Annual Progress Report for 2008 Cropping Season

Effect of Rotation on Soybean Yields and Determining the Soybean Nitrogen Equivalent Contribution on Sandy Soils in Holt County

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Location: **SW ¼ Section 33 T28N R6W Antelope County (Sheet 10, Antelope County Soil Survey)**

Executive Summary:

This report summarizes the fifth year of a five year study designed to determine the rotation effect of soybeans on corn and the value of both a corn/soybean (C/S) and corn/corn/soybean(C/CS) rotation on sandy loams soils. The four sub-objectives and what we found are listed below:

1. Estimate the 'N credit' of soybeans for the following corn crop. In 2008, the C/S rotation achieved a maximum yield of 223 bu/acre with 250 lbs of nitrogen per acre. The corn following corn (CC) achieved a maximum of 191 bu/acre with 200 lbs of nitrogen per acre (Table 3). This is very interesting since optimum yield was higher, but took more N in C/S rotation compared to the CC. To get the same yield in C/S as CC it took 50 lbs less N per acre. Based on the regression equations for the two rotations the C/S following soybeans achieved a maximum yield of 212 bu/acre with 234 lbs N/acre and the CC yielded 195 bu/acre with 260 lbs N/acre in 2008 (Figure 1). **Using the regression analysis indicates a 'nitrogen' credit of 25 lbs N/acre with a 17 bu/acre yield increase.**

2. Determine if there is a difference in potential yield due to soybeans in a corn/soybean and corn/corn/soybean sequence compared to corn/corn/corn. Because this is the fifth year of the project and there are three year rotations, this is the second year that we have corn data that is complete for this part of the project. The second corn year after soybeans yield average over all nitrogen rates was 154 bu/acre compared to continuous corn at 145 bu/acre and corn following soybeans at 185 bu/acre (Table 3). **The second year of corn in the corn/corn/soybean rotation yielded 6% more than continuous corn, but corn following soybeans yielded 20% more than 2nd year corn.**

3. Determine the effect of continuous soybeans on soybean yields. Continuous soybeans (60.9 bu/acre) yielded less than soybeans in the corn/soybean rotation which averaged 63.4 bu/acre in 2008. The three year average (2006, 2007, 2008; but in soybeans since 2004) for continuous soybean yield was 63.5 bu/acre and the soybeans following corn averaged 63.9 bu/acre (Table 7). **There was no rotation effect on soybean yields.**

4. Determine the effect of nitrogen application during early reproductive stage to soybeans. Average yields were 61 bu/acre where no nitrogen was applied, compared to 62.3 bu/acre where nitrogen was applied. **There was no soybean response to nitrogen in 2008.**

Introduction:

The University of Nebraska currently gives a soybean credit of 45 lbs N for a 'good' soybean crop, defined as over 25 bu/acre. When soybean yields are less than 25 bu/acre, the credit is 1 lb/bu of soybeans. These credits are relatively low when compared to calculated rates from research results. However, most of the rotation research has been conducted on silt loam and silty clay loams in rainfed areas in the eastern part of the state. There have been irrigated rotation studies in the central part of the state, which have shown similar or higher credits, but none in the irrigated sands of the Upper Elkhorn Natural Resources District (UENRD).

Soybean yields, while higher than other parts of the state may be difficult to sustain on the low organic matter, coarse texture soils in parts of the UENRD. Producers are asking whether two years of corn and one year of soybeans maybe a more sustainable rotation than a corn/soybean rotation. There has been no documentation of the yield effects or soil quality effects of either rotation on sandy soils.

Nitrogen application to soybeans during the growing season has been shown to increase yields in Kansas; the results in Nebraska are variable and unpredictable (Wesley et al., 1998). Replicated research on sands has not been conducted.

There may be significant nitrogen leaching implications to all these practices.

Objectives:

Determine the rotation effect of soybeans on corn and the value of both a corn/soybean and corn/corn/soybean rotation on sandy loams soils.

Sub-objectives:

1. Estimate the 'N credit' of soybeans for the following corn crop.
2. Determine if there is a difference in potential yield due to soybeans in a corn/soybean and corn/corn/soybean sequence compared to corn/corn/corn.
3. Determine the effect of continuous soybeans on soybean yields.
4. Determine the effect of nitrogen application during early reproductive stage to soybeans.

Procedures:

Conducting a rotation experiment is complicated by the need to have every year of the rotation in each cropping year. In a soybean/corn evaluation one would have both corn and soybeans every year so that there was always a treatment with corn following soybeans. With this study, the corn-corn-soybean rotation means that there will be three experimental units in each replication each year so that there will always be data to compare the rotations. Conducting the experiment in a production field means that the cooperating farmer and landlord have to commit to several years of research, as will the funding agency. Mr. Eugene Zuhlke has cooperated with the Upper Elkhorn NRD and the investigators on several studies over the past several years and has done an excellent job of cooperating on this study. We thank him for his time and effort to let us use his land.

Below are the rotations used in this study. In experimental design jargon, the rotations are main plots and the nitrogen rates within the rotations are split plots. Each rotation treatment will be split with six N rates. The N treatments to the corn part of the study are 0, 50, 100, 150, 200, and 250 lbs N/acre. Soybeans will get 0, 20, 40, 60, 80, and 100 lbs N/acre. In the table below the useable rotations for 2008 are highlighted. The corn treatments are in **bold** and the soybeans in *italics*.

