A Soil Quality Update for Cropland CEAP

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Presentation Overview

- Acknowledgements
- Soil quality assessment timeline
- What is soil quality assessment?
- Sampling locations and conditions evaluated
- Sampling strategy and measurements made
- Data trends and preliminary assessments
- SMAF assessments
- Summary and conclusions

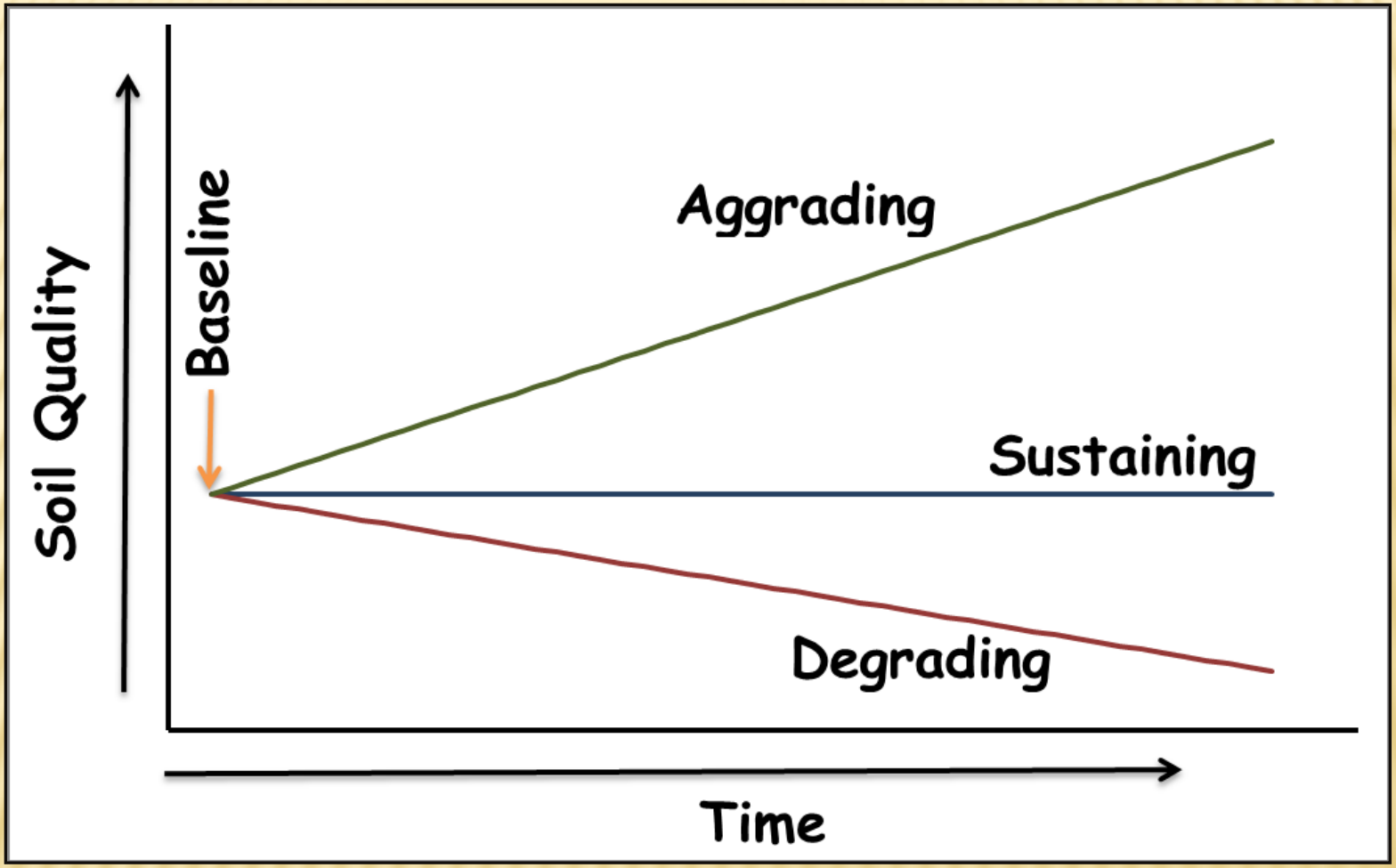
Acknowledgements

- We thank Larry Pellack, Rhonda Graef, and all other technical support personnel at each location who assisted with sample collection, processing, and analysis.
- Thank you also to the SYs at each location who are assisting with data analysis, interpretation, and manuscript preparation.
- Thank you to the Global Change Program for providing supplemental resources for the study.

