

Soil Health Benchmarking 2017 – Stormont County

OSCIA Tier 1 – Stormont SCIA

Purpose:

To quantitatively assess the health of agricultural soils in Stormont County, and to establish benchmark measurements for future monitoring of soil health trends. The soil health assessment evaluates a suite of indicators of soil physical, chemical, and biological properties. The results of the assessment, along with a producer-completed Farmland Health Checkup, helps to elucidate potentially limiting factors to soil functions and crop production (e.g. compaction) or low-hanging fruit for targeted improvements (e.g. nutrient levels).

Methods:

Stormont SCIA members were invited to participate in the benchmarking project and were offered the cost of one analysis each. Those who wanted to have multiple fields or locations tested could do so at their own cost. Of the 13 participants, 12 found it worthwhile to do so.

Where multiple samples were requested, most decided to sample different fields, choosing to use the project to compare productive and less productive fields to see if the soil health assessment would help to explain the yield differences they experience. The other option was to sample a field and an adjacent fencerow, which could provide a comparison between agricultural and “natural” soil health within a field.

Samples and measurements were taken by OMAFRA staff and students between June 8th and June 14th, 2017. Participants were asked to identify a representative area of each field to be sampled. In these places, the in-field assessment was conducted on a 4 x 6m area. See appendix 1 for a list of analyses currently included in the Ontario Soil Health Assessment.

Thirty 6” (15cm) soil cores were taken from the sample area, mixed together and divided into three. The first portion was for lab analysis (phosphorus, potassium, magnesium, manganese, zinc, pH, organic matter and texture). The second part was sent for lab analysis for potentially mineralizable nitrogen and the third part was analyzed for aggregate stability.

Other measurements included sampling for nematodes where eight to ten cores were taken from the area for analysis. The top two inches (5cm) of soil were removed and the next six inches (15cm) were sampled. A soil probe was used to take a core of the soil profile to determine the depth of the A horizon. Infiltration measurements were taken using an eight inch (20cm) diameter ring. The ring was driven in the soil leaving about 2.5” (6cm) of the 4” (10cm) height of the ring above the soil surface. A plastic bag was placed over the ring and the soil. The equivalent of an inch (2.5cm) of water was poured onto the plastic. The plastic was removed and the time it took for the water to infiltrate was recorded. This was repeated and the second time was used for the infiltration measure. Infiltration was not measured on the fencerow areas. Three penetrometer readings were also taken in each sample area. The global position of the centre point of

Crop Advances: Field Crop Reports

the sample area was recorded so samples could be taken in the future to measure change.

An additional biological indicator was placed in one of the participants fields. A new, washed pair of men's cotton briefs was buried in the field leaving the waistband exposed.

Cooperators were asked to fill out the Farmland Health Check-up so their practices could be assessed using the assessment part of the check-up. It was used to help interpret the sample results and help to identify practices that could help to improve or maintain the health of a field.

The results of the assessments were given ratings, either categorical (poor to very good) or ordinal (score out of 100), and colour coded for ease of interpretation by participants. An example of how this would look for a single participant with three fields is given in figure 1 (scores provided in parentheses). For some properties, the ratings are dependent on soil texture.

	Indicators	Values	Values	Values
Physical	Texture	loamy sand	silt loam	loam
	Resistance	367 (31)	348 (35)	442 (10)
	A-horizon	7.1	10.2	8.3
	Aggregate stability	67.7 (89)	51.8 (86)	62.8 (96)
	Infiltration (min/in)	30.8 (M)	48.8 (M)	514 (S)
Chemical	pH	7.0	7.3	7.6
	P	15 (MR)	12 (MR)	10 (MR)
	K	56 (HR)	80 (MR)	73 (MR)
	Ca	2118.0	2952.0	4752.0
	Mg	58.0	64.0	94.0
Biological	OM (%)	4.1	4.1	4.7
	PMN ($\mu\text{gN/gdwsoil/week}$)	9.3 (24)	24.3 (90)	14.1 (44)
	Total Nematodes	4800	5600	6200
	% Parasitic Nem	1.3	20.0	13.9

Figure 1. Example of tabulated results from a participant who sampled three fields. Those indicators in red represent potentially limiting factors that should be addressed in priority.

Results:

A total of 28 samples were taken on thirteen cooperators' farms. Fields sampled were primarily in corn or soybeans, with only one field in hay.

Physical properties: Interestingly, soil textures were predominantly medium to coarse (silt loam to loamy sand), despite significant areas of clay loam under production in the county. One field sampled had an organic (muck) A horizon.

A horizon (topsoil) depth ranged from 7.1 inches (14 cm) to 16.5 inches (41 cm), with an average of 10 inches (25 cm). Shallow topsoil is generally less productive and can be an indication of erosion.

Aggregate stability is a measure of the extent to which soil aggregates resist falling apart when wetted and hit by rain drops. It is measured by the proportion of aggregates remaining intact after wet-sieving. The values ranged from 46% to 92% and averaged 63%. This is a measure where texture matters, so the rankings are more useful. They ranged from 30 to 100. Soils with low aggregate stability are more susceptible to wind and water erosion, as well as crusting and compaction, which can impact crop emergence and reduce water infiltration. Disturbance of aggregates by tillage disrupts aggregation processes and diminishes aggregate stability.