Rotation treatment set:

Treatment	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1 Cont. Corn	Soy	Corn	Corn	Corn	Corn	**Corn**
2 Soy/Corn	Soy	Corn	Soy	Corn	Soy	**Corn**
3 Corn/Soy	Soy	Soy	Corn	Soy	Corn	*Soy*
4 Cont. Soy	Soy	Soy	Soy	Soy	Soy	*Soy*
5 Soy/C/C	Soy	Soy	Corn	Corn	Soy	**Corn (1st)**
6 C/Soy/C	Soy	Corn	Soy	Corn	Corn(2nd)	Soy
7 C/C/Soy	Soy	Corn	Corn	Soy	Corn (1st)	**Corn (2nd)**

Notes:

1. Continuous soybeans is not a practical treatment, but is needed for statistical and long-term information.
2. Crop strips are 12 30 in rows wide. This is wide enough to avoid the border effect between corn and soybean strips.
3. Nitrogen is applied both by hand and with fertilizer spreaders. Yields and data collected from the inner two rows. Subplot length is 30 ft.
4. Due to the need to avoid continuous treatments with lower N rates than optimum, creating a permanent deficit plot, the rotation blocks are split into two six-row subplots. One side gets a constant, optimum rate and the other side gets the N rates. These areas are switched every year so the N rate plots will be on ground that was treated uniformly the year before. The uniform rate applied will be slightly below recommended so excess nitrogen does not carry over to the future year.

This aerial photograph in True Color was taken July 27, 2008. Corn is in the darker areas, with the higher nitrogen rates the darkest areas. One can see in the north of the rotation is a lime experiment. The surrounding field was corn in 2008.

Table 1. Preseason soil sampling. April, 2007. N 4/2008 Brunswick, NE.

Crop Rotation	Data	0-8" sample
Continuous Corn	Water pH	5.2
	Buffer pH	6.1
	K (ppm)	138
	P (ppm)	24
	OM LOI (%)	0.8
	Pounds N (48 in)	26
Corn (2008) Soybean (2007)	Water pH	5.3
	Buffer pH	6.4
	K (ppm)	179
	P (ppm)	40
	OM LOI (%)	1.1
	Pounds N (48 in)	31
Continuous Soybeans	Water pH	5.6
	Buffer pH	6.6
	K (ppm)	201
	P (ppm)	40
	OM LOI (%)	1.0
	Pounds N (48 in)	34

Note: Samples taken in bulk treatments, 2 cores per sample, one sample per replication and averaged.

Only deep N samples were taken in the spring of 2008. Spring 2007 soil samples indicated that soil pH continues to be low three years after a pelleted lime application (Table 1). The ag lime recommendation based on the April 21, 2007 analysis indicates a need for another 5000 lbs. The last application of lime was 500 lbs/acre pelleted lime that was applied into the standing crop June 19, 2006. Pelleted lime is being used since we are trying to avoid tillage. Although the pH is low, and most agronomists would recommend it to be raised to 6.5, the potential yield improvement may be low.

The yields in the lime studies that are also on the same quarter do not show much pH change or yield response to added lime.

Soil potassium (K) and phosphorus (P) are above the University of Nebraska critical levels of 125 and 15 ppm, respectively. In order to maintain soil fertility KSulfaMag (0-0-21-21-11) was spread on May 19, 2008 at a rate of 25 lbs S/acre. Using the University of Nebraska corn calculator with the data from Table 1, the irrigation water nitrate ppm (19.5), average nitrogen in the soil of 26 lbs N/acre for continuous corn and 31 lbs N/acre for corn following soybeans, and a 220 bu/acre yield goal the nitrogen recommendations for continuous corn was 205 lbs N/acre and 153 lbs N/acre for corn following soybeans.

Nitrogen was applied to corn in the treatment areas three times during the season. Each nitrogen rate was split with 40% spread pre-emergence (May 19, 2008), 30% spread at V6 (June 23, 2008), and the remaining 30% spread at V10 (July 3, 2008). Nitrogen was ammonium nitrate to avoid potential volatilization problems. On the bulk strips, nitrogen was applied once as ESN at a rate of 180 lbs N/acre on May 19, 2008. Nitrogen in the irrigation water, calculated at 9 in (actually 12 were applied) added about 40 lbs N per acre to each treatment. All corn in the bulk strips received the same nitrogen rate, regardless of whether it was following soybeans or not.

Nitrogen was applied as 34-0-0 on the soybeans on July 9, 2008 at the R1 stage.

Table 2. Cultural Practices at Rotation Experiment. Brunswick. 2008.		
Practice	**Corn**	**Soybeans**
Planting date	5/13	5/13
Variety	NuTech 1X112 HTX	Pioneer 93M11
Tillage	None	None
N applied	5/19; 6/23; 7/3	7/9
$CaSO_4$ applied	6/5	6/5
Chlorophyll meter readings	7/9; 7/23; 8/12; 8/25	Not collected
Pesticides:		
Dual II Magnum	5/13	5/13
Liberty	5/31, 6/30	
GlyStar Plus		5/31, 6/30
AMS	5/31, 6/30, 8/22	5/31, 6/30, 8/22
GlyStar Plus (spot spray)		8/22
Liberty (spot spray)	8/22	
Lorsban (aphids)		8/14
Dry matter harvest	10/14	Not collected
Combine	11/25-26	10/18
N in water; N applied Calculated for 9 in.	19.5 ppm	40 lbs N/acre

Cultural practices are summarized in Table 2. The year began with greater than normal rainfall, 6.5 inches of rain in May is unusual (Table 8). In the two weeks after we applied ammonium nitrate 6 in of rain fell, this would move nitrate N down through the profile. There were no other major weather related anomalies. Dry matter samples were taken shortly after physiological maturity from all the corn nitrogen treatments. Nitrogen uptake was calculated for the grain by dividing protein levels by 6.25 and multiplying that times the pounds grain at zero percent moisture. Percent nitrogen was multiplied by dry pounds of plant material (non-grain) harvested at physiological maturity. The two were combined for the total N uptake.

