CONSERVATION CROPPING SYSTEMS PROJECT

3rd ANNUAL REPORT

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PROJECT DESCRIPTION

The Conservation Cropping Systems Project (CCSP) is located on a 130-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 resource 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 of legumes in rotations reduces dependence on fertilizer N. The ability to 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.

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

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 is composed of 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 western Dakotas where 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 and demonstrate the use of crop rotations and crop management strategies that are effective in sustaining the environment and producing ample food and fiber within the climate, hydrology, soils and social aspects of this geographic area.

WEATHER AND FARMING 2004

The winter of 2003 – 2004 was mild as temperatures averaged 5.5 degrees warmer than the long-time average in December 2003 and 3.8 degrees above the long-time average in February 2004. January was mild except for the last five days when daily highs ranged from 1 to -17 and daily lows from -23 to -25 degrees. Although snow cover was never plentiful it was adequate to insulate winter wheat from the cold when it was no-tilled in standing residue.

Spring came early as temperatures in March averaged 8.4 degrees above the long-time average as shown in Table 1. Daily temperatures topped 52 degrees on 10 days during the last two weeks of the month. Although precipitation was near normal soils began to dry out with warm temperatures. April continued dry as precipitation was 1.4 inches less than the long-time average. Conditions were nearly ideal for small grain planting and most of the small grains were planted the first two weeks of April. A much needed rainfall of 0.6 inch was received on April 20, promoting uniform germination.

Corn planters were in the field by the third week in April and corn planting was nearly done when a much needed rain of 1.2 inches was recorded on May 11. Due to dry soil conditions prior to the rain, farmers resumed planting in a few days. Soybean planting began in earnest the second week in May, continued in full swing and was mostly completed by May 24 when the weather turned wet. Precipitation totaled 5.1 inches from May 25 through June 1 and totaled 7.1 inches for May. A wet May coupled with temperatures averaging 2.9 degrees below the long-time average slowed crop growth.

The cool temperatures continued as temperatures averaged 3.1 and 2.1 degrees below the long-time average for June and July, respectively. Precipitation in June was 2.1 inches below the long time average. Wheat was not stressed however as it began the month with a fully charged soil profile. Timely rains in July totaling 2.3 inches allowed the wheat crop to mature without stress. Cool temperatures at flowering reduced the incidence of head scab in wheat. The 2004 cropping season was a banner year for wheat production, especially in intensively managed fields. One hundred bu/ac winter wheat and 80 bu/ac spring wheat were not uncommon. Three months of cool weather, ideal for wheat, were causing a disaster in row crops.

The row crop situation got worse in August as temperatures averaged 5.3 degrees below the long-time average. Growing Degree Units (GDU's) for corn in 1993, 2004 and the 15 yr mean for Oakes, ND are shown in Figure 2. GDU's for 1993 are used as a reference point of a cold growing season that resulting in poor yields, low test weight and high moisture corn. Oakes is 26 miles west of Forman. Except for 11 days from May 1 through September 20, GDU's for corn were below those accumulated in 1993. The low point occurred on August 29 when GDU's accumulated at that time were 124 units below 1993 and about 332 units below the 15 yr mean. Things took a dramatic turn for the better in September as temperatures averaged 2.4 degrees warmer than the long-time average. The season came to an end with a killing frost on October 2. Although corn had accumulated 273 GDU's less than the long-time average by September 30, the September heat advanced the corn more rapidly than the heat units indicated. Even though corn was not mature on this frost date it was far enough along to produce good yields, adequate test weights and reasonable moisture contents, unlike the disaster of 1993. Soybeans which had great potential produced average yields due to a dry August.

Table 1. Growing season temperature and precipitation at Forman, ND in 2004

	Temperature		**Precipitation**	
Month	Mean of 64 Years	2004 Mean	Mean of 64 Years	2004 Total
January	7.6	6.0	0.5	0.6
February	11.9	15.7	0.5	0.5
March	26.0	34.4	0.8	0.8
April	44.0	44.7	2.0	0.6
May	55.7	52.8	3.0	7.1
June	65.0	61.9	3.6	1.5
July	70.1	68.0	2.9	2.3
August	68.2	62.9	2.8	0.6
September	59.5	61.9	2.1	4.4
October	46.0	47.7	1.4	3.2
November	28.6	34.7	0.6	0.1
December	15.3	20.7	0.6	0.4
MEAN	41.5	42.6		
TOTAL			20.5	21.9

