CORN STOVER HARVEST

IOWA STATE UNIVERSITY
Extension and Outreach

Managing Crop Residue Removal and Soil Organic Matter

Post-harvest crop residue is a critical source of soil organic matter. Crop residues provide soil protection against water and wind erosion as well as improvement of soil health. Leaving crop residue in the field improves nutrients cycling and soil health, and sustains soil productivity. Use of corn residue for various purposes, such as animal use, cellulosic ethanol production, or other industrial processes, needs to be approached carefully to minimize effects on soil health and water quality.

Residue removal effects on soil productivity and environmental quality may not always be apparent in the first few years, particularly in the Midwest, where high soil organic matter, high soil productivity, and good agriculture production conditions minimize effects in the short-term. However, when considering crop residue removal, keep in mind the adverse effect on soil productivity and environmental quality over the long-term. Continuous removal of corn residue coupled with intensive tillage is well documented in long-term studies that show soil health and crop productivity are compromised. Long-term tillage studies established in the late 1800s and continuing to present in the Midwest with different crop rotations, manure, and tillage treatments show that intensive tillage decreased soil organic matter across all rotations, but more so with continuous corn by almost 64 percent. The loss of original soil organic matter due to tillage exceeds potential additions of carbon from crop residue because the majority of crop residue carbon will be lost as carbon dioxide during the decomposition process in the field. Therefore, the role of crop residue is to protect soil from water and wind erosion along with adding of organic matter to the soil. It is well documented that intensive tillage and continuous corn, along with residue removal, can have a significant effect on reducing soil organic matter.

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Residue Removal and Soil Organic Carbon

Effects of residue removal and tillage system on soil carbon were summarized in a three-year study near Ames and Lewis, Iowa (Figure 1). The results show a decline in total organic carbon (TOC) as residue removal rates increased, especially under chisel plow (CT). However, the decline occurred with both no-tillage (NT) and chisel plow (CT) tillage systems at sites with well-drained soils compared to poorly drained soils. These changes in soil organic carbon represent a short-term effect of residue removal under continuous corn.

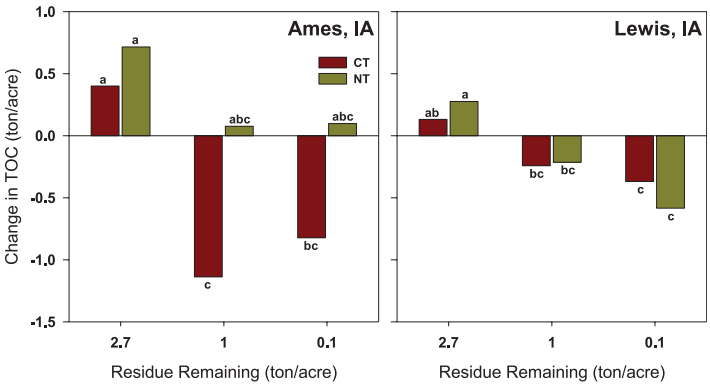


Figure 1. Tillage and residue removal effects on soil carbon at the top 12 inches over three years under continuous corn, west of Ames (central) and near Lewis (southwest), Iowa. (Treatments with the same letters are not significantly different at p=0.05.)

Residue Removal and Soil Microbial Biomass Carbon

Another indicator of soil carbon change is the microbial biomass carbon (Figure 2). The microbial biomass carbon is an indicator of a more sensitive carbon fraction that is highly affected by management practices. Microbial biomass carbon was measured with different residue removal rates and tillage systems. The results show a steady decline in the microbial biomass carbon with increased residue removal and tillage intensity under continuous corn. Generally, the declining trend in microbial biomass carbon is affected by the amount of remaining residue left on the soil surface, even though no significant difference was observed because of the short time frame of the study (three years). However, residue removal with no-tillage (NT) had less impact on carbon fractions compared to that under the chisel plow (CT) system.

