Mosaic
AgriSight®
TRUSTED CROP NUTRITION EXPERTISE℠
ISSUE 19: 2021

Five Benefits of Soil Organic Matter

Organic matter (O.M.) plays a significant role in crop production and soil health. Building and maintaining a healthy soil that has more O.M. can aid in providing a stronger foundation for higher crop yields and resiliency to environmental stresses. Higher soil O.M. levels often translate into sustainable systems that produce higher, more consistent yields and greater long-term profitability. A review of soils with varying quantities of O.M. were correlated with yield and indicated productive soils often had 3.0-3.5% O.M. and that maximum yields were generally achieved on soils with approximately 3.75% O.M. (Figure 1, Fernández et al., 2012, Oldfield et al, 2019).

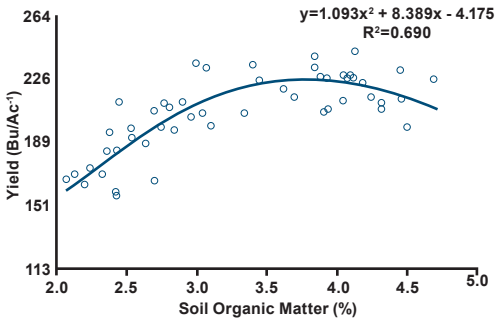


Fig 1: Relationship between topsoil organic matter and corn grain yield. Source: adapted from Fernández et al, 2012.

What is organic matter?

Organic matter is the fraction of the soil that includes approximately 5% of living organisms, 10% crop residues, 33-50% decomposing O.M. (the active fraction) and 33-50% stable O.M. (humus) by weight (USDA-NRCS, 2014). The active fraction of O.M. readily changes mass and form as it decomposes; thus, it is unstable in the soil and is most affected by management practices such as tillage, cover crops, and crop rotations (Carter, 2002). The rapid turnover of the active fraction can contribute to nutrient release for crops. Humus on the other hand, is organic matter that has been converted by microorganisms to a resistant state of decomposition. Humus improves soil fertility by acting as a reservoir for nutrients, increasing the water holding capacity of the soil, improving soil structure and friability, and providing a source of energy for living soil organisms.

The Benefits of Organic Matter

Increasing levels of O.M. improve the physical, chemical, and biological functions of the soil. The benefits of O.M. are summarized into the following five functions:

1. Biological Function

There are many benefits to O.M., most of which begin with enhancing the biological diversity and activity in the soil. As O.M. increases, microbial activity tends to increase. Organic matter consists of 58% carbon, which is required in combination with other nutrients for microbial activity. Micro-organisms excrete compounds that also act as a binding agent for soil particles, which can increase aggregate stability, water infiltration, and water holding capacity.

2. Nutrient Supply

Organic matter is a valuable nutrient source for plants and living organisms. As microorganisms increase their activity during warmer weather that occurs predominantly in the spring and summer, greater amounts of nutrients are cycled from organic forms into those that are inorganic and plant available. For every % of O.M. in the top 6-inches of a medium-textured soil (silt and loam soils), approximately 10-20 lbs. of nitrogen,

- Organic matter plays a significant role in crop production and soil health by improving physical, chemical, and biological functions in the soil.
- Increasing levels of organic matter aid in soil structure, water-holding capacity, nutrient mineralization, biological activity, and water and air infiltration rates.
- Soil organic matter is the single most important soil property that can be influenced through management practices.

1-2 lbs. of phosphorus, and 0.4-0.8 lbs. of sulfur are released per acre annually (USDA-NRCS, 2014). In addition, O.M. particles contain sites of negative charges (i.e., cation exchange capacity [CEC]) that attract and hold positively charged ions such as calcium, potassium, magnesium, and ammonium-nitrogen.

3. Soil Structure

Organic matter causes soil particles to bind and form stable soil aggregates, which improves soil structure. With better soil structure, water infiltration through the soil increases and improves the soil's ability to absorb and hold water as well as reduces the potential for surface crusting of the soil.

4. Water Holding Capacity

Soils with higher O.M. can infiltrate and store water at greater capacities. Organic matter behaves similar to a sponge, with the ability to absorb and hold up to 90 percent of its weight in water. A great advantage of the water-holding capacity of O.M. is that it will release most of the water that it absorbs. Figure 2 shows the increase in plant available water with higher O.M. content across three different soils. Increasing O.M. one percent in the topsoil decreases the bulk density and increases the available water capacity by approximately 0.2-0.3 inches, which can be extremely valuable to help plants manage water through periods of moisture deficits.