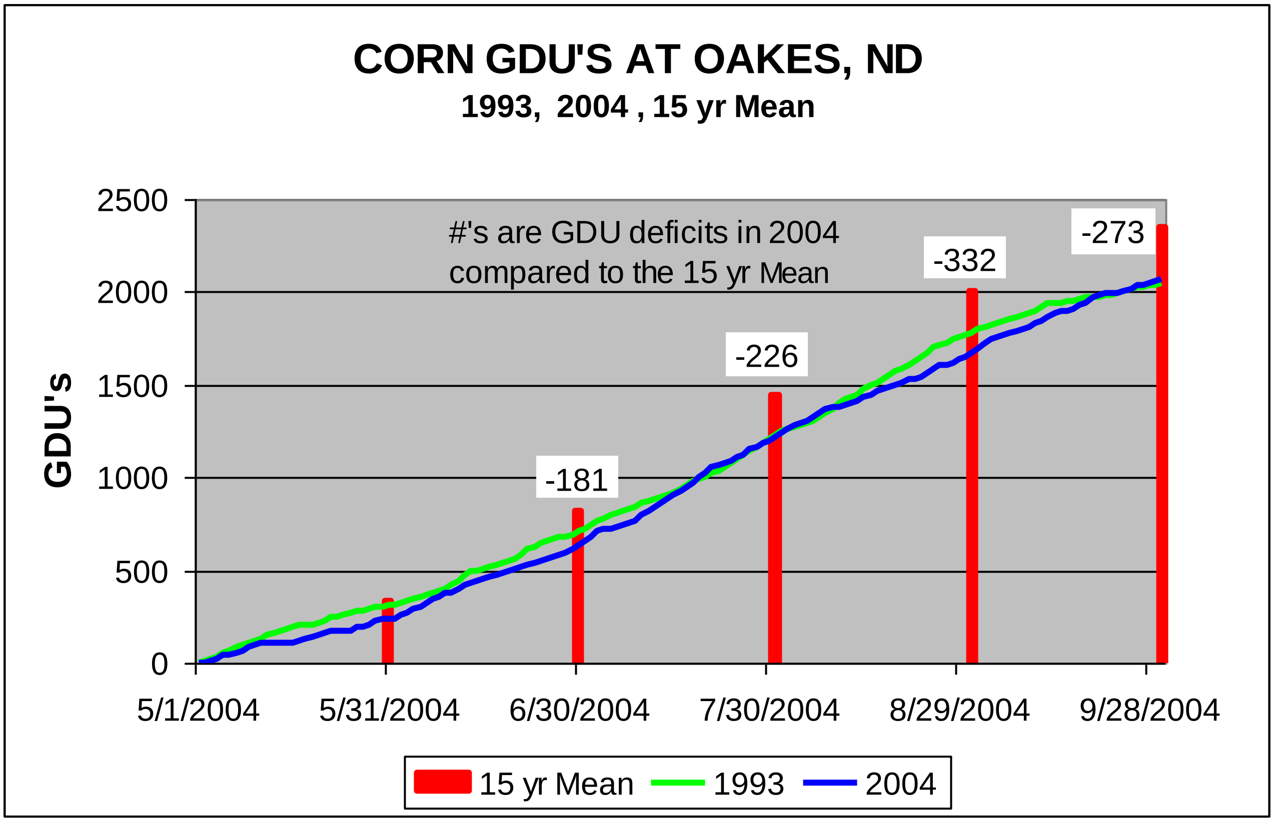

Figure 2. Growing degree units accumulated for corn at Oakes, ND in 2004 compared to 1993 and the 15-yr average at Oakes, ND.

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 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 ($10,000 or greater), gold ($5,000 - $9,999), silver ($2,500 - $4,999) and bronze ($500 - $2,499). We wish to thank our sponsors listed on page 7 for their support! Without them this project would not exist.

PROJECT SPONSERS

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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 may be required in climates where precipitation exceeds evapotranspiration even though high moisture crops are grown. Conversely, low-water-use crops may be 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.

Table 2. Moisture intensity and diversity of the crop rotations at the Conservation Cropping Systems Project at Forman, ND, 2004.

Rotation		Moisture Intensity[a]	Diversity[b]
sw/ww/c/s - disk drill	A	1.50	3.92
sw/ww/c/s - shank drill	B	1.50	3.92
sw/ww/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	1.83
sw/ww/c/s/c/s	H	1.67	2.92
sw/ww/(ds)canola/c/c/s	I	1.50	3.08
ww/s/c/c/can(ds)	J	1.60	4.33
sw/ww/c/c/s/s	L	1.67	2.92
sw/ww/a/a/c/s	N	1.67	2.08

sw = HRSW	ww = HRWW	c = corn	(ds) = dormant seeding
can = canola	a = alfalfa	s = soybean	

[a]1.00 lowest water use, 2.00 highest water use.
[b]The larger the number the more diverse the rotation. Seeding and harvesting conflicts are not considered in these diversity indexes.

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. For example in rotation F, corn is replicated three times as Fc1, Fc2 and Fc3.