Results:

Corn

Rotation effects

Chlorophyll meter readings, population, yield, stalk nitrates, grain N, and total N had rotation effects that were statistically significant (Table 3 and 4). Grain yield was increased when corn was grown following soybeans anywhere in the rotation (145 bu for continuous corn vs 173 bu for the three rotated treatments). In the three year Corn-Corn-Soybean (CC/S) rotation the corn immediately after soybeans (181 bu/acre) was significantly greater than the second year after corn (154 bu/acre). There was no difference in the C/S (185 bu/acre) compared to the first year corn in the corn, corn, soybean rotation (181 bu/acre). Chlorophyll meter readings were affected by rotation and N rate at all dates, and there was an interaction between Rotation and N rate at the last 2 reading dates (Table 4). Although significant, the effect was small.

Nitrogen Rates

Nitrogen was significant at the 0.0001 level for chlorophyll meter readings (Figure 1), yield, Harvest Index, stalk N, and stover matter. There were no N effects of population, grain moisture and test weight. Although both grain moisture and test weight showed linear affects of N rate. All the chlorophyll meter readings, stalk N, grain N, stover N, and yield had significant linear and quadratic response to N. This is similar to previous years and expected. Figure 2 shows the effect of nitrogen on continuous corn (rotation 1) compared to corn following soybeans (rotation 2). The curves show that the corn following soybeans consistently yields more than corn following corn, the lines are almost parallel. Grain and stover N uptake patterns were similar to yield, in that when corn follows corn (continuous corn and the second year corn) the grain and stover N values are similar (79 and 84 lbs N/acre), and when corn follows soybeans in either the two or three year rotation, the grain and stover N are similar (47 and 48 lbs N/acre).

We will combine all year's data before making a recommendation on a 'soybean credit' for sands, but this year's data indicates that more corn is produced for the same N rates following soybeans than following corn. This trend is consistent since 2005. Regression equations were fitted to the data and both rotations had quadratic equations that fit with R squares of 0.97, which is a very close fit. Based on the regression equations the maximum yield for the continuous corn was 195 bu/acre and for the corn following soybeans was 212 bu/acre. The nitrogen needed for maximum yields was 260 and 235 lbs N/acre for corn following corn and corn following soybeans, respectively. The corn following soybeans used 25 lbs N less than the continuous corn and this resulted in 17 more bushels of corn. The predicted nitrogen needs for 175 bu corn is 160 lbs N per acre for corn following corn and 95 lbs N/acre for corn following soybeans. Clearly there is a difference in how corn responds to nitrogen between these two systems. Table 6 contains some economic analysis to go along with the yields. The net returns after the nitrogen was paid for was calculated based on $3.50/bu corn and $ 0.50/lb nitrogen (C:N ratio of 7.0) which is typical of the current situation.

Soybeans

There are three soybean rotations; continuous soybeans, soybeans following one year of corn, and soybeans after two years of corn. Soybean yields were not significantly different in the continuous soybeans (60.9 bu/acre) followed by the soybeans after corn (63.4 bu/acre). The Least Significant Difference (LSD 0.05) was 6.1 bu/acre, all soybean rotations were within 3 bu of each other. The nitrogen application did not increase yield, with the no nitrogen treatment yielding (61 bu/acre). The soybeans with N averaged 62 bu/acre. However, the irrigation water had about 40 lbs-N in it, and that may account for lack of response. There were no interactions between the rotations and the nitrogen rates.

Weather and Soil Water Measurements

The test plots had corn and soybeans side-by-side making it impossible to irrigate the crops to meet the water requirements of each individual crop. Consequently, irrigation management was done to meet the needs of the crop outside of the test plot area. In 2008, that crop was corn.

Soil water sensors were installed in one corn and one soybean plot in 2008. Watermark sensors were installed 6", 18", and 30" below the soil surface. A data logger was used to record the information 4 times per day. However, on two occasions rodents chewed the wires which connected the sensors with the data logger causing interruptions in the data collection. Mark Pavlik recorded the soil water sensors on a daily bases during most of the growing season. Since his data set is more complete and without interruption, his readings are shown in Figures 3 and 4**.** For a loamy fine sand soil (Thurman and Boelus), 50% depletion is reached at an average Watermark sensor reading between 45 and 50. Watermark readings for field capacity would be approximately 10-15 for this soil.

Soil water readings indicate that no yield reductions should have resulted due to limited water supplies. Readings for soybeans were typically below 30 until late in the growing season (Figure 3), suggesting that some water conservation would have been possible if the crop had been watered separately. Readings for corn also indicated that some extra irrigation water might have been applied but due to the low water holding capacity, it is much more difficult to allow soil water readings to dry down prior to the next irrigation.

