1996 Research and Cropping Results

Thirteenth Annual Progress Report

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NOTICE

Contents relate to a Cooperative Agreement between USDA-ARS and Area IV Soil Conservation Districts represented by the Area IV SCD Research Advisory Committee. The preliminary results of this report cannot be used for publication or reproduction without permission of the research scientists involved.

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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 by 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 1996 cropping plans for the four field areas designated as F, G, H, and I. Figure 3 shows the precipitation for the growing season and total precipitation history for the duration of the Area IV project (1984-1996).

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 spring wheat in 1995 that was 100% destroyed by hail on July 20, 1995. On September 20, 1995 the field was sprayed with Roundup RT at 9 oz ai/a. Roughrider winter wheat was planted on September 21, 1995 with JD 750 drill with 7.5" row spacing at a seeding rate of about 1-million viable seeds/a. Starter fertilizer, 50 lb of 11-52-0, was applied with the seed and 20 lb N/a was also applied at seeding between the rows. On April 24, 1996, 50 lb N/a as urea was broadcast on the soil surface by Cenex. The field was sprayed with Buctril plus Tiller (4 oz + 5.4 oz ai/a) on May 28, 1996. The field was swathed on August 2, 1996 and combined on August 9, 1996. The winter wheat yielded 44.5 bu/a with a protein content of 12.1%. Field F2 was sprayed with Roundup Ultra after harvest on August 22, 1996 to control weeds.

Field F3. The previous crop was winter wheat that yielded about 21.2 bu/a after being hailed out on July 20, 1995. The winter wheat was swathed as close to the ground as possible in 1995 to salvage as much of the hailed winter wheat as possible. Therefore, standing stubble height was only about 2-3 inches. The field was sprayed after winter wheat harvest on September 20, 1995 with Roundup (8 oz ai/a) to control weeds and volunteer grain. On April 24, 1996, 80 lb N/a as urea was broadcast on the soil surface by Cenex. Sonalan granules (1 lb ai/a) was applied with a Gandy applicator mounted on a Haybuster undercutter on May 24, 1996. A second incorporation with the undercutter was performed on May 29, 1996. Sunflower (Cargill 270) was seeded on

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

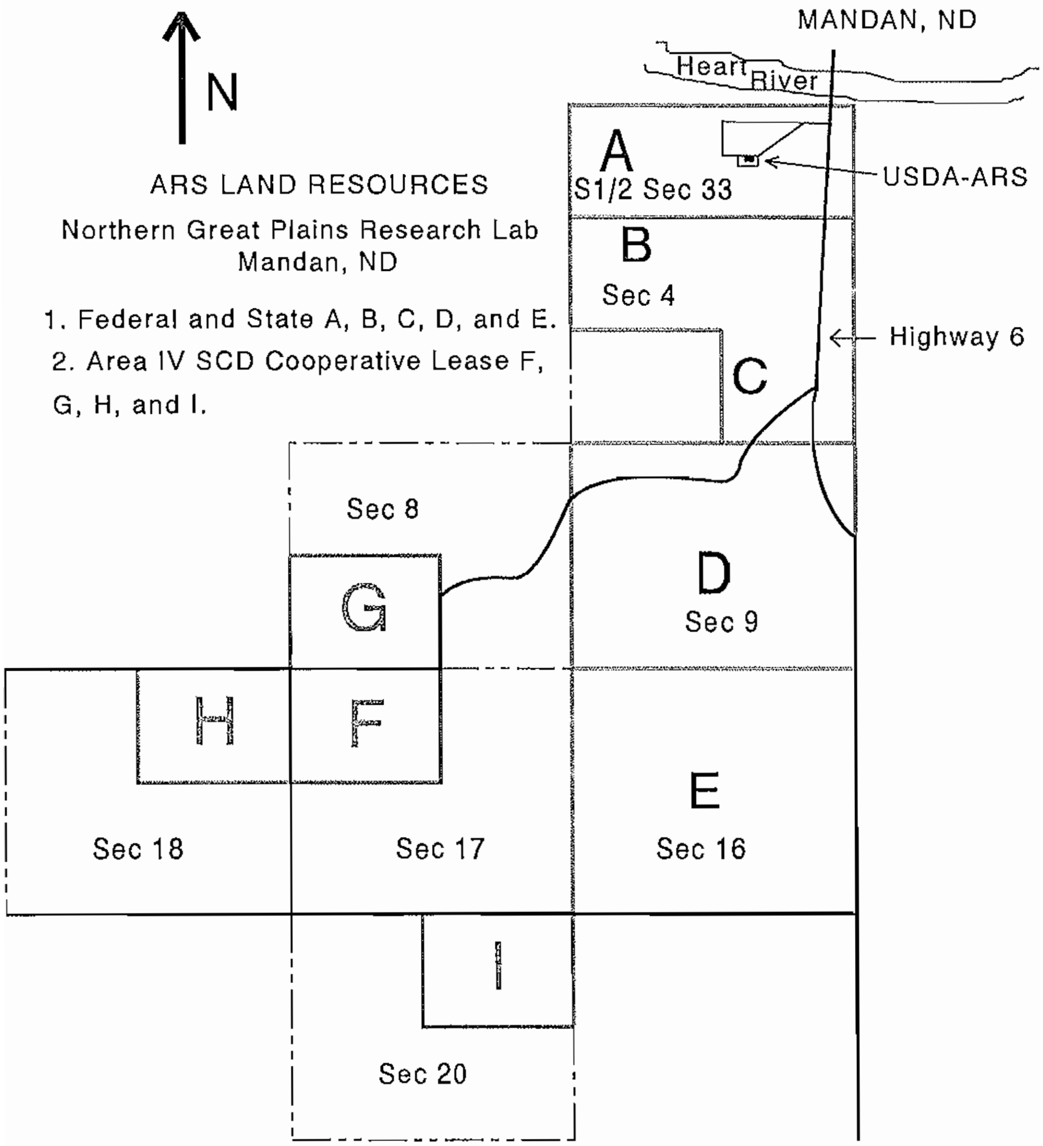
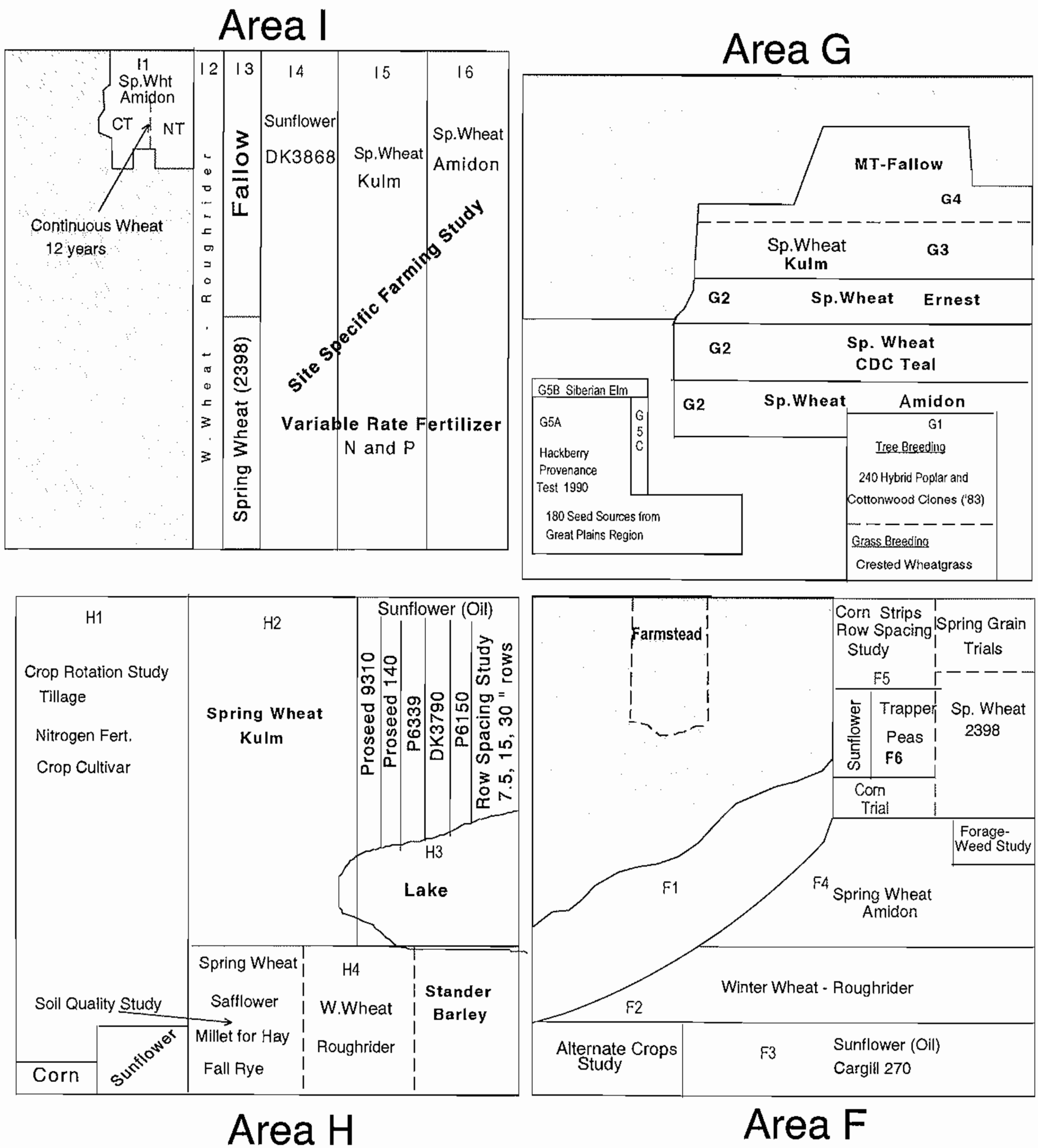
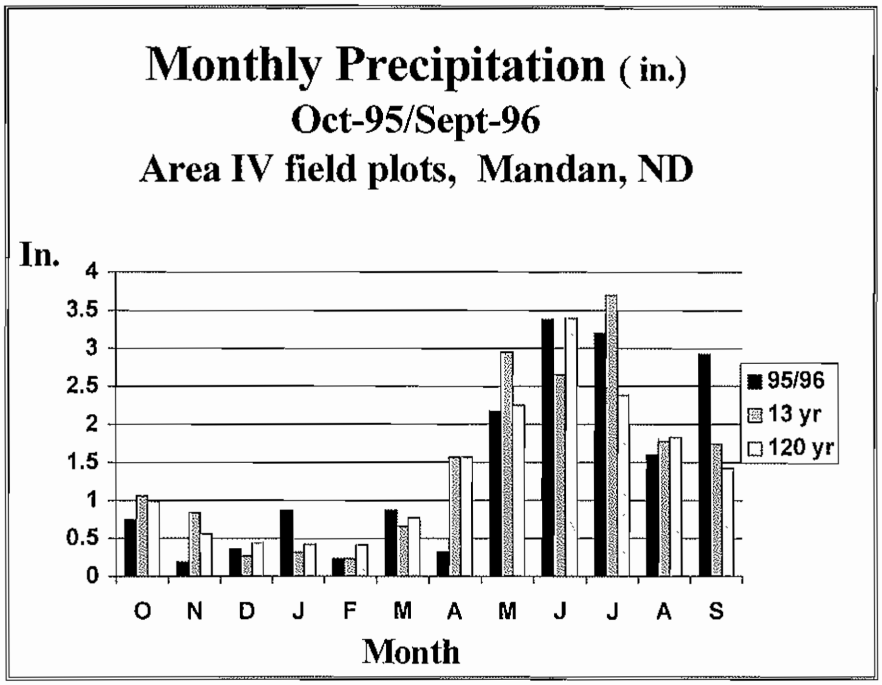


Figure 2. Area IV Research Farm Crop Plan - 1996.





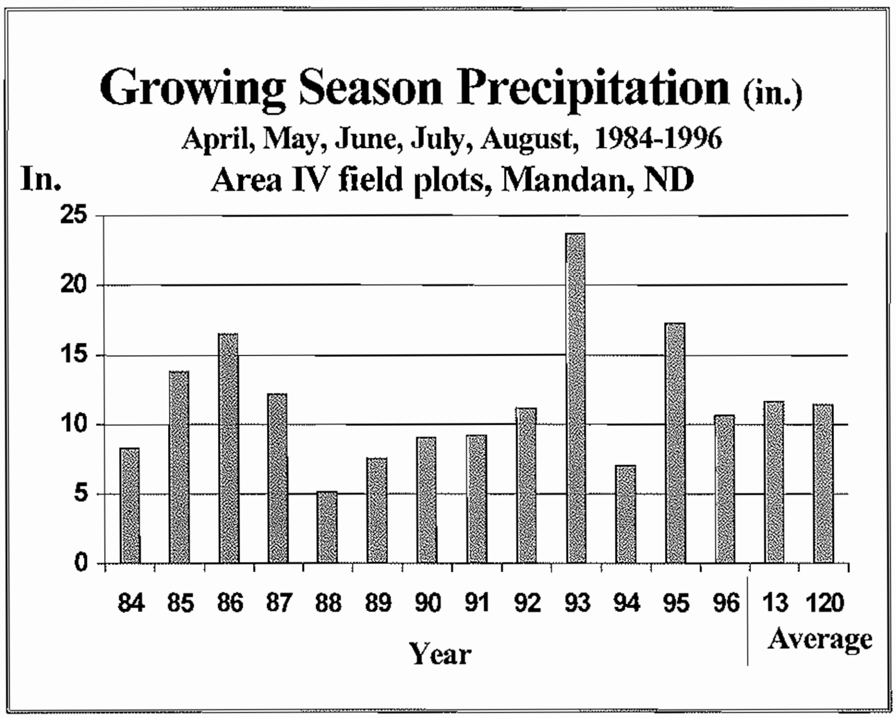


Figure 3. Monthly precipitation during the 1995-96 crop year and growing season precipitation at the Area IV SCD-ARS Research Farm.