Soil Quality Assessment Timeline

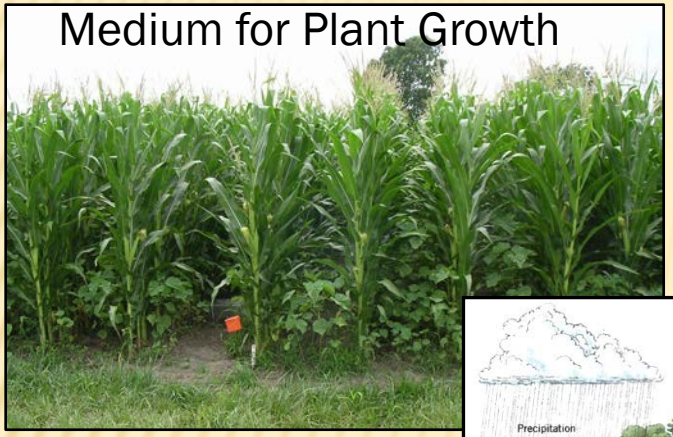
- 1993 – NRC publishes "Soil and Water Quality: An Agenda for Agriculture"
- 2002 – Farm Bill authorized an 80% increase in conservation expenditures
- 2003 – Multiple USDA Agencies initiated CEAP
- 2004 – Cropland CEAP studies initiated
- 2006 – 2010 – Soil quality sampling and analysis conducted within 17 watersheds
- 2011 – present – data synthesis and publication

What is Soil Quality Assessment?

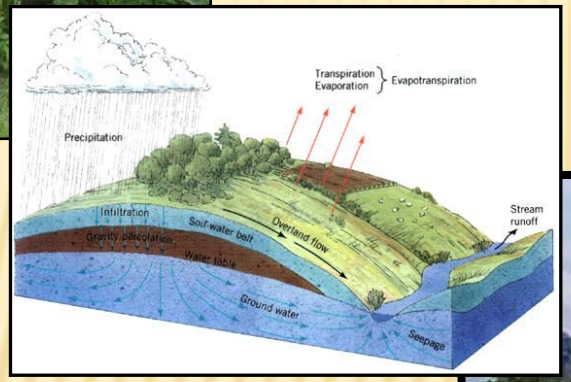


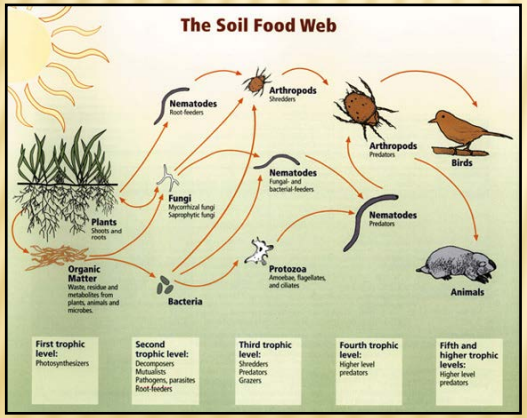
An evaluation of how well a soil is performing one or more of its critical functions.

