Measuring Soil Health in Alabama

Charles C. Mitchell*, Gobena Huluka, and Tabby Bosarge[1]

ABSTRACT

Almost 200 years of cropping and abuse have left many soils in the State of Alabama (USA) in poor condition with generally low quality and low productivity. A 2001 survey of Central Alabama cotton fields indicated that 55% of fields had soil organic matter less than 0.4% and 63% had root restricting compaction within 30 cm of the surface. Eighty-five percent of the producers were not using a cover crop which exposed the bare soil to erosion for 6 months during the year. On the other hand, most were soil testing and doing an outstanding job of liming and fertilizing based on soil test results. Data from Alabama's long-term "Old Rotation" experiment (circa 1896) show a significant correlation between soil organic C and crop yield potential. Because many soil quality/soil health parameters can be measured in an existing public soil testing laboratory, we have incorporated these tests into a "Soil Quality Index" (SQI) value that producers can use to evaluate their soil health. Our SQI was developed with objectives to: 1) make producers aware of soil quality/soil health, 2) suggest ways of improving soil quality/soil health, 3) use existing, low-cost, soil test methodologies, 4) use existing, routine, composite soil samples from producers and 6) provide information in a simple, easy-to-understand manner. Best management practices will be recommended to help producers improve their SQI value. A draft of this index based on a scale of 0 to 100 is presented.

SITUATION

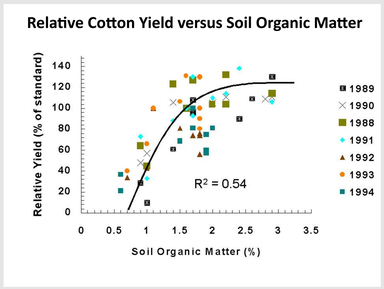
Alabama soils as well as most of the soils of the southeastern U.S. have poor soil quality/soil health because of . . .

- A history of severe erosion
- Low soil organic matter
- Excessive runoff/poor infiltration
- Traffic pans or surface crusting/soil compaction
- Shallow rooting of crops
- Lack of cover crops
- Sloping land (> 3% slopes in many fields)
- Soil borne diseases e.g. nematodes
- Low water holding capacity
- Low productivity

A 2001 survey of Central Alabama cotton fields showed that. . .

- 55% had <0.4% soil organic matter in the top 5 cm
- 63% had traffic pans in spite of in-row subsoiling
- 85% were not using a cover crop
- 80-95% were doing a great job of fertilizing and liming according to soil test; soil pH and plant nutrients were in ideal range.

https://sites.aces.edu/group/timelyinfo/Documents/S-01-02.pdf



Data from Alabama's historic "Old Rotation experiment" (circa 1896), the oldest continuous cotton experiment and one of the oldest cover crop studies in the world, show a good relationship between plow layer organic matter and relative crop yield. (Mitchell and Entry, 1998. Soil Tillage Res.47:331-338)

While some soil quality/soil health factors must be measured in the field, there are many other factors that we can measure on routine soil samples in our public and private soil testing laboratories:

- Routine soil test (pH, extractable P, K, Ca, Mg, and micronutrients)
- Estimated cation exchange capacity
- Soil texture
- Base saturation
- Soil organic C/organic matter
- Aggregate stability/slaking
- Electrical conductivity
- Soil respiration
- Mineralizable nitrogen
- Metals/soil contamination

PROPOSAL

Develop a "Soil Quality Index" for Alabama that . . .

- will make farmers and gardeners aware of soil quality/soil health.
- provides information in a simple, easy-to-understand manner.
- suggests ways of improving soil quality/soil health.
- is adaptable to existing soil test methodologies.
- is relatively inexpensive to run on traditional soil samples.

