

## Cornell Soil Health Laboratory: Comprehensive Assessment of Soil Health (CASH)

The Comprehensive Assessment of Soil Health (CASH), commonly known as the Cornell Soil Health Test, is designed for farmers, gardeners, agricultural service providers, landscape managers and researchers who want to go beyond simply testing the nutrient levels of their soils. The Cornell Soil Health Lab was the first to offer a comprehensive soil health package analysis that provides standardized information on a suite of important soil biological and physical parameters in addition to standard nutrient analyses. The CASH assessment is regarded as a key tool for soil health measurement by a diverse clientele of growers, research projects, and national initiatives.

The Cornell Soil Health Lab conducts many thousands of soil health package analyses each year. The Soil Health Report lists the laboratory results from each analysis. Each lab value is scored against the large database with color-coding for clarity. The Cornell Soil Health Lab also offers a Soil Health Management Planning framework to focus soil management options on the identified parameters.



The Cornell Soil Health Lab offers cutting edge soil assessments, many of which were developed in house, and which serve as the standard for soil health lab analytics around the world. The analyses are offered as individual assessments and as parts of soil health assessment packages. The suite of lab analyses include:

- pH and Nutrient Testing
- Loss on Ignition/Organic Matter
- Active Carbon
- Total Carbon, Total Nitrogen
- Soil Organic Carbon
- Surface and Sub-Surface Hardness
- Rapid Texture
- Wet Aggregate Stability
- Soil Respiration
- Autoclave-Citrate Extractable (ACE) Protein
- Available Water Capacity
- Predicted Available Water Capacity
- Predicted Autoclave-Citrate Extractable (ACE) Protein
- Heavy Metal Analysis
- Bulk Density and Stone Content
- Soluble Salts

Our website offers a collection of one-page, two-sided Fact Sheets designed to explain each the soil indicators listed above. The Fact Sheets provide information regarding each soil analysis in a ready format for researchers, growers, Extension personnel and Ag Service Providers.

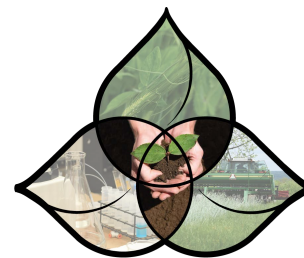
More comprehensive details regarding the CASH soil assessment indicators and soil health management strategies for improving soil health are available in the Comprehensive Assessment of Soil Health Training Manual, available free online.

Also available online are the Cornell Soil Health Lab Standard Operating Procedures for each of the soil lab analyses.

### Acknowledgments

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# CASH: Soil Health Test Report Interpretation Guide

The raw data from the submission form are synthesized in an auto-generated and grower-friendly report. The report presents measured values, interpretive ratings, and constraints in a summary page (Figure 1), followed by a short narrative description of each indicator's importance and status, and selection tables with suggestions for targeted management (Figure 2).

Comprehensive Assessment of Soil Health				
From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences School of Integrative Plant Science, Cornell University, Ithaca, NY 14853 <a href="https://soilhealthlab.cals.cornell.edu">https://soilhealthlab.cals.cornell.edu</a>				
Grower: Bamidaaye Sinon	Sample ID: www626	Field ID: NRCS Trial	Date Sampled: 09/30/2022	Given Soil Type: Raynham
Ag Service Provider: Bob Schindelbeck	Date Sampled: 09/30/2022	Given Soil Type: Raynham	Crops Grown: ONP/TOM/IDL	Tillage: more than 9 inches
Measured Soil Textural Class: <b>loam</b>	Sand: <b>44%</b>	Silt: <b>42%</b>	Clay: <b>13%</b>	
Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	0.23	86	
physical	Surface Hardness	114	71	
physical	Subsurface Hardness	287	54	
physical	Aggregate Stability	9.3	11	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
biological	Organic Matter Soil Organic Carbon: 2.20 / Total Carbon: 2.22 / Total Nitrogen: 0.15	3.4	68	
biological	ACE Soil Protein Index	8.3	70	
biological	Soil Respiration	0.6	43	
biological	Active Carbon	623	74	
chemical	Soil pH	6.7	100	
chemical	Extractable Phosphorus	8.1	100	
chemical	Extractable Potassium	153.5	100	
chemical	Additional Nutrients Ca: 1099.7 / Mg: 209.2 / S: 13.0 Al: 31.4 / B: 0.32 / Cu: 0.01 Fe: 8.1 / Mn: 3.8 / Zn: 0.2		88	
Overall Quality Score:		72 / High		

Figure 1. Page one of the ten page CASH report shows the laboratory results of specific analyses. Values are provided and ratings are color coded.

Table 1. Shown below is the key to the circled numbers identifying important attributes of the CASH Report in Figure 1 above.