May 29, 1996 at a seeding rate of 25,000 seeds/a with a new JD Model 7340 narrow-row MaxEmerge II Integral vacuum air drill in 30 inch rows. Wild mustard was a serious weed problem in this sunflower field in 1996. We were unable to spray the mustard because the sunflower were too small tolerate an early spraying and the mustard was to large when the sunflower was advanced enough to spray. There were about 3 flushes of wild mustard in the sunflower during the 1996 growing season. The mustard combined with little snow trapping ability overwinter due to short stubble height probably limited the available water supply to the sunflower crop. We contract aerial sprayed for insect control with Asana XL (3.25 oz material/a) on July 30th, 1996 at a cost of $8.58/a. The sunflower crop was harvested on October 10, 1996 and yielded 1209 lb/a with an oil content of 47.3%. No after harvest operations were performed on this field in the fall of 1996.

Field F4. The previous crop was sunflower which yielded 1531 lb/a. The sunflower stubble (15-24 inches high) was left standing over winter to augment snow trapping and soil water storage. On April 24, 1996, 80 lb N/a as urea was broadcast on the soil surface by Cenex. Amidon spring wheat was seeded with a JD 750 disk drill with 7.5" row spacing on May 19, 1996. Starter fertilizer, 50 lb/a of 18-46-0, was applied with the seed at planting. The field was sprayed with Tiller plus Buctril (6.75 and 4 oz ai/a) on June 13th. The field was swathed on August 23rd and combined on August 28, 1996 with grain yield of 28.3 bu/a and a protein content of 13.2%.

On October 1, 1996 the south edge (100 ft) of the field was sprayed with Roundup RT (8 oz ai/a). Winter wheat (Roughrider) was seeded with a JD 750 no-till drill (7.5" 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.

Field F5. Spring wheat (cultivar 2398) was planted no-till into standing corn stalks from the 1995 corn crop with the JD 750 no-till drill (7.5" row spacing). Fertilizer was applied with the drill at seeding, 80 lb N/a as 34-0-0 between the rows and 50 lb/a of 18-46-0 with the seed. The field was sprayed with Tiller plus Buctril (6.75 oz plus 4 oz ai/a) on June 17, 1996. The field was swathed in late August and combined on September 3, 1996. The 2398 spring wheat yielded 41.4 bu/a with a protein content of 14.4%.

Field F6 CORN. Several corn hybrids were planted no-till into 1995 spring wheat stubble on the north and south ends of field F6 in 1996. The south end was the NDSU corn hybrid trial and the north end was strip tests of several DeKalb and Pioneer corn hybrids. The corn fields were sprayed with Roundup RT (9 oz ai/a) on May 13th. Fertilizer, 90 lb N/a (34-0-0) was broadcast about April 29, 1996. Atrazine plus Dual (8 oz + 24 oz ai/a) was applied on May 18, 1996 to both sites. On May 20-21, 1996, Pioneer hybrids 3732 (103 day corn), 3893 (88 day corn), 3921(87 day corn) and 3963 (83 day) were planted in addition to DeKalb 385 (88 day corn) and 343 (84 day corn) with a new JD MaxEmerge II air planter with 30 inch row spacing and a plant population of about 16000 seeds/a. Accent herbicide (0.4 oz ai/a) was sprayed on all corn plots on June 17, 1996 to control pigeon grass (green and yellow foxtail). Weed control was fair with only pigeon grass giving some problem late in the season. The corn plots were harvested on October 16, 1996. The grain moisture content at harvest ranged from 20 for the 83 day P3963 to 37% for the 103 day P3732. The corn did get to black layer before frost in September but was slow in drying. Grain yields and test weights are reported in the following Table 1.

Table 1. Corn hybrid grain yields (15% moisture) and grain test weight in Field F6.

Hybrid	Maturity Length	Harvest Moisture	Test Weight	Grain Yield
Pioneer 3732	103 day	51.3%	44.4 lb/bu	61.4 bu/a
Pioneer 3893	88 day	27.1%	48.5 lb/bu	76.7 bu/a
Pioneer 3921	87 day	23.9%	53.6 lb/bu	83.8 bu/a
Pioneer 3963	83 day	17.8%	54.1 lb/bu	77.6 bu/a
DeKalb 385	88 day	24.5%	50.9 lb/bu	102.5 bu/a
DeKalb 343	84 day	20.7%	54.1 lb/bu	83.7 bu/a

Field F6 PEA. In 1996, 5 acres of Trapper Field Pea were planted under minimum tillage conditions to 1995 spring wheat stubble. Sonalan (1 lb ai/a) was applied on May 11, 1996 with Haybuster undercutter and Gandy granular applicator followed by a second incorporation with the undercutter about a week later. The peas were seeded with the JD 750 no-till drill (7.5 inch row spacing) on May 22, 1996 with 50 lb/a of 18-46-0 with the seed. No other fertilizer was applied to the pea crop. The peas grew well and remained relatively weed free until the peas began to mature. At harvest, a few broadleaf weeds and pigeon grass were the dominant problem. The peas were harvested by just using the pickup grain head on the combine on September 3, 1996. We were late in harvesting the peas and a considerable quantity had shelled out of the pod unto the ground (visual estimate 200-400 lb/a). The Trapper field pea combine yield was 1905 lb/a with a gross return of $164/a.

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

Field G1. Forage Grass Breeding and Genetics - Dr. John Berdahl

See research report by Dr. Berdahl.

Field G2. This field has been in a spring barley-winter wheat-sunflower rotation since 1983 using minimum or no-till production systems. The spring barley has averaged 40 bu/ac; winter wheat, 35 bu/ac; and sunflower about 1500 lbs/ac over the 11-year period. The previous crop was sunflower in 1995. Field G2 was divided into three subfields with sunflower 'Pioneer 6339' seeded on the north 8 acres yielding 1741 lb/a, Pioneer 6150 on the center 7 acres yielding 1697 lb/a, and DeKalb 3868 on 3 acres on the south side of the field yielding 1652 lb/a. The remainder of the south field was taken up with an alternate crop, safflower, and sunflower studies. In 1996, Field G2 was divided into three spring wheat subfields with Ernest being seeded on the north third, CDC Teal on the center third, and Amidon on the south third of field G2 (see Figure 2 for layout). Cenex broadcast applied 80 lb N/a as urea over the entire field on April 24, 1996. At planting, 50 lb/a of 18-46-0 was placed with the seed in each wheat field. The field was relatively weed free so no preplant glyphosate was applied. The Amidon was seeded with the JD 750 no-till drill (7.5" row spacing) on May 16, 1996. The Ernest and CDC Teal wheats were seeded on May 22, 1996 with the Haybuster 1000 no-till disk drill (7" row spacing). Buctril and Tiller (4 oz and 6.75 oz ai/a) were sprayed on the Amidon on June 7, 1996 and on the Ernest and CDC Teal on June 17, 1996. The Amidon was swathed on August 19th and combined on August 26, 1996. The Amidon yielded 42.8 bu/a with a protein content of 12.9%. The Ernest was swathed on August 19th and combined on August 26, 1996 with a yield of 28.8 bu/a and protein content of about 12.8%. The CDC Teal was swathed on August 21 and combined on August 26, 1996 with a yield of 35.6 bu/a and a protein content of 13.3%.

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 " 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 the cool temperatures, winter wheat growth was minimal in the fall of 1996.

Field G3. This field was chemically fallowed in 1995. The field was seeded on April 29, 1996 to Kulm spring wheat using a Concord air seeder no-till drill with 10" row spacing. The drill was provided by NDSU Soil Department and the grain/fertilizer cart by Concord Inc. At seeding, 40 lb N/a as urea and 50 lb/a of 11-52-0 was applied between the split seed row. The field was sprayed with 2,4-D amine (7.6 oz ai/a) on June 7, 1996. The spring wheat was swathed on August 2, 1996 and combined on

August 8, 1996. The Kulm spring wheat yielded 47.4 bu/a with a test weight of 60 lb/bu. Grain protein was 13.1%.

Field G4. This field was summer fallowed in 1996 following spring wheat in 1995. The field was undercut for the first fallow operation on June 4, 1996. The field was chemically fallowed for the rest of the season with Roundup RT (9 oz ai/a) on July 9, 1996 and again on August 23, 1996.

Field G5. USDA-ARS Leased Land - Tree Germplasm Plantations

5a. **Hackberry Provcnance 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 form 18 seed 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.

Field G5 Grain Sorghum: Grain sorghum (DeKalb variety) was planted in the fallow area bordering the tree plantations. The fallow was undercut on June 7, 1996 prior to planting. The sorghum was seeded with the JD 750 no-till drill (7.5" row spacing) at a population of 80,000 seeds/a. The soil was very dry, resulting in only a fair stand of sorghum. Pigweed and lambsquarter severely infested the sorghum because a residual herbicide was not applied. The objective was just to plant some sorghum to see how it might perform. The sorghum yielded 453 lb/a. This low yield was anticipated due to lack of weed control measures and the late planting.

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. The study involves two cropping systems (spring wheat-fallow and spring wheat-winter wheat-sunflower), 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, 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. See the research report by Dr. Halvorson for details.

Field H2. This field was seeded to sunflowers in 1995 that yielded about 1404 lb/a. In 1996, field H2 was seeded to Kulm spring wheat on May 19, 1996 into the standing sunflower stalks with a Haybuster 1000 disk drill (7" row spacing). Cenex applied 80 lb N/a as urea on April 24, 1996 and 50 lb/a of 18-46-0 was applied with the seed. The field was relatively weed free, therefore, glyphosate was not applied preplant. The field was sprayed with Tiller and Buctril (6.75 oz and 4 oz ai/a) on June 14, 1996. The field was swathed on August 14th and combine on August 20, 1996. The spring wheat yielded 31 bu/a with a protein content of 13.1%. The field was sprayed to control after harvest weeds with Roundup Ultra on August 26, 1996.

Field H3. This field was in winter wheat in 1995 that yielded 33.1 bu/a after being damaged by hail on July 20, 1995. The field was sprayed after winter wheat harvest on August 31, 1995 with Fallowmaster (4.5 oz ai/a). In 1996, the field was planted to sunflowers. On April 24, 1996, 80 lb N/a as urea was applied broadcast by Cenex. On May 23, 1996, Sonalan 10G granules were applied with undercutter at a rate of 1 lb ai/a. A second incorporation with the undercutter occurred on May 28th. On May 29-30, 1996, the field was divided into strips with the following sunflower cultivars planted in strip tests (4 or 7 rounds the length of the field) with a new 6-row JD MaxEmerge II air seeder (30" row spacing) at a seeding rate of 25,000 seeds/a. Seven rounds of ProSeed 9310, ProSeed 140, and Pioneer 3868 were seeded on the west part of field H3. Four rounds of DeKalb 3790 and Pioneer 6150 were planted in the center rounds of the field. A sunflower row spacing study and solid seeding strips occupied the east part of field H3 along with strips of DeKalb 3790 and Pioneer 6150 seeded in 30 inch rows at a population of about 28,000 plants per acre. In addition, the DK3790 and P6150 were seeded in 7.5" row spacing (solid seeded) with the JD 750 no-till drill. The sunflower row spacing results are reported by Dr. Halvorson in the research section. Because of the hail damage to the winter wheat in 1995, there was severe weed pressure from volunteer winter wheat. The tillage operations to incorporate the Sonalan did not kill the volunteer winter wheat due to wet, cool conditions. Therefore, Ultima 160 was applied post emergence on June 17th at a rate of 3.25 oz ai/a. The winter wheat was controlled with the Ultima 160 application. Weed control was good in field H3 until about August when a second or third flush of wild mustard infested the field. The field was aerial sprayed for insect control on July 30, 1996 with Asana XL (3.25 oz material/a). The sunflowers were harvested on October 10, 1996 with an average yield across the field of about 1918 lb/a. The gross yield results (no dockage measured) for the various sunflower cultivars in the strip tests are reported in the following Table.

Sunflower Cultivar	Seeding rate, seeds/a	Row Spacing, inches	Grain Yield, lb/a	Oil Content, %
Proseed 9310	25000	30	2085	44.8
Proseed 140	25000	30	2263	46.1
P 6339	25000	30	2364	46.8
P 6150	25000	30	1928	42.4
DK 3790	25000	30	2206	46.2
DK 3790	40000	7.5 (solid seeded)	2290	-----
P 6150	40000	7.5 (solid seeded)	1857	-----

In the bulk field strip tests, the solid seeded sunflowers were relatively weed free compared to a heavy infestation of wild sunflower in the 30" row spacing strips. This is similar to the observation made in 1995 between the solid seed sunflowers and those planted in 36 inch row spacing. The solid seeded were weed free at harvest compared to a heavy infestation of weeds in the 36 inch rows.

