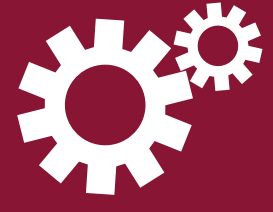




GEAR UP for 2008 Crop Management



Key Nutrient Management Questions when Switching from Corn/Soybean to Corn/Corn Rotations

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When changing from a corn/soybean to corn/corn cropping sequence, re-examine nutrient management practices to ensure they are appropriate.

There are many questions producers and their advisers are asking as more corn is being incorporated into crop rotations. In this article, we focus on a few key concerns related to switching from corn/soybean (CS) to corn/corn (CC) rotations.

How much do I need to change my N rate?

The following factors should be considered when deciding how much N to apply to corn in CC versus CS systems:

- **The effect of soybeans.** When soybeans are grown previous to corn, their net effect is to enhance mineralization of N from soil organic matter. This effect can lead to reductions in the quantity of N recommended for corn. **Figure 1** shows the level of such reductions for states reported to have corn/soybean rotations. In warmer climates where soil N mineralization rates are more rapid, soybeans do

not appreciably reduce recommended N rates. So, just how N rates for corn will change when shifting from CS to CC will depend to some degree on where in the country corn is grown.

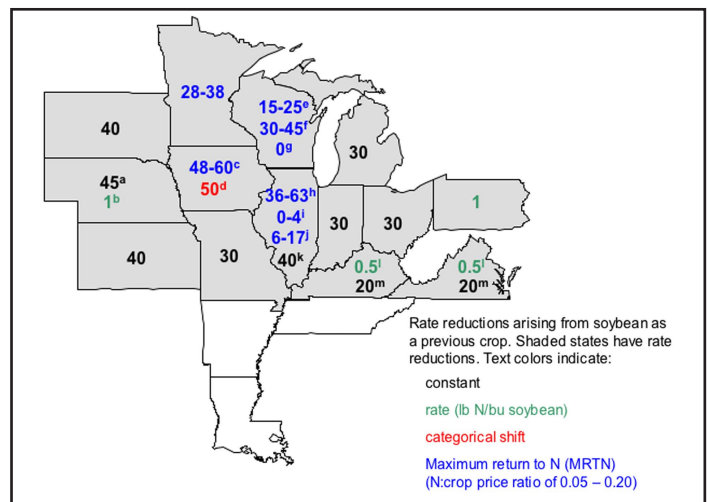


Figure 1. Reductions in N rate arising from soybean as a previous crop. States shown are those reported by USDA-ERS to have corn/soybean rotations.

Data taken from state extension publications and the online regional MRTN database. State specific notes:

Nebraska:

- a Constant used when soybean yield is equal to or greater than 30 bu/A.
- b Rate used when soybean yield is less than 30 bu/A.

Iowa:

- c Range in MRTN from online database.
- d Categorical shift in ranges given in pub. PM1714.

Wisconsin:

- e High/very high yield potential soils.
- f Medium/low yield potential soils.
- g Sands/loamy sands.

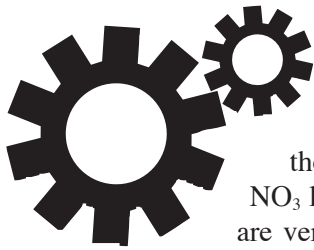
Illinois:

- h Northern Illinois
- i Central Illinois
- j Southern Illinois
- k Constant given in Illinois Agronomy handbook

Kentucky and Virginia:

- l Rate when previous soybean crop yield is known.
- m Constant used when previous soybean crop yield is unknown.





- **Soil NO₃ level.** Soybeans are good scavengers of soil NO₃. When soybeans are omitted and the switch is made to CC, residual soil NO₃ levels may increase, although levels are very dependent on the weather. Drier years typically produce higher levels of residual NO₃. Given such variability, it is usually a good practice to test for residual soil NO₃ before deciding how much N to apply.

- **Attainable yield.** University research has shown that there is a potential for CC systems to yield, on average, less than CS systems when managed in the same way. This possibility reinforces the need to keep accurate yield records on fields. If, over time, yields have in fact decreased, N rates will need to be adjusted downward in recommendation systems using yield goal as a factor.

Tools are available to assess how well corn is being fed with N. Of course, visual inspections can identify more severe cases where deficiency symptoms are apparent. Many states provide guidance for using a chlorophyll meter to identify more obscure in-season N nutrition problems. Finally, the stalk NO₃ test can be used at the end of the season to assess the appropriateness of the N rates used. Incorporating some or all of these monitoring tools can be very helpful when the switch is first made from CS to CC.

What happens to soil pH when I apply N more often?

Switching from CC to CS means applying N every year, rather than biennially. Most N fertilizers have an acidifying effect on soils. In some cases, the initial reaction may be alkaline, but over the long run, the ultimate reaction is acid. There are a few reasons for this:

- **Nitrification.** This natural process in soils is the conversion of NH₄⁺-N to NO₃-N. The conversion of one mole of NH₄⁺ produces two moles of acidity (H⁺). Common commercial N fertilizer sources either directly contain or produce NH₄⁺ and are therefore ultimately acid in reaction.
- **Nitrate leaching.** The downward movement of NO₃ is accompanied by positively charged ions (cations), most commonly basic cations, such as Ca and Mg. This process ultimately leaves a greater proportion of acidic cations in the surface soil.
- **Volatilization.** Under some conditions, such as basic pH, NH₄⁺ converts to ammonia (NH₃). One mole of NH₄⁺ produces one mole of H⁺.

