Converting CRP land to corn: Minimizing phosphorus loss

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With the increased interest in ethanol, more CRP land may be pressed into corn production, putting surface water at risk from increased phosphorus in runoff.

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. Conservation Reserve Program lands were removed from production because of their vulnerability to erosion and placed in perennial cover to minimize soil and nutrient losses. Recent interest in ethanol production has created increased demand for corn, which, in turn, could result in CRP acres going back into corn production. Returning highly erodible CRP lands to corn production has the potential to sharply increase runoff of sediment and phosphorus (P), putting surface water at risk of pollution. Elevated phosphorus levels in lakes and streams result in excessive aquatic plant and algal growth, which in turn can result in fish kills and cause human and animal health problems. In addition to phosphorus loss, other constituents necessary for soil quality, including carbon and nitrogen, are lost with erosion, resulting in significant negative soil quality and receiving water quality impacts.

This publication evaluates phosphorus loss via runoff from a variety of different tillage and rotations conducted on fields with steep slopes and recommends actions to limit phosphorus losses. Companion publication A3830, *Converting CRP to Corn: Minimizing Soil Loss*, focuses on ways to produce corn while retaining the soil quality and conservation benefits of the Conservation Reserve Program.

About the study

This study used the Snap-Plus nutrient management planning software to evaluate the risk of increasing phosphorus runoff loss for nine different corn rotations and tillage methods on highly erodible fields. The Snap-Plus program includes the Wisconsin Phosphorus Index (WPI), which uses soil test phosphorus, soil type, land slope, and field management information to estimate annual phosphorus movement in runoff from a field to the nearest surface water body. The phosphorus index is reported with no unit values to allow relative comparisons of phosphorus loss from fields under different management systems. (For more information on the Snap-Plus software and the WPI, visit www.snapplus.net and wpindex.soils.wisc.edu). Under current Wisconsin nutrient management planning guidelines (NRCS 590), management practices that maintain a field's rotation average phosphorus index value at 6 or below are acceptable.

To evaluate potential phosphorus loss increases, we selected land with slopes of 6–12% (group C) and 12–20% (group D) from 11 counties with significant CRP acreages. Table 1 summarizes the characteristics of each site.

Each field was analyzed with a grass hay management (to represent CRP) and nine corn-based rotation and tillage management combinations commonly used in Wisconsin. All field operations were conducted following the land's contour. Assessments were made with and without liquid dairy manure applied at a rate to meet corn nitrogen needs in the spring after all frost was out of the ground. For field management scenarios with spring

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**	**Assumed corn yield*** (bu/acre)	**Field slope** (%)	**Slope length** (ft)	**Field slope** (%)	**Slope length** (ft)
NE	Fond du Lac	Hochheim	Loam	160	9	150	16	100
S	Richland	Norden	Silt loam	160	9	150	16	100
S	Rock	Kidder	Sandy loam	160	9	150	16	100
SW	Dane	Dunbarton	Silt loam	120	9	150	16	100
SW	Grant	Dubuque	Silty clay loam	140	9	200	12	150
SW	Iowa	Dodgeville	Silt loam	160	8	200	14	150
WC	St. Croix	Amery	Loam	140	9	150	16	100
WC	Dunn	Hayriver	Fine sandy loam	120	9	150	16	100
WC	Eau Claire	Elkmound	Loam	120	10	95	16	85
WC	Pierce	Derinda	Silt loam	140	9	150	16	100
WC	Trempealeau	Gale	Silt loam	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).

tillage, the manure was assumed to be incorporated by the tillage. For no-till and strip-till managements, it was assumed to be unincorporated. The Bray 1 soil test P (STP) was set at 10 ppm to represent fields where additional phosphorus will be required to grow corn. Phosphorus fertilizer was assumed to be applied at planting by banding at University of Wisconsin-Extension recommended rates to meet crop needs for moderate to good yields for those soils.

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Phosphorus fed this algae bloom. As these thick mats of algae die, decomposition depletes oxygen from the water, potentially leading to a fish kill.

Analysis results

In general, most of the phosphorus in runoff from these sites is expected to be bound to eroding sediment and for that reason, the phosphorus index trends are similar to those for soil loss as shown in the companion publication. The modeling indicates that the grass hay or CRP management is expected to lose comparatively little phosphorus in runoff (figure 1). Converting a field from permanent grass to corn will lead to increased nutrient losses in runoff even with the most careful management. It is estimated that converting a field from CRP to no-till or strip till corn for grain will increase phosphorus in runoff by 2 to 10 times, and up to 20 times if manure is applied or if soybeans are included in the rotation with corn. Corn for silage leaves little residue cover resulting in very high erosion rates for these fields. If corn silage replaces CRP, estimated annual average phosphorus losses increase by as much as 100 times.

