Soil Health Benchmarks for New York State Farms

Overview

Quality standards exist to protect air and water resources, but no comparable metrics are available for soils. A study[1] was conducted to understand the factors that influence soil health in New York State (NYS). Soil samples were collected from locations across the state and analyzed for multiple biological and physical soil health indicators using the Comprehensive Assessment of Soil Health framework. Results were grouped by different production environments: two regions (Long Island and all other NYS regions), four soil types (coarse, loam, silt loam and fine), and six cropping systems (annual grain, processing vegetables, mixed vegetables, dairy crops, orchard, and pasture). From this scientific foundation, benchmarks were developed for farmers to target soil health levels that are realistic to achieve for any particular field or farm.

Background

On December 23, 2021, NYS signed the "Soil Health and Climate Resiliency Act" into law, which aims to support farmers in improving soil health as well as mitigate and adapt to the impacts of climate change. It also calls for the establishment of voluntary standards – or benchmarks – for soil health. The health of soils must be considered in the context of the natural conditions, which are influenced by geology, climate, landscape characteristics and biological processes, as well as human-driven effects from land use or cropping systems. Within any given context, management decisions can be made to achieve higher soil health levels, but land managers need realistic benchmarks for different production environments to assess their fields and guide management decisions.

Figure 1. A comparison between healthy soil with good soil structure (left) and compacted soil with poor soil health (right) from the same soil type and field. Benchmarks help evaluate the effects of management on soil health.

Policy Considerations

- **Promote Comprehensive Soil Health Metrics:** Apply physical, biological, and chemical indicators for effective soil health assessment and monitoring.
- **Adapt Metrics to Production Environments:** Tailor soil health metric interpretation to specific production environments, considering geographic region, soil type, and cropping system.
- **Advance Soil Health Benchmarks as Voluntary Standards:** Integrate soil health benchmarks into soil and water conservation programs to identify soil health concerns and establish targets. Benchmarks need to be (i) scientifically based (ii) relevant to production environments, and (iii) support realistic soil health targets.
- **Establish Pasture-Based Benchmarks as Reference:** Adopt pasture-based metrics as the upper-limit reference condition for assessing soil health gaps and setting aspirational targets for a farm or field.
- **Support Farmer Calibration:** Provide tools, education, and resources to align farmers' land management and business goals with soil health practices using benchmarks.
- **Develop Online Tool for Benchmark Comparison:** Explore an online tool enabling farmers and professionals to assess their soil health against voluntary soil health benchmarks.

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Results

Metrics for biological and physical soil health indicators, along with scoring functions (Figure 2), were developed for each production environment (chemical soil health standards were previously established):

Regional Variation

- Soil and climate differences impact soil health interpretation[2]

Soil Health Across Cropping Systems[1]

- Pastures & Mixed Vegetable maintain highest levels
- Annual Grain & Processing Vegetable face challenges
- Dairy & Orchard maintain moderate health metrics

Soil Texture Matters

- Soils with more fine silt and clay store more organic matter and labile organic carbon than coarse-textured soils

Benchmarks for each soil health indicator were established based on the 75th and 90th percentile of the distribution grouped by production environment. These represent soil health levels achieved by the top 25% or 10% of farmers, respectively. Farmers can use these benchmarks to assess their field's soil health levels relative to peers, providing realistic targets. We propose the 90th percentile benchmarks as aspirational soil health targets within a given production environment (Table 1). In addition, we propose the 90th percentile benchmarks for pastures as reference levels that represent optimum soil health conditions. Benchmarks can be accessed from an open-access publication[1] as well as the New York Soil Health website.

Table 1. Soil health benchmarks for loam soils in New York (not including Long Island). The 90th percentile of the distribution for each indicator is proposed as an aspirational target.

	90th Percentile					
Cropping System	**SOM**	**POXC**	**Protein**	**Resp**	**WAS**	**AWC**
	%	mg C/kg	mg/g	mg CO_2/g	%	g H_2O/g
Annual Grain	**3.7**	757	7.2	0.69	44	0.24
Processing Vegetable	3.5	579	6.5	0.66	44	0.23
Dairy Crop	4.5	775	8.8	0.89	66	0.24
Mixed Vegetable	5.6	927	14.7	0.86	62	0.25
Orchard	3.7	731	9.0	0.76	68	0.23
Pasture	**5.2**	895	11.8	1.27	82	0.26

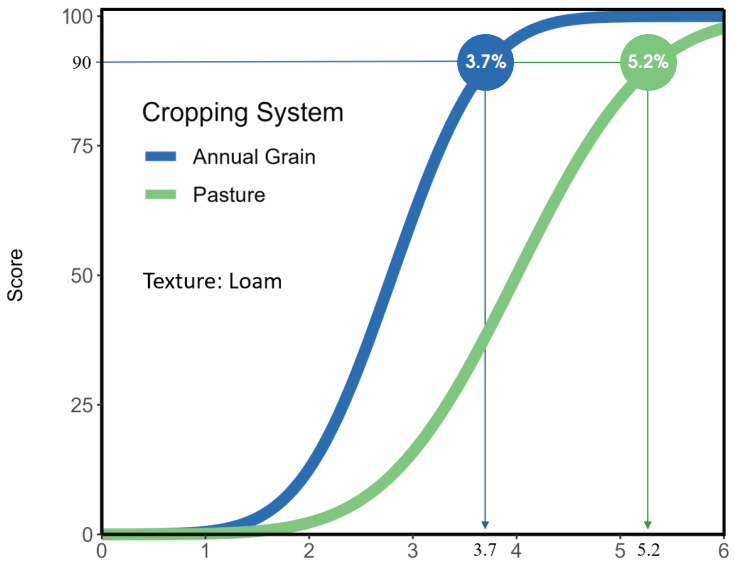

Figure 2. Soil organic matter scoring functions (cumulative distribution) for annual grain and pasture systems and loam soils in New York (not including Long Island) indicating 90th percentile benchmarks.

[1]Amsili, J. P., van Es, H. M., Aller, D. M. & Schindelbeck, R. R. 2023. Empirical approach for developing production environment soil health benchmarks. Geoderma Regional, 34, e00672. https://doi.org/10.1016/j.geodrs.2023.e00672.

[2]Aller, D.M., Amsili, J.P., and van Es, H.M. 2022. Status of Soil Health on Long Island Farms. New York Soil Health Initiative. Cornell University, Ithaca, NY.

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