Crop Residues: Abundance and Considerations for Alternative Uses

MF3165

The demand for crop residues for expanded uses, including being used as a feedstock for bioenergy production and other established and emerging markets, is expected to increase in the near future. Crop residues are thought to be a prime feedstock for bioenergy production in the United States because of their perceived abundance and availability (Wilhelm et al., 2004; USDA, 2010). While the use of corn stover for bioenergy production and other expanded uses appears feasible, the magnitude at which different levels of stover removal affect soil erosion, soil properties, crop production, and other ecosystem services is being studied.

This publication identifies crop residues, which may have potential applications in other industries, and their relative abundance. However, while considering alternative uses of residue, it is important to use best management practices for cropland soil to ensure good crop health and future sustainability.

Factors to consider before harvesting crop residue

Removal of stover for bioenergy may harm ecosystem services provided by crop residues such as erosion control (Cruse and Herndl, 2009). Even no-till soils may be affected if residues are removed at high rates. In an experiment near Hays, Kansas, residue was removed at different levels in both tilled and no-tilled fields. This study concluded that the erosion protection provided by no-till management is lost when residue removal exceeds 25 percent.

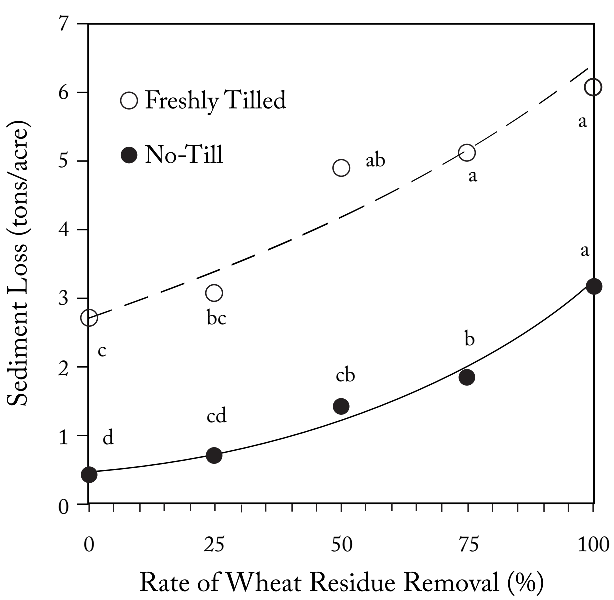


Figure 1. *Influence of wheat residue removal on sediment loss in runoff in western Kansas. Means followed by the same lowercase letter within the same tillage treatment are not significant (Blanco et al., 2009).*

Figure 1 illustrates the influence of wheat residue removal on sediment loss in runoff near Hays. This experiment was conducted on a Harney silt loam. The soil had a 6 percent slope. Rainfall was simulated for a storm that is predicted to occur once every 25 years in western Kansas, at a rate of 4.5 inches of precipitation in 30 minutes (Blanco et al., 2009).

In this experiment there were two different tillage practices: freshly tilled and no-tilled. The USDA-Natural Resources Conservation Service gives each soil type a "T" value rating, which represents the "tolerable" amount of soil loss (in tons) that can occur per acre per year. For the freshly tilled soil, the removal of greater than 50 percent of the crop residue in this one rainfall event caused the entire allowable amount of soil loss for the entire year. For the no-till soil, the soil losses were less than for the freshly tilled; however, this study illustrates that a no-tillage field is susceptible to erosion once the residue is removed.

Further documentation of the effects of different levels of stover removal on soil erosion are needed to establish acceptable levels of stover removal for every combination of soil type, tillage system, and climate. High rates of stover removal may increase risks of both wind and water erosion in regions with limited precipitation, but intense and localized rainstorms, such as those that occur in the central Great Plains. This can be of particular concern under increasing climatic fluctuations and intense weather systems.

Stover removal may degrade soil physical properties and reduce the soil carbon pool. Hammerbeck et al. (2012) reported that stover removal decreased organic matter and soil aggregation in a no-till corn-soybean rotation after 8 years of management in South Dakota. An increase in stover removal rate also may increase soil temperature fluctuations (Sharratt, 2002), increase evaporation (Flerchinger et al., 2003), and decrease plant-available water (Blanco-Canqui and Lal, 2007; Moebius-Clune et al., 2008). Stover removal effects on crop yields can be inconsistent and depend on multiple factors such as the weather, slope of the field, fertility, and amount of soil organic matter. A recent study concludes that producing bioenergy from crop residues could reduce soil organic matter and ultimately increase carbon dioxide emissions (Liska et al., 2014).

