CORN STOVER HARVEST

IOWA STATE UNIVERSITY
Extension and Outreach

Managing Crop Residue Removal and Soil Quality Changes

The implementation of conservation systems to sustain soil and improve environmental quality has to be considered when shifting acreage to continuous corn, as well as when removing corn residue for livestock uses, cellulosic ethanol production, or other industrial uses. Continuous corn production can increase the use of more intensive tillage systems to manage corn residue. The increase in tillage intensity coupled with high use of nitrogen (N) fertilizer in continuous corn present significant soil and water quality challenges, which can lead to economic and environmental concerns that need to be considered. The removal of corn residue for any purpose should be weighed against the potential impact on soil quality and productivity.

Sustainable partial residue removal rates depend on several factors, which include soil erodibility, surface slope, cultural practices, and climate conditions. Recent research suggests that partial residue removal should be approached carefully and based on ground cover requirements to control soil erosion and maintain soil quality and soil organic matter. The methods or guidelines for residue removal from any given field are not well documented. It is also not clear whether current management practices for soil erosion control are appropriate for maintaining soil organic matter level and soil quality in general. Possible short-term impacts of partial corn residue removal may include an increase in N, phosphorus (P), potassium (K), and other nutrients application to replace these nutrients. If not replenished, these nutrients will be lost from the soil nutrients pool. Soil quality parameters such as water infiltration, aggregate stability, bulk density, soil crusting , and soil structure is highly affected by the amount of residue remaining on the soil surface (Figure 1). The resiliency of soil structure and improvement in soil environment are key components of long-term sustainability of soil productivity.

Lack of adequate residue cover can lead to:

- *Decline of soil carbon source*
- *Decline of soil quality*
- *Removal of soil nutrients source*
- *Acceleration of soil erosion risk*
- *Reduction of long-term productivity*

A

B

Figure 1. (A) No-till with 0% residue removal and (B) No-till with complete residue removal.

Residue Removal and Soil Bulk Density

After three years of residue removal under no-till (NT) and conventional tillage (CT) at agronomic N rate (Figure 2), there was a significant increase in bulk density compared to the baseline at the beginning of the study in 2008, especially when significant amounts of residue were removed. The results show that bulk density increased significantly from base, especially when the amount/level of remaining residue decreased to 0.1 ton/acre. The lack of adequate residue cover along with tillage led to an increase in soil bulk density due to deterioration of soil structure in the absence of good residue cover. Bulk density is a measure of pore spaces available

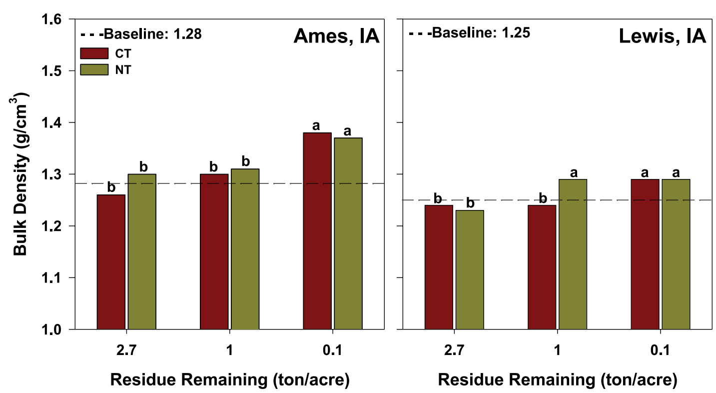

Figure 2. Residue removal and tillage effects on soil bulk density over three years under continuous corn west of Ames (central) and near Lewis (southwest), Iowa. (Treatments with the same letters are not significantly different at p=0.05.)

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to store water and provide aeration to the root system. The reduction in corn residue remaining on the soil surface affected bulk density equally in both tillage systems. The results show that maintaining 2.7 ton/acre is needed to keep the bulk density at the baseline level prior to the residue removal process.

