Soil Health Survey Across Ohio Farms

OBJECTIVE

Survey farm fields to better understand how soil health values are influenced by i) soil type and CEC, ii) sampling depth, and iii) past management practices such as no-till and cover cropping.

eFields Collaborating Farm

OSU Extension

Statewide

BACKGROUND INFORMATION

Measuring soil health properties represents a great opportunity to better understand how farm management practices impact key soil functions. Soil health testing builds on our current methods of soil testing to provide additional information to farmers. Rather than focusing solely on soil chemistry, additional biological and physical components of soil are incorporated into a common framework. Building and maintaining high functioning soils require that all three key components (chemistry, biology and physical structure) to be consciously managed and optimized.

There are many potential soil health measurements or indicators to choose from. For this study, we selected the following three indicators:

1. ***Total organic matter.*** A very important soil property that is has long been recognized as a master variable in soil. This is commonly measured in routine soil testing.
2. ***POXC (permanganate oxidizable carbon).*** POXC (aka, 'Active C') is a biologically active pool that represents a small fraction (<5%) of total organic matter. POXC is a more sensitive indicator of changes in management practices compared with total organic matter, which changes slowly over time. In contrast POXC represents a more dynamic pool of organic matter and nutrients that are more rapidly cycled and plant available.
3. ***Aggregate stability.*** Soil aggregation is the essence of a soil's structure. Soil minerals (sand, silt, clay) are bound together by organic matter to form micro-aggregates which, in turn assemble to form macro-aggregates. Aggregate stability is measured as the ability of a soil to hold together and not slake in water. This relates to greater pore space for gas exchange, faster water infiltration, resistance to water and wind erosion and compaction by traffic.

STUDY DESIGN

Soils were sampled from 88 fields across 26 counties in Ohio in May-July 2020. Soil cores (10-15 cores per sample) were taken from 3 different depths:

- 0 – 4 inch
- 0 – 6 inch
- 0 – 8 inch

Soil cores from each depth were pulled from the same locations. Fields represented different soil types and management histories (ex., long-term no-till vs. recently tilled, history of cover crops vs. no recent cover crops). All soils were mailed to the Ohio State Soil Fertility Lab for analyses. Analysis included:

- Routine nutrient analysis: pH, total organic matter, cation exchange capacity (CEC), Mehlich-3 extractable nutrients
- Permanganate oxidizable carbon (POXC)
- Aggregate stability (only run on a subset of samples)

RESULTS

Influence of Cation Exchange Capacity

A primary challenge of quantifying soil health is to know how soil type influences your values and what represents a 'good' vs. 'bad' value. Cation exchange capacity (CEC) is a reasonable predictor of soil type, with sandy soils having low CECs and clay soils having higher CECs. We examined how CEC was related to total soil organic matter, POXC (a biologically pool of organic matter), and aggregate stability (Figure 1). Overall, all three measurements increased as CEC increased. However, the slope (steepness) of the blue line represents the influence the CEC has on the soil health variable. Both total organic matter and aggregate stability had a stronger relationship with CEC than POXC. This suggests that POXC is less influenced by soil type, and more reflective of soil management history than total organic matter. This agrees with other studies that have shown this same trend.

