CONSERVATION CROPPING SYSTEMS PROJECT

2nd ANNUAL REPORT

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CONSERVATION CROPPING SYSTEMS PROJECT
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PROJECT DESCRIPTION

The Conservation Cropping Systems Project (CCSP) is located on a 150-acre tract of farm land two miles south of Forman, ND along highway 32, Figure 1. A ten member Board of Directors composed of local producers in northeastern South Dakota and southeastern North Dakota advises the CCSP staff. Professionals from ag research, as well as natural resources conservation agencies and non-profit interest groups, assist the Board with technical advice and support.

Diverse crops are grown in rotations that range from 2 to 6 years under no-till cropping systems. Rotations are studied to compare their effect on water and wind erosion, soil tilth, soil moisture retention, organic matter changes, infiltration and most importantly, profitability. Each crop within a rotation is grown every year and replicated three times. This project has a planned duration of at least 12 years. The goal is for this demonstration to go on indefinitely.

The project provides producers with data that allows them to qualify and quantify the advantages and disadvantages of a range of crop rotations in no-till crop production. The effective use of crop rotations to break weed, disease and insect cycles is demonstrated. The placement and timing of legumes reduces dependence on fertilizer N. The ability to more efficiently cycle plant nutrients in diverse rotations reduces nutrient runoff into surface water and leaching into ground water. This project will be a living classroom to demonstrate that agriculture can produce food and fiber in an environmentally favorable manner, preserving and enhancing wildlife habitat and water quality, while providing producers with good economic returns.

PROJECT PURPOSE

The landscape of eastern ND and SD is dissected by numerous tributaries and sub-watersheds that eventually end up in Hudson Bay or the Gulf of Mexico. The land area is composed of the rolling topography and wetland complexes of the prairie coteau, undulating features of the drift prairies, transitional beach ridges and the level cropland of the Red River Valley Basin. The sub-humid to semi-arid climate of this region receives significantly more precipitation than the central and western Dakotas. The growing season is also longer. Rotations from the west whose strategy is to conserve and store moisture may be problematic in the east where moisture intense crops and possibly cover crops are needed to use excess moisture. Currently there is an absence of information on no-till cropping systems in this region.

It is the purpose of this project to evaluate crop rotations and crop management strategies effective in sustaining the environment and producing ample food and fiber within the climate, hydrology, soils and social aspects of this geographic area.

WEST

Figure 1. Aerial picture of the Conservation Cropping Systems Project.

PROJECT SPONSORS

The Conservation Cropping System Project is funded through the sponsorship of governmental, corporate and private parties. The Wild Rice Soil Conservation District is the principle cooperating agency, supplying office space, facilities and provides administration of the project. Other cooperating agencies are the Natural Resources Conservation Service (NRCS), North Dakota State University (NDSU), South Dakota State University (SDSU). Sponsorship is either as a cash donation, in-kind or both. There are four levels of sponsorship: Platinum (greater than $10,000), gold ($5,000 - $10,000), silver ($2,500 - $5,000) and bronze ($500 - $2,500). We wish to thank our sponsors listed below for their support! Without them this project would not exist.

Platinum

Ducks Unlimited
Environmental Protection Agency 319 Project
Wild Rice Soil Conservation District

Gold

Farmer Union Oil Co.; Lisbon, Elliot, Forman
Titan Machinery

Silver

Pioneer Hybrid International
Monsanto
Wheat Growers
K & S Soil Analysis
Green's Implement

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Bill Smith
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Horsch-Anderson
TeeJet

WEATHER AND FARMING 2003

The winter of 2002 - 2003 overall was mild and dry. Table 1 shows that temperatures in December and January averaged 5 and 3 degrees warmer than the long time average, respectively. These mild temperatures were welcome after experiencing a near record cold October in 2002. Precipitation totaled 1.0 inches from November 2002 through February 2003 compared to a long time average of 2.1. A particularly stressful period for winter wheat was from January 11, through February 16, as temperatures dipped below minus 2 degrees on 27 days and below minus 9 degrees 17 times. Although snow cover was light, it was adequate for winter wheat planted into standing residue as evidenced by fairly vigorous spring stands. This cold period in February resulted in temperatures averaging 2.2 cooler than normal for the month.

