1997 Research and Cropping Results

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NOTICE

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TABLE OF CONTENTS

RESEARCH REPORTS (CONTINUED)

INTRODUCTION TO AREA IV RESEARCH FARM

The Area IV Research Farm is the result of a specific cooperative agreement between USDA-ARS and the twelve Soil Conservation Districts (SCD) that make up Area IV. This agreement was put in place in 1984. Through this agreement, the Area IV SCD's lease cropland from the Nelson estate for USDA-ARS to perform cooperative research projects with the Area IV SCD's. Total cropland leased bu AREA IV SCD's is 382 acres. In addition, USDA-ARS has leased 55 acres in sec. 17 and sec. 18 for soil and water conservation research for many years and another 26 acres in sec. 8 for tree breeding since 1989. Total acreage leased for research purposes is 463 acres. See Figure 1 for location of Area IV Research Farm in relation to the location of the USDA-ARS Northern Great Plains Research Laboratory facilities. Figure 2 shows the 1997 cropping plans for the four field areas designated as F, G, H, and I. Figure 3 shows the precipitation for the growing season and the total precipitation history for the duration of the Area IV project (1984-1997).

REPORT OF ACTIVITIES FOR AREA F. NW 1/4 Section 17 (see Figure 2)

Field F1. Conservation Bench Terrace Area - This hay producing area has been excluded from the total acreage leased by AREA IV SCD since 1987.

Field F2. The previous crop was winter wheat which yielded 44.5 bu/a. Field F2 was sprayed with Roundup Ultra (8 oz ai/a) on August 22, 1996 to control weeds. Sonalan granules (1 lb ai/a) were applied with a Gandy applicator mounted on a Haybuster undercutter on May 16, 1997. The field was sprayed with Roundup Ultra (9 oz ai/a) on May 19, 1997 to control Downy Brome. The second incorporation of Sonalan was performed with a Phoenix Harrow on May 28, 1997. The following sunflower cultivars were planted in test strips with a 6 row JD MaxEmerge II integral vacuum air drill in 30 inch rows. Five rounds of Proseed 9310 and four rounds each of Proseed 140 and Pioneer 6300 were seeded at a population of 25,000 seeds/a on May 28,1997. Nitrogen was applied at seeding at a rate of 80 lb N/a as 28% liquid. The liquid was sprayed in a band beside the seed row. We contract sprayed for insect control with Asana (5.82 oz material/a) on July 16,1997. The sunflower crop was harvested on October 17, 1997. The gross yield results (no dockage measured) are reported in the following table.

Sunflower Cultivar	Grain Yield lb/a	Oil Content %
Proseed 9310	1500	43.2
Proseed 140	1586	43.2
Pioneer 6300	1358	44.9

No after harvest operations were performed on this field in 1997.

Field F3. The previous crop was sunflowers which yielded 1209 lb/a. The sunflower stubble was left standing over the winter to augment snow trapping and soil water storage. Verde spring wheat was seeded with a JD 750 no-till disk drill with 7.5" row

Figure 1. Map of the land associated with the USDA-ARS Northern Great Plains Laboratory and the Area IV SCD-ARS Research Farm.

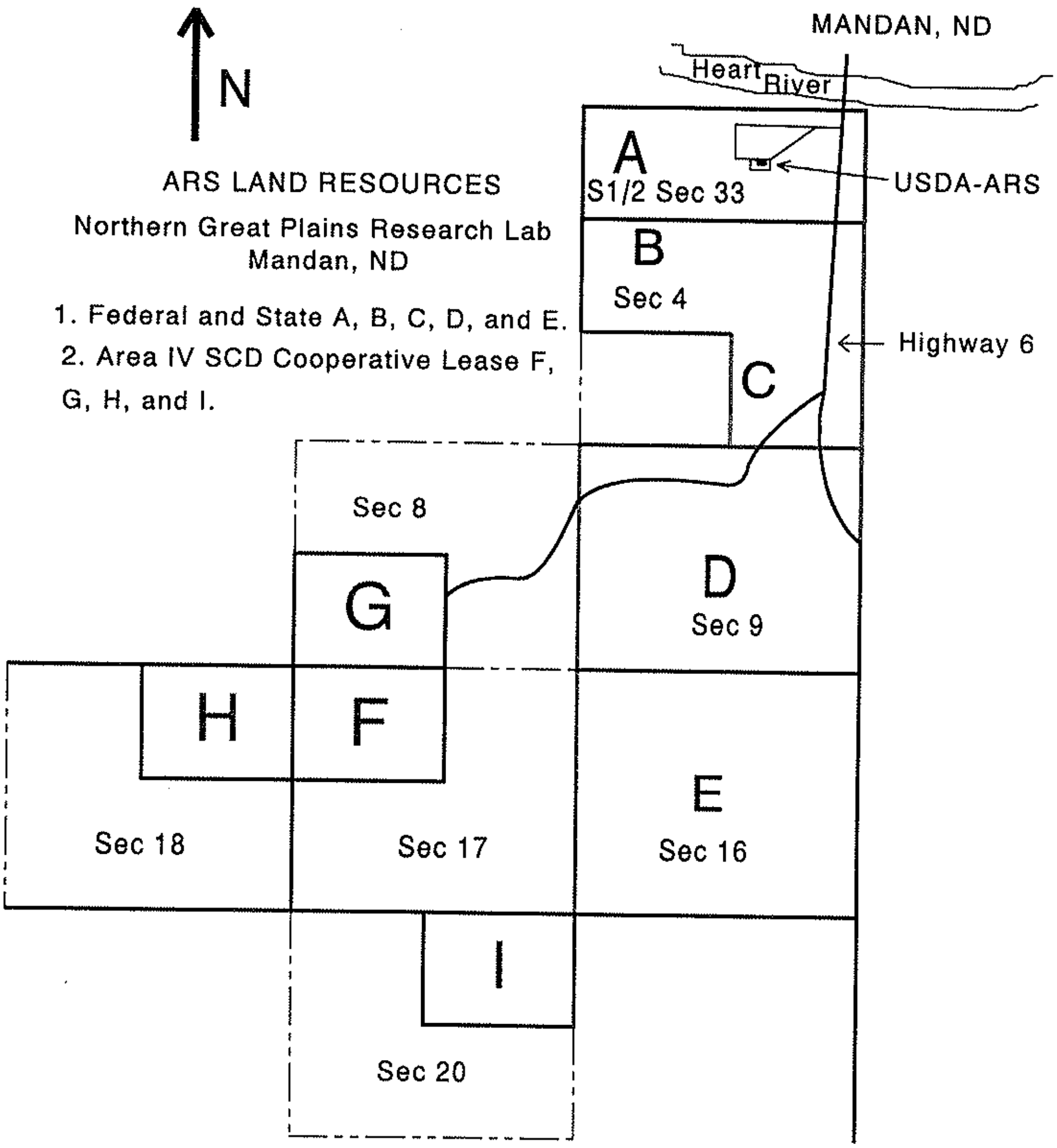


Figure 2. Area IV Research Farm Crop Plan - 1997.

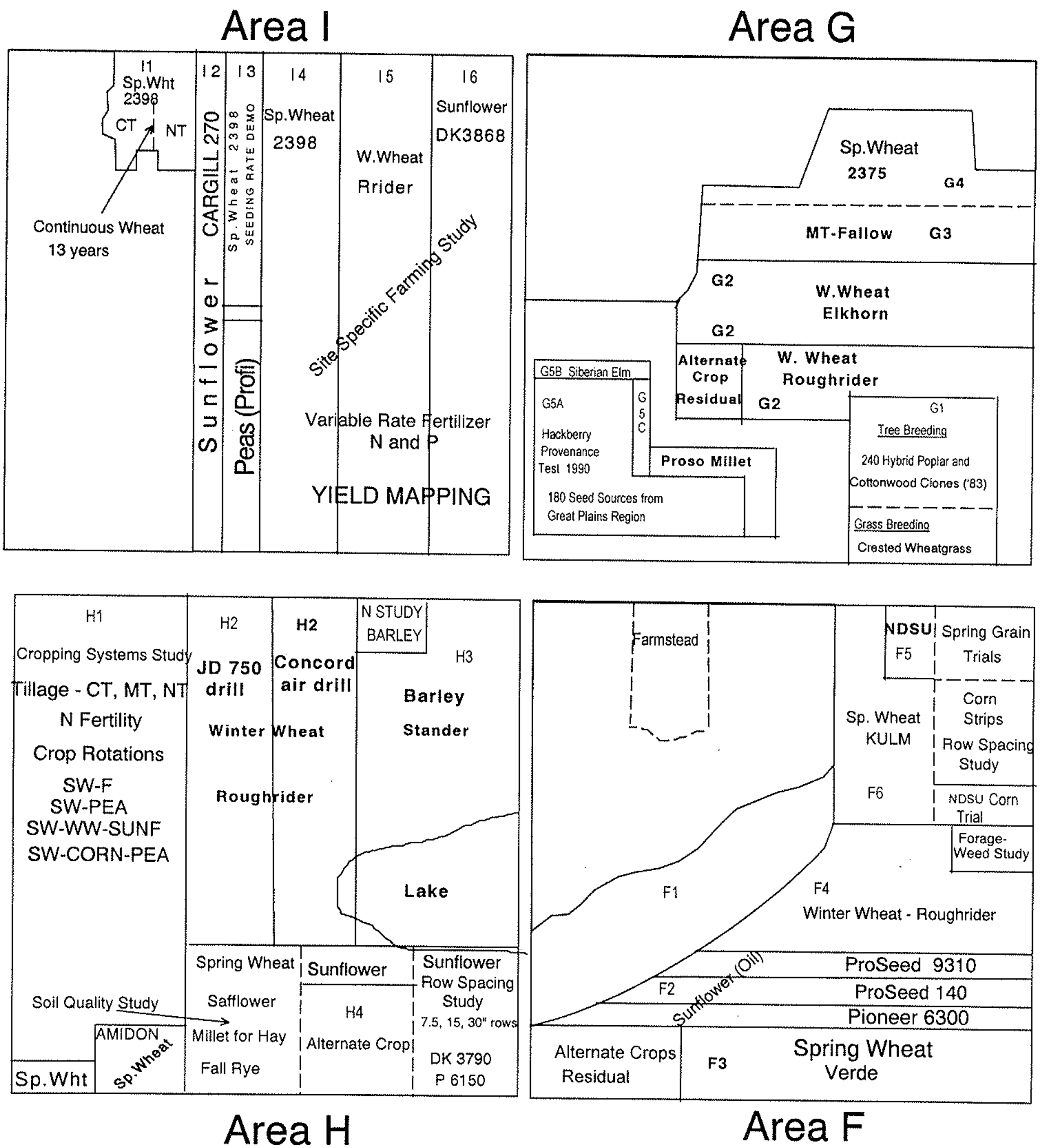
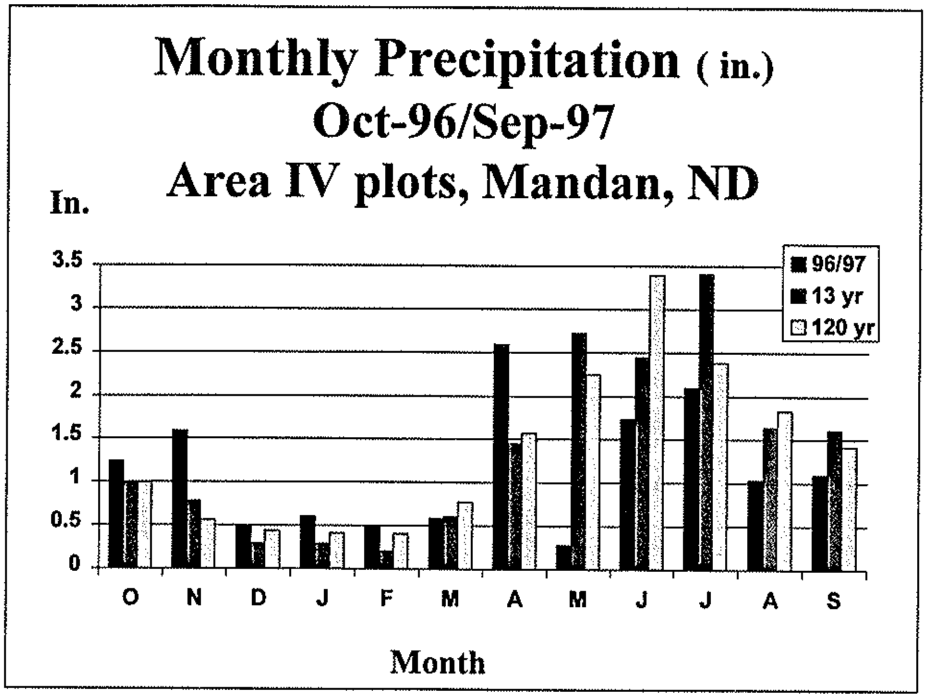
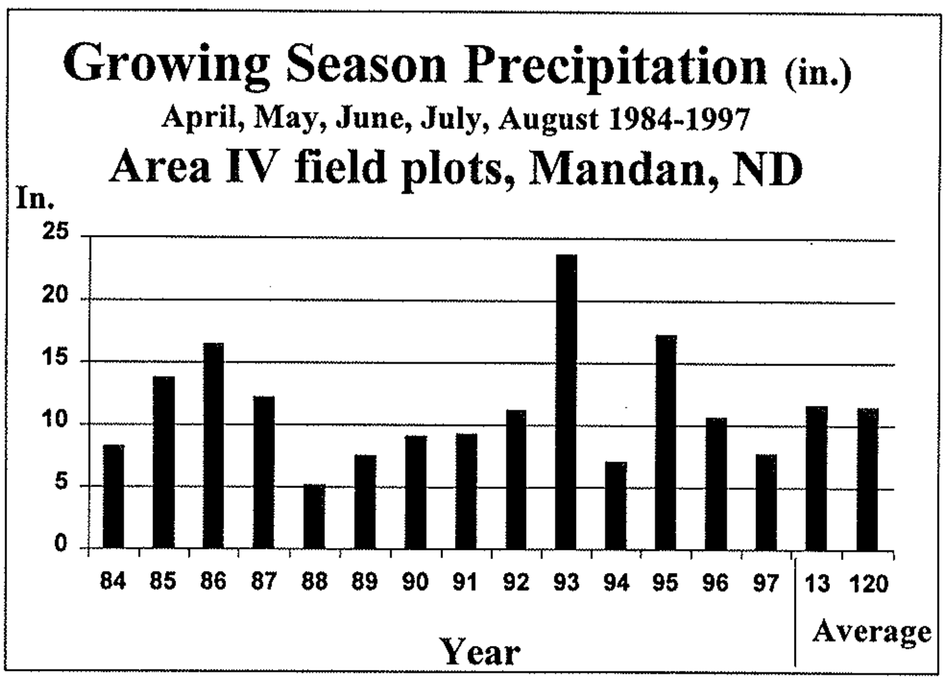


Figure 3. Monthly precipitation during the 1996-97 crop year and growing season precipitation at the Area IV SCD-ARS Research Farm.





spacing on May 20, 1997. Nitrogen as 46-0-0 was banded between the rows at 80 lb N/a and starter fertilizer, 50 lb/a of 18-46-0, was applied with the seed at planting. The field was sprayed with Roundup Ultra (6 oz ai/a) on May 22, 1997. Bronate (4 oz ai/a) was sprayed on June 5, 1997. The field was swathed on August 18, 1997 and combined on August 25, 1997 with a grain yield of 47.5 bu/a and a protein content of 14.5%.

The field was sprayed with Roundup Ultra (6 oz ai/a) on September 25, 1997. The Downy Brome was in the 1 - 2 leaf stage at that time. Elkhorn winter wheat was seeded with a JD 750 no-till disk drill (7.5" row spacing) with 60 lb N/a as 46-0-0 applied between the seed rows and 50 lb/a of 18-46-0 applied with the seed on October 2, 1997.

Field F4. The previous crop was spring wheat which yielded 28.3 bu/a. On September 25, 1996 the South edge (100 ft.) was sprayed with Roundup RT (8 oz ai/a) for Downy Brome control. Roughrider winter wheat was seeded with a JD 750 no-till disk drill (7.5 inch row spacing) with 75 lb N/a as urea applied between the seed rows and 50 lb/a of 11-52-0 applied with the seed on October 2, 1996. The field was sprayed with Harmony Extra + 2, 4-D (.375 +6 oz ai/a) on May 22,1997. The field was swathed on July 23, 1997 and combined on July 29, 1997 with a yield of 25.8 bu/a and protein content of 14.5%. The field was sprayed with Roundup Ultra + Banvel (4.5 + 3 oz ai/a) to control weeds on August 5, 1997 and again with Roundup Ultra (6 oz ai/a) on September 26, 1997 when the Downy Brome was in the 1 - 2 leaf stage. The late fall spraying in 1996 did not control the Downy Brome on the South edge of the field.