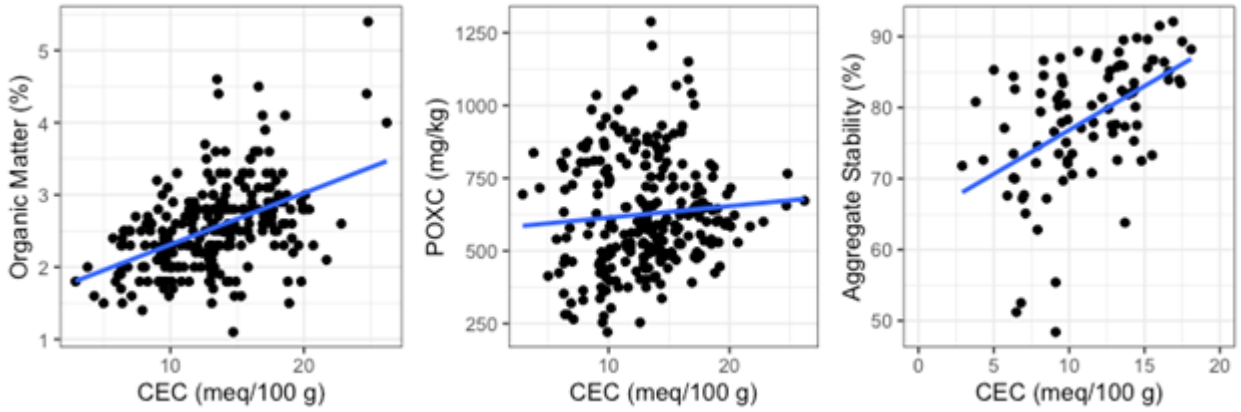

Figure 1. The influence of cation exchange capacity (CEC) on total soil organic matter, permanganate oxidizable carbon (POXC) and aggregate stability. Total organic matter is strongly driven by soil type, that is CEC, but POXC is influenced more by management.

Influence of Depth

As expected, most soil properties differed according to the depth the soil was sampled. The shallower depth (0-4") yielded greater values than the deeper sampled soils (0-6" or 0-8"). Nutrients and organic matter are naturally stratified in soil (enriched at the surface) relative to deeper depths. This underscores the importance of keeping sampling depth consistent between samplings and over time to be able to evaluate trends in soil test values.

Table 1. Soil properties by depth, averaged across all fields. Nutrients and organic matter were enriched in shallow depths (0-4") relative to lower depths (0-8").

Depth	pH	Organic Matter (%)	Mehlich-3 P (ppm)	Mehlich-3 K (ppm)	POXC (ppm)	Aggregate Stability (%)
0-4"	6.4	2.7	70.2	198.4	678.1	79.1
0-6"	6.4	2.5	61.0	181.0	621.0	79.0
0-8"	6.4	2.4	53.5	166.1	582.5	76.8

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RESULTS CONTINUED

Influence of No-Tillage

Years in no-tillage had mixed effects on soil health in farmers' fields (Figure 2). Measurements of total organic matter and POXC had a weak, but slight negative relationship with years in a no-till. However, aggregate stability increased on average as years in no-till increased. Overall, no-till did not show a clear trend in soil health, likely indicating that differences in soil type and other management practices need to be examined when considered effects of long-term no-till practices.

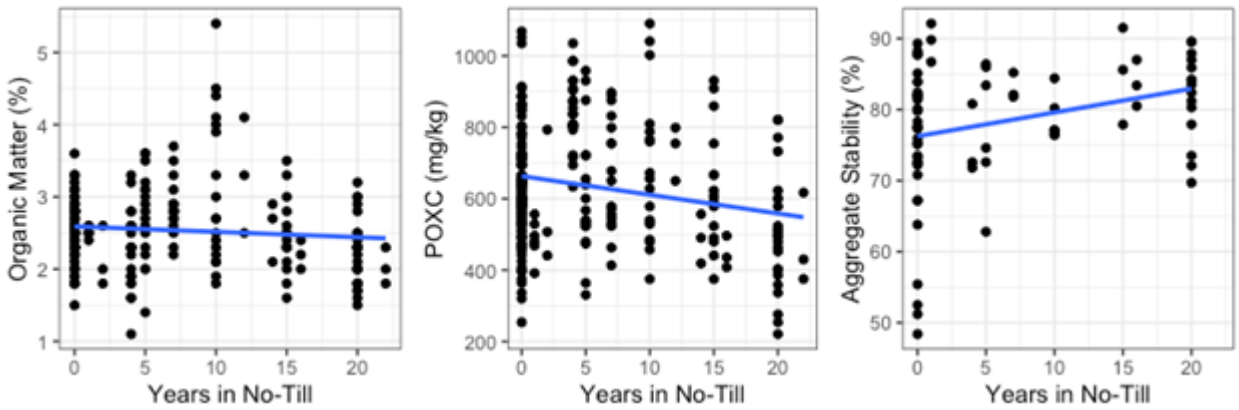


Figure 2. The influence of years in no-till on soil organic matter, POXC and aggregate stability.