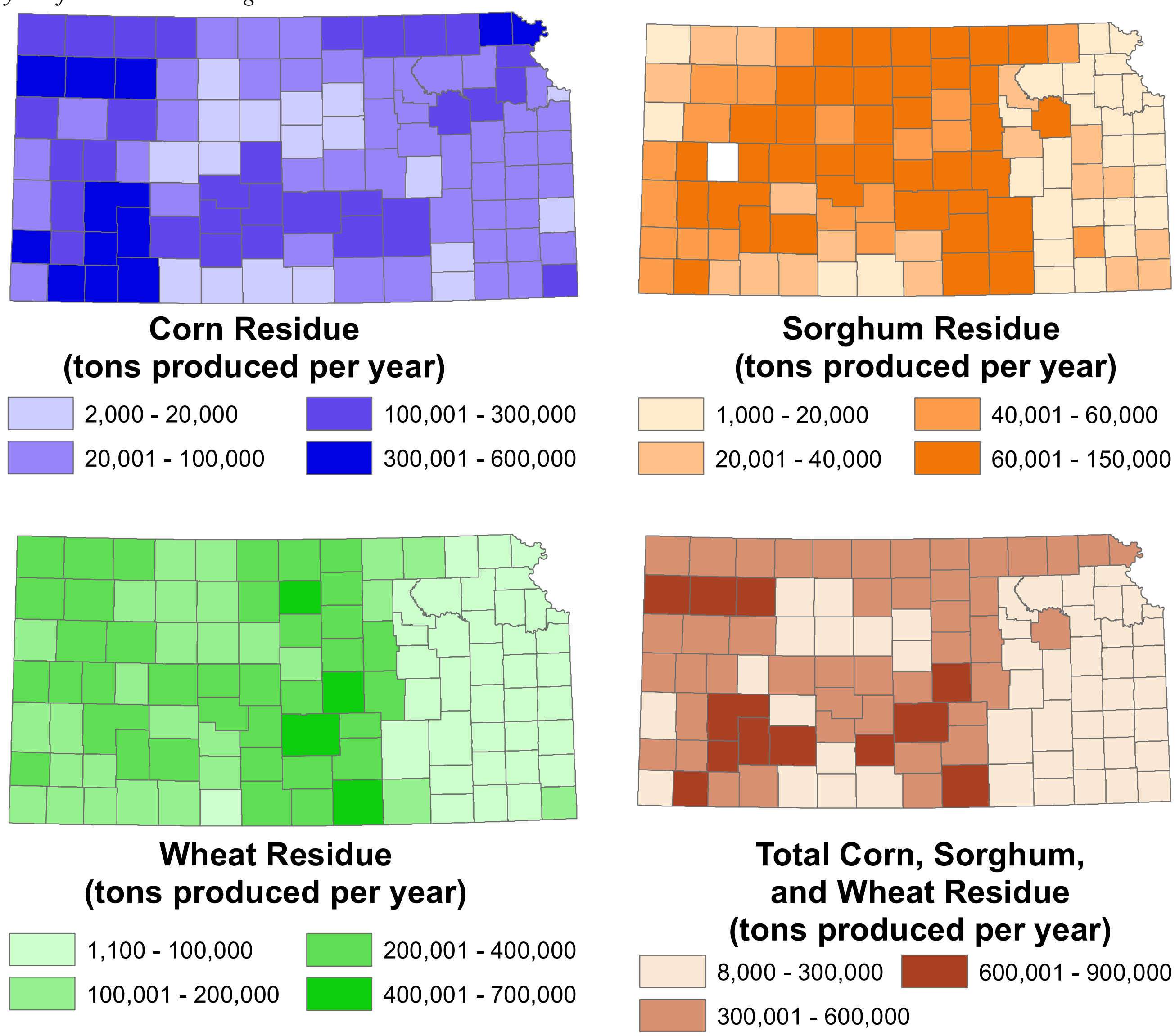
The maps in Figure 2 show data for corn, sorghum, and wheat. The data are an estimated quantity of total residue present per year. Producers should determine how much, if any, residue should be harvested. This decision must be made on a field-by-field basis to avoid soil degradation. Other major crops, such as soybeans, sunflowers, canola, and cotton, have either low residue production or have narrow carbon/nitrogen residues that cause those residues to break down (decompose) quickly. On these fields, the amount of residue on a per acre basis is so low that it would be impractical to harvest.

Crop residue abundance

The information for the maps shown in Figure 2 was collected from the USDA's National Agricultural Statistics Survey. The three crops selected — corn, sorghum, and winter wheat — were based on highest total production within Kansas. The survey provided data regarding harvested acres, grain yield, and overall production at the county level. Because weather variations can cause crop yields to vary widely from year to year, data from these survey results were averaged from 1999 through 2010.