Field H4. Soil Quality Study - Drs. Don 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. East Bulk Area. The east part of the field that was in winter wheat in 1995 that yielded 24.2 bu/a after being severely damaged by hail. The field was sprayed after winter wheat harvest with Roundup RT (8.0 oz ai/a) on September 20, 1995 to control volunteer winter wheat. On April 24, 1996, Cenex bulk spread 30 lb N/a as urea on the field. On May 13, 1996, the field was sprayed with Roundup RT (9.0 oz ai/a). On May 15 an d 21, 1996, Stander barley was seeded with the Haybuster 107 disk drill (7" row spacing) with 60 lb/a of 11-52-0 placed with the seed. The barley was sprayed on June 17th with Tiller and Buctril (6.75 oz and 4 oz ai/a). The barley was swathed on August 15th and combined on August 23rd. The Stander barley yielded 72 bu/a with a test weight of 49 lb/bu. The field was sprayed with Roundup Ultra on August 26, 1996 to control after harvest weeds.

Field H4. Center Bulk Area. This area was planted to Amidon spring wheat in 1995 that yielded 25 bu/a after being severely damaged by hail. The field was spayed with Roundup RT (8 oz ai/a) on September 20, 1995. Roughrider winter wheat was seeded in this field on September 21, 1995 with JD 750 no-till drill (7.5"row spacing) with 50 lb/a of 11-52-0 applied with the seed and 20 lb N/a as urea placed between the seed rows. Cenex bulk spread 30 lb N/a as urea on April 24, 1996. The winter wheat was sprayed on June May 28th with Tiller (5.4 oz ai/a) plus Buctril (4 oz ai/a). The winter wheat was swathed on July 30th and combined on August 8th. The Roughrider winter wheat yielded 34.3 bu/a with a protein content of 11.3%. The field was sprayed on August 22, 1996 with Roundup Ultra to control fall weeds.

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

Field I1. Root and Leaf Disease Work - Dr. Joe Krupinsky

LEAF SPOT DISEASES in Long-Term Continuous Wheat. Investigations of spring wheat root rot diseases and leaf spot disease observations were continued in this field in 1996. For the last 12 years two residue treatments, no-till (high residue with standing stubble, >60% surface cover) and maximum till (low residue, disking before planting, <30% surface cover) were applied to the same spring wheat field located south of Mandan. This provides an opportunity to investigate plant disease development in a continuous wheat monoculture. 'Amidon' spring wheat was seeded with a JD 750 no-till drill (7.5" row spacing) on May 20, 1996 with 50 lb/a of 18-46-0 with the seed and 80 lb N/a bulk applied on April 24, 1996 as urea. Both the conventional till strip and the no-till strip were sprayed with Tiller and Buctril (6.75 and 4 oz ai/a) on June 17th. Other details are as follows:

Conventional Till: Disked with a tandem disk on May 13, 1996 prior to seeding wheat followed by Roundup RT application (9 oz ai/a) to patches of quackgrass on May 13th. The wheat yielded 34.9 bu/a with a protein content of 13.4%.

No-till: The field was sprayed with Roundup RT (9 oz ai/a) on May 13th. The spring wheat yielded 33.9 bu/a with a protein content of 13.4%.

See research report by Dr. Krupinsky for more details.

Fields I2. This field was in durum wheat that yielded 24.1 bu/a in 1995. The field was sprayed with Roundup RT on September 20th. Winter wheat (Roughrider) was seeded in this field on September 22, 1995 with JD 750 no-till drill with a row spacing of 7.5". Fertilizer, 50 lb/a of 11-52-0 and 20 lb N/a, were applied at seeding. Cenex applied 50 lb N/a as urea on April 24, 1996. On May 28th, the field was sprayed with Buctril and Tiller (4 and 5.4 oz ai/a). The winter wheat was swathed on July 30th and combined on August 7th. The winter wheat yielded 39.3 bu/a with a protein content of 10.9%.

Field I3. The field was divided in half in Spring of 1995 with the south half of the field fallowed and the north half planted to sunflowers (oil).

South Half: Seeded to spring wheat (cultivar 2398) in 1996 following the 1995 fallow treatments: tilled with JD Mulch Master on May 19, 1995; sprayed with Roundup RT (9 oz ai/a) on June 10th and Fallowmaster (6.3 oz ai/a) on August 23rd. Cenex applied 40 lb N/a as urea on April 24, 1996. Spring Wheat, 2398, was seeded with JD 750 no-till drill on May 20, 1996 with 50 lb/a of 18-46-0 with the seed. The field was sprayed with Buctril and Tiller (4 and 6.75 oz ai/a) on June 17th. The field was severely damaged by hail (estimated 50+% loss) August 2nd. The field was swathed on August

23rd and combined on August 28th. The spring wheat yielded 23.9 bu/a with a protein content of 14.4%.

North Half: The field was in sunflowers that yielded 1819 lb/a in 1995. The stalks were left standing over winter and summer of 1996 for snow trapping and wind erosion control. The field was fallowed in 1996 with the following operations: June 7, 1996, sprayed with Roundup Ultra (9 oz ai/a), again on July 9th and again on August 22, 1996.

Field I4. This field was in Amidon spring wheat that yielded 25.3 bu/a in 1995. In 1996, the field was seeded to sunflowers, DeKalb 3868, with a new JD MaxEmerge II air planter (30" row spacing) at a seeding rate of 25,000 viable seeds/a. This field is part of the Site-Specific Farming Study, so a variable rate of urea (46-0-0) and 11-52-0 were applied across the field based on soil test results and 1995 spring wheat yields with a Concord air seeder equipped with variable rate application controls on April 30, 1996. Granular Sonalan (1 lb ai/a) was applied with a Gandy applicator mounted on a Haybuster undercutter on May 16, 1996 followed by a second undercutter incorporation on May 24th. The field was aerial sprayed for insects on July 30th with Asana XL (3.25 oz material/a). The grain yields from this field were mapped using a grain yield monitor and GPS equipment. The field was harvested on October 8th. The sunflowers yielded 1870 lb/a with an oil content of 48.9%.

Field I5. This field is part of the Site-Specific Farming Study and was in confection sunflowers in 1995 that yielded 1190 lb/a. The field was planted to Kulm spring wheat on April 25, 1996 using a Concord air seeder equipped with variable rate fertilizer application equipment/controls. Based on soil test results, yield potential, and 1995 yield maps, urea (46-0-0) and 11-52-0 were applied as needed across the field at seeding. The field was sprayed with 2,4-D (LV-4) on June 4th to control broadleaf weeds. Pigeon grass was not a problem in this field. About half of the field was swathed on August 2nd with a severe hail storm the evening of August 2nd. Yield loss of 30-60% was estimated by Insurance Adjuster. The field was combined on August 7th with an average yield of 34.6 bu/a and a protein content of 13.7%. The grain yields were mapped.

Field I6. This field is part of the Site-Specific Farming Study and was in Amidon spring wheat in 1995 that yielded 24.5 bu/a. The field was planted to Amidon spring wheat on April 26, 1996 using a Concord air seeder equipped with variable rate fertilizer application equipment/controls. Based on soil test results, yield potential, and 1995 yield maps, urea (46-0-0) and 11-52-0 were applied as needed across the field at seeding. The field was sprayed with Buctril and Tiller (4 and 5.4 oz ai/a) on June 4th to control broadleaf weeds and pigeon grass. A hail storm on August 2nd severely damage the spring wheat field, reducing yields 30-60%. The field was swathed on August 8th and combined on August 12-13th with an average yield of 29.6 bu/a and a protein content of 12.1%.

See the research report by Drs. Franzen, Hofman, 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, and Don Tanaka

Field H1. This large field is dedicated to the cropping systems--conservation tillage and nitrogen study initiated in 1984. The study involves 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. The following Tables (A1 through D3) report field operations and grain yields for the spring wheat, winter wheat, and sunflower crops for each rotation.

Spring Wheat-Fallow Results (Table A3): Spring wheat yields were average in 1996 due to delayed seeding caused by wet soils and cold temperatures. Precipitation was adequate to produce an average yielding crop. In 1996, there was a significant difference between spring wheat varieties with Butte86 out yielding Stoa. There was a significant response to N fertilization and but not to tillage system. There was a significant tillage x N interaction (Prob. = 0.064) and a tillage x cultivar interaction (Prob.=0.063). In 1996, the NT plots had the highest grain yields. In the CT plots, rainfall right after seeding resulted in crusting which reduced the plant population slightly. The 1996 SW-F yield expressed on an annual basis averaged 17.8 bu/a. The 12-year average yield data for SW-F are reported in Table A4 with an average annual yield of 16.1 bu/a. In the no-residue plots, there was no significant response to N or cultivar in 1996 with an average yield of 31.5 bu/a or annual yield of 15.8 bu/a.

Spring Wheat in SW-WW-SUN System (Table B2): In 1996, there was a significant difference between spring wheat varieties (Prob. = 0.067) in the annual cropping system (SW-WW-SUN). There was a significant response to N fertilization and to tillage system. The CT and MT system had significantly lower yields than NT. As was the case in the SW-F plots, soil crusting was a problem following seeding in the CT and MT plots which visibly reduced the stand. A significant tillage x N and tillage x cultivar interaction was present in 1996. The 1996 average spring wheat yield (26.3 bu/a) in the SW-WW-SUN system was 48% greater than the annual spring wheat yield in the SW-F system. The 12-year average spring wheat yield data are reported in Table B3 with an 12-yr average annual yield of 22.5 bu/a.

Winter Wheat in SW-WW-SUN System (Table C2): In 1996, tillage system had a significant effect on winter wheat yields in the annual cropping system with NT>MT>CT yields. Downy brome infestations were heavy in the NT plots again in 1996, particularly in those plots nearest the west fence row. The CT plots appeared to have suffered more winter kill than the NT plots which may account for the reduced yield for CT. There was not a significant difference between winter wheat varieties even though Roughrider yielded 3.6 bu/a more than Norstar. Both varieties responded positively to N fertilization. The 1996 average winter wheat yield was 30.2 bu/a. The 12-year average yield data are presented in Table C3 with an average annual yield of 28.7 bu/a.

Sunflower in SW-WW-SUN System (Table D2): In 1996, N fertilization and cultivar had a significant effect on sunflower yield. The Sigco 651 (early maturity, short variety) yielded significantly more than the Sigco 658 (medium maturity, tall variety). There was a significant N x cultivar interaction in 1996. Tillage system had no significant affect on sunflower yields in 1996, but weeds (wild mustard) was more of a problem in the NT, 30 lb N/a plots than in CT and MT. At the higher N rates, 60 and 90 lb N/a, the sunflowers were more competitive with the wild mustard. In 1996, glyphosate was applied at planting time in the NT plots. Ultima 160 herbicide was applied post emergence in the NT plots to control volunteer wheat and downy brome. Sunflower yields in 1996 averaged 1512 lb/a in this annual cropping system with an oil content of 48%. The 12-year average annual grain yields are reported in Table D3, with an average yield of 1327 lb/a.

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

Table A1. Fallow-Spring wheat plots, 1996 schedule of operations for each tillage system for the 1996 fallow series of plots.

Date	Conventional-till		Minimum-till	No-till
mo/day/yr	No residue	<30% Cover	30-60% Cover	>60% Cover
5/13/96	-----	-----	*Roundup RT	Roundup RT
5/30/96	Deep disked	-----	-----	-----
6/3/96	-----	undercut	-----	-----
6/10/96	-----	-----	Roundup Ultra	Roundup Ultra
7/8/96	double disk	chisel plow	Roundup Ultra	Roundup Ultra
8/16/96	-----	-----	undercut	-----
8/20/96	Disked	disked	-----	Roundup Ultra

*Roundup (9.0 oz ai/a) with ammonium sulfate.

Table A2. Spring wheat-fallow plots, 1996 schedule of operations for each tillage system following 1995 fallow.

