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Converting CRP land to corn: Minimizing soil loss

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With the increased interest in ethanol, more CRP land may be pressed into corn production, leaving it vulnerable to soil loss.

Currently there are more than 600,000 Wisconsin acres enrolled in the USDA's Conservation Reserve Program (CRP). The contracts for approximately 45% of these acres will expire between 2007 and 2009. Because of their vulnerability to erosion, CRP lands were removed from production and placed in perennial cover where soil and nutrient losses are minimal. However, recent interest in ethanol production has created increased demand for corn that could result in growers deciding to put CRP acres back into production. Returning highly erodible CRP lands to corn production has the potential to increase surface water runoff, sediment loss, and nutrient export, causing significant environmental harm. This publication focuses on ways to manage corn production on former CRP lands that retain the soil quality and conservation benefits of the Conservation Reserve Program. A companion publication looks at ways to minimize phosphorus loss.

About the study

This study used Snap-Plus nutrient management planning software, a program developed by University of Wisconsin-Madison soil scientists to evaluate sediment loss for different corn rotations and tillage methods on highly erodible fields. Snap-Plus incorporates the Revised Universal Soil Loss Equation 2 (RUSLE2), the Natural Resource Conservation Service's current field-scale soil erosion estimation tool for conservation planning. Snap-Plus assesses the effects of a variety of management practices and field conditions on soil loss from Wisconsin fields. (For details about the software, visit www.snapplus.net.)

To evaluate potential soil loss, we selected land with slopes of 6–12% (group C) and 12–20% (group D) from counties with significant CRP acreages. Table 1 details the characteristics of each site including soil mapping unit name, texture, tolerable soil

Table 1. Field location and site characteristics of representative fields used in this study.

						6–12% slope (Group C)		12–20% (Group D)	
Region	**County name**	**Soil name**	**Surface texture**	**Tolerable soil loss (T)** (tons/acre/yr)	**Assumed corn yield*** (bu/acre)	**Field slope** (%)	**Slope length** (ft)	**Field slope** (%)	**Slope length** (ft)
NE	Fond du Lac	Hochheim	Loam	5	160	9	150	16	100
S	Richland	Norden	Silt loam	3	160	9	150	16	100
S	Rock	Kidder	Sandy loam	5	160	9	150	16	100
SW	Dane	Dunbarton	Silt loam	2	120	9	150	16	100
SW	Grant	Dubuque	Silty clay loam	3	140	9	200	12	150
SW	Iowa	Dodgeville	Silt loam	4	160	8	200	14	150
WC	St. Croix	Amery	Loam	5	140	9	150	16	100
WC	Dunn	Hayriver	Fine sandy loam	3	120	9	150	16	100
WC	Eau Claire	Elkmound	Loam	2	120	10	95	16	85
WC	Pierce	Derinda	Silt loam	3	140	9	150	16	100
WC	Trempealeau	Gale	Silt loam	3	140	9	150	16	150

* Corn yield is the 75th percentile yield associated with each soil's corn yield potential category using Extension publication *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin* (A2809).

loss, assumed corn yield, and field slope and slope length. Tolerable soil loss (T) represents the rate of soil loss that is, in theory, equal to the rate of soil formation. Soil loss values that exceed T therefore result in long-term damage to the soil's production ability. Comparing soil loss estimates to T values helps to identify areas in need of erosion control management.

Each field was analyzed under grass hay (similar to CRP) and nine corn-based rotation and tillage combinations commonly used in Wisconsin. All operations were conducted on the contour.

