WHAT CAN SOIL HEALTH TESTS TELL YOU?

Steve Culman
Associate Professor of Soil Fertility
Ohio State University
culman.2@osu.edu
soilhealth.osu.edu; soilfertility.osu.edu

Soil Health Webinar Series
January 21, 2021
Soil Function ➔ Soil Indicator

If we want to manage it, we must be able to measure it!
There are many potential soil indicators

<table>
<thead>
<tr>
<th>Chemical Indicators</th>
<th>Physical Indicators</th>
<th>Biological Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic matter</td>
<td>Texture</td>
<td>Microbial biomass</td>
</tr>
<tr>
<td>Total C &amp; N</td>
<td>Bulk density</td>
<td>Earthworms</td>
</tr>
<tr>
<td>pH</td>
<td>Penetration resistance</td>
<td>Nematodes</td>
</tr>
<tr>
<td>CEC</td>
<td>Aggregate stability</td>
<td>Arthropods</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Water holding capacity</td>
<td>Mycorrhizal fungi</td>
</tr>
<tr>
<td>Electrical conductivity</td>
<td>Infiltration rate</td>
<td>Respiration rate</td>
</tr>
<tr>
<td>Heavy metals</td>
<td>Depth to hardpan</td>
<td>Soil enzyme activities</td>
</tr>
<tr>
<td>Other toxins</td>
<td>Depth to water table</td>
<td>Pollutant detoxification</td>
</tr>
<tr>
<td>Erosive potential</td>
<td></td>
<td>Decomposition rates</td>
</tr>
<tr>
<td>Aeration</td>
<td></td>
<td>Microbial community</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fingerprinting</td>
</tr>
</tbody>
</table>
Minimum Set of Indicators

**Soil Methods**
- Sensitive to management changes
  - Reflect soil or plant function
  - Reliable, robust, repeatable

**Commercial lab constraints**
- Rapid
- Inexpensive
  - High-throughput
Soil Health Is...

- A young and emerging field, needing refinement
Organic matter is... kinda a big deal

• The importance of soil organic matter in soil quality and functioning cannot be overstated
• Critical component that influences
  • Aggregation
  • Resistance to water and wind erosion
  • Bulk density
  • Root proliferation
  • Biological activity
  • Nutrient cycling and uptake
  • And more....

• Small fraction of soil’s mass
It is the decay of organic matter, and not the mere presence of it, that gives ‘life’ to the soil.

Cyril Hopkins, 1910

Attempting to hoard as much organic matter as possible in the soil, like a miser hoarding gold, is not the correct answer. Organic matter functions mainly as it is decayed and destroyed. Its value lies in its dynamic nature.

William Albrecht, 1938
How do we measure soil organic matter?

• **Total Organic Matter**
  - Direct combustion – gold standard but $$$
  - Loss on Ignition – Fast, simple, cheap

• **Some fraction of the total**
  - Many possible methods
Active Organic Matter

- Small fraction of total organic matter (OM)- 5-10%
- Rapidly cycled nutrients, very important for soil fertility
Active Organic Matter Pools

- Respiration (Microbial Activity)
- POXC (Carbon Pool)
- Soil Protein (Nitrogen Pool)

Process-based measurements of soil biology and chemistry
Respiration

- Measures activity of soil microbes – CO₂ released from soil
- Solvita commercial example
- Can be measured on field-moist or dried soils
- Can measure CO₂
  - Directly with gas analyzer
  - Trap CO₂ with NaOH base trap
POXC (Permanganate Oxidizable Carbon or Active C)

- POXC reflects a processed but available pool of organic matter
- 1—4% of total organic C in soil
- Biologically active soil C fraction
- Sensitive to management

2.5 g soil + 20 ml 0.02 M KMnO₄

Shake for 2 minutes

Settle for 10 minutes

0.5 ml of supernatant + 49.5 ml H₂O

Read on spectrophotometer
Active C vs. Respiration

- Active C reflects management practices that promote OM stabilization
- Respiration reflects practices that promote OM mineralization

_Hurisso, Culman, et al., 2016, SSSAJ_
3 g soil + buffer

Shake and autoclave for 30 minutes

Cool, shake for 5 minutes

Centrifuge, transfer solution to plate

Read color development on spectrophotometer

Incubate plate to allow protein to react

Soil Protein

- Abundant in plant and microbial biomass
- Contain a large proportion of organically-bound N
- Enzymatically-degradable by a wide array of microbes
- Supply of amino acids most often is the rate-limiting step in soil N cycling
Field Measurements of Physical Structure

- Penetration Resistance
- Infiltration
- Aggregate stability
- Bulk Density
Infrared Spectroscopy (DRIFTS)

- Non-destructive, very rapid
- Measures reflectance of energy
- Can predict a wide number of soil properties
Where can I find commercially available soil health testing?

**Self-assessments in Field**
NRCS Soil Quality Test Kit  

**Commercial labs**
- Brookside Labs  
  www.blinc.com/
- Ward Labs  
  www.wardlab.com/
- Woods End  
  woodsend.org/

**University labs**
- Cornell University  
  soilhealth.cals.cornell.edu/
- University of Missouri  
  cafnr.missouri.edu/soil-health/
Resources

https://soilhealth.osu.edu

Great, free online manual

http://soilhealth.cals.cornell.edu