Date	Conventional-till		Minimum-till	No-till
mo/day/yr	No residue	<30% Cover	30-60% Cover	>60% Cover
4/26/96	Applied N-fertilizer (34-0-0) treatments, 0, 20, and 40 lb N/a			
5/6/96	disked	disked	-------	------
5/10/96	-------	-------	undercut	------
5/13/96	------	------	-------	Roundup (9 oz ai/a)
5/13-15/96	Seeded Butte 86 and Stoa spring wheat with Haybuster 1000 disk drill at a rate of 1.4 million seeds/a (Vitavax treated seed)			
6/17/96	Sprayed all plots with Tiller (6.75 oz ai/a) plus Buctril (4 oz ai/a)			
8/16/96	Swathed grain for plot harvest (10 ft cut across each plot) from Butte 86 plots			
8/19/96	Biomass harvest samples obtained using bundle cutter from Butte 86 plots			
8/23/96	Swathed grain for plot harvest (10 ft cut across each plot) from Stoa plots			
8/23/96	Biomass harvest samples obtained using bundle cutter from Stoa plots			
8/26/96	Combined Butte 86 plots for yield			
8/26/96	Combine Stoa plots for yield			
9/5/96	Cleaned up plots with large combine			
10/2/96	undercut	undercut	--------	--------

Table A3. 1996 Spring wheat grain yields in sp.wheat-fallow rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System				Average (excluding No Residue Treatment)
		CT	CT	MT	NT	
		No residue	<30% Cover	30-60% Cover	>60% Cover	
	lb N/a	--------------------------bu/a------------------------------				
Butte 86	0	31.9	36.8	33.6	33.4	34.6
	20	31.8	40.5	39.8	39.2	39.9
	40	31.2	33.4	38.4	40.7	37.5
Butte 86 Average		31.6	36.9	37.2	37.8	37.3
Stoa	0	30.0	33.4	31.6	35.4	33.5
	20	31.6	34.7	35.2	36.3	35.4
	40	32.8	32.2	30.6	36.4	33.1
Stoa Average		31.5	33.4	32.4	36.0	34.0
Tillage Average		31.5	35.2	34.8	36.9	35.6

Table A4. Twelve-year average (1985-1996) spring wheat yields in the spring wheat-fallow cropping system as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System				Average (excludes no residue)
		CT	CT	MT	NT	
		No residue (10-yr avg)	<30% Cover	30-60% Cover	>60% Cover	
	lb N/a	---bu/a---				
Butte 86	0	29.9	33.9	31.6	29.3	31.6
	20	31.6	34.8	32.8	31.4	33.0
	40	30.6	34.6	33.4	33.2	33.7
Butte 86 Average		30.7	34.4	32.6	31.3	32.8
Stoa	0	28.9	31.2	31.6	30.8	31.2
	20	30.0	32.4	31.8	30.8	31.7
	40	29.6	31.9	32.2	32.1	32.1
Stoa Average		29.5	31.8	31.9	31.2	31.6
Tillage Average		30.1	33.1	32.2	31.3	32.2

Table B1. Spring wheat, 1996 schedule of operations in sp.wheat-w.wheat-sunflower rotation.

Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
4/24/96	Broadcast 34-0-0 N-fertilizer treatments, 30, 60, and 90 lb N/a		
5/6-13/96	disked	undercut	Roundup RT
5/13-15/96	Seeded Butte 86 and Stoa sp.wheat with Haybuster 1000 disk drill at 1.4 mill seeds/a		
6/17/96	Sprayed Tiller (6.75 oz ai/a) plus Buctril (4 oz ai/a)		
8/16/96	Swathed grain for plot harvest (10 ft cut across each plot) from Butte 86 plots		
8/16/96	Biomass harvest samples obtained using bundle cutter from Butte 86 plots		
8/23/96	Swathed grain for plot harvest (10 ft cut across each plot) from Stoa plots		
8/27/96	Biomass harvest samples obtained using bundle cutter from Stoa plots		
8/26/96	Combined Butte 86 plots for yield		
8/26/96	Combine Stoa plots for yield		
9/5/96	Cleaned up plots with large combine		
9/20/96	disked	undercut	Roundup Ultra (8 oz ai/a)
9/25/96	Seeded w.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)		

Table B2. 1996 Spring wheat grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	--------------------------bu/a------------------------------			
Butte 86	30	21.0	24.5	25.9	23.8
	60	23.9	26.9	36.9	29.2
	90	20.5	23.1	39.7	27.8
Butte 86 Average		21.8	24.9	34.2	26.9
Stoa	30	23.7	23.2	25.4	24.1
	60	24.4	23.0	30.5	26.0
	90	23.8	24.8	33.3	27.3
Stoa Average		24.0	23.7	29.7	25.8
Tillage Average		22.9	24.3	31.9	26.4

Table B3. Twelve-year (1985-1996) average annual spring wheat yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	--------------------------bu/a------------------------------			
Butte 86	30	21.2	23.0	21.4	21.9
	60	23.0	24.5	25.0	24.1
	90	23.1	25.3	27.6	25.3
Butte 86 Average		22.5	24.2	24.7	23.8
Stoa	30	18.4	20.7	18.8	19.3
	60	21.1	22.1	20.9	21.3
	90	21.0	23.7	23.8	22.8
Stoa Average		20.1	22.1	21.2	21.1
Tillage Average		21.3	23.2	22.9	22.5

Table C1. Winter wheat crop plots, 1995 schedule of operations for each tillage system following spring wheat in the sp.wheat-w.wheat-sunflower rotation.

Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
9/5/95	Combined spring wheat, cleaned up plots		
9/19-20/95	disked	undercut	Roundup (9 oz ai/a)
9/21-22/95	Seeded Roughrider and Norstar winter wheat with Haybuster 8000 hoe drill, 10" spacing, at a rate of 1.3 mill seeds/a with 50 lb/a of 11-52-0 with seed and 25 lb N/a broadcast (total of 30 lb N/a)		
5/1/96	Top-dressed N-fertilizer (34-0-0) at 30 and 60 lb N/a to 60 and 90 lb N/a treatments		
7/30/96	Swathed winter wheat plots for grain harvest		
7/31/96	Collected biomass samples and head counts		
8/7/96	Combined plots for yield		
8/9/96	Cleaned up plots with large combine		
8/20/96	Roundup (8 oz ai/a)	Roundup	Roundup
10/2/96	undercut	-------	-------

Table C2. 1996 winter wheat grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			Average
		CT	MT	NT	
	lb N/a	---------------------------bu/a------------------------------			
Roughrider	30	27.7	34.2	30.8	30.9
	60	23.6	33.1	36.5	31.1
	90	27.6	36.1	38.0	33.9
Roughrider Average		26.3	34.5	35.1	31.9
Norstar	30	28.8	28.6	31.0	29.5
	60	18.6	25.1	32.1	25.3
	90	26.0	29.9	35.2	30.4
Norstar Average		24.4	27.9	32.8	28.4
Tillage Average		25.4	31.2	33.9	30.2

Table C3. Twelve-year (1985-1996) average annual winter wheat grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	---------------------------bu/a-------------------------------			
Roughrider	30	26.2	27.8	28.0	27.3
	60	27.1	29.5	31.4	29.3
	90	27.4	30.5	31.1	29.7
Roughrider Average		26.9	29.3	30.2	28.8
Norstar	30	26.5	28.2	27.9	27.5
	60	26.0	30.0	30.4	28.8
	90	27.5	29.7	31.7	29.6
Norstar Average		26.7	29.3	30.0	28.7
Tillage Average		26.8	29.3	30.1	28.7

Table D1. Sunflower plots, 1996 schedule of operations for each tillage system following spring wheat in the sp.wheat-w.wheat-sunflower rotation.

Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
9/20/95	undercut	Roundup RT (9 oz ai/a)	Roundup RT (9 oz ai/a)
10/26/95	-----	-----	Broadcast Sonalan 10G (1.25 lb ai/a) soil surface
5/1/96	Broadcast applied N-fertilizer (34-0-0) at 30, 60, and 90 lb N/a		
5/22/96	*undercut, applied Sonalan 10G granules	*undercut, applied Sonalan 10G granules	Roundup Ultra (8 oz ai/a)
5/28/96	disked	undercut	-----
5/28/96	Seeded all plots to Sigco 651 and 658 with JD MaxEmerge II air seeder at 25,000 seeds/a (30" rows)		
6/17/96	-----	-----	Ultima 160 (3.25 oz ai/a)
7/30/96	Aerial sprayed all plots with Asana XL insecticide (3.6 oz material/a) ($8.58/a total cost)		
10/8/96	Hand harvested plots for yield, 2 rows 9 ft. long at 2 locations		
10/10/96	Bulk combined plot area		

*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.

Table D2. 1996 sunflower grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			Average
		CT	MT	NT	
	lb N/a	---------------------------lb/a------------------------------			
Sigco 651	30	1390	1328	1100	1273
	60	1495	1667	1652	1605
	90	1611	1891	1928	1810
Sigco 651 Average		1499	1629	1560	1563
Sigco 658	30	1396	1540	1446	1461
	60	1439	1558	1336	1444
	90	1447	1424	1566	1479
Sigco 658 Average		1428	1507	1449	1461
Tillage Average		1463	1568	1504	1512

Table D3. Twelve-year (1985-1996) annual sunflower grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	---------------------------lb/a------------------------------			
Early Maturing Cultivar	30	1260	1294	1206	1254
	60	1317	1433	1278	1343
	90	1367	1452	1504	1441
Cultivar Average		1315	1394	1330	1346
Medium Maturing Cultivar	30	1217	1323	1125	1221
	60	1284	1385	1269	1313
	90	1314	1430	1422	1388
Cultivar Average		1272	1379	1272	1308
Tillage Average		1278	1370	1282	1327

PLANT DISEASES, 1996

Drs. Joe Krupinsky, Ardell Halvorson, and Don Tanaka

LEAF SPOT DISEASE COMPLEX

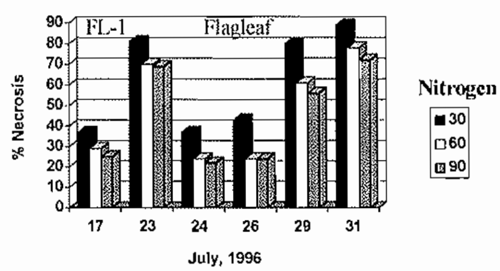
Spring wheat and winter wheat leaves from experimental plots were analyzed for plant pathogens present. Septoria nodorum blotch (*Septoria nodorum* or *Stagonospora nodorum*), tan spot (*Pyrenophora tritici-repentis* or *Drechslera tritici-repentis*), spot blotch (*Helminthosporium sativum* or *Bipolaris sorokiniana*) and Septoria avenae blotch (*Septoria avenae* f. sp. *triticea*) made up the leaf spot disease complex present on wheat in this area. With Septoria covering the most leaf 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 in 1996. 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.

LONG-TERM CROPPING SYSTEMS STUDY, Leaf spot diseases

Field H1. (For details on plot treatments check results of Halvorson)

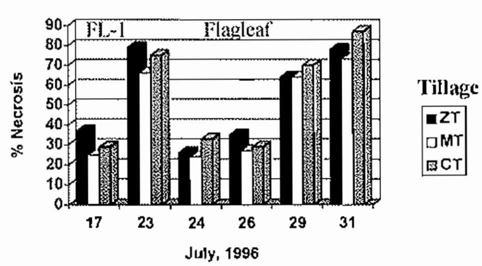
In 1996, differences in severity of leaf spot diseases among nitrogen treatments were significant when the fields were rated. Wheat leaves from the low nitrogen treatment (30 lb N/acre) had higher levels of necrosis and chlorosis than those from the 60 and 90 lb N/acre treatments (e.g. Figure 1). This is consistent with previous years.

Figure 1. Leaf spot diseases on spring wheat after sunflowers as related to nitrogen, averaged over tillage and cultivars, Mandan, ND, 1996.



There was a trend for the leaf spot diseases to be higher under zero tillage compared to minimum and conventional tillage for winter wheat after spring wheat and for spring wheat after fallow but not for spring wheat after sunflowers. The severity of leaf spot diseases was similar for zero till and conventional till (Figure 2) with spring wheat following sunflowers.

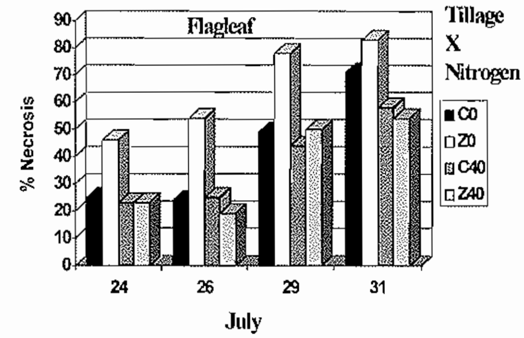
Figure 2. Leaf spot diseases on spring wheat after sunflowers related to tillage, averaged over N and cultivars, Mandan, ND, 1996.



Interaction of nitrogen treatments with tillage, 1996.

In 40 % (7 out of 18) of the statistical analyses of the leaf spot ratings for winter and spring wheat crops in this conservation tillage-cropping project, the nitrogen X tillage interaction was significant. This indicates that the tillage effect may vary at different nitrogen treatments. At the low nitrogen level the severity of leaf spot diseases is higher for zero till than conventional till but at the high nitrogen level the difference in severity of leaf spot diseases for the tillage treatments was greatly reduced or eliminated (Figure 3).

Figure 3. Leaf spot diseases on spring wheat after fallow related to nitrogen and tillage, Mandan, ND, 1996. C0=CT at 0N; Z0=ZT at 0N; C40=CT at 40N; Z40=ZT at 40N

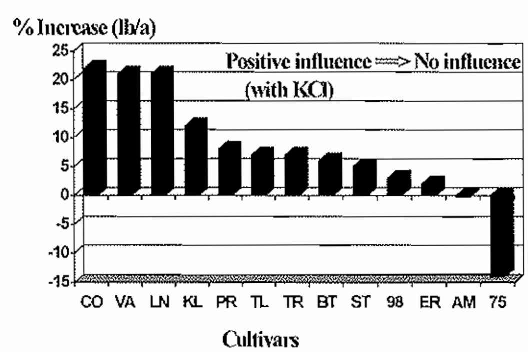


SPRING WHEAT TRIALS AND CHLORIDE, Leaf spot diseases.
Field F5. (For details on plot treatments check results of Tanaka)

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 always 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 soil types, location, and/or year. Response to chloride application is not affected by tillage.