Field F5. Several corn hybrids were planted no-till into 1996 spring wheat stubble. On May 15, 1997 DeKalb hybrids 343 (84 day corn) and 365 (86 day corn) with Pioneer 3893 (88 day corn) and 3963 (83 day corn) and Proseed 180 (80 day corn) were planted with a JD MaxEmerge II planter with 30 inch row spacing and a plant population of 16,000 plants/a. Nitrogen was applied in a band beside the row at 90 lb N/a as 28% liquid. The field was sprayed with Accent + Buctril (.454 + 4 oz ai/a) on June 11, 1997. The plots were harvested on October 19, 1997. The grain yields at 15.5% moisture and test weights are reported in the following table.

Hybrid	Maturity Length	Test Wt	Grain Yield
DeKalb 343	84 day	58.1 lb/bu	46.1 bu/a
DeKalb 365	86 day	56.3 lb/bu	44.9 bu/a
Pioneer 3893	88 day	58.0 lb/bu	41.4 bu/a
Pioneer 3963	83 day	56.9 lb/bu	54.9 bu/a
Proseed 180	80 day	59.1 lb/bu	37.8 bu/a

Field F6. The portion of the field planted to peas in 1996 was disked late that fall. It was again tilled with a Phoenix Harrow in 1997 just prior to planting, to eliminate volunteer pea growth. The remainder of the field was corn stalks and was seeded no-till. Kulm spring wheat was seeded with a JD 750 no-till disk drill (7.5 inch row spacing) on May 21, 1997. Fertilizer was applied with the drill at seeding, 80 lb N/a as 46-0-0 between the rows and 50 lb/a 18-46-0 with the seed. The field was sprayed with Tiller + Buctril (1.2 + 4 oz ai/a) on June 5, 1997. The field was swathed on August 21, 1997 and combined on August 26, 1997 with a yield of 31.1 bu/a and protein of 14.3%.

REPORT OF ACTIVITIES FOR AREA G. SW 1/4 Section 8 - Research Activities (see Figure 2)

Field G1. Forage Grass Breeding and Genetics

See research report by Drs. John Berdahl and John Hendrickson.

Field G2. Field G2 was sprayed with Roundup RT (8 oz ai/a) after spring wheat harvest to control fall weeds. On October 1-2, 1996 half of field G2 was seeded to Elkhorn winter wheat and the other half to Roughrider winter wheat with the JD 750 no-till drill (7.5 inch row spacing). Urea, 75 lb N/a was banded between the seed rows with 50 lb/a of 11-52-0 being applied with the seed. Due to cool temperatures, winter wheat growth was minimal in the fall of 1996. The field was sprayed with Harmony Extra + 2, 4-D (.375 + 6 oz ai/a) on May 23, 1997. The Elkhorn was swathed on July 24, 1997 and the Roughrider was swathed on July 28, 1997. Both varieties were combined on August 4, 1997 with Roughrider yielding 34.9 bu/a and Elkhorn yielding 29.6 bu/a. The field was sprayed with Roundup Ultra + Banvel (4.5 + 3 oz ai/a) on August 12, 1997.

Field G3. This field was chemically fallowed in 1997 following spring wheat in 1996. Roundup Ultra (9 oz ai/a) was applied on May 28, 1997. Roundup Ultra + Banvel (4.0 + 2.75 oz ai/a) was applied on July 15, 1997 and again (4.5 + 3.0 oz ai/a) on August 12, 1997.

Field G4. This field was fallowed in 1996. The field was seeded on May 30, 1997 to 2375 spring wheat with a JD 750 no-till drill (7.5 inch row spacing). Urea, 40 lb N/a was banded between the seed rows with 50 lb/a 18-46-0 being applied with the seed. The field was sprayed with Harmony Extra + MCPE (.375 + 6 oz ai/a) on June 3, 1997. The spring wheat was swathed on August 1, 1997 and combined on August 5, 1997. The 2375 wheat yield was 45.3 bu/a and the protein content was 14.3%. Roundup Ultra + Banvel (4.5 + 3 oz ai/a) was applied to control fall weed growth on August 12, 1997.

Field G5. USDA-ARS LEASED LAND-Tree Germplasm Plantations

5a. Hackberry Provenance Test - This area serves as the site for a seed source trial of hackberry accessions collected from 180 native stands throughout the Great Plains.

5b. Siberian Elm Provenance Test - Seedlings from 18 sources from Russia were planted in 10 replications in the spring of 1992.

5c. Siberian Elm Clonal Test - Fifty-five trees, from windbreaks in North and South Dakota, selected for possible disease and insect resistance were planted in four replications in 1990.

REPORT OF ACTIVITIES FOR AREA H. NE 1/4 Section 18 - Research Activities (see Figure 2)

Field H1. This large field is dedicated to the cropping systems--conservation tillage and nitrogen study initiated in 1984. See the research report by Dr. Halvorson for details.

Field H2. This field was seeded to spring wheat in 1996 which yielded 31 bu/a. The field was sprayed with Roundup Ultra (9 oz ai/a) on August 26, 1996 to control after harvest weeds. Roughrider winter wheat was seeded on September 30, 1996. Half of the field was seeded with a JD 750 no-till disk drill (7.5 inch row spacing) while the other half was seeded with a Concord air seeder with hoe openers (10 inch row spacing). Urea, 75 lb N/a, was banded between the seed rows and 50 lb/a 11-52-0 was applied with the seed. The field was sprayed with Harmony Extra + 2, 4-D (.375 + 6 oz ai/a) on May 23, 1997. The winter wheat was swathed on July 22, 1997 and combined on July 28, 1997. The area planted with the Concord drill yielded 28.5 bu/a while the area planted with the JD 750 yielded 25.0 bu/a. The field was sprayed with Roundup Ultra (6 oz ai/a) on September 26, 1997. The Downy Brome was at the 1-2 leaf stage.

Field H3. Field H3 was seeded to sunflower varieties in 1996 which produced an average across the field yield of 1918 lb/a. Stander barley was seeded into the sunflower stalks with a JD 750 no-till drill (7.5 inch row spacing) on May 19, 1997. Urea, 80 lb N/a, was banded between the seed rows and 50 lb/a 18-46-0 was applied with the seed. The field was sprayed with Roundup Ultra (9 oz ai/a) on May 20, 1997. Bronate (4 oz ai/a) was sprayed on June 4, 1997. The field was swathed on August 6, 1997 and combined on August 12, 1997 with a yield of 78.7 bu/a.

Roundup Ultra (6 oz ai/a) was sprayed on September 25, 1997 to control fall weeds. The field was seeded to Roughrider winter wheat on September 26, 1997 with half of the field seeded with a JD 750 no-till disk drill (7.5 inch row spacing) and half seeded with a Concord air seeder with hoe openers (10 inch row spacing). Urea, 60 lb N/a, was banded between the seed rows and 50 lb/a 18-46-0 was applied with the seed.

Field H4. Soil Quality Study - Drs. Donald Tanaka and Steve Merrill

A long term study was initiated in the spring of 1993 to evaluate the influence of tillage and crop rotations on soil quality factors. See research report by Drs. Tanaka and Merrill.

Field H4. Center Bulk Area. This area was used for the Alternative Crops For Dryland Crop Rotation study. See research report by Drs. Tanaka, Merrill, and Halvorson.

Field H4. East Bulk Area. This area was planted to barley which yielded 72.0 bu/a in 1996. The sunflower row spacing study (see research report by Dr. Halvorson) was seeded on May 27,1997. On May 29, 1997 the remainder of the field was divided into strips. Two sunflower cultivars, DeKalb 3790 and Pioneer 6150, were bulk seeded directly into barley stubble at row spacings of 30 inch, 15 inch, and 7.5 inches at a plant population of 28,000 seeds/a. The 30 and 15 inch row spacing strips were seeded with a JD MaxEmerge II planter. Nitrogen as 28% liquid was sprayed in a band between the seed rows at a rate of 80 lb N/a. The 7.5 inch row spacing (solid seeded) was seeded with a JD 750 no-till drill. Urea, 80 lb N/a, was banded between the seed rows. The field was sprayed with Roundup Ultra (6 oz ai/a) on May 30, 1997. We contract sprayed for insect control with Asana (5.82 oz material/a) on August 10, 1997. The field was combined with a 30" row spacing header on October 10, 1997 and the bulk yields (no dockage measured) are as follows:

Cultivar	30" row	15" row	7.5" row
Pioneer 6150	1139 lb/a	1176 lb/a	1189 lb/a
DeKalb 3790	2182 lb/a	1943 lb/a	1392 lb/a

The oil content at 10% moisture was 44.2% for DeKalb 3790 and 40.3% for Pioneer 6150. There was evidence of sunflower midge damage in this field with the Pioneer cultivar receiving the most damage.

The 30" row planting was in the lower part of the field close to the lake where the water table may have been higher. The 15" and 7.5" row plantings had major portions of the field farther from the lake, which may account for the 30" row having the highest yield for the DeKalb 3790. The 30" row planting was heavily infested with weeds, the 15" row planting had less weeds, and the 7.5" row planting was relatively weed free. This weed observation has been consistent for three years, as the row spacing becomes narrower, there are less weeds at harvest.

REPORT OF ACTIVITIES FOR AREA I. NE 1/4 Section 20
(see Figure 2)

Field I1. The maximum till, (< 30% surface cover) half of the field was disked just prior to seeding on May 5, 1997. The entire field was seeded to 2398 spring wheat with a Concord air seeder (10 inch row spacing) on May 5, 1997. Urea, 80 lb N/a, and 50 lb/a 11-52-0 was banded between the split seed row. The field was sprayed with Harmony Extra + MCPE (.375 + 6 oz ai/a) on June 4, 1997. The spring wheat was swathed on August 8, 1997 and combined on August 14, 1997. Separate yields were not taken from the maximum till and no-till areas. The spring wheat yield from the entire field was 25.0 bu/a with a protein content of 14.1%.

Field I2. This field produced a 39.3 bu/a winter wheat yield in 1996. Sonalan granules (1 lb ai/a) were applied with a Gandy applicator mounted on a Haybuster undercutter on May 6, 1997 followed by a second incorporation with a Phoenix Harrow on May 23, 1997. The field was planted to sunflowers, Cargill 270, with a JD MaxEmerge II planter (15 inch row spacing) at a population of 25,000 seeds/a. Nitrogen, as 28% liquid was sprayed in a band beside the seed row at 80 lb N/a. We contract sprayed for insect control with Asana (5.82 oz material/a) on August 10, 1997. The field was combined on October 17, 1997 with a yield of 1704 lb/a and oil content of 40.2%.

Field I3. South Half: This portion of the field was seeded to spring wheat in 1996 which yielded 23.9 bu/a. Sonalan granules (1 lb ai/a) were applied with a Gandy applicator mounted on a haybuster undercutter on May 1, 1997 with a second incorporation using the undercutter on May 15, 1997. The field was seeded to Profi peas with a JD 750 no-till drill (7.5 inch row spacing) at a population of 300,000 seeds/a on May 15, 1997. The peas were swathed with the combine following directly behind on August 13, 1997. No yield data were taken from this field. The field was sprayed with Roundup Ultra (6 oz ai/a) on September 29, 1997 to control Downy Brome which was in the 1-2 leaf stage.

North Half: This portion of the field was chemically fallowed in 1996 following a 1995 sunflower crop. This field was divided into 36 ft wide strips for a plant population demonstration project to test out the new variable rate seeding equipment installed on the Concord Air Seeder. Five strips were set up with May 1, 1997 seeding rates of 0.7, 1.0, 1.3, 1.6, and 1.9 million seeds/a of spring wheat (2398). The Concord seeder had a 10 inch row spacing equipped with variable rate fertilizer application equipment/controls. Urea (46-0-0) at 80 lb N/a and 50 lb/a of 11-52-0 were applied in a band between the split seed rows at seeding. The field was sprayed with Harmony Extra + MCPE (0.375 + 6 oz ai/a) on June 4, 1997. The field was swathed on August 1, 1997 and combined on August 8, 1997 with an average yield of 48.9 bu/a and a protein content of 14.4%. Grain yields were 48.2, 50.3, 46.8, 44.5, and 44.6 bu/a for the 0.7, 1.0, 1.3, 1.6, and 1.9 million seeds/a seeding rates, respectively. Because of the dry growing season conditions, grain yields were highest at the 1.0 million seeds/a rate with decreasing yields as seeding rate increased. If precipitation would have been better, the higher seeding rates would have been expected to yield more than the lower seeding rates. In 1997, the higher seeding rates used more water to produce biomass which reduced the amount of water available for seed/grain production. The normal seeding rate used by USDA-ARS at the Area IV research farm is 1.3 million seeds/a. The seeding rate demonstration should be repeated in the future with replication to get multiple year information before drawing any conclusions.

Field I4. This field is part of the Site-Specific Farming Study and was planted to sunflowers which yielded 1870 lb/a in 1996. The field was planted to spring wheat, 2398, with a Concord air seeder (10 inch row spacing) equipped with variable rate fertilizer application equipment/controls. Based on soil test results, yield potential, and 1996 yield maps, urea (46-0-0) and 11-52-0 were applied as needed across the field at seeding. The field was sprayed with Express + MCPE (.122 + 6 oz ai/a) on June 4, 1997. The field was swathed on August 1, 1997 and combined on August 7, 1997 with an average yield of 37.0 bu/a and a protein content of 15%. Grain yields were mapped using a grain yield monitor and GPS equipment. The field was sprayed with Roundup Ultra + Banvel (4.5 + 3 oz ai/a) to control after harvest weeds on August 12, 1997 and again with Roundup Ultra (6 oz ai/a) on September 24, 1997 to control Downy Brome at the 1-2 leaf stage.

Roughrider winter wheat was seeded with a Concord air seeder (10 inch row spacing) equipped with variable rate application equipment/controls on September 30, 1997. Urea (46-0-0) and 11-52-0 were applied at variable rates determined by soil test results and spring wheat yield maps.

Field I5. This field is part of the Site-Specific Farming Study and was planted to spring wheat which yielded 34.6 bu/a after hail damage in 1996. The field received an application of 55 lb/a 0-0-60 on September 10, 1996. Roughrider winter wheat was seeded with a Concord air seeded (10 inch row spacing) with variable rate application equipment/controls on September 25, 1996. Urea (46-0-0 and 11-52-0 were applied as needed across the field at seeding based on soil test results, yield potential, and 1996 yield maps. The field was sprayed with Harmony Extra + 2, 4-D (.375 + 6 oz ai/a) on May 27, 1997. The winter wheat was swathed on July 21, 1997 and combined on August 1, 1997 with an average yield of 27.8 bu/a and protein content of 12.2%. The grain yields were mapped using a grain yield monitor and GPS equipment. Roundup Ultra + Banvel (4.5 + 2 oz ai/a) were sprayed on August 5, 1997 to control after harvest weeds.

Field F6. This field is part of the Site-Specific Farming Study and was in spring wheat in 1996 which yielded 29.6 bu/a after hail damage. Sonalan granules (1 lb ai/a) were applied with a Gandy applicator mounted to a Haybuster undercutter on May 16, 1997. The second incorporation of the Sonalan was done with a Phoenix harrow on May 27, 1997 just prior to seeding. The field was planted to DeKalb 3868 sunflowers with a JD MaxEmerge II planter (30 inch row spacing) at a population of 25,000 seeds/a. Nitrogen (28% liquid) was sprayed, at planting, in a band beside the seed row as needed based on soil test results, yield potential, and 1996 yield maps. We contract sprayed for insects with Asana (5.82 lb material/a) on August 10, 1997. The field was combined on October 17, 1997 with an average yield of 1954 lb/a and an oil content of 46.4%. The yields were mapped using a grain yield monitor and GPS equipment.

See the research report by Drs. Franzen, Hofman, Krupinsky, and Halvorson on site-specific farming project for details on this research project which is using fields I4, I5, and I6.

