Introduction

There are many properties influencing soil quality, but one that requires increased attention is soil organic matter. Organic matter is directly related to a number of vital soil functions and can be altered by land management practices. Surface residues protect the soil surface from the detrimental impacts of wind and water erosion. Also, organic materials incorporated into the soil provide an energy source for biological activity, a nutrient source for plants and microbes, and serve as a structural component that improves soil permeability. This Fact Sheet will provide a discussion of these benefits as well as management strategies that increase crop residues and soil organic matter.

What is Organic Matter?

Soil organic matter is composed of plant and animal tissue that is at different stages of decomposition within the soil. Soil organic matter must be separated into three basic components to provide a proper discussion of its benefits and management strategies in a no-till system. These three components include surface residues, belowground residues and humus. Humus is most often discussed, however, it is directly tied to surface and belowground residues, and each must be discussed in order to properly understand the role that organic matter plays in a soil system. Surface residues are aboveground plant matter which can be anchored by means of root mass, or simply laying on the soil surface. Belowground residues are partially decomposed organic material, which are located beneath the soil surface, such as roots, dead animals or residues buried by animals. Humus is the stable fraction of organic matter that has undergone humification, where microbes decompose organic residues into dark colored complex structures.

Importance of Organic Matter

Each component of soil organic matter benefits a no-till production system in a different way. Understanding the importance of these components is critical to maintaining a no-till production system.
Factors Controlling Organic Matter

Content of Soils

Soils in Oklahoma are very diverse due to rainfall and temperature gradients, as well as the wide range of parent materials from which they are formed. Therefore, the amount of organic matter found in Oklahoma soils can vary greatly. In fact, the organic matter content of Oklahoma’s historically cultivated cropland soils ranges from 3.5 percent in the silty clay soils of northeast Oklahoma near Miami, to as little as 0.5 percent in the loamy sand soils in southwest Oklahoma near Fort Cobb.

Native vegetation plays a direct role in the organic matter present within a specific soil system. Soils formed under grassland systems will contain deep layers of organic matter due to the growth and die-back of roots under prairie grasses. In contrast, much of the organic matter in forest systems is deposited on the surface from leaf litter and therefore organic matter contents will be shallower than that of a grassland system. Typically, soils formed under grassland systems will contain a higher overall organic matter content.

Soil texture directly influences the amount of organic matter found within a soil system. Coarse textured soils are more aerated, and will have less organic matter due to the presence of oxygen resulting in rapid decomposition. Sandy soils generally have low productivity therefore crop residue input is lower in very sandy soils. In contrast, fine textured soils will contain more organic matter due to the fact that they are more productive; therefore, more residues are available. Aeration is also lower, particularly in soils containing high levels of clay. Lastly, organic matter can form complexes with clay particles which decrease its susceptibility to microbial decomposition.

The amount of organic matter found in soils is also influenced by soil moisture and temperature. First, moisture influences plant growth, therefore, if all else is equal, organic matter concentrations decline in Oklahoma as we move from east to west due to decreased productivity from lack of rainfall. Additionally, anaerobic conditions caused by excessive wetness will slow the decay due to a lack of oxygen; this is why organic matter can accumulate in wetland soils.

The most substantial loss of organic matter in Oklahoma cropland soils is from tillage. The Magruder plots, a long-term continuous wheat trial established in 1892, found that after more than 100 years of tillage, 55 percent to 67 percent of organic matter was lost (Davis et al., 2003). Tillage increases aeration and soil temperature, thereby increasing the rate of organic matter decomposition. Also, replacing perennial grassland with continuous wheat decreased the amount of residues deposited in the soil system annually, which contributes to this decline. In addition, organic matter has been lost from our cropland soils as a result of erosion. There is no reliable data available to assess the magnitude of this loss mechanism. Yet, the impact of erosion on organic matter concentrations in soils can be observed when highly eroded soils are compared to similar soils where erosion was minimal.

Managing Organic Matter and Crop Residues

Carefully managing organic matter and crop residues is a critical part of maintaining or increasing productivity in a no-till system. There are a variety of specific ways to increase organic matter and crop residues including the intensification of crop rotation, establishment of cover crops, and the reduction or elimination of grazing.