In a preliminary study, potassium chloride was applied across varieties in the spring wheat trial. Varieties with KCl and without KCl were rated five times during the growing season. The differences between the KCl and no KCl treatments indicated that varieties respond differently to KCl application. Although yield was not effected by the KCl treatment, there was an increase in total dry matter with the KCl treatment (Figure 4). The study will be repeated in 1997 to determine if varieties are consistent in their response to KCl.

Figure 4. Chloride effect on total dry matter Wheat cultivars, Mandan, ND, 1996. Statistical difference: KCl and without KCl



MANAGEMENT STRATEGIES FOR SOIL QUALITY, Leaf spot diseases.
Field H4. (For details on plot treatments check results of Tanaka)

In 1996, 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 among the crop rotations for severity of leaf spot diseases. In four out of the eight ratings there were statistical differences between tillage treatments. The minimum tillage treatment had higher disease severities than the zero tillage treatment.

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 higher on plots with no nitrogen compared to plots with 60 lb N/ac.

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.

ACKNOWLEDGMENTS

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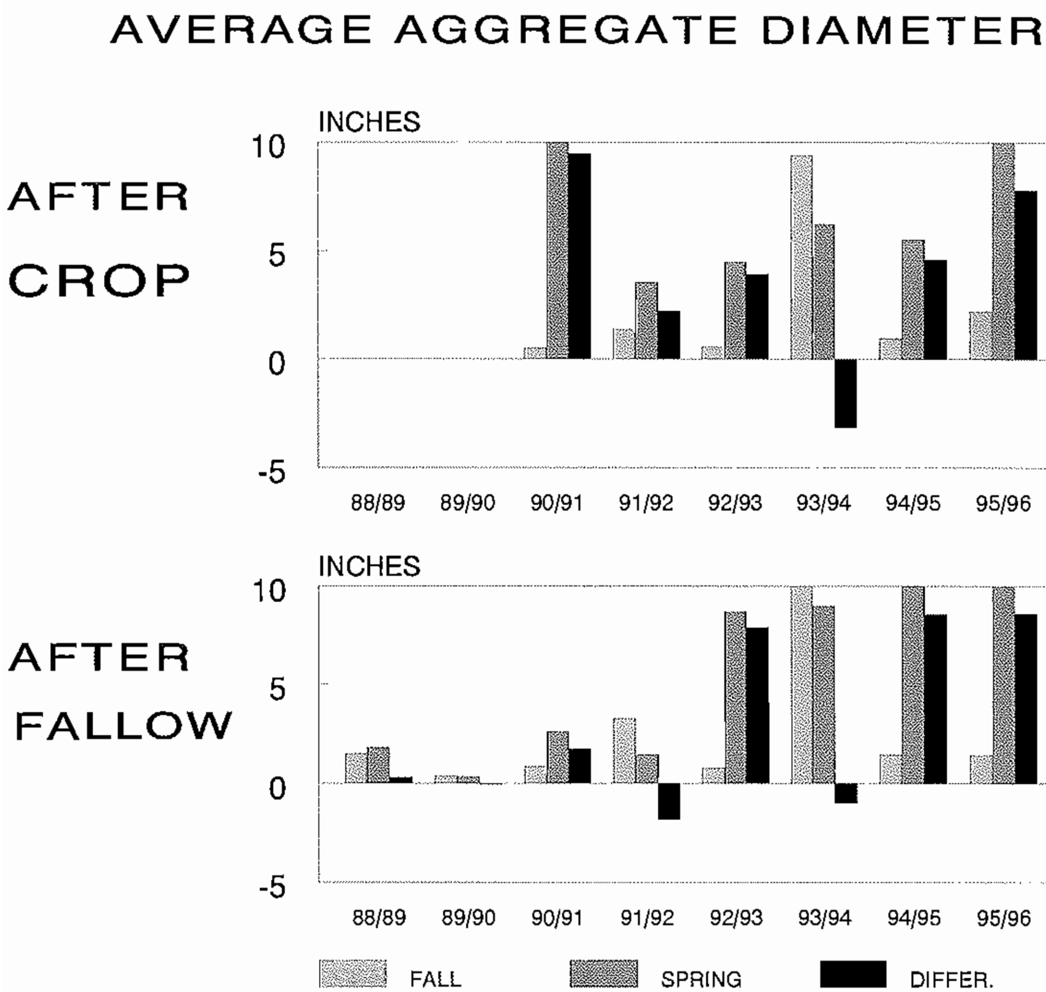
WIND ERODIBILITY STUDIES

Drs. Steve Merrill and Ardell Halvorson

Field H1. Measurements in spring wheat - fallow. Wind erodibility studies have expanded beyond the spring wheat-summerfallow system in recent years. However, the longest and most valuable data record has been obtained from study of wheat-fallow, and the results discussed this year come from that cropping system. Basic wind erodibility measurements consist of (a) soil-inherent wind erodibility, estimated by rotary sieve measurements of aggregate sizes in surface soil; (b) soil surface roughness measurement, now being made by the chain technique; and (c) measurements of surface residue coverage and standing residue profile. Of these factors, the least understood and therefore the scientifically most valuable are measurements of soil-inherent wind erodibility. In general, we have found that the long-term wet-dry weather cycle has greater influence than tillage on soil-inherent wind erodibility . We show in the Figure average aggregate size measurements from rotary sieving of samples taken from spring wheat - fallow in the long-term Conservation Tillage Cropping Systems Experiment. Aggregate sizes can often change considerably over winter, and so we show measurements taken in fall, in spring, and the difference between spring and fall values. Low aggregate size values found in the period from 1988 through 1991 are the result of multiyear drought and represent more wind-erodible surface soil conditions. It can be seen from the Figure that overwinter conditions tend to increase soil aggregation on our productive soil, and thus decrease soil wind erodibility. This is especially true during the current period of relatively wetter years. However, open winters with lack of snowcover can and do have a destructive effect on surface soil aggregation. Average aggregate size tends to decrease over summer, and the measured values show that soil-inherent wind erodibility during non-droughted years is generally lower in the spring than in the fall.

Figure. Soil inherent wind erodibility measured as average aggregate size by rotary sieving. Values are averaged over tillage treatments.



Field H1. Estimated wind erosion hazards. We have applied the new USDA-Agricultural Research Service working model for the prediction of wind erosion hazards to our measurements in spring wheat - fallow. This model is known as the Revised Wind Erosion Equation (RWEQ), and was developed by ARS principally at Big Spring, TX, but with the assistance of other ARS locations, including Mandan. It is practical and relatively easy to use, and should be available to producers, advisors and general researchers in the not-too-distant future. The Table shows estimated wind erosion hazards as calculated soil losses. Drought accelerates wind erosion, and application of RWEQ indicates that wind erosion hazard was much greater during droughty 1989-1990 than during wetter 1992-1994. The standing residue of no-till usually protects soil from wind erosion hazard, and values in the Table show that wind erosion hazard under no-till was considerably lower than under near clean-till (disk tillage) for 5 out of the 6 cases displayed. Low wheat growth in severely droughted 1988 resulted in inadequate crop residues in 1990, and residues were further weakened by the seeding operation in the spring of 1990. Thus, the Table shows that wind erosion hazard after seeding was nearly as great (in practical terms, about the same) under no-till as under low-residue disk tillage. Our studies have been done on a productive soil that ordinarily does not have high wind erodibility. Practice of crop-fallow rotations on more fragile soils will encounter significant wind erosion hazards. No-tillage will greatly reduce those hazards, but as our study shows, no-tillage will not guarantee soil protection in an environment ruled by chaotic weather.

Table 1. Calculated long-term soil losses from wind erosion in pounds per acre.

		Fallow May - Dec.	Fallow Jan. - April	After seeding May - July
DROUGHT 1989-1990	CLEAN-TILL	2760	2150	690
	NO-TILL	1	280	370
WETTER 1992-1994	CLEAN-TILL	65	70	45
	NO-TILL	near 0	0.04	0.04

ROOT GROWTH OF ALTERNATIVE CROPS

Drs. Steve Merrill and Don Tanaka

Field F3. Observations of root growth were conducted in 1995 and 1996 in crops that are being proposed as alternatives to small grains in dryland rotations. Direct observation of the rooting characteristics of these crops will enable 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 rotations. 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. It is currently planned that the study be repeated during the 1997 cropping season.

A microvideo camera system is used with two different types of minirhizotron tubes that are installed in the field. A total of 8 minirhizotrons were installed in plots of each of 7 alternative 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. Both 1995 and 1996 results are summarized in the Table.

Data shown in the Table indicate characteristics of the rooting systems at a time when the various crops had more or less produced their maximum amount of root growth. One of the most important characteristics of a root growth system is the average maximum depth of rooting. The crops 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 of 3.4 to 3.9 feet. The mustard family crops crambe and canola are next, with maximum depths averaging 4.1 to 4.3 feet. Spring wheat at 4.3 feet is less deeply rooted than the oilseed crops sunflower and safflower, which have average maximum rooting depths of 4.7 and 5.6 feet, respectively. The rankings of the crops in maximum rooting depth were quite consistent over the 2-year period.

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. Root length growth measurements by the scientifically credible minirhizotron system are dominated by finer and shorter-lived branch roots, which is one of the reasons why measurements of total root length growth can often appear somewhat chaotic, as do our results. Total root lengths for 1996 are generally higher than the 1995 values, which, again, may be related to weather pattern. The 1995 total root length for spring wheat is uncharacteristically low, while the 1996 value for crambe probably reflects extensive, unpunishable growth by the botanically closely related weed, wild mustard.

These results indicate that the oilseed crops 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 root growth, and total root length growth per area for alternative crops.

CROP	Maximum depth of root growth (feet)			Median depth of root growth (feet)		Total root length: median (mile/sq.yd.)	
	Site 1 1995	Site 2 1996	Avg	Site 1 1995	Site 2 1996	Site 1 1995	Site 2 1996
Blackbean	3.63	3.20	3.42	1.49	0.85	6.85	9.10
Soybean*	3.34	3.77	3.56	1.64	0.79	2.04	3.69
Dry pea	3.63	4.06	3.85	1.35	1.12	1.62	7.43
Crambe**	3.91	4.34	4.13	1.15	1.78	1.92	11.69
Canola	4.20	4.34	4.27	1.48	1.42	6.29	6.16
Spr. wheat	4.20	4.34	4.27	1.90	1.97	2.18	16.45
Sunflower	4.76	4.62	4.69	1.56	1.20	4.54	2.91
Safflower	5.62	5.48	5.55	3.00	2.04	5.72	6.61

* There was low stand in 1996 over a significant fraction of one of the soybean replications that root observations were made in.
** Growth of wild mustard weed undoubtedly affected crambe observations in 1996.

MANAGEMENT STRATEGIES FOR SOIL QUALITY

Drs. Donald Tanaka and Stephen Merrill

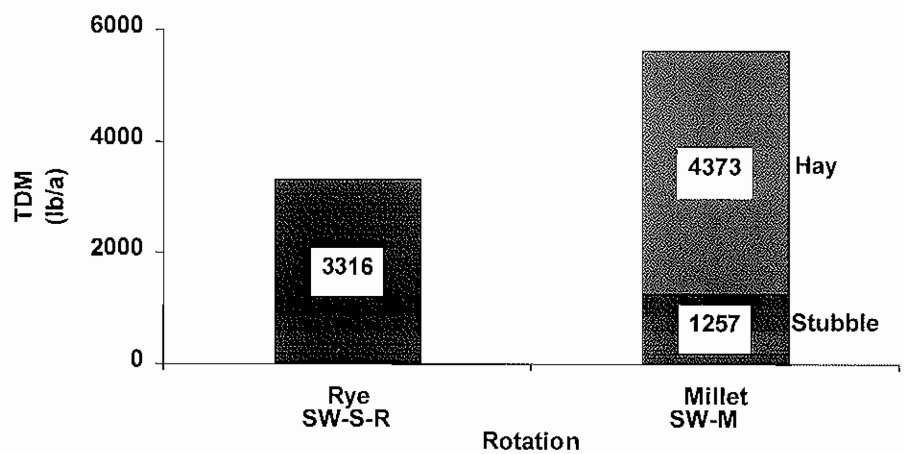
Field H4. A long-term study was initiated in the spring of 1993 to evaluate the influences of residue management and crop rotations on soil quality. Tillage, crops, and crop residues were all in the appropriate places in 1994. Treatments for the 1995 crop included minimum- and no-till for the following 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)

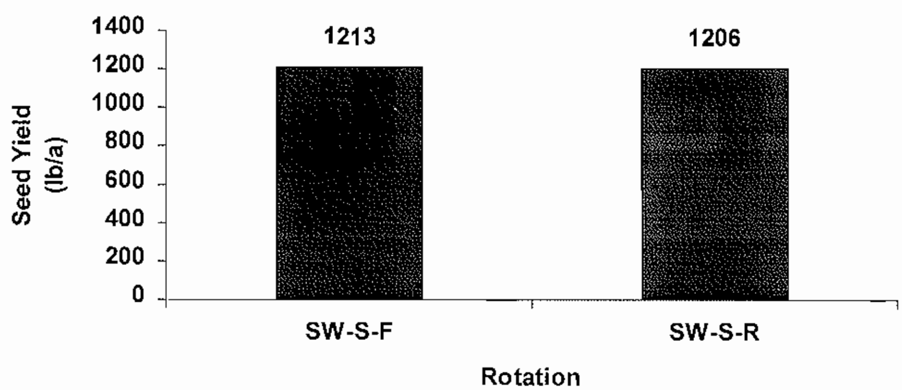
Spring wheat was seeded at 1.3 million viable seeds per acre on April 30, 1996. Safflower was seeded at 200,000 viable seeds per acre on April 30, 1996. Millet was seeded on June 6, 1996 at 4 million viable seeds per acre. Spring wheat, safflower, and millet were all seeded with a JD 750 no-till drill. Rye was seeded on October 3, 1995 at 1.3 million viable seeds per acre with a Haybuster 8000. Recrop plots received 60 lb N/a and 10 lb P/a while crops seeded after fallow received 30 lb N/a and 10 lb P/a. Growing season precipitation (May through August) was 10.4 inches compared to a long-term average of 9.9 inches.

