THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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Summary

This resource is intended to provide some guidance to farmers, crop consultants and the agricultural industry who are wanting to collect soil health information in their fields. The information has been compiled from collective work based on the Healthy Soils Signature Program (soilhealth.osu.edu) and the Fertility Lab (soilfertility.osu.edu) at Ohio State University. For 2020, growers that participate in *eFields* trials are welcome to submit their soils through an OSU Extension Educator to the Soil Fertility Lab for Active C analysis. See below for more details.

Making Sense of Soil Health Testing

The topic of soil health has been receiving a great deal of attention lately and farmers are increasingly interested in understanding more about their soils. There are a number of labs that now offer some sort of soil health package, typically made up of tests that reflect biological, chemical and physical components of the soil. But as a farmer, how do you make sense of all these new soil tests, and what they mean for your operation and management?

Soil testing for nutrient analysis (standard soil testing) has a rich history, and in Ohio we enjoy an incredible infrastructure that helps us manage nutrients more effectively – from soil sampling services, to commercial soil testing laboratories, to the nutrient recommendations provided. These are all important pieces that inform us of what is required for optimal crop fertility.

Soil health testing seeks to build on this infrastructure by providing additional information to farmers. Rather than focusing solely on soil chemistry, soil health testing provides insight into the biological and physical components of soil and tie it all together in a common framework. This is a tall order and the field is still in development. There are many more questions than answers at this point, but scientists, agronomists, farmers and others are working together and trying to make sense of it all.

It is challenging to generate a list of 'recommended' measurements across all fields, as the list may vary depending on goals. To inform this process, there are some key questions a grower needs to answer:

- What is the goal with these measurements? Establish a baseline in your field? Understand how some change in management will impact your soil?
- What components are of greatest interest? Soil biology? Nutrient cycling? Compaction? Water infiltration and retention?

- Are you willing to make measurements in the field yourself, or do you want to send samples out to a commercial soil testing laboratory? Does the lab you normally send soils to offer any soil health analyses?

Key points to consider:

- Lab-based measurements are generally more reliable and reproducible than field-based measurements. Whenever possible, ***we recommend submitting soils to a lab for analysis***.
- Soil health testing can be expensive. Costs can be controlled by using the same soils you submit for standard nutrient analysis. ***We recommend running soil health analyses on the same soils (same depth, time of year, sampling densities and frequency) as you submit to a lab for nutrient analysis.***
- There are a number of promising tractor-mounted sensors and other tools that can provide feedback on soil health. Few have been independently evaluated to date. Examples include Precision Planting's Smart Firmer (OM, H2O), Veris iScan (EC, OM, H2O), Delta Force (downward hydraulic force for compaction layers and soil hardness), AirScout imagery (soil temperature, crop stress). This information can potentially be far cheaper to produce than laboratory analyses. ***Consider using these tools to help make decisions.***
- If you soil test for routine nutrient analysis, ***you already test for a really important soil health measure – total organic matter***. This is a number that you should pay attention to and constantly strive to increase. Numerous benefits are directly influenced by soil organic matter.

What follows are the recommended tests for Ohio growers, based on costs, robustness of analysis and the information it provides. The Soil Fertility Lab has been working to develop methods into a quick and affordable soil health testing package. At this time, we do not offer services to the general public, but can run some samples for research purposes. We are working to develop capacity over the next several years with the possibility of limited commercial testing.

Soil Chemistry

- Routine nutrient analysis provides a great foundation for assessing soil chemistry
- Optimal pH and available nutrients are a critical component of a healthy soil
- Total organic matter is typically run with a standard soil test and serves as a critical component to soil health
- Key lab measurements (already included with standard soil test):
    - Soil pH
    - Extractable nutrients, especially P and K
    - Total organic matter
- Key field measurements:
    - None recommended

Soil Biology

- Soil biological function
- Key lab measurements:
    - Soil Respiration – 24-hour CO_2 measurement (ex. Solvita)

- Active Carbon – biologically available C pool
- Soil Protein – biologically available organic N pool

Soil Physics

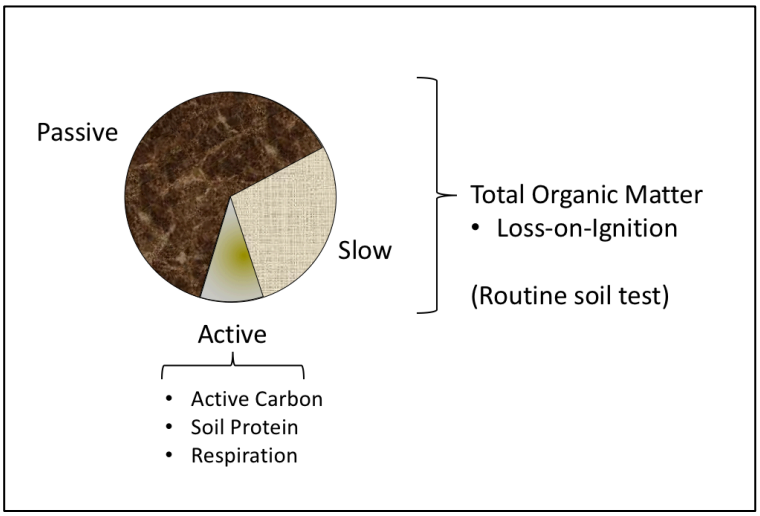
- Soil physical structure can be difficult to measure in the lab, because most soils entering the lab are immediately dried and ground
- Key lab measurements:
  - Aggregate stability via rainfall simulation
- Key field measurements:
  - Soil Compaction
  - Soil Infiltration