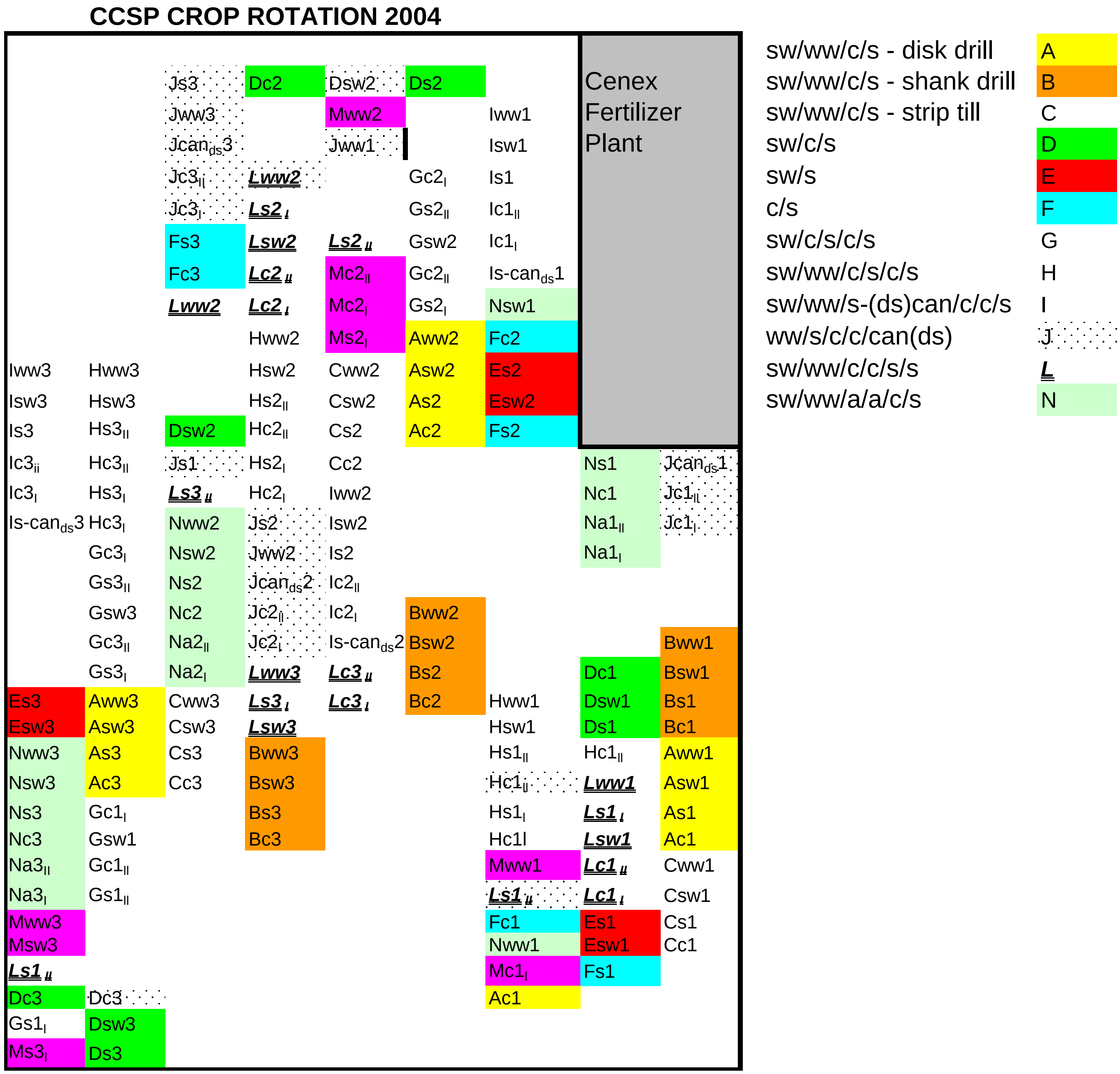

Figure 3. Plot map of rotations and their location in 2004.

SOIL ANALYSIS

Four soil cores per plot were composited for the 0-6 inch and 6-24 inch depths. The samples were further composited for each crop in the rotation and that crop's position in that rotation. Both depths were analyzed for nitrate-N. The 0-6 inch depth was analyzed for P, K, OM, electrical conductivity and pH. Table 3 shows the average soil fertility levels for fall soil sampling dates from 2001 to 2004 when all samples from the CCSP site are averaged for each year.

Table 3. Mean values for soil parameters of 159 plots at the Conservation Cropping Systems Project in the fall of 2001, 2002, 2003 and 2004.