Intensification of your crop rotation will generally increase below and above ground residue input into the soil system. The inclusion of cover crops where cash crops are not practical can be used to increase residue as well. Keep in mind that crop type is an important consideration for residue management.

Table 1 provides estimates of below and above ground residue for crops commonly grown in Oklahoma. Crop type influences the distribution of above and below ground residues. For example, a 120 bushel corn crop will produce more
aboveground residue compared to a 30 bushel wheat crop or 36 bushel canola crop. However, on a per pound of yield produced basis, wheat and canola produce approximately two times the above ground biomass of corn. In addition, canola will produce 1 lb of root biomass in the top 4 inches of soil for every lb of grain, in contrast to corn which produces only 0.2 lbs of root mass per lb of grain yield.

The C:N ratio also plays a factor in residues, the higher the ratio the more resistant that residue is to being broken down by soil microbes. Soybeans have a low C:N ratio (30:1) and will break down faster compared to residues of other crops. The structural characteristics of surface residues are also important in determining decomposition rates. For example, residues that are lying on the ground will tend to decompose quicker than upright residues because they are in direct contact with the soil surface. This is another reason to minimize traffic on no-till fields. When possible, efforts should be made to maximize harvest height.

No-till production systems can be successfully grazed, in fact, recent studies in the southeast United States (Franzluebbers and Stuedemann, 2006) have shown that moderate to light grazing of cover crops can improve microbial activity. However, caution should be taken, especially in graze-out situations, to ensure that sufficient residues remain to cover the soil surface. No studies have been conducted to determine the specific amount of residue needed after graze-out, but a good rule of thumb would be to leave sufficient residue to cover 80 percent of the soil surface. This will prevent crusting and allow for water infiltration and the alleviation of compaction after the cattle are removed. If graze-out results in limited residue, a high residue cover crop, such as forage sorghum, will provide beneficial cover to the soil surface and provide summer grazing potential or an additional hay crop.

### Table 1: Average yields, amount of surface residue and roots in the top 4 inches producer per pound of yield and average amount of residue and roots left after common crops in Oklahoma.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average yield</th>
<th>Surface Residue</th>
<th>Roots in Top 4 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs acre⁻¹</td>
<td>lbs lb⁻¹ of yield</td>
<td>lbs acre⁻¹</td>
</tr>
<tr>
<td>Wheat</td>
<td>30 bu</td>
<td>1800</td>
<td>1.7</td>
</tr>
<tr>
<td>Canola</td>
<td>36 bu</td>
<td>1450</td>
<td>2.0</td>
</tr>
<tr>
<td>Corn</td>
<td>125 bu</td>
<td>7000</td>
<td>1.0</td>
</tr>
<tr>
<td>Sorghum</td>
<td>47 bu</td>
<td>2600</td>
<td>1.0</td>
</tr>
<tr>
<td>Sunflower</td>
<td>52 bu</td>
<td>1300</td>
<td>2.2</td>
</tr>
<tr>
<td>Cotton</td>
<td>1.4 bale</td>
<td>680</td>
<td>3.0</td>
</tr>
<tr>
<td>Soybean</td>
<td>25 bu</td>
<td>1400</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Average yields are the Oklahoma 10 year (2001-2010) average yields reported by the National Ag Statistics Service except for Canola and Sunflower which are from 2009-2010.

### Summary

Although there are a number of specific ways to manage organic matter and crop residues, producers must not forget to look at the big picture. Continuous no-till along with intensified crop rotations that minimize fallow periods will optimize the accumulation and maintenance of organic matter. Of course, this interest must be weighed against forage needs and crop water availability. Therefore, it is clear that the same practices cannot be used for every production system. Also, it is imperative to understand that these practices work together to improve soil function. The main goal of a no-till production system should be to improve organic matter, soil quality, and soil function. Producers should examine their needs and the risks/benefits of each management strategy. Every situation is different and must be treated accordingly.

### References


The Oklahoma Cooperative Extension Service

Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.

- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.