SHOULD SOYBEAN N CREDITS BE TAKEN IN 2005?

Larry G. Bundy[1/]

High N fertilizer costs projected for the 2005 growing season provide an incentive for assigning appropriate N credits where soybean was grown in 2004. The 2004 growing season caused late soybean planting and delayed maturity for some areas resulting in low grain yields. Soybean production experiences ranged form normal grain harvest to abandoned acreage with all of the dry matter left in the field. In some cases immature soybean was harvested as a forage, again with all above ground dry matter removed. In other cases, soybean residue was removed for feed or bedding after grain harvest. With this variation in soybean production outcomes, questions on assigning appropriate N credits for the crops to be grown following soybean have emerged. The purpose of this paper is to provide soybean N credit recommendations for several of the production conditions encountered in 2004. The specific situations include the following:

- Normal grain harvest with expected grain yields.
- Soybean grain harvest, but low yields (less than 20-25 bu/acre).
- Soybean grain harvest, residues removed.
- Soybean harvested as forage with all top-growth removed.
- Abandoned acreage due to immaturity or low yield, dry matter left in field.

Research results from several Midwestern states (Vanotti and Bundy,1995; Green and Blackmer, 1995; Gentry et al., 2001) indicate that the apparent N contribution of soybean to subsequent crops results primarily from the effect of soybean on net mineralization of soil N in the year after soybean is grown rather than an addition of N from the soybean residues returned to the soil. This concept is important for understanding the effects of soybean production outcomes on the appropriate N credit for a subsequent crop. Soybean production usually results in more N being removed in the soybean grain than is fixed from the atmosphere by the soybean crop. Most of the N accumulated by soybean is stored in the grain (approximately 6% N by weight) while relatively little N is returned to the soil in the soybean residue. Schoessow (1996) determined forage and residue amounts and N contents for soybean in Wisconsin and these results are summarized in Table 1.

Normal Grain Harvest with Expected Grain Yields

Although the mechanism of the soybean N effect is likely different from that seen with forage legumes, there is strong evidence that the N needs of corn following soybean is lower than for corn following corn. In most Midwestern states a soybean N credit of 30-50 lb N/acre is suggested. The current 40 lb N/acre soybean credit recommended in

[1/] Professor and Extension Soil Scientist, Dept. of Soil Science, Univ. of Wisconsin-Madison.

Table 1. Average soybean residue and forage dry matter yields and nitrogen concentration and uptake at four Wisconsin locations, 1993 to 1995 (Schoessow, 1996).

Year	Material [1/]	Dry matter	Nitrogen (N)	
			Concentration	Uptake
		lb/acre	%	lb N/acre
1993	forage	5339	2.99	165
	residue	2839	0.84	24
1994	forage	10563	2.81	293
	residue	6679	0.83	54
1995	forage	9214	2.63	236
	residue	6259	0.83	53

[1/] Forage yields determined by harvesting top-growth at R6 growth stage; residue yields determined after grain harvest.

Wisconsin is an average of observed soybean N credits that vary across locations and years. Previous work by Schoessow et al. (1998) and Bundy et al. (1993) supported the current N credit recommendation of 40 lb N/acre, but showed that the apparent soybean N credit varied widely across sites and years and that no credit was observed on sandy soils (sands and loamy sands). The latter observation is in agreement with similar findings in Minnesota (Hesterman et al., 1986). Schoessow et al. (1998) also found that site and year variation in optimum N rates for corn following soybean could be lowered through use of a preplant soil nitrate test in addition to the 40 lb N/acre N credit. Recent Wisconsin data (Fig. 1) showing lower optimum N rates for corn following soybean than for corn following corn supports the need for a soybean N credit.

The size of the soybean N credit cannot be accurately determined from Fig. 1 because the corn-corn and soybean-corn experiments were not done at the same locations in the same years. However, at maximum yield levels in the two rotations, corn yields after soybean were maximized with 35 lb N/acre less than was needed for corn following corn.

With increasing N costs, corn:N price ratios are now in the range where the N rate recommendation is influenced more strongly by these prices than when the corn:N price ratio was at 10:1 or higher. The relationships between economic optimum N rate and corn:N price ratio is illustrated for corn following corn and corn following soybean in Fig. 2. This information also supports N credits for soybean and lower N application rates than are needed for corn after corn. However at current corn:N price ratios, current N rate recommendations are somewhat higher than the economic optimum based on corn:N price ratios.

