

CONSERVATION CROPPING SYSTEMS PROJECT

1st ANNUAL REPORT



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CONSERVATION CROPPING SYSTEMS PROJECT
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PROJECT DESCRIPTION

The Conservation Cropping Systems Project (CCSP) was initiated in the fall of 2001, on a 160-acre tract of farm land, located 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 Project to go on indefinitely.

The project provides producers with data that allows them to qualify and quantify the advantages and disadvantages of a wide 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 appropriate timing of legumes in rotations results in reduced 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 at Forman, ND on July 29, 2002.

PROJECT SPONSORS

The Conservation Cropping System Project is funded solely 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
Meyer Equipment
Monsanto

Silver

AgVise
Pioneer Hybrid International
Wheat Growers

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Bronze

4 Seasons Cooperative, Britton
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Wensman Seed

Weather and Farming 2002

The winter of 2001-2002 was relatively mild and short on snow. The heavy wheat residue at the Conservation Cropping Systems Project (CCSP) trapped what snow there was for soil moisture recharge. Good sub-soil moisture from the previous fall along with 2.3 inches of precipitation in April resulted in soil moisture being fully recharged prior to planting. Pea to marble size hail on April 18 pounded the wheat residue into a dense surface mat that resisted soil drying.

The 2002 growing season at Forman, North Dakota was characterized by a cold spring followed by a very hot and wet summer. Table 1. shows that April and May temperatures averaged 4 and 5 degrees below the long term average. The cold May was especially harmful to corn planted in April and early May. The temperature dipped to 29 degrees on May 17 and 24th. Corn and soybeans at this site were not damaged from frost because they had not yet emerged. The impact was more severe in northern South Dakota in corn planted in April. Temperatures dipped below 27 degrees each day from May 17-19 and dropped to 24 degrees on May 24 at Britton, South Dakota.

Wet cool conditions the first two weeks in May were detrimental for planting in the dense mat of wheat residue. We were able to plant 50 spring wheat plots from May 6-7. Eleven wheat plots were not planted until May 29 due to the muddy conditions. Corn planting was delayed until May 21 by 1.6 inches of precipitation during the second week of May. Soybean planting began on May 24 and was completed on the 28th.

Temperatures became hot in June as temperatures averaged 4 degrees warmer than normal. June temperatures were what we normally expect in July. Warm wet conditions were ideal for corn and soybean growth. Precipitation totaled almost 5 inches for the month.

July was wet and warm as precipitation totaled over 5.5 inches and the temperature averaged 3 degrees above normal. Although humid conditions favored white mold infestations in soybeans, the infections were not great enough to seriously impact yield. Corn plots that were planted late and replanted corn in farm fields continued to catch up with ideal growing conditions.

Temperatures were near normal in August and slightly warmer than normal in September. Precipitation was above normal in both months. Corn and soybeans matured prior to the first killing frost on October 9. October was one of the coldest on record as temperatures averaged 8 degrees below normal.

Figure 2. shows the accumulation of growing degree units in corn from May through September. The GDUs at Forman in 2002 are compared to the 15-yr average at Oakes, ND. A significant reduction in GDUs in May was more than offset by above normal accumulations in June and July.

Table 1. Growing season temperature and precipitation at Forman, ND in 2002.

Month	Temperature		Precipitation	
	2002	64 Yr	2002	64 Yr
	Mean	Mean	Total	Mean
	-----degrees-----		-----inches-----	
April	40	44	2.31	2.0
May	51	56	1.64	3.0
June	69	65	4.85	3.6
July	73	70	5.51	2.9
August	67	68	3.57	2.8
September	63	60	1.76	2.1
October	38	46	1.68	1.4

