Aggregate Stability

What are aggregates?

Soil aggregates are clusters of soil: sand, silt, clay, and organic matter held together by chemistry and biology. Aggregates come in many sizes. Small, microaggregates form from the binding of mineral particles. Bacterial sugars, fungal hyphae, and plant roots bind these microaggregates into larger, macroaggregates (Figure 2). A diversity of aggregate sizes, including macroaggregates, are a characteristic of healthy soil. Aggregate stability is the ability of aggregates to resist degradation from physical forces such as rainfall, wind, and tillage.

Figure 1: Aggregates are the foundation of soil structure. They create pore space for air and water movement and protected spaces for organic matter and microbes. Source: Interreg North Sea Region Carbon Farming, European Regional Development Fund.

Benefits of well-aggregated soil

Soils with many diverse aggregate sizes are porous and maintain natural ecosystem functions such as the following.

- **Provide habitat** for soil organisms such as beneficial protozoa, nematodes, and microarthropods, which graze on microbes and increase nutrient cycling.
- **Improve water management** by increasing water-holding capacity, improving water infiltration, and resisting surface crusting, thereby reducing soil erosion, runoff, and ponding of water.
- **Improve aeration** in soil to support healthy roots and beneficial soil organisms.
- **Protect organic matter** from decomposition. This organic matter can also provide a steady and stable source of nutrients for plants through time.

What affects aggregate stability?

Many factors affect a soil's aggregate stability, such as soil texture and soil biology. Sandy soils do not form aggregates as easily as silt and clays, and soils with more organic matter tend to have greater aggregate stability.

Each soil type has unique characteristics and inherent soil properties. You likely already know many of your soil's tendencies and behaviors. Testing for soil aggregation will give you additional information because it combines biology with physical properties.

We do not recommend the aggregate stability test for Vergennes clay soils because the method does not differentiate between the adhesion of heavy clays and aggregates.

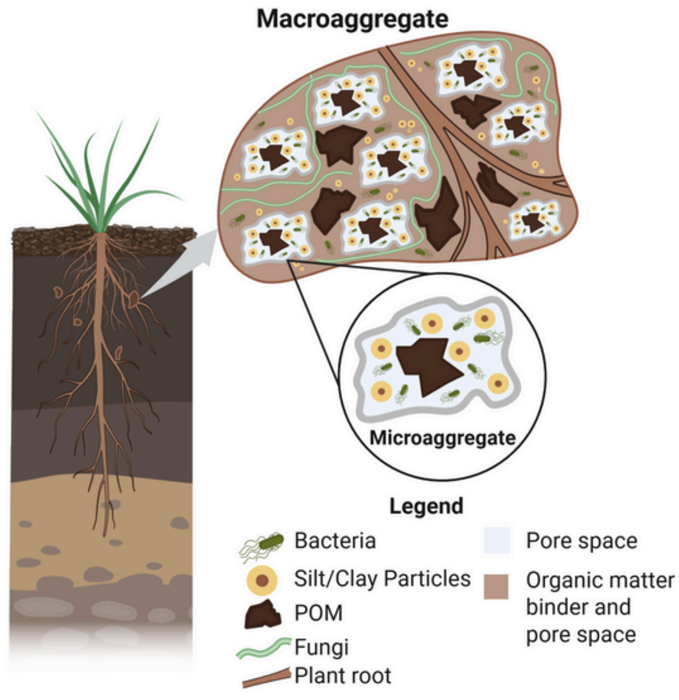

Figure 2: Detailed look at the protection that aggregates provide to organic matter and habitat for soil microbes. Microaggregates are clusters of bacteria, clay and silt particles, and particulate organic matter. Fungi, roots, and organic residues including soil protein bind microaggregates into macroaggregates. The space between these macroaggregates allows room for water, air, and roots, and creates habitat for soil microbes and microinvertebrates.
Inspired by Wilpiszeski et al. 2019. Created with BioRender.com

Basic protocol for testing wet aggregate stability

- Air-dried soil aggregates, sized < 8 mm, are spread across the top of a stack of 4 sieves arranged in descending order (2 mm, 500 µm, 250 µm, 53 µm mesh opening).
- The sieve stack is wet-sieved for 10 minutes using a motorized dunking machine: a Yoder apparatus.
- The sieves are drained, and each soil fraction is oven-dried and weighed. Rocks are removed and not included in final calculations.

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Understanding scoring

SHREC reports aggregate stability in two ways: percentage (%) of wet aggregate stability (WAS) for each soil fraction size class and mean weight diameter (MWD) for the whole sample.

WAS reports the percentage of the entire soil sample that each of the five soil size fractions (> 2 mm, 500 µm – 2 mm, 250 µm – 500 µm, 53 µm – 250 µm & < 53 µm) represents. Higher WAS percentages for the > 2 mm soil fraction are most favorable and indicate a more highly aggregated soil, an attribute of healthy soil.

MWD is the sum of the weighted mean diameters (mm) of all size fractions tested, with the weighting factor of each class being its proportion of the total sample weight. A higher MWD value indicates a healthier soil because it contains a diversity of aggregate sizes, including macroaggregates.

Samples submitted to SHREC will be used to inform interpretation of aggregate stability measurements based on management practices, geography, and soil type. SHREC aims to have a Vermont-specific scoring system (high, intermediate, and low values) in place as soon as an adequate quantity of representative soils have been processed.

How to improve aggregate stability

- **Reduce tillage**: Tillage physically breaks apart aggregates and introduces more air into the soil, which stimulates microbial decomposition of the organic matter holding aggregates together.
- **Add diverse organic matter sources:** Soil bacteria secrete residues that glue aggregates, and fungal hyphae bind aggregates. Feeding these microbes with green manures, cover crops, animal manures, and mulches will further build aggregates.
- **Increase crop diversity:** Crops with fine, deep, and extensive roots help bind and maintain aggregates. Crops that produce more surface residues protect aggregates from rain and wind. Cover crops help protect the soil surface and allow more organic matter accumulation.
- **Incorporate perennial crops** such as pasture, hay, fruit, and tree fruit/nuts. These systems eliminate tillage for multiple years and protect the soil from erosion, provide organic material, and maintain root systems to help build and retain aggregates.

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