Table 8 provides a summary of climatic data for the 2008 growing season and estimated crop water use for corn and soybeans based of the automatic weather station located about 3 miles to the east of the field site. Crop water use totaled nearly 23 inches for corn and just over 21 inches for soybean. However, the combination of precipitation and irrigation water applied totaled over 31 inches. Precipitation was recorded on 47 days totaling nearly 19 inches during the 2008 growing season. Of the precipitation events, half were events less that 0.2". In addition, as shown in Table 8, an extra 5.5 inches of precipitation (precipitation – corn ET) was recorded in May.

The impact of the early season rainfall on the water balance at the site is depicted in Figure 5. Most of the extra water applied occurred in late May to early June. The remainder of the season saw the differential between the two only increased by a couple inches. On two occasions after July 1, precipitation amounts greater than 1.2 inches were recorded within two days following the irrigation event. These events accounted for much of the remaining extra water application to the field.

A total of 2481 Growing Degree Days (GDD's) which was lower than the past 5-year average of 2560 GDD's indicating that overall the 2008 summer was substantially cooler than 3 of the past 5 years. Only 2004 was cooler with 2372 GDD's. This would suggest crop water use should have been lower than the previous 3 years and crop development would be slower as well.

Discussion

The data is clear the yields from the continuous corn are below corn following soybeans, and it takes more nitrogen to produce that yield. Yields were about average in 2008 with the higher nitrogen rates. The challenge that agronomists face is choosing the correct yield goal before the season. The UNL recommended nitrogen rates for this field were 205 and 155 lbs per acre for the continuous corn and the corn following soybeans without adjustment for N and corn prices. The actual nitrogen rates that produced the maximum yields were 225 and 200 lbs per acre, respectively.

Literature Cited:

Wesley, T.L., R.E. Lamond, V.L. Martin, and S.R. Duncan. 1998. Effects of late-season nitrogen fertilizer on irrigated soybean yield and composition. J. Prod. Agric. 11:331–336.

Table 3. Effect of rotation and N rate on chlorophyll meter readings, plant population, corn grain yield, grain moisture and test weight. Brunswick, NE 2008.

		----------applied nitrogen (lbs N/acre) [1] ----------						
Rotation	Data	0	50	100	150	200	250	Rotation Mean
(1)Cont. Corn	Grain yield (bu/acre)	66.5	109.4	146.6	173.1	191.0	184.4	145.2
(2) Sb/Corn		118.6	165.3	193.3	194.4	216.8	223.2	185.3
(7)Sb/Corn/**Corn**		80.6	107.9	143.0	177.3	195.8	219.8	154.1
(5)Corn/Sb/**Corn**		94.1	162.6	186.8	217.5	211.8	211.5	180.7
Mean		89.9	136.3	167.4	190.6	203.8	209.7	
(1)Cont. Corn	Stover DM (tons/acre)	2.5	3.3	4.4	3.5	4.0	4.0	3.6
(2) Sb/Corn		2.9	4.0	4.2	4.6	5.0	4.2	4.1
(7)Sb/Corn/**Corn**		2.6	3.5	3.7	4.5	4.2	4.3	3.9
(5)Corn/Sb/**Corn**		2.8	3.5	4.1	3.9	4.5	4.7	3.8
Mean		2.7	3.6	4.1	4.1	4.4	4.3	
(1)Cont. Corn	Stover N Uptake (lbs/a)	26.8	34.1	53.9	50.7	57.1	58.8	46.9
(2) Sb/Corn		32.1	39.3	47.7	58.8	82.4	65.2	54.2
(7)Sb/Corn/**Corn**		29.4	36.2	39.5	53.2	64.3	66.7	48.2
(5)Corn/Sb/**Corn**		25.1	38.5	50.2	54.5	72.6	89.7	55.1
Mean		28.3	37.0	47.8	54.3	69.1	70.1	
(1)Cont. Corn	Grain N Uptake (lbs/a)	33.0	55.0	76.2	92.1	112.0	106.8	79.2
(2) Sb/Corn		57.7	84.3	105.1	110.5	126.2	129.5	102.2
(7)Sb/Corn/**Corn**		37.3	53.0	74.4	94.3	111.4	130.6	83.5
(5)Corn/Sb/**Corn**		48.0	83.3	103.7	121.9	122.1	126.2	100.8
Mean		44.0	68.9	89.8	104.7	117.9	123.2	
(1)Cont. Corn	Stalk nitrates (ppm)	83	19	487	1012	3268	4619	1581
(2) Sb/Corn		47	50	1145	2726	6927	5785	2780
(7)Sb/Corn/**Corn**		18	45	194	541	3440	4819	1509
(5)Corn/Sb/**Corn**		123	55	1284	2182	6166	6055	2644
Mean		67	42	777	1615	4950	5319	
(1)Cont. Corn	Chlorometer (8/12)	29.6	36.0	47.9	51.1	55.7	54.5	45.8
(2) Sb/Corn		36.2	45.3	51.6	52.6	55.5	54.8	49.3
(7)Sb/Corn/**Corn**		31.7	38.6	48.0	49.8	53.2	53.9	45.9
(5)Corn/Sb/**Corn**		32.0	44.4	50.8	52.9	55.5	55.3	48.5
Mean		32.4	41.1	49.6	51.6	55.0	54.6	
(1)Cont. Corn								
(2) Sb/Corn								
(7)Sb/Corn/**Corn**								
(5)Corn/Sb/**Corn**								
Mean								
Grain moisture (%)		20.8	20.5	20.7	20.3	20.4	20.2	20.5
Protein (%)		6.4	6.6	7.0	7.3	7.6	7.8	7.1
Test weight (lbs/bu)		50.4	51.9	52.09	51.9	52.0	52.6	51.8
Population (#/acre)		32,167	31,686	31,560	33,047	32,356	32,020	32,139

[1]N rates do not include the 40 lbs applied in the first 9" of irrigation water.