Soil Parameter	Sample Depth	Unit	Mean Value 2001	2002	2003	2004
	inches					
nitrate-N	0-24	lb/ac	55	40	45	32
P -Olsen	0-6	ppm	11	15	16	19
K	0-6	ppm	329	364	357	370
conductivity	0-6	mmho/cm	0.47	0.39	0.54	0.41
ph	0-6		7.5	7.4	7.4	7.2

In the spring of 2002 191 lb/ac of 11-52-0 was applied to all plots to address P variability among plots. The theory was to raise the lower testing plots to levels where P wouldn't be limiting with just planter applied applications in future years. This accounts for the increase in soil P test levels in the fall of 2002. Planter P applications have been applied to maintain soil P levels. Finding the correct position for sampling soil P in a no-till setting with six different crops using three methods of banding P is challenging. Because these soil test means are the average of 636 soil cores it can be assumed that sampling error should be minimal. This data suggests that our planter applications of P fertilizer are maintaining soil test levels and possibly increasing them.

CROP FERTILITY

Fall 2003 and fall 2004 soil nitrate-N means, fertilizer N application and yield for corn, HRSW and HRWW is presented in Table 4. Fall soil nitrate-N plus applied fertilizer N divided by corn yield averaged 1.19 lb N/bu of yield which is virtually identical to NDSU and SDSU recommendations. In these calculations a 40 lb/ac N credit was given to corn planted on soybean ground. HRSW and HRWW didn't require as much fall soil nitrate-N plus fertilizer N as expected. HRWW was planted on HRSW or canola stubble which was, for all practical purposes, hailed out in 2003. Therefore most of the N taken up in the 2003 crop was left in the residue for the 2004 crop. HRSW was planted on soybean stubble that was hailed out on July 3, replanted on July 16 and yielded 11 bu/ac. Again a minimal amount of N left the field.

Table 4. Fall 2003 and fall 2004 soil nitrate-N, fertilizer N, P fertilizer and yield in corn, HRSW and HRWW at the Conservation Cropping System Project 2004.

Crop 2003	Crop 2004	Soil nitrate-N Fall 2003	Fall 2004	Planter P[d]	Planter N	Post N	2004 Yield bu/ac
		lb/ac	lb/ac	lb/ac	lb/ac	lb/ac	
Corn	Corn[a]	48	31	39	12	106	140
Canola	Corn[a]	49	33	39	12	106	154
Soybean	Corn[a]	33	35	39	12	106	156
HRSW	Corn[a]	42	31	39	12	106	150
HRWW	Corn	45	34	39	12	106	131
Soybean	HRSW[b]	31	22	42	9	106	95
Canola	HRWW[c]	58	32	45	13	106	109
HRSW	HRWW[c]	49	32	45	13	106	106

[a]All means are from corn planted with disk drill.

[b]All means are from HRSW planted with disk drill.

[c]All means are from HRWW planted with shank drill.

[d] P as P_2O_5

AGRONOMIC PRACTICES AND YIELD

A general outline of agronomic practices as listed in Table 5 gives an idea of agricultural inputs in crops. Individual plots within a crop were treated on a plot by plot basis when necessary. For example, several of the individual corn plots that followed winter wheat received an additional one or two glyphosate applications not applied to the remaining corn plots. In some instances these particular corn plots may not have received the atrazine, Callisto glyphosate treatment because it was unnecessary.

CDC Falcon HRWW was planted on September 22, 2003 with a 7.5-foot Horsch-Anderson drill with triple shoot Anderson boots at a 15-inch spacing. CDC Falcon was also planted on September 24, 2003 with a John Deere (JD) 1560 single disk drill with 7.5-inch spacing. Croplan Hyclass 2061 canola was dormant planted at 6 lb/ac on November 20 with the JD 1560 drill.

Briggs spring wheat was planted with the JD 1560 drill on April 5, 2004. Shank till plots were planted to Briggs spring wheat on April 8, with a 10-foot Concord drill with triple shoot Anderson boots at a 10-inch spacing.

Dekalb DKC42-95 corn was planted on April 26 in strip till plots and on April 28 in remaining plots with an 8 row Case IH 1200 planter with 30-inch spacing equipped with residue cleaning wheels, spading wheels and seed firmers. Croplan RT0874 soybeans were planted in 30-inch rows with the CIH 1200 planter on May 20. The same variety was planted on May 21, in the shank till plots, with the Concord drill with the triple shoot boots on 10-inch spacing.

