

Soil Quality: What You Need to Know to Maintain Productivity!

Iowa Fact Sheet

Natural Resources Conservation Service (NRCS)
Des Moines, Iowa

March 2011

Soil Organic Matter/Soil Health

Perhaps the most important factor to consider for productivity is soil quality. One of the most important soil quality indicators is soil organic matter.

What Does Organic Matter Do?

Soil organic matter is that fraction of the soil composed of anything that once lived. It includes plant and animal remains in various stages of decomposition, cells and tissues of soil organisms, and substances from plant roots and soil microbes. Well-decomposed organic matter forms humus, a dark brown, porous, spongy material that has a pleasant, earthy smell. In most soils, the organic matter accounts for less than 5% of the volume.

Organic matter is an essential component of soils because it:

- provides a carbon and energy source for soil microbes;
- stabilizes and holds soil particles together, thus reducing the hazard of erosion;
- aids the growth of crops by improving the soil's ability to store and transmit air and water;
- stores and supplies such nutrients as nitrogen, phosphorus, and sulfur, which are needed for the growth of plants and soil organisms;
- retains nutrients by providing cation-exchange and anion-exchange capacities;
- maintains soil in an uncompacted condition with lower bulk density;
- makes soil more friable, less sticky, and easier to work;
- retains carbon from the atmosphere and other sources;
- reduces the negative environmental effects of pesticides, heavy metals, and many other pollutants.

Soil organic matter also improves tilth in the surface horizons, reduces crusting, increases the rate of water infiltration, reduces runoff, and facilitates penetration of plant roots.

Ways to Reduce the Impact of Residue Removal

1. Reduce or eliminate tillage operations

Tillage operations could bury much of the remaining crop residue and increase the rate of residue decomposition adding to the negative effects of crop residue removal. Switching to a no-till system would reduce the negative impacts of crop residue removal.

2. Reduce the number of years low residue crops are grown in the crop rotation

The negative impact of harvesting crop residue is greater if the rotation includes low residue crops such as soybeans. Switching from a corn-soybean rotation to a continuous corn, corn-corn-soybean or corn-soybean wheat rotation would somewhat offset the negative impact of removing crop residue.

3. Growing a cover crop

Establishing a cover crop prior to harvest or immediately after harvesting crop residue would minimize the negative impacts of crop residue removal. Cover crops protect the soil surface, enhance soil biology, capture remaining nutrients and, if legumes are included, add nitrogen back into the system.

4. Utilize manure

When applied at the correct rates, manure will not only replace some of the nutrients that were removed with the crop residue but will also add some organic matter back into the system. Manure alone would not be adequate for soil erosion control on HEL fields because it would not provide enough cover to protect the soil. Manure would work best in combination with a cover crop.

Soil organic matter contributes directly to the nutrient availability, nutrient holding capacity, and water holding capacity of a soil. It also plays a significant role in the formation of water stable aggregates in the soil which affects infiltration, aeration and drainage.

Soil organic matter also plays a significant role in soil health as it provides carbon and energy for soil microorganisms. These are essential for nutrient cycling in the soil and some form a mutually beneficial relationship with plant roots providing nutrients to the plants in exchange for energy in the form of simple sugars.

Removing crop residue in excess of what the soil can tolerate will ultimately result in the deterioration of the soil resource and declining yield. Research by the USDA-Agricultural Research Service at the University of Nebraska Agricultural Research and Development Center found an average yield decrease of 6% over five years for continuous no-till corn when an average of 50% of the crop residue was removed each year (Varvel et al, 2008). While the nutrients removed can be replaced, the functions of soil organic matter are not so easily mitigated.

Recommendations

To maintain productivity, residue must only be removed when soil quality will not suffer as a result. In some regions the combination of crop, management practice, soil, and climate work together to produce more than is needed to maintain soil health. In this case, excess residues could potentially be used for conversion to biomass energy. It is important to discern in what systems residue harvest is possible, or even beneficial, and at what rates (See Table 1).

Determine Sustainable Residue Removal Rates

Sustainable removal rates will vary by region and management system, sometimes even with fields. Removal rates will need to be reduced as climates become warmer or more humid; for lower C:N residue; for lower yielding crops; as soil disturbance (e.g. tillage) increases; and as soils become coarser textured compared to the conditions in which most studies occurred (in the Midwest Corn Belt for no-till corn).

Table 1: General Guidelines for Sustainable Residue Harvest (after USDA-NRCS 2006)

Sustainable harvest amounts will vary by:	Residue harvest rates should DECREASE with:	Recommendations for sustainable residue harvest:
Management practice	Increased soil disturbance	Use no-till with cover crops
Crop & yield	Lower yield or lower C:N	Harvest high residue crops and only in good yield years
Soil type	Coarser soil texture	Heavy clay, poorly drained soils are good candidates
Topography	Greater slope	Do not remove residue from steep hillsides and eroded knolls

Tools like RUSLE2, WEPS, and the SCI are likely to be the most practical ways to predict safe removal rates to maintain erosion protection and soil quality. Conservation planners in the NRCS Field Office can use RUSLE2 to determine harvestable crop residue using expected yield (and associated residue production) from producer records or county averages. Trial or ‘what if’ runs can be made with reduced amounts of residue (simulating harvest), to determine what amount is required to hold soil loss to T and maintain a positive SCI. The weight of crop residue available for harvest would then be determined by difference.

Table 2. General Benefits of Crop Residues to Soil Quality (after Larson, 1979)

Primary	Secondary	Tertiary
Contributes to soil organic matter	Improves Chemical, Physical and Biological Properties	Increases yield and yield sustainability
Provides Physical buffer	Reduces raindrop impact and wind shear	Reduces soil erosion

Using RUSLE2 and the Soil Conditioning Index (SCI) is probably the most expedient method to estimate sustainable residue removal rates in the NRCS field office.