Table 4. Analysis of variance and statistical results from rotation study. Brunswick. 2008.								
	Chlorophyll Meter				Population	Yield	Grain Moisture	Test weight (lbs/bu)
	7/09	7/23	8/12	8/25	(plants/ac)	(bu/ac)	(%)	
Rotation Effect[1] (Prob. > F)	0.0029	0.0293	0.0011	0.076	0.0199 CC vs O 0.0072 C/B vs CCB 0.06	0.0004	0.2244	0.257
LSD $_{0.05}$	1.2	2.0	1.6	4.7	1030	14.1	1.0	0.9
Nitrogen Rate Effect (Prob. > F)	.0001	.0001	0.0001	0.0001	0.1040	0.0001	0.244	0.059
N linear	.0001	.0001	.0001	0.0001	0.3946	0.0001	0.0154	0.009
N quadratic	.0001	.0001	.0001	0.0001	0.6666	0.0001	0.970	0.3138
LSD $_{0.05}$	1.1	1.7	1.7	2.5	1090	13.8	0.4	1.4
Rot x N rate	0.084	0.796	0.020	0.016	0.511	0.120	0.941	0.642
CV (%)	3.3	5.0	5.1	5.1	4.8	11.7	3.0	3.8

[1]Effects are considered significant if the Prob.>F is 0.05 or less.

Table 5. Analysis of variance and statistical results from rotation study. Brunswick. 2008.							
	Harvest index	Protein[1]	Stalk N	Grain N uptake	Stover DM	Stover N uptake	Total N uptake
Rotation Effect[1] (Prob. >F)	0.3199	0.1436	0.0197	0.0004	0.1898	0.3203	0.0055
LSD $_{0.05}$	0.0288	0.3	920	9.0	0.5	11.4	17.5
Nitrogen Rate Effect (Prob. > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
N linear	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
N quadratic	0.0023	0.3535	0.0011	0.0001	0.0001	0.4391	0.0005
LSD $_{0.05}$	0.0227	0.2	1110	7.7	0.5	8.8	12.7
Rot x N rate	0.2019	0.1488	0.6420	0.0918	0.576	0.2019	0.4507
CV (%)	6.4	4.0	74	12.0	16.6	24.3	12.6

[1]Effects are considered significant if the Prob.>F is 0.05 or less.

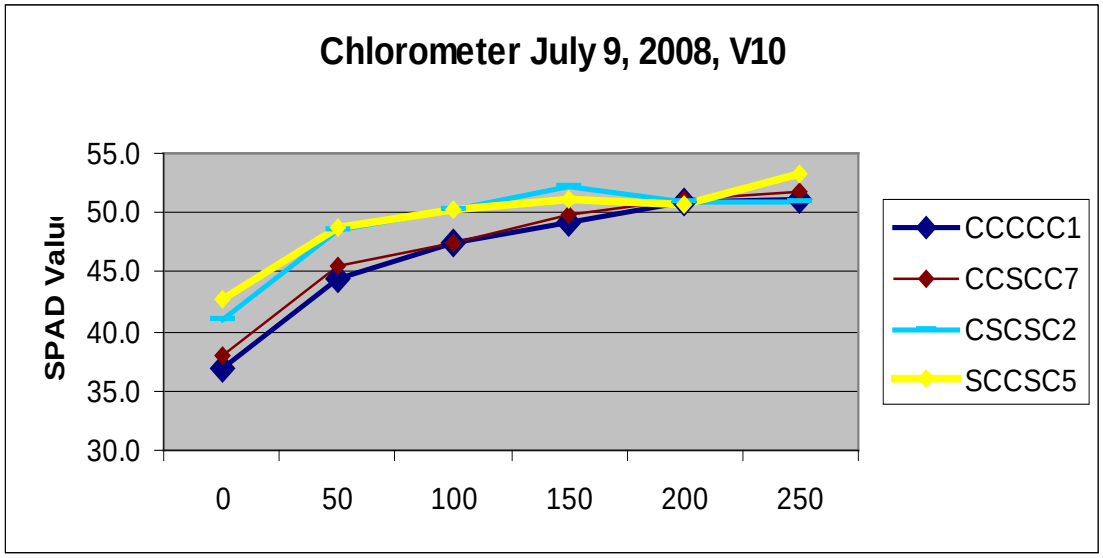
Table 6. Summary of rotation effect on yield, nitrogen rate and net return for predicted maximum yield and maximum returns over nitrogen costs. Brunswick, NE. 2008.