Our model was based on successful programs such as the Cornell Soil Health Testing services (http://soilhealth.cals.cornell.edu/) , published data on the subject, plus extensive local experience. Selected references are listed below:

Bastida et al.. 2006. Geoderman 147:159-171

Doran and Jones (ed.). 1996. SSSA spec. pub. No 49

Karlen et al., 2008. J. Int. Bioscience 6: 3-14.

Shukla et al., 2006. Soil Tillage Res. 87:194-204.

Wienhold et al., 2004. Geochem. Health 26:89-95.

Linking SQI to Conservation Practices

A Soil Quality Index, like a routine soil test, should provide recommendations that can be used to improve soil quality. Recommendations are based on existing USDA-NRCS-AL best management practices;

Primary Practices (PP)

1. Conservation crop rotation (328)
2. Residue and Tillage Management "No-till/strip till" (329)
3. Cover crops (340)
4. Nutrient management (590)
5. Integrated Pest Management (590)

Supporting Practices (SP)

1. Contour Farming (330)
2. Deep Tillage (324)
3. Forage and Biomass Planting (512) – for sod based rations
4. Irrigation water Management (449)
5. Contour Buffer Strips (332)
6. Filter Strips (393)
7. Mulching (345)
8. Terrace (600)

Complete list of conservation practices can be found at:
http://efotg.sc.egov.usda.gov/toc.aspx?CatID=321

[1]*Mitchell is Extension Agronomist-Soils & Professor, Huluka is Associate Professor and Laboratory Director, and Bosarge is Graduate Research Assistant in the Dep. Crop, Soil & Environmental Sciences, Auburn University, AL 36849-5412. Email: mitchc1@auburn.edu ; hulukgo@auburn.edu*

EXAMPLES

Factor84	Values					Max. value	Your Score	BMP recommended
Soil CEC/ soil group	<4.6 (Grp 1)	4.7-9.0 (Grp 2)	9.0-15.0 (Grp 3)	>15.0 (Grp 4)				
	2	4	5	5		5	5	
Soil pH_w	<5.0	5.1-5.8	5.9-7.0	7.0-8.0	>8.0			
	0	10	15	10	5	15	15	
P RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH			
	0	5	10	5	0	10	10	
K RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH			
	0	3	5	3	2	5	5	
Base saturation	<10%	11-25%	26-50%	50-75%	>75%			
	0	3	6	10	8	10	10	
Soil O.M. (%)	<0.5	0.6-1.0	1.1-2.0	2.1-3.0	>3.0			
	0	5	15	20	25	25	15	
N mineralized (lb/a)	<10	11-20	21-30	31-50	>50			
	0	1	2	3	5	5	3	
Soil respiration	VeryLow	Low	Moderate	High	Very High			
	0	1	2	3	5	5	2	
Aggregate stability	No aggregates	Weak	Moderate	Good	Very strong aggregates			
	0	2	4	6	8	8	4	
EC (1:2) Mmho/cm	<0.40	0.40-0.80	0.81-1.60	1.61-3.20	>3.20			
	3	5	3	2	0	5	5	
Metals	Two or more metals "very high"		One metal is "very high"		All metals optimum			
	-10		-5		7	7	7	
TOTAL SOIL QUALITY INDEX						100	84	Continue with existing practices

Comments: Soil Quality Index is high. Continue with existing practices

A very productive soil from the Tennessee Valley region of North Alabama.

