# Conservation Cropping Systems Initiative

## Report Structure
This report is prepared for an individual farmer cooperator, with data from commercial soil health tests taken in 2015 and 2016. The report is structured as follows:
- Goals of the soil health tests analysis
- Summary of results from this individual cooperator
- Results in detail—this section discusses in detail the individual site results that are summarized in the immediately previous section, for the cooperator and others who may want to study the results in more depth.

A short summary of the results from all cooperators is provided in a separate report. Further synthesis of all data from all sites is ongoing, and will be provided as available.

## Soil Health
Soil health has been defined as "the capacity of soil to function as a vital living system to sustain biological productivity, promote environmental quality and maintain plant and animal health."[1] Developing sustainable agronomic practices is directly related to their ability to influence soil health. Any attempt to categorize an agricultural practice as sustainable must first consider the effect on the soil.

## Goals of Soil Health Analyses
A key component of the project conducted by the Conservation Cropping Systems Initiative (CCSI) is the evaluation of four different commercial soil health tests—Phospholipid Fatty Acids (PLFA), Earthfort Biological Soil Analysis, Cornell Soil Health Assessment, and Haney-Soil Health Tool. The objectives of this facet of the project are to assess the usefulness and value of the different commercial tests on evaluating the health of Indiana soils as well as the ability of the soil health indicators to distinguish among different cropping practices. Each of the four commercial soil health tests contain upwards of 10 separate soil health measures and most also include a ranking or calculation of overall soil health. While each of these commercial tests includes a large number of different soil properties, they each are supposed to evaluate overall soil health. One of the main goals of this project is to assess the usefulness of these tests on Indiana soils when comparing different cropping systems.

1 Doran et al., 1996; Doran and Zeiss, 2000

### Climate

| Climate | |
|---|---|
| Mean Annual Temperature: | 54.7°F |
| Mean Annual Precipitation: | 46.0 in |

### Location

| Location |
|---|
| No-till + Cover Crop |
| No-till, No Cover |
| Neighbor (Tillage, No Cover) |

## Individual Site Report:

# Mike Brocksmith
### Knox County

## Authors:
### Dr. Stacy Zuber
### Dr. Eileen Kladivko

## Summary of Brocksmith Site
The Brocksmith farmer site included comparisons of cover and no cover no-till treatments as well as a comparison with a neighbor in 2016. The three main soil health measurements that successfully detected differences between cover crop and no cover no-till treatments were active carbon, 96 hour soil respiration and water extractable organic C. Both of the carbon measures attempt to measure the same portion of soil organic matter, which is the part that is most easily available to microbes as food. This is important for encouraging microbial growth and nutrient cycling within the soil. Soil respiration is a measure of the activity of those microbes, indicating that not only do the microbes have food, but they are active. Together, these measures are strong indicators that the soil environment under cover crops is more habitable for microbes and supportive of a strong microbial community. However, neither of the soil commercial health tests that more directly measure the soil microbial community—PLFA or Earthfort, detected any significant differences between the cover and no cover plots within no-till.

The neighbor soil was in a lower landscape position with higher clay content than the cover and no cover no-till soils, even though both were mapped primarily as the same soil series (Patton silt loam). This difference in texture contributed to higher organic matter at the neighbor compared to the cover and no cover no-till treatments. In contrast, both cover and no cover no-till had greater water extractable organic N and the cover no-till had greater water extractable organic C than the neighbor. The no cover no-till also had greater total microbial biomass, total bacteria, and mycorrhizal fungi in 2016 than the neighbor. These measures indicate strong nutrient cycling potential within the no-till system plots. One complication is that the different cash crops in the no-till

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plots at Brocksmith vs. the neighbor in 2016 may have also reduced our ability to detect significant differences, as the corn at the neighbor may have temporarily increased several soil health indicators compared to the lower values with soybean in the no-till plots.

More work is needed to further evaluate the potential usefulness of these commercial tests for characterizing differences in soil health as found in Indiana cropland. The commercial tests as performed in this project, were often unable to distinguish between treatments that appear in the field to show differences. This may reflect a lack of sensitivity of the tests to important characteristics of key field soil functions. Please refer to the separate overall summary report for further discussion of overall questions, further analyses planned, and questions for future research on soil health assessment methods.