Spring wheat grain yields ranged from 2953 to 3510 lb/a. Spring wheat after fallow yielded the same as continuous spring wheat. Safflower seed yields were 1200 lb/a and were reduced because the lack of rain in late July and August. Rye produced 3316 lb/a of dry matter (growth terminated June 20, 1996) for soil and water conservation while millet produced 4373 lb/a of hay and 1257 lb/a of residue for erosion control.

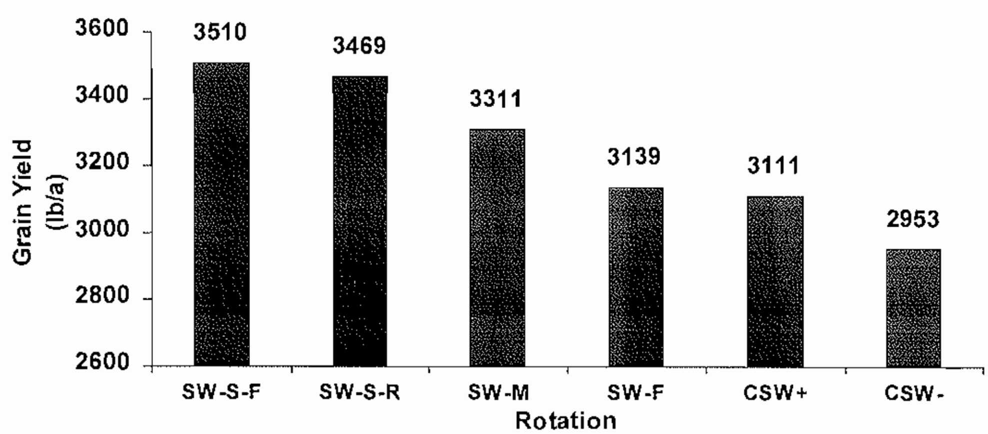
1996 Rye and Millet Total Dry Matter



1996 Safflower Seed Yield



1996 Spring Wheat Grain Yields



TILLAGE AND N FERTILITY EFFECTS ON CROP RESIDUE DECOMPOSITION

Drs. Brian Wienhold and Ardell Halvorson

Field H1. A study was initiated in the fall of 1995 to determine dry matter and nutrient dynamics in spring wheat, winter wheat, and sunflower residue from conventional, minimum, and no-tillage fields receiving N at three different rates. Residue was collected from each field immediately after harvest in 1995. The residue was placed in nylon mesh bags and returned to the field. Twelve bags were placed in each field, six on the soil surface and six buried vertically in the soil. Surface bags will be used to determine surface residue decomposition and buried bags will be used to determine decomposition of residue that is incorporated by tillage or planting equipment. Six bags were collected from each field during the 1996 growing season, a surface bag and a buried bag, at each of three collection dates. Collection dates were May 6, July 8, and October 24. Additional bags will be collected during the 1997 growing season. When bags are collected they will be returned to the lab, oven dried, and mass of residue remaining determined. Remaining residue will be ground and analyzed for nutrient content at the conclusion of the experiment.

CROPPING SYSTEM, TILLAGE, AND N FERTILITY EFFECTS ON SOIL QUALITY PARAMETERS

Drs. Brian Wienhold and Ardell Halvorson

Field H1. Soil samples from two depths (0 to 2 inches and 2 to 6 inches) were collected from all plots of the 65 acre cropping rotation study in the spring of 1995. Soil samples were returned to the laboratory and are being analyzed for a number of physical, chemical, and biological soil quality parameters. Bulk density is the only physical parameter being measured. Chemical parameters being measured include: pH, mineral N, organic N, and organic C. Biological parameters being measured include: microbial numbers, microbial biomass, and potentially mineralizable N. Analysis of physical and biological parameters is largely complete. Chemical analysis will be completed this winter. Patterns emerging from the data include: higher biological activity in the 0 to 2 inch layer than in the 2 to 6 inch layer, no difference in the numbers of bacteria and actinomycetes between the two cropping systems, higher numbers of fungi in the continuous cropping system than in the crop fallow system, and an increase in inorganic N as N fertility rate increases. A more rigorous analysis of the data will be completed when the laboratory work is complete.

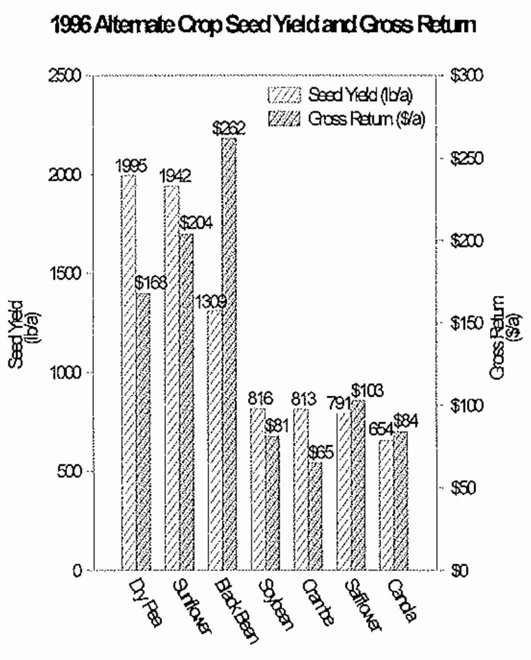
ALTERNATE CROPS FOR DRYLAND CROP ROTATIONS

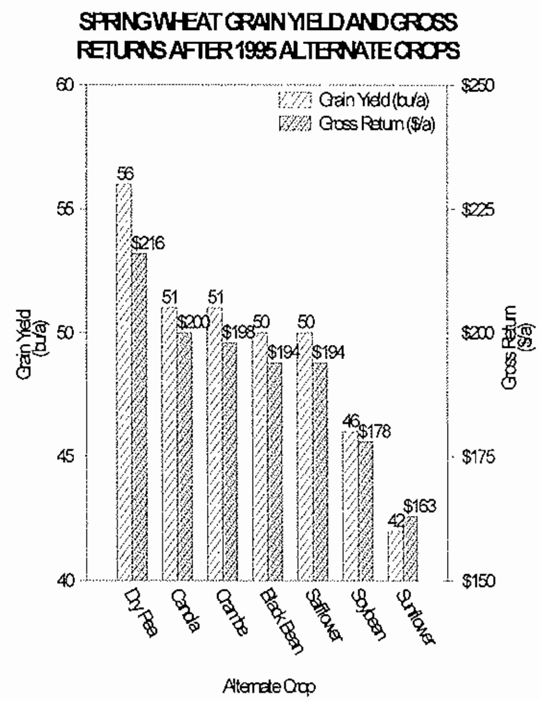
Drs. Donald Tanaka, Stephen Merrill, and Ardell Halvorson

Field F3. A study was initiated in 1995 to develop high residue cultural practices for the production of crops other than small grains using small grain equipment. Alternate crops included canola, crambe, safflower, dry pea, sunflower, dry beans, and soybeans. Sonalan (1 lb ai/a) was applied and incorporated in a one-pass operation with an undercutter that has 32 inch sweeps. All seeding was done with a JD 750 no-till drill. Canola, crambe, dry pea, and safflower were seeded on April 29, 1996. Sunflower, dry beans, and soybeans were seeded on May 23, 1996.

Crambe and canola did not compete well with weeds, yield and dollars per acre were greatly reduced for these crops. Crops that did the best were dry pea, sunflower, and dry bean (Black bean). Safflower was intermediate in gross returns. Soybean may have potential, but finding a variety suited for a specific environment may be difficult.

Spring wheat grain yield and gross returns were the greatest following dry pea and the least following sunflower. Protein has not been determined and gross returns may change depending on protein concentration.





ROW SPACING EFFECTS ON SUNFLOWER GRAIN YIELD IN A MINIMUM-TILL SYSTEM

Dr. Ardell Halvorson

Field H3. Narrowing the row spacing of sunflowers from the traditional 30 or 36 inch row spacings to less than 24 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 1996, 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 35,000 to 40,000 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 on May 30, 1996. Prior to planting, Sonalan 10G granules (1 lb ai/a) were applied with a Gandy applicator mounted on a Haybuster undercutter on May 23rd with a second undercutting on May 28th. This field had been in winter wheat in 1995 which was damaged by hail. The field was sprayed after winter wheat harvest on August 31, 1995 with Fallowmaster (4.5 oz ai/a). On April 24, 1996, 80 lb N/a as urea was applied broadcast by Cenex. Because of the hail damage to the winter wheat in 1995, there was severe weed pressure from volunteer winter wheat. The tillage operations to incorporate the Sonalan did not kill the volunteer winter wheat due to wet, cool conditions. Therefore, Ultima 160 was applied post emergence on June 17th at a rate of 3.25 oz ai/a. The winter wheat was controlled with the Ultima 160 application. Weed control was good in all plots. The field was aerial sprayed for insect control on July 30, 1996 with Asana XL (3.25 oz material/a). The sunflowers were harvested on October 9, 1996.

Sunflower grain yield, oil content, grain test weight, and harvest plant population are shown in Table 1. Grain yields at the 7.5 and 15 inch row spacings were significantly higher than the 30 inch row spacing. There was no significant difference in yield between cultivars. Cultivar and Row spacing resulted in significant differences in plant population. Cultivar caused a difference in grain test weight.

In addition to the replicated study, these same sunflower cultivars were planted in 7.5 and 30 inch rows in bulk field strip tests. The bulk field data shows that the sunflower yields from the 7.5 inch row spacing equaled that from the 30 inch row spacing. 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 observations on weed growth in narrow row vs wide row spacing are similar to those of 1995. This two year observation 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 1996.

Cultivar	Row Spacing, inches	Yield, lb/a	Oil Content, %	Test Weight, lb/bu	Harvest Population, plants/a
DeKalb 3790	7.5	2592	47.5	31.9	40,144
DeKalb 3790	15	2416	47.4	31.3	27,404
DeKalb 3790	30	2150	47.6	31.7	23,665
Pioneer 6150	7.5	2547	43.7	29.4	36,779
Pioneer 6150	15	2754	44.5	29.3	36,298
Pioneer 6150	30	2231	44.7	29.9	32,888

FUTURE PLANS: The study will continue in 1997 using a no-till system (no incorporation of herbicide) rather than a minimum-till system (two undercut operations to incorporate herbicide). Equal plant populations will be used in the 7.5 inch row spacing to that of the 15 and 30 inch rows.

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

Dr. Ardell Halvorson

Field F5. 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 20, 1996. The 15 and 30 inch treatments were planted with a new 6 row JD MaxEmerge II air planter. The 7.5 inch row spacing treatment was planted with a JD 750 no-till drill that had been calibrated in a stationary position. The corn was planted no-till into 1995 spring wheat stubble on the north end of field F6. The corn fields were sprayed with Roundup RT (9 oz ai/a) on May 13th. Fertilizer, 90 lb N/a (34-0-0) was broadcast about April 29, 1996. Atrazine plus Dual (8 oz + 24 oz ai/a) was applied on May 18, 1996. Accent herbicide (0.4 oz ai/a) was sprayed on all corn plots on June 17, 1996 to control pigeon grass (green and yellow foxtail). Weed control was good with only pigeon grass giving some problem late in the season. The corn plots were harvested on October 16, 1996.

Visual differences in weed competition would be for a slight reduction in pigeon grass 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 lower than expected from visual examination of the corn, probably because the grain was very dry at the time of test weight determination. Harvest plant populations were near the 16,000 plants/a goal for the 15 and 30 inch row spacing. However, the population with the 7.5 inch row spacing was very high for dryland corn. However, sufficient rainfall late in the growing season resulted in excellent grain yields. In 1997, we plan to calibrate the drill when in motion in a field.