Water infiltration rates should also be rated relative to soil texture, as loamy sand has more rapid inherent drainage than silt loam. Relative to the expected rate, 25% of the samples infiltrated water more slowly than they should. These values ranged from 3.8 minutes per inch of water (min/in) to 514 min/in, and the average was 41.3 min/in. Penetration resistance (a measure of subsurface hardness) becomes a limiting factor to root growth above 300psi. Ranging from 295psi to 575psi, the average penetration resistance recorded was 379psi, and the average score was 24/100. Only one sample was under the threshold of 300psi and this was the indicator that had the most results in the "poor" category. Two of the fields sampled did not yield measurements as the soils were too stony.

Chemical properties: In general, the sampled soils were neutral to slightly alkaline, with an average pH of 6.8. Ranging from 5.7 to 7.7, only three samples were in need of lime. Above pH 7.5, potassium availability decreases, as do some micronutrients. Six samples were in this category.

Phosphorus (P) levels (bicarbonate extraction) ranged from 8ppm to 146ppm. The average P level was 26.7ppm (21.5ppm excluding the sample at 146ppm). Three samples were very low in P, though most were medium to high.

Potassium (K) levels were equally variable (56ppm to 354ppm, average of 130.5ppm), with two samples very low and most medium or high. Those samples testing low in K were not the same as those low in P, though the highest value for both was found in the same sample.

Calcium and magnesium were also tested. Calcium levels ranged from 1136ppm to 7053ppm, averaging 3252ppm, and were all sufficient. Magnesium levels ranged from 58 to 267ppm with an average of 134ppm, and six samples were low.

Biological properties: Organic matter (OM) levels ranged from 3.5 to 64.5%. The sample with 64.5% OM was from the organic (muck) soil. Without this sample, the average OM content was 5%. Organic matter levels are also rated according to texture, and on this basis every sample was in the “good” or “very good” category.

Potentially mineralizable nitrogen (PMN) is an indicator of the capacity of the soil microbial community to convert (mineralize) nitrogen tied up in complex organic residues into the plant available form of ammonium, and is expressed as micrograms of N per gram of dry soil per week ($\mu\text{N gdwsoil}^{-1} \text{ week}^{-1}$). Excluding the organic soil ($190 \mu\text{N gdwsoil}^{-1} \text{ week}^{-1}$), the values ranged from 4.8 to 38.8, averaging $22 \mu\text{N gdwsoil}^{-1} \text{ week}^{-1}$. On an ordinal scale, this represents scores of 8-100. Three samples were judged low, the rest good to very good.

Nematode samples were analyzed for total and parasitic nematodes. If over 30% of the nematodes are parasitic, that is cause for concern. The samples ranged from 0% to 74%. Four samples had high ratios, and two had no detectable parasitic nematodes. Four fields had low numbers of total nematodes, where a healthy number is 10,000 total nematodes. Two of these had high parasitic nematode populations and the lowest of these had the highest proportion of parasitic nematodes and also the lowest PMN score. Only one sample had more than 10,000 total nematodes.

After about 70 days in the ground, the underwear were collected, meticulously hand washed, and weighed when dry. Final weight was compared to initial weight to determine percent weight lost. The average weight loss was 35%, ranging from 13% to 54%. The higher this figure, the more active and effective the soil biology, which would also translate to faster residue decomposition in the field.

Summary:

Soil health is variable in those fields sampled in Stormont County. While most samples scored relatively well on most indicators, none were without room for improvement, though a few came close.

This project reinforced the need for a more rounded assessment of the state of our soils beyond the typical soil fertility test, which includes only organic matter as a proxy for physical and biological soil quality. This project clearly showed that this is not enough. All the sampled soils had high organic matter levels, yet low scores for penetration resistance and mediocre aggregate stability, for example, indicate that these properties – and the important soil functions they imply – could potentially be limiting the productivity of soils in Stormont County.

Next Steps:

Individual reports will be delivered to each participant once their Farmland Health Checkup workbooks are received. These will include recommendations for best management practices that could help to address the specific issues found on their fields.

More samples will give a more rounded picture of soil health in Stormont County and make this assessment tool available to more producers to inform their management decisions.

Acknowledgements:

Thanks to the participants for providing their fields and for completing the Farmland Health Check-up. Thanks to the summer students who helped with the sampling, especially those who were stuck washing the underwear, and data entry. This project came together with help notably from Scott Banks and Alan Kruszel.

Project Contacts:

Adam Hayes (OMAFRA) adam.hayes@ontario.ca

Sebastian Belliard (OMAFRA) sebastian.belliard@ontario.ca

Location of Project Final Report:

Appendix 1 – Indicators measured in the Ontario Soil Health Assessment

Physical

- A horizon depth
- Aggregate stability
- Infiltration rate
- Subsurface hardness (penetrometer)

Chemical

- pH
- CEC
- P
- K
- Mg
- Zn
- Mn

Biological

- OM
- PMN
- Nematode total:parasitic