Factor	Values					Max. value	Your Score	BMP recommended
Soil CEC/soil group	<4.6 (Grp 1)	4.7-9.0 (Grp 2)	9.0-15.0 (Grp 3)	>15.0 (Grp 4)				
	2	4	5	5		5	2	
Soil pH_w	<5.0	5.1-5.8	5.9-7.0	7.0-8.0	>8.0			Apply Ag. lime at recommended rates
	0	10	15	10	5	15	10	
P RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH			
	0	5	10	5	0	10	10	
K RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH			See soil test K recommendations
	0	3	5	3	2	5	3	
Base saturation	<10%	11-25%	26-50%	50-75%	>75%			Apply Ag. lime
	0	3	6	10	8	10	6	
Soil O.M.(%)	<0.5	0.6-1.0	1.1-2.0	2.1-3.0	>3.0			PP_2, PP_3, SP_3, SP_7
	0	5	15	20	25	25	5	
N mineralized (lb/a)	<10	11-20	21-30	31-50	>50			Building soil organic matter will help.
	0	1	2	3	5	5	1	
Soil respiration	VeryLow	Low	Moderate	High	Very High			Building soil organic matter will help.
	0	1	2	3	5	5	1	
Aggregate stability	No aggregates	Weak	Moderate	Good	Very strong aggregates			PP_1, PP_2, PP_3, SP_7, SP_2
	0	2	4	6	8	8	3	
EC (1:2) Mmho/cm	<0.40	0.40-0.80	0.81-1.60	1.61-3.20	>3.20			
	3	5	3	2	0	5	5	
Metals	Two or more metals "very high"		One metal is "very high"		All metals optimum			
	-10		-5		7	7	7	
TOTAL SOIL QUALITY INDEX						100	52	See BMPs above

Comments: Soil could use improvement. Consider implementing one or more of the above practices. Soil compaction and/or runoff is a hazard. Consider reduced or no-till, high residue management, use of cover crops, and mulching. Consider in-row subsoiling or strip tillage.

A sandy, eroded soil from the Lower Coastal Plain of southeastern Alabama.

INTERPRETATION OF ALABAMA'S SQI

Factor	Comment on report	NRCS practice
If SQI>80	Soil Quality Index is high. Continue with existing practices	
If pH<5.8	Add ag. lime at recommended rates	
If P=EH	P is excessive and additional P in fertilizers or manures should be avoided.	
If P value = VL or L	Consider using animal manures to build soil P (PP_4)	PP_4
If K = VL, L or M		See soil test K recommendations
If SOM= <1.0%	Consider residue and tillage management and cover crops	PP_2, PP_3, SP_3, SP_7
If N mineralized > 50 lb/a	Consider reducing commercial N applied by 30 to 50 lb. N/acre	
If aggregate stability is moderate or less	Soil compaction and runoff is a hazard. Consider reduced or no-till, high residue management, use of cover crops, and mulching. Consider in-row subsoiling or strip tillage.	PP_1, PP_2, PP_3, SP_7, SP_2
If N mineralized <20 lb N/ acre	Building soil organic matter will help increase mineralizable N.	
If respiration is VL or L	Building soil organic matter will help improve soil respiration.	
If EC>1.60	WARNING. . . SALT BUILDUP COULD DMAGE CROPS.	
If one metal is VH	**CAUTION. Zn, Cu, Cd, Pb, or Cr** is very high. This could be an indication of contamination from micronutrient fertilizers, manures or some other application. Metals cannot be removed from the soil. Keep soil pH above 6.0 to reduce metal uptake by plants.	
If 2 or more metals are VH	**WARNING.** This soil has been contaminated from excessive metal application either from fertilizers or some other application. Metals cannot be removed from the soil. Keep soil pH above 6.0 to reduce metal uptake by plants.	
If 50<SQI<80	Soil could use improvement. Consider implementing one or more of the above practices.	See BMPs above.
If SQI< 50	Your total soil quality index is low. Use one or more of the following primary practices to help improve the soil quality index. Re-test your soil in 3 years to determine if the practices are helping. You may be eligible for assistance from your local Soil and Water Conservation District Office or USDA-NRCS office.	(list of NRCS Primary and Secondary practices)

SUMMARY

This SQI was introduced by the Auburn University Soil, Forage and Water Testing Laboratory in November, 2015, based on a study of 300 samples from Alabama and Georgia. Factors included in the SQI and the weight of each factor will be adjusted as we gain more experience. Projected cost of this service will be $50 per sample and samples are to be collected similar to routine soil samples.