CROPPING SYSTEM, TILLAGE, AND NITROGEN FERTILITY STUDY

Drs. Ardell Halvorson, Joe Krupinsky, Steve Merrill,
Brian Wienhold, and Donald Tanaka

Field H1. This large field is dedicated to a cropping systems--conservation tillage and nitrogen study initiated in 1984. The study involved two cropping systems (spring wheat-fallow (SW-F) and spring wheat-winter wheat-sunflower (SW-WW-SUN)), three tillage systems (conventional-till (CT), minimum-till (MT) and no-till (NT)) plus a no-residue spring wheat-fallow treatment to serve as a check plot for assessing wind erodibility and plant diseases, three nitrogen (N) fertilizer levels (0, 20, and 40 lb N/A for spring wheat-fallow, and 30, 60, and 90 lb N/A for the 3-yr annual crop rotation, spring wheat-winter wheat-sunflower) and two varieties of each crop from 1985 through 1996. In 1997 the cultivar plots were terminated in each of the rotations. One 2-year rotation (spring wheat-Pea or SW-P) replaced one of the cultivar treatments of the original SW-F system. One 3-year rotation (spring wheat-corn-pea or SW-C-P) replaced one of the cultivar treatments of the original SW-WW-SUN rotation. The field operations and grain yields for the spring wheat, winter wheat, sunflower, pea, and corn crops for each rotation are reported in Tables 1 through 8. Because of a buildup of residual soil N, we decided not to apply any fertilizer to the 2-year rotation plots and only 30 lb N/a to all the 3-year rotation plots in 1997. This would give us a chance during this transition year to new rotations to reduce the level of residual soil N in the higher N fertilizer rate plots.

Two-Year Rotation Results

Spring Wheat-Fallow: Despite the droughty conditions during the growing season (only 5.1 inches precipitation from May through August), spring wheat yields (Table 1) were average in 1997 due to a soil profile full of water and timely rains at critical growth stages. There were no significant responses of spring wheat to tillage or N fertilization treatments in the SW-F rotation in 1997. The overall average yield at 12% moisture content was 32.0 bu/a or an average annual yield of 16.0 bu/a.

Spring Wheat-Fallow (No Residue): The spring wheat yields averaged 29.5 bu/a at 12% moisture content in 1997 with no significant response to the N treatments (Table 1). The average annual yield was 14.8 bu/a.

Spring Wheat-Pea: Spring wheat yields averaged 32.8 bu/a at 12% moisture content in 1997 with no significant responses to tillage or N treatments (Table 1). In 1997, the spring wheat in this rotation was grown on 1996 fallow plots from the previous SW-F treatments. In 1998, the spring wheat will follow peas and be in the proper cropping sequence.

Pea-Spring Wheat: The 1997 peas were grown on the 1996 spring wheat plots in the previous SW-F rotation. Pea grain yields were significantly affected by tillage treatment in 1997 with NT>MT>CT (Table 1). NT was far superior to CT in 1997 due to poor early emergence for CT plots in May due to lack of rainfall. Pea emergence in May was NT>MT>CT. After June rainfall, the peas emerged in the CT and MT plots, but maturity was delayed and yields were reduced. Considering the drought conditions during the growing season, the NT pea yield of 1470 lb/a at 13% moisture content was very acceptable. Total biomass yields at 0% moisture were 3417, 3162, and 2231 lb/a for NT, MT, and CT treatments respectively, with the NT and MT treatment biomass yields being significantly greater than CT.

Three Year Rotations Results

Spring Wheat-Winter Wheat-Sunflower: Crops grown in this sequence in 1997 followed the proper crop rotation and is a continuation of the previous 12 year sequence without the cultivar variable.

Spring wheat in this cropping sequence did not respond to tillage or N treatments in 1997 (Table 2). The average overall grain yield in 1997 was 31.1 bu/a at 12% moisture content following the 1996 sunflower crop. This was equivalent to the spring wheat yields in the SW-F system without the need for a fallow period. Soil water was near field capacity which was critical to the 1997 crop with only 5.1 inches of growing season precipitation.

Winter wheat yields were low in 1997 with an average overall yield of 14.1 bu/a at 12% moisture content (Table 2). The 20 bu/a grain yield of the NT treatment was significantly greater than that of the MT (11 bu/a) and the CT (11.3 bu/a) treatments. The extremely dry conditions in May (only 0.28 inches of precipitation) and below normal precipitation in June (1.73 inches) resulted in the poor winter wheat yields. The NT system demonstrated its value during drought conditions in 1997.

Sunflower yields were excellent in 1997 with an overall average yield of 2109 lb/a at 10% moisture content. The MT treatment had a significantly higher yield (2551 lb/a) than the NT (1909 lb/a) and the CT (1867 lb/a) treatments in 1997 (Table 2). Although the sunflowers got off to a slow start due to the early drought conditions, they did take advantage of the soil profile filled to near field capacity with water. The 1997 crop was seeded in 15 inch rows to enhance yield potential and improve competition with late season weeds. The sunflowers did respond to the residual N in the 60 and 90 lb/a N treatments with the 90 lb/a N rate being significantly greater than the 30 lb/a N rate. Note, only 30 lb N/a was applied to all N treatments in 1997.

Spring Wheat-Corn-Pea: This was a new rotation for 1997, with the spring wheat being grown following the 1996 sunflower crop, the corn following the 1996 spring wheat crop, and the peas following the 1996 winter wheat crop of the former SW-WW-SUN rotation.

Spring wheat yields averaged 33.6 bu/a at 12% moisture content in 1997. Although the trend was for higher yields with NT (Table 2), there were no significant responses to tillage treatment in 1997. There was no significant response to N in 1997, probably due to the droughty conditions.

Corn silage yields averaged 14,894 lb/a at 70% moisture in 1997. At a probability of 9%, the NT treatment had a significantly higher silage yield (16,402 lb/a) than the MT (14,614 lb/a) and the CT (13,666 lb/a) tillage treatments. In 1997, N treatment had no significant affect on silage yields. **Corn grain** yields in 1997 were significantly affected by tillage treatment with NT yielding 43.2 bu/a, MT 33.8 bu/a and CT 26.1 bu/a at 15.5% moisture content (Table 2). There was a significant tillage x N interaction which probably resulted due to variability in yield with increasing N rate for each of the tillage treatments. Considering the drought conditions in 1997, the 43.2 bu/a yield for the NT treatment is encouraging. Including corn in the rotation will provide a different arsenal of herbicides to help control some of the grassy weed problems, especially downy brome, that have become a problem in the NT system. In 1997, a residual herbicide was not applied preplant due to the early season drought conditions. The potential of harvesting the corn for silage in a bad grain production year gives an operator some flexibility to reduce the potential for economic loss in a crop-livestock type operation.

Pea yields averaged 1458 lb/a at 13% moisture content in 1997. The trend, although not significant, was for grain yields to be greater for NT (1693 lb/a) and MT (1549 lb/a) than for CT (1132 lb/a) (Table 2). There was no grain yield response to N treatment in 1997. Again, the drought conditions during the early growing season created a large amount of variability in the plots due to slow emergence. The overall average total pea biomass yield was 3458 lb/a at 0% moisture content. Harvesting the peas as a forage crop would provide 1.7 t/a of dry matter which in a drought year such as 1997 would provide a livestock operator with a quality forage.

Field operations for each of the crops and rotations are presented in Tables 3 through 9. These tables describe the sequence of operations, crop variety/hybrid planted, insecticides and herbicides applied, N fertilizer applied, and tillage operations.

Acknowledgment: We thank J. Harms, L. Renner, M. Hatzenbuhler, J. Leppert, and K. Kalvoda for their efforts in conducting this cropping systems study and collection of field data.

Table 1. Grain yields for the two-year rotation crops in 1997.					
Tillage	N Rate	SW-F	SW-P	P-SW	SW-F (no residue)
		Sp.Wheat	Sp.Wheat	Pea	Sp.Wheat
	lb/a	bu/a	bu/a	lb/a	bu/a
CT	0	33.0	34.8	734	28.9
CT	20	28.3	31.0	777	29.6
CT	40	28.4	31.0	924	30.0
MT	0	35.5	34.7	1148	----
MT	20	32.4	34.8	1008	----
MT	40	30.4	33.1	1070	----
NT	0	35.3	30.3	1545	----
NT	20	33.5	31.8	1471	----
NT	40	31.0	33.6	1393	----
CT	AVG	29.9	32.3	812	29.5
MT	AVG	32.8	34.2	1076	----
NT	AVG	33.2	31.9	1470	----
AVG	0	34.6	33.3	1142	28.9
AVG	20	31.4	32.5	1086	29.6
AVG	40	29.9	32.6	1129	30.0

Table 2. Grain yields for the three-year rotation crops in 1997.

Tillage	N Rate	SW-WW-SUN			SW-C-P		
		Sp.Wheat	W.Wheat	Sunflower	Sp.Wheat	Corn	Pea
	lb/a	bu/a	bu/a	lb/a	bu/a	bu/a	lb/a
CT	30	28.0	12.7	1851	34.3	25.8	1079
CT	60	26.3	10.6	1785	30.1	29.1	1134
CT	90	29.5	10.5	1966	31.2	23.3	1182
MT	30	33.5	10.9	2276	35.4	27.0	1631
MT	60	30.8	12.1	2567	33.6	37.0	1388
MT	90	34.4	10.2	2810	34.6	37.4	1629
NT	30	32.4	22.8	1375	32.4	48.1	1638
NT	60	31.6	20.3	1973	35.1	36.3	1523
NT	90	33.0	17.0	2380	35.3	45.3	1917
CT	AVG	27.9	11.3	1867	31.9	26.1	1132
MT	AVG	32.9	11.0	2551	34.5	33.8	1549
NT	AVG	32.3	20.0	1909	34.3	43.2	1693
AVG	30	31.3	15.5	1834	34.0	33.6	1450
AVG	60	29.6	14.3	2108	32.9	34.1	1348
AVG	90	32.3	12.6	2385	33.7	35.3	1576

Table 3. Fallow plots, 1997 schedule of operations for each tillage system for the 1997 SW-F series of plots.

Date	Conventional-till		Minimum-till	No-till
mo/day/yr	No residue	<30% Cover	30-60% Cover	>60% Cover
5/6/97	------	------	Roundup Ultra (9 oz ai/a)	Roundup Ultra (9 oz ai/a)
6/13/97	------	------	*Roundup Ultra + Banvel	*Roundup Ultra + Banvel
6/17/97	disked	disked	------	------
7/15/97	------	------	*Roundup Ultra + Banvel	*Roundup Ultra + Banvel
7/17/97	disked	disked	------	------
7/29/97	chisel plow	------	------	------
8/12/97	------	------	undercut	------
9/09/97	------	------	------	*Roundup Ultra + Banvel

*Roundup Ultra (4.0 oz ai/a) plus Banvel (2.5 oz ai/a).

Table 4. Spring wheat plots, 1997 schedule of operations for each tillage system in the SW-F and SW-Pea sequences.

Date	Conventional-till		Minimum-till	No-till
mo/day/yr	No residue	<30% Cover	30-60% Cover	>60% Cover
April 1997	No N fertilizer was applied to any of these plots in 1997.			
5/5/97	disked	disked	undercut	------
5/6/97	------	------	------	Roundup Ultra (9 oz ai/a)
5/12/97	Seeded Amidon spring wheat with Haybuster 1000 disk drill at a rate of 1.3 million seeds/a (Vitavax treated seed) with no N applied.			
6/5/97	Sprayed all plots with Tiller (1.2 oz ai/a) plus Buctril (4 oz ai/a)			
8/11/97	Swathed grain for plot harvest (10 ft cut across each plot)			
8/12/97	Biomass harvest samples obtained (1 sq.m., hand clipped)			
8/21/97	Combined plots for yield			
8/26/97	Cleaned up plots with large combine			

Table 5. Peas plots, 1997 schedule of operations for each tillage system in the P-SW and P-SW-C sequences.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
April 1997	No N fertilizer was applied to any of these plots in 1997.		
5/6/97	Applied Sonalan 10G at 10 lb/a (1 lb ai/a) with Haybuster undercutter with front mounted Gandy granular applicator		Roundup Ultra (9 oz ai/a)
5/13/97	disked	undercut	------
5/14/97	Seeded Profi peas with JD 750 no-till disk drill (7.5" row spacing) at 300,000 seeds/a (inoculated) with no N applied.		
6/13/97	Sprayed all plots with Ultima 160 at 7.3 oz ai/a		
8/4/97	Biomass harvest samples obtained (3.75 sq.ft, hand clipped)		
8/5/97	Combined MT and NT plots for yield in P-SW sequence		
8/14/97	Combined MT and NT plots for yield in P-SW-C sequence		
8/22/97	Combined CT plots for yield in P-SW and P-SW-C sequences		
8/22/97	Cleaned up all remaining peas with combine		
9/9/97	Sprayed P-SW-C plots with Roundup Ultra (5.2 oz ai/a) plus Banvel (3 oz ai/a)		
9/25/97	Sprayed P-SW-C plots with Roundup Ultra (6 oz ai/a), P-SW plots were clean.		

Table 6. Spring wheat, 1997 schedule of operations in SW-WW-SUN and SW-C-P rotations.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
5/5-6/97	------	------	Roundup RT
5/12/97	disked	undercut	
5/13/97	Seeded Amidon spring wheat with Haybuster 1000 disk drill at 1.3 mill seeds/a with 30 lb N/a as urea banded between the rows on all plots. No additional N was added to the 60 and 90 lb N/a treatments in 1997 due to residual soil N buildup.		
6/5/97	Sprayed Tiller (1.2 oz ai/a) plus Buctril (4 oz ai/a)		
8/11/97	Swathed grain for plot harvest (10 ft cut across each plot)		
8/12/97	Biomass harvest samples obtained (1 sq.m., hand clipped)		
8/21/97	Combined plots for yield		
8/26/97	Cleaned up plots with large combine		
9/25/97	Roundup Ultra (6 oz ai/a) sprayed on no-till plots in SW-WW-SUN rotations and all plots in SW-C-P rotation to kill downy brome.		
9/29/97	disked (SW-WW-SUN)	------	------
9/30/97	------	undercut (SW-WW-SUN)	------
10/1/97	Seeded Roughrider winter wheat with JD 750 disk drill (7.5" row spacing) at 1.3 mil seeds/a with 30, 60, and 90 lb N/a banded.		

Table 7. Winter wheat plots, 1997 schedule of operations for each tillage system SW-WW-SUN rotation.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
9/20/96	disked	undercut	Roundup Ultra (8 oz ai/a)
9/25/96	Seeded Elkhorn winter wheat with JD 750 disk drill, 7.5 inch row spacing, at 1.3 mill seeds/a with 50 lb/a of 11-52-0 with seed and 25 lb N/a of urea banded (total 30 lb N/a)		
April 1997	No additional N fertilizer applied to 60 and 90 lb N/a treatments		
5/22/97	Sprayed all plots with Harmony Extra (0.375 oz ai/a) plus 2,4-D (6 oz ai/a)		
7/24/97	Swathed winter wheat plots for grain harvest (10 ft cut across plots)		
7/28/97	Collected biomass samples and head counts (1 sq.m., hand clipped)		
7/29/97	Combined plots for yield		
8/4/97	Cleaned up plots with large combine		
9/9//97	Roundup Ultra (5.2 oz ai/a) plus Banvel (3 oz ai/a) on all plots		
9/25/97	Sprayed all plots with Roundup Ultra (6 oz ai/a) to kill downy brome		

Table 8. Sunflower plots, 1997 schedule of operations for each tillage system in the SW-WW-SUN rotation.

Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
8/20/96	Roundup Ultra applied to all plots		
10/2/96	undercut	------	------
October 1996	------	------	No Sonalan applied, planned to use Prowl in Spring on NT plots
5/6/97	*undercut, applied Sonalan 10G granules	*undercut, applied Sonalan 10G granules	Roundup Ultra (9 oz ai/a)
5/12-13/97	disked	undercut	------
5/22/97	Seeded all plots to DeKalb 3790 with JD MaxEmerge II air seeder at 25,000 seeds/a (15" rows) with 30 lb N/a banded near seed row as liquid 28% UAN. No additional N was applied to the 60 and 90 lb N/a treatments in 1997.		
6/13/96	Sprayed Ultima 160 (7.3 oz ai/a)		
7/8/97	Sprayed Poast (4.5 oz ai/a) on all plots		
8/10/97	Aerial sprayed all plots with Asana XL insecticide (5.82 oz material/a)		
10/15/97	Biomass harvest samples taken (1 row x 6ft long, hand clipped)		
10/15/97	Hand harvested plots for yield, 2 rows 9 ft. long at 2 locations in each plot		
10/17/97	Bulk combined plot area with large combine		

*Sonalan was applied using a Haybuster undercutter with a front mounted Gandy granular applicator. This was the first tillage operation for incorporation of Sonalan G-10 granules.