Analysis results

Figure 1 summarizes the average soil loss plus the minimum and maximum losses for each crop/tillage combination on the two slopes. Soil loss increased with decreases in corn residue remaining in the field across the rotation. Estimated soil loss for grass hay was minimal for all sites (0.1 ton/acre) and greater for all the corn rotations. For all no-till corn grain systems, soil loss was below 1 ton/acre annually; and soil loss for strip-tilled corn grain was below the NRCS standard for T (shown in table 1) at all sites. The D slope fields with soils having the lowest T values (2 tons/acre per year, Dunbarton and Elkmound soils) could not meet T with no-till if the corn stalks were baled or if soybeans were added to the rotation every third year. Six of the fields with corn grain could not meet T with one-pass tillage and only two could meet T with a chisel plow system (Hochheim and Kidder soils). Fields with corn silage had very high soil losses, ranging from 4 to more than 10 times T, which was 80 to 400 times more than that of grass hay.

Soil erodibility and slope both greatly impact soil loss. Fields with flatter slopes are expected to lose less soil under the same rotations. The corn-soybean no-till rotation on one of the most vulnerable soils analyzed (Dunbarton), did not meet T for the example field with D slopes, but did meet T for C slopes. Corn silage no-till systems could meet T on a 9% slope for just one of the soils examined (Hochheim). When a wheat cover crop was added to the continuous corn silage no-till system, six C-slope fields and only three D-slope fields could meet T. Row orientation on the contour was very important to keep soil loss estimates low for all systems with tillage, including strip tillage.

Figure 1. Soil losses under various crop rotation and tillage practices.
(The gray bars represent the average loss while the black lines show the actual range.)