## Results

Results are presented in the following tables with a subset of a soil health measures from each of the commercial soil health tests evaluated in 2015 and 2016 at the Brocksmith farmer site. The selected variables were chosen based on preliminary analysis that indicated that these soil parameters had the greatest potential to be sensitive to conservation cropping practices and allow us to distinguish between treatments.

Average values are presented for each of the treatments at the location—cover/no-till, no cover/no-till, and neighbor (2016 only). We compared each of the treatments in pairs (cover vs. no cover, cover vs. neighbor, and no cover vs. neighbor) to evaluate them for statistically significant differences. These are found for each year in the column(s) to the right of the averages and degree of significance is indicated by the number of asterisks. Three asterisks (***) indicates a very strong statistical significance while comparisons with fewer asterisks are less statistically significant. Lower significance or lack of significant differences between treatments could be because of a smaller (or no) difference between treatments, but could also be due to greater variability within the measure so we are less confident that the apparent differences between treatments are real.

### Brief Statistics Primer—Statistically Significant Differences

Here is an example from one of our farmer cooperators of the highly variable numbers we are analyzing. The average total fungi for four strips of no-till with cover crops was 195 ng/g compared to the neighboring field with an average of 51.5 ng/g of total fungi. These seem like those numbers are very different, but the difference between them is NOT statistically significant.

***How in the world can these two numbers not be different? The no-till cover crop is 4x larger than the other, why do the statistics say they aren't different?*** Statistical analysis tries to determine how confident we can be that this difference is real and would occur again. It's not based just on how large the difference is. We compare how different the two fields are to the amount of variation within each field.

## Example

| Treatment | Rep #1 | Rep #2 | Rep #3 | Rep #4 | Average |
|---|---|---|---|---|---|
| No-Till + Cover Crops | 98 | 38 | 390 | 254 | **195** |
| Neighbor | 32 | 85 | 33 | 56 | **51.5** |

To make sense of this, we need to look to the numbers that go into the averages. For the no-till, cover crop field, we have numbers that are kind of all over the place with some lower values—38 and 98, but also two very high numbers—254 and 390. For this field, the average is much higher than the average of the neighbor, but there is a high amount of variability in this measure as well. With so much variability in the measure, we can't be confident that this treatment is truly different from the neighbor.

As an example, if you have a field that has a lot of variability in it, you could randomly select a few different spots to check for yield. Depending on what spots you check, you may think you could have record yields or that it's going to turn out to be a disappointing harvest. In this case, eventually you will harvest the whole field and so you know what your true yield is. For the soil health indicators we are looking at, we can only estimate these measures based on the 3 or 4 replicated plots in each field. When there is high amounts of variability, we have no way of knowing what the true average is so we need to be cautious in declaring these differences to be real. If we were to repeat this experiment with four different plots in those fields, we might get a very different average and the difference between the no-till cover crop and the neighbor might end up being much smaller.

The soil health measurements tend to be much more variable than standard soil fertility tests, as the soil biology can be very patchy with microbes clustering near cover and cash crop roots and residues. Wheel tracks can reduce pore space in the soil, affecting water and oxygen availability for microbes. We try to reduce this problem by collecting 20-30 soil cores from each strip to get a more representative sample, but high variability still remains. Soil biology can also change dramatically throughout the summer as moisture and temperature change so these tests only provide a snapshot of these measures at the time of sampling. Ultimately, these issues complicate our ability to detect significant differences even when there are large numerical differences between the treatments.

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## Site Details—Soils, Treatments

| Conservation Cropping System Experimental Plots | | | | | | |
|---|---|---|---|---|---|---|
| % of Field | Soil Series Name | Soil Texture | Slope | Drainage Class | Native Vegetation | Parent Materials |
| 73% | Patton | silt loam | 0-2 % | (very) poorly drained | Transition | Loamy glaciolacustrine deposits |
| 27% | Sylvan | silt loam | 2-6% | Well drained | Forest | Loess |

| Neighbor | | | | | | |
|---|---|---|---|---|---|---|
| % of Field | Soil Series Name | Soil Texture | Slope | Drainage Class | Native Vegetation | Parent Materials |
| 100% | Patton | silt loam | 0-2 % | (very) poorly drained | Transition | Loamy glaciolacustrine deposits |