Spring wheat seeding was timely and uninterrupted due to a dry March and early April, with favorable temperatures. A wet period from April 15-18, when 2.6 inches of precipitation was recorded, was very welcome as only 0.6 inches of precipitation had been measured for the year at this time. Timing of precipitation was excellent as the majority of small grain was seeded. Within 5 days planting resumed and was uninterrupted until May 3, by which time most of the corn acres were planted.

Planting came to a standstill for about 21 days in May when 4.2 inches of precipitation was recorded from May 3-19. This and cool temperatures was detrimental to corn stands. Poorly drained areas in fields became water logged reducing stands by 50% or more. Conventional till, strip-till and no-till all suffered. Once planting resumed, it was intense, with the majority of soybeans planted by the end of the month. The planting season can best be described as three, two week periods of intense planting; first two week's of April (small grains), last two week's of April (corn) and the last two week's of May (soybeans).

Soybean stand establishment was excellent as conditions were near ideal from planting through emergence. Soybean emergence was enhanced by 0.90 inch of precipitation on June 9. Conditions became extremely wet the fourth week in June, as 4.6 inches of precipitation was recorded from June 21-27. Poorly drained soils in corn and bean fields were lost from flooding. Small grains were in their maximum water use period which allowed them to better utilize the precipitation for beneficial use.

July was slightly warmer and wetter than normal. Two devastating hail storms passed through southeastern ND and northeastern SD in July. Sargent County in ND was significantly impacted by both storms, July 3 and 20. Marshall and Day Counties in SD were mostly impacted by the July 20 storm. It was estimated that the two storms impacted about 256,000 acres of crop land in Sargent County alone. The CCSP site was on the northern edge of the July 3, storm. Interestingly, soybeans which are generally more resilient to hail prior to flowering, were the only crop completely hailed out and were re-planted on July 16. Hail damage was estimated to be 95% in spring wheat at this site. Damage to corn, winter wheat and canola was estimated at 65%. Weed control became a serious issue in corn plots due to an open canopy.

Small grains in the region not impacted by hail produced outstanding yields. Spring wheat yields above 70 bu/ac and winter wheat yields above 80 bu/ac were not uncommon.

August was a stressful month for corn and beans as temperatures averaged 4.7 degrees above the long time average and precipitation was 1.6 inches below. Temperatures exceeded 90 degrees on 7 days. By the end of August corn, which was still about a week behind normal in July, was back on track.

September temperatures were normal and precipitation was 0.8 inches less than the long time average. The light rain was beneficial for winter wheat planting.

The weather was ideal for row crop harvesting in October. Temperatures were 3.4 degrees above the long term average and precipitation totaled 1.1 inches with most of that falling on October 11. Most of the soybeans were in by mid-month and most the corn was harvested by the end of the month.

Figure 2. shows the growing degree units (GDU) for corn from May through September at Forman, ND compared to the 15 yr average at Oakes, ND. Corn got off to a slow start in 2003 as corn accumulated 685 GDUs during May and June compared to the 15 yr average of 817. This deficit was gained back during a hot August. Almost all corn in the area was mature prior to the first killing frost on October 1.

Table 1. Growing season temperature and precipitation at Forman, ND in 2003.

	Temperature		Precipitation	
Month	2003 Mean	64 Yr Mean	2003 Total	64 Yr Mean
	-----degrees------		------inches------	
April	46	44	2.6	2.0
May	55	56	4.2	3.0
June	65	65	5.7	3.6
July	71	70	3.0	2.9
August	73	68	1.2	2.8
September	59	60	1.3	2.1
October	49	46	1.1	1.4