Note: Due to the extreme May drought, the spring application of Prowl planned for the NT plots was not applied.

Table 9. Corn plots, 1997 schedule of operations for each tillage system in the SW-C-P rotation.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
8/20/96	Roundup Ultra applied to all plots		
10/2/96	undercut	------	------
5/6/97	------	------	Roundup Ultra (9 oz ai/a)
5/12/97	disked	undercut	------
5/14/97	Seeded corn plots with Pioneer 3893 using JD MaxEmerge II air seeder at 16,000 seeds/a (30" rows) with 30 lb N/a banded near seed row as liquid 28% UAN. No additional N was applied to the 60 and 90 lb N/a treatments in 1997.		
6/11/97	Sprayed corn with Accent (0.454 oz ai/a) plus Buctril (4 oz ai/a)		
7/10/97	Sprayed all plots with Roundup Ultra (12 oz ai/a) using a shielded band sprayer to apply the Roundup between the corn rows.		
9/2/97	Hand harvested corn plots for silage (Total Biomass) (2 rows x 6ft long)		
10/6/97	Hand harvested plots for grain yield (2 rows x 9ft long at 2 locations in each plot)		
10/10/97	Bulk combined plot area with large combine		
Note: Due to the extreme May drought, the spring application of atrazine or other residual herbicide were not made to any of the corn tillage treatments.			

PLANT DISEASES

Drs. Joe Krupinsky, Donald Tanaka, and Ardell Halvorson

LEAF SPOT DISEASE COMPLEX

Spring wheat and winter wheat leaves from experimental plots were analyzed for plant pathogens present. Septoria nodorum blotch (*Septoria nodorum* or *Stagonospora nodorum*), tan spot (*Pyrenophora tritici-repentis* or *Drechslera tritici-repentis*), spot blotch (*Helminthosporium sativum* or *Bipolaris sorokiniana*) and Septoria avenae blotch (*Septoria avenae* f. sp. *triticea*) made up the leaf spot disease complex present on wheat in this area. Septoria nodorum blotch and tan spot were the most common diseases on spring wheat and winter wheat and the two main components of a leaf spot complex present on wheat. Spot blotch and Septoria avenae blotch were both detected but at lower levels. This again indicates that leaf spot diseases on wheat are not caused by one pathogen but rather a complex of fungi.

Since precipitation levels were rather low in 1997 in the Mandan area (Figure 3), leaf spot diseases developed rather slowly at the beginning of the season. In general, leaf spot diseases were not severe enough for rating on spring wheat until the middle of July.

LONG-TERM CROPPING SYSTEMS STUDY, Leaf spot diseases

(For details on plot treatments check write-up for Cropping system, Tillage, and Nitrogen Fertility Study, Field H1)

New rotations were initiated for this study in 1997. In general, differences between tillage treatments or nitrogen treatments were not significant. Without nitrogen or tillage differences, there were no nitrogen X tillage interactions.

SPRING WHEAT TRIALS AND CHLORIDE, Leaf spot diseases.

Field F5. (For details on plot treatments check results of Tanaka)

Chloride application, such as potassium chloride, has been reported to reduce foliar diseases and root-rot diseases of small grains in the northern Great Plains area if chloride levels are low (less than 30 lb/ac) but the results are not consistent. For example, common root rot of wheat and barley may or may not be reduced with chloride application (Tinline. Can. J. Plant Pathol. 15:65-73). Results can vary depending on the cultivars, soil types, location, and/or year. Response to chloride application is not affected by tillage.

In 1997, the second year of this study, potassium chloride was applied across varieties in the spring wheat trial. Varieties with KCl and without KCl were rated seven times during the growing season. The differences between the KCl and no KCl treatments indicate that varieties respond differently to the application of KCl.

MANAGEMENT STRATEGIES FOR SOIL QUALITY, Leaf spot diseases.

Field H4. (For details on plot treatments check results of Tanaka)

In 1997, Amidon spring wheat was evaluated under various crop rotations and two tillage types, minimum till and no till. Cropping systems included: spring wheat (SW)-fallow (F); SW-safflower (S)- rye; SW-S-F; SW-millet; continuous SW with residue; and continuous SW with residue removed. No differences were found between tillage treatments for severity of leaf spot diseases. In two out of the six ratings there were statistical differences among the crop rotations, with the continuous SW rotations having more leaf spot disease than other crop rotations early in the season.

CONVERSION OF CRP TO CROP PRODUCTION, Leaf spot diseases.

(For details on plot treatments check results of Tanaka)

In 1996, Roughrider winter wheat was evaluated on CRP land with three tillage treatments, 2 nitrogen treatments, on plots that had been hayed and not hayed. Leaf spot diseases were similar on the hayed and nonhayed plots, and on the three tillage treatments. Leaf spot diseases were highest on plots with no nitrogen compared to plots with 60 lb N/ac. Since peas were used in the rotation in 1997, there is no leaf spot disease data on wheat.

MANAGE TO MINIMIZE DISEASES

Important management decisions that need to be considered in your operation include: using crop rotation; using tolerant or disease resistant varieties adapted to your area; using pathogen-free seed with high germination; eliminating volunteer plants that can harbor diseases; weather permitting, planting at the proper time and at seeding rates recommended for your area; using a proper balance of fertilizers, especially nitrogen; and monitoring your fields, if foliar diseases are present and your yield potential is high, the use of fungicides is an option. These management decisions will reduce the disease potential in all tillage systems not just zero till. Since diseases can have a negative impact on your crop, decisions that lower the disease potential in your crop will increase your yield potential and profit margin.

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SOIL-INHERENT WIND ERODIBILITY OF SPRING WHEAT-FALLOW

Drs. Steve Merrill and Ardell Halvorson

Field H1. Soil-inherent wind erodibility is measured as apparent dry aggregate size distribution using a rotary sieve. We have been sampling the uppermost inch of soil in the spring wheat-fallow part of the long-term Conservation Tillage Cropping Systems Experiment and measuring soil inherent wind erodibility since 1988. There are three tillage treatments for which cropping results are reported elsewhere (conventional-till, CONVT, minimal-till, MINML, and no-till, NOTIL), and there is a fourth treatment in which low residue cover is maintained (low-residue, LORES).

Two measures of aggregate size distribution are commonly used as indicators of soil-inherent wind erodibility: (a) erodible fraction (EF), which is the percentage by weight of aggregates less than 0.84 mm (0.033 inch) in diameter. Soil aggregates and particles of this size are considered to be immediately wind erodible. (b) The other common index is geometric mean diameter (GMD), a measure of average aggregate size. Generally, the greater the GMD, the lower is the EF. Soils with an EF greater than 50% or with GMD of 2 mm or less are more subject to wind erosion hazard.

Measurements of soil-inherent wind erodibility made in spring wheat-fallow in 1997 show generally low EF values and correspondingly high GMD values. This reflects the fact that the overall climatic pattern of the past 5 years or so has been characterized by generally wetter conditions. While there appear to be statistically significant differences among GMD and EF values for tillage treatments (Table 1), the significance of this is unclear. The no-till treatment shows the lowest average GMD value in the 1997 data here. This is not the case every year by any means. Observations made in the Soil Quality Management Experiment (see report here on "Soil-Inherent Wind Erodibility as a Soil Quality Indicator") indicate that GMD was higher and EF was lower under no-till compared to minimal-till.

Considerable changes in aggregate size distribution values were observed over the 1997 season, with the higher GMD values measured in the spring (Table 2) reflecting wetter, more cohesive surface soil conditions. This pattern has been observed in other years, but usually not with so great a variation over time. Changes in GMD values over seasons are characteristically greater than differences among tillage treatments.

Average annual GMD values (see Figure) measured over years show considerable long-term variation. The generally low values observed between 1988 and 1991 or 1992 were the result of a very significant multi-year drought in the period of 1988 through 1990. Drought accelerates wind erosion both through low crop plant growth producing lesser amounts of protective residues, and through significant increases in soil-inherent wind erodibility.

While no-till is indeed "the last line of defense against wind erosion", this occurs through the superior standing residues conserved under no-till management, and generally not because of any effect of no-till on soil-inherent wind erodibility itself.

Table 1. Geometric mean diameter (GMD) and erodible fraction during 1997 for tillage treatments[1].

	PHASE	TILLAGE				AVG.
		LORES	CONVT	MINML	NOTIL	
Geo. Mean Diameter (mm)	Crop	33.6	27.0	23.7	19.4	25.9X
	Fallow	14.9	39.4	14.2	10.5	19.8Y
	Avg.	24.1B	33.2A	18.9C	15.0C	22.8
Erodible Fraction (%)	Crop	28.4	25.7	27.8	26.2	27.0X
	Fallow	23.9	21.0	26.3	24.3	23.9Y
	Avg.	26.1AB	23.3C	27.1A	25.2B	25.4

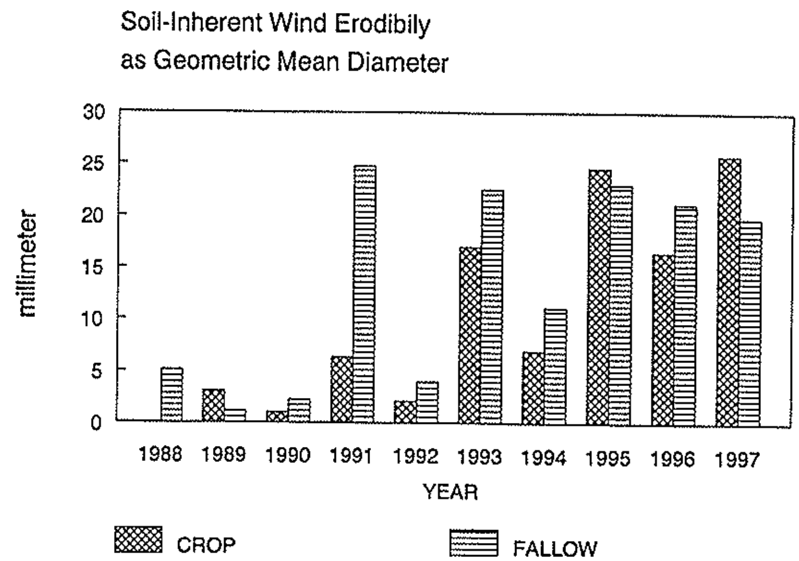
Table 2. GMD (in mm) averaged across tillages[2].

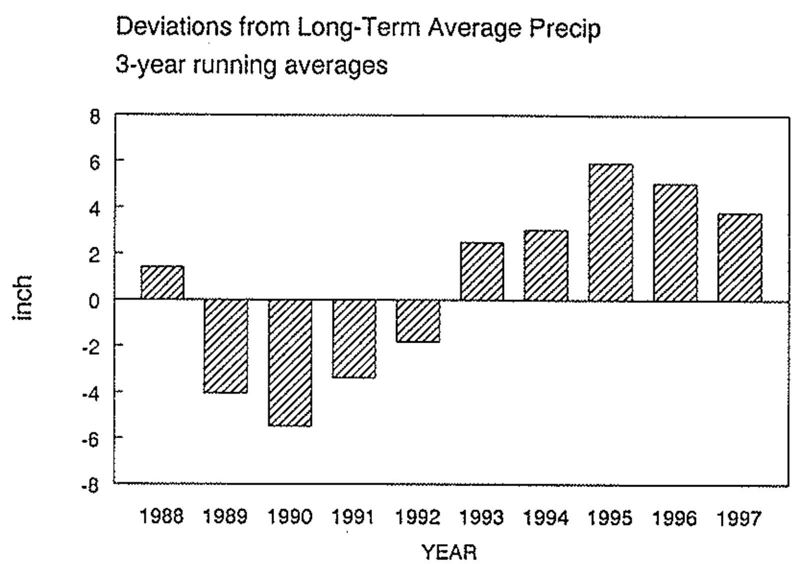
DATE	PHASE	
	Crop	Fallow
04 APR 97	94.5	
05 MAY 97		50.0
06 JUN 97		33.2
11 JUN 97	21.0	
07 JUL 97		7.1
08 JUL 97	4.1	
04 AUG 97	4.8	
05 AUG 97		6.5
07 OCT 97		3.9
08 OCT 97	3.9	

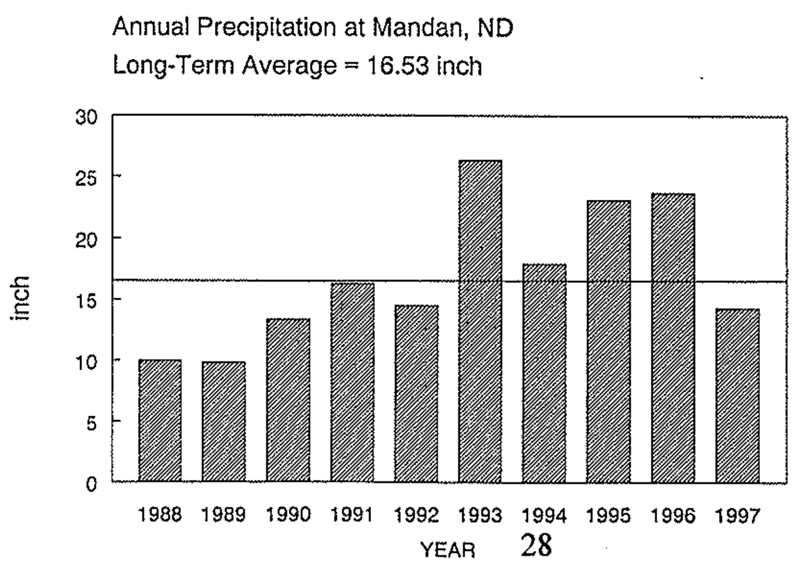
[1] Values of tillage averages in rows followed by different letter are significantly different from each other at 10% probability level; values of phase averages followed by different letter are significantly different at 10% level.

[2] Values of GMD are considered to not exceed 99.9 mm.

Figure 1. **<u>Upper Figure:</u> Soil-inherent wind erodibility measured as geometric mean diameter using a rotary sieve.**
<u>Middle Figure:</u> Annual 3-year running average of the difference from the mean of 16.5 inches precipitation.
<u>Lower Figure:</u> Annual precipitation at Mandan, ND.







SOIL-INHERENT WIND ERODIBILITY AS A SOIL QUALITY FACTOR

Drs. Steve Merrill and Donald Tanaka

Field F3. Information about measurements of soil-inherent wind erodibility is discussed in the report "Soil-Inherent Wind Erodibility of Spring Wheat-Fallow". Soil-inherent wind erodibility measurements have been made in the Soil Quality Management Experiment from the fall of 1993 through the 1997 cropping season. The upper inch of soil has been sampled in spring, generally in late May, and in October in tillage treatments (minimum-till (undercutter) and no-till) in all rotations: (a) continuous spring wheat, residue undisturbed (SpW+Res); (b) continuous spring wheat, residue removed (SpW-Res); (c) spring wheat - safflower - rye (SpW-Saffl-Rye); (d) spring wheat - safflower - fallow (SpW-Saffl-Fall); (e) spring wheat - millet (SpW-Mill); (f) spring wheat - fallow (SpW-Fall).

Geometric mean diameter (GMD) and erodible fraction (EF) measures of soil-inherent wind erodibility are shown in Table 1 averaged over year and season. EF can be taken as a measure of immediate wind erodibility, whilst GMD is more of a measure of potential wind erodibility and surface soil tilth state. The residue-undisturbed continuous spring wheat shows the highest average GMD value and the lowest average EF value of the crop rotations. For all rotations, the tillage averages showed GMD to be higher and EF to be lower in no-till than in minimal-till.

Soil-inherent wind erodibility values are subject to chaotic and periodic changes induced by the weather, as indicated by the data in Table 2 showing annual averages. The annual variations in GMD are of the same general size as greatest crop rotation and tillage differences, while annual variations in EF are somewhat greater than largest crop rotation differences and generally greater than tillage differences.

The higher GMD values in undisturbed continuous spring wheat may be taken as an indication of a positive soil quality effect of maximum cropping intensity. Removal of residue from continuous spring wheat causes it to show approximately the same GMD values as the less intensively cropped rotations.

Table 1. Soil-inherent wind erodibility measurements from samples taken in spring (generally late May) and fall (October) from 1993 through 1997*.

