IMPLEMENTATION OF REGIONAL NITROGEN FERTILIZATION GUIDELINES FOR CORN IN WISCONSIN

Carrie Laboski[1]

Introduction

Recently soil fertility specialists in Wisconsin, Minnesota, Iowa, and Illinois have agreed to use the same philosophy to develop N rate guidelines for corn (grain). This new philosophy will reduce some of the differences in N rate recommendations between states and more importantly will provide for producer flexibility in setting a N rate that maximizes profitability. The approach used is data intensive (both research farm and grower fields) and is based on maximizing return to N fertilizer.

The new N rate guidelines for Wisconsin are provided in Table 1. In order to determine the N application rate using this table, one must first know:

- ✓ Soil yield potential. All soils in Wisconsin have been classified into yield potential categories based on the soil's rooting depth, water holding capacity, drainage, and length of growing season. Soil yield potentials can be found in bulletin UWEX A2809 "Soil test recommendations for field, vegetable, and fruit crops".
- ✓ Previous crop.
- ✓ N:corn price ratio. This is the price of N per pound divided by the price of corn per bushel.

Using these three pieces of information, a N rate can be identified that will, on average, maximize economic return to N (MRTN). A range of N rates that will produce economic profitability within one dollar per acre of the maximum can also be identified.

Example: *If corn will be grown on a high yield potential soil, N costs $0.36/ lb N and the outlook for corn is $2.40/bu (a price ratio of 0.15), and the previous crop was corn, then the N application rate that would be most likely to produce the greatest economic return is 120 lb N/a. A range in profitable N rates for this situation is 100 to 135 lb N/a. If the situation were the same except that the previous crop was soybean, then the N rate would be 100 lb N/a with a profitable range of 85-115 lb N/a.*

Within this system there is no longer a soybean N credit. Instead, a separate analysis of sites where corn followed soybean was used to develop the recommendations. It is important to continue to take N credits for forage legumes, leguminous vegetables (snap beans, peas, lentils, etc), green manures, and animal manures. These N credits are not changing. With regard to soil nitrate tests, the preplant nitrate test (PPNT) will remain the same; while the presidedress nitrate test (PSNT) will be used as an N credit to subtract from a previously determined N application rate.

These N rate guidelines are based on research where N losses were minimal or non-existent. Thus, time of application and form of N used does not affect the profitable N rates, because no loss of N is assumed.

[1] Assistant Professor and Extension Soil Scientist, Dept. of Soil Science, University of Wisconsin-Madison, 1525 Observatory Dr. Madison, WI 53706

Table 1. Suggested N application rates for corn (grain) at different N:corn price ratios.

Soil and Previous Crop	N:Corn Price Ratio ($/lb N:$/bu)							
	0.05		0.10		0.15		0.20	
	Rate[1]	Range[2]	Rate[1]	Range[2]	Rate[1]	Range[2]	Rate[1]	Range[2]
	lb N/a (Total to Apply)[3]							
HIGH/V. HIGH YIELD POTENTIAL SOILS								
Corn, Forage legumes, Leguminous vegetables, Green manures[4]	165	135-190	135	120-155	120	100-135	105	90-120
Soybean, Small grains[5]	140	110-160	115	100-130	100	85-115	90	70-100
MEDIUM/LOW YIELD POTENTIAL SOILS								
Corn, Forage legumes, Leguminous vegetables, Green manures[4]	110	90-135	100	80-110	85	70-100	75	60-90
Soybean, Small grains[5]	90	75-110	60	45-70	50	40-60	45	35-55
IRRIGATED SANDS AND LOAMY SANDS								
All crops[4]	215	200-230	205	190-220	195	180-210	190	175-200
NON-IRRIGATED SANDS AND LOAMY SANDS								
All crops[4]	110	90-135	100	80-110	85	70-100	75	60-90

[1] Rate is the N rate that provides the maximum return to N (MRTN).
[2] Range is the range of profitable N rates that provide an economic return to N within $1/a of the MRTN.
[3] These rates are for total N applied including N in starter fertilizer and N used in herbicide applications.
[4] Subtract N credits for forage legumes, leguminous vegetables, green manures, and animal manures. This includes 1st, 2nd, and 3rd year credits where applicable. Do not subtract N credits for leguminous vegetables on sand and loamy sand soils.
[5] Subtract N credits for animal manures and 2nd year forage legumes.

