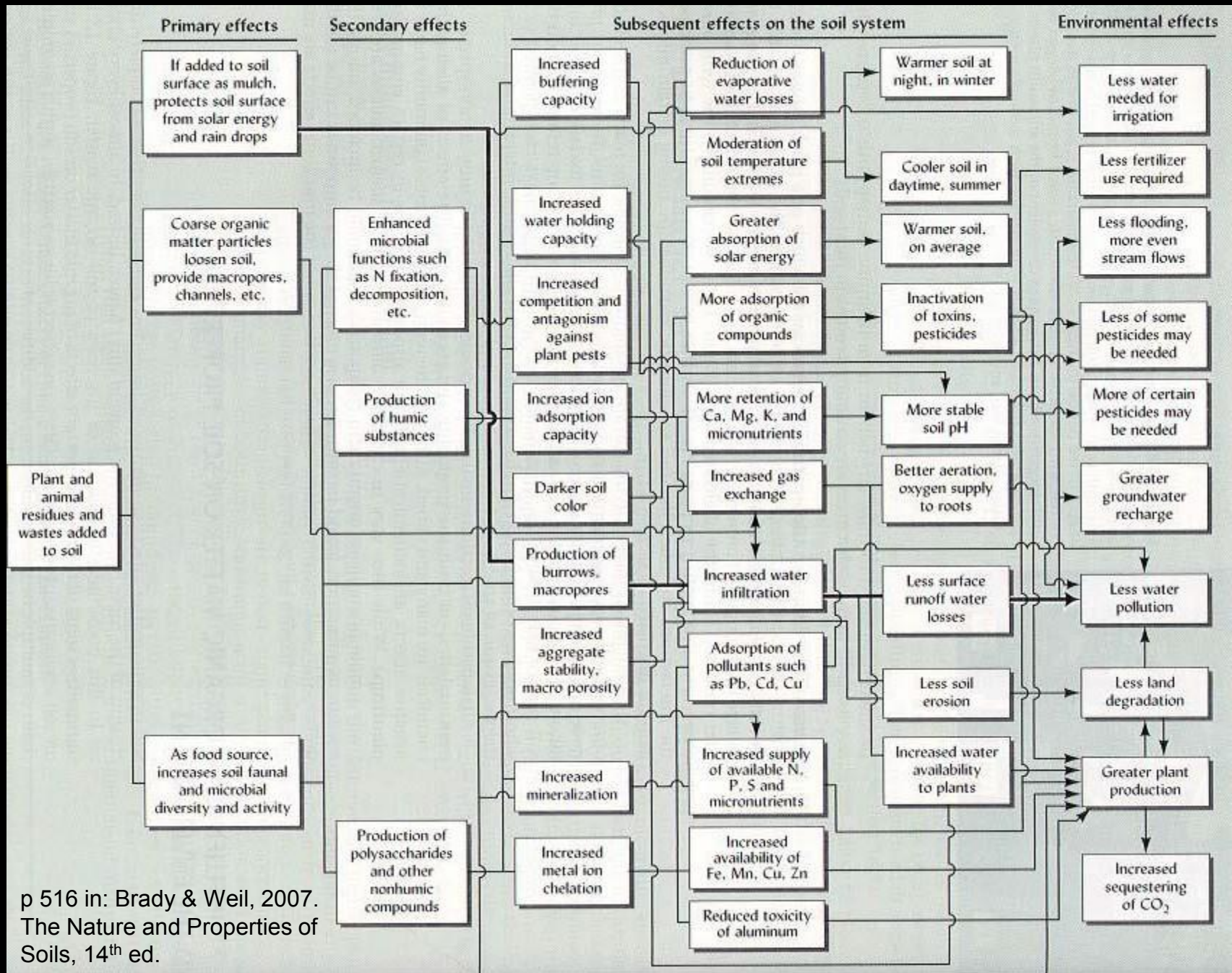


Tillage & Cover Crop Impacts on Soil & Nutrient Losses

State	Tillage & Crop	Cover Crop	Soil Loss	Nitrate N Loss	Soluble P Loss	Reference
			-----	(lbs/ac/yr)	-----	
AL	CT Cotton	None	1997	3.07	0.36	Yoo et al. (1998)
	NT Cotton	None	953	1.25	0.28	
	NT Cotton	W. Wheat	232	0.50	0.14	
GA	CT Corn	None	3271	--	0.25	Langdale et al. (1985)
	CT Corn	W. Rye	838	--	0.27	
KY	CT Corn	None	--	2.20	0.44	Klausner et al. (1974)
	NT Corn	Ryegrass	--	1.26	0.12	
	CT Wheat	None	--	1.02	0.29	
	NT Wheat	Rye/Alfalfa	--	0.83	0.15	
MD	CT Corn	None	234	0.32	0.01	Angle et al. (1984)
	NT Corn	Barley	29	0.04	0.01	
MO	NT Soybean	None	1333	3.00	0.41	Zhu et al. (1989)
	NT Soybean	Chickweed	208	0.69	0.15	
	NT Soybean	C. Bluegrass	83	0.79	0.38	
	NT Soybean	D. Brome	105	0.75	0.24	

Cover Crop Impacts on Nitrate Leaching

Location	Cover Crop	Reduction in Nitrate Leaching (%)	Reference
CA	Rye	65-70	Wyland et al. (1996)
DE	Rye	30	Ritter et al. (1998)
France	Ryegrass	63	Martinez and Guirard (1990)
IN	Winter Wheat (and reduced fertilizer)	61	Kladivko et al. (2004)
IA	Rye	61	Kaspar et al. (2007)
KY	Rye	94	McCracken et al. (1994)
KY	Hairy Vetch	48	McCracken et al. (1994)
MD	Rye	77	Staver and Brinsfield (1990)
MD	Rye	80	Staver and Brinsfield (1998)
MI	Rye	28-68	Rasse et al. (2000)
MN	Rye	13	Strock et al. (2004)



Enriching Soil, Enhancing Life

AN ACTION PLAN FOR SOIL HEALTH



RESEARCH

What we don't know

MEASUREMENT & ASSESSMENT

What the current status is

ECONOMIC ANALYSES

What the costs, risks, and benefits are

COMMUNICATIONS & EDUCATION

Getting the word out

POLICY

A cornerstone for decision making