Residue Removal and Soil Aggregate Stability

Aggregate stability is one of many physical indicators in assessing the impact of management practices on soil stability and tolerance to rain intensity and soil compaction. How residue is managed, how much is retained on soil surface, and type of tillage system used can affect the stability and size of different aggregate fractions as shown in Figure 3. In general, the greatest soil aggregation occurred under no-till when no residue was removed. However, as more residue was removed there was a decrease in soil aggregate size and stability. The level of remaining residue cover of 2.7 ton/acre in both sites appears to be needed to maintain stable and large soil aggregate that will ensure soil health. The larger aggregate size is necessary for improving soil moisture storage, soil aeration, and microbial activities. Crop residue left on the soil surface can play a significant role in improving these qualities that are essential for soil productivity.

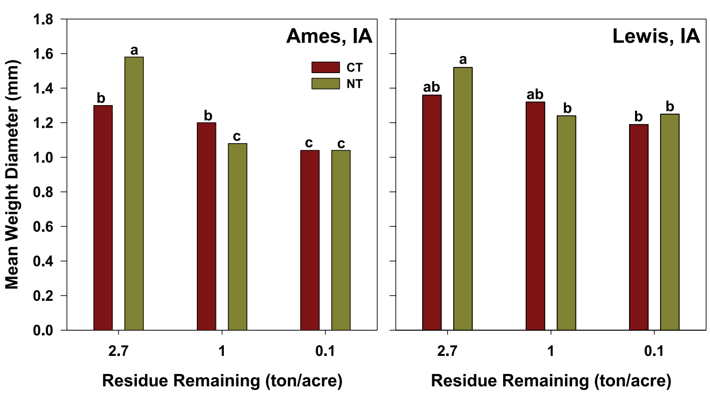

Figure 3. Residue removal and tillage effects on soil aggregate stability over three years under continuous corn, west of Ames (central) and near Lewis (southwest), Iowa. (Treatments with the same letters are not significantly different at p=0.05.)

Residue Removal and Water Infiltration

Changes in bulk density and soil aggregation will influence water infiltration. These changes are highly linked to residue management and tillage practices. Residue management and tillage system effects on water infiltration are presented in Figure 4, in which the amount of residue left on the soil surface after partial or complete removal was documented. The decreased trend in water infiltration rate was observed in both no-till (NT) and chisel plow (CT) with the increase in residue removal. Generally, the results show water infiltration decreased as the amount of residue remaining decreased. Lack of residue cover reduces protection of the surface soil and increases the exposure of the soil surface to direct rain intensity. This leads to surface soil sealing, reduced infiltration rates, and increased surface runoff. The adoption of no-till did help maintain the water infiltration rate in combination with residue coverage at various levels. Even though results show no significant differences in infiltration rate in the short-term in central Iowa, it is obvious this effect is site specific as shown in well-drained soil in southwest Iowa, where significant decline in infiltration rate was observed with increased residue removal.

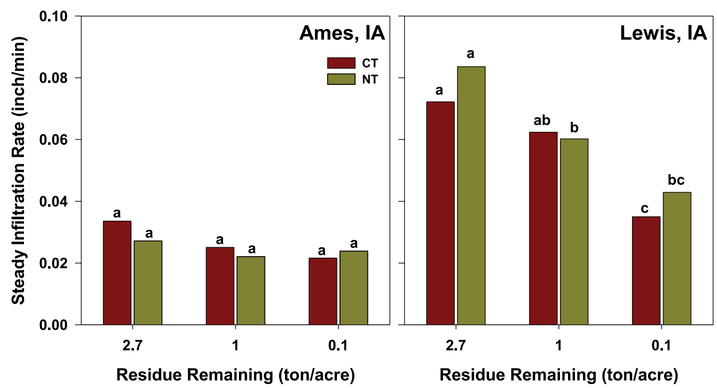

Figure 4. Residue removal and tillage effects on water infiltration over three years under continuous corn west of Ames (central) and near Lewis (southwest), Iowa. (Treatments with the same letters are not significantly different at p=0.05.)

Summary

Significant short-term effects of residue removal on soil physical properties can take place with residue management or removal. Bulk density can be affected by residue removal and tillage system, especially when low amounts of residue remain after harvest. Furthermore, soil aggregation and size decreased with increased residue removal rates. These changes in soil physical properties led to reductions in water infiltration rate regardless of tillage system. In general, the adoption of no-till can offset, to some degree, some of the negative effects of residue removal, but potential losses of soil organic carbon and deterioration of soil physical properties were still observed.

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