Five Critical Functions Affected by Soils



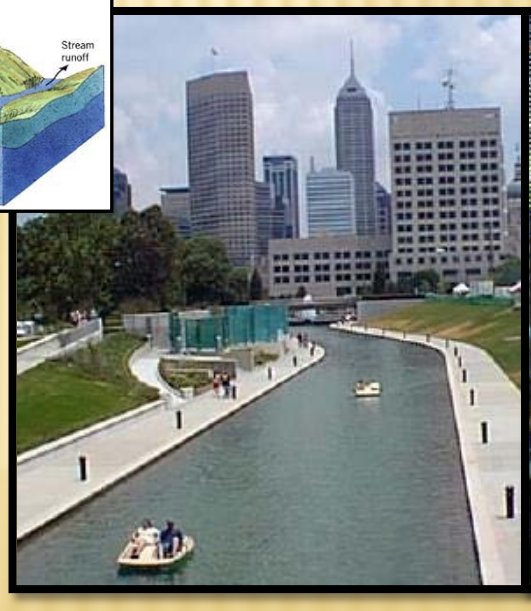
Water Supply & Purification

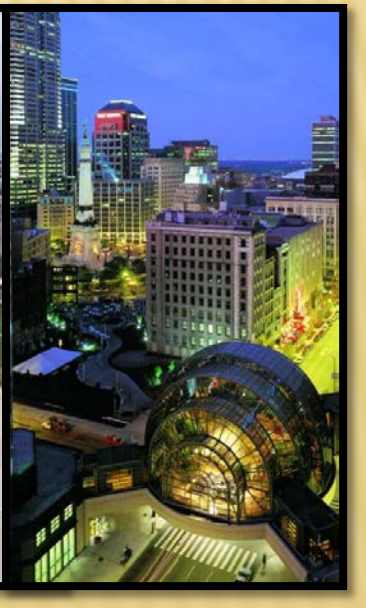


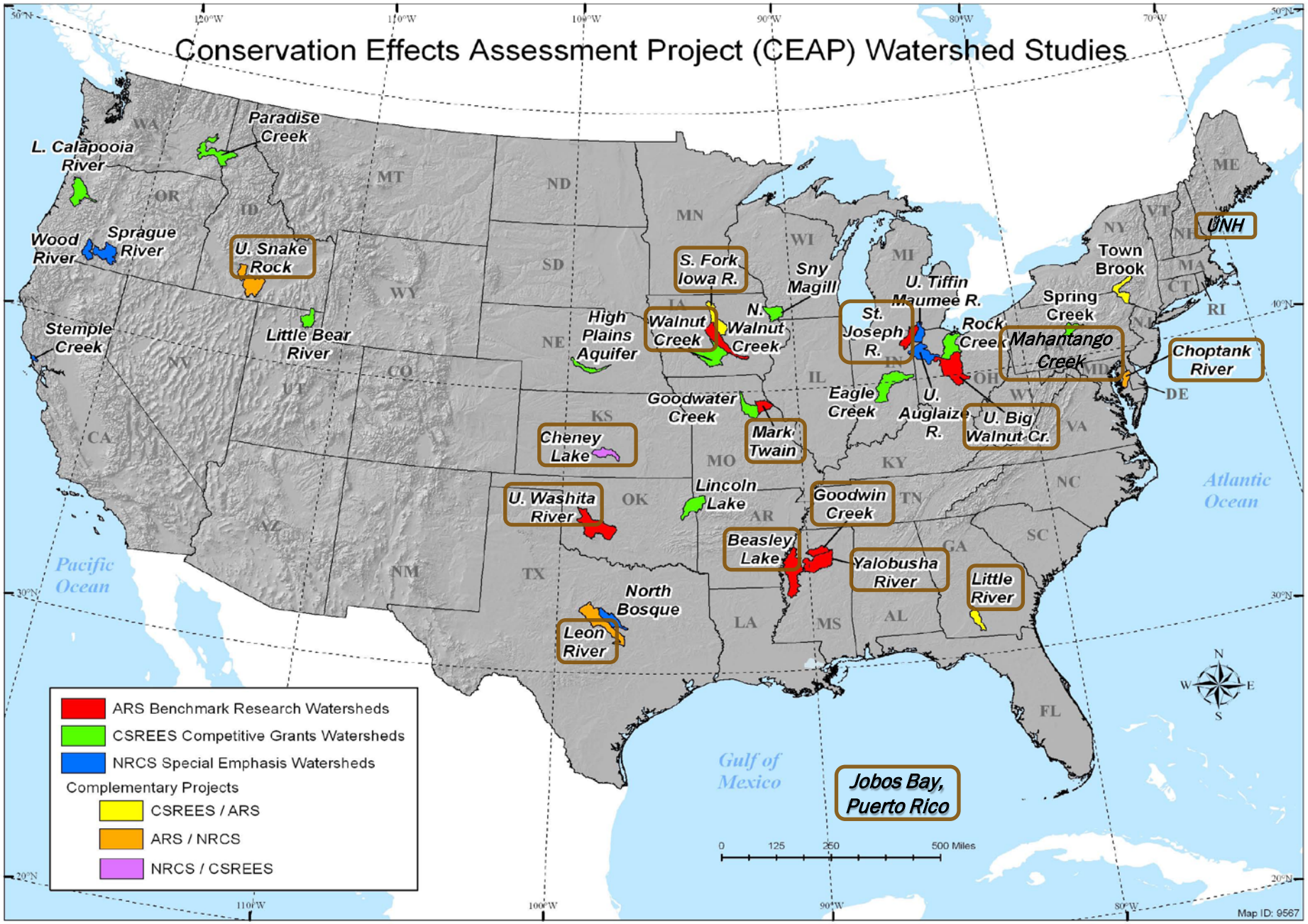


Habitat for Soil Organisms

Engineering Medium






Conservation Effects Assessment Project (CEAP) Watershed Studies
Paradise Creek
L. Calapooia River
Wood River
Sprague River
U. Snake Rock
Stemple Creek
Little Bear River
S. Fork Iowa R.
Sny Magill
U. Tiffin Maumee R.
Town Brook
UNH
Spring Creek
High Plains Aquifer
Walnut Creek
N. Walnut Creek
St. Joseph R.
Rock Creek
Mahantango Creek
Choptank River
Eagle Creek
U. Auglaize R.
U. Big Walnut Cr.
Goodwater Creek
Mark Twain
Cheney Lake
Lincoln Lake
U. Washita River
Goodwin Creek
Beasley Lake
Yalobusha River
Little River
North Bosque
Leon River
Jobos Bay, Puerto Rico
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
ARS Benchmark Research Watersheds
CSREES Competitive Grants Watersheds
NRCS Special Emphasis Watersheds
Complementary Projects
CSREES / ARS
ARS / NRCS
NRCS / CSREES
0 125 250 500 Miles
Map ID: 9567

Vegetation at Selected Sampling Sites

Ft. Cobb, OK

Little River, GA

UNH Organic Site

Sampling Sites Continued

Jobos Bay, Puerto Rico

ChopTank, MD

St. Joseph's River, Indiana

Upper Snake River Watershed

White eroded soil from furrow irrigation

Sample Collection & Processing Protocols

- Based on available resources each watershed location could submit up to 250 samples
- The Global Change Program connection required sample collection from 0 to 5 cm
  - All samples from 0-5 cm or fewer sites with multiple depth increments (generally 5-15-cm or 5-20 cm)
- Sieving, moisture, BD and sample fractionation were carried out locally or by NLAE & NSERL techs
- Chemical analyses conducted at the NLAE
