

Soil organic matter: The secret to successful farming

Dennis Hancock for *Progressive Forage Grower*

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The most important and least appreciated component of most farm operations is the organic matter in the soil. Some folks will read that first sentence, roll their eyes and stop reading. For those who have continued reading, I'll let you in on a little secret: If you want to increase your farm's return on investment, focus on protecting and improving soil organic matter (OM).

What is soil organic matter?

Scientifically speaking, soil OM is a collective term that refers to the amount of carbon-based material in the soil. In a sense, soil OM quantifies the living component of the soil (i.e., roots, fungi, bacteria, earthworms, etc.). Many do not realize that the soil is alive. It is a bustling metropolis of activity. Healthy soils have more species at work in one teaspoon than there are people in our whole country. The number and type of these organisms are an indication of how much productivity is occurring in

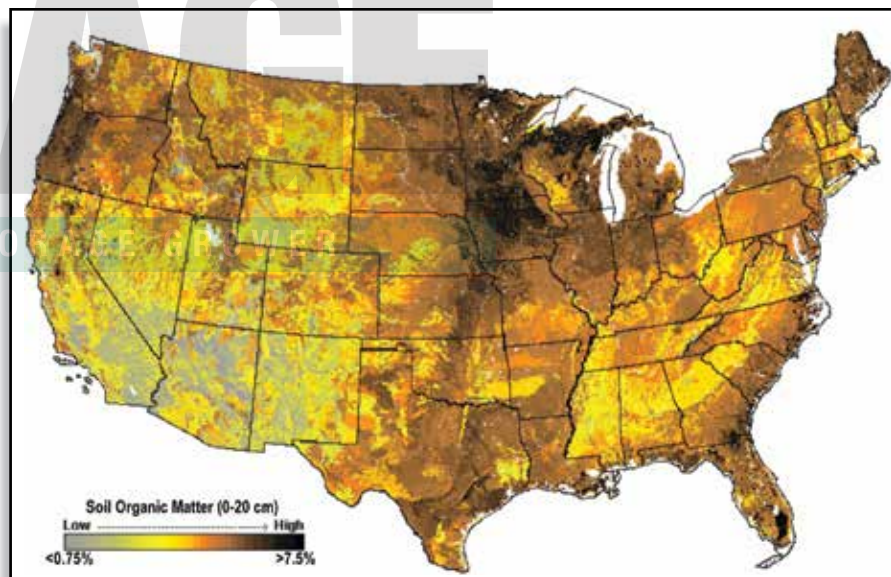
soil. There is a tremendous amount of diversity in the OM levels in the soils of the U.S. (Figure 1). It is no accident that the most productive farmland in the U.S. is located on soils where soil OM is very high (greater than 5.0 percent).

Why does OM matter?

Soil OM matters for several reasons. First, soil OM holds up to 90 percent of its own weight in water, so it acts like a giant sponge. Soil scientists have found that a 1 percentage point increase in soil OM can increase the soil's water-holding capacity by 20,000 to 27,000 gallons of water per acre, which is nearly 1 acre-inch of water. An acre-inch of rain can sometimes mean the difference in profit and catastrophic losses.

Soil OM is also a sponge for nutrients. It can hold up to 20 times more nutrients than an equivalent weight of sand, silt or clay. As a rule of thumb, every 1 percent of soil OM will release 20 to 30 pounds of nitrogen (N), 4.5-6 pounds of phosphorus pentoxide (P₂O₅), 10 to 40 pounds of potassium oxide (K₂O), and 2 to 3 pounds of sulfur (S) per acre over the course of each year. Because this release is dependent upon biological activity, most of these

Figure 1 Percentage of organic matter in the top 20 cm (~8 in.) of soil in the U.S.

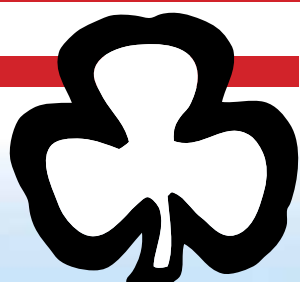


Source: Hargrove and Luxmoore, 1998, USDOE, Oak Ridge National Laboratory.

nutrients will be released in warm weather (i.e., spring and summer) and may not be as beneficial to winter crops. Additionally, soil OM buffers against changes in soil pH. This means that soil pH of soils with high OM are much slower to decrease than low-OM soils, allowing more years between lime applications.

Soil OM also provides a major

improvement in the structure of the soil. Soil OM helps soil particles to aggregate or clump together. These large aggregates are a sign of healthy soil. Soil with larger aggregates allows water to infiltrate faster, absorbs more water and decreases runoff. Because the soil more readily absorbs water, greater OM levels also can substantially decrease erosion.



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Stimulating root production and turnover

To produce more soil OM, one must stimulate new root growth. The roots of grasslands, whether in a pasture, hay or silage field, are regularly turned over. The frequency of this turnover is dependent upon how frequently the crop is cut or grazed. Each time a forage crop is grazed or cut, the root system dies back. As regrowth begins, new roots are formed and a new flush of exudates is released (Figure 2, page 46). But don't worry about the root exudates from the last growth cycle. Research suggests that many of the root exudates may last for over 50 years in the soil, if it remains in grass and is not tilled or aerated. Even the roots themselves take a while to deteriorate, as their lignin content is more than two times greater than the lignin concentration in the above-ground mass.