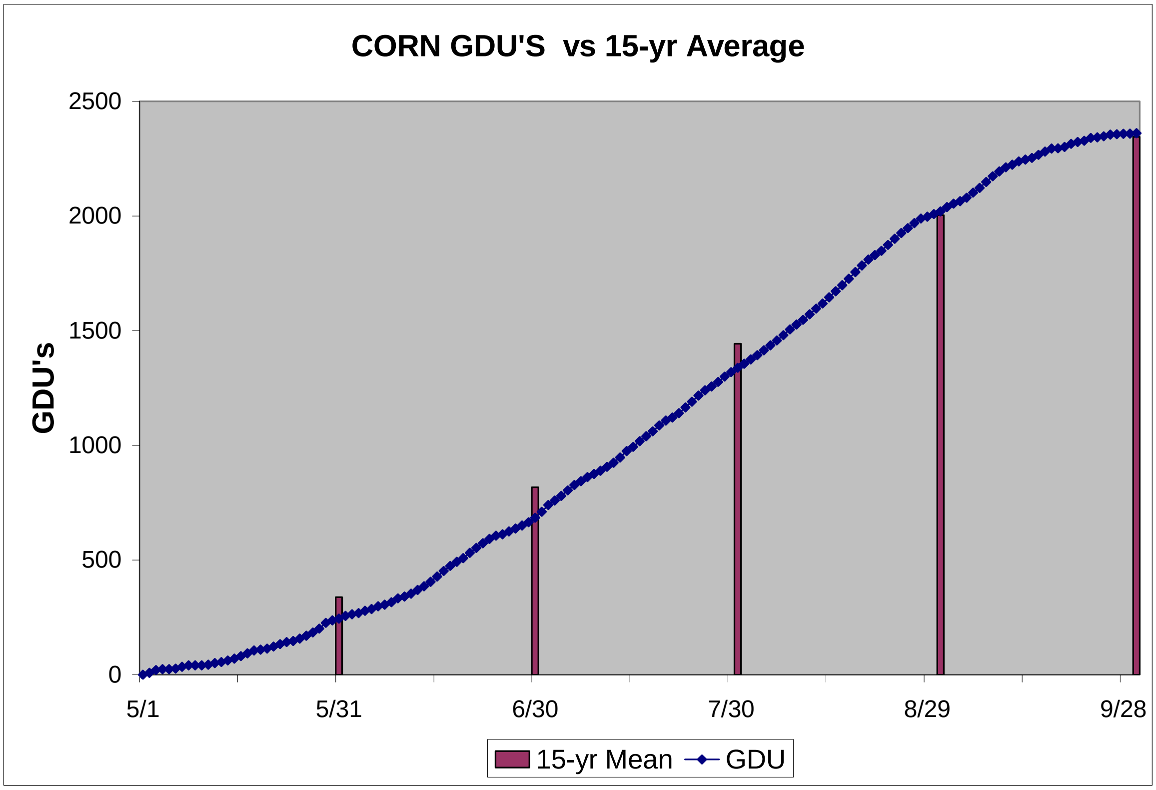

Figure 2. Growing degree units accumulated for corn at Forman, ND in 2003 compared the 15-yr average at Oakes, ND.

CROP ROTATIONS AT CCSP

Ten crop rotations ranging from 2 to 6 years in length are being studied, Table 2. Six crops are present in rotations: HRSW, HRWW, corn, soybean, alfalfa and canola. Three seeding techniques, disk drill, shank drill and strip till, are being studied within the HRSW-HRWW-corn-soybean rotation. Additional crops will be added and subtracted as deemed necessary. The key components of rotations are their moisture intensity and their plant diversity. Moisture intensity of the rotation must be increased as one moves from arid to humid climates and when the cropping system is changed to no-till. Cover crops maybe required in climates where precipitation exceeds evapotranspiration even though high moisture crops are grown. Conversely, low water use crops maybe required in arid climates to store soil moisture. Crop diversity is needed to reduce the level of pathogens (weeds, disease, insects) specific to a crop type. This saves time, energy and money that would be spent in an attempt to control the pathogens. Instead of trying to treat the symptom, the idea is to address the problem.

Some plots were lost due to the construction of a fertilizer plant on the northeast portion of the CCSP site. This and the poor suitability of some plots near wetlands resulted in rotations K and M being deleted in 2003. Corn and soybeans in rotation G were changed from being stacked to being un-stacked.