Fertilizer applied in corn and wheat is listed in Table 4. Planter fertilizer in corn was applied in a band three inches to the side of the seed and two inches below. Canola in rotation J received 91 lb N /ac as UAN on May 19, applied with stream bars. Canola stands in rotation were too poor to fertilize. Disk drill soybeans received a planter application of 12 lb N/ac and 39 lb P_2O_5 applied three inches to the side of the seed and two inches below. Shank-till soybeans received 8 lb N/ac and 39 lb P_2O_5/ac out the point of the triple shoot openers below the seed. Note all planter applied fertilizer in soybeans was placed a safe distance from the seed. Fertilizer N applications of 63 and 43 lb/ac of actual N as UAN were applied with stream bars in HRWW plots on April 13 and May 4. HRSW plots were treated the same on April 14 and May 18. Corn plots received the same applications on April 14 and May 5. Undiluted UAN at these quantities must be applied before corn emerges to prevent plant burn. All fertilizer in strip till corn, 109 lb N/ac and 44 lb P_2O_5/ac was applied with the applicator on November 19, 2003. Fertilizer sources were NH_3 and MAP.

Dormant seeded canola began to emerge on April 5. It dropped to 28 degrees or colder for 14 days from March 30 through April 14. At this point canola on winter wheat stubble was shot and the canola population on corn stubble was severely diminished. Ideal conditions for canola development in May, June and July allowed canola on corn stubble to branch out, fill in rows, and bloom for an extended time period. Almost unbelievably this canola yielded 2,374 lb/ac.

Crop yields and crop sequence comparisons are presented in Figures 4-8. As reported in the weather and farming section, weather was ideal for small grains and was demonstrated in HRWW and HRSW yields of 106 and 95 bu/ac, respectively at this site. HRWW had an average test weight of 61.8 lb/bu and a protein content of 11.1 compared to 62.7 lb/bu and 13.8 % protein in HRSW.

Corn overcame a cold summer and averaged 142 bu/ac. Harvested plots ranged from 15.4 to 24.7 % moisture and averaged 19.9 %. Samples from harvested plots ranged from 48.5 lb/bu to 54.8 lb/bu. When corn grain samples were air dried to 9.6% moisture, corn on winter wheat, corn on corn, corn on spring wheat, corn on alfalfa, corn on canola and corn on soybean had test weights of 53.0, 53.7, 54.1, 54.3, 54.9 and 55.2 lb/bu, respectively.

Figure 5 shows equal yield of HRWW on canola and HRSW stubble. Canola stubble trapped enough snow for winter survival in the winter of 2003 – 2004. Evidently carry over pathogens from HRSW stubble didn't reduce winter wheat yield. Although no conclusive results can be ascertained in Figure 6, there is a trend for HRSW yield to be higher the more years it is preceded by broadleaf crops. Note, soybeans follow soybeans only in rotation L, which is stacked. Two years of wheat is followed by two years of corn and then two years of soybeans. Four years of high residue grass crops preceding the soybean crop diminishes soybean pathogens and provides adequate crop residue for the second soybean crop. Soybean yields were un-affected by previous crop sequence except for alfalfa ground that ran out of moisture in August, Figure 7. Corn yields were higher the more years corn was preceded by a broadleaf crop, except for alfalfa ground which ran out of moisture in August, Figure 8.

Table 5. General agronomic practices for crops at the the Conservation Cropping Systems Project, 2004.

Crop	Planting Date	Harvest Date	Planting Rate	Chemical	Rate	Date
Alfalfa 1st Yr	2-Apr-04	not harvested	13 #/ac			
Alfalfa 2nd Yr	24-Apr-03	14-Jun-04	12 #/ac			
		16-Jul-04				
		24-Aug-04				
HRSW	5-Apr-04	11-Aug-04	108 #/ac	Bison Advanced	1.2 pt/ac	18-May-04
				Headline	3 oz/ac	18-May-04
				Headline	6 oz/ac	14-Jun-04
				Folicur	4 oz/ac	23-Jun-04
				Roundup Ultra Max II	22 oz	31-Aug-04
				Roundup Ultra Max II	22 oz	17-Sep-04
HRWW	22-Sep-03	3-Aug-04	115 #/ac	Bison Advanced	1.2 pt/ac	17-May-04
				Headline	3 oz/ac	17-May-04
				Headline	3 oz/ac	3-Jun-04
				Folicur	4 oz/ac	14-Jun-04
				Roundup Ultra Max II	22 oz	31-Aug-04
				Roundup Ultra Max II	22 oz	17-Sep-04
Corn	28-Apr-04	26-Oct-04	29,000	Atrazine	1 pt/ac	4-Jun-04
		11-Nov-04	plants/ac	Callisto	3 oz/ac	4-Jun-04
				Roundup Ultra Max II	22 oz	4-Jun-04
				Roundup Ultra Max II	30 oz	25-Jun-04
Soybean	20-May-04	5-Oct-04	165,000[a]	Roundup Ultra Max II	30 oz	10-Jun-04
			plants/ac	Roundup Ultra Max II	25 oz	29-Jun-04
				Roundup Ultra Max II	22 oz	20-Jul-04
Canola	20-Nov-03	8/2/2004[b]	6 #/ac	Roundup Ultra Max II	22 oz	24-May-04
				Roundup Ultra Max II	22 oz	June