Guidelines for Choosing an Appropriate N Application Rate for Corn (Grain)

1. If there is >50% residue cover at planting, use the upper end of the range.
2. When corn follows small grains, the mid-to-low end of the profitable range is most appropriate.
3. If 100% of the N will come from organic sources, use the top end of the range. In addition, up to 20 lb N/a in starter fertilizer may be applied in this situation.
4. For medium and fine textured soils with >10% organic matter, use the low end of the range.
5. For course textured soils with <2% organic matter, use the high end of the range.
6. For course textured soils with >2 % organic matter, use the mid to low end of the range.
7. If there is a likelihood of residual N (carry over N), then use the low end of the range or use the high end of the range and subtract preplant nitrate test (PPNT) credits.

Examination of the range of profitable N rates for the various price ratios reveals that there generally is significant overlap between ranges. This suggests that a N application rate may be chosen that will come close to maximizing profitability for many economic scenarios. Figure 1 provides a graphical depiction of this. At favorable price ratios (smaller numbers; e.g. 0.05), the range in profitability is larger than at less favorable price ratios. This is largely because the penalty for over application of N at favorable price ratios is not as severe when the price of N is low and the price of corn is high. As the price ratio becomes less favorable (gets larger; e.g. 0.20), the range of profitability becomes smaller because the penalty for over application of more expensive N is much greater than at favorable price ratios.

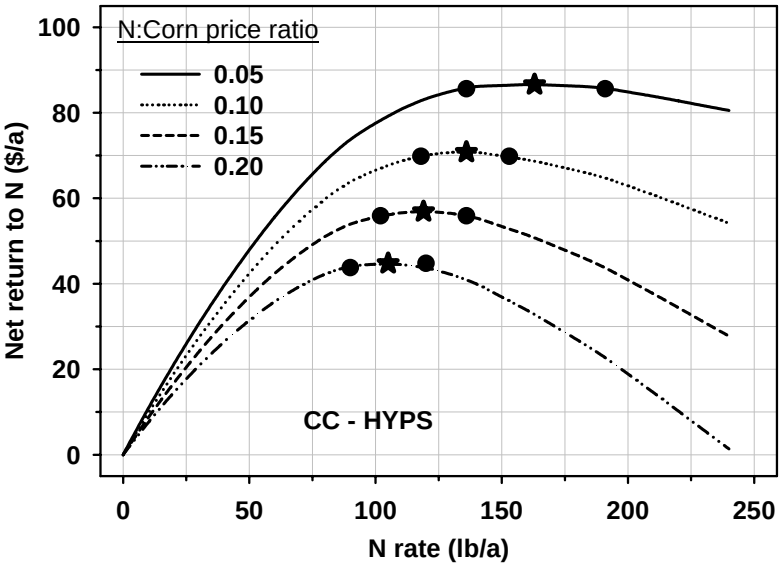

Figure 1. Profitable N rates for corn following corn (CC) on high/very high yield potential soils (HYPS) for N:corn price ratios of 0.05, 0.10, 0.15, and 0.20. Stars represent the maximum return to N (MRTN) and circles the low and high ends of the range of profitability (within $1/a of MRTN) at each N:corn price ratio.