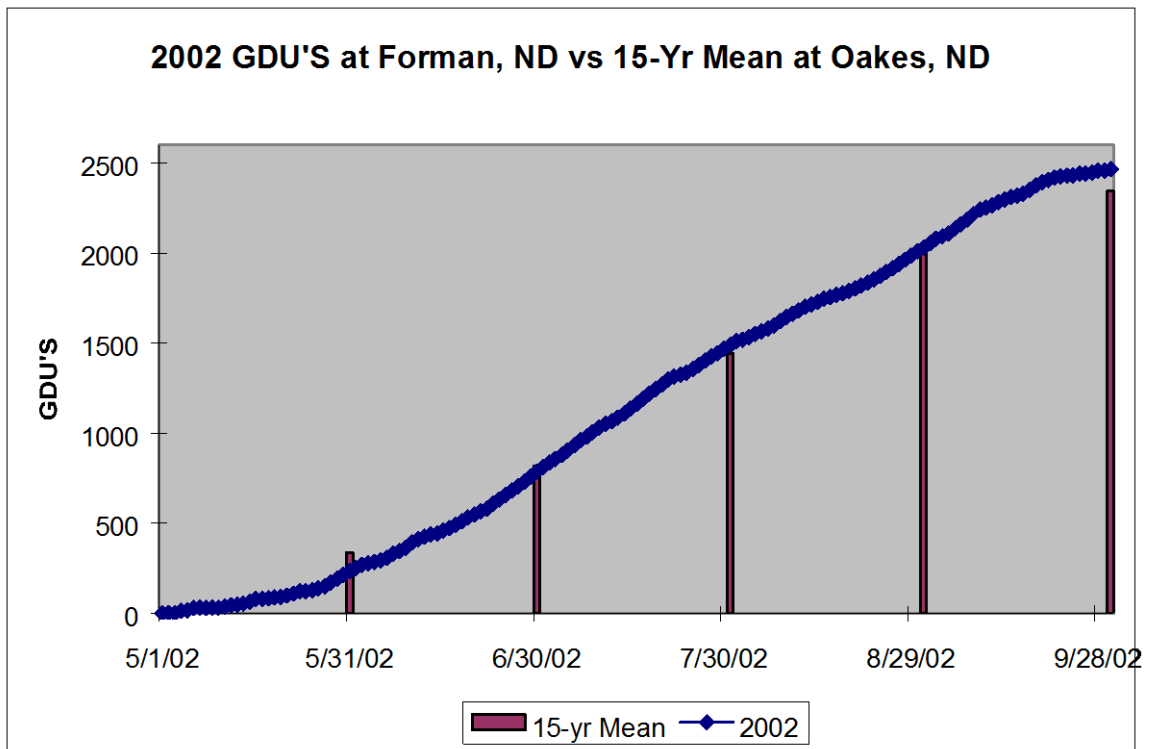


Figure 2. Growing degree units accumulated for corn at Forman, ND in 2002 compared the 15-yr average at Oakes, ND.

CROP ROTATIONS AT CCSP

Twelve crop rotations ranging from 2 to 6 years in length are being studied, Table 2. Seven crops presently in rotations are HRSW, HRWW, corn, soybean, alfalfa, canola and millet. 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.

Table 2. Moisture intensity and diversity of the crop rotations at the Conservation Cropping Systems Project at Forman, ND, 2002.

Rotation		Moisture Intensity	Diversity
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/c/s/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(ds)/s/c/c/s	K	1.80	1.23
sw/ww(cc)/s/c/s	L	1.60	2.23
sw/ww(cc)/s/c/m/s	M	1.50	2.83
sw/ww(cc)/a/a/c/s	N	1.67	2.00

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

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.