	Maximum Yield			Field result vs Corn Calculator		Maximum Net Returns Profit		
	N rate (lbs/acre)	Yield (bu/a)	Net over costs ($/a)	Field N rate for 175 bu	Calculator* N rate for 175 bu	N rate (lbs/acre)	Yield (bu/a)	Net over fert costs ($/a)
Corn following soybeans	235	212	$ 625	95	105	200	210	$ 634
Corn following corn	260	195	$ 553	161	156	225	192	$ 561

Net returns calculated on corn valued at $3.50/bu and nitrogen at $0.50/lb N (C:N ratio 7.0). In addition to the N above, 40 lbs of N was applied in the irrigation water.

Table 7. Effect of rotations and nitrogen on soybeans. Brunswick. Average population plants/acre (2008).

Treatments	Grain Moisture 2008 (%)	Yield 2004 (bu/acre)	Yield 2005 (bu/acre)	Yield 2006 (bu/acre)	Yield 2007	Yield 2008
Rotation effects:						
(4) Soybeans (2003, 2004, 2005, 2006, 2007)	14.0	---	63.5	66.1	63.6	60.9
(3) Corn/Soybeans	13.6	---	61.3	70.8	57.7	63.4
(7) Corn/Corn/Soybeans	13.9	---	---	68.0	60.8	61.9
$LSD_{0.05}$	0.88	---	7.6	2.2	5.5	6.1
Nitrogen rates:						
0	13.8	62.9	60.9	69.5	61.8	61.0
20	14.1	64.2	61.3	67.6	61.3	61.6
40	13.8	61.1	62.2	67.3	59.0	62.5
60	13.8	65.0	62.7	69.0	61.4	61.3
80	13.7	65.4	62.8	67.6	59.1	63.7
100	13.8	66.0	63.0	68.9	61.7	62.1
$LSD_{0.05}$	0.29	3.1	2.0	3.06	3.3	2.2
CV (%)	2.6	5.8	3.9	5.5	6.5	4.2
Rotation (Prob. > F)	0.4772	-----	0.6469	0.1109	0.0968	0.0067
N rate (Prob. > F)	0.1622	0.4292	0.1881	0.5766	0.2902	0.6517
N rate x Rotation (Prob. > F)	0.3219	-----	0.9397	0.2672	0.6211	0.0565



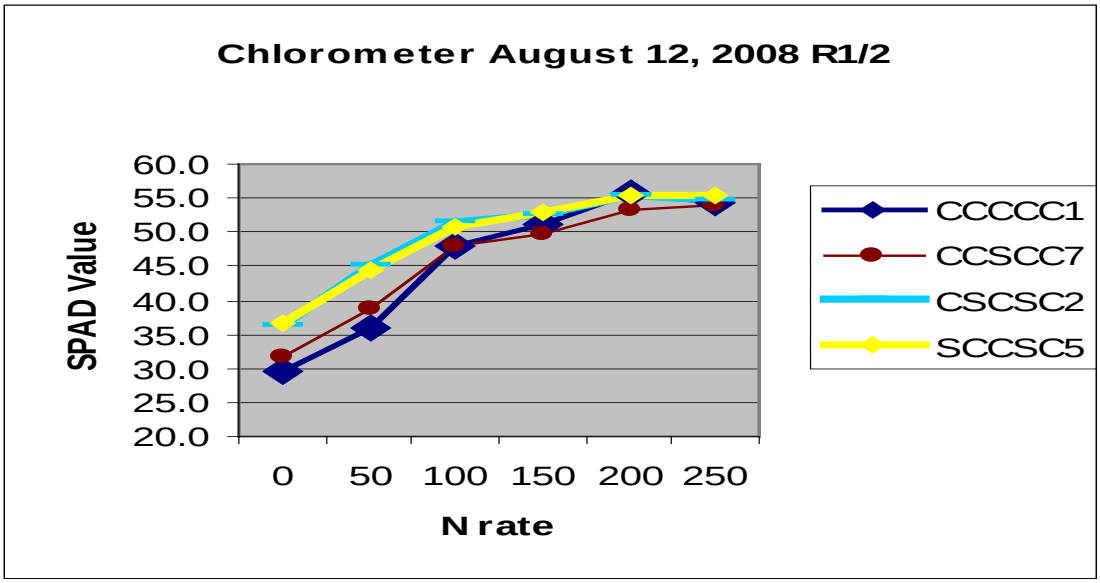


Figure 1. Effect of rotation and nitrogen rate on SPAD meter readings at two dates. 2008. Brunswick, NE. Rotation is the last letter in the sequence in the legend: for example, SCCSC5 means that it was corn in 2008, soybeans in 2007, and corn in 2006.