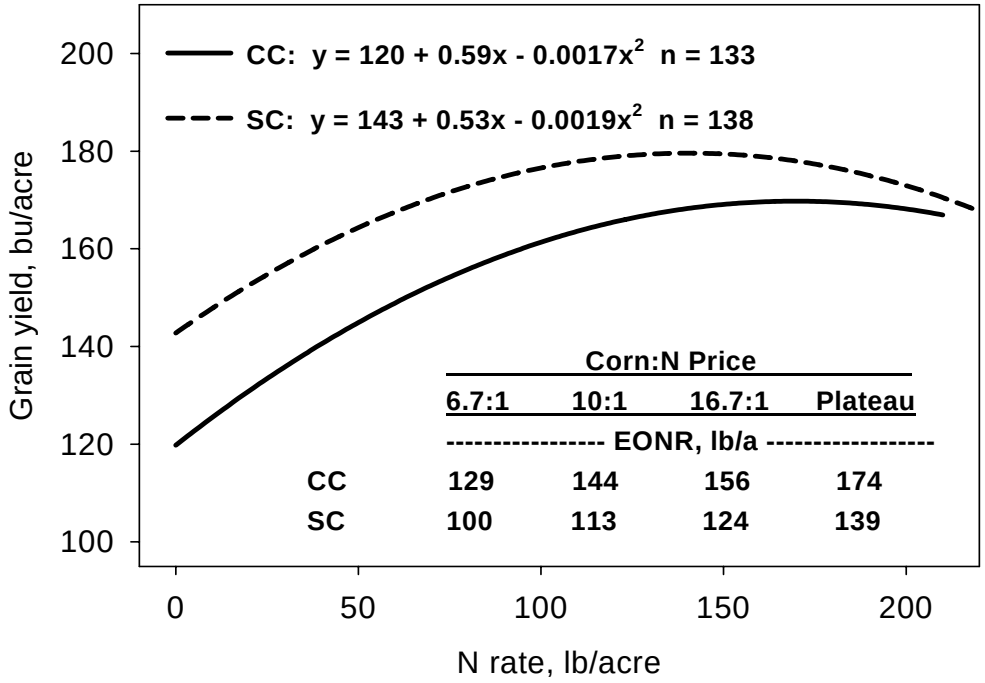

Figure 1. Corn grain yield response to N rate and EONR for various corn:N price ratios in 21 corn following corn and 26 corn following soybean experiments on silt loam soils in southern Wisconsin during 1991-2003.

