Optimum Corn Stover Removal for Biofuels and the Environment

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The 2007 United States energy bill calls for 36 billion gallons of ethanol to be produced by 2020. In 2007, the U.S. produced 6.5 billion gallons of ethanol. A large expansion in ethanol production was predicted in 2008 with expansion of existing plants and new plants coming on-line. Estimates were as high as 13.3 billion gallons. A financial crisis in the ethanol industry put many projects on hold and also caused some plants to close, resulting in a production of 9.2 billion gallons.

If corn grain was able to supply 15 billion gallons of ethanol, 21 billion gallons of ethanol would have to come from cellulosic material (biomass) to meet the 2020 mandate. The production of 21 billion gallons of cellulosic ethanol will require 350 million tons of dry biomass. Presently, perennial grasses and corn stover are the most available. About 194 million ton/ac of biomass are produced in U.S. production agriculture annually, with 75 million tons coming from corn stover.

Before we commit ourselves to using corn stover for fuel we need to study the environmental and economic consequences of this action. What effect will stover removal have on soil organic matter, soil erosion and ultimately sustainability of the land resource?

The objective of this study is to determine what rates of stover removal within different cropping systems are conducive to maintaining and possibly improving the productive capacity of the land while providing a renewable energy source.

Materials and Methods

Soil:	Embden sandy loam, Hecla sandy loam and Maddock sandy loam; Block 1: soil-N 16 lbs./acre; soil-P and soil-K were very high; soil-S was very low. Block 2: soil-N 14 lbs./acre; soil-P and soil-K were very high; soil-S was low. Block 3: soil-N 14 lbs./acre; soil-P and soil-K were very high; soil-S was low.
Cropping Systems:	Two cropping systems are used: continuous (c-c) no-till corn utilizing strip-till (block 1) no-till corn on soybean (c-s) utilizing strip-till (blocks 2 and 3). Blocks 2 and 3 are alternated between corn and soybean each year.
Previous crops:	Block 1: 2007 – field corn; 2006 – soybean; 2005 – sweet corn. Block 2: 2007 – field corn; 2006 – soybean and edible bean; 2005 – sweet corn. Block 3: 2007 – onion; 2006 – sunflower and edible bean; 2005 – sweet corn.
Seedbed preparation:	No-tilled with a Monosem drill using a shark-tooth residue manager.
Planting:	Block 1: Planted Dekalb corn 43-27 May 14 in 30-inch rows at 33,000 seeds/acre. Block 2: Planted Croplan soybean 1077 May 9 in 30-inch rows at 174,000 seeds/acre. Block 3: Planted Dekalb corn 43-27 May 16 in 30-inch rows at 33,000 seeds/acre.

Fertilizer: April 22 broadcast 28 lbs. N/acre, 44 lbs. P_2O_5/acre, 55 lbs. K_2O/acre and 22 lbs. S/acre as 10-16-20-8 to all blocks. Stream bar applied 100 lbs. N/acre as 32-0-0 on May 15 to Block 1. Stream-bar applied 60 lbs. N/acre as 32-0-0 on May 16 to block 3. Knifed in 80 lbs. of N/acre as 32-0-0 on June 17 to blocks 1 and 3.

Irrigation: Hand-move sprinkler irrigation as needed.

Pest Control: Apply Buccaneer Plus (40 oz/acre) + NIS (0.5% v/v) + AMS (8.5 lb/50 gal) on May 12 to entire study; Lumax (3 pt/acre) + Buccaneer Plus (32 oz/acre) + NIS (0.5% v/v) + AMS (1 lb/10 gal) on May 31; Cornerstone Plus (40 oz/acre) + AMS (1 lb/10 gal) on June 18 to blocks 1 and 3; Valor (2.5 oz/acre) on May 12, Cornerstone Plus (32 oz/acre) + AMS (1 lb/10 gal) on July 14 and Proline (5 oz/acre) on July 14 to Block 2.

Treatment: All corn residue from 2007 was removed from the plots in the fall. Corn residue was spread on the plots at rates of 100, 200 and 300 lbs. (66, 33 and 0 percent removal) per acre in block one on May 14, 2008, prior to planting.

Harvest: Block 1: Hand harvest a 10 ft. section of rows 4, 5, 8 and 9 from each plot on October 28, combined remainder October 31 with 4400 JD with a 4-row head.
Block 2: Combined entire study October 1 with M2 Gleaner with 18 ft. lovebar.
Block 3: Hand harvest a 10 ft. section of rows 4, 5, 8 and 9 from each plot November 4, combined remainder same day with 4400 JD with a 4-row head.

Results

All the corn stover was removed in the fall of 2007. To get data in 2008, ground corn stover was weighed to equal 0, 33, 66, and 100% removal and evenly spread in respective plots. This amounted to approximately 8, 5, and 3 tons/ac of corn residue added to the 0, 33, and 66 removal plots, respectively. This resulted in a heavy mulch, especially in the 0% and 33% removal plots. Unlike standing corn residue, the mulch covered the ground like a blanket. The day after planting 100 lb N/ac as 32-0-0 was broadcast to help degrade the residue and help prevent immobilization of N in the 0, 33, and 66% removal plots.

The 0% removal rate was lower yielding than other treatments (Table 1). The yield among other treatments was not significantly different. Corn grain moisture was highest and test weight lowest in the 0% removal plots. Corn in the 100% removal plot silked and reached maturity five and eight days earlier than corn in the 0% removal plots, respectively (Table 2). Chlorophyll meter readings increased with increasing stover removal. Due to a high coefficient of variability there was no significant difference in stalk nitrate tests among treatments. A definite trend can be noted as stalk nitrate-N went from 1033 ppm in the 0% removal treatments to 5118 ppm in the 100% removal treatments.

Table 1. The effect of corn stover removal from 0 to 100% on corn grain yield and other agronomic parameters.

Stalk Removal	Grain Yield	Harvest Moisture	Test Weight	Fall 2008 Nitrate-N	8/1/01 Chlorophyll Reading	8/15/08 Chlorophyll Reading	9/5/08 Chlorophyll Reading
%	bu/ac	%	lb/bu	lb/ac			
0%	185.5	29.8	55.3	11	56.1	55.9	54.8
33%	210.0	26.8	56.7	17	57.0	59.2	56.7
67%	217.1	26.6	57.0	16	57.9	58.8	56.9
100%	216.5	25.8	56.9	16	58.8	59.9	57.5
Mean	207.3	27.2	56.5	15	57.4	58.4	56.5
LSD 0.05	21.9	1.4	1.1	NS	1.7	2.6	1.6
C.V. (%)	6.6	3.1	1.2	29.5	1.9	2.8	1.8

Table 2. Effect of corn stover removal on corn performance and corn stalk nitrate levels.

Stalk Removal	Population	Stalk Nitrate-N	Ears/Plant	Silk Date	Mature Date
%		ppm			
0%	30492	1033	0.97	7/30/08	10/14/08
33%	30274	3705	0.99	7/26/08	10/11/08
67%	31472	2959	1.01	7/26/08	10/11/08
100%	30165	5118	1.01	7/26/08	10/7/08
Mean	30601	3204	0.99	7/27/08	10/11/08
LSD 0.05	1413	NS	NS	1	5
C.V. (%)	3	58	2.56	0.00	0.01