Corn and soybeans in rotation L were changed from being un-stacked to being stacked. These changes were made for a better study of stacked rotations. The changes could be made with no detrimental effect on rotation history as only one crop season passed.

Table 2. Moisture intensity and diversity of the crop rotations at the Conservation Cropping Systems Project at Forman, ND, 2003.

Rotation		Moisture Intensity[a]	Diversity[b]
sw/ww(cc)/c/s - disk drill	A	1.50	3.92
sw/ww(cc)/c/s - shank drill	B	1.50	3.92
sw/ww(cc)/c/s - strip till	C	1.50	3.92
sw/c/s	D	1.67	2.25
sw/s	E	1.50	0.50
c/s	F	2.00	0.00
sw/c/s/c/s	G	1.80	1.23
sw/ww(cc)/c/s/c/s	H	1.67	2.42
sw/ww(cc)/s-(ds)canola/c/c/s	I	1.50	2.83
ww/s/c/c/can(ds)	J	1.60	4.03
sw/ww(cc)/c/c/s/s	***L***	1.67	2.42
sw/ww(cc)/a/a/c/s	N	1.67	2.00

sw = HRSW	ww = HRWW	c = corn	s = soybean
can = canola	a = alfalfa		cc = cover crop

[a]1.00 lowest water use, 2.00 highest water use.
[b]The larger the number the more diverse the rotation.

Figure 3, shows the location of each crop within each rotation. Each plot is 60 feet by 200 feet. Each crop within the rotation sequence is present each year. Each rotation sequence has 3 replications.

CCSP CROP ROTATION 2003

		Jww3	Dsw2	Ds2	Dc2		Cenex	
		Jcan$_{ds}$3		sw2		Isw1	Fertilizer	
		Jc3$_{II}$		Jcan$_{ds}$1		Is1	Plant	
		Jc3$_{I}$	**Lsw2**		Gsw2	Ic1$_{II}$		
		Js3	**Lc$_{II}$2**		Gc2$_{II}$	Ic1$_{I}$		
		Fc3	**Ls2$_{II}$**	**Ls2$_{I}$**	Gs2$_{II}$	Is-can$_{ds}$1		
		Fs3	**Lc2$_{I}$**	c2	Gs2$_{I}$	Iww1		
		Lsw2	**Lww2**	s2$_{I}$	Gc2$_{I}$	Ns1		
			Hsw2	ww2	Asw2	Fs2		
Isw3	Hsw3		Hs2$_{II}$	Csw2	As2	Esw2		
Is3	Hs3$_{II}$		Hc2$_{II}$	Cs2	Ac2	Es2		
Ic3$_{ii}$	Hc3$_{II}$	Ds2	Hs2$_{I}$	Cc2	Aww2	Fc2		
Ic3$_{I}$	Hs3$_{I}$	Jww1	Hc2$_{I}$	Cww2			Nc1	Jc1$_{II}$
Is-can$_{ds}$3	Hc3$_{I}$	**Ls3$_{I}$**	Hww2	Isw2			Na1$_{II}$	Jc1$_{I}$
Iww3	Hww3	Nsw2	Jww2	Is2			Na1$_{I}$	Js1
	Gsw3	Ns2	Jcan$_{ds}$2	Ic2$_{II}$			Nww1	
	Gc3$_{II}$	Nc2	Jc2$_{II}$	Ic2$_{I}$				
	Gs3$_{II}$	Na2$_{II}$	Jc2$_{I}$	Is-can$_{ds}$2	Bsw2			
	Gs3$_{I}$	Na2$_{I}$	Js2	Iww2	Bs2			Bsw1
	Gc3$_{I}$	Nww2	**Lsw3**	**Lc3$_{I}$**	Bc2		Dsw1	Bs1
Esw3	Asw3	Csw3	**Lc3$_{II}$**	**Lww3**	Bww2	Hsw1	Ds1	Bc1
Es3	As3	Cs3	**Ls3$_{II}$**			Hs1$_{II}$	Dc1	Bww1
Nsw3	Ac3	Cc3	Bsw3			Hc1$_{II}$	Hs1$_{I}$	Asw1
Ns3	Aww3	Cww3	Bs3			Hs1$_{I}$	**Lsw1**	As1
Nc3	Gsw1		Bc3			Hc1$_{I}$	**Lc1$_{II}$**	Ac1
Na3$_{II}$	Gs1$_{II}$		Bww3			Hww1	**Ls1$_{II}$**	Aww1
Na3$_{I}$	Gs1$_{I}$					sw1	**Lc1$_{I}$**	Csw1
Nww3	Gc1$_{II}$					**Ls1$_{I}$**	**Lww1**	Cs1
sw3						Fs1	Esw1	Cc1
s3$_{II}$						Nsw1	Es1	Cww1
Ls1$_{I}$						s1$_{I}$	Fc1	
Dsw3	Dsw3					Aww1		
Gc1$_{I}$	Ds3							
ww3	Dc3							

