Soil Organic Matter

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition). Most of our productive agricultural soils have between 3 and 6% organic matter.

Soil organic matter contributes to soil productivity in many different ways. In this fact sheet, we describe the various components of organic matter and the different roles organic matter plays in soil productivity. We also discuss field management practices that will help preserve or increase soil organic matter levels over time.

What is Soil Organic Matter?

Organic matter is made up of different components that can be grouped into three major types:

1. Plant residues and living microbial biomass.
2. Active soil organic matter also referred to as detritus.
3. Stable soil organic matter, often referred to as humus.

The living microbial biomass includes the microorganisms responsible for decomposition (breakdown) of both plant residues and active soil organic matter or detritus. Humus is the stable fraction of the soil organic matter that is formed from decomposed plant and animal tissue. It is the final product of decomposition.

The first two types of organic matter contribute to soil fertility because the breakdown of these fractions results in the release of plant nutrients such as nitrogen, phosphorus, potassium, etc.

The humus fraction has less influence on soil fertility because it is the final product of decomposition (hence the term “stable organic matter”). However, it is still important for soil fertility management because it contributes to soil structure, soil tilth, and cation exchange capacity (CEC, see Agronomy Fact Sheet #22). This is also the fraction that darkens the soil’s color.

Benefits of Stable Soil Organic Matter

There are numerous benefits to having a relatively high stable organic matter level in an agricultural soil. These benefits can be grouped into three categories:

Physical Benefits

- Enhances aggregate stability, improving water infiltration and soil aeration, reducing runoff.
- Improves water holding capacity.
- Reduces the stickiness of clay soils making them easier to till.
- Reduces surface crusting, facilitating seedbed preparation.

Chemical Benefits

- Increases the soil’s CEC or its ability to hold onto and supply over time essential nutrients such as calcium, magnesium and potassium.
- Improves the ability of a soil to resist pH change; this is also known as buffering capacity (see Agronomy Fact Sheet #5).
- Accelerates decomposition of soil minerals over time, making the nutrients in the minerals available for plant uptake.

Biological Benefits

- Provides food for the living organisms in the soil.
- Enhances soil microbial biodiversity and activity which can help in the suppression of diseases and pests.
- Enhances pore space through the actions of soil microorganisms. This helps to increase infiltration and reduce runoff.

Organic Materials

Over time, the application and incorporation of organic materials can result in an increase in stable soil organic matter levels. Sources of organic materials include:

- Crop residues.
- Animal manure.

- Compost (Figure 1).
- Cover crops (green manure)
- Perennial grasses and legumes.

The quickest increases are obtained with sources that are high in carbon such as compost or semi-solid manure.

Figure 1: Compost application can increase soil organic matter levels over time.

Organic Matter Management

Farm practices that help to maintain or increase soil organic matter levels:

- Use of conservation tillage practices (for example zone tillage or no-till). Tillage exposes the organic matter to air and will result in the lowering of stable organic matter due to increased mineralization rates and erosion losses.
- Rotation of annual row crops with perennial grass or legume sods will reduce erosion and build up organic matter as a result of the decomposition of the rootmass.
- Establishment of legume cover crops will enhance organic matter accumulation by providing the nitrogen (N) needed for decomposition of freshly added organic materials, especially those with a high C to N ratio (corn stover, cereal straw, heavily bedded manure, etc.).
- Avoiding soil compaction which increases waterlogging, and maintaining proper pH to enhance microbial activity and decomposition of freshly added materials.

Actual buildup of stable organic matter will, in addition to the amount and source of organic material added, and tillage and rotation practices, also depend on:

- Soil temperature.
- Precipitation and soil moisture holding capacity.
- Soil type and drainage class.
- Existing microbial community.
- Soil fertility status and soil pH.

Monitoring Soil Organic Matter

To get an idea of the effect of farm management practices on soil organic matter buildup or decrease, soil samples should be taken over time. Consistency in sampling time is important to build records for fields over time (see Agronomy Fact Sheet #1). Although other tests are available, most laboratories will do a loss-on-ignition (LOI) test to estimate the organic matter content of the soil. At Cornell University, soil is exposed to 105°C (221°F) for 1.5 hours to remove soil moisture and then to 500°C (932°F) for 2 hours to determine LOI. Not all laboratories us the same method so for accurate records over time, it is important to consistently use the same laboratory service.

In Summary

With careful management the preservation and accumulation of soil organic matter can help to improve soil productivity resulting in greater farm profitability.

Additional Resources

o Cornell University Agronomy Fact Sheet series: nmsp.css.cornell.edu/publications/factsheets.asp.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

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Nutrient Management Spear Program
http://nmsp.css.cornell.edu

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