

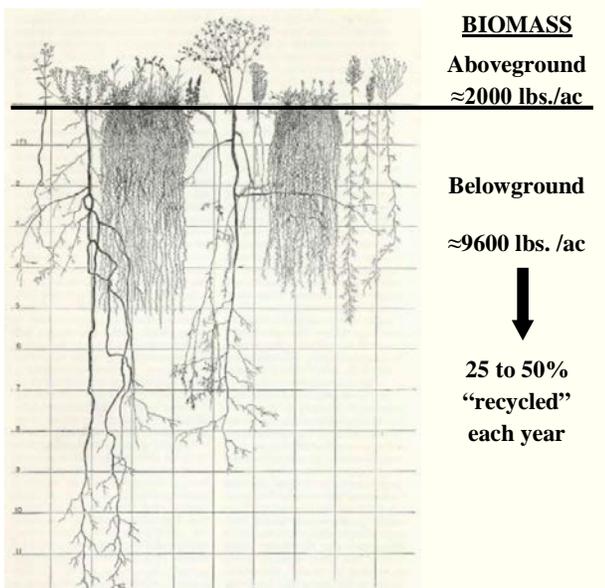
# Rangeland Soil Quality – Organic Matter

## What is soil organic matter?

Soil organic matter is carbon-rich material that includes a mixture of plant, animal, and microbial residue in various stages of decomposition. Soil organisms mix and breakdown soil organic matter through physical and biochemical reactions releasing carbon and nutrients back to the soil. Soil organic matter comprises 0.5 to 5% on a weight basis of the surface horizon of mineral soils.

The quantity and composition of soil organic matter vary significantly among major ecosystems. Soils in arid, semiarid, and hot, humid regions commonly have less organic matter than soils in other environments. Soil organic matter percentages for North Dakota rangelands would vary by ecological site (e.g. loamy versus wet meadow) and historically are believed to have ranged from 4 to 7% in the surface horizon (Parton et al., 1987).

Roots are the primary source of soil organic matter. Dead roots and gelatinous materials exuded by living plant roots are decomposed by soil organisms and converted into organic matter. In grasslands, 70 to 90% of the plant community’s annual production occurs below the soil surface. Every year about 25 to 50% of the total root biomass dies and becomes available for conversion to organic matter.



Plant residues which are in contact with the soil surface are important for providing soil cover, protecting the soil surface from rain drop impact and moderating soil surface temperatures. Accordingly, plant residues may impact the amount of organic matter at the immediate surface of the soil profile.

Soil organic matter includes three main fractions (Table 1). The light fraction is more biologically active than the other two and includes relatively fresh plant materials. Physically protected organic matter is locked within aggregates of mineral particles, where it is protected from microbial decomposition. Chemically stable organic matter gives soil its dark color and is generally the largest pool of soil organic matter. Physically protected organic matter may also be chemically stable.

**Table 1. – Soil Organic Matter**

Component	Rate of decay	Primary function
Light fraction	Weeks to months	*Serves as food for soil organisms *Stores and provides plant nutrients
Physically protected	Decades	*Enhances soil structure, porosity, and water-holding capacity
Chemically stable	Hundreds to thousands of years	*Holds nutrients *Stabilizes micro-aggregates and nutrients

## Why is organic matter important?

Soil organic matter enhances soil functions and environmental quality because it:

- binds soil particles together into stable aggregates, thus improving porosity, infiltration, and root penetration;
- enhances soil fertility and plant productivity by improving the ability of the soil to store and supply nutrients, water, and air;
- provides habitat and food for soil organisms;

- sequesters carbon from the atmosphere;
- reduces mineral crust formation and runoff;
- enhances water quality by actively trapping or transforming pesticides, heavy metals, and other pollutants.



### What affects soil organic matter?

The amount of organic matter in the soil is a balance between additions of plant and animal materials and losses through decomposition and erosion.

- **Environmental factors** interacting over time affect the amount of organic matter in soil. Rainfall and temperature affect plant productivity and the rate of organic matter decomposition.
- **Plant composition and distribution** control the distribution of organic matter in soil. The horizontal and depth distribution of roots, the distribution of plants across the landscape, and the susceptibility of roots to decay vary among species. The roots of forbs and shrubs generally contribute less organic matter to the surface layer of the soil than roots of grasses. Changes in the composition of plant species, especially from grasses to shrubs, affect the contribution of roots to soil organic matter.
- **Fire** initially reduces the amount of plant residue added to the soil surface. If the fire results in a shift from shrubs to grasses, however, the long-term effect can be an

increase in soil stability and soil organic matter.

- **Soil organisms** play an important role in the decomposition of root rhizosphere exudates and dead plant material including roots and above-ground litter. Root rhizosphere exudates are an important soluble energy source for soil organisms and can make up a sizeable portion of carbon fixed by plants.

As microbes decompose various organic matter materials, they convert nutrients into plant-available forms and release carbon dioxide into the atmosphere. Soil microbes such as soil fungi are important in developing physically protected carbon by stabilizing soil aggregates. Soil organic matter is subject to higher decomposition rates by soil organisms under warm, moist conditions than waterlogged, dry, or cool soil.

### Management strategies

Disturbances (e.g. grazing, fire, drought) or lack of disturbance (e.g. long-term rest) can affect vegetation composition and distribution, thereby increasing, decreasing, or maintaining the amount of organic matter in the soil. Improper grazing management reduces the amount of plant energy available for new root growth, altering the amount and distribution of organic matter within the soil profile.

Management strategies which will help maintain or increase soil organic matter in rangeland soils include:

- increase or maintain plant production above and below ground;
- promote the growth of species with high root production;
- promote a mix of species with different rooting depths and patterns;
- protect the soil from erosion by maintaining or increasing the plant cover and reducing the amount of bare soil and;
- properly manage grazing intensity, frequency, and timing to promote the desired plant community and protect the soil from erosion.

Parton, W.J., D.S. Schimel, C.V. Cole, and D.S. Ojima. 1987. Analysis of factors controlling soil organic matter levels in Great Plains grasslands. *Soil Sci. Soc. Am. J.* 51:1173-1179