

## Impact of Cornell Soil Health Program on Soil Management Practices in New England

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Degraded soils in the Northeastern U.S. have become prevalent because management practices usually focus on directly “feeding the crop” with ready nutrients through fertilizers, and less so on “feeding the soil” so that it can feed the crop. Degraded soils become less resilient to more extreme temperatures and precipitation events brought on by climate change. Compaction, disease pressure, lacking resilience to droughts and intense rainfall, loss of organic matter, surface crusting, erosion, increasing inputs with stagnant or declining yields and other problems are common on Northeast farms, and result from ignoring physical and biological soil properties and the need to manage these along with nutrient contents. As agronomically essential soil functions and processes are degraded, this significantly impacts agricultural productivity and the environmental sustainability of agriculture.

Standard chemical soil analysis has been hugely successful in helping growers manage nutrient constraints to cropping, but physical and biological soil constraints that impact crops had been largely ignored by soil testing services until the first version of the Cornell Soil Health Test (CSHT; <http://soilhealth.cals.cornell.edu/>) became available to the public in 2006. It is available in its current form since 2007, and the team is working on making expanded packages available in the future. This test was developed in NY State (NYS) for use in the Northeast in response to increasing concerns from growers. The CSHT measures, rates and interprets an integrative set of 15 physical, biological, and chemical indicators that represent agronomically important soil processes. Growers receive a color-coded report that provides information about which soil processes are constrained. The grower can then adapt soil management to specifically choose management strategies that promise to alleviate identified constraints.

The following developments by the Cornell Soil Health Team will be discussed:

1. Interpreting a Cornell Soil Health Report
2. A four-step process to guide management decisions based on a CSHT report
3. Impact in New England thus far
4. Manual, resources

### 1. Interpreting a Cornell Soil Health Report

The CSHT report (Figure 1.) identifies constraints in agronomically essential soil processes (indicators and

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)				
Name of Farmer: Willboro Farm		Sample ID: E128		
Location: Sayward Rd. Willboro NY 12296		Agent: Bob Schindelbeck, Cornell University		
Field/Treatment: TILL 3A		Agent's Email: 0		
Tillage: 7-9 INCHES		Given Soil Texture: CLAY		
Crops Grown: COG/COG/COG		Date Sampled: 4/25/2007		
Indicators	Value	Rating	Constraint	
PHYSICAL	Aggregate Stability (%)	12	3	eration, infiltration, rooting
	Available Water Capacity (m/m)	0.17	43	
	Surface Hardness (psi)	57	91	
	Subsurface Hardness (psi)	200	82	
BIOLOGICAL	Organic Matter (%)	3.3	25	energy storage, C sequestration, water retention
	Active Carbon (ppm) [Permanganate Oxidizable]	559	20	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/g soil/week)	4.8	0	N Supply Capacity
	Root Health Rating (1-9)	2.5	88	
CHEMICAL	pH	6.1	67	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	2.5	44	
	*Extractable Potassium (ppm)	83	100	
	*Minor Elements		100	
OVERALL QUALITY SCORE (OUT OF 100)		55.3	Medium	

Figure 1. Cornell Soil Health Test Report (usually in color), showing constraints (Rating < 30, in red) in a long-term moldboard-plowed corn grain field.

rating is explained in our manual). A lower rating means the process is functioning less well. The rating system is as follows: Each measured value receives a rating from 0-100. Ratings of 70 and above indicate optimal functioning (in green), while medium scores (>30, but <70, in yellow) indicate marginal functioning. Ratings below 30 indicate constraints in soil processes that need to be addressed. The constraints column shows what about the soil is not functioning properly when the indicator rating is red.

## 2. Four-Step Process to Guide Management Decisions Based on a CSHT Report

A key concept in soil health assessment is that indicators measured in the CSHT represent how well agronomically important soil processes are functioning in the soil. For example, when aggregate stability receives a low rating (Fig. 1), this means that soil crumbs fall apart easily in the rain, and this means that problems with aeration, infiltration, shallow rooting, surface crusting and erosion are likely.