**Treatment Details:**
Both cover crop and no cover system plots at Brocksmith were no-till. The neighbor was no cover with conventional tillage.

| Treatments | Summer 2013 | Fall 2013-Summer 2014 | | Fall 2014-Summer 2015 | | Fall 2015-Summer 2016 | | Fall 2016-Summer 2017 | |
|---|---|---|---|---|---|---|---|---|---|
| | Cash | Cover | Cash | Cover | Cash | Cover | Cash | Cover | Cash |
| **NT+CC** (MB 1,3,5) | CN | CR/CL/RD | SB | OA/CL/RD/RP | CN | CR/RP | SB | OA/CR | CN |
| **NT** (MB 2,4,6) | CN | – | SB | – | CN | – | SB | – | CN |
| **NBR** (MB 7,8,9,10) | ? | – | ? | – | ? | – | CN | – | SB |

NT+CC—Cover Crop No-till; NT—No Cover No-till; NBR—Neighbor
Cash and Cover Crop Abbreviations: CN—Corn; SB—Soybean; CR—Cereal Rye; CL—Crimson clover;
RD—Radish; OA—Oats; RP—Rapeseed
Cover crops are color-coded as light green.

| Soil Health Sampling Dates | Soil Moisture (%) | | |
|---|---|---|---|
| | NT+CC | NT | NBR |
| June 10, 2015 | 25.0 | 25.8 | – |
| June 14, 2016 | 19.6 | 20.7 | 20.3 |

## Phospholipid Fatty Acids (PLFA)

Phospholipid fatty acids are found in the cell membrane of all cells. Each microbial group also has specific fatty acids only found in the cell membrane of that certain group of microbes—these are called biomarkers. The amount of biomarker fatty acids measured in the soil tell us how large each of these microbial groups are within the soil sample.

- In soils, we look at total microbial biomass as well as several microbial groups—bacteria, fungi, mycorrhizal fungi, and protozoa.
- The PLFA tests in 2015 and 2016 were analyzed by two different commercial laboratories so the units between years are different and make comparisons between 2015 and 2016 difficult.

**Table 1.** Average values for Phospholipid Fatty Acid (PLFA) for cover crop no-till (NT+CC) and no cover no-till (NT) plots at Brocksmith from 2015 and 2016 as well as neighbor (NBR) in 2016. PLFA tests in 2015 were analyzed by Ward Laboratories and measured in ng/g while in 2016, PLFA tests were analyzed at the Missouri Soil Health Assessment Center and measured in nmol/g. Statistical differences within pairs of treatments are indicated as significant at <0.01 by ***, at <0.05 by ** and at <0.10 at *. Measurements in italics are calculations within commercial tests purported to be indicators of overall soil health. **NOTE: Different units and labs between the two years, make direct comparisons between 2015 and 2016 impossible, except for Diversity Index and Fungi:Bacteria Ratio.**

| **PLFA—Ward Laboratories** | **June 10, 2015** | | |
|---|---|---|---|
| | Average Values | | **Significant Differences** |
| | NT+CC (CN) | NT (CN) | |
| Total Microbial Biomass (ng/g) | 1120 | 1164 | |
| Total Bacteria (ng/g) | 541 | 583 | |
| Total Fungi (ng/g) | 104 | 24 | |
| Mycorrhizal Fungi (ng/g) | 12.3 | 0 | |
| Protozoa (ng/g) | 6.6 | 0 | |
| Fungi:Bacteria Ratio | 0.14 | 0.04 | |
| *Diversity Index* | 1.25 | 1.14 | |

| **PLFA—Missouri** | **June 14, 2016** | | | | | |
|---|---|---|---|---|---|---|
| | Average Values | | | Significant Differences | | |
| | NT+CC (SB) | NT (SB) | NBR (CN-Till) | NT+CC vs NT | NT+CC vs NBR | NT vs NBR |
| Total Microbial Biomass (nmol/g) | 72.3 | 86.5 | 64.5 | | | ** |
| Total Bacteria (nmol/g) | 38.8 | 47.1 | 34.1 | | | ** |
| Total Fungi (nmol/g) | 1.10 | 0.82 | 0.59 | | | |
| Mycorrhizal Fungi (nmol/g) | 2.70 | 3.18 | 2.19 | | | ** |
| Protozoa (nmol/g) | 0.34 | 0.82 | 0.37 | | | |
| Fungi:Bacteria Ratio | 0.20 | 0.19 | 0.20 | | | |
| *Diversity Index* | 1.32 | 1.33 | 1.34 | | | |

