University of Kentucky
College of Agriculture, Food and Environment
*Cooperative Extension Service*

# How Understanding and Managing Soil Organic Matter Can Improve Beef Cattle Production

*Steve Higgins and Morgan Hayes, Biosystems and Agricultural Engineering*

Beef-cattle production is directly affected by soils, but active soil management is limited. Most producers' soil-management decisions are limited to submitting a soil sample, getting the analysis back, and then applying the tons of fertilizer or lime recommended at the bottom of the sheet. Meanwhile, producers request assistance to reduce or eliminate mud, weeds, gully erosion, and compaction (if they have identified compacted ground). Occasionally, producers don't have enough forage or hay to get cattle through drought or winter because of low forage production. These issues may have little to do with soil fertility but instead be directly related to soil properties.

## What is Soil Organic Matter (SOM)?

Soil organic matter (SOM) is an ignored component of an ideal soil (Figure 1). SOM is the organic component of soil, which consists of small plant residues, small living soil organisms, decomposing organic matter, and stable organic matter (humus) (NRCS). An ideal soil will have approximately 45 percent mineral content, 5 percent SOM, and 50 percent void space, which is occupied by water and air.

SOM should be important to a beef producer because a beef producer's input (forage) is used to create their output/product (beef) and improving the SOM will improve the forage production in a field. SOM can improve the soil by retaining moisture, increases water infiltration, acting as a reservoir of nutrients for crops, increases nutrient exchange, and reduces compaction. Every one percent increase in SOM increases a soil's water holding capacity by 27,000 gallons per acre. That is an increase of one acre inch in water holding capacity. This extra water holding capacity can make huge differences in the ability for grass to utilize rainfall. Although SOM may make up less than 5 percent of the total soil by weight, it can hold approximately 20 times its weight in water. Imagine how that could transfer into forage production during a drought. SOM also reduces runoff from fields by increasing the water infiltration rate. For example, when the steep slopes of the Eden Shale Farm receive a one inch rainfall event in an hour, the estimated infiltration rate might be as little as a sixteenth of an inch. Only 6 percent of the water infiltrates the soil, and 94 percent runs off. When this volume of runoff occurs on bare soil, the first components to wash away are the organic matter, the topsoil and nutrients. Erosion eventually reduces the forage productivity of that area. Vehicle and cattle traffic, as well as implements, could further reduce the potential of soil to produce forage by leading to compaction and further topsoil erosion. Desired forages will be lost and replaced with weeds, which flourish in poor soils. At this point, the cycle could spin out of control, which is often signified by gulley erosion. Producers who want to eliminate these conditions will face the costs and labor needed for renovation. Eliminating soil compaction may be difficult to accomplish or cost prohibitive.

If soil fertility is defined as the ability to supply nutrients for crops and forages, then soil productivity refers to a soil's ability to yield crops and forages. Factors that control soil productivity are SOM, soil texture, structure, depth, nutrient content, and water storage capacity. SOM directly or indirectly impacts four of the six factors to soil productivity. SOM is extremely important for producing forages and crops and therefore should be extremely important to beef producers. How does increasing SOM help? Increasing SOM increases the infiltration rate in soils in less than ideal situations, such as steep slopes where there may be low permeability and rapid runoff.

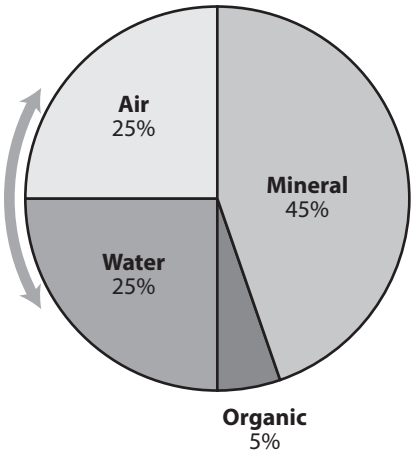


**Figure 1.** The physical makeup of an ideal soil.

SOM increases cation exchange capacity (CEC), which is a measure of the soil's ability to retain cations or anions, and the soil's capacity to retain nutrients. Soil organic matter may provide 40 percent to 50 percent of the soil's total CEC. SOM increases microorganisms in the soil profile that decompose organic matter and turn it into nutrients that forages utilize. The cattle themselves often cycle nutrients but without these microorganism, the nutrients are not available to the forages. Many of these microorganisms also eliminate harmful pathogens, which cause forage and animal diseases.