The question then is – what can a grower do to alleviate such a problem? It is important to understand that a CSHT report is a guide to management, rather than a prescription (such as nutrient recommendations). Soil health constraints generally require a more integrated and long-term approach, and there are usually many different management approaches that can mitigate the same problem. Also one management practice can affect multiple indicators. What works on one farm is not necessarily feasible or ideal on another, and so report information must be adapted situationally. It is also important to remember that soil health changes slowly over time (on the order of several years to decades).

We have developed a four-step process, to help growers (often in collaboration with their extension educators or consultants) make management decisions that will alleviate

<b>Cornell Soil Health Test Report Field Management Sheet</b>	
<b>Step 1. Identify constraints, prioritize</b>	<i>Low aggregate stability (poor soil structure)</i>
Identified in the Soil Health Report	<i>Low organic matter (low energy/C storage, low water retention)</i> <i>Low Active C (hungry soil food web)</i> <i>Low PMN (low biological activity)</i>
<b>Step 2. List management options</b>	<i>Add/ grow fresh organic matter</i>
Some suggestions found in Table 5 (page 52)	<i>Add stable organics (composts, biochar)</i> <i>Reduce tillage intensity, Rotate with shorter season crop</i> <i>Find window for shallow-rooted cover crop</i>
<b>Step 3. Determine site history/ farm background</b>	<i>Far from dairy farm, Short growing season</i>
Note here any situational opportunities or limitations	<i>Soil "addicted to tillage"</i> <i>Diverse inventory of field equipment</i> <i>Grower willing to "try anything"</i>
<b>Step 4. Management Strategy 2010</b>	<i>Drill barley/ timothy/ clover mix in spring</i>
The agronomic science of Steps 1 and 2 combine with the grower realities of Step 3 to create Field Management Plan	<i>Harvest barley, Mow timothy/ clover as green manure</i> <i>Fall mow, rent ripper for strip till for corn 2011</i> <i>Learn about strip tillage</i> <i>(Build soil for transition to strip till)</i>

Figure 2. Completed management decision worksheet for the CSHT report in Fig. 2.

identified soil constraints. Fig. 2 shows an example of this process. The grower, in Step 1, lists the constraints identified in the CSHT report (Fig. 1) and then, in Step 2, lists potential management options for those constraints. Examples of

such options, such as those listed in Fig 2, Step 2, can be found on page 52 of the Cornell Soil Health Assessment Training Manual (available online, see below). For example adding or growing fresh organic matter and reducing tillage will both improve low aggregate stability and low biological activity. In Step 3, the grower then, considers relevant opportunities (such as having access to diverse equipment, and being willing to try anything) and limitations of the farm and field (such as being far from a dairy farm, and thus having no access to manure, etc). Combining the agronomic science (Steps 1 and 2) with the realities on the ground (Step 3), the grower can then plan short- and/or long-term management strategies that will be feasible on that field.

### **3. Impact in New England**

The soil health lab has received over 700 samples from New England since 2007, most from VT (well over 400), over 200 from NH over the last two years, a few dozen from MA, and several from ME. Use of the Cornell Soil Health Test in New England has increased with almost 300 samples received this year from NH, VT and MA. The NH NRCS has integrated the soil health test in their high tunnel program and is making it available through other cost share programs as well. As part of the high tunnel program, soil health is assessed before the high tunnel is put in place, with the goal to tailor tunnel soil management to preventing degradation and improving identified constraints for sustainable long-term tunnel use. We are currently in the process of assessing the impact of our program on New England soil management practices, and will provide a summary of our findings during the presentation.

### **4. Manual, Resources**

- a. Manual – the second Edition of Cornell Soil Health Assessment Training Manual is available on our website <http://soilhealth.cals.cornell.edu>
- b. Another good reference is the new edition of the book “Building Soils for Better Crops” by Fred Magdoff and Harold van Es. It can be downloaded for free from the SARE website <http://www.sare.org/publications/soils.htm>