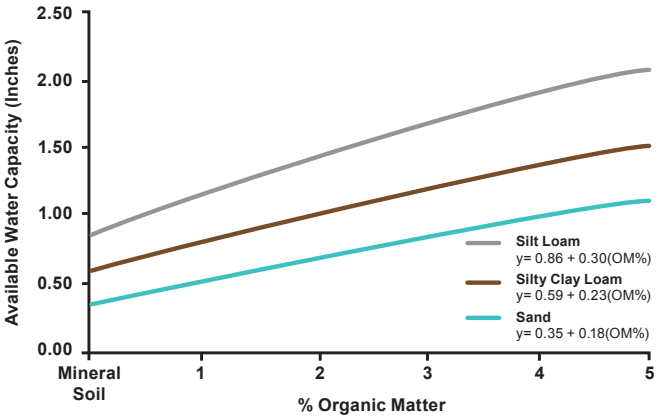


Fig 2: Relationship between organic matter (%) and available water capacity (inches) in the top six inches of three different soils. Source: Adapted from data by Hudson, 1994.

5. Erosion Control

Greater aggregate stability is often the result of soils with more O.M., which can increase water infiltration rates and result in reduced potential for water, soil, and nutrients to erode. Data used in the universal soil loss equation indicate that increasing soil O.M. from 1 to 3% can reduce erosion 20 to 33% because of increased water infiltration and stable soil aggregate formation.

Management Practices to Increase Soil Organic Matter

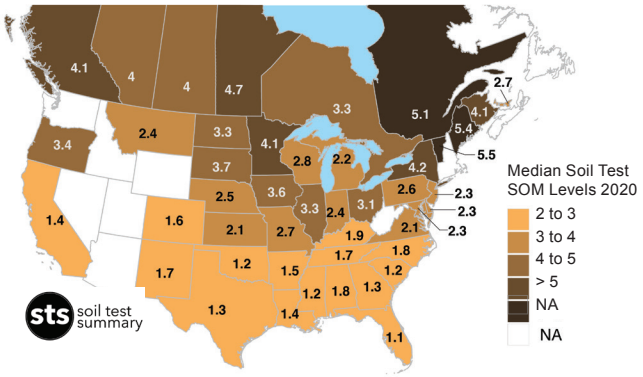
Several factors such as climate, soil type, crop grown, and specific management practices can each influence the amount of soil O.M. regionally or in specific fields; therefore, local conditions should be used as benchmarks for comparison when implementing practices to increase soil O.M. (Figure 3, STS).

Soils that have greater O.M., such as those originally developed in prairies, annually cycled residues to the soil whereas forest soils with lower O.M. took longer to cycle the woody material back to the soil. Building soil O.M. is a slow process that takes years or decades as it requires the addition of substantial plant biomass and protection from loss over time. Listed below are three management strategies to build and maintain soil O.M.:

1. Minimize tillage or adopt no-till: slows soil organic residue decomposition and gives greater protection to the soil from erosion.

2. Add crop residues by including cover crops, organic materials (e.g., residues, manure, etc.), or growing a high biomass/yielding crop rotation. Crop residues help protect the soil surface from raindrop impact and erosion and add carbon back to the soil.

3. Soil test and apply advanced crop nutrition: identify and correct yield-limiting factors to encourage greater growth of crops that can be returned to the soil. Adding crop residues that help build or maintain O.M and other potentially limiting essential crop nutrients can create more productive and sustainable cropping systems.



Only states with 2,000 samples or more are shown on this map.

Fig 3: Median soil organic matter (%), as measured in soil tests in 2020. Source: Soil Test Summary, 2020.

References:

Carter MR (2002) Soil quality for sustainable land management. Organic Matter and aggregation interactions that maintain soil function. Agron. J 94:38-47. doi: 10.2134/agronj2002.3800

Fernández, FG, Farmaha BS and Nafziger ED (2012) Soil fertility status of soils in Illinois. Commun. Soil Sci. Plant Anal. 43:2897-2914.

Hudson BD (1994) Soil organic matter and available water capacity. J. Soil Water Conserv. 49:189-194. doi: 10.1201/9780429445552-36.

Oldfield, EE, Bradford, MA, and Wood, SA (2019) Global meta-analysis of the relationship between soil organic matter and crop yields, SOIL, 5, 15–32, https://doi.org/10.5194/soil-5-15-2019.

Soil Test Summary (STS) (2020) Median Soil Test Organic Matter %, https://soiltest.tfi.org/maps/Median. accessed 6.14.2021.

USDA-NRCS (2014) Soil Organic Matter. United Stated Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Soil Health – Guides for Educators.

The Mosaic Company • 101 East Kennedy Blvd. • Suite 2500 • Tampa, FL 33602
800-918-8270 • www.CropNutrition.com