Rotation	Phase	Geom. Mean Diam. (mm)			Erodible Fraction (%)		
		Min-Till	No-Till	Avg.	Min-Till	No-Till	Avg.
SpW +Res	Continous	**14.0**	**21.7**	**17.9A**	**20.5**	**16.9**	**18.7B**
SpW -Res	Continous	**7.2**	**10.2**	**8.7B**	**23.8**	**20.1**	**22.0AB**
SpW-Saffl-Rye	SpW	5.9	7.9	6.9	27.3	24.0	25.6
	Saffl	8.0	9.9	9.0	23.5	19.7	21.6
	Rye	8.3	13.0	10.7	25.1	19.5	22.3
	Avg.	**7.4**	**10.3**	**8.8B**	**25.3**	**21.1**	**23.2A**
SpW-Saffl-Fall	SpW	6.4	8.9	7.7	27.7	26.5	27.1
	Saffl	7.9	12.1	10.0	23.9	19.1	21.5
	Fall	12.1	12.4	12.3	24.6	21.1	22.9
	Avg.	**8.8**	**11.1**	**10.0B**	**23.4**	**22.2**	**23.8A**
SpW-Mill	SpW	7.8	10.1	9.0	22.9	22.5	22.7
	Mill	8.3	10.4	9.3	25.3	21.8	23.6
	Avg.	**8.1**	**10.3**	**9.2B**	**24.1**	**22.2**	**23.2A**
SpW-Fall	SpW	6.5	7.4	7.0	27.1	24.9	26.0
	Fall	9.6	14.5	12.1	23.3	19.6	21.5
	Avg.	**8.0**	**11.0**	**9.5B**	**25.2**	**22.3**	**23.7A**
Average		**8.5B**	**11.5A**	10.0	**24.6A**	**21.3B**	

*Values in a column or in a group of two followed by different letters are significantly different at the 10% probability levels.

Table 2. Soil-inherent wind erodibility measurements averaged by season and year of sampling.						
	Season	1993	1994	1995	1996	1997
Geometric Mean Diameter (mm)	Spring	--*	7.6	8.2	10.7	18.1
	Fall	11.1	6.1	6.8	17.9	3.6
	Avg.	**11.1**	**6.9**	**7.5**	**14.3**	**10.8**
Erodible Fraction (%)	Spring	–	24.5	25.3	18.8	21.5
	Fall	18.0	25.2	22.6	16.3	31.4
	Avg.	**18.0**	**24.9**	**24.0**	**17.6**	**26.5**

*Measurements were not taken in spring of 1993.

ROOT GROWTH OF CROPS USED AS ALTERNATIVES TO WHEAT

Drs. Steve Merrill and Donald Tanaka

Field H4. Direct observation of the rooting characteristics of crops proposed for inclusion in wheat-based dryland rotations enables us to better understand the way that they use soil nitrogen and water, and thus, we will be able to better understand how individual crop species interact with each other in the rotations.

We report preliminary data for the 1997 field season of study of root growth in alternative crops. Results from the 1995 and 1996 field seasons are also included here for comparison. The agronomic results of this study are the subject of another report here. The crops in this study followed winter wheat, which in turn followed spring wheat. A different site on the ARS-Area IV Cooperative Research Farm is used for the study each year.

A microvideo camera system was used with two different types of minirhizotron tubes that are installed in the field. The majority of the minirhizotrons were 6 feet long, have an inside diameter of 2 inches, and are made of rigid and durable plastic. A minority of the tubes were either 6 or 9 feet in length, have a moderately rigid inner plastic tube of 3 inch diameter, and are enclosed in a flexible, outer wall of polyvinyl plastic sheeting. This outer wall is constantly pressurized at about 2 to3 psi with solar panel-driven air pumps.

A total of 8 minirhizotrons were installed in plots of each of 7 alternative crops in 1995 and 1996. For the 1997 field season, a total of 12 minirhizotrons were installed in each of the 7 crops. Roots growing against the minirhizotrons are measured from video tapes. For purposes of comparison, root growth was measured in spring wheat crops growing at other sites on the Farm. In 1997, observations were made on root growth of the flax crop.

Data shown in Table 1 indicate characteristics of the rooting systems at a time when the various crops had more or less produced their maximum amount of root growth. The early part of the 1997 cropping season was cold and dry, and crop development was delayed. The data reported for 1997 are of a preliminary nature, and the fact that most of the maximum and median values are more shallow than 1995 and 1996 values may be in part due to some of the crops not reaching maximum depth by late July.

One of the most important characteristics of a root growth system is the average maximum depth of rooting. The crops studied here fall quite well into botanical and agronomic groups when ranked by their maximum rooting depths. The legume crops -- blackbean, soybean, and dry pea -- are the most shallowly rooted, with maximum depths observed over 3 years ranging from 2.5 to 4.1 feet. The mustard family crops crambe and canola are the next group, with maximum rooting depths ranging from 3.3

to 4.3 feet. The oilseed crops sunflower and safflower are the most deeply rooted, with maximum rooting depths of 4.2 to 5.6 feet. Observations in trenches in 1993 showed that sunflower roots can reach more than 6 feet deep and safflower more than 7 feet deep in our glacial till type soil. The grouping and ranking of the original 7 alternative crops in terms of maximum and median rooting depths were more or less consistent over the 3-year period of this study.

The comparative observations on spring wheat show that it is comparable to the mustard family crops canola and crambe with respect to maximum rooting depths, which ranged from 3.3 to 4.3 feet. Spring wheat rather outperformed the mustard family crops with regard to median depth of root length growth, being 1.4 to 2.0 feet. Observations of flax rooting in 1997, showing a maximum of 3.6 feet and a median of 1.3 feet, indicate that the performance of this crop is comparable to that of the mustard family crops.

The median depths of root length growth -- the depth above which 50% of the observed growth has occurred -- fall into approximately the same order by crop as do the maximum depths of root growth. However, the median depths for 6 out of the 8 crops were deeper in 1995 than in 1996. This may be related to the weather pattern in 1995, in which a late, cool, wet spring was followed by a period of heat and dryness in June and July, while the weather pattern in 1996 was nearer to the mean.

The root systems of the oilseed crops sunflower and safflower are notably different from the root system of spring wheat and other small grain crops. Wheat plants depend upon finely branched adventitious roots originating at the crown area near the soil surface. Both sunflower and safflower possess taproots, which can penetrate deeply into subsoil and then extend lateral roots. The safflower plant in particular has the ability to make use of subsoil resources, as shown by the relatively deep maximum and median depths of its rooting. These results indicate that the oilseed crops sunflower and safflower can usually be depended upon to utilize both subsoil water and nitrogen to consistently greater depths and to a greater extent than other crops commonly proposed as alternatives to wheat in dryland crop rotations.

Table 1. Maximum and median depths of observed root length growth for alternative crops.							
CROP	Maximum depth of root growth (feet)				Median depth of root growth (feet)		
	1995	1996	95-96 Avg.	1997*	1995	1996	1997**
Blackbean	3.63	3.20	3.42	2.78	1.49	0.85	0.93
Soybean	3.34	3.77	3.56	2.49	1.64	0.79	0.76
Dry Pea	3.63	4.06	3.85	3.63	1.35	1.12	0.93
Flax				3.63			1.29
Crambe	3.91	4.34	4.13	3.63	1.15	1.78	1.48
Canola	4.20	4.34	4.27	3.34	1.48	1.42	1.08
Spr. Wheat	4.20	4.34	4.27	3.34	1.90	1.97	1.44
Sunflower	4.76	4.62	4.69	**	1.56	1.20	**
Safflower	5.62	5.48	5.55	4.20	3.00	2.04	2.18

* 1997 data are of a preliminary nature.

** Sunflower emerged relatively late and not enough data is currently available for 1997.

MANAGEMENT STRATEGIES FOR SOIL QUALITY

Drs. Donald Tanaka and Steve Merrill

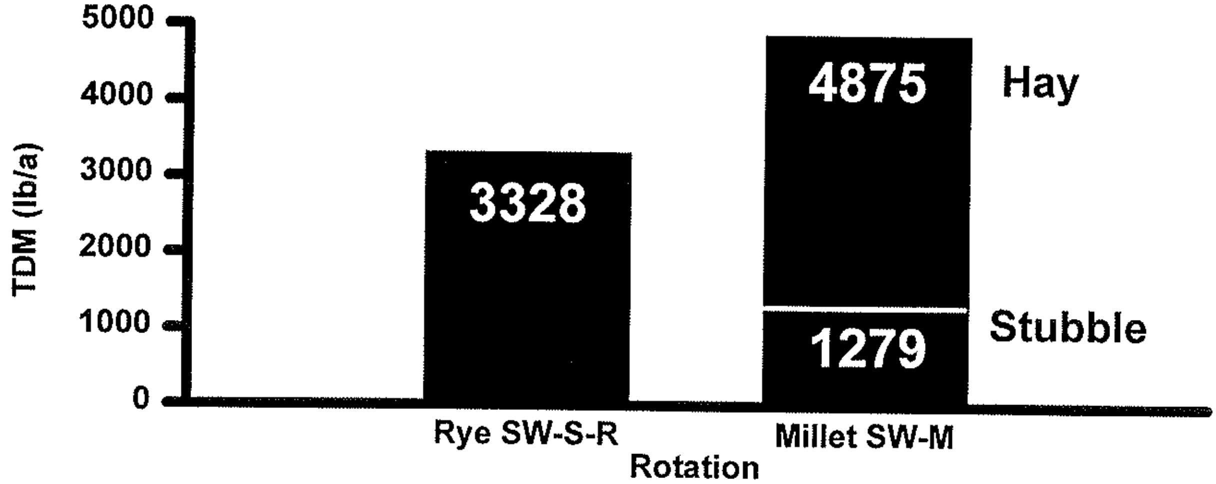
A long-term study was initiated in the spring of 1993 to evaluate the influences of residue management and crop rotations on soil quality. Tillage, crops, and crop residues were all in the appropriate places in 1994. Treatments for the 1995 crop included minimum- and no-till for the following crop rotations:

1. Continuous spring wheat (CSW+); straw chopped and spread
2. Continuous spring wheat (CSW-); stubble left in place, straw removed
3. Spring wheat - millet for hay (SW-M)
4. Spring wheat - safflower-fallow (SW-S-F)
5. Spring wheat - safflower-rye (partial fallow, cover crop) SW-S-R)
6. Spring wheat - fallow (SW-F)

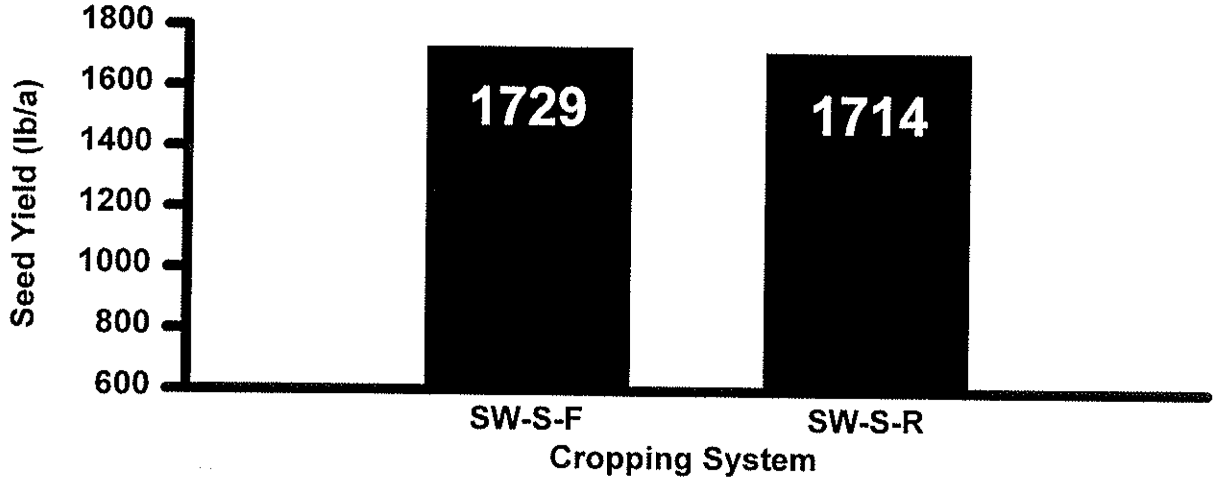
Spring wheat was seeded at 1.3 million viable seeds per acre on May 12, 1997. Safflower was seeded at 200,000 viable seeds per acre on May 13, 1997. Millet was seeded on June 6, 1996 at 4 million viable seeds per acre. Spring wheat, safflower, and millet were all seeded with a JD 750 no-till drill. Rye was seeded on September 30, 1996 at 1.3 million viable seeds per acre with a Haybuster 8000. Recrop plots received 60 lb N/a and 10 lb P/a at seeding while crops seeded after fallow or partial fallow received 30 lb N/a and 10 lb P/a at seeding. Growing season precipitation (May through August) was 4.67 inches compared to the long-term average of 9.9 inches.

Spring wheat grain yields ranged from 3068 to 2707 lb/a. Yield trends for 1997 were similar to 1996 where SW-S-F, SW-S-R, and SW-M systems produced the greatest yield. These systems produced grain yields that were greater than the SW-F system. The removal of straw from the CSW-system resulted in 200 lbs/a less spring wheat grain than the CSW+system. Safflower seed yields were over 1700 lb/a; the dry July and August along with a soil profile that was at field capacity helped to produce these yields. Rye produced 3328 lb/a of dry matter (growth terminated about June 20) for soil and water conservation while millet produced 4875 lb/a of hay and 1279 lb/a of residue for erosion control.

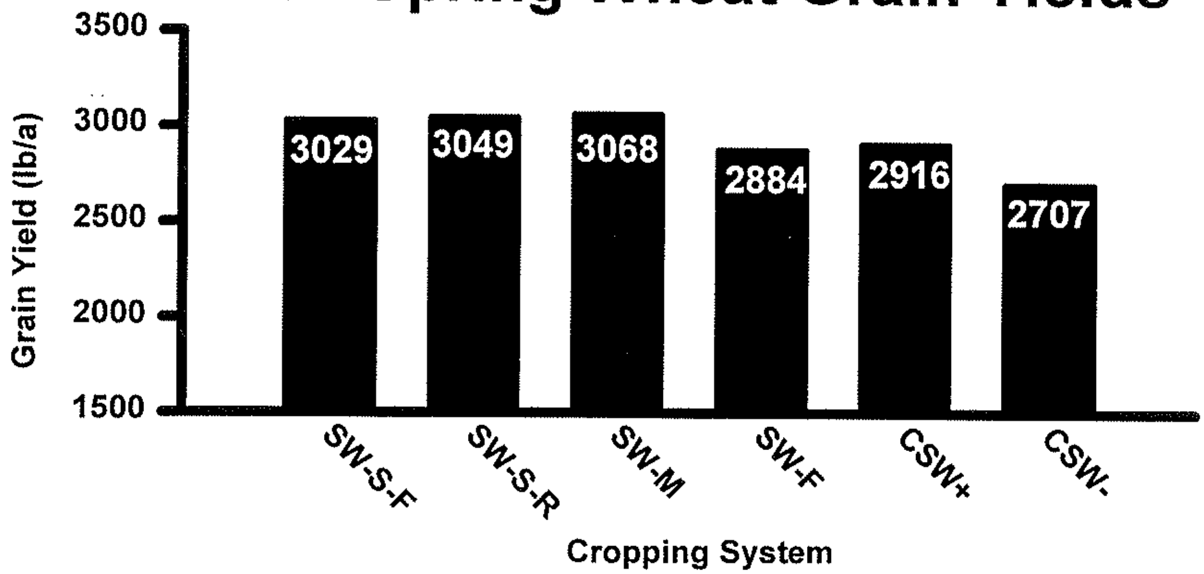
1997 Rye and Millet Total Dry Matter



1997 Safflower Seed Yield



1997 Spring Wheat Grain Yields



CHLOROPHYLL METER AS A N MANAGEMENT TOOL FOR MALTING BARLEY

Drs. Brian Wienhold and Al Frank

Field H3. A study was initiated in 1997 to develop a method for calculating fertilizer N needs of malting barley using a commercially available chlorophyll meter. The objective of the study is to determine if potential yield estimated by counting spikelets on the emerging head at an early growth stage and chlorophyll meter readings to estimate the N status of the seedling can be used to calculate topdress N rates for malting quality barley. First year results indicate that spikelet numbers may be useful in estimating potential yield and that chlorophyll meter readings correlate well with seedling tissue N amounts. A split application of N, at planting and a topdress application at the Haun 4 to 5 stage, appears to maximize yield and to influence grain protein content. The results suggest that a method can be developed that will result in more efficient fertilizer N management in malting barley.