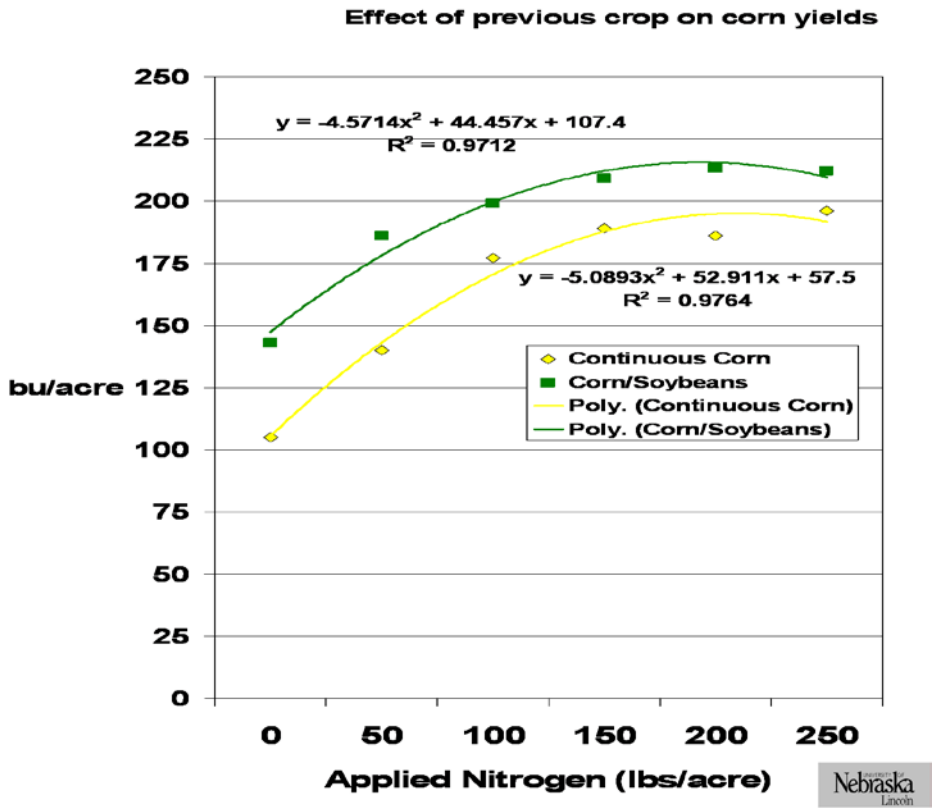


Figure 2. Effect of rotation and N rate on corn grain yield. 2008. Brunswick, NE. An additional 40 lbs N was applied in the irrigation water based on 19.5 ppm nitrate-N and 9 in applied irrigation.

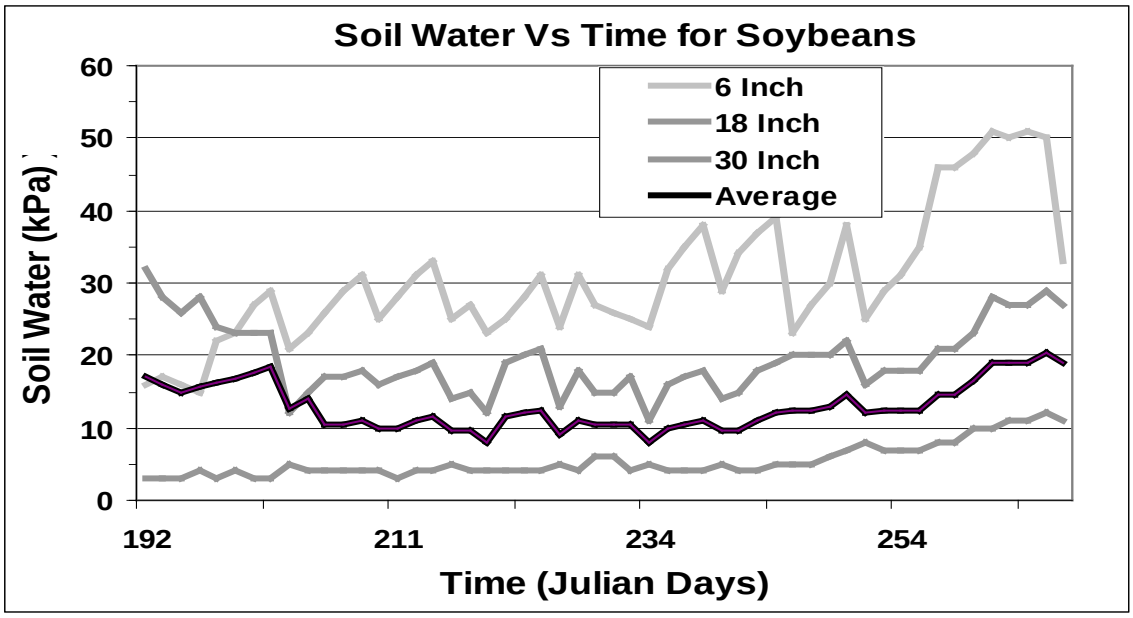


Figure 3. Soil water readings recorded at 6", 18", and 30" below the soil surface planted to soybeans at the Brunswick site in 2008.