Determining Price Ratios

One question many producers may have is related to determining the appropriate price ratio for their situation. The first thing to do is determine how much N costs on a $/lb basis. The next thing to do is to determine the price or value of the corn in $/bu. Then the price ratio can be calculated as the price of N divided by the price of corn. Table 2 was developed to help producers with this. In Table 2 the price of N ranges from $0.20 to $0.50/lb and the price of corn ranges from $1.80 to $3.60/bu. This provides a fairly large range of N and corn prices at which to look. However, attention should be focused on the price ratios in the box outlined in black. This box highlights the price ratios when N is $0.30 to $0.40/lb and corn is $2.00 to $2.60/bu. These are likely reasonable price ranges that producers will be working with in 2006. It can be seen that the price ratio varies from 0.12 (top right) to 0.20 (bottom left). These ratios are no where near the very favorable price ratio of 0.05 that appears on the left side of Table 1 nor are they close to the 0.06 price ratio that was used to develop our previous recommendations.

Table 2. Price ratio of N:corn (ie. $/lb N ÷ $/bu corn).

Price of N†	Price of Corn ($/bu corn)									
$/lb N	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
0.20	0.11	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06
0.22	0.12	0.11	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.06
0.24	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07
0.26	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07
0.28	0.16	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08
0.30	0.17	0.15	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08
0.32	0.18	0.16	0.15	0.13	0.12	0.11	0.11	0.10	0.09	0.09
0.34	0.19	0.17	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.09
0.36	0.20	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10
0.38	0.21	0.19	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.11
0.40	0.22	0.20	0.18	0.17	0.15	0.14	0.13	0.13	0.12	0.11
0.42	0.23	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.12	0.12
0.44	0.24	0.22	0.20	0.18	0.17	0.16	0.15	0.14	0.13	0.12
0.46	0.26	0.23	0.21	0.19	0.18	0.16	0.15	0.14	0.14	0.13
0.48	0.27	0.24	0.22	0.20	0.18	0.17	0.16	0.15	0.14	0.13
0.50	0.28	0.25	0.23	0.21	0.19	0.18	0.17	0.16	0.15	0.14

† Price of N ($/lb N) = $/ton fertilizer x (100 / % N in fertilizer) ÷ 2000

Valuing Grain and Manure N

Placing a value on fertilizer N is relatively easy in that the price of N is known at the time of purchase and application. The realistic value of grain will vary depending on where the grain is sold and how savvy a producer is in marketing the grain. Grain that will be used on farm as livestock feed should be valued at the price it would cost to purchase grain if feedstocks run short. The value of N in manure may vary between farms and between fields on farms depending upon the availability of land on which to spread manure. If a large enough land base is available to spread all manure, then the value of the N in manure could be considered to be equivalent to fertilizer N. This would mean that it would be more useful to spread the manure on as many acres as possible and reduce purchased N fertilizer, assuming poor or less than desirable N:corn price ratios. If the land base is limited, then spreading manure at a rate not to exceed the amount needed to maximize yield (top end of the profitability range for a N:corn price ratio of 0.05) would be appropriate. On some farms, there may be some fields that cannot receive manure and others that can. Thus, N application rates may be higher for fields receiving manure and lower for fields receiving fertilizer N.

Profitability and Potential Yield Loss

The price ratios in Table 2 show that current economics are not similar to the price ratio that was used to develop the old guidelines. Thus, using a price ratio of 0.05 to determine N application rates in 2006 is likely not appropriate for most producers. To maintain profitability, producers should reduce N rates to a level determined by current economics. One concern that many producers have is that reducing N rates will greatly reduce yield. Figure 2 shows the percent of maximum yield obtained for corn following corn and corn following soybean on high/very high yield potential soils, along with irrigated sands. It can be seen that for corn following corn on high yield potential soils, reducing N rates to 120 lb N/a will result in yield being about 97 % of maximum yield. Or stated another way, will result on average in a 3% yield

reduction. At a 200 bu/a yield level, this is a loss of approximately 6 bu/a from maximum yield. It must be remembered that producing maximum yield is not economical because the cost of the additional N is more than the value of the yield gain. So reducing N rates will reduce yield, but improve overall profitability. In this example, when N rates are reduced to 120 lb N/a, it is likely that some firing of the lower leaves on the stalk will be seen. It is acknowledged that most producers generally consider late season firing to be undesirable. However, it must be noted that supplying enough N to keep plants dark green through physiological maturity (black layer) means that N fertilizer has been over supplied from a profitability standpoint. For all soil types, the N rate at the MRTN for the 0.20 N:corn price ratio produces, on average, 94-95 % of maximum yield.