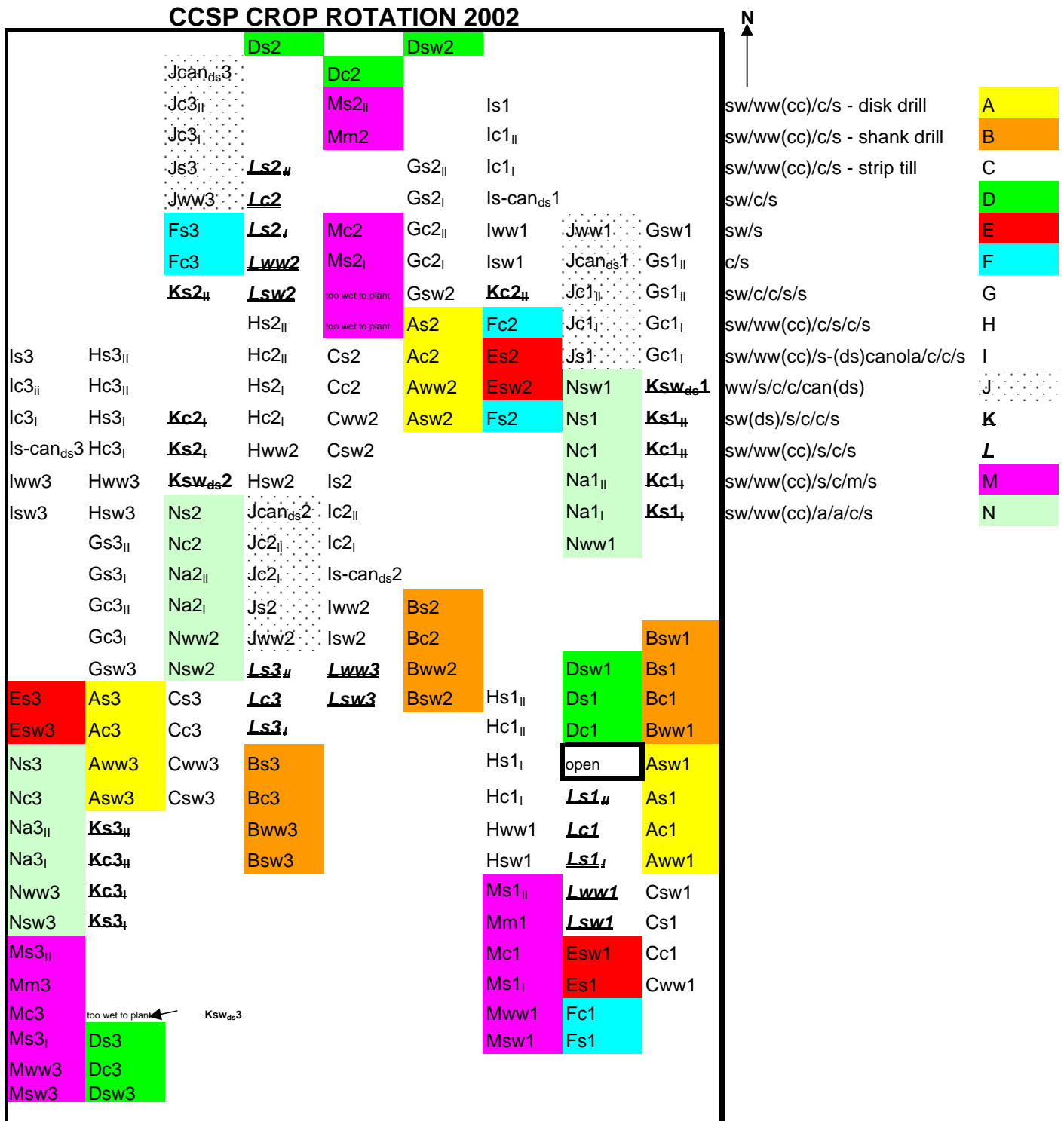


Figure 3. Plot map of rotations and their location in 2002.

SOIL ANALYSIS

Eight soil cores per plot (198 plots total) at the 0-6 inch depth and 6-24 inch depth were taken in the fall of 2001. Both depths were analyzed for nitrate-N, sulfate-S and electrical conductivity. The 0-24 inch depth was analyzed for chloride. The 0-6 inch depth was analyzed for P, K, Zn, Cu, Mg, Ca, CEC, pH and carbonate. The mean values for soil parameters are given in Table 3.

The quarter section, where the CCSP site is located, has been uniformly cropped each year since 1994. HRSW, sunflower, HRSW, soybean, HRSW, corn, soybean and HRSW were the crops planted on the 140 acres of tillable land in 1994, 1995, 1996, 1997, 1998, 1999, 2000 and 2001, respectively. This data presents an excellent opportunity to study the variability of crop nutrients across a field landscape. Figure 4, shows variability between the mean values for all plots compared to the mean value for the top 25% and the bottom 25% of the plots. Plot to plot variability was more pronounced as shown in Figure 5, with nitrate-N and in Figure 6, with phosphorus concentrations.