[a]Disk drill soybeans@165,000 and shank till @ 200,000 seeds/ac
[b]Date swathed

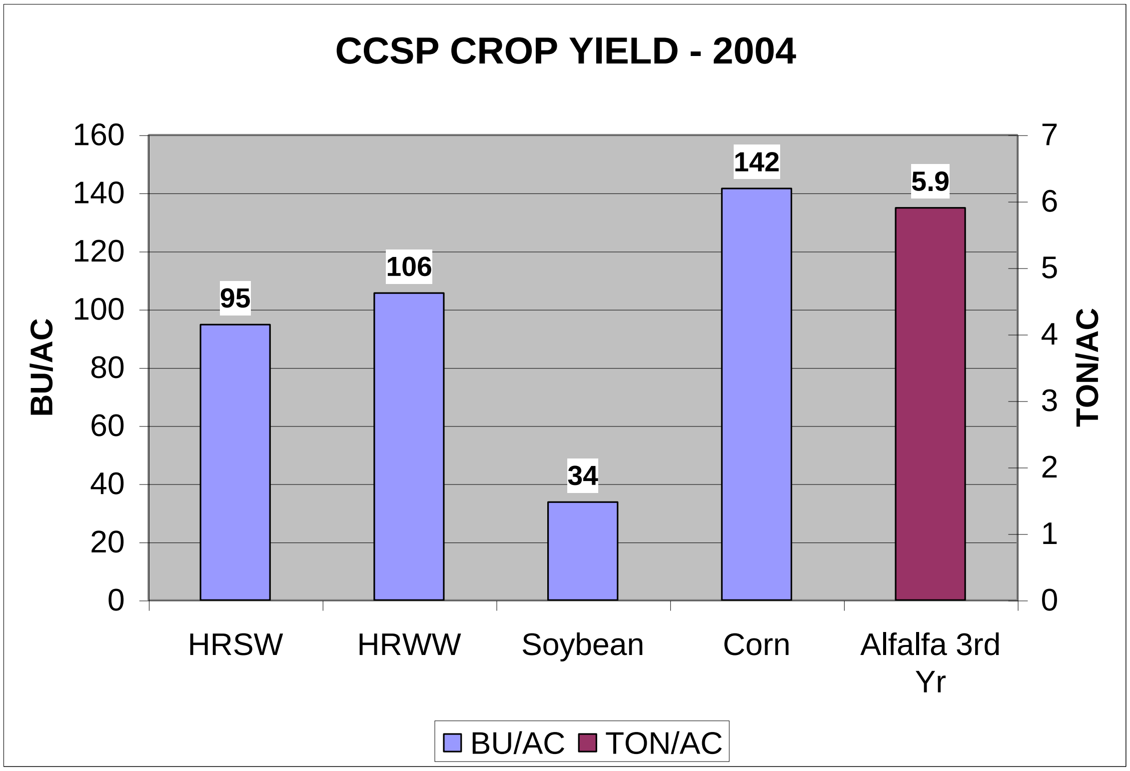

Figure 4. Crop yield averaged across all rotations at the Conservation Cropping Systems Project in 2004.