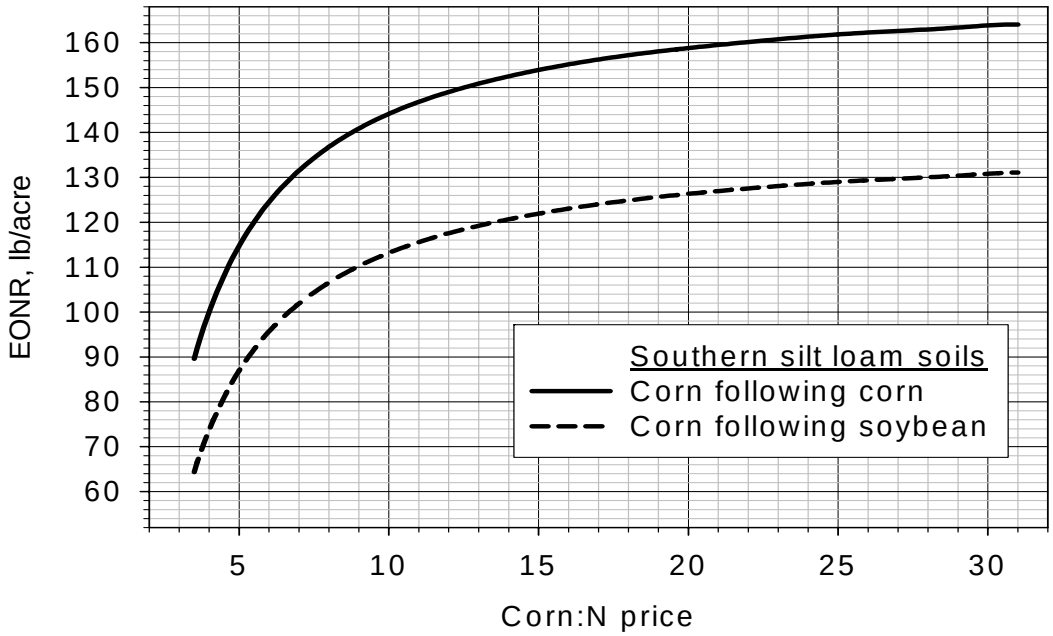

Figure 2. Relationship between economic optimum N rate (EONR) and corn:N price ratio based on 21 corn following corn and 26 corn following soybean experiments on silt loam soils in southern Wisconsin during 1991-2003.

Soybean Grain Harvest, but Low Yields (less than 20-25 bu/acre)

The influence of previous crop soybean grain yield on soybean N credits to subsequent crops was studied by Schoessow et al. (1998). Based on results from 15 experiments with corn following soybean at several Wisconsin locations where soybean yields ranged from 25 to 68 bu/acre. As shown in Fig. 3, there was no relationship between soybean yield and the optimum N rate for corn following soybean. Although few of the experiments had low soybean yields, the absence of a relationship between soybean yield and optimum N rates for corn following soybean is consistent with the conclusion that soybean yields do not influence the soybean N credit. Therefore, we recommend use of the 40 lb N/acre soybean N credit at all soybean yield levels.

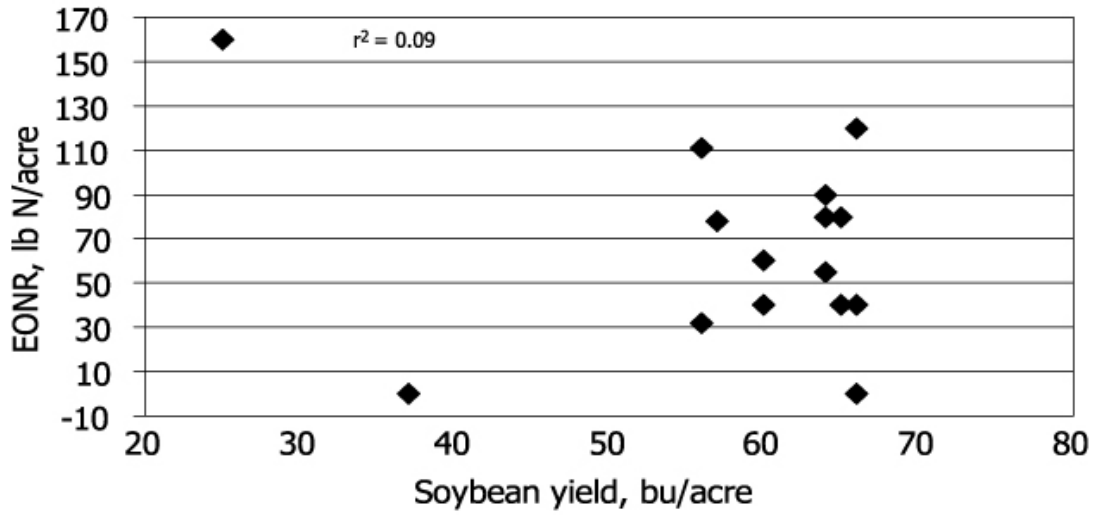

Figure 3. Relationship between economic optimum N rate (EONR) for corn following soybean and soybean yield in the previous year, 1994-1996.

Soybean Harvested as Forage or Residues Removed after Grain Harvest

Schoessow (1996) conducted a detailed study of the effects of soybean residue management on apparent N contributions to a subsequent corn crop. Results from this work showed that removing or returning soybean residue or removing soybean top-growth in a forage harvest at the R6 development stage usually had no effect on yield or N response of corn grown following soybean. Findings from this three-year study are illustrated in by the data from 1994 (Table 2). Where soybean residue management had a significant effect, corn yields were lower and more N was required to optimize yields where residues were returned than where residues were removed. These observations support the concept that soybean N credits do not depend on release of N from soybean residues, but are related to an increase in net N mineralization from soil organic matter. Early work by Fribourg and Bartholomew (1956) also showed that adding soybean residue where corn was grown the previous year had no effect on subsequent corn yield.