Table 3. Mean values for soil parameters of 198 plots at the Conservation Cropping Systems Project in the fall of 2001.

Soil Parameter	Sample Depth	Unit	Mean Value
nitrate-N	0-24	lb/ac	54
P -Olsen	0-6	ppm	12
K	0-6	ppm	323
Cl	0-24	lb/ac	66
sulfate-S	0-6	lb/ac	30
sulfate-S	6-24	lb/ac	93
Zn	0-6	ppm	1.19
Cu	0-6	ppm	0.85
Mg	0-6	ppm	721
Ca	0-6	ppm	4318
OM	0-6	%	3.9
mmho/cm	0-6		0.5
mmho/cm	6-24		0.5
ph	0-6		7.5
CEC	0-6	meq	28
Ca	0-6	%	76
Mg	0-6	%	21
K	0-6	%	3
Carbonate %	0-6		1.91

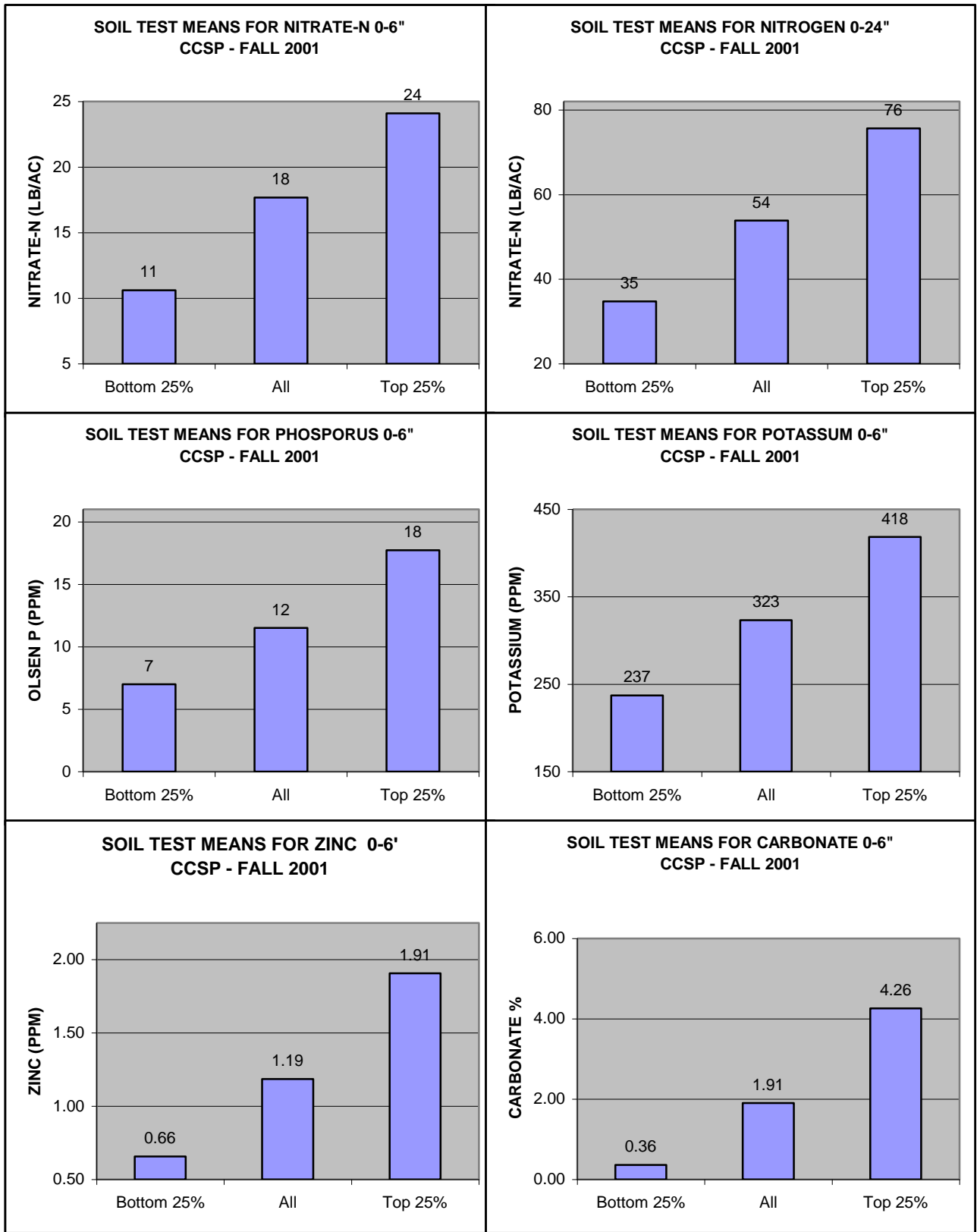


Figure 4. Mean values for soil parameters from all plots and from the top and bottom 25% of the plots at the CCSP in the fall of 2001.

AGRONOMIC PRACTICES AND YIELD

A general outline of agronomic practices performed in crops is listed in Table 4. The mean yield for each crop from plot sampling is shown in Table 5 as well as maximum and minimum plot yields. The combined mean is the yield when the entire area in all plots within a crop were harvested and weighed. In the case of soybeans, the combined mean included the 17 acres of soybean plots plus 26 bulk acres.

A broadcast application of 191 lb/ac of 11-52-0 and 9 lb/ac of ZnSO₄ was applied prior to planting on May 6, to address the nutrient variability among plots that was discussed in the previous section entitled Soil Analysis. 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.

As has been stated previously, all crops were planted on a dense wet mat of HRSW residue. This was especially detrimental for HRSW in the rotations. Wheat planting was delayed until May 6. Conditions weren't fit to plant at this time, but we decided we couldn't wait any longer. As it turned out, it began raining on the afternoon of May 7, and the plots that were too wet to bear the weight of the tractor at this time weren't planted until May 29. Alsen wheat was planted at 1.9 bu/ac with a 20-foot concord air seeder with triple shoot Anderson seed boots