Table 1. Corn grain yield (15.5% moisture), grain test weight, and harvest plant population as a function of row spacing in 1996.			
Row Spacing, inches	Grain Yield bu/a	Grain Test Weight, lb/bu	Harvest Population, plants/a
7.5	141.5	50.7	25,962
15	143.0	51.3	16,587
30	103.9	52.0	16,626

SPRING WHEAT TRIALS

Dr. Don Tanaka

Field F5. Spring wheat variety trials were initiated in 1979 and have continued with the cooperation of the Williston Research Center. New varieties for 1996 were Trenton and 2398. Varieties were seeded with a 7-foot Kirschmann drill in 6-inch rows on April 30, 1996 at a rate of 1.3 million viable seeds per acre. Seeding depth was 1 inch or less because adequate soil water was present for germination. Wheat plants emerged in less than six days. The field had been chemically fallowed the previous year and weed control prior to seeding was done with an undercutter at a depth of about 2 inches. Fifty pounds of N per acre and 10 pounds of P per acre were applied at seeding. Weeds in the crop were minimal because of the rapid wheat growth; broadleaf weeds were controlled using Buctril (16 oz/a). Potassium chloride (KCl), at the rate of 200 lb/a of material, was applied to part of two replicates before tillage.

Varieties performed well in 1996 with grain yields ranging from greater than 60 bu/a for 2375 and 2398 to 44 bu/a for Len (Table 1). The variety Grandin was seeded, but seeds did not germinate. All varieties had a good plant population and heads per square yard were 350 or greater. Kernel weight and kernels per head were grater in 1996 than in 1995; therefore, 1996 grain yields were greater. Grain protein for 1996 was higher than 1995 and ranged from a high of 16.0% for Len to a low of 12.8% for 2398. Most varieties were greater than 14.0%.

The addition of KCl to part of two replicates significantly increased straw yield and straw to grain ratio (Table 2). The grain yields for Coteau, Trenton, Kulm, and Vance were at least 5 bu/a greater where KCl was applied. The other varieties had no grain yield advantage from the addition of KCl.

Table 1. Spring wheat agronomic measurements for 1996 at Mandan, ND.

Variety	Grain Yield (bu/a)	Grain Protein[1] (%)	Grain Test Wt. (lb/bu)	Straw Yield (lb/a)	Straw to Grain Ratio	Plants per Yard²	Heads per Plant	Kernel Wt. (mg/ kernel)	Heads per Yard²	Kernels per Head	Plant Height (inches)	Plants per Viable Seed (%)
Len	44	16.0	60	4835	1.83	197	2.2	26.5	434	22	32	73
Coteau	50	15.3	61	5418	1.80	168	2.2	28.4	377	26	42	63
Ernest	50	15.0	62	5570	1.79	202	2.0	28.1	400	26	37	75
Trenton	50	14.6	62	4847	1.54	173	2.0	32.6	348	26	38	64
CDC Teal	51	15.8	61	4833	1.55	204	2.2	31.5	449	21	36	76
Stoa	51	14.9	60	5336	1.75	165	2.6	25.5	426	26	38	61
Kulm	55	14.8	62	4949	1.47	205	2.1	28.4	432	26	36	76
Vance	55	14.7	58	5245	1.65	168	2.4	28.5	398	27	32	63
Butte 86	56	15.1	62	4710	1.35	133	3.1	33.2	410	24	34	50
Prospect	57	13.7	61	5932	1.73	143	2.6	29.2	371	30	33	53
Amidon	58	14.6	62	5970	1.67	268	1.7	28.1	444	27	39	100
2375	62	14.0	63	4826	1.24	234	1.9	32.5	435	26	32	87
2398	69	12.8	63	5328	1.22	169	2.6	35.1	439	27	32	63
LSD	6	0.5	1	477	0.14	20	0.3	1.2	50	3	1	–

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

Table 2. Spring wheat agronomic measurements when potassium (K) was applied in 1996 at Mandan, ND.

Variety	Grain Yield (bu/a)	Grain Protein[1] (%)	Grain Test Wt. (lb/bu)	Straw Yield (lb/a)	Straw to Grain Ratio	Kernel Wt. (mg/ kernel)	Heads per Yard²	Kernels Per Head
Len	42	16.0	59	6585	2.91	28.6	472	17
Coteau	55	15.7	60	6991	2.09	30.8	431	24
Ernest	47	14.6	62	5958	2.15	29.7	439	21
Trenton	56	14.1	60	5178	1.53	32.5	403	24
CDC Teal	51	16.0	60	5455	1.78	32.2	461	20
Stoa	54	14.6	61	5541	1.70	31.2	415	24
Kulm	62	14.4	63	5427	1.39	30.7	489	24
Vance	67	14.4	59	6265	1.58	30.9	470	26
Butte 86	54	15.4	61	5447	1.66	34.2	431	21
Prospect	58	13.7	61	6653	1.94	31.3	478	22
Amidon	54	15.0	61	6221	1.88	30.6	450	23
2375	57	13.9	61	3987	1.18	32.8	542	18
2398	63	13.1	60	6187	1.64	33.8	499	21

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

SUNFLOWER IN CULTURAL SYSTEMS

Dr. Donald Tanaka

Field F3. A study was conducted in 1996 to compare conventional sunflower production using Sonalan (1 lb ai/a) in minimum-till (MT) and prowl (1.5 lb ai/a) in no-till (NT) when sunflower were planted in 30 inch rows (planted on May 23, 1996) with cultural sunflower production systems that had 15 inch rows, a delayed seeding date of June 10, 1996 and a plant population of 29,000. All seeding was done with a JD 750 no-till drill. Due to the cool-wet June, weed biomass was about two fold greater on the cultural systems when compared to the conventional systems. Seeding on June 10, 1996 may create problems with crop maturity and dry down in most years. Weeds reduced seed yield, head diameter, and kernel weight (Table 1). Similar treatments in the Central Plains favored the cultural system. Transposing conclusions from one location to another needs to be done with caution.

Table 1. Sunflower plant parameters as influenced by no-till and minimum-till in conventional and cultural systems in 1996.

Treatment	Seed yield lb/a	Head diameter inches	Test weight lb/bu	Kernel weight mg/seed
Conventional				
NT	1950	7.2	30.7	31.3
MT	2060	6.9	31.1	34.4
Cultural				
NT	1350	5.4	30	26.7
MT	1040	4.7	30.1	21.6

CONVERSION OF CRP TO CROP PRODUCTION

Drs. Donald Tanaka, Stephen Merrill, and Ardell Halvorson

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 cooperator, Mr. Keith 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. Spring wheat grain yield in 1995 was not influenced by haying, residue management, or N fertilizer, but grain protein was increased from 16.3% for zero N to 17.1% for 60 lb N/a. Roughrider winter wheat was seeded on October 3, 1995 at a 1.3 million viable seeds per acre. The late spring of 1996 caused a volunteer alfalfa problem in the winter wheat crop. Slow growth of winter wheat along with volunteer alfalfa made weed control difficult. No-till and minimum-till on the nonhayed plots with no fertilizer had the lowest yield (Table 1).

Table 1. Winter wheat grain yield when CRP was converted to crop production (1996).

	Hayed			Nonhayed		
	CT	MT	NT	CT	MT	NT
	--------------------------------bu/a----------------------------					
Nitrogen rate (lb/a)						
0	33	34	32	33	30	26
60	36	36	36	32	35	30

WEED SEED IN SOIL SEEDBANK

Drs. Ron Ries, Don Tanaka, and Ardell Halvorson

Field H1. 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. Understanding the dynamics of the soil seedbank of weedy species in the Northern Great Plains is important to the design of weed management strategies.

In the fall of 1995, a study to evaluate the soil seedbank of 14 locations with different past histories was begun. Locations included native rangeland heavily and moderately grazed since 1915; 1985 reseeded pastures of crested wheatgrass, western wheatgrass, and smooth bromegrass; 1993 reseeded grass plots of blue grama, western wheatgrass, and a mixture of bluegrama and western wheatgrass; and a spring wheat/fallow area with 0 nitrogen at the Area IV Farm with the treatments of conventional tillage, minimum tillage (undercut/herbicide), and no-till (herbicide only) seeded to spring wheat and conventional tillage, minimum tillage, and no-tillage summer fallowed. Duplicate soil cores 2 inches in diameter were taken at each location in soil depth increments of 0-1, 1-2, 2-4, 4-6 inches. One set of these cores will be mulched over sterilized soil in the greenhouse with the germinating and emerging seedlings counted and identified by species. The second set of cores will be washed from the soil and counted and identified by species. For the set of cores to be washed out, core samples were also collected at the soil depths of 6-9 and 9-12 inches to evaluate the possibility of buried seed at the 14 locations.

Soil cores taken in the fall of 1995 to a depth of 6 inches were mulched over sterilized soil during the winter of 1996 in the greenhouse. Trays with the mulched soil cores were kept under growing temperatures and watered for a period of 8 weeks to insure the germination of as many viable, non dormant seed as possible. Germinating seeds were counted and identified by species. Results observed during the 1996 mulch study are presented in Table 1 for the spring wheat/fallow locations. In the cropland areas, most seeds were found in the top 2 inches of soil and were primarily broadleaf plants. The fallow - minimum tillage treatment had the fewest seeds to a depth of 6 inches, 3 million seeds. The most seeds to a depth of 6 inches were found in the spring wheat - minimum tillage treatment, 93 million seeds. This is very preliminary data and until more coring dates are taken and evaluated, no real trend in seed numbers or distribution in the soil will be known.

During the past year, a seed washing devise has been complete. Field samples were again collected in the spring and fall of 1996 at each of the 14 sites with different crop/forage histories. During the winter of 1997 soil cores will again be mulched over sterilized soil in the greenhouse and washing out and counting of the seeds in the duplicate soil cores will begin.

Table 1. Weeds germinated from soil core taken from zero-N plots of the spring wheat-fallow study (field H1) after harvest -- 1995.						
	Soil Depth				Total	
Tillage	0-1"	1-2"	2-4"	4-6"	0-6"	Composition *
	---------------------in millions/acre---------------------					-------%-------
Conventional till-fallow	10	12	4	1	27	98/2
Minimum till-fallow	0.7	1.3	1	0	3	78/22
No-till-fallow	41	3	2	2	48	99/1
Conventional till-wheat	18	18	7	1	44	97/3
Minimum till-wheat	46	33	13	1	93	98/2
No-till-wheat	45	19	5	1	70	99/1

*Composition of weed seed -- % Broadleaf / % Grassy.

ANNUAL FORAGE CROPS FOR WEED MANAGEMENT IN CROP ROTATIONS

Drs. Ron Ries, Don Tanaka, and Ardell Halvorson

Field F4. Weeds in crops and forages can cause decreased production and a lessening of crop and forage quality. Control of weeds with herbicides must be properly and carefully done in order to insure minimal environmental damage. The better we understand weed development and growth in relationship to environmental conditions and specific crops, the better we can design effective weed management strategies for use in crop and forage systems. Inclusion of annual forage crops in spring wheat/sunflower crop rotations may result in different weed seed populations in the soil seedbank with improved weed control potential.

Areas of spring wheat and sunflowers stubble produced during the 1995 growing season were selected. During the 1996 growing season, lentils 'CDC Richly' , sudan grass 'Piper', millet 'Siberian', annual alfalfa 'Sava Snail', and spring wheat 'Amidon' were no-till seeded into the sunflower stubble. Also included was a chemical fallow of the sunflower stubble. Lentils, sudan grass, millet, annual alfalfa, oat/pea, leafless peas 'Profi', vine peas 'Arvia' and spring wheat were also no-till seeded on the spring wheat stubble. The annual alfalfa stand failed in the wheat stubble. An area chemical fallow of the spring wheat stubble was also included. All annual forage crops and the spring wheat were managed using the best practices for each of the crops.

Hay was harvested from each forage crop at the recommended growth stage. Hay production was 2079, 5373, 4317, 3270, 2901, and 3994 pounds/acre, respectively, for lentils, sudan grass, millet, oat/pea, leafless peas, and vine peas seeded in spring wheat stubble (Table 2). Annual alfalfa, lentils, sudan grass and millet were similarly seeded into sunflower stubble and yielded 988, 1836, 4640, and 3808 pounds/acre of hay, respectively (Table 2). The spring wheat plots, along with ½ of the annual forage crop plots were also harvested as grain. Grain yield was 1462, 368, 1363, 2092, 2443, 2665, and 2090 pounds/acre for lentils, sudan grass, millet, oat/pea, leafless peas, vine peas, and spring wheat, respectively, when seeded in spring wheat stubble (Table 2). In sunflower stubble, grain yields were 311, 1123, 347, 904, and 1853 pounds/acre for annual alfalfa, lentils, sudan grass, millet, and spring wheat, respectively. An estimated $ return/acre for both hay and grain is also provided in Table 2. Vine peas returned the greatest $/acre of all the hay crops - $130. Lentils grown in spring wheat stubble returned the most $/acre when sold at .15/lb - $219.

Weed development, seed numbers, and species were measured in each crop during the first 3 weeks of growth. Weed seeds in the soil seedbank will be identify and count from soil cores collected from 0-2, and 2-6 inch soil depth in each annual forage crop before seeding and after harvest. Soil samples have also been collected from the annual forage crop areas for overwinter analysis of total N and P.

Plans are to seed both the spring wheat and sunflower stubble areas in 1997. Weed emergence, growth, and seed content in the soil seedbank will be monitored on each original forage crop.

Table 2. Annual forage crop production -- 1996.