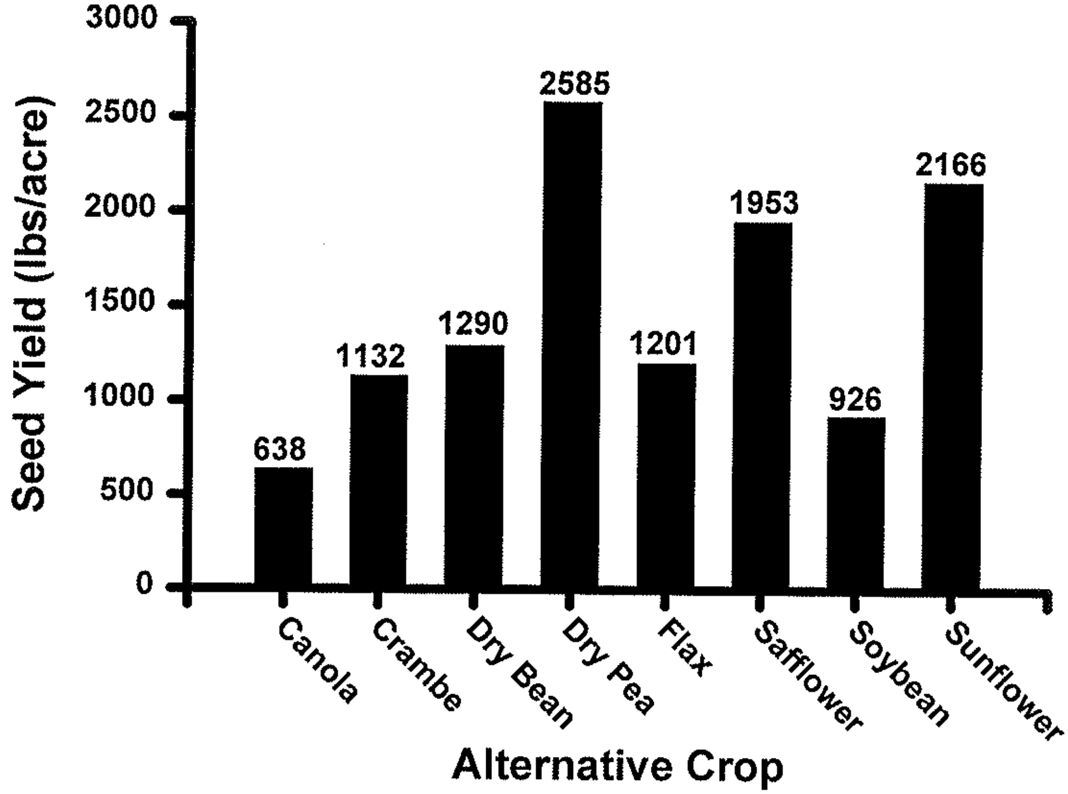
ALTERNATIVE CROPS FOR CROP ROTATIONS

Drs. Donald Tanaka and Steve Merrill

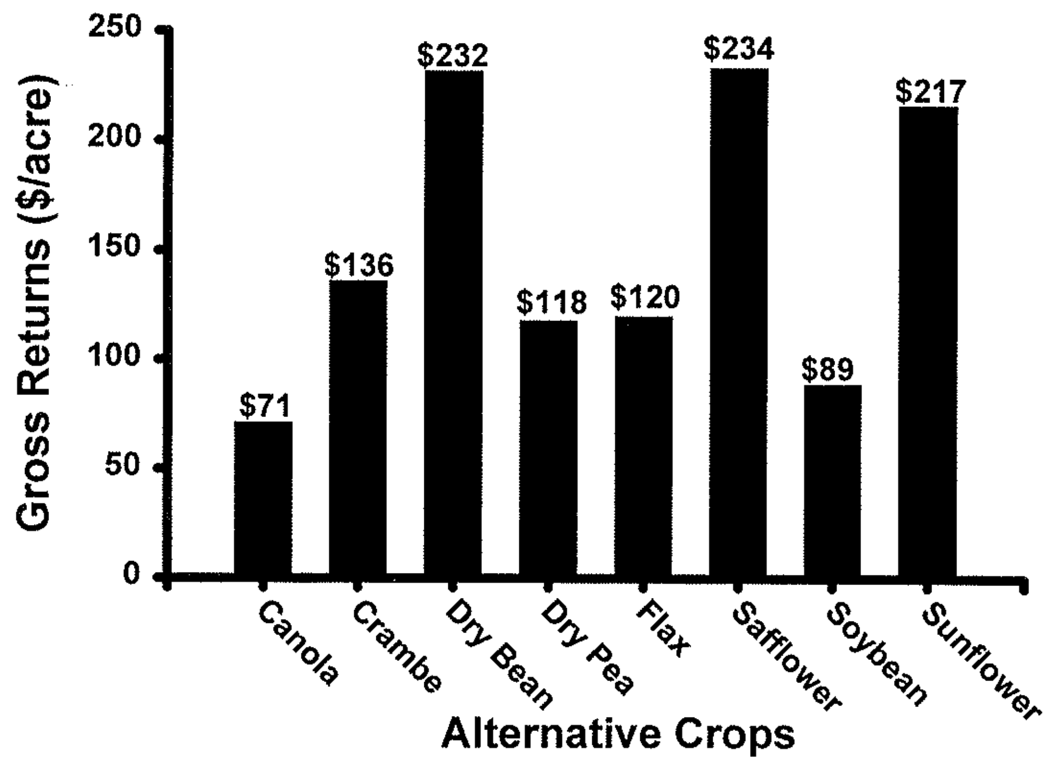
A study was initiated in 1995 to produce and harvest alternative crops using small grain equipment. Alternative crops in 1997 included canola, crambe, dry bean, dry pea, flax, safflower, soybean, and sunflower. All crops were seeded with a JD 750 no-till drill. Sonalan (1 lb ai/a) was applied and incorporated in a one-pass operation with an undercutter for weed control in all crops, except flax. Flax was no-till seeded and sprayed prior to emergence with Roundup (1 pt/a). Canola, crambe, dry pea, flax, and safflower were seeded on May 12, 1997. Sunflower, dry bean, and soybean were seeded on May 28, 1997.

Because of the dry May, canola and crambe crops did not establish well until after rain in mid-June. Crambe was then able to produce a reasonable yield (1132 lb/a) but canola continued to suffer because of the warm June. Of all the alternative crops in 1997, dry bean, safflower, and sunflower were the most surprising. These crops produced gross returns of at least $80/a more than any of the other alternative crops. Dry pea yielded well, but the price ($2.75/bu) was about half of the 1996 price. Therefore, pea gross returns were only $118/a. Producers may want to consider two or three alternative crops for rotations.

1997 Alternative Crop Yield



1997 Alternative Crop Gross Returns



ROW SPACING EFFECTS ON SUNFLOWER GRAIN YIELD IN A NO-TILL SYSTEM

Dr. Ardell Halvorson

Field H4. Narrowing the row spacing of sunflowers from the traditional 30 or 36 inch row spacings to less than 20 inches would allow producers to potentially utilize small grain drills for seeding sunflower. In addition, Dr. Tanaka demonstrated in 1995 that narrowing row spacing from 30 inches to 15 inches significantly reduced weed biomass in sunflower plots. Limited information is available on the effects of narrow row spacing on sunflower yields in minimum-till and no-till systems. Farmers, the National Sunflower Association, Sunflower Seed Companies, and Federal Crop Insurance have shown a great deal of interest in narrow row spacing sunflowers. Therefore, this study was initiated to evaluate the effects of row spacing (30, 15, and 7.5 inch) on sunflower yields and oil content, and to visually observe the effects of row spacing on weed competition within sunflowers.

In 1997, two sunflower cultivars (DeKalb 3790 and Pioneer 6150) were seeded in 7.5, 15, and 30 inch rows in a replicated study. The 7.5 inch rows were planted with a JD 750 no-till small grain disk drill at a population of about 28,000 seeds/a. The 15 and 30 inch rows were planted with a JD MaxEmerge II row crop planter at 28,000 seeds/a. The sunflowers were planted no-till into standing barley stubble on May 27, 1997. On May 30th, the field was sprayed with Roundup Ultra (6 oz ai). No other herbicides were applied because of drought conditions. The plots were aerial sprayed with Asana (3.25 oz material/a) on August 10, 1997. The plots were infected with sunflower midge which cause considerable damage to the Pioneer 6150 cultivar. N fertilizer was band applied as liquid UAN (28%) at a rate of 80 lb N/a at seeding in the 15 and 30 inch row spacings. N (80 lb N/a as urea) was banded between the rows in the 7.5 inch row spacing plots seeded with the JD 750 drill. Weeds were not a problem until late July because of drought during the early part of the growing season. A late flush of weeds develop as in previous years. The 30 inch row plots were heavily infested with weeds, with less weeds in the 15 inch row plots, and few weeds in the 7.5 inch row plots. This is consistent with observations made in 1995 and 1996. The sunflowers were harvested on October 10, 1997.

Sunflower grain yield, oil content, grain test weight, and harvest plant population are shown in Table 1. Grain yields were significantly different between sunflower cultivars. A contributing factor to the significantly lower yield of the Pioneer 6150 was the damage caused by the sunflower midge. When averaged over cultivars, row spacing did not have a significant affect on grain yield in 1997. The DeKalb 3790 did show trends of an 8% and 17% increase in yield with the 7.5 and 15 inch row spacings, respectively, when compared to the 30 inch row spacing. The 15 inch row spacing had significantly less plant population than the 7.5 and 30 inch row spacings in 1997. The reason for this difference in 1997 is not known.

In addition to the replicated study, these same sunflower cultivars were planted in 7.5, 15, and 30 inch rows in bulk field strip tests (see report for Field H4 East Bulk). The bulk field data shows that the sunflower yields from the 7.5 inch row spacing were less than those of the 15 and 30 inch row spacings. This may reflect variability in the field areas where each of the bulk row spacings were planted. For instance, the 30 inch row spacings were planted in a lower area closer to a lake, whereas, the 7.5 inch row spacings had a larger portion of the area farther up slope from the lake in a drier area. However, the weed observations made in 1997 were similar to those observed in 1996. The 7.5 inch row spacing strips were relatively weed free at harvest, whereas the 30 inch row spacing sunflowers had a considerable density of weeds. The 1996 and 1997 observations on weed growth in narrow row vs wide row spacing are similar to those of 1995. These three years of observations on weed growth suggests that planting sunflowers in narrow (7 to 8 inch row spacing) may be an effective management tool for reducing weed competition in minimum- and no-till sunflower fields.

Table 1. Sunflower grain yield (10% moisture), oil content, grain test weight, and harvest plant population as a function of row spacing and cultivar in 1997.

Cultivar	Row Spacing, inches	Yield, lb/a	Oil Content, %	Test Weight lb/bu	Harvest Population, plants/a
DeKalb 3790	7.5	2481	45.9	34.8	22,022
DeKalb 3790	15	2675	47.0	34.0	10,285
DeKalb 3790	30	2287	46.7	34.4	21,417
Pioneer 6150	7.5	1636	40.8	31.8	17,545
Pioneer 6150	15	1623	40.8	31.2	15,125
Pioneer 6150	30	1630	41.1	30.8	21780

Acknowledgment: Thanks to Jim Harms, Larry Renner, Marvin Hatzenbuhler, John Leppert, and Kari Kalvoda for their efforts in conducting this sunflower row spacing study and collection of field data.

ROW SPACING EFFECTS ON CORN GRAIN YIELD IN A NO-TILL SYSTEM

Dr. Ardell Halvorson

Field F6. Narrowing the row spacing of corn from the traditional 30 inch row spacing to less than 24 inches would allow producers to potentially utilize small grain drills for seeding corn. In addition, research has shown that narrowing row spacing from 30 inches to 15 inches significantly reduced weed biomass in the sunflower fields. Limited information is available on the effects of narrow row spacing on dryland corn yields in no-till systems in the Northern Great Plains. Farmers are showing a great deal of interest in narrow row spacing because of the potential to utilize small grain equipment for seeding rather than row crop planters. Therefore, this study was initiated to evaluate the effects of row spacing (30, 15, and 7.5 inch) on corn yields and to visually observe the effects of row spacing on weed competition within the corn.

Corn, P3893, (88 day corn) was planted in 7.5, 15, and 30 inch rows at a population of 16,000 seeds/acre in a replicated study on May 15, 1997. The 15 and 30 inch treatments were planted with a JD MaxEmerge II air planter equipped to plant both 15 and 30 inch rows. The 7.5 inch row spacing treatment was also planted with a JD MaxEmerge II planter by making a second pass and splitting the 15 inch rows. This worked only fair with considerable variation in distance between the 7.5 inch rows. We chose this option in an attempt to achieve uniform seeding rates between all row spacings. In 1996 we used a 750 no-till drill that had been calibrated in a stationary position, but we ended up with a higher seeding rate than with the MaxEmerge II planter. The corn was planted no-till into 1996 spring wheat stubble in field F5. Because of drought conditions, a preplant residual herbicide was not applied. The corn field was sprayed with Accent + Buctril (0.454 + 4 oz ai/a) on June 11, 1997. The plot area was not sprayed prior to planting or immediately after planting with Roundup because few weeds were visible. Fertilizer, 90 lb N/a as 28% liquid UAN was banded beside the row at planting. Mid- to late-season weed control was poor in 1997. The corn plots were harvested on October 19, 1997 with no need for grain drying due to the dry summer conditions.

Visual differences in weed competition would be for a slight reduction in weed competition in the 7.5 and 15 inch rows over that of the 30 inch rows. Table 1 reports the grain yield (15.5% moisture), test weight, and harvest plant population. The data show that narrowing the row spacing to 7.5 or 15 inches resulted in a significantly higher yield than with 30 inch row spacing. Grain test weights were excellent in 1997. Harvest plant populations were near the 16,000 plants/a goal for the 15 and 30 inch row spacing. However, the population in the harvested area of the 7.5 inch row spacing was higher than expected. The soil profile was at field capacity moisture content at planting to 5 ft. Although rain fall was minimal, it was timely which helped corn grain yields in 1997. The 1997 data support the 1996 observations of higher yields with the 7.5 and 15 inch row spacings than with 30 inch row spacing. The two year average grain yield (Table 1) was 117.4, 111.9, and 89.9 bu/a for the 7.5, 15, and 30 inch row spacings, respectively. These data indicate a need to continue looking at the use of narrow row spacing for dryland corn production in NT systems in the Northern Great Plains. The two year average corn yields are very encouraging for inclusion of corn in dryland rotations.

Table 1. Corn grain yield (15.5% moisture), grain test weight, and harvest plant population as a function of row spacing in 1997 and 1996.

Year	Row Spacing, inches	Grain Yield bu/a	Grain Test Weight, lb/bu	Harvest Population, plants/a
1997	7.5	93.3	54.8	21,054
1997	15	80.5	55.2	15,972
1997	30	76.9	55.3	15,004
1996	7.5	141.5	50.7	25,962
1996	15	143.0	51.3	16,587
1996	30	103.9	52.0	16,626
AVG	7.5	117.4	52.8	23,508
AVG	15	111.8	53.3	16,279
AVG	30	89.9	53.7	15,815

Acknowledgment: Thanks to Jim Harms, Larry Renner, Marvin Hatzenbuhler, John Leppert, and Kari Kalvoda for their efforts in conducting this corn row spacing study and collection of field data.

SPRING WHEAT IN CONSERVATION TILLAGE

Drs. Donald Tanaka and Joe Krupinsky

Spring wheat trials were initiated in 1979 and have continued with the cooperation of the Williston Research Center. Keene was the new variety for 1997. Varieties were seeded with a 7-foot Kirschmann drill in 6-inch rows on May 9, 1997 at a rate of 1.3 million viable seed per acre. Because of the dry conditions, emergence was very spotty. The field had been chemically fallowed the previous year and weed control prior to seeding was done with an undercutter at a 2-inch depth. Fifty pounds of N and 10 pounds of P were applied at seeding. Weeds in the crop were controlled using Buctril (16 oz/a). Potassium chloride (KC1), at the rate 200 1b/a of material, was applied to part of all four replicates before tillage.

Because of the dry May (0.28 inches compared to the long-term averages of 2.20 inches) the % plants per viable seed was quite low when compared to previous years (Table 1 and 2). Because of the poor plant stand, grain yields were usually the best where crop stands were the best.