with a 15-inch row spacing on the first planting date. Eighty lb/ac of 10-50-0 fertilizer was placed in-between and below the paired rows at planting. Alsen wheat was planted at 2.0 bu/ac with a 15-foot JD1560 no-till drill with 7.5-inch row spacing in the remaining plots on May 29. Enhance seed treatment at 2 oz/bu was applied to the seed. Eighty lb/ac of 10-50-0 fertilizer was placed with the seed at planting. The 50 plots planted by May 7 yielded from 12 to 28 bu/ac whereas plots planted on May 29 yielded from 7 to 11 bu/ac. Four plots planted May 29 were not harvested due to lack of stand and damage from excessively wet conditions.

Pioneer 46A76 clearfield canola was planted May 7 at 11 lb/ac with the Concord air seeder used for wheat planting. Forty-eight lb/ac of 10-50-0 fertilizer was placed with the seed. We were unable to get the seeding rate to less than 11 lb/ac, even with the canola roller. Rain clouds were building in the west so it was decided to plant the canola instead of spending more time trying to get the seeding rate reduced. We finished planting canola in the rain.

Planting resumed on May 21 with corn. Although 6 days had passed from the last rain, planting conditions were tough. Corn hybrid Dekalb DKC42-22 YGCB was planted at 26,500 seeds/ac. Corn was planted with a 6-row, 30-inch spacing JD 1760 planter with residue cleaners, seed firmers and spaded closing wheels. Eighty lb/ac of 10-50-0 fertilizer was placed in a 2" x 2" band at planting. Five gal/ac of 10-34-0 fertilizer was placed with the seed as pop up fertilizer. Despite the adverse conditions the planter worked well if mandatory periodic stops were made for mud cleaning. Overall corn stands were good. The exceptions were plots located near wetlands. Blackbirds roosting in the wetlands went down the corn rows, removing the seed. Populations were severely

Table 4. Agronomic practices used in rotations at CCSP in 2002.