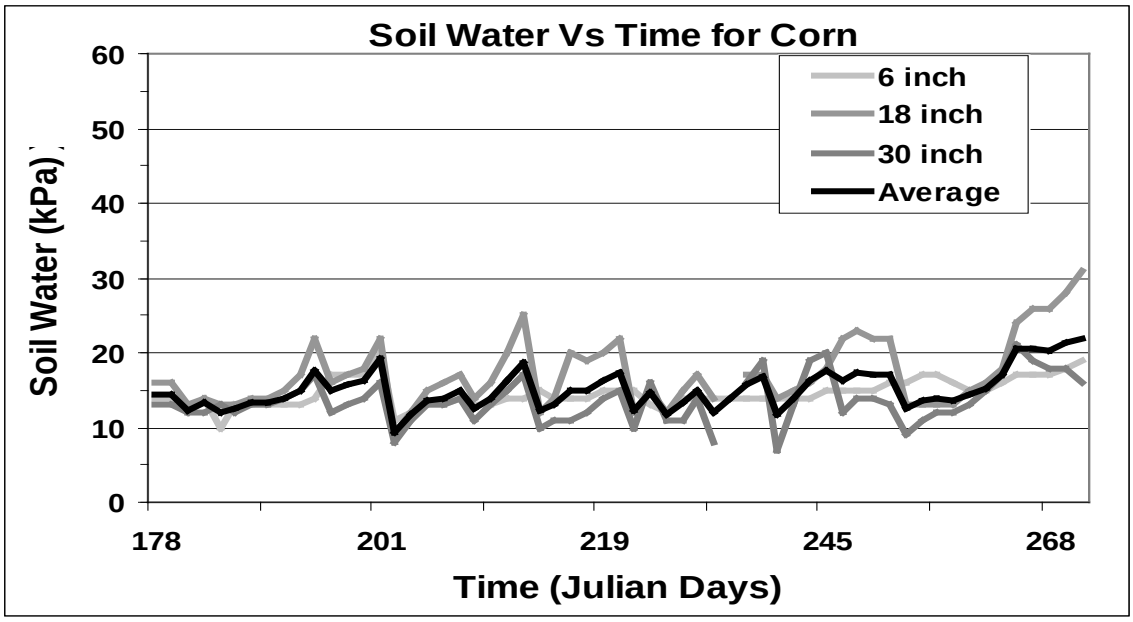


Figure 4. Soil water readings recorded at 6", 18", and 30" below the soil surface planted to corn at the Brunswick site in 2008.

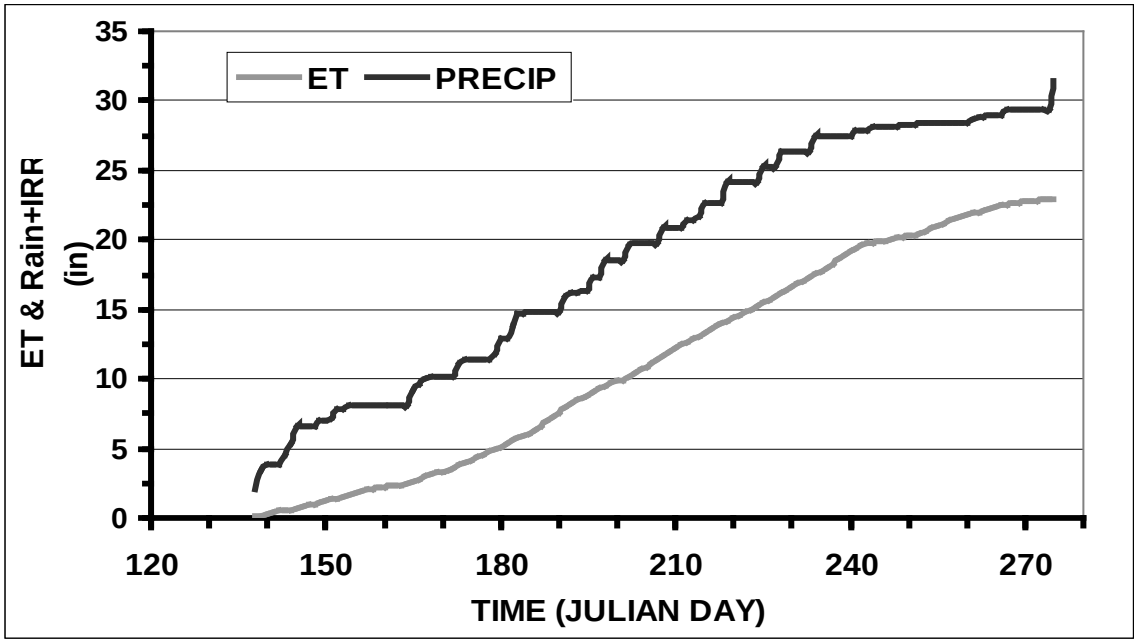


Figure 5. Accumulated estimated crop water use and water applied via precipitation and irrigation for the Brunswick site in 2008.

Table 8. Summary of climatic and estimated crop water use for corn and soybeans for the Brunswick site in 2008.

		Month												
YEAR	**Data**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Average**
2008	Avg T_{max} (^{o}F)	29.0	32.0	44.7	56.2	67.2	79.8	85.7	83.6	75.0	60.4	42.7	28.1	**57.0**
	Avg T_{min} (^{o}F)	8.8	10.7	23.3	31.8	44.4	56.3	62.0	58.4	50.3	37.9	26.1	7.5	**34.8**
	Avg Soil temp (^{o}F)	29.4	27.8	33.1	42.6	57.6	73.5	80.1	79.2	46.8	52.1	38.7	30.8	**49.3**
	Avg Wind Sp (mi hr^{-1})	11.0	11.1	11.0	13.5	10.9	8.3	7.8	7.7	9.3	9.7	11.6	12.7	**10.4**
	Avg Solar Rad (Langleys)	195	277	339	465.0	443.0	547.5	513.9	492.6	359.7	227.9	146.2	151.2	**346.6**
	Sum of Prec (inch)					6.5	4.8	9.5	6.5	2.0	2.0			**31.39**
	Sum of ET_{CORN} (inch)					1.0	3.6	7.1	7.3	3.8	0.3			**22.96**
	Sum of ET_{BEANS} (inch)					1.0	4.1	7.3	7.1	1.8	0.1			**21.40**

Note: Sum of Precip, where irrigation data is available, includes irrigation and rainfall amounts.

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