Table 1. Spring wheat agronomic measurements when no potassium was applied in 1997 at Mandan, ND.											
Variety	Grain Yield (bu/a)	Protein[1] (%)	Test Wt. (lb/bu)	Straw Yield (lb/a)	Straw to Grain Ratio	Plants per sq. yd.	1000 Kernel Wt. (g)	Heads per yard[2]	Kernels per Head	Plant Height (inches)	Plants per viable seed (%)
Keene	48	15.1	61	3406	1.18	48	23.5	326	39	31	18
Grandin	46	15.9	59	3407	1.23	71	28.2	348	27	36	26
Butte 86	45	15.2	57	2939	1.10	84	27.6	346	26	28	31
Trenton	44	14.5	60	3156	1.19	65	28.4	303	29	31	24
Kulm	42	15.0	60	2982	1.19	70	25	309	30	30	26
Stoa	41	14.8	58	2937	1.21	57	23.8	288	33	30	21
2398	40	14.1	57	2695	1.12	76	26.4	301	29	25	28
2375	40	14.7	59	2611	1.18	62	29.1	270	28	27	23
Teal	38	15.7	58	2637	1.18	91	26	309	27	30	34
Vance	37	15.0	56	2938	1.31	49	24.8	265	32	28	18
Coteau	34	15.4	58	3176	1.51	59	23.7	265	31	32	22
Ernst	33	15.7	58	3166	1.80	41	22.1	284	29	31	15
Prospect	31	14.5	57	2504	1.37	53	23.1	217	35	28	20
Len	30	15.7	59	2807	1.60	46	22.1	305	25	27	17
Amidon	27	15.1	54	3182	2.06	31	21.2	272	26	33	12
$LSD_{0.05}$	8	0.4	3	680	0.42	30	3	69	7	--	--

[1]Protein analysis courtesy of Heartland, Inc., Bismarck, ND.

Table 2. Spring wheat agronomic measurements when potassium was applied in 1997 at Mandan, ND.											
Variety	Grain Yield (bu/a)	Protein[1] (%)	Test Wt. (lb/bu)	Straw Yield (lb/a)	Straw to Grain Ratio	Plants per sq. yd.	1000 Kernel Wt. (g)	Heads per yard[2]	Kernels per Head	Plant Height (inches)	Plants per viable seed (%)
Grandin	54	15.5	60	3692	1.12	87	29.8	369	23	27	32
Stoa	54	14.6	58	3633	1.17	69	24.7	324	31	29	26
Butte86	55	14.8	58	3073	0.99	75	28.7	351	24	28	28
Teal	54	16.1	57	3368	1.10	82	26.7	352	25	28	31
Trenton	52	14.3	60	3458	1.12	56	28.3	310	27	30	21
Amidon	51	14.5	59	3805	1.27	45	24.9	333	28	32	17
2375	51	14.9	59	2612	0.87	90	28.7	289	28	25	34
Len	50	15.4	58	3252	1.19	53	25.3	308	29	27	20
Keene	50	15.1	60	3774	1.32	76	24.8	376	24	30	28
Ernest	50	14.7	60	3617	1.22	67	26.8	293	29	30	25
Vance	50	15.1	57	3358	1.19	63	25.4	277	31	27	23
2398	47	13.9	58	2940	1.08	49	27.2	311	25	24	18
Coteau	46	15.2	59	3378	1.26	81	25.6	277	30	31	30
Kulm	40	15.0	58	2835	1.31	48	24.3	293	26	28	18
Prospect	30	14.4	57	2118	1.27	36	25.2	169	30	27	13
$LSD_{0.05}$	14	0.5	3.1	840	0.32	26	2.50	64.3	5.3	--	--

[1]Protein analysis courtesy of Heartland, Inc., Bismarck, ND.

CULTURAL SYSTEMS FOR SUNFLOWER

Drs. Donald Tanaka and Randy Anderson (USDA-ARS, Akron, CO)

Cultural systems were designed and a study was conducted in 1997 to compare conventional sunflower production in minimum-till (1 MT) and no-till (1 NT) with cultural systems that incorporate reduced row spacing and herbicide use with seeding date and increased plant population (Table 1). All seeding was done with a JD 750 no-till drill. The sunflower variety was Cenex 803.

Weed biomass at the sunflower flower plant development stage was reduced by 50% in all treatments, except 3 NT. No explanation can be given as to why weed biomass in treatment 3 NT was almost the same as the conventional no-till treatment (1 NT). The 480 lb/a of weed biomass did not affect seed yield since all cultural systems produced seed yields (Table 2) that were equal to or greater than the minimum- and no-till conventional systems (1 MT and 1 NT). The interaction of seeding date, narrow rows, and increased plant population has a positive effect on sunflower weed control.

Table 1. Treatment descriptions for sunflower at Mandan, ND in 1997.

Treatment Code	Residue Management	Seeding Date	Row Spacing (inches)	Herbicide and Rate (lb ai/a)	Population Target (plants/a)
1 NT	No-till (NT)	May 28	30	Prowl (1.5)	25,000
1 MT	Minimum-till (MT)	May 28	30	Sonalan (1.0)	25,000
2 NT	No-till (NT)	May 28	15	Prowl (1.5)	30,000
2 MT	Minimum-till (MT)	May 28	15	Sonalan (1.0)	30,000
3 NT	No-till (NT)	June 12	15	Prowl (0.75)	30,000
3 MT	Minimum-till (MT)	June 12	15	Sonalan (0.50)	30,000
4 NT	No-till (NT)	June 12	15	none	30,000
4 MT	Minimum-till (MT)	June 12	15	none	30,000

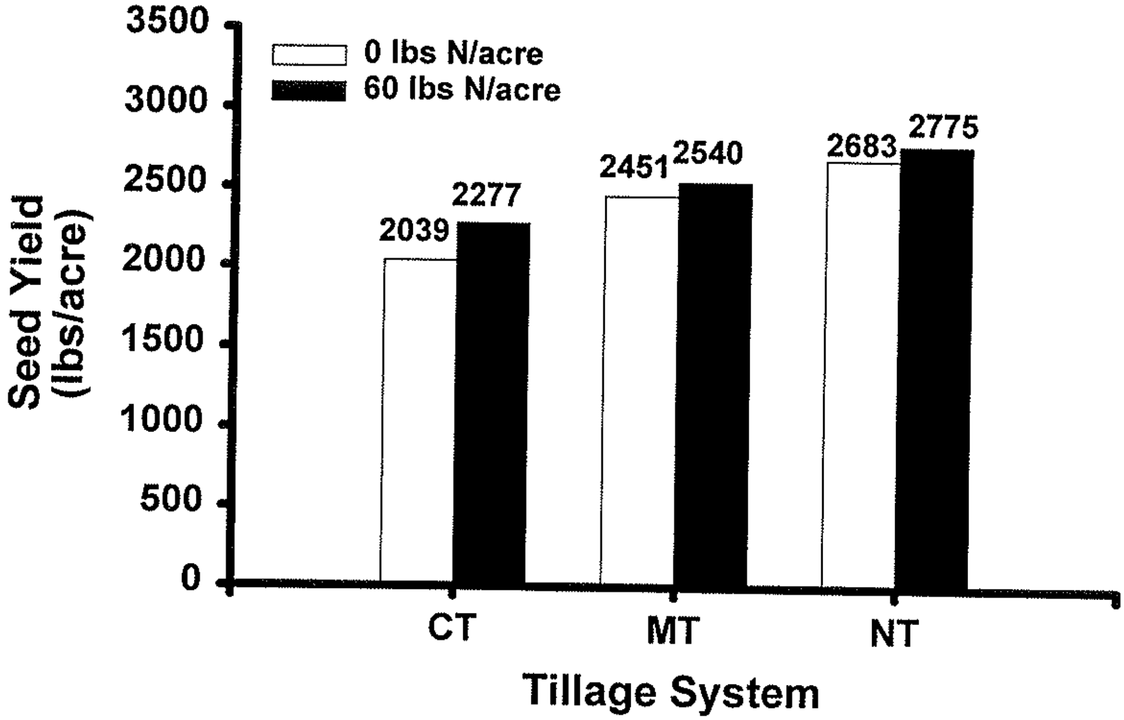
Table 2. Sunflower treatment parameters as influenced by cultural systems at Mandan, ND.		
Treatment	Sunflower Seed Yield	Weed Biomass
	lb/a	lb/a
1 NT	1860	600
1 MT	1830	990
2 NT	2080	140
2 MT	2440	50
3 NT	2160	480
3 MT	1900	250
4 NT	1810	140
4 MT	1890	130

CONVERSION OF CRP TO CROP PRODUCTION

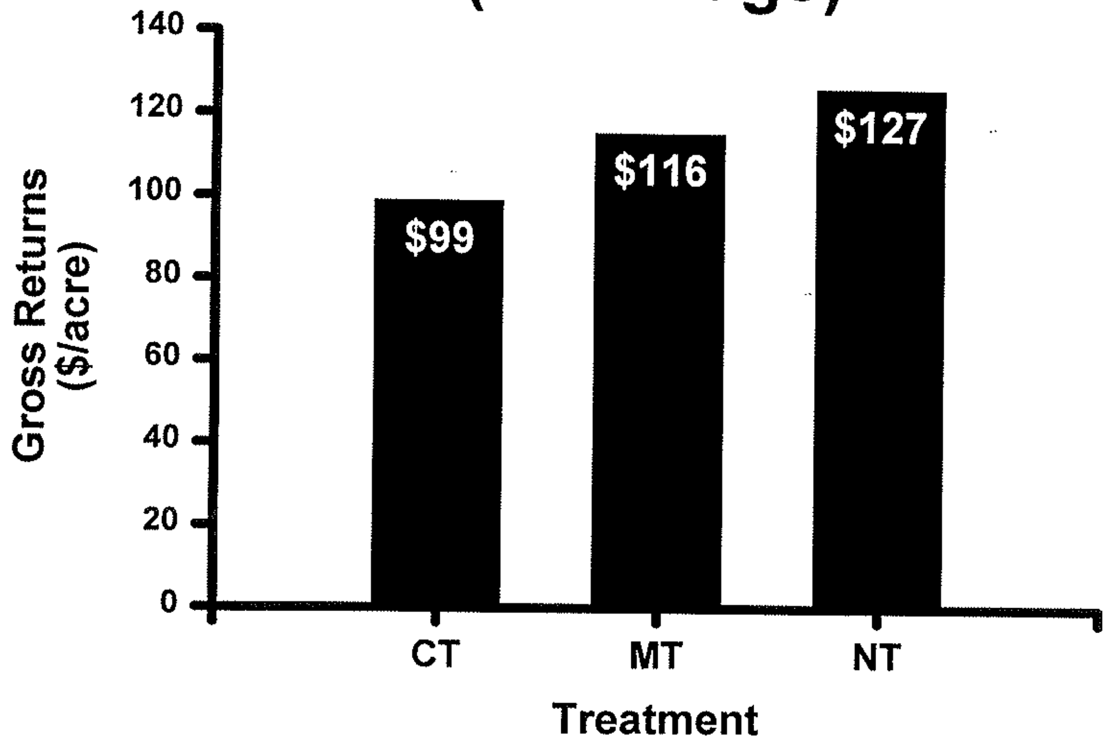
Drs. Donald Tanaka and Steve Merrill

In October 1994, a cooperative study was initiated to determine techniques for conversion of CRP land to crop production. Cooperators included NRCS, Consolidated Farm Service Agency, and the farm cooperators, Mr. Keith Boehm and Lyle Boehm. Treatments were: 1) hayed or nonhayed prior to tillage or spray operations; 2) residue management, conventional-till (<30% surface cover), minimum-till (30-60% surface cover) and no-till (>60% surface cover); and 3) nitrogen fertilizer, 0 and 60 lb N/a. Reference treatments included permanent hay and cover. Plots were hayed on October 11, 1994 and tillage and spray operations were done on October 14, 1994. In 1997, the third year of the 3-year rotation, dry pea was seeded on May 9, 1997 at 350,000 viable seed per acre. Post emergence weed control on all treatments was pursuit (0.7 oz/a material) plus poast (1pt/a material) applied on June 13, 1997. Pea were harvested on August 4, 1997. No treatment differences in pea yield occurred for hay or nonhay prior to tillage or application of N. Seed yield ranged from about 36 bu/a for convention-till (CT) to 46 bu/a for no-till (NT). The long-term influences of CRP were preserved better with no-till and resulted in a better pea environment.

1997 CRP Dry Pea Yields



1997 CRP Dry Pea Gross Returns (N average)



WEEDS IN SPRING WHEAT GROWN AFTER ANNUAL FORAGE CROPS

Drs. Ron Ries, Donald Tanaka, and Ardell Halvorson

There is a need to develop new theories, knowledge, and techniques for weed management in crop and forage systems. Weeds in crops and forages can cause decreased production and a lessening of crop and forage quality. Research is needed to evaluate the importance of inserting annual forage crops into spring wheat and sunflower crop rotations for farm/ranch income and better options for efficient weed control.

Areas of spring wheat stubble produced during the 1995 growing season was minimum till seeded to lentil 'CDC Richly', sudan grass 'Piper', millet 'Siberian', annual alfalfa 'Sava Snail', oat/pea, leafless pea 'Profi', vine pea 'Arvia', and spring wheat 'Amidon'. Also included was a chemical fallow treatment. The annual alfalfa stand failed and this plot area was then conventionally fallowed. Lentils, sudan grass, millet, annual alfalfa, and spring wheat were also minimum till seeded into sunflower stubble. A chemical fallow area was also included. All annual forage crops and the spring wheat were managed using the best practices for each of the crops and harvested as hay and grain in 1996.

In 1997, both areas were seeded to spring wheat 'Amidon' and fertilized with 60 lb/a N and 20 lb/a P_2O_5 on May 13th. Wheat emerged on May 21st. The plots were sprayed with buctril/tiller on May 23rd. The 1996 crop plots, harvested as grain or hay, and fallow plots were sampled individually for weeds present before seeding (5/12/97) and at three weeks after wheat emergence (6/13/97). Each 1996 plot was sampled for wheat yield at harvest 8/7-11/97.

Tables 1-4 present weed and wheat harvest data from the 1997 growing season. Broadleaf weeds were more abundant before seeding than grassy weeds. A comparison of weed densities before seeding and 3 weeks after wheat emergence gives some idea of the success of our herbicide treatment. This treatment was more effective on broadleaf weeds than the grassy weeds. The density of grassy weeds was more variable when related to past crop than broadleaf weed densities. The primary broadleaf weeds observed were fairy candlelabra, horseweed, and flixweed, with horseweed and flixweed being the most competitive. The major grassy weeds observed were the foxtails. The wheat stand densities were higher at 3 weeks after emergence on the original sunflower stubble. Wheat densities were lowest after lentil production regardless of original wheat or sunflower stubble. Wheat production in 1997 was highest on chemical and conventional fallow areas. However, several prior year cropped plots, such as grain vine pea and hay millet, had wheat yields similar to the fallow plots on original wheat stubble.

Table 1. Weed and wheat data from 1997 growing season from annual forage crop plots harvested for grain in 1996.						
	WHEAT STUBBLE					
	before seeding		3 weeks after wheat emergence			
	Broadleaf weeds	Grassy weeds	Wheat	Broadleaf weeds	Grassy weeds	Wheat Yield
	---------------------plants/a (in 1000s)---------------------					bu/a
Chemical Fallow	1298.1	0.0	932.2	8.7	0.0	59.4
Conv. Fallow	82.8	248.3	840.7	0.0	47.9	56.0
Spring Wheat	527.1	61.0	788.4	39.2	13.1	45.9
Lentil	2831.4	4.4	535.8	409.5	0.0	28.3
Millet	509.7	126.3	879.9	8.7	52.3	52.2
Oat/Pea	805.9	300.6	997.5	108.9	69.7	40.5
Leafless Pea	357.2	1019.3	1298.1	8.7	261.4	46.9
Sudan Grass	313.6	8.7	1010.6	8.7	26.1	42.1
Vine Pea	248.3	65.3	906.0	0.0	379.0	51.8

Table 2. Weed and wheat data from 1997 growing season from annual forage crop plots harvested for grain in 1996.						
	SUNFLOWER STUBBLE					
	before seeding		3 weeks after wheat emergence			
	Broadleaf weeds	Grassy weeds	Wheat	Broadleaf weeds	Grassy weeds	Wheat Yield
	---------------------plants/a (in 1000s)---------------------					bu/a
Chemical Fallow	1468.0	4.4	1180.5	8.7	0.0	43.5
Spring Wheat	670.8	100.2	1097.7	13.1	0.0	35.9
Annual Alfalfa	797.1	178.6	1280.7	30.5	13.1	35.4
Lentil	1036.7	30.5	1010.6	30.5	4.4	35.0
Millet	605.5	257.0	1128.2	56.6	4.4	35.6
Sudan Grass	348.5	82.8	771.0	26.1	13.1	35.6

Table 3. Weed and wheat data from 1997 growing season from annual forage crop plots harvested as hay in 1996.