- 1) **Background information and measured soil texture information.**
- 2) **Measured indicators.**
- 3) **Indicator values: Provided in the units of measure with texture-adjusted scoring functions on a scale of 0 to 100.**
- 4) **Color coded ratings: Red indicates a constraint to proper soil functioning. Orange and yellow indicate current or potentially developing soil health problems. Green and dark-green indicates optimal functioning.**
- 5) **Constraints: Poor ratings automatically generate list of constraints.**
- 6) **Overall quality score: Averaged individual indicator ratings provide an indication of the overall health status.**

Management Suggestions for Physical and Biological Constraints		
Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Predicted Available Water Capacity Low	<ul style="list-style-type: none"> <li>Add stable organic materials, mulch</li> <li>Add compost or biochar</li> <li>Incorporate high biomass cover crop</li> </ul>	<ul style="list-style-type: none"> <li>Reduce tillage</li> <li>Rotate with sod crops</li> <li>Incorporate high biomass cover crop</li> </ul>
Surface Hardness High	<ul style="list-style-type: none"> <li>Perform some mechanical soil loosening (strip till, aerators, broadfork, spader)</li> <li>Use shallow-rooted cover crops</li> <li>Use a living mulch or interseed cover crop</li> </ul>	<ul style="list-style-type: none"> <li>Shallow-rooted cover/rotation crops</li> <li>Avoid traffic on wet soils, monitor</li> <li>Avoid excessive traffic/tillage/loads</li> <li>Use controlled traffic patterns/lanes</li> </ul>
Subsurface Hardness High	<ul style="list-style-type: none"> <li>Use targeted deep tillage (subsoiler, yeomans plow, chisel plow, spader)</li> <li>Plant deep rooted cover crops/radish</li> </ul>	<ul style="list-style-type: none"> <li>Avoid plows/disks that create pans</li> <li>Avoid heavy loads</li> <li>Reduce traffic when subsoil is wet</li> </ul>
Organic Matter Low	<ul style="list-style-type: none"> <li>Add stable organic materials, mulch</li> <li>Add compost and biochar</li> <li>Incorporate high biomass cover crop</li> </ul>	<ul style="list-style-type: none"> <li>Reduce tillage/mechanical cultivation</li> <li>Rotate with sod crop</li> <li>Incorporate high biomass cover crop</li> </ul>
ACE Soil Protein Index Low	<ul style="list-style-type: none"> <li>Add N-rich organic matter (low C:N source like manure, high N well-finished compost)</li> <li>Incorporate young, green, cover crop biomass</li> <li>Plant legumes and grass-legume mixtures</li> <li>Inoculate legume seed with Rhizobia &amp; check for nodulation</li> </ul>	<ul style="list-style-type: none"> <li>Reduce tillage</li> <li>Rotate with forage legume sod crop</li> <li>Cover crop and add fresh manure</li> <li>Keep pH at 6.2-6.5 (helps N fixation)</li> <li>Monitor C:N ratio of inputs</li> </ul>
<b>Aggregate Stability Low</b>	<ul style="list-style-type: none"> <li>Incorporate fresh organic materials</li> <li>Use shallow-rooted cover/rotation crops</li> <li>Add manure, green manure, mulch</li> </ul>	<ul style="list-style-type: none"> <li>Reduce tillage</li> <li>Use a surface mulch</li> <li>Rotate with sod crops and mycorrhizal hosts</li> </ul>
Active Carbon Low	<ul style="list-style-type: none"> <li>Add fresh organic materials</li> <li>Use shallow-rooted cover/rotation crops</li> <li>Add manure, green manure, mulch</li> </ul>	<ul style="list-style-type: none"> <li>Reduce tillage/mechanical cultivation</li> <li>Rotate with sod crop</li> <li>Cover crop whenever possible</li> </ul>
Soil Respiration Low	<ul style="list-style-type: none"> <li>Maintain plant cover throughout season</li> <li>Add fresh organic materials</li> <li>Add manure, green manure</li> <li>Consider reducing biocide usage</li> </ul>	<ul style="list-style-type: none"> <li>Reduce tillage/mechanical cultivation</li> <li>Increase rotational diversity</li> <li>Maintain plant cover throughout season</li> <li>Cover crop with symbiotic host plants</li> </ul>

Figure 2. Short and Long Term Management Suggestions Table. The low Aggregate Stability rating in red on page 1 of the CASH report generates a list of constraints (Figure 1, red arrow point) that are linked to potential management suggestions on page 9 of the report (red arrow tail).

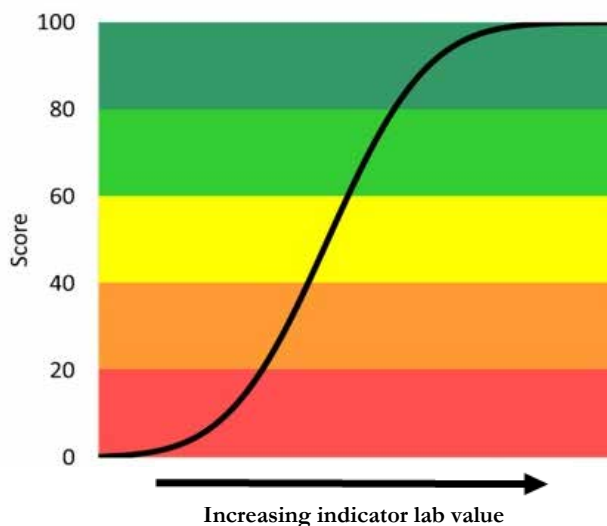


Figure 3. Example of CASH scoring curve. In this situation, the higher the measured value of the indicator, the higher the score until a maximum score of 100 is attained.