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HEALTHY SOIL HEALTHY ENVIRONMENT

Soil Aggregate Stability: A Soil Health Physical Indicator

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A suite of soil health measurements are becoming available which are not part of the traditional soil chemical tests. Soil aggregate stability is an important physical indicator of soil health, which protects organic matter accumulation, improves soil porosity, drainage and water availability for plants, decreases soil compaction, supports biological activity, and nutrient cycling in the soil. Aggregates are primary soil particles (sand, silt, clay) held together in a single mass or cluster, such as a crumb, block, prism or clod using organic matter, calcium and metals as cementing materials. Soil aggregates are formed by natural forces (such as alternate wetting-drying) and organic substances derived from root exudates, roots, soil animals and microbial by-products which cement primary particles into smaller aggregates (micro-aggregates) or smaller aggregates into larger particles, such as macro-aggregates.

Micro-aggregates are 20–250 μm in size and are composed of clay microstructures, silt-size micro-aggregates, humic materials, organic-metal bridging, and mycorrhizal fungus hyphae: these particles are stable in nature. Roots and microbes combine micro-aggregates to form soil macro-aggregates. Macro-aggregates are linked mainly by particulate organic matter, fungi hyphae, roots fibers, and polysaccharides and are less stable than micro-aggregates. Macro-aggregates are greater than 250 μm in size and give soil its structural stability, and allow air circulation and water infiltration and drainage. Compacted soils have more micro-aggregates than macro-aggregates.

Recent research studies have suggested that polysaccharides like glomalin acts like a glue to cement micro-aggregates together to form macro-aggregates and improve soil structure. Soils composed mainly of micro-aggregates prevent water infiltration due to the lack of and/or reduced macro-pores in the soil, so water tends to pond on the soil surface. Farm fields that have been excessively tilled tend to crust, seal, and compact more than no-till fields with surface crop residues and a living crop with active roots to promote fungal growth and glomalin production.

Aggregate stability refers to the ability of soil aggregates especially macro-aggregates to resist disintegration when disruptive forces associated with tillage and water or wind erosion are applied. Wet aggregate stability suggests how well a soil can resist raindrop impact and water erosion, while size distribution of dry aggregates can be used to predict resistance to abrasion and wind erosion. The loss of these physical properties through soil destructive events (tillage) can turn a great soil into a problematic compacted soil of low crop productivity.

The Cornell aggregate stability test is measured by the fraction of dried aggregates that disintegrate under a controlled, simulated rainfall event similar in energy delivery to a hard spring rain; the value is presented as a percent, and scored against a distribution observed in regional soils with similar textural characteristics.

Test facility	Long-term grass sod	Corn with chisel plow
Woods End Lab	48 Medium	19 low
Cornell University	99 Optimal	14 very low
OSU Soil Health Center	89 Excellent	46 Low to medium

Table 1: Soil aggregate stability test results (2017 Wood County, Ohio for same soil health qualitative rating)

The Woods End lab test uses the Solvita Volumetric Method for aggregate stability. Results range from 0 to 80%, the high value being rare. Water stable aggregates result from the quantity of favorable soil texture (clay) combined with the quality of the biology system, which aids binding soil particles in a sponge-like network. VAST (Volumetric Aggregate Stability Test) measures this volumetrically in re-wetted soil that has not been machine-ground.

The Ohio State University Soil health test uses comprehensive wet sieving (5, 2, 1, 0.5, 0.24, 0.125, 0.053, and <0.053 mm, respectively) method to measure soil aggregate stability. Soil aggregate stability below 25% is considered poor physical quality, 30 to 50% is considered low to medium physical quality, 50 to 75% medium to good physical quality, and above 80% is considered excellent physical quality, scaled over similar textured soils.

