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Avoid Excessive Harvest of Corn Residue to Maintain Soil Productivity

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Corn residue as a commodity?

In most fields, corn residue remaining after grain harvest is incorporated into the soil with tillage or is left on the soil surface. Currently, corn residue is being harvested by some livestock producers, and there is interest in producing ethanol from corn residue in the near future (Perlack et al., 2005). However, soil productivity (synonymous with soil carbon) will be reduced if all corn residue in a field is harvested regularly and there is not another source of carbon being returned to the soil to replace the carbon removed with the residue. Good sources of carbon include: i) manure; ii) bi-products from industrial processes such as ash; and iii) winter cover crops. Increased fertilization in fields where residue is harvested will help replace some of the nutrients removed in the residue, but it will not compensate for the lost carbon. In addition, nitrogen fertilizer rates in continuous corn should actually be reduced following corn residue harvest.

Why is soil carbon important?

Carbon is important because it is the backbone of soil organic matter. Soil organic matter represents decaying plant and animal residues, microscopic soil organisms that decompose plant and animal residues, and substances released by these organisms into the soil (Brady and Weil, 2002). Since plants are at the top of the soil food chain, they are the initial source of all soil organic matter. For producers, soil organic matter is important because: i) it is bank of nutrients that will be slowly released over time; ii) it improves the water-holding capacity of the soil; and iii) it promotes the aggregation of soil particles. Aggregation is important because it promotes water infiltration, increases the rooting ability of plants, and allows the soil to be tilled with less horsepower. As a result, soil organic matter (or soil carbon) is synonymous with soil productivity. The light-colored forest-derived soils in the eastern Corn Belt contain about half the organic matter that our dark prairie-derived soils contain in Minnesota. As a result, crop water stress is often common on these soils, even though rainfall in the eastern Corn Belt is generally greater than that in Minnesota.

How much corn residue can be harvested?

The amount of corn residue that can be sustainably harvested in the absence of supplemental carbon (manure, industrial bi-products, or cover crops) depends on the crop rotation and tillage system. On average, the amount of corn residue that needs to be retained to preserve soil organic matter and protect against wind and water erosion in the Corn Belt is shown in Figure 1 (Wilhelm et al., 2007). It should be noted, however, that the amount of corn residue needed to protect against soil erosion is less than the amount needed to maintain soil organic matter levels. For reference, Figures 2 and 3 show surface residue coverage with removal of none and approximately all of the corn residue in a chisel plow tillage system.

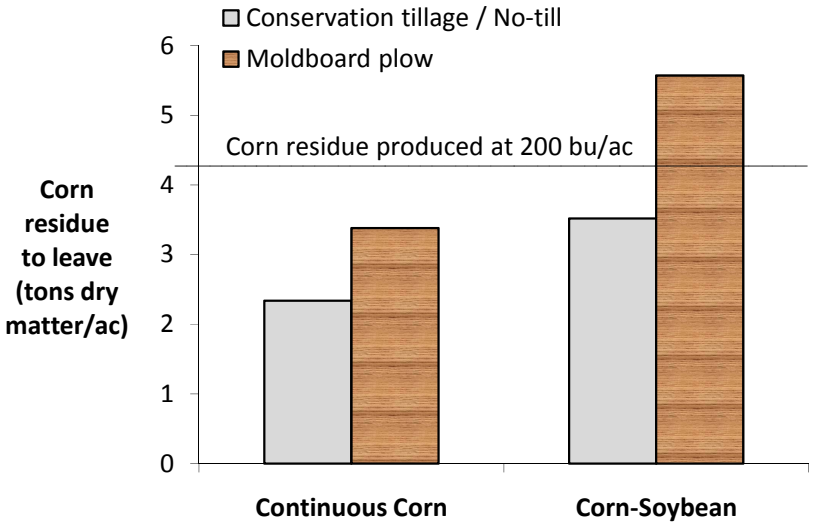

Figure 1. *Corn residue to retain to preserve soil organic matter and protect against erosion, depending upon crop rotation and tillage system. Source: Wilhelm et al., 2007.*

Figure 1 shows that a 200 bushel per acre corn crop produces 4.22 tons of dry matter per acre as corn residue (assuming a harvest index of 0.53). In a corn-soybean rotation where corn residue is moldboard plowed, the amount of corn residue that needs to be retained is greater than the amount produced with a 200 bushel corn crop. Thus, it is not sustainable to harvest corn residue in this system, and this system is actually reducing soil productivity over time. On the other hand, if continuous corn is grown with moldboard plow tillage, the amount of corn residue that needs to be retained is about 0.84 tons per acre less than that produced with a 200 bushel corn crop. This leaves 0.84 tons of corn residue per acre (20% of the total residue production) that could be harvested annually, but this would require a 200 bushel yield level every year. The potential for residue harvest is much greater when a conservation tillage system such as no-till, strip-till, or chisel plow tillage is used. With conservation tillage in continuous corn, up to 45% of the corn residue could be harvested annually if grain yields are consistently 200 bushel per acre.

Figure 2. *Surface residue coverage after stalk chopping and chisel plowing in a field where no corn residue was harvested. Photo by Jeff Coulter.*

Figure 3. *Surface residue coverage after chisel plowing in a field where corn residue was chopped, raked, and baled. Photo by Jeff Coulter.*

Considerations for sustainable harvest of corn residue:

Residue harvest is best suited to continuous corn systems that consistently have high yields and utilize little or no tillage. If corn residue is harvested, do not remove more than 45% of the residue. Harvesting only 45% of the corn residue is tricky, but it can be done if stalks are cut high during grain harvest and if stalks are not chopped prior to baling. If a rake is used prior to baling, make sure that the rake is set as high as possible to avoid collecting too much residue.

Another useful idea when harvesting residue is to rotate residue harvest among fields. This ensures that residue is not harvested from the same field every year. In addition, think seriously about reducing tillage following residue harvest. Also target manure applications rather than fertilizer for these fields if soil test levels indicate that phosphorus is needed. Winter cover crops should also be considered for fields where residue is removed. In addition to serving as a carbon source, the roots from winter cover crops are extremely effective at scavenging residual soil nitrate. This is especially important following dry years where uptake of nitrogen by the corn crop is lower than normal.

When residue is removed in continuous corn systems, reduce the nitrogen fertilizer rate for the next year's corn crop. Research that I conducted for my Ph.D. at three locations in northern and central Illinois on dark prairie-derived soils in 2006 and 2007 showed that the economically optimum nitrogen fertilizer rate in continuous corn is reduced by 13% when half or all of the corn residue is harvested. This was consistent for both chisel plow and no-tillage systems. In continuous corn, less nitrogen is needed for the following year's crop when residue is harvested because corn residue promotes tie up (immobilization) of nitrogen by soil microorganisms. While it is critical to maximize profitability from the land, we need to balance short-term economics with long-term sustainability. When removing residue this fall, use common sense to preserve soil organic matter and protect against erosion.

References

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