CN—Corn; SB—Soybean

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PLFA, cont

### Total Microbial Biomass
Represents the overall size of the microbial community within the soil; larger microbial communities indicate a more favorable environment for microbial growth and a healthier soil.
- No significant difference between treatments was detected in either 2015.
- Ward Laboratories, which analyzed PLFA in 2015, has a rating system for total microbial biomass (see Appendix).
  - According to the rating system, all of the plots at Brocksmith fall in the slightly below average category.
- In 2016, the total microbial biomass was significantly greater for the no cover no-till treatment than the neighbor.

### Total Bacteria
Bacteria are decomposers that help break down residues and cycle nutrients and are an important part of the microbial community. However, for optimal soil health, it is important that the microbial community not be dominated by bacteria. Therefore, a high bacteria number does not indicate by itself that the soil has high soil health.
- No significant difference between treatments was detected in 2015.
- In 2016, the no cover no-till plot had higher bacteria PLFA than the neighbor.

### Total Fungi
Fungi, like bacteria, are decomposers, but some fungi have fairly specialized enzymes that break down residues that are more complex and difficult to break down. They are also important to soil organic matter formation and soil aggregation. This makes fungi a very valuable part of the microbial community, and high levels of fungi can be a strong indicator of soil health.
- No significant differences between any of the treatments for fungi in either 2015 or 2016, but there was a trend towards more fungi in the cover crop soils both years.

### Mycorrhizal Fungi
Mycorrhizal fungi, also known as arbuscular mycorrhizae fungi (AMF), can be beneficial to many crops as they colonize plant roots and form mutually beneficial relationships. Mycorrhizae are able to scavenge for nutrients in the soil that the plant would not otherwise be able to reach—these can be especially important for P and N.
- No significant difference between treatments was detected in 2015.
- More mycorrhizal fungi measured in 2016 in the no cover no-till treatment than the neighbor.

### Protozoa
These microbes are important to nitrogen cycling within soils. Protozoa mainly feed on bacteria and as they eat, they release excess nitrogen that is then available for crop uptake.
- No significant differences found between treatments in either year.

### Fungi: Bacteria Ratio
As mentioned above, fungi can be a strong indicator of soil health so it is important to have a high ratio of fungi to bacteria.
- There were no significant differences between either of the conservation cropping systems in either year.
- Ward Laboratories has a rating system for this measurement as well (see Appendix).
  - Based on this, the values for the 2015 measurements for cover crop treatment fall in the slightly below average category and the no cover treatment measurement is categorized as very poor.
  - In 2016, both cover and no cover treatments were in the average category.

### Diversity Index
This measurement is calculated using the proportion of the microbial biomass that is in each of the microbial groups listed above and indicates how much diversity is found within the microbial community. High diversity is preferred as a microbial community is better able to deal with environmental stresses and able to decompose a more diverse array of residues.
- Ward Laboratories provided a rating system for this calculation as well (see Appendix).
  - The cover crop measurements are rated as average while the no cover plots are slightly below average in 2015.
  - The measurements in 2016 from both cover and no cover treatments are slightly above average.



Photo Credit: Betsey Bower

April 10, 2017. Cover crop at time of biomass sampling.

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## Earthfort Biological Soil Analysis

Similar to PLFA, this commercial test measures the size of various microbial groups; however, these measurements were made using microscopy, directly counting the size of these microbe groups. This analysis was only completed in 2015.

