The Cornell Soil Health Test Report: A new way to identify unhealthy soil

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When we aren't feeling well we might go to the doctor to have our blood pressure checked, our cholesterol tested or a throat culture taken to see if we have strep throat. The doctor might suggest weight loss, exercise, an anti-acid for a sour stomach or an anti-biotic for strep throat to bring us back to good health. Now we can do the same thing for our soil when it isn't performing quite as expected.

A group of Cornell scientists, growers, extension educators and crop consultants evaluated 39 potential physical, biological and chemical indicators for their use in rapidly assessing soil health. They were able to boil these down into 9 grower friendly measurements or "indicators. Farmers can now send soil samples to the Cornell Soil Health Lab to get the health of their soils “diagnosed”...much like a person going to the doctor to find out how healthy they are. These 9” indicators are shown below.

Four **soil physical health indicators** including aggregate stability, available water capacity, surface and subsurface hardness are evaluated. **Aggregate stability** uses a rain simulation sprinkler to determine the fraction of a soil sample that remains on a sieve after a specific amount of time and rainfall. Soils with low aggregate stability tend to form surface crusts which can reduce water infiltration and air exchange and can even make it tough for germinating seeds to emerge from the soil. **Available water capacity** measures the amount of water in a disturbed sample that is actually available for plant use. **Surface and subsurface hardness** is a measure of penetration resistance at 0 to 6 inches and 6 to 18 inches respectively, using a field penetrometer, an instrument that measures the extent and depth of compaction that may restrict the growth of roots or movement of air and water through the soil. This measurement needs to be taken in the field. All other indicators are measured in the laboratory using a sample submitted by the customer.

The four **biological soil health** indicators tested include organic matter, active carbon, potentially mineralizable nitrogen and a root health rating as determined in the soil health lab. **Organic matter** contributes to overall soil tilth, soil water holding capacity, and nitrogen availability, among other things. **Active carbon** is a leading indicator of soil health by telling us how fast soil organic matter will become available for use by important soil microbes. Likewise, **potentially mineralizable nitrogen** tells us how much plant available N will be released by organic matter. The **Root Health Rating** is based on a soil bio-assay with bean plants to determine the incidence of root pathogens like Fusarium, Pythium, Rhizoctonia and Thielaviopsis - and no, I don't know how to pronounce that last disease.

A standard soil test, **conducted by Agro-One**, is used to determine **the chemical health** of a soil. This includes pH, extractable phosphorus, extractable potassium and several other secondary and minor elements.

Results are summarized in a “report card” of sorts (Figure 1) that identifies potential problem areas based on the evaluation of physical, biological and chemical characteristics as measured by Cornell and Agro-One. It also identifies limitations or constraints that may be seen in the test soils.

The Cornell Soil Health Website provides additional information and suggested management practices to correct these soil health constraints including:

- Reducing or modifying tillage.
- Changes in the crop rotation to add organic matter and/or break up pest life cycles.
- Growing cover crops to build organic matter.
- Adding organic amendments (manure or compost).
- Adding chemical amendments (limestone, gypsum, fertilizer, etc).

The Cornell Soil Health Report (Figure 1) shows the actual measured value, i.e. % aggregate stability, hardness (psi), % organic matter, pH, ppm P, ppm K, and so on. Each indicator is then scored on a scale of 1 to 100. Scores less than 30 are considered low and receive a red color code on the report. A score of 30 - 70 is medium and earns a yellow color code. A score above 70 is considered to be high or good and earns a green. The report also identifies possible constraints or problems associated with a particular indicator if it receives a low (red) rating. For example, a poor aggregate stability rating may indicate poor aeration, poor water infiltration and poor rooting depth in the affected soil. This may explain why a soil with an excellent soil test (pH, P, K, etc) is failing to meet expectations.

These ratings are averaged to provide an overall quality score (out of 100) as shown in Figure 1.

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

Name of Farmer: Bob Schindelbeck	Sample ID: G140
Location: Cornell University Musgrave Research Farm, Poplar Ridge, NY 13026	Agent: Bob Schindelbeck
Field/Treatment: G140 Plot 1A Long term tillage trial	Agent's Email:rrs3@cornell.edu
Tillage: 9+ inch	Given Soil Texture: silty
Crops Grown: COG/COG/COG	Date Sampled: 4/16/2009

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	38	56	water retention
	Available Water Capacity (m/m)	0.09	8	
	Surface Hardness (psi)	66	90	
	Subsurface Hardness (psi)	350	27	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	2.6	25	energy storage, C sequestration, water retention
	Active Carbon (ppm) (Permanganate Oxidizable)	585	44	
	Potentially Mineralizable Nitrogen (ugN/gdwsoil/week)	5.2	0	N Supply Capacity
	Root Health Rating (1-9)	3.2	75	
CHEMICAL	*pH	7.9	0	Toxicity, Nutrient Availability (for crop specific guide, see CNAL report
	* Extractable Phosphorus (ppm) (Value <3.5 or >21.5 are downscored)	6.5	100	
	* Extractable Potassium (ppm)	48	72	
	*Minor Elements		56	
OVERALL QUALITY SCORE (OUT OF 100):			46.1	LOW

Measured Soil Textural Class:--> silt loam
SAND (%): 41.7 *SILT (%): 53.6* *CLAY (%): 4.7*

Location (GPS): Latitude=> 42.732892 *Longitude=> -76.659594*

*** See Agro-One report for recommendation**

Figure 1 - Sample of a Cornell Soil Health Test Report

Soils play a key role on every farm. Dairy farmers and cash crop producers are familiar with standard soil testing to identify nutrient deficiencies or imbalances in their soils. But many farmers have learned, some the hard way, that the chemical "health" of a soil is just one part of the puzzle. This may explain why certain fields perform poorly despite having an adequate and well balanced soil fertility profile. Something else, like soil compaction, poor drainage or root pathogens may limit crop performance and profitability unless corrective measures are taken to address the problem(s). So, send your soil samples to the Cornell Soil Health lab for a full work up if you think your soils are “sick” or you just want to know what is needed to help your soil meet it's full potential.

*You can go to **http://soilhealth.cals.cornell.edu/extension/test.htm** for complete information on services, pricing, sample sheets, guidelines needed to collect a representative sample, shipping samples and interpreting results including the physical and biological evaluations done by Cornell and the chemical evaluation done by Agro-One.*