	WHEAT STUBBLE					
	before seeding		3 weeks after wheat emergence			
	Broadleaf weeds	Grassy weeds	Wheat	Broadleaf weeds	Grassy weeds	Wheat Yield
	---------------------plants/a (in 1000s)---------------------					bu/a
Chemical Fallow	1298.1	0.0	932.2	8.7	0.0	59.4
Conv. Fallow	82.8	248.7	840.7	0.0	47.9	56.0
Spring Wheat	527.1	61.0	788.4	39.2	13.1	45.9
Lentil	1694.5	13.1	400.8	470.2	4.4	27.9
Millet	500.9	8.7	958.3	43.6	169.9	56.5
Oat/Pea	1820.8	74.1	832.0	243.9	43.6	31.5
Leafless Pea	287.5	161.2	954.0	13.1	426.9	50.8
Sudan Grass	217.8	47.9	1123.8	13.1	252.6	51.7
Vine Pea	657.8	113.3	975.7	13.1	422.5	50.4

Table 4. Weed and wheat data from 1997 growing season from annual forage crop plots harvested as hay in 1996.

	SUNFLOWER STUBBLE					
	before seeding		3 weeks after wheat emergence			
	Broadleaf weeds	Grassy weeds	Wheat	Broadleaf weeds	Grassy weeds	Wheat Yield
	---------------------plants/a (in 1000s)---------------------					bu/a
Chemical Fallow	1468.0	4.4	1180.5	8.7	0.0	43.5
Spring Wheat	670.8	100.2	1097.7	13.1	0.0	35.9
Annual Alfalfa	736.2	139.4	1089.0	0.0	130.7	38.2
Lentil	1319.9	17.4	644.7	13.1	0.0	32.9
Millet	274.4	43.6	1150.0	8.7	4.4	41.1
Sudan Grass	291.9	100.2	1071.6	21.8	65.3	32.5

FORAGE GRASS BREEDING AND GENETICS

Drs. John Berdahl and John Hendrickson

Field G1. Reliant intermediate wheatgrass has had higher long-term forage yields than Manska at all test sites where yields have been measured 4 or more years after seeding. In regional tests at 5 sites in North Dakota and the Prairie Provinces of Canada, relative dry matter yields of hay beginning with the fourth year after seeding were 100, 96, 87, and 82%, respectively, for the intermediate wheatgrass cultivars Reliant, Chief, Manska, and Greenleaf. We believe that the high sustained productivity of Reliant can be attributed to improved resistance to root-rot diseases. Reliant was developed primarily for use in mixtures with alfalfa for hay. The upright growth habit, slow rhizomatous spread, and relatively late maturity of Reliant are traits that suit the cultivar for mixtures with alfalfa in areas such as the western two-thirds of North Dakota where lower precipitation often eliminates opportunities for multiple cuttings. Its long-term persistence would be an important consideration for both hay production and as a major component in mixtures for CRP. Intermediate wheatgrass becomes dormant under hot, dry conditions, and Reliant as well as other cultivars of intermediate wheatgrass are not recommended for areas that average less than 14 inches of annual precipitation.

SITE-SPECIFIC MANAGEMENT UPDATE

Dr. Dave Franzen, Ext. Soils Specialist, NDSU
Vern Hofman, Ext. Ag. Engineer, NDSU
Dr. Joe Krupinsky, USDA-ARS
Dr. Ardell Halvorson, USDA-ARS, Ft. Collins, CO

Site-specific farming is a management practice that allows farming fields as zones within a field as compared to the conventional method of farming fields uniformly. Site-specific farming suggests that plant nutrient levels may be better utilized if fields are sampled and fertilizer applied in manner to take advantage of differences within a field. The success of site-specific farming depends on the level of variability within a field and the economic and environmental benefits of determination and managing the variability.

This project began during 1995 as a cooperative effort between USDA-ARS, the Area IV Soil Conservation Districts, Case-Concord and NDSU Extension Service. In 1995 a yield monitor was installed on the combine at the Mandan station. Yield data was collected from I4, I5 and I6, which was only marginal in accuracy. This was due to inexperience with using a yield monitor and changes in the calibration factor while harvesting. Also, some of the components of the monitor did not perform correctly and were replaced. After harvest, soil samples were collected and tested. Spring wheat and sunflower were planted in the spring of 1996 with the application of fertilizer based on three methods. These included conventional, variable application based on grid soil sampling and variable application based on topographic soil sampling. In the fall, yield monitoring was again completed. An economic analysis was completed to determine the return from variable-rate fertilizer application as compared to conventional practices. Returns show that variable application was positive in the range of \$6.50 - \$10.50 per acre for sunflower. The return for variable application for fertilizer application on wheat show a negative value ranging from about \$4.50 to \$11.50 per acre as compared to conventional fertilizer application. This analysis is based on wheat profitability that was compounded by hail damage. The sunflower crop also received hail but was early enough in the season to not be affected as much. After harvest, soil samples were taken and analyzed.

Winter wheat was planted in the fall of 1996 with variable fertilizer applied similar to the crop planted in the spring of 1996 on field I5 with the Concord seeder. Spring wheat was planted with the air seeder with variable fertilizer application on field I4 similar to the winter wheat. Sunflower was planted on field I6 as shown in the adjoining 1997 field map. The crop was harvested and the 1997 yield maps for all three I fields is shown on the next page. Wheat yields varied from near 5 bu/acre to over 55 bu/acre with an average for the winter wheat of 28 bu/acre and the average for spring wheat of 37 bu/acre. The sunflower yield on I6 varied from about 500 lb/acre to over 2750 lb/acre with an average of 1954 lbs/acre.

Below the yield maps is a 3 dimensional map of the topography for the 3 I fields in the study. The map is included as crop yield and soil fertility often correlates with topography.

This study is collecting considerable information and experience is being accumulated on variable fertilizer application and yield monitoring so a reliable economic analysis can be made.

Changes in soil test levels with time and cropping

The three fields of study were sampled for the third year in 1997. In each year, samples were taken from the east field in a 110 foot grid. The center and west fields were sampled in a 150 foot grid. Samples consisted of 5-8 soil cores, 0-6 inch and 6-24 inch in depth. Phosphate was analyzed on the 0-6 inch depth, while nitrate-N and chloride were analyzed on both depths and reported as a 0-2 foot depth.

In 1995, the center field, which had been sunflower in 1995, tested low in nitrate-N except for an area in which the sunflower died out due to high water. The center field was fertilized to the same level of the east field in 1996 and both fields were in spring wheat in 1996. The 1996 sampling showed that the center field contained about 20 lb N/acre more than expected based on similar yields for the center and east fields. The west field was in sunflower in 1996 and showed low levels of ending nitrate-N that fall.

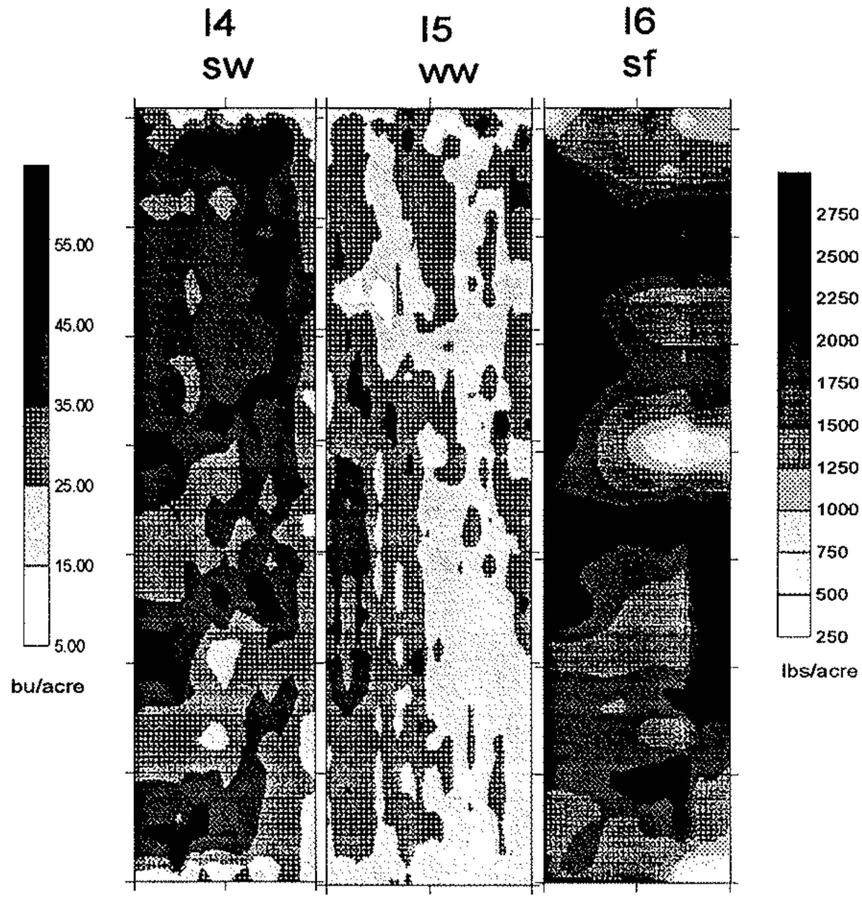
In 1997, the east field was in sunflower and tested low in N. The center field continued to test higher in N than the west field. The center field was in winter wheat and the west field was in spring wheat.

In 1995, chloride levels were variable, with a relationship to topography. In 1996, the field decreased in chloride levels generally, especially the center field. In the fall of 1996 prior to winter wheat, an application of chloride was made to the field. The 1997 chloride levels show the results of chloride fertilization. The east field, which was in sunflower in 1997 showed lower levels of chloride than in 1996, while the west field showed similar levels to those in 1996. The comparison of years suggests that in wet years such as 1995 and 1996, chloride levels may tend to decrease, while applications of chloride during a dry season such as 1997 stay in the soil. Sunflower may also accumulate chloride in the plant tops, making soil levels appear lower than they actually are.

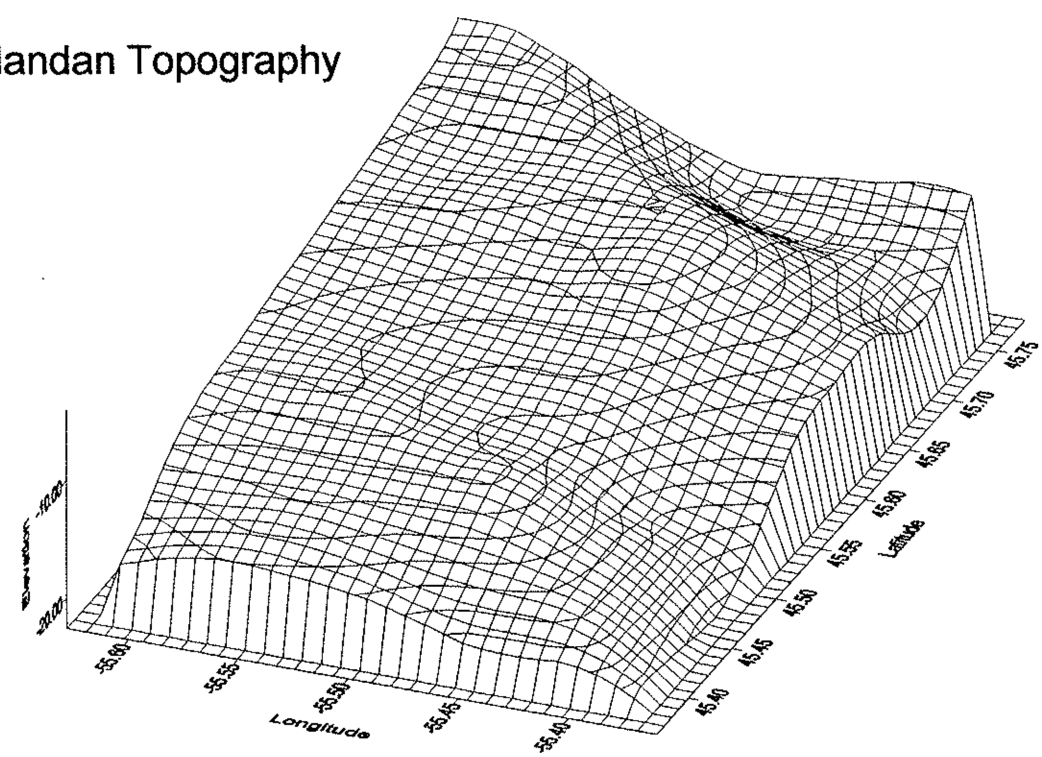
Phosphate levels were not influenced greatly by cropping. Unlike nitrate-N, P levels remained in similar patterns regardless if the crop was wheat or sunflower. The high P areas revealed in 1995 were high in 1996 and 1997, while the low areas tended to be low in each year. The values of P changed and tended to build throughout the three year period due to P treatments applied each year of the study. The treatments were based on sampling by a uniform application rate through an average soil test value, topography directed sampling and sampling from a 4.5 acre grid. Treatments were applied randomly during 1995 and 1996 to each field.

The effect of cropping is interesting because nutrient levels remain related to topography. Cropping is important because if nitrate-N is being accumulated in sunflower and release into subsequent crops at levels higher than after wheat, a previous crop credit system should be established for sunflower. Work in sugarbeet and potatoes in eastern North Dakota suggest that other broadleaf crops besides legumes may have this property.

1997 Mandan I fields

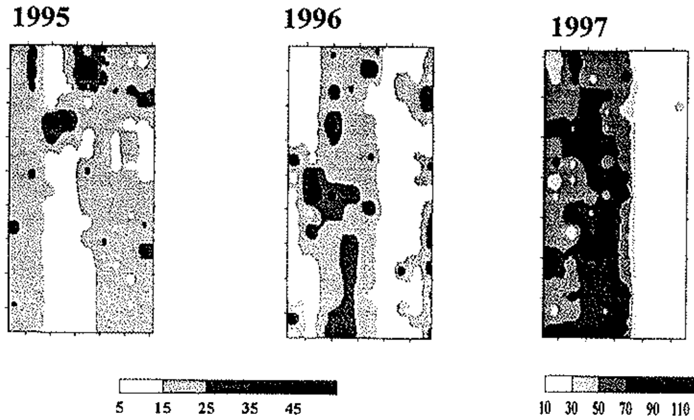


Mandan Topography



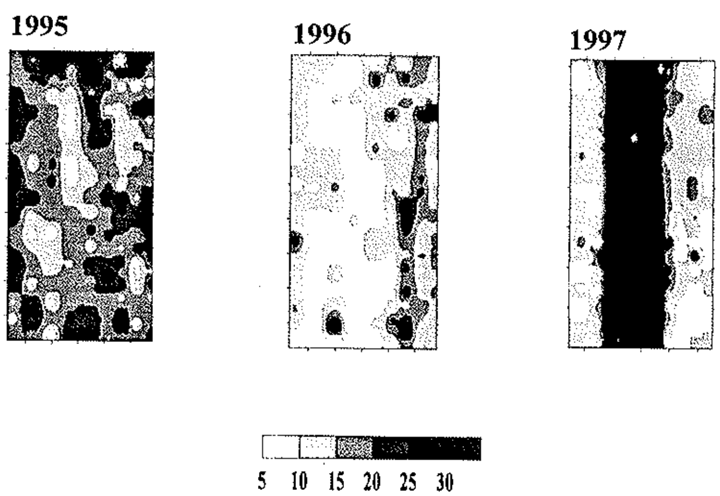
Changes in NO_3-N, chloride and P from 1995-1997.

NO_3-N levels



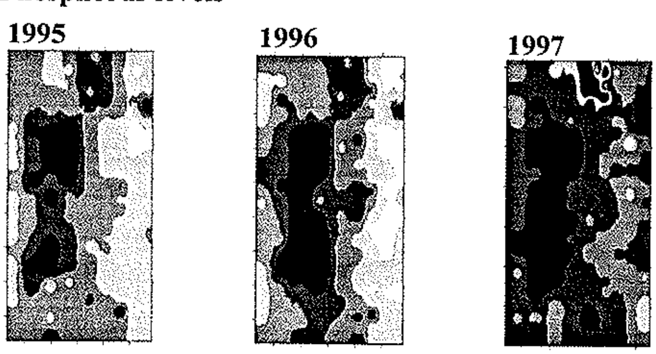
NO_3-N, lb/acre 2 feet

Chloride levels



Chloride, lb/acre 2 feet

Phosphorus levels



P, ppm