sw/ww(cc)/c/s - disk drill	A
sw/ww(cc)/c/s - shank drill	B
sw/ww(cc)/c/s - strip till	C
sw/c/s	D
sw/s	E
c/s	F
sw/c/s/c/s	G
sw/ww(cc)/c/s/c/s	H
sw/ww(cc)/s-(ds)can/c/c/s	I
ww/s/c/c/can(ds)	J
sw/ww(cc)/c/c/s/s	**L**
sw/ww(cc)/a/a/c/s	N

Figure 3. Plot map of rotations and their location in 2003.

SOIL ANALYSIS

Eight soil cores per plot (176 plots total) at the 0-6 inch depth and 6-24 inch depth were taken in the fall of 2002. Both depths were analyzed for nitrate-N. The 0-6 inch depth was analyzed for P, K, OM, Zn, electrical conductivity and pH. A base line for the whole site and individual plots was established in the fall of 2001, as this site was uniformly cropped for seven previous years. Despite this uniform cropping history, nutrient concentrations were found to be highly variable from plot to plot and is discussed in the 2001 CCSP Annual report. A broadcast application of 191 lb/ac of 11-52-0 and 9 lb/ac of $ZnSO_4$ was applied in the spring of 2002 to address this variability. The plan was to raise the P and Zn levels of the low testing plots to levels where plant sufficiency can be maintained with planter applications of these nutrients. By comparing soil test levels from the fall 2001 and fall 2002 in Table 3 we can analyze the success of this strategy

Table 3. Mean values for soil parameters of 176 plots at the Conservation Cropping Systems Project in the fall of 2001 and 2002.

Soil Parameter	Sample Depth	Unit	Mean Value 2001	Mean Value 2002
	inches			
nitrate-N	0-24	lb/ac	54	40
P -Olsen	0-6	ppm	11	16
K	0-6	ppm	326	361
Zn	0-6	ppm	1.1	2.2
OM	0-6	%	3.9	3.5
mmho/cm	0-6		0.48	0.40
ph	0-6		7.5	7.5

These data suggest that the strategy was successful as P levels were raised 45% and Zn levels were raised 100%. One could argue that K levels went up without potash application so the increase in phosphorus level was due to year to year sampling differences. Although some what valid, this can't account for the magnitude of soil P increase as K only increased by 11%. Also P and K values are not strongly related to one another in these samples. The 100% increase in Zn levels strongly supports the influence of the fertilizer application, especially since Zn and OM levels were moderately related to each other in 2001 but non-related in 2002. This data shows that the soil P level for the lowest 25% of the samples was raised from a low testing value to a medium testing value and that Zn levels in this group were raised from the medium to the high range.

CROP FERTILITY

Pre-plant soil test means for each crop, quantity and application time of fertilizer and post harvest nitrate-N are presented in Table 4. To our surprise fall 2003 nitrate-N values were about the same as in the fall of 2002. We anticipated soil test values to be higher due to the yield reductions from the July 3, hailstorm.

Table 4. Fertilizer application and pre-plant and post harvest residual soil nitrogen by crops at the Conservation Cropping System Project 2003.