- Texture, AGS, and enzyme analyses at NSERL

Measured Soil Quality Indicators

	Abbreviation
➢ Physical	
➢ % Sand, Silt & Clay	
➢ *Bulk Density (g cm^{-3})	BD
➢ *Wet Aggregate Stability (%)	AGS
➢ *Water-filled Pore Space (%)	WFPS
➢ Chemical	
➢ *pH	pH
➢ *Electrical Conductivity (ds/m)	EC
➢ Nutrient concentrations	(see next slide)
➢ Biochemical	
➢ *Total Soil Organic C (g kg^{-1})	SOC
➢ *Microbial Biomass C (mg kg^{-1})	MBC
➢ Mineralizable C (mg kg^{-1})	C_{min}
➢ *β-Glucosidase (mg PNP kg^{-1} hr^{-1})	BG

➢ (*SMAF Scoring Functions Available)

Measured Nutrients

Nutrient	Abbreviation
Total Nitrogen (g kg^{-1})	TN
*Nitrate N (mg kg^{-1})	NO_3-N
*Potentially Mineralizable N (mg kg^{-1})	N_{min}
*Mehlich 3 extr. P (mg kg^{-1})	P
*Mehlich 3 extr. K (mg kg^{-1})	K
Mehlich 3 extr. Ca (g kg^{-1})	Ca
Mehlich 3 extr. Mg (mg kg^{-1})	Mg
DTPA extr. Iron (mg kg^{-1})	Fe
DTPA extr. Manganese (mg kg^{-1})	Mn
DTPA extr. Copper (mg kg^{-1})	Cu
DTPA extr. Zinc (mg kg^{-1})	Zn

- (*SMAF Scoring Functions Available)

Assessment Status Update – July 2012

Watershed	Lead	Phys/Biol NSERL	Nutrients NLAE	N_{min} NLAE	SMAF NSERL	Author	Status
Sampled in 2006							
South Fork	Ames, IA	done	done	done	done	Diane Stott	published
Walnut Creek	Ames, IA	done	done	done	done	Greg McCarty	data sent
Ft. Cobb	El Reno, OK	done	done	done	done	Jean Steiner	data sent
Riesel (Bushy Creek)	Temple, TX	done	done	done	done	Diane Stott	analyzed
Little River	Tifton, GA	done	done	done	done	Tim Strickland	data sent
Sampled in 2007							
UNH Organic	Univ. Park, PA	done	done	done	done	Curtis Dell	data sent
Choptank	Beltsville, MD	done	done	done	done	Greg McCarty	data sent
St. Joseph	W. Lafayette, IN	done	done	done	done	Diane Stott	data sent
Beasley Lake	Oxford, MS	done	done	done	done	Martin Locke	data sent