## What can a producer do to increase SOM though active soil management?

Producers interested in increasing SOM should use rotational grazing with a stocking density based on vegetative production. Frequent rotation or moving cattle to fresh pastures can increase SOM. Increasing the rest period or the time cattle are not in a field builds SOM.

A rest period of 30 days is considered an ideal target, but will need to be adjusted based upon forage growth. Time in a field should be limited to approximately six days or less, depending on stocking density. Thirty days of rest divided by a grazing period of six days equals five additional pastures. Six to nine pastures of equal size are an ideal number, though beef producers might have several dozen pastures depending on grazing days per pasture, herd size, and the size of the fields. Rotational grazing will increase grazing efficiency. Estimations of grazing efficiency are depicted in Table 1 based on increasing the number of paddocks and grazing days. The table shows there could be a ten to fifteen percent increase in efficiency moving from continuous to rotational grazing of five to eight pastures with a five-day grazing period. Another way of looking at the data is that there is an increase in efficiency from 30 percent to 45 percent (150 percent).

Not only does rotational grazing improve the SOM it also improves grazing efficiency of the cattle. In a study at the Eden Shale Farm in Owenton, KY, eight equally sized pastures with a five-day grazing period and 40 days of rest were compared to one pasture of continuous grazing. There was a 10-pound gain for the cattle in the continuous grazed field and a 49-pound gain in the rotationally grazed pastures, an almost a fourfold increase in productivity.

More pastures and reduced grazing time also decrease denuded areas, trampling, bare spots, etc., in pastures. Rotating a pasture into a hay field or allowing a field to lie fallow will boost SOM. Manure applications with rates based on a soil test requirements, a manure test for nutrient values, and a realistic crop yield also increase SOM.

**Table 1.** The efficiency achieved by increasing the number of paddocks in a rotational grazing system.

| Number of paddocks | Days of Grazing | Grazing Efficiency |
|---|---|---|
| 1* | >14 | 30 |
| 3-6 | 9 | 35 |
| 3-8 | 7 | 40 |
| 5-8 | 4 | 45 |
| 8-24 | <2 | 50 |
| >24 (or hay) | 1 | 70 |

*Or continuous grazing.
Source: USDA-NRCS

Beef-cattle production is directly affected by soils. It is the surface on which cattle stand and the media for growing forages. SOM is a critical component of topsoil and soil productivity. Beef producers who depend on forage production and healthy soils should not ignore SOM. Areas with unavoidable traffic should be hardened with an all-weather surface to protect the surrounding soil. Planned feeding areas designed with all-weather surfaces protect pastures during winter or drought, and they also reduce compaction and erosion of saturated soils. With thoughtful placement, these all-weather surfaces can keep tractors and equipment out of the field or reducing the number of passes and turns, especially when the soils are susceptible to compaction, improving both forage production and SOM.

Other ways to improve SOM include managing nutrients. While most producers are focused on adding nutrients based on soil tests to create forage for the cattle to eat, nutrient management also creates biomass in the root structures of the forage. The better the root development on forages the more material that can be broken down into SOM in the future. Similarly, dragging a field after rotational grazing to more evenly distribute manure can allow more plants to utilize the nutrients in the manure. This can create better nutrient availability across a field.

## So why should SOM be a focus?

In general, while beef producers may seek to improve nutrient availability in a field, they often don't actively seek to improve other soil properties like SOM. By actively managing SOM, in what are quite cost-effective ways, they can mitigate existing problems, head off future ones, and potentially benefit the bottom line. Losses in forage or hay production, the obvious results of erosion and compaction, may limit a producer's ability to get cattle through drought and/or winter. Ultimately, the practices described above (rotational grazing, utilizing all weather surfaces, and proper nutrient application) have additional value for beef producers, but the potential improvements to SOM are not often the focus. By not managing for SOM, additional costs may arise as a result of having to renovate pastures, particularly those with denuded areas. It is worth utilizing a soil test to not only apply nutrients but also to keep track of a field's SOM from year to year. SOM levels reported in a soil test will likely not shift quickly, but over time with good cattle management practices should rise.

## References

Brady, N.C. and Weil, R.R. 2002. The Nature and Property of Soils. Prentice Hall.

USDA NRCS. Soil Organic Matter Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053264.pdf



Issued 8-2020