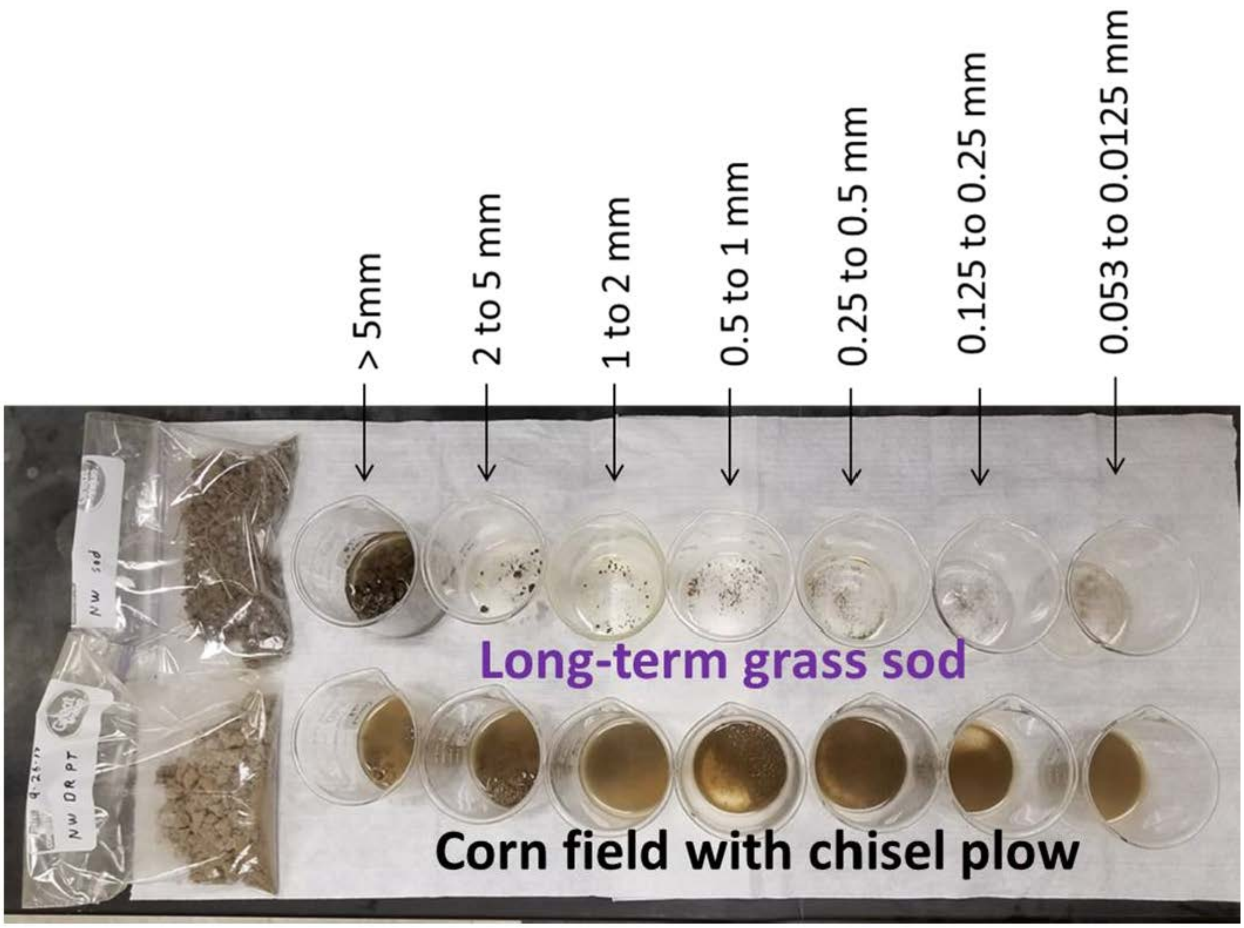
Resources

These labs conduct aggregate stability testing:

- soilhealth.cals.cornell.edu/ Comprehensive Assessment of Soil Health – Cornell University
- hwoodsend.org/soil-health-tool/overview/ Woods End Laboratories
- cafnr.missouri.edu/soil-health/ Soil Health Assessment Center – University of Missouri
- southcenters.osu.edu/soil-water-bioenergy/extention/soil – Ohio State University Soil Health Center, Piketon, Ohio.

More information on aggregate stability can be found at:

- Sundermeier et al. (2011) Continuous no-till impacts on soil biophysical carbon sequestration. Soil Sci. Soc. Am. J. 75:1779–1788.
- ohioline.osu.edu/factsheet/SAG-10 The Biology of Soil Compaction
- nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053287.pdf NRCS Soil Quality Indicators: Aggregate Stability



Picture: Vinayak Shedekar (OSU Soil Health Center)