Assessment Status Update – July 2012

Watershed	Lead	Phys/Biol NSERL	Nutrients NLAE	N_{min} NLAE	SMAF NSERL	Author	Status
Sampled in 2008-2009							
Upper Big Walnut Creek	Columbus, OH	done	done	In progress	TBD	Diane Stott	pending
Mark Twain	Columbia, MO	In progress	done	done	TBD	Bob Kremer	pending
Goodwin Creek	Oxford, MS	In progress	done	TBD	TBD	Ron Bingner	pending
Little Topashaw	Oxford, MS	TBD	done	TBD	TBD	Rob Wells	pending
Cheney Lake	Oxford, MS	TBD	done	TBD	TBD	Rob Wells	pending
Ponce, Jobos Bay	Tifton, GA	TBD	done	TBD	TBD	Tim Strickland	pending
Upper Snake River	Kimberly, ID	TBD	done	TBD	TBD	Jim Ippolito	pending
Mahantango	Univ. Park, PA	TBD	done	TBD	TBD	Peter Kleinman	pending

SMAF Indicator Data (max. & min.)

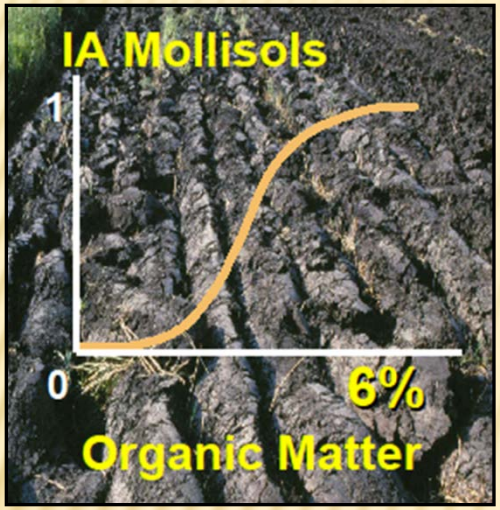
Indicator	Depth	South Fork, IA		Riesel, TX		Little River, GA	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
BD (g cm^{-3})	0 to 5 cm	0.8	1.6	1.0	1.7	0.9	2.0
AGS (% macro)	0 to 5 cm	57	93	73	100	85	97
pH	0 to 5 cm	4.8	7.9	7.7	8.0	4.4	7.1
EC (µS)	0 to 5 cm	84	560	451	1131	5	217
SOC (g kg^{-1})	0 to 5 cm	9	221	13	43	2	53
MBC (mg kg^{-1})	0 to 5 cm	122	1875	551	2498	63	1019
N_{min} (µg N g^{-1})	0 to 5 cm	6	134	12	82	3	105
Ext. P (mg kg^{-1})	0 to 5 cm	9	496	0	149	8	431
Ext. K (mg kg^{-1})	0 to 5 cm	100	1072	109	503	6	205
ß-glucosidase (µg p-nitrophenol g^{-1} hr^{-1})	0 to 5 cm	24	291	100	280	4	123

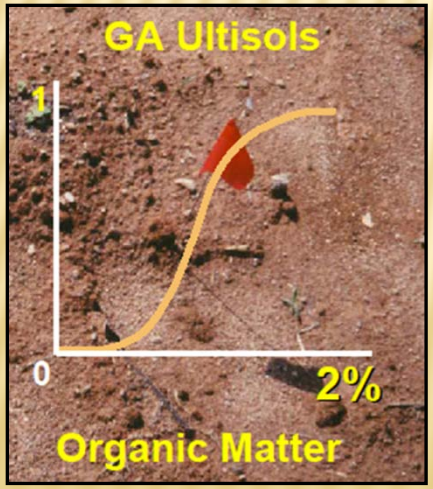
SMAF Indicator Data (max. & min.)