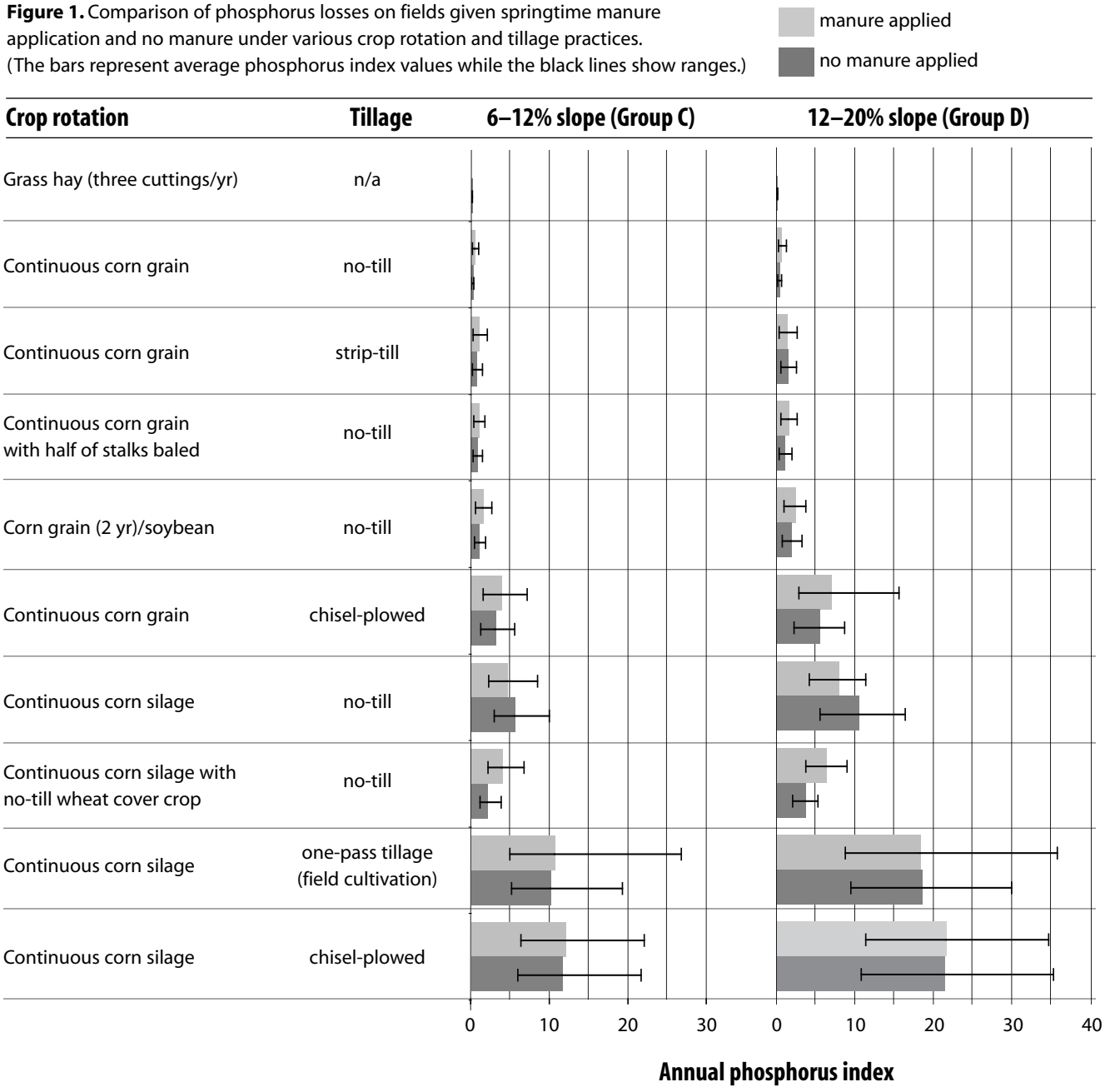
The estimated phosphorus loss following manure applications was affected by a number of factors, including application rate, method of application, type of animal manure, and time of application.

Fertilizing with broadcast liquid dairy manure rather than chemical fertilizer banded at planting generally caused a slight increase in the estimated phosphorus losses for these scenarios. This is due to increased soil phosphorus levels at the surface as well as manure phosphorus dissolved in runoff water. The exception to this trend occurred with no-till corn for silage. In this case, liquid dairy manure added residue to the soil surface that reduced runoff volume and erosion sufficiently to counteract the effects of the elevated phosphorus concentrations at the soil surface, but this effect did not reduce phosphorus index values significantly.

If solid or semi-solid manure with bedding was applied rather than liquid, as was used in these scenarios, soil loss and consequently phosphorus loss, would be reduced. For these scenarios, all manure application was assumed to occur during the spring. On the other hand, fall application without incorporation leaves this source of phosphorus at the soil surface over the winter and through the snowmelt period and would therefore be expected to increase runoff phosphorus losses.

It is also important to note that manure application at rates needed to meet corn nitrogen needs, as was assumed in this analysis, generally resulted in applying more phosphorus than the crop will remove, leading to a build-up in soil phosphorus levels. If corn yields are lower than those assumed in this study, soil residue levels would be lower and phosphorus loss values would be higher.

Figure 1. Comparison of phosphorus losses on fields given springtime manure application and no manure under various crop rotation and tillage practices. (The bars represent average phosphorus index values while the black lines show ranges.)



Recommendations

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

- Those fields most vulnerable to soil erosion are also susceptible to phosphorus loss in runoff and should be maintained in CRP for as long as possible.
- For those fields going back into corn production, steps should be taken to minimize soil disturbance by tillage and maximize residue cover (i.e., no-till or minimum tillage systems).
- Fertilizer should be injected or banded (not broadcast) at planting in a manner that minimizes soil disturbance. This reduces potential nutrient loss by runoff.
- Where available, solid or semi-solid manure with bedding is preferable to liquid dairy manure on steep slopes to reduce runoff and soil erosion and the corresponding phosphorus losses.
- Soil conservation and nutrient management plans must be updated to reflect changes in land use; in cases where no plan exists, one should be developed. These plans should be carefully followed.
- The magnitude of soil and phosphorus loss impacts will be site-specific. A modeling tool such as Snap-Plus can be used to evaluate the effects of management while taking into account site-specific conditions including slope steepness and length, management, and soil type.

Piles of rotting algae—a byproduct of elevated phosphorus levels—washed up on this beach, leaving it unfit for human use.

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