	Soil Test			Planter		Post
	N		P	N	P	N
Crop	**Fall 2002**	**Fall 2003**	**Fall 2002**			
HRSW	45	46	15	9	42	90
HRWW	51	51	16	12	39	130
Corn	41	47	14	13	43	120
Soybean	35	31	17			
Canola	38	54	16			60
Alfalfa	22	38	17			

AGRONOMIC PRACTICES AND YIELD

A general outline of agronomic practices and crop yield listed in Table 5 and fertilizer application in Table 4. CDC Falcon HRWW was planted on September 25, 2002 at 2 bu/ac with a 7.5-foot Horsch-Anderson drill with triple shoot Anderson seed boots on 15-inch spacing. Ten gallons of 10-34-0 was placed in-between and below the paired seed rows. The disk drill treatment was planted at the same seeding rate with a 15-foot John Deere 1560 single disk drill with 7.5-inch spacing. Spring planting good off to a good start with HRSW on April 9. Briggs wheat was planted at 87 lb/ac with a 15-foot John Deere 1560 single disk drill with 7.5-inch spacing.

Eighty lb/ac of 11-52-0 fertilizer was placed with the seed. Wheat in the shank drill treatment was planted at the same seeding rate with a 7.5-foot Horsch-Anderson drill with triple shoot Anderson seed boots on 15-inch spacing. Ten gallons of 10-34-0 was placed in-between and below the paired seed rows. Three fungicide applications were made to HRWW and HRSW to control leaf disease and head scab. Two nitrogen applications of 60 and 70 lb/ac N were made on April 15 and May 22, respectively with stream bars to HRWW. Ninety lb/ac N was applied to HRSW on May 23 with stream bars. The July 3, hailstorm almost completed destroyed the HRSW as the plots averaged 5 bu/ac. HRWW yields were surprising at 35 bu/ac.

Dekalb DKC42-95 corn was planted on May 2, with an 8 row Case IH 1200 planter with 30-inch spacing equipped with residue cleaning wheels, spading wheels and in disk seed firmers. Seeds were dropped at 28,000 seeds/ac with 11 gal/ac of 10-34-0 fertilizer placed 3 x 2. Two applications of nitrogen as 28-0-0 were dribbled between every other row on June 16 and 30 at 75 and 45 lb/ac of N, respectively. Damage to corn from the hailstorm wasn't limited to leaf and stalk damage during the storm. A significant number of stalks that were bruised broke off in subsequent wind storms. Despite being clean after two applications of roundup herbicide weed infestations were a major problem by late season due to an open corn canopy. Corn averaged 45 bu/ac.

After three weeks of cool, wet weather Croplan RT0874 soybeans were planted on May 29. Soybeans were planted with an 8 row Case IH 1200 planter with 30-inch spacing equipped with residue cleaning wheels, spading wheels and in disk seed firmers. Seeds were dropped at 175,000 seeds/ac. When it was obvious that there was minimal bean re-growth after the hailstorm, they were re-planted on July 16, at 200,000 seeds/ac. The variety was Northstar 0206. The hot August was very beneficial for soybean maturation. The beans were harvested on November 13 and averaged 11 bu/ac.

Croplan hyclass 2061 canola was dormant planted with the JD 1560 drill at 7 lb/ac on corn and HRSW ground on November 6, 2002. Good stands of canola especially in the HRSW stubble emerged by April 25. This early emergence coupled excellent moisture conditions in May and June with moderate temperatures resulted in an extended bloom period. Canola was setting for an excellent yield prior to the hail event. Canola was straight cut on August 14, and yielded 660 lb/ac.

Alfalfa benefied from above normal rainfall from April through July. Second year alfalfa averaged 3.1 and 2.1 ton/ac, on June 12 and August 13 harvests. Magnum V Dairyland alfalfa planted on April 24, averaged 1.5 ton/ac on the August 13, harvest.

Table 5. Agronomic practices and crop yields[a] at the Conservation Cropping Systems Project, 2003.