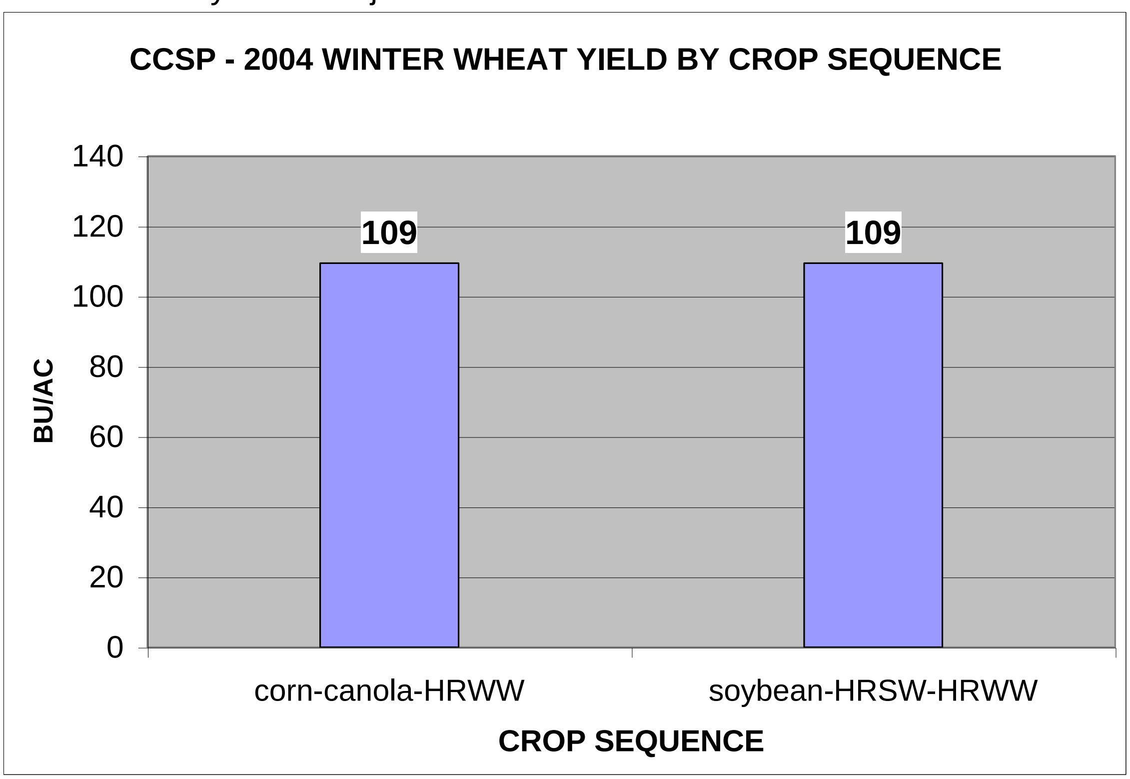

Figure 5. HRWW yield for two cropping sequences at the Conservation Cropping Systems Project in 2004.

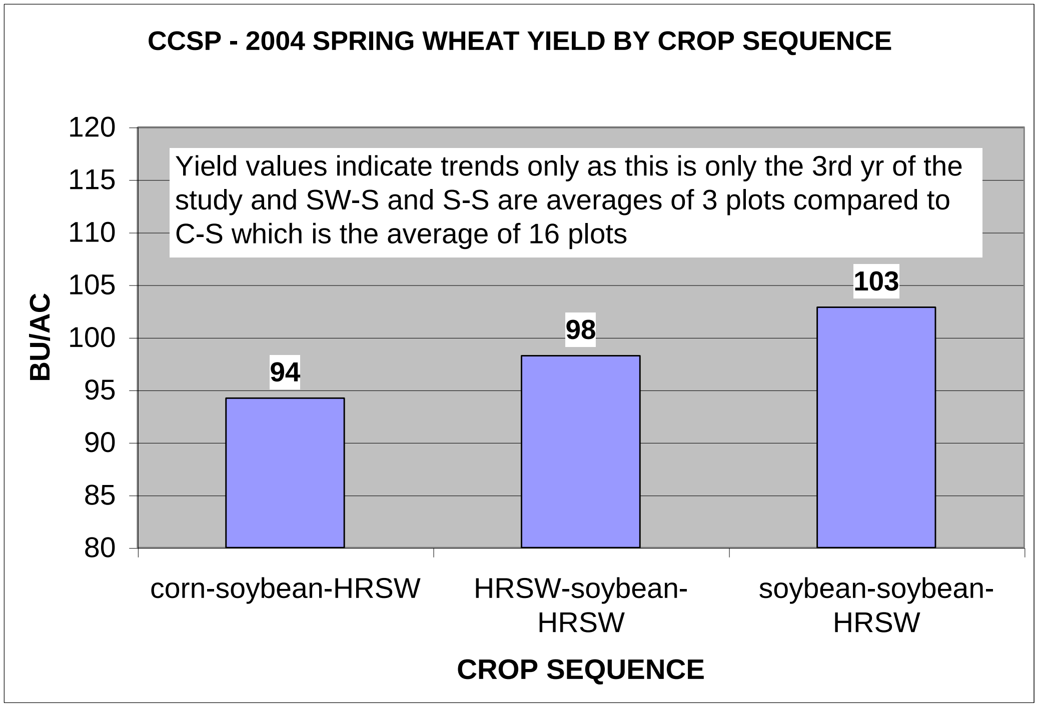

Figure 6. HRSW yield for three cropping sequences at the Conservation Cropping Systems Project in 2004[a]