**Table 2.** Average values for Earthfort Biological Analysis in 2015 for cover crop no-till (NT+CC) and no cover no-till (NT) plots at Brocksmith farmer site. Statistical differences within pairs of treatments are indicated as significant at <0.01 by ***, at <0.05 by ** and at <0.10 at *.

| Earthfort | June 10, 2015 | | |
| --- | --- | --- | --- |
| | Average Values | | |
| | NT+CC (CN) | NT (CN) | Significant Differences |
| Active Bacteria (µg/g) | 55.2 | 58.4 | |
| Total Bacteria (µg/g) | 2197 | 1874 | |
| Active Fungi (µg/g) | 22.2 | 21.7 | |
| Total Fungi (µg/g) | 720 | 658 | |
| Protozoa--Flagellates (µg/g) | 6235 | 10499 | |
| Protozoa--Amoeba (µg/g) | 158689 | 331118 | |
| Protozoa--Ciliates (µg/g) | 35 | 39 | |
| Total Fungi: Total Bacteria Ratio | 0.36 | 0.35 | |

CN—Corn

*Total and Active Bacteria*
As mentioned above, bacteria are decomposers, but are not considered strong indicators of soil health. While some bacteria may be dormant or dead, active bacteria gives an indication of how many bacteria are able to actually cycle nutrients and contribute to decomposition of residues at the time of soil sampling.
- There were no significant differences between any of the treatments for either total or active bacteria.

*Total and Active Fungi*
Fungi are also decomposers, but because of their contributions to soil aggregation and soil organic matter, it is preferred to have high fungi levels and have a fungal dominated microbial community. Again, the active fungi gives a better indication of how many fungi are currently able to contribute to nutrient cycling.
- There were no significant differences between treatments for total or active fungi in 2015.

*Protozoa*
As mentioned above, protozoa eat bacteria and release excess nitrogen, which is now plant available. The Earthfort analysis measures the amounts of three different types of protozoa. Flagellates and amoebae are aerobic protozoa that require oxygen to survive. Ciliates are the largest and least common protozoa, and they are able to survive without oxygen in anaerobic conditions.
- There were no significant differences between any of the treatments for any of the protozoa types.

*Total Fungi: Total Bacteria Ratio*
Fungal dominated microbial communities are a strong indicator of soil health so higher values of the fungi: bacteria ratio are preferred.
- No significant differences were found between any of the treatments.

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## Cornell Soil Health Assessment

This commercial soil test consists of twelve different measures of different aspects of the soil, which are all rated and then combined together to form an overall quality score (out of 100). The chemical tests of soil pH, P, K and minor elements are not shown in this report as they were not different between treatments, but they are included in the calculated quality score. In general, most of the chemical tests were in the optimal range, reflecting long-term good soil fertility practices.

Note on Rating System:
The ratings in the Cornell Soil Health Assessment are determined by scoring functions for each soil property. The scoring functions used in this report are specific to the Midwest region and some differ based on the soil texture (sandy soils would be rated differently than finer soils). These scoring functions were developed based on a large database of measurements collected from throughout the region. Certain soil measurements rate higher for higher values (Aggregate Stability, Available Water Capacity, Organic Matter, ACE Protein, Soil Respiration, and Active Carbon). Surface and Subsurface hardness are rated higher with lower measured values. Others, such as pH and phosphorus, are rated closer to 100 when within an optimum range; above and below that range are rated lower.

**Table 3.** Average values for Cornell Soil Health Assessment in 2015 and 2016 for cover (NT+CC) and no cover (NT) no-till plots at Brocksmith and values in 2016 from neighbor (NBR). Statistical differences within pairs of treatments are indicated as significant at <0.01 by ***, at <0.05 by ** and at <0.10 at *. Measurements in italics are calculations within commercial tests purported to be indicators of overall soil health.

| Cornell Soil Health Assessment | June 10, 2015 | | | June 14, 2016 | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Average Values | | | Average Values | | | Significant Differences | | |
| | NT+CC (CN) | NT (CN) | Significant Differences | NT+CC (SB) | NT (SB) | NBR (CN-Till) | NT+CC vs NT | NT+CC vs NBR | NT vs NBR |
| *Quality Score* | 47.0 | 46.7 | | 55.1 | 57.3 | 53.6 | | | |
| Aggregate Stability (%) | 14.0 | 14.2 | | 25.2 | 24.2 | 23.2 | | | |
| Available Water Capacity | 0.30 | 0.30 | | 0.25 | 0.25 | 0.30 | | | |
| Surface Hardness (psi) | 261 | 318 | * | 299 | 276 | 279 | * | | |
| Subsurface Hardness (psi) | 346 | 321 | | 300 | 290 | 295 | | | |
| Organic Matter (%) | 2.17 | 2.10 | | 2.19 | 2.21 | 2.72 | | *** | *** |
| Active Carbon (ppm) | 432 | 404 | | 411 | 397 | 442 | ** | | |
| ACE Soil Protein Index | 4.70 | 4.40 | | 4.45 | 4.49 | 4.61 | | | |
| Soil Respiration-96 hrs (ppm) | 400 | 390 | | 380 | 350 | 290 | * | * | |