Table 2. Effects of soybean forage harvest and residue removal on corn yield and N response at three Wisconsin locations in 1994 (Schoessow, 1996).

		Nitrogen (N) rate, lb/acre	
Location	Residue mgmt.	0	120
		---------- Yield, bu/acre ----------	
Arlington	Returned	183	207
	Removed	180	200
	Forage	191	199
Lancaster	Returned	123	201
	Removed	122	216
	Forage	130	213
Belmont	Returned	175	214
	Removed	174	214
	Forage	194	208

Abandoned Soybean Acreage, Dry Matter Left in Field

Little research data exists to establish soybean N credits in the abandoned acreage situation, but information from some of the situations reviewed earlier in this paper can provide some guidance as to appropriate N crediting. It seems reasonable to assign a minimum of 40 lb N/acre for this situation since soybean was grown and previous work indicates yield has little effect on the soybean N credit when grain or forage is harvested. An additional adjustment for the un-harvested grain seems appropriate where maturity was sufficient to produce mature or immature grain. Since soybean grain is rich in nitrogen (6% N by weight) much of the N accumulated in the grain would likely be released to a subsequent crop. If we assume 15 bu/acre of grain remained un-harvested, the approximate N content of this grain would be 47 lb N/acre. While any additional adjustment will be influenced by how much grain was actually left in the field, an additional 20 to 25 lb N/acre seems justified, bringing the total N credit in the abandoned acreage category to 60 to 65 lb of N/acre.

Summary

Soybean N credits are an important component of effective N management in 2005. Where normal soybean grain harvest occurred, the 40 lb N/acre credit should be used. This credit is appropriate even where soybean yields were below expected levels. The credit can be fine-tuned through use of the preplant soil nitrate test. Adjustments for both the 40-lb credit and the results of the soil nitrate test should be used. Removing soybean residues or harvesting soybean as forage has no effect on the 40 lb N/acre credit. For abandoned soybean acreage, use the standard 40 lb N/acre credit and consider additional

credits based on the amount of grain left in the field. Typical total credits for abandoned acreage would be 60 to 65 lb N/acre.

References

Bundy, L.G. 1998. Soybean nitrogen contributions and rotation effects. In Proc. 28th North Central Extension-Industry Soil Fert. Workshop, St. Louis, MO, 11-12 Nov. 1998. 14:27-36.

Bundy, L.G., T.W. Andraski, and R.P. Wolkowski. 1993. Nitrogen credits in soybean-corn crop sequences on three soils. Agron. J. 85:1061-1067.

Fribourg, H.A., and W. V. Bartholomew. 1956. Availability of nitrogen from crop residues during the first and second seasons after application. Soil Sci. Soc. Am. Proc. 20:505-508.

Hesterman, O.B., C.C. Sheaffer,D.K. Barnes, W.E. Lueschen, and J.H. Ford. 1986. Alfalfa dry matter and nitrogen production, and fertilizer nitrogen response in legume-corn rotations. Agron. J. 78:19-23.

Gentry, L.E., F.E. Below, M.B. David, and J.A. Bergerou. 2001. Sources of the soybean N credit in maize production. Plant Soil 236:175-184.

Green, C.J., and A.M. Blackmer. 1995. Residue decomposition effects on nitrogen availability to corn following corn or soybean. Soil Sci. Soc. Am. J. 59:1065-1070.

Schoessow, K.A. 1996. Evaluation of soil nitrogen availability tests for predicting soybean N credits. M.S. Thesis. Univ. of Wisconsin, Madison.

Schoessow, K.A., K.C. Kilian, and L.G. Bundy. 1996. Site-specific prediction of soybean nitrogen contributions. p. 27-40. *In* Proc. North Central Extension-Industry Soil Fertility Workshop (vol. 12). 20-21 Nov. 1996. St. Louis, MO.

Schoessow, K.A., L.G. Bundy, and K.C. Kilian. 1998. Predicting optimum N rates for corn in soybean/corn rotations. Proc. Wis. Fert., Aglime and Pest Mgmt. Conf. 37:235-243.

Vanotti, M.B., and L.G. Bundy. 1995. Soybean effects on soil nitrogen availability in crop rotations. Agron. J. 87:676-680.