Annual Forage Crop	1/ $/T	Hay pounds/ acre	$/acre	1/$	Grain pounds/ acre	$/acre
Sunflower Stubble						
Annual Alfalfa	90	988	44	.70/lb	311	218
Lentils	65	1836	60	.15/lb	1123	168
Sudan Grass	30	4640	70	.20/lb	347	69
Millet	40	3808	76	.09/lb	904	81
Spring Wheat	--	--	--	3.89/bu	1853	120
Spring Wheat Stubble						
Lentils	65	2079	68	.15/lb	1462	219
Sudan Grass	30	5373	81	.20/lb	368	74
Millet	40	4317	86	.09/lb	1363	123
Oat/Pea	60	3270	98	3.75/bu	2092	131
Leafless Pea	65	2901	94	4.00/bu	2443	163
Vine Pea	65	3994	130	4.00/bu	2665	178
Spring Wheat	--	--	--	3.89/bu	2090	136

1/ Best estimate of crop value -- 12/18/96.

FORAGE GRASS BREEDING AND GENETICS

Dr. John Berdahl

Field G1. Forage yield, plant vigor, and nutritive quality data were collected on progenies of 107 fairway-type and 196 standard-type crested wheatgrass selections and 240 western wheatgrass selections. Hay yields averaged over all entries for 3 years were 4398, 4305, and 2793 lb per acre dry matter, respectively, for fairway crested wheatgrass, standard crested wheatgrass, and western wheatgrass. Nordan, Kirk, and Hycrest check cultivars of crested wheatgrass averaged 4853, 4820, and 4810 lb per acre dry matter yield, respectively. The fairway-type crested wheatgrass cultivar Ephriam averaged 2408 lb per acre and is not well adapted to the Northern Great Plains. Rodan and Rosana check cultivars of western wheatgrass averaged 3595 and 3524 lb per acre, respectively. For crested wheatgrass, 16 of the 107 fairway-type progenies and 29 of the 196 standard-type progenies averaged greater hay yields than Nordan over the 3-year test. For western wheatgrass, 17 of the 240 progenies had greater yields than the Rodan check. Parents for new experimental strains of crested and western wheatgrass will be selected based on yield and nutritive quality data on these progenies. New cultivars will not have substantial increases (greater than 10%) in forage yield over current cultivars, but there is good promise for improving forage digestibility and animal performance from these grass species.

PRECISION FARMING PROJECT - PERSISTENCE OF VARIABILITY, GRID VS. TOPOGRAPHY SAMPLING AND FIRST YEAR ECONOMIC ANALYSIS

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INTRODUCTION

Precision farming is the management of zones within fields, as compared to the conventional method of farming fields uniformly within field boundaries. Precision farming intuitively suggests that plant nutrient levels may be better managed if fields are sampled and fertilizer applied in a manner to take advantage of within field differences.

The success and justification of this assumption depends on the level of variability within a field, and the economic and environmental benefits of determining and managing the variability. This project began in 1995 as a joint cooperative effort between USDA-ARS and NDSU Extension.

METHODS

Fields I4, I5, I6. The study is being conducted on the I4, I5 and I6 fields at the Area IV Research Farm, operated by the USDA-ARS at Mandan. Soil samples were taken on a 110 ft. grid in the I6 field (east field), while the other two fields were sampled on a 150 ft. grid. Topography was determined using a laser-surveying device to measure relative elevation in a 110 ft. grid. Soil cores are taken from the 0-2 ft. levels, dividing the cores into 0-6 inch and 6-24 inch increments. Topography sampling was based on 14 sample points from the field, each representing a different topographic polygon determined from the elevation mapping and from 1995 yield monitor results. Grid sample comparisons were made by deleting sample numbers from the field data set, leaving sample points representing different size grids, then producing a map of field nutrient levels using the new grid size. Estimates were correlated with the original dense grid sampling after deleting common points to eliminate autocorrelation of values.

The fields were divided into nutrient management grids. The nutrient management grids were treated randomly with fertilizer rates from one of three different methods:

Uniform urea and 11-52-0 using a composite sample.
Variable urea and 11-52-0 using a 4.5 acre grid.
Variable urea and 11-52-0 using topographic sampling.

Fertilizer rates were applied in the spring of 1996 using a Concord air-seeder equipped with independently operated dual fertilizer storage tanks modified for variable-rate fertilizer application. The sunflower variety was DK3868, the center field wheat variety was Kulm, and the east field wheat variety was Amidon.

Yields were measured and georeferenced with a Micro-trak© yield monitor during the fall of 1996. Samples of grain were collected and georeferenced. The grain was analyzed for protein and test weight in wheat, and oil in sunflower. Following harvest, residue samples were collected in each sampling grid in a 2 ft square area, dried and weighed. A residue map was made for the fields. Mapping of soil, yield and residue yield was conducted using Surfer for Windows 3.0.

RESULTS and DISCUSSION

Stability of nutrient levels over the first two years.

Some soil nutrient levels were stable over time and rotation, while others changed, perhaps because of rotation differences or other factors. Phosphate, K, pH, sulfate and chloride levels between 1995 and the 1996 samplings (Figures 1-5 respectively) were similar between years.

Soil nitrate-N was different between the two years (Figure 6). In 1995, sunflower was grown on the center field, resulting in a depletion of soil nitrate-N except for a drowned out area in the north part of the field showing high nitrate-N levels. Final rates of N applied for both the center and east fields were similar, with some variation within the fields due to variable-rate treatment differences. However, in 1996, the nitrate-N levels in the center field following sunflower in 1995 resulted in ending nitrate-N consistently 10-20 lb/acre higher than the east field.

Two possible reasons for the apparent difference could be given from the data. First, organic matter levels (Figure 7) are generally higher in the center field than the east or west fields. However, higher organic matter levels are wider east and west than the center field boundaries. The higher nitrate-N levels have relatively sharp boundaries at the field edges. The second reason could be that sunflower takes up more N than is removed by seed harvest and that a portion remains behind in the residue. It is reasonable to speculate that sunflower residue contains a lower C/N ratio than wheat straw and decomposition could proceed at a much faster pace, releasing more N for the following crop than wheat on wheat.

Further evidence that mineralization is faster after sunflower comes from the residue yield map (Figure 8). The center field of wheat contains about 1000 lb/acre less residue than either the sunflower field in the west or the wheat on wheat in the east. Some of the residue, from its condition in these no-till fields comes from previous years. However, the center field averages about 2200 lb/acre, while the west and east fields average about 3200 lb residue per acre. This difference in residue could be the result of increased decomposition of both wheat straw and sunflower residue from previous years from sunflower residue decomposition.

Grid vs Topography

Topography nutrient level mapping was conducted using 14 sample point locations within the three field area. The west field was defined by three areas, the center field by five and the east field by six areas. Despite these low sample numbers, the correlation of nitrate-N, chloride, phosphate and sulfate-S was higher than most grid soil sampling strategies, especially nitrate-N, which was higher than all tested grid sampling densities (Table 1). Topography sampling also defined nitrate-N level boundaries within the fields better (Figure 9).

Table 1. Correlation (r) of nitrate-N, phosphate, chloride and sulfate-S from grid and topography sampling designs with 110 ft.-150 ft. grid spacing levels, 1995.

Nutrient	Topography	220 ft. grid	330 ft. grid	5 acre grid
Nitrate-N	0.76	0.29	0.44	0.23
Phosphate	0.58	0.58	0.22	0.58
Sulfate-S	0.13	0.48	0.24	0.08
Chloride	0.22	0.56	0.44	0.23

Profitability of site-specific sampling strategies and variable-rate N and P application on sunflower and spring wheat.

In the west field grown to sunflower in 1996, harvest was made on 10/14/96. Yields were adjusted based on hail damage estimates made on the crops. Hail damage ranged from 9-22% in the west field, to 8-67% in the center field to 64-65% in the east field. Given the yield estimates made after the hail damage was taken into consideration, the economic analysis of different sampling directed fertilizer applications must be taken with some degree of caution, particularly in the center and east fields.

Average yield in the conventional treatment for sunflower was 1651 lb/acre. The 4.5 acre grid out-yielded the conventional by 200 lb/acre, and the topography directed application out-yielded conventional by 219 lb/acre. Cost of fertilizer for topography directed application was slightly lower than grid fertilizer. Fertilizer costs were figured at $0.14/lb urea and 11-52-0 at $0.135/lb. Cost of sampling was figured at a commercial rate of $5/acre for topography, $10/acre for a grid and $0.75/acre for a composite sample for each of the three fields ($20/field, 3 fields, approximately 80 acres sampled). The price received for the sunflower crop was $0.1175/lb delivered. Results are presented in Table 2.

Table 2. Profitability of variable-rate N and P on sunflower at Mandan, 1996, directed by topography or 4.5 acre grid sampling compared to a conventional, uniform application of N and P from a composite sample.

Treatment	% Oil	Yield	Gross Return	Fertilizer cost	Sampling cost	Net Return	Net gain/loss
Conventional	45.9	1651	$193.99	$24.36	$ 0.75	$168.88	----------
Variable/grid	45.5	1851	$217.49	$26.31	$10.00	$181.18	$12.30
Variable/topography	45.1	1870	$219.73	$24.96	$ 5.00	$189.77	$20.89

In the center field, I5, adjusted spring wheat yields averaged 58.5 bu/acre adjusted for hail in the conventional treatments. Wheat price for the analysis was set at $4.00/bushel. The results of the analysis are presented in Table 3. Topography directed fertilizer N and P resulted in a net loss of $1.30/acre, while the grid sampled N and P fertilizer application resulted in a net loss of $7.15/acre. There were no differences in protein levels between treatments.

In the east field, hardest hit by hail, adjusted spring wheat yields averaged 79 bu/acre in the conventional treatments. Topography directed N and P resulted in a net loss of $12.96/acre and the grid directed N and P resulted in a net gain of $1.49/acre. There were no differences in protein between treatments.

Table 3. Profitability of variable-rate N and P on spring wheat yields from I5 at Mandan, 1996 (center field), directed by topography or 4.5 acre grid sampling compared to a conventional, uniform application of N and P from a composite sample.

Treatment	Yield bu/acre	% Protein	Gross Return	Fertilizer cost	Sampling cost	Net Return	Net gain/loss
Conventional	58.5	14.1	$234.00	$30.57	$0.75	$202.68	--------
Variable/grid	59.5	14.2	$238.40	$32.87	$10.00	$195.53	-7.15
Variable/topography	59.6	14.1	$238.00	$31.62	$5.00	$201.38	-1.30

Table 4. Profitability of variable-rate N and P on spring wheat yields from I6 at Mandan, 1996 (East field), directed by topography or 4.5 acre grid sampling compared to a conventional, uniform application of N and P from a composite sample.

Treatment	Yield bu/acre	% Protein	Gross Return	Fertilizer cost	Sampling cost	Net Return	Net gain/loss
Conventional	79.0	11.8	$316.00	$32.67	$0.75	$282.58	--------
Variable/grid	81.6	11.9	$326.40	$32.33	$10.00	$284.07	+1.49
Variable/topography	77.1	11.9	$308.40	$33.78	$5.00	$269.62	-12.96

Given 21 acres in the west field, 29 acres in the center field and 29 acres in the east field, the total gain/loss from using grid sampling to direct P and K on the whole farm was +$94.16. The total gain/loss from using topography sampling on the farm was +$25.15.

The lack of more substantial gain by gridding and topography sampling may have been related to the lack of variability of N within the fields. The conventional application of urea, for example, was 187 lb/acre in the east field. The grid and topography based urea application had a range of between 171 and 209 lb urea/acre. There was little opportunity for major yield and protein adjustments due to the narrow range of variability. Also, the uncertainty of the variability of hail damage within the fields probably served to distort our measurement of actual yields within the fields, due to the assumptions made when adjusting for hail damage. Judging from the low protein levels of the Amidon variety wheat in the east field, we would have expected substantially higher yield measurements if hail had not fallen, but the adjusted yields between 70 and 80 bu/acre are probably not realistic.

Environmental benefits

Environmentally, reduction in soil nitrate-N at the end of the growing season may result in less risk of nitrate leaching with spring moisture. Table 5 shows the change in nitrate-N levels between 1995 and 1996 from conventional and variable-rate N treatments.

Given the acres in each field, use of the conventional N and P levels resulted in a net gain of 91 lbs nitrate-N within the field over levels in the fall of 1995. Using grid sampling, a gain of 351 lbs nitrate-N was produced, over the fall 1995 levels. Using topography sampling directed N application, a net loss of 299 lbs nitrate-N was achieved. The difference using topography directed N compared to conventional N was 390 lbs of N less over the entire field.

Table 5. Change in soil nitrate-N levels from fertilizer N treatments 1995 to 1996. Mandan, 1996, west field (sunflower following spring wheat), center field (wheat following sunflower) and east field (wheat following wheat).

Treatment	Change in soil nitrate-N levels, lb/acre 2 ft.		
	west field	center field	east field
Conventional	-0.9	+ 8.1	-4.3
Variable/grid	-6.9	+20.2	-3.1
Variable/topography	-6.1	- 1.6	-4.3

SUMMARY

Certain soil nutrient levels showed stability between 1995 and 1996, including P, K, pH, chloride and sulfate-S. Nitrate-N levels showed differences perhaps due to soil organic matter levels or mineralization by sunflower residue. Residue levels were decreased in wheat one year following sunflower, suggesting increased mineralization. Topography was better correlated than grid sampling for expressing soil nitrate-N levels, while a 220 ft. grid was