CN—Corn; SB—Soybean

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*Cornell, cont.*

### Quality Score
This is calculated based on the rating for each of the 12 different soil measures within this commercial soil health test. It is supposed to indicate overall soil health and values above 60 are considered excellent. Quality scores between 40 and 60 are rated medium and indicate soil health could still be improved. If the values are less than 20, this is considered a constraint and needs to be addressed.
- No significant difference in either year, but all values are rated as medium.
- Quality scores were higher in 2016 for both cover and no cover treatments.

### Aggregate Stability
This measures how well the soil aggregates stay together and can be a strong indicator of how well the soil is able to resist erosion. High aggregate stability can prevent crusting and increase water infiltration
- No significant differences were found between treatments, but measurements were higher in 2016 than in 2015.

### Available Water Capacity
This measures how much water the soil holds between field capacity and permanent wilting point, which is the amount of plant-available water the soil can store. Available water capacity is dependent on the soil texture as coarse texture soils are able to store much less water than finer soils. However, for a specific soil texture, more organic matter can increase available water capacity.
- There were no significant differences between any treatment for either year.

### Surface and Subsurface Hardness
These are measures of strength of the soil and is an indication of the physical structure of the soil. High levels of surface and subsurface hardness can restrict root growth and influence water infiltration. Surface hardness is measured in the top 6 inches, while subsurface hardness measures 6-18 inches. These measures can also be affected by soil moisture at the time of sampling. These numbers were taken with a cone penetrometer at the time of the field sampling
- In 2015, the surface hardness was greater in the no cover plots than the cover crop plots; however this difference was reversed in 2016 with greater surface hardness in the cover crop plots compared to the no cover plots.
  - These differences were rather small and are not likely to be of much practical significance.
- No significant difference in subsurface hardness in either year.

### Organic Matter
Soil organic matter is one of the most important indicators of soil health due to its relationship with many other aspects of the soil, including water infiltration and holding capacity, aggregate stability, and nutrient cycling. However, the limitation of this measure is that it can take several years to significantly alter organic matter.
- There were no significant differences between cover and no cover treatments in either year.
- The organic matter at the neighbor was higher than in either of the conservation cropping system plots.
  - Soil texture can affect the amount of organic matter in a soil as more clay can protect and stabilize organic matter. The neighbor soils have about 8% higher clay than the cover and no cover no-till plots which would contribute to the greater amount of organic matter at the neighbor.

### Active Carbon
This measures the portion of organic matter that is most easily decomposed by soil microbes. High active carbon is an indicator of good soil health and is much more sensitive to management changes than organic matter as a whole.
- While not statistically significant, there was a trend towards greater active carbon in the cover crop plots compared to no cover. This same trend was statistically significant in 2016.
- This is a good sign of soil health improvement with cover crops in conjunction with no-till.

### ACE Soil Protein Index
This is similar to active carbon as it represents the most easily cycled part of organic matter, but measures nitrogen. Proteins are readily broken down by microbes, which mineralizes N into plant-available forms.
- No significant differences were found in 2015 or 2016.

### Soil Respiration
Soil respiration measures the amount of carbon dioxide released by soil microbes over a certain period of time. For Cornell, it is measured over 96 hours so the measure is able to stabilize and is more consistent than measures over a short period of time. This measures how active the soil microbes are.
- There were no differences between the treatments in 2015.
- In 2016, soil respiration from the cover crop treatment was significantly greater than the no cover treatment as well as the neighbor.

## Haney-Soil Health Tool

Like the Cornell commercial soil health test, the Soil Health Tool consists of many different tests that evaluate different aspects of the soil. The tests focus on nutrient availability and microbe activity.