Crop	Date	Date	Planting Rate	Yield*	Chemical	Rate	Date
HRWW	25-Sep-02	31-Jul	120 lb/ac	35 bu/ac	Bronate Advanced	1.2 pt/ac	27-May
					Tilt	2 oz/ac	27-May
					Tilt	2 oz/ac	13-Jun
					Folicur	4 oz/ac	27-Jun
					Roundup Ultra	26 oz/ac	22-Jul
HRSW	9-Apr	11-Aug	87 lb/ac	5 bu/ac	Bronate Advanced	1.2 pt/ac	27-May
					Tilt	2 oz/ac	27-May
					Tilt	2 oz/ac	18-Jun
					Folicur	4 oz/ac	27-Jun
					Roundup Ultra	26 oz/ac	24-Jul
Corn	2-May	3-Nov	28,000	45 bu/ac	Roundup Ultra	26 oz/ac	5-Jun
					Roundup Ultra	26 oz/ac	30-Jun
Soybean	29-May	hailed out	175,000		Roundup Ultra	26 oz/ac	7-Jun
Re-plante	16-Jul		200,000	11 bu/ac	Roundup Ultra	26 oz/ac	18-Jul
					Roundup Ultra	26 oz/ac	21-Aug
Canola	6-Nov-02 Dormant seeded	14-Aug	7 lb/ac	660 lb/ac	Roundup Ultra	26 oz/ac	13-Jun
					Roundup Ultra	26 oz/ac	22-Jul
Alfalfa	2nd yr	12-Jun		3.1 ton/ac			
		13-Aug		2.1 ton/ac			
Alfalfa	24-Apr	13-Aug	12 lb/ac	1.5 ton/ac			

[a]Yields significantly reduced by July 3, hailstorm

EFFECT OF CROP SEQUENCE AND SOIL SERIES ON YIELD

Table 6. shows the effect of previous crop on corn and soybean yield in 2003. This data must be viewed with caution due to the effect of extremely wet conditions in May and June and the influence of the July 3, hailstorm. Also soybeans grown on soybeans are in stacked rotations where the land is out of soybeans for four years before the first crop of soybeans is repeated.

Table 6. The effect of previous crop on corn and soybean yield at the Conservation Cropping Systems Project in 2003.

Previous Crop	Corn Bu/Ac	Previous Crop	Soybean Bu/Ac
HRSW	32	Corn	10
Corn	35	HRSW	12
Soybean	67	Soybean	12

Table 7 shows the effect of soil type and landscape position on corn and soybean yields with excessive soil moisture early in the growing season. The Cavour-Cresbard association is a slowly permeable soil with a clay pan at 6-17 inches found in depressional flats. The Forman soils have a moderately slow permeability and are found on flat uplands and back slopes. Forman-Buse soils are well drained, with moderately slow permeable soils found on back slopes and shoulders. Buse-Forman soils are well drained and found on shoulders and hill tops. In 2003 the Forman-Buse and Buse-Forman soils yielded highest due to their better surface drainage characteristics. In normal to dry years we expect the Forman soil to have the yield advantage, especially compared to the Buse-Forman with its significantly shallower topsoil. Bean yields were impacted by the higher pH and salt content in the Cavour-Cresbard soils.

Table 7. The effect of soil series on corn and soybean yield at the Conservation Cropping Systems Project in 2003.

Soil Type	Texture	Slope %	Corn	Soybean
			Bu/Ac	
Cavour-Cresbard	L	0-3	40	7
Forman	CL	0-3	40	11
Forman-Buse	CL	3-6	50	11
Buse-Forman	CL		44	13

ADDITIONAL RESEARCH IN 2004

The study of soil and plant nitrogen relationships in a no-till cropping system is a goal of this demonstration project. To meet this objective a wheat – corn – soybean rotation will be established in a long term study with fertilizer N treatments of 50, 100 and 150 lb/ac of N as shown in figure 4. Soybeans will not receive fertilizer N. Soil test data along with plant indicators of N sufficiency from chlorophyll meter readings and remote sensing will be compared to yield measurements and other agronomic data. The goal of this study is to develop a long term data base of soil and plant parameters that assists producers in applying N rates and timing of N application that results in the highest economic returns with little or no negative impact on the environment.

