Effects of Corn Stover Removal on Nutrient Management

Figure 1. Corn Stover Bale. *Photo courtesy of Jennifer Rees, Extension Educator, University of Nebraska*

The harvesting of cornstalk residue (corn stover) after grain harvest has been used as bedding and an additional food source for livestock. Interest in corn stover has also been increasing for other uses, such as for energy production as cellulosic ethanol. While corn silage harvest has been practiced for many years, and nutrient removal with silage is well known, corn stover harvest and related nutrient removal are different due to the later timing of harvest.

Stover harvested for ethanol production must have low soil contamination, and frequent total removal of stover will not be desirable for soil sustainability reasons. Therefore, the amount of biomass left over after stover is harvested for bioenergy will typically be less than the total amount of corn residue remaining after grain harvest. For use in ethanol production, energy company suggestions are for only partial stover harvest, 20 to 60 percent, which is much less than the 90 to 95% percent usually removed when silage is harvested. Grain harvest plus some stover harvest will remove less biomass carbon (C) and plant nutrients compared to silage harvest. The amount and frequency of stover harvested in a specific rotation will determine the long-term impact on nutrient removal and recycling to the soil.

Phosphorus (P) and potassium (K) have been the main nutrients lost with silage harvest due to the large amount of biomass removed, but not nitrogen (N) and other nutrients. This, however, is changing as more focus is being placed on C and N due to the effects of their removal and the sustainability of the soil resource and water quality.

Stover Nutrient Content

Determining the amount of nutrients in corn stover is complicated because nutrients, especially K, can be leached out of plant tissue from maturity to grain harvest, and from the stover after grain harvest. This means that nutrient concentrations of stover can be quite different depending on the rainfall amount and pattern from plant maturity to the time of harvest.

Table 1 illustrates the average nutrient analysis of corn at maturity for grain, vegetative components (stalks, leaves, tassel, ear shank, and husk), and cobs from fields in recent years. Grain dry matter (DM) is approximately one-half of the above-ground vegetative material plus cobs. Since the C concentration in corn is similar for all plant components (on a DM basis), grain C is also approximately one-half of the vegetative plus cob components. The N concentration of cobs is lower than that for vegetative plant parts, and for the data in Table 1 only cob C and N were measured. There is more N and P in grain than in the vegetative component, and more K in the vegetative component than in grain. This difference in the relative P and K content of vegetative tissue compared to grain is why nutrient removal must be calculated differently for grain, silage, and stover

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harvest. As is typically found, the concentration and amount of micronutrients are low in both corn grain and vegetative components. There is some additional Ca and Mg removed with stover harvest, but the additional amount removed is easily corrected by normal liming in most soils and is not an issue in soils with a neutral pH or with free lime.

Nutrient	Grain	Vegetation	Cob
	lb/ton (DM)		
C	795	840	787
N	24	12	10
P (P_2O_5)	12	3	--
K (K_2O)	8	22	--
Ca	2	9	--
Mg	2	6	--
S	2	1	--
Zn	0.030	0.031	--
Mn	0.006	0.069	--
Cu	0.004	0.015	--
B	0.009	0.015	--
Fe	0.047	0.281	--

From 14 site years in 2006-2007; DM, dry matter; J.E. Sawyer and D.W. Barker

Table 1. Corn nutrient composition at plant maturity by plant part. *Courtesy of J.W. Sawyer and Antonio Mallarino, PM3052C, Nutrient Consideration with Corn Stover Harvest, Iowa State University Extension and Outreach.*

Change in Nutrient Content with Time

Phosphorous and K concentrations in corn stover decrease after maturity. The largest decrease occurs from black layer to grain harvest. After that, there is a slow but steady decline for K (the amount is determined by the amount of rainfall) in the fall and spring, but P concentrations stay approximately the same in the fall and then decreases slightly across the wintertime. The large change in stover K concentration with time from harvest until late fall makes estimates of K removal with baling complicated.

Corn N, P, and K Fertilization after Stover Harvest

Phosphorous and K removal with harvest is an important piece of information needed to maintain desirable soil-test values and is included in P and K fertilizer recommendations. Although N removal with grain harvest is not used to determine the N fertilizer rate for the next crop, it is reflected in traditional N rate recommendations since field response trials include N removal in grain harvest. Most N response trials have not included stover harvest, however, so an estimate of that removal is of interest due to the potential impact of less corn residue being returned to the soil. In an ongoing continuous corn study at two Iowa sites, stover harvest reduced the N rate needed for maximum economic yield in the next-year corn. The economic optimum N rate has been 20 lb N/acre less with partial removal (approximately 30 to 40% stover harvest) and 40 lb N/acre less with full removal (approximately 90% stover harvest). At first, this seems backward as more N is removed with stover harvest and a greater need for N application would be expected. However, with stover removal there is less additional C in the soil for microbial processing; therefore, it appears that the change in biomass return (with a high C:N ratio) to the soil has a greater influence on N fertilization requirement than less return of N.

Currently, the suggested average concentrations (per dry ton) of stover are:

- 12 lb N/Ton
- 3 lb P2O5/Ton
- 19 lb K2O/Ton

Source (Web source verified, 8/19/19)

PM 3052C, Iowa State University Extension, Nutrient Considerations with Corn Stover Harvest, John E. Sawyer and Antonio P. Mallarino, professors, Department of Agronomy, Iowa State University Extension and Outreach.

https://store.extension.iastate.edu/product/Nutrient-Considerations-with-Corn-Stover-Harvest

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