Crop	Planting Date	Harvest Date	Planting Rate Seeds/ac	Pre-Plant Fertilizer			Planter Fertilizer		Post Fertilizer	Herbicide		
				N	P	Zn	N	P	N	Chemical	Rate	Date
HRSW	7-May	20-Aug	1.7 million	20	95	3	8	40	68	Bison Roundup UltraMAX	1.25 pt/ac 1.0 pt/ac	12-Jun 11-Aug
Corn	21-May	6-Nov	26,500	20	95	3	13	58	76	Steadfast Callisto	0.75 oz/ac 3.0 oz/ac	17-Jun
Soybean	28-May	27-Sep	177,500	20	95	3	-	-	-	Roundup UltraMAX Roundup UltraMAX	1.5 pt/ac 1.0 pt/ac	20-Jun 8-Jul
Canola	7-May	7-Aug	11 lb/ac	20	95	3	5	24	68	Beyond	4 oz/ac	26-Jun
Alfalfa	8-Jul	17-Oct	15 lb/ac	20	95	3	-	-	-	Roundup UltraMAX	1.5 pt/ac	24-Jun
Millet	2-Jul	26-Sep	20 lb/ac	20	95	3	-	-	-	Roundup UltraMAX 2,4-D amine	1.5 pt/ac 0.75 pt/ac	2-Jul 2-Aug

reduced in those plots. The low yield of 103 bu/ac was recorded in a blackbird damaged plot.

Soybean planting began on May 24. Soybeans were planted with a 6-row, 30-inch spacing Kinze planter equipped with row cleaners, seed firmers and spaded closing wheels at 177,500 seed/ac. In the shank-till treatment, soybeans were planted with a 20-foot concord air seeder with single shoot Anderson openers in a 15-inch spacing at 182,000 seeds/ac. The variety was Croplan RT0874 RR. Soybeans thrived in the no-tilled wheat residue as evidenced by the 53 bu/ac average of 60 plots.

Cerise red millet was planted at 20 lb/ac on July 2 with a 15-foot JD 1560 no-till drill with 7.5-inch spacing. Warm temperatures in July were ideal for millet growth but stand establishment suffered from ponded water in plots from 4.2 inches of precipitation from July 7 to the 18. The 22 bu/ac yield reflects the drowned out areas.

Dairyland Forecast 3000 alfalfa was planted at 15 lb/ac with the JD 1560 no-till drill on July 8. Although alfalfa plots suffered from excess moisture after planting, they didn't have ponded water like the millet plots so excellent stands resulted. This is borne out by the 2.1 ton/ac yield taken after killing frosts in October.

Table 5. Mean, maximum and minimum yields for crops in plots and the combined plot and bulk area yield at the CCSP site in 2002.

CROP	Plot			Combined Mean
	Mean	Max	Min	
	-----bu/ac-----			
HRSW	19	28	7	
Millet	22			22
Soybeans	53	61	46	47
Corn	134	164	103	122
	-----lb/ac-----			
Canola	712			712
	-----ton/ac-----			
Alfalfa	2.1			2.1

ADDITIONAL RESEARCH IN 2003

Producers often ask, why when I apply fertilizer nitrogen (N) according to a modest yield goal based on a soil test, say 30 bu/ac for wheat or 80 bu/ac corn, yields often exceed this goal when weather factors are favorable. Although a thorough explanation of this phenomenon is beyond the scope of this report, some basic principles can be explored. One is that the yield-N relationship is not linear but curvilinear. This allows crops to exceed the initial yield goal when growing conditions are more favorable than was anticipated, especially if yield goals were low. Also fertilizer recommendations are based on an assumed amount of N coming from the organic fraction during the growing season. This release of soil N for crop use is called mineralization and is dependent on soil organic matter, moisture content, carbon to nitrogen ratio of organic matter, temperature, etc. It is apparent that site location, farming practices and climatic conditions can cause large differences in mineralized N. When a cropping system is changed from a tillage based system to a no-till system, plant-soil N relationships are dramatically altered. With this in mind, an N study will be initiated at the CCSP site in 2003.

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 in a no-till cropping system. Soybeans will not receive fertilizer N. The plot area will be grid sampled to study spatial variability in plant-N relationships. 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.