Harvest index refers to the amount of grain produced divided by the total amount of aboveground biomass produced. In other words, for corn and sorghum, 0.5 is a typical harvest index. Of the total aboveground biomass, on average, half of that mass is grain, and the other half is crop residue. For corn and

Figure 2. *Tons of crop residues produced per year for each Kansas county. Average values from 1999 to 2010 were calculated from crop yields from the National Agricultural Statistics Service.*



sorghum, the total production of a county (in bushels of grain) was multiplied by the weight of a bushel of the crop (56 pounds per bushel). The harvest index of wheat is about 0.4. If a bushel of wheat weighs 60 pounds, the crop residue produced by those plants would weigh 100 pounds. Therefore, the total winter wheat grain yield in bushels was multiplied by 100 to estimate the mass of winter wheat residue produced per county. These data are presented in Figure 2.

Estimating percent residue cover remaining on field

How much residue is enough? For producers, it is important to know how to measure crop residue, as this measurement provides an estimate of how well soil is protected from wind and water erosion. To meet the definition of conservation tillage, including no-till, strip-till, ridge-till, and mulch-till, at least 30 percent of the soil surface must be covered with residue after planting.

There are two main methods used to estimate residue, but the most commonly used approach is the line-transect method (Figure 3). Use either a 100-foot tape measure or a rope with 100 knots tied at 1-foot intervals. Stretch the tape or rope at a 45-degree angle to the row direction, walk along the tape, and count the number of times a piece of residue at least 1/8 inch in diameter occurs under each foot mark or knot. To get a field-wide estimate, move the tape measure to a different spot in the same vicinity, and repeat this process three times, making 100 observations at each site, and repeat this process at five sites per field in order to determine the field average.

You can also compare your fields to photos that contain a known percentage of crop residue. The

Figure 3. *Tape measure used for the line-transect method. Place tape measure at a 45-degree angle to the rows. This field has very low residue coverage (<30%). Photo: DeAnn Presley.*

following K-State Research and Extension publications help estimate crop residue:

- Soybean and sunflower residue: *www.ksre.ksu.edu/bookstore/pubs/L783.pdf*
- Grain sorghum residue: *www.ksre.ksu.edu/bookstore/pubs/L782.pdf*
- Corn residue: *www.ksre.ksu.edu/bookstore/pubs/L784.pdf*

Potential applications for crop residue

In addition to being used as bioenergy feedstocks and for animal agriculture, crop residues can be used in the production and use of horticultural commodities (Poincelot, 2003). These horticultural uses of crop residues include mulch, compost, and soil conditioners.

Mulch composed entirely or partially of crop residues can be used in many ways: commercially grown vegetable, fruit, tree, and shrub production; home and community gardens; and in ornamental landscapes. In the same way as leaving a portion of crop residue in the field after harvest, mulch used in landscapes conserves soil moisture, prevents erosion, lowers weed levels, and improves plant growth (Sharenbroch, 2009).

Compost made from crop residues or amended with crop residues can be used to increase soil organic matter in the mentioned horticultural applications. Additionally, there is a potential for some crop residues to be used as components of alternative potting materials in container-grown ornamental nursery crops. Research in this area is ongoing; however, a website has been developed to archive all research related to this topic (*www.SustainableSubstrates.com*).

Crop residue also can be used as a soil conditioner on disturbed sites. Studies show organic materials used in urban landscapes improve soil quality and plant health (Scharenbroch, 2009). Although there are few studies evaluating use of agronomic crop residues as soil amendments, the evidence for other organic materials improving soil health is strong (Loper et al., 2010; Brown and Gorres, 2011).

Challenges and opportunities to adoption of enhanced use residue products

The most important attribute of crop residues used in horticultural applications is assurance that the material is herbicide-free. There is a small chance that herbicides used in crop production could contain herbicide residues. However, the most problematic source of herbicide residues is from hay (Davis et al., 2010). Long-lasting herbicides containing triclopyr and/or picloram are very common pasture-applied herbicides for the control of brush, but these herbicides are not common in crop production. If herbicides are a concern, a grower can do a bioassay — grow some plants in a container, apply the crop residue (or hay), and inspect the seedlings for herbicide damage or inhibited growth.

The only drawback for some consumers to use crop residue as mulch may be a perceived lack of aesthetic appeal to those accustomed to more traditional wood- and bark-based mulches. With the growing interest in being more sustainable, there may be interest in locally sourcing mulch materials.

While homeowners and landscapers may appreciate the value of crop residues in horticultural settings, obtaining the materials can be a significant barrier. Determining how to distribute residue materials to new markets needs to be explored to make expanded uses viable. Developing markets close to the product or close to the buyers can reduce costs for distribution.

Enhanced-use products provide farmers with the opportunity to diversify their business operations. Pursuing these markets and finding the right partners are highly personal decisions, which should be considered carefully. Ask for crop records so that herbicide-free residues are selected. Developing expanded uses for crop residues can be a sustainable and profitable way to manage agronomic crops in Kansas.

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DeAnn Presley

Associate Professor
Soil Management Specialist

Cheryl Boyer

Associate Professor
Ornamental Nursery Crops Specialist

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