Indicator	Depth	Choptank, MD		Beasley Lake, MS		UNH Organic Site	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
BD (g cm^{-3})	0 to 5 cm	0.9	1.6	0.9	1.8	0.8	1.7
AGS (% macro)	0 to 5 cm	71	100	63	98	76	98
pH	0 to 5 cm	4.9	7.4	4.4	7.3	5.4	7.0
EC (µS)	0 to 5 cm	65	855	100	503	91	478
SOC (g kg^{-1})	0 to 5 cm	5	28	5	42	12	78
MBC (mg kg^{-1})	0 to 5 cm	41	468	29	927	635	3551
N_{min} (µg N g^{-1})	0 to 5 cm	0	70	0	214	0	213
Ext. P (mg kg^{-1})	0 to 5 cm	35	387	13	96	7	740
Ext. K (mg kg^{-1})	0 to 5 cm	50	464	103	807	46	717
ß-glucosidase (µg p-nitrophenol g^{-1} hr^{-1})	0 to 5 cm	26	197	37	247	30	359

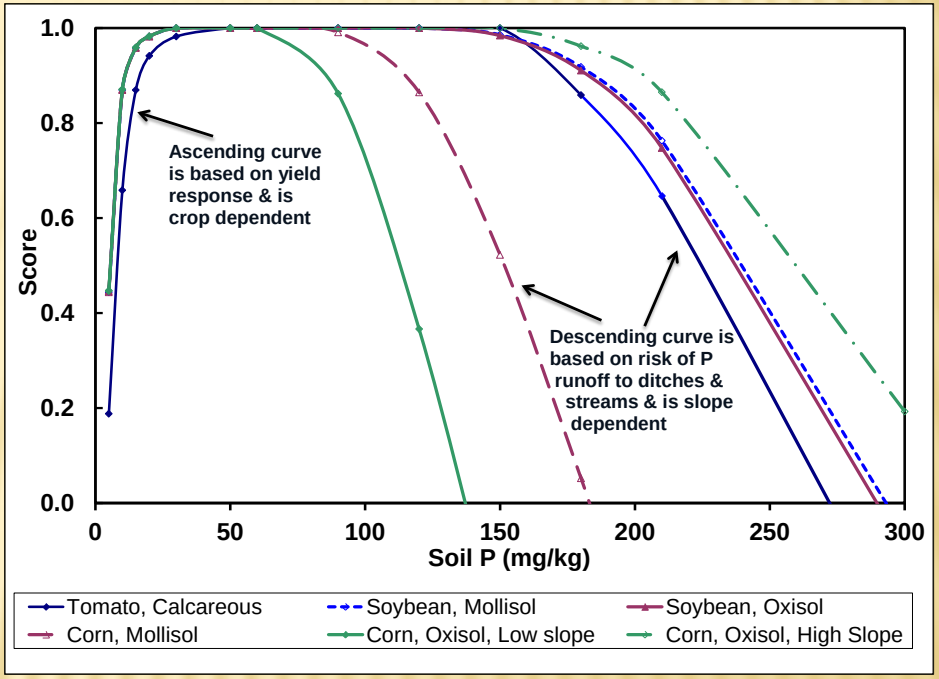
Representative SMAF Scoring Curves

More is better





Midpoint optimum



Also “Less is Better” – e.g. Bulk Density

SMAF Results for Selected Watersheds

Watershed	Types of comparisons	Minimum	Maximum
South Fork, IA	Determining causes for remotely sensed well- and poorly-developed corn canopy areas. Soil series, landscape position & manure history evaluated.	64	94
Riesel, TX	Native prairie, Coastal Bermuda grass (BG), BG + turkey litter, row crop (RC1) – wheat-corn/sorghum-cotton-pasture (4 yr), RC2 – W – C/S - Cot/fallow	61	83
Little River, GA	Rotations -- cotton/corn/peanut; peas/tobacco/peanut; peanut/grazed millet/butterbeans; cotton/peanut; continuous cotton; forest & riparian zones	51	86
Choptank, MD	Tillage/no-tillage; Landscape position; corn/wheat/soybean rotation;	61	87
Beasley Lake, MS	Row crop, buffer, CRP, ditch areas having various soil types and slope conditions	58	87
UNH Organic Transition Farm	Fields in various stages of transition from conventional to organic agricultural practices – alfalfa; blue & orchard grass w/fine fescue & white clover; B & O -grass/white clover, corn, fallow, sorghum-sudan grass grown on various soils with slopes of 0 to 3%, 3 to 8%, and 8 to 15%	58	87

Summary and Conclusions

- Soil quality sampling was carried out efficiently at 17 Cropland CEAP locations
- All analyses are anticipated to be completed by the end of 2012
- A substantial amount of summarization and data interpretation remains to be done locally
- Baseline information provided is already being used for subsequent evaluations at many sites
- SMAF analysis for the first 8 watersheds shows the soils were functioning at between 55 and 95% of their potential for crop production

Questions?