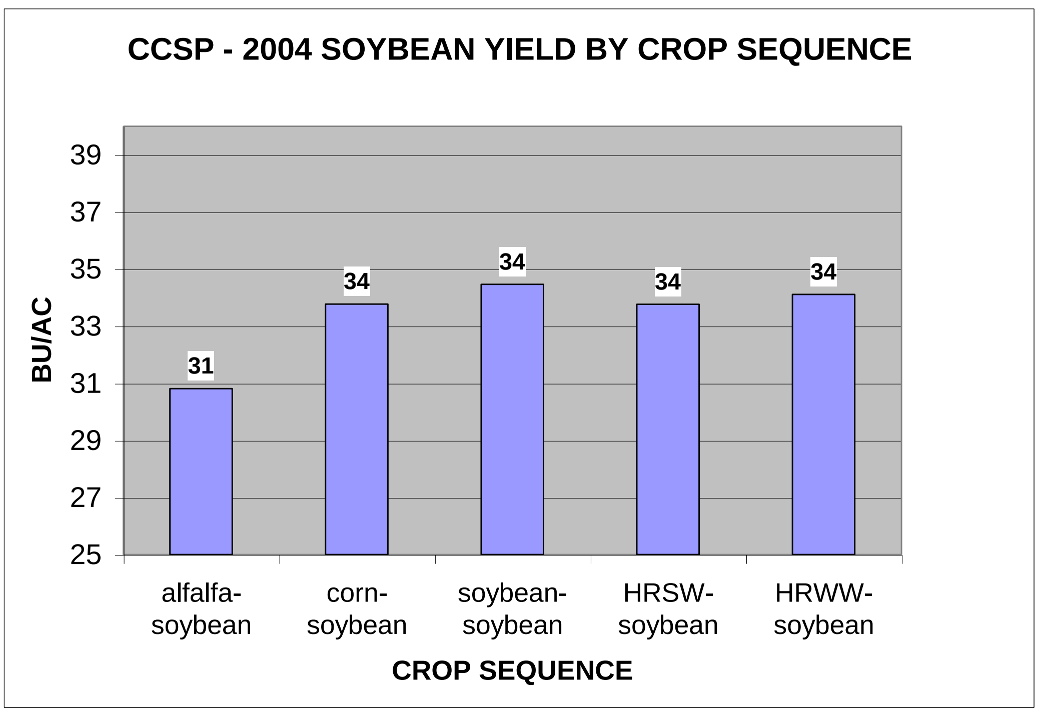

Figure 7. Soybean yield for five cropping sequences at the Conservation Cropping Systems Project in 2004.[a]

[a]Soybean follows soybean only in rotation L where soybean is preceded by four years of high residue grass crops.

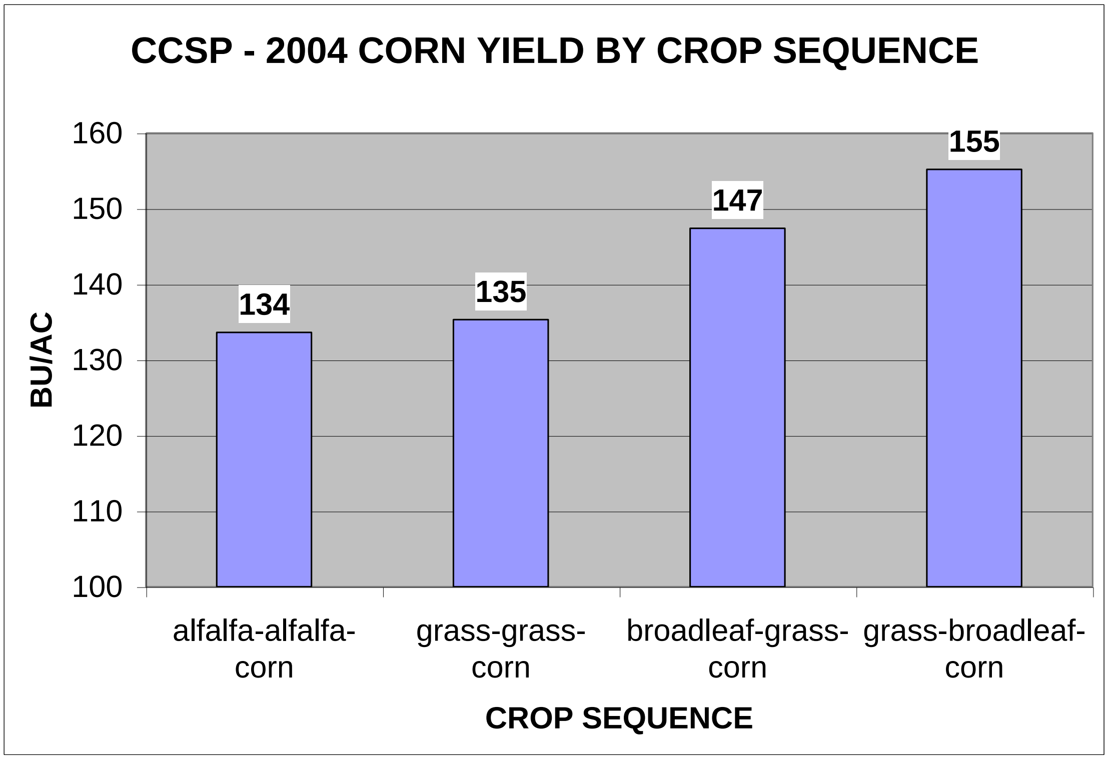

Figure 8. Corn yield for five cropping sequences at the Conservation Cropping Systems Project in 2004.