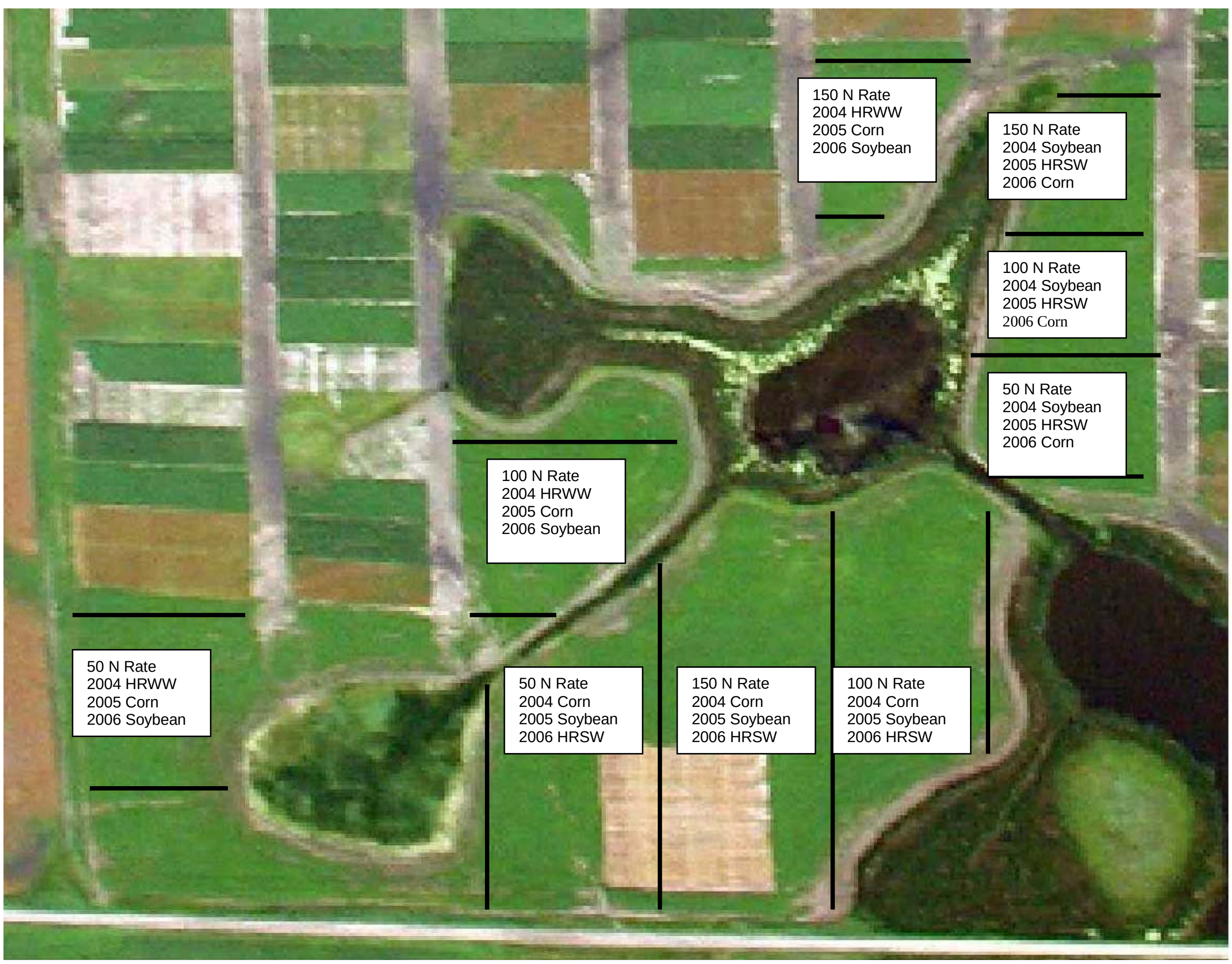

Figure 4. Long time nitrogen study to be initiated at the CCSP site in 2004.