But not all defoliation is the same. Work in Georgia has shown that grazing bermudagrass can raise soil OM in the surface 2 inches by 50 percent or more in five years, while haying it only increases soil OM by 10 percent and leaving the land fallow will only increase it by 20 percent. In that study, intensively managed grazing at a land's carrying capacity resulted in the top inch of soil having a 2.2-fold increase in microbial biomass.

The effect of grazing is not always the same. A different study of the effects of grazing on soils in Georgia showed that soil OM in row crop land increased from about 1.0 percent to over 3.5 percent within eight years of conversion to intensively-managed, rotationally grazed dairy pastures. However, research done on the shortgrass and tallgrass prairies on the Great Plains show that grazing increases the number of fine roots in the top 4 to 6 inches of soil in shortgrass prairies, but not in tallgrass prairies. In fact, grazed shortgrass prairies were observed to have slight increases in total (fine plus coarse) root biomass, but the same management of tallgrass prairies resulted in a decrease in total root biomass. Consequently, grazing resulted in increased soil OM in shortgrass prairies and a decrease in tallgrass prairies.

There are a number of other complicating factors. For example, heavily stocking pastures beyond their carrying capacity has been shown to rapidly deplete soil OM reserves. Recent research out of China has shown that as forage utilization rate goes above 50 percent due to overgrazing, forage yields and root production decreases. In that research, maintaining moderate stocking rates (i.e. at the land's

carrying capacity) throughout the season optimized root production and soil OM. Even the location of shade and water sources can play a role. In general, soils located closer than 200 feet from shade or water will have a measurable increase in soil OM over time.

Does commercial fertilizer decrease OM?

In pastures and range, commercial fertilizer has

consistently been shown to benefit root production and soil OM in pastures managed for rotational grazing, but the impact on continuously stocked pastures is largely negative. The cycling of nutrients and regular re-inoculation of the soil with microbes via animal manure has a major positive effect. If manure is not added or is poorly distributed across the pasture, the benefits of grazing are muted.

Recent reports from northeast

China on grasslands harvested as hay demonstrate these effects. They compared the long-term (25 years) effects of fertilizing with commercial

Continued on page 46



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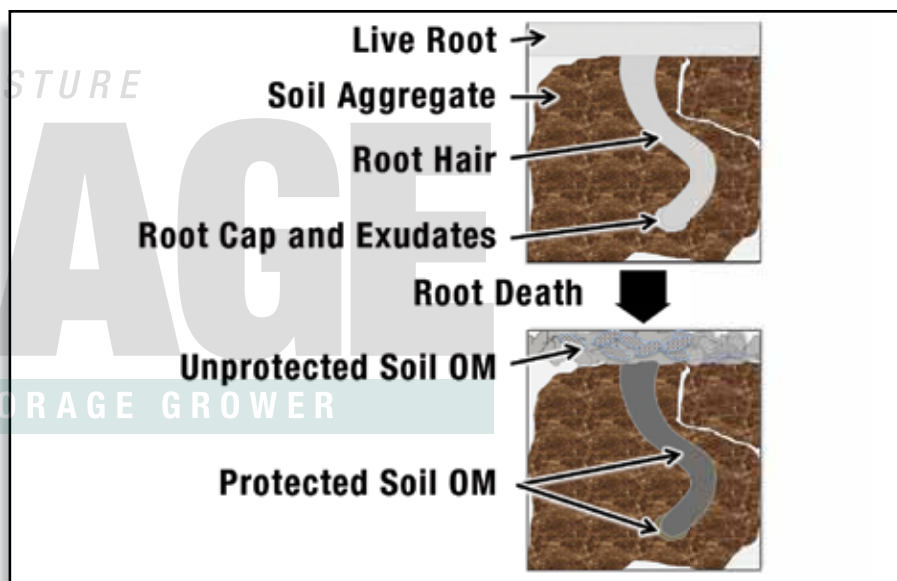
“ Soil scientists have found that a 1 percentage point increase in soil OM can increase the soil’s water-holding capacity by 20,000 to 27,000 gallons of water per acre, which is nearly 1 acre-inch of water. ”

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N fertilizer; recommended levels of N, phosphorus (P), and potassium (K) as commercial fertilizer; and manure with the balance of recommended fertility provided by commercial N, P, and K fertilizer. They found that the OM actually decreased in the top 8 inches of soil by nearly 15 percent when just commercial N or the NPK blend was used. However, if they used manure and added enough N, P, and K to meet the soil test recommendations, they increased soil OM in the top

8 inches by 33.4 percent and in the 8- to 16-inch depth by 47.3 percent! Manure is quickly decomposed, but this substantial increase in soil OM was not in the carbon fraction that is labile and quickly destroyed. The manure and NPK treatment bolstered the recalcitrant (stable) form of carbon in the soil. This is an indication of greater fungal growth and root development, as well as improved aggregate stability. The improvement is both to the benefit of soil OM and soil health. **FG**

Figure 2



As roots slough off or die, the OM in and associated with the root is left behind. The fate of this OM is dependent upon its chemical structure and physical location relative to the soil aggregate.



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