Influence of Cover Crops

The number of years a field was in continuous cover crops was associated with positive increases in all three soil health measurements (Figure 3). These relationships were weak, but suggest that long-term cover cropping is associated with positive increases in soil health.

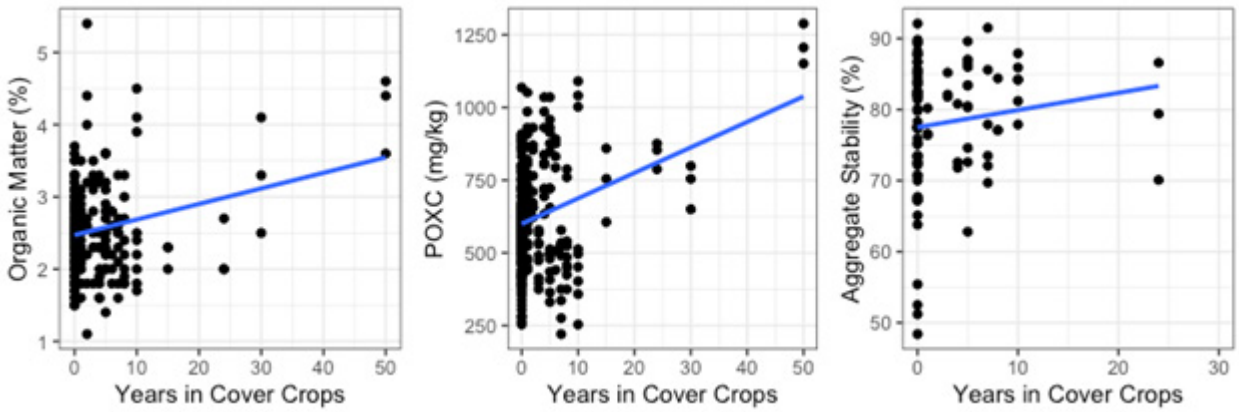
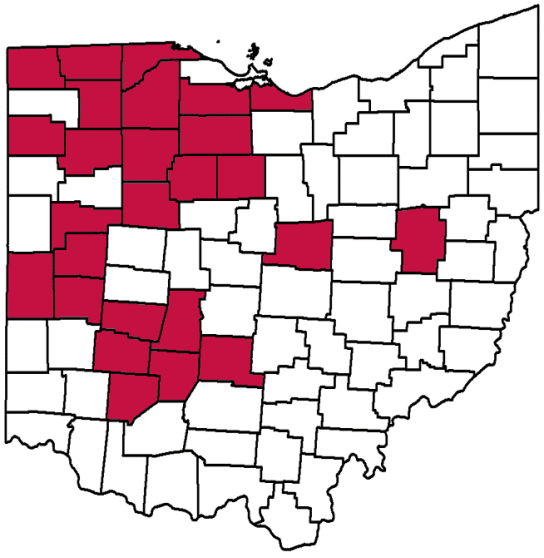


Figure 3. The influence of years growing cover crops on soil organic matter, POXC and aggregate stability.

SUMMARY

- Soil type matters. The type of soil has a major influence on soil health properties. We need to adjust what a 'good' soil health value is based on the type of soil. As CEC increases:
  - Total organic matter, POXC and aggregate stability increase
- Depth of soil sampling matters. As sampling depth increases, soil values typically decrease. We need to consider the depth sampled when we examine soil health values and be consistent with depth the soil is sampled over the years.
- Management matters. The way soils are managed over time have large impacts on soil health. Across 88 fields, we found that:
  - Years in no-till was associated with both increase and decreasing soil health values
  - Years in cover crops was associated with increases in soil health values
- Much more work is needed. Although we analyzed 261 soil samples from 88 fields, this dataset in no way is comprehensive and additional work is needed to better understand the trends observed here.



Soil samples were collected from fields across Ohio (counties highlighted in red are where samples were collected) and lab analyses that help characterize soil health.

TOOLS OF THE TRADE

Soil Health Evaluation
Soil samples can be used to better understand changes in the soil over time. Total organic matter, POXC, and aggregate stability are lab tests to consider when tracking soil health.

PROJECT CONTACT

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