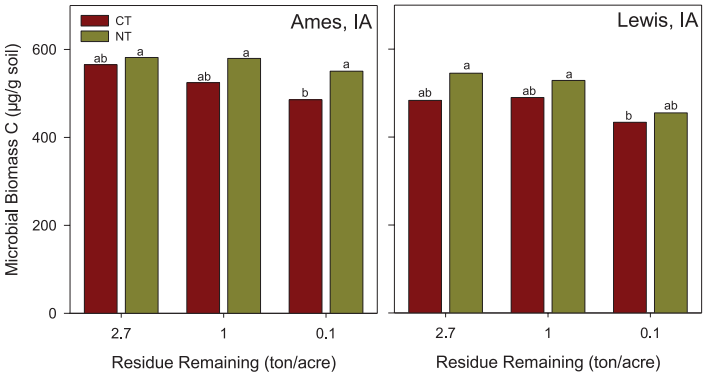
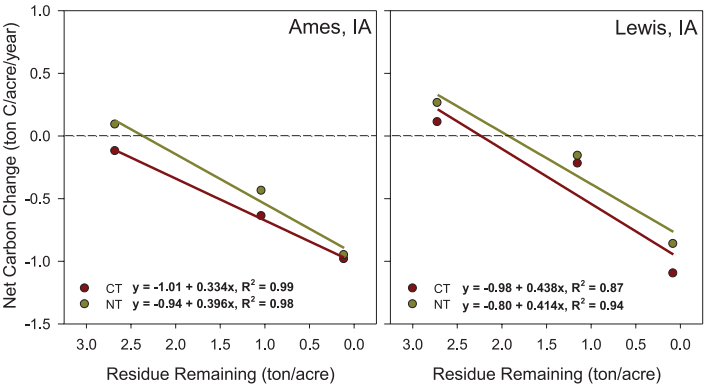


Figure 2. Tillage and residue removal effects on soil microbial biomass carbon in the top 6 inches over three years under continuous corn, west of Ames (central) and near Lewis (southwest), Iowa. (Treatments with the same letters are not significantly different at p=0.05.)

Residue Removal and Soil Carbon Budget

Soil carbon budgets are calculated by including aboveground biomass, belowground (roots) biomass, and soil carbon lost as carbon dioxide during the growing season. Soil carbon budget results from recent research studies are presented in Figure 3. The results show how much residue is needed on the soil surface to sustain soil organic carbon at its current level under different residue removal rates and tillage systems. The amount of crop residue that should be left on the soil surface depends on actual amounts of biomass produced and the tillage system for corn production. After three years under continuous corn rotation, the amount of residue after harvest averaged approximately 3 and 4 ton/acre for the Lewis and Ames sites, respectively. To maintain soil organic carbon at



Figures 3. Potential soil carbon change due to residue removal and tillage system over three years under continuous corn, west of Ames (central) and near Lewis (southwest), Iowa.

The amount of crop residue that should be left on the soil surface depends on actual amounts of biomass produced and the tillage system for corn production.

no change in central Iowa, the amount of crop residue remaining that was needed under no-tillage (NT) was 2.4 ton/acre and 3.0 ton/acre with chisel plow (CT) tillage. However, in southwest Iowa, the amount of residue remaining needed to maintain soil organic carbon on well-drained soil was 2.0 to 2.2 ton/acre under no-tillage (NT) and chisel plow (CT) tillage, respectively. In this study, the remaining amount of residue to keep soil organic carbon with no change from the baseline was calculated for nitrogen fertilization rates by averaging 150 and 250 lb/acre treatments for continuous corn over three years. Residue removal for any use needs to be determined by the actual amount of crop residue produced, type of tillage system, and nutrient management program, as well as field slope and erosion potential.

Type of soil (well drained vs. poorly drained), slope, soil erosion potential, and crop productivity of each individual field need to be considered to maintain a level of residue cover for sustaining soil organic matter.

Summary

In general, potential decreases in soil organic carbon were observed when residue was removed. The adoption of no-tillage did reduce some of the carbon losses due to residue removal. The use of no-tillage can sustain soil organic carbon level in the short term, when at least 2.7-3.0 ton/acre of residue is kept on the soil surface on both poorly drained soil (central Iowa) and well-drained soil (southwest Iowa). Proper management such as no-tillage and other conservation systems are important practices in considering residue removal for any use. Type of soil (well drained vs. poorly drained), slope, soil erosion potential, and crop productivity of each individual field need to be considered to maintain a level of residue cover for sustaining soil organic matter.

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