More details on tests can be found here: https://soilhealth.osu.edu/resources/publications

More on Soil Health and Active Organic Matter in Soils

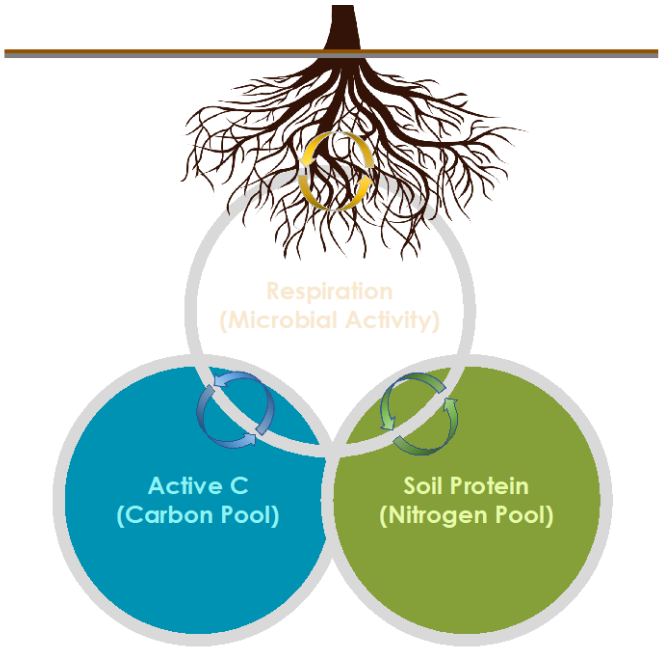
Total organic matter is a very important soil property that is commonly measured in routine soil tests. However total organic matter is not an ideal indicator of nutrient availability, because the majority of this pool is in forms that turnover slowly over time and hence not plant available. Active organic matter is only a small fraction (5-20%) of the soil's total organic matter, but is very important to crop nutrition since nutrients in this fraction are rapidly cycled and taken up by crops.

Not all organic matter is created equal. Total organic matter is made up of passive, slow and active pools. Each pool has different functions and important in its own right. The active pool feeds soil microbes and is the source of rapidly cycled nutrients that feed crops. Increasing the health of a soil will ultimately increase this smallest, but critical pool of organic matter.



We are working hard to develop meaningful and affordable soil health tests for farmers. Since soil organic matter influences so many soil properties, organic matter tests are of particular interest. Roughly half of organic matter is made up of carbon. Carbon is the backbone of life and is the currency that plants and the soil food web use to cycle nutrients and energy throughout the soil.

We are working with three tests that measure the active pool of organic matter: 1) active carbon, 2) soil protein, and 3) respiration. These tests each provide unique information about the active organic matter of a soil. They are complementary and related, as these three components interact to determine how fast and how much a nutrient will cycle within the soil and become available to growing crops. The larger the pools, the more fertile and resilient a soil will be.



This soil health test provides three measurements of active organic matter. Each measurement serves as an indicator of soil function. Respiration indicates how large and active the microbial community is. Active C indicates the amount of carbon (energy) available to the microbes. Soil protein indicates the amount of available organic nitrogen in the soil. Taken together these indicators provide insight into the health and fertility of a soil.

Active Carbon (Permanganate Oxidizable Carbon)

Active Carbon (or POXC) is a simple, inexpensive test that uses a weak oxidizing solution to measure readily available carbon. Oxidation is the chemical process of decomposition with oxygen. We can think of it the same way as a fire using oxygen to burn wood. In the case of the soil, it's a microorganism using oxygen to get energy (fire) from soil organic matter (wood). The more oxidation that happens, the more active carbon there is in the soil. Research has shown active carbon to be very sensitive to management changes (cover crops, tillage, rotations, etc.) and it is therefore a good indicator of recent changes to management.

Soil Respiration

Soil Respiration is a method that measures the burst of CO_2 from a dried soil over 24 hours after it has been rewetted with water. Drying and wetting cycles occur naturally in soils. When soils dry down, organisms go into a resting state to survive. This method measures how fast the soil food web can 'wake back up' and become active again. Carbon dioxide (CO_2) is the product of oxidation of active organic matter. (We can use the same analogy here as the burning wood with a fire.) The more CO_2 that is respired, the more active organic matter is in

the soil. Note the Solvita® test is based on this method. This test is also very sensitive to changes in management.

Soil Protein

Most of the nitrogen in soil is in an organic form, and the majority of this is made up of proteins from plants and microbes. Soil protein provides an important source of readily-available nitrogen that is recycled and taken up by plants. Our recent work shows this pool is a useful indicator of soil nitrogen availability. In addition to plant response, a robust soil nitrogen pool acts as a reservoir for the microbial community and soil resilience in general.

If you have any questions, please contact Dr. Steve Culman at culman.2@osu.edu or (330) 822-3787.