**Table 4.** Average values for the Haney Soil Health tool in 2015 and 2016 for cover (NT+CC) and no cover (NT) no-till plots at Brocksmith and values in 2016 from neighbor (NBR). Statistical differences within pairs of treatments are indicated as significant at <0.01 by ***, at <0.05 by ** and at <0.10 at *. Measurements in italics are calculations within commercial tests purported to be indicators of overall soil health.

| Haney-Soil Health Tool | June 10, 2015 | | | June 14, 2016 | | | | | |
| | Average Values | | | Average Values | | | Significant Differences | | |
| | NT+CC (CN) | NT (CN) | Significant Differences | NT+CC (SB) | NT (SB) | NBR (CN-Till) | NT+CC vs NT | NT+CC vs NBR | NT vs NBR |
|---|---|---|---|---|---|---|---|---|---|
| Nitrogen (N lb/A) | 72.9 | 67.1 | | 55.7 | 49.8 | 84.4 | | * | ** |
| Phosphorus ($P_2O_5$ lb/A) | 96.7 | 98.2 | | 126.8 | 122.8 | 24.2 | | *** | *** |
| Soil Respiration-24 hrs (ppm) | 162 | 165 | | 98 | 85 | 107 | | | |
| Water Extr. Organic C (ppm) | 199 | 209 | | 184 | 155 | 154 | ** | ** | |
| Water Extr. Organic N (ppm) | 16.5 | 16.4 | | 19.0 | 16.1 | 13.3 | | ** | ** |
| Carbon: Nitrogen Ratio | 12.1 | 12.7 | | 9.8 | 9.6 | 11.6 | | ** | *** |
| *Soil Health Calculation* | 19.8 | 20.3 | | 13.5 | 11.6 | 13.6 | | | |

CN—Corn; SB—Soybean

*Nitrogen and Phosphorus Nutrient Content*
These are measures of N and P currently in the soil.
- No significant differences were detected in 2015 for either N or P.
- For 2016, N was greater at the neighbor than both the cover and no cover no-till plots while P was greater in the cover and no cover plots than at the neighbor.
- These differences may be related to differences in fertilizer application and timing.

*Soil Respiration*
As for the Cornell soil respiration, this measures the amount of microbial activity by measuring the amount of carbon dioxide released. For this test, it is measured over 24 hours. Since this is such a short time period, these measures can be highly variable.
- No significant differences between treatments in either year.

*Water Extractable Organic Carbon and Nitrogen*
Like active carbon and protein in the Cornell commercial test, water extractable organic C and N are supposed to measure the amount of carbon and nitrogen in organic matter that is readily available to soil microbes.
- In 2015, there were no differences between cover and no cover for either C or N.
- In 2016, organic C was greater in the cover crop no-till plots than either the no cover no-till plots or the neighbor.
- Both the cover crop and no cover plots had greater water extractable organic N than the neighbor in 2016.

*Soil Health Calculation*
This is calculated from the 24 hour soil respiration as well as the water extractable organic carbon and nitrogen. It is supposed to represent the overall soil health and can range from 0 to over 30. While the Soil Health Tool does not provide a rating system, they do suggest that good management practices that improve soil health will cause this calculation to increase over time.
- No differences were detected between treatments in either year.

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## Appendix

The rating system provided by Ward Laboratories for Total Biomass, Fungi: Bacteria Ratio and Diversity Index.

| Rating | Total Biomass (ng/g) | Fungi: Bacteria Ratio | Diversity Index |
|---|---|---|---|
| Very Poor | < 500 | < 0.05 | < 1.0 |
| Poor | 500+ - 1000 | 0.05+ - 0.1 | 1.0+ - 1.1 |
| Slightly Below Average | 1000+ - 1500 | 0.1+ - 0.15 | 1.1+ - 1.2 |
| Average | 1500+ - 2500 | 0.15+ - 0.2 | 1.2+ - 1.3 |
| Slightly Above Average | 2500+ - 3000 | 0.2+ - 0.25 | 1.3+ - 1.4 |
| Good | 3000+ - 3500 | 0.25+ - 0.3 | 1.4+ - 1.5 |
| Very Good | 3500+ - 4000 | 0.3+ - 0.35 | 1.5+ - 1.6 |
| Excellent | > 4500 | > 0.35 | > 1.6 |

Conservation Cropping Systems Initiative

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**CCSI is a program of the Indiana Conservation Partnership  icp.iaswcd.org**

CCSI Individual Site Report
Brocksmith—2015 & 2016
Report date: Nov. 2017

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