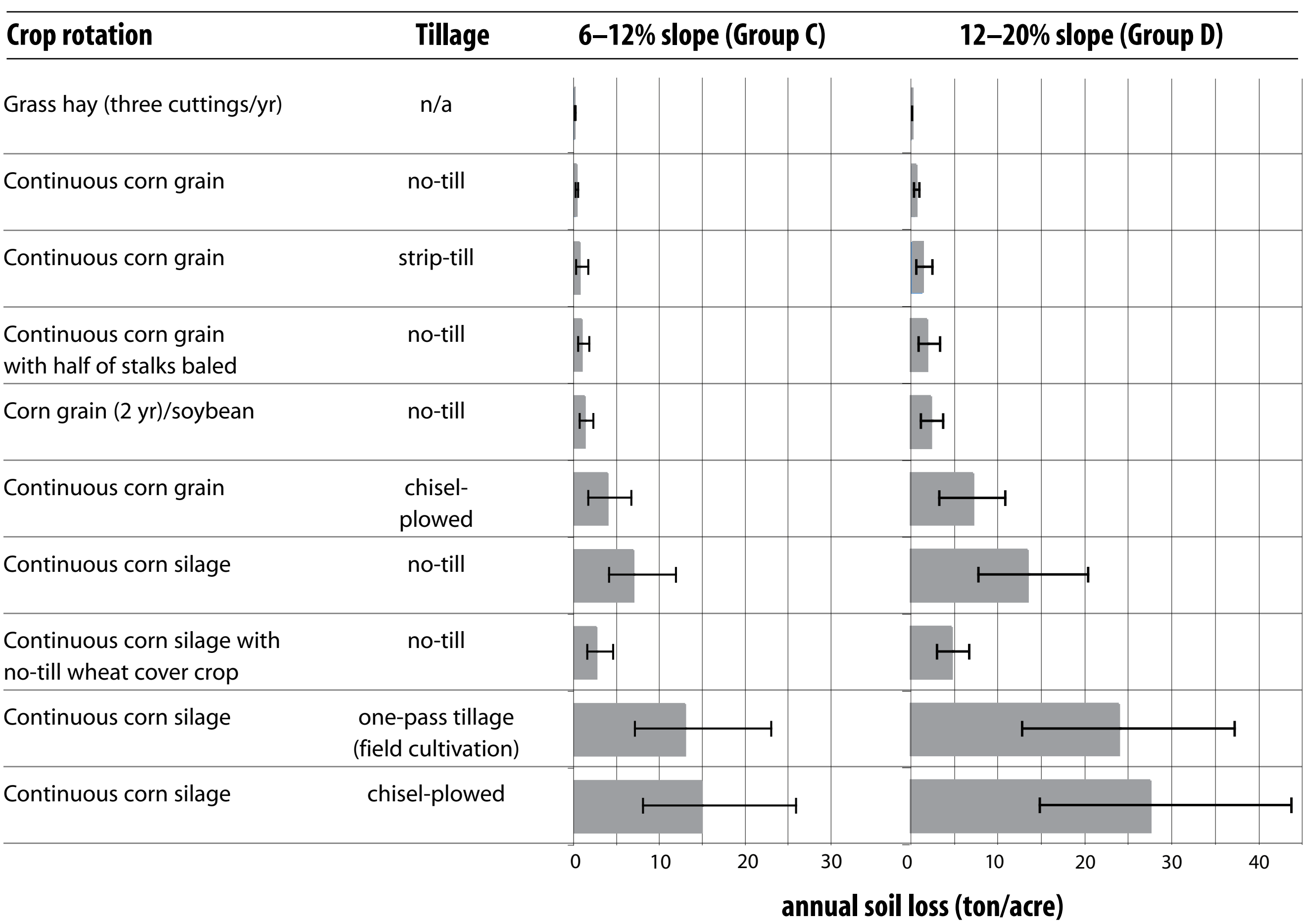

Figure 2. Soil conditioning index values (SCI) for a silty clay loam (Dubuque, 12% slope) using different rotations and tillage methods. The SCI measures whether organic matter is increasing (positive values) or decreasing (negative).

Crop rotation	Tillage
Grass hay (three cuttings/yr)	n/a
Continuous corn grain	no-till
Continuous corn grain	strip-till
Continuous corn grain with half of stalks baled	no-till
Corn grain (2 yr)/soybean	no-till
Continuous corn grain	chisel-plowed
Continuous corn silage	no-till
Continuous corn silage with no-till wheat cover crop	no-till
Continuous corn silage	one-pass tillage (field cultivation)
Continuous corn silage	chisel-plowed

Soil conditioning index

The soil conditioning index (SCI) is a comparatively new index calculated by RUSLE2 and used by the NRCS to indicate the effect of a management system on soil organic matter content. It accounts for crop biomass additions and removals, field operations, and erosion. If the calculated SCI value is positive, organic matter will be increasing with the rotation; the reverse is true if the SCI value is negative. Figure 2 illustrates how SCI values change with differing rotations in one example field. Almost all of the corn grain rotations, except where chisel-plowed, had positive SCI values. By contrast, all of the corn silage rotations had negative SCI values, except for no-tilled with a cover crop. This indicates that the corn silage systems would be expected to have reduced soil quality over time. The SCI values for all of the fields in the study were similar to those shown in figure 2.

No-till systems maximize residue cover while minimizing soil disturbance.

Recommendations

Based on the results of this analysis, the following actions are recommended.

- Fields that are most vulnerable to soil erosion should be maintained in CRP permanently or for as long as possible.
- For CRP fields going back into corn production, steps should be taken to minimize soil disturbance by tillage and to maximize residue cover. Recommended practices include (1) the use of no-till or minimum tillage systems, (2) selecting rotations with low soil loss, (3) minimizing residue removal (e.g., rotations with corn silage) and (4) using a no-till cover crop where silage is grown.

  Research on two Grant County fields converted from CRP to continuous corn grain in 1998 showed that it's possible to use no-till production without sacrificing yields as compared to chisel-plowing. The Grant County study also demonstrated the importance of fall applications of herbicides plus scouting to determine the need for post-emergence herbicides for the success of no-till CRP conversions.
- Soil conservation and nutrient management plans should be updated to reflect these land use changes. In cases where no plan exists, one should be developed. These plans should be carefully followed.
- The magnitude of soil loss impacts will be site-specific. A modeling tool, such as Snap-Plus, can be used to evaluate these site-specific conditions.

Limited corn residue plus tillage performed up and down the slope allowed water to freely run, creating rills where soil has eroded.

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