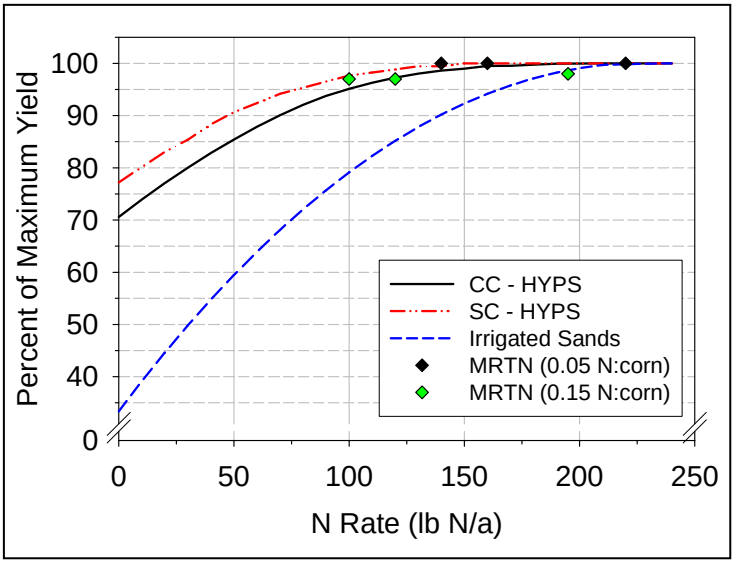

Figure 2. Percent of maximum yield obtained on average at each N rate for corn after corn (CC) and corn after soybean (SC) on high/very high yield potential soils (HYPS) and for all previous crops on irrigated sands with the exception of forage legumes and green manures. Diamonds represent the maximum return to N (MRTN) for each situation at price ratios of 0.05 and 0.15.

Nutrient Management Standards

These new N application rate guidelines can work well with nutrient management standards. Currently, the nutrient management standards reference the 1998 version of UWEX bulletin A2809 (Soil test recommendations for field, vegetable, and fruit crops). That document contains our old recommendations. A comparison of the old recommendations, which were developed at a price ratio of 0.06, to the new guidelines at a price ratio of 0.05 shows a minimal difference in N rates, particularly when starter fertilizer N is considered. The new N rate guidelines will rarely provide a N rate that is greater than the old recommendations that are referenced in the standards. Thus, these guidelines can be used and still meet the criteria outlined in the nutrient management standards.

What About Corn Silage?

The relationship between silage yield and N application rate is similar to that for grain yield and N rate. Silage quality is not greatly influenced by N application rate over the range of N rates provided in Table 1. Thus, these new N application rate guidelines can also be used for corn silage. If a producer would like to reduce N rates on silage, then they can do so by choosing a N:corn price ratio that reflects typical prices for N and grain.

Percent of maximum silage yield at various N application rates is similar to the percent of maximum grain yield provided in Figure 2. Thus, a producer can use Figure 2 to determine the amount of silage yield that will likely be lost when N rates are reduced. In a situation where all of the silage is being feed to livestock on the farm, producers my want to maximize yield, in order to minimize purchased feed, and therefore would use the 0.05 price ratio. However, if a producer is selling silage, then they would likely want to maximize the profitability of silage production and would reduce N rates according to the N:corn price ratio using relevant N and grain prices.

Summary

- The new N rate guidelines provide producers flexibility in setting N application rates that reflect economic conditions on their individual farm operations.
- These guidelines were developed using a regional philosophy that confirms our previous recommendations and are consistent with current nutrient management regulations.