- **Increased uptake of basic cations.** Where N is needed, fertilization increases plant biomass and uptake of basic cations from the soil.

Table 1. Changes in soil pH after 16 years of cropping on a Sharpsburg silty clay loam (Liebig et al., 2002; Liebig, personal communication).

Rotation [‡]	-----N rate [†] -----		
	Zero	Low	High
	----- 0 to 3 in. depth -----		
Corn/corn (C/C)	6.45	6.19	5.51
Corn/soybean (C/S)	6.65	6.43	6.32
	----- 0 to 12 in. depth -----		
Corn/corn (C/C)	6.89	6.65	6.05
Corn/soybean (C/S)	6.86	6.59	6.71

[†]Annual N rates for corn were 0, 80, and 160 lb N/A; annual rates for soybean were 0, 30, and 60 lb N/A. Ammonium nitrate was the N source, applied in the spring of each year.

[‡]CC = corn/corn; CS = corn/soybean; corn stalks were shredded, soil disked once or twice (4 to 6 in. deep) then harrowed just prior to planting.

Whether or not soil acidification rates will increase with CC compared to CS will depend a lot on the soil. A study in Iowa showed no differences in acidification between rotations after 23 or 48 years (Russell et al., 2006). Conversely, a Nebraska study (Table 1) showed that CC rotations decreased soil pH more than CS systems when measured after 14 years (Liebig et al., 2002). Both studies demonstrated that N fertilization increased acidification. The possible influence of rotation and the known impact of N fertilization upon soil acidification reinforce the need to regularly monitor soil pH, especially in the first few years when switching from one rotation to the other.

Table 2. A comparison of nutrient removal for 2 years of corn compared to one year of corn and one year of soybean, holding corn yield constant at 180 bu/A and soybean yield at 60 bu/A.

Rotation	2-yr. nutrient removal				
	N	P ₂ O ₅	K ₂ O	Mg	S
	----- lb/A -----				
Corn/corn (C/C)	324	137	97	32	29
Corn/soybean (C/S)	390	119	127	29	25
Difference (C/C) - (C/S)	-66	18	-30	3	4



How does nutrient removal change?

To answer this question, let's examine the quantity of nutrients removed in CC and CS. **Table 2** shows, at the yields assumed, that a CC sequence removes more P, Mg, and S than a CS sequence, but less N and K. Just how large such differences are depends on the yield levels of each crop. To estimate this for yourself, multiply your corn and soybean yields by the values in **Table 3**.

Table 3. Average nutrient removal rates calculated from published coefficients in the northcentral U.S. (Murrell, 2005).

	Removal coefficients				
	N	P ₂ O ₅	K ₂ O	Mg	S
	----- lb/bu -----				
Corn	0.90	0.38	0.27	0.09	0.08
Soybean	3.8	0.84	1.3	0.21	0.18

Do I need to consider applying starter fertilizer?

The benefits of starter fertilizer have long been recognized. Placement of N, P, K, and other nutrients in a concentrated band near the seed at planting often results in early season growth responses that can translate to end of season yield increases. Several factors affect response to starter fertilizer. Soil conditions that increase the probability of response include:

- cool, moist soil conditions at planting
- longer season hybrids planted later in the spring
- root growth restrictions, such as soil compaction, soil acidity, and soil salinity

In a 4-year Minnesota study, starter fertilizer produced equally beneficial responses (8 bu/A average) for CC and

CS under a variety of tillage systems: no-till, zone till, strip till, and conventional tillage (Vetch and Randall, 2002). The need for starter fertilizer for corn, regardless of rotation, may arise from the rapid influx of nutrients by corn roots early in the season and the positive effect of N and P on root proliferation. ■

For more about Plant Food Uptake:

Wallet-sized cards listing numbers for plant food uptake (PFU) and nutrient removal values for major crops are available for purchase from IPNI; call (770) 825-8082 or fax to (770) 448-0439.

ABBREVIATIONS AND NOTES:

N = nitrogen; NO₃ = nitrate; NH₄⁺ = ammonium; P = phosphorus; K = potassium; S = sulfur; Mg = magnesium; Ca = calcium; CC = corn/corn rotation; CS = corn/soybean rotation

References

- Liebig, M.A., G.E. Varvel, J.W. Doran, and B.J. Wienhold. 2002. Crop sequence and nitrogen fertilization effects on soil properties in the western corn belt. *Soil Sci. Soc. Am. J.* 66:596-601.
- Murrell, T.S. 2005. Average nutrient removal rates for crops in the Northcentral region [Online]. Available at <http://www.ipni.net/northcentral/nutrientremoval> (accessed 14 Jun. 2007; verified 14 Jun. 2007).
- Russell, A.E., D.A. Laird, and A.P. Mallarino. 2006. Nitrogen fertilization and cropping system impacts on soil quality in Midwestern mollisols. *Soil Sci. Soc. Am. J.* 70:249-255.
- Vetch, J.A. and G.W. Randall. 2002. Corn production as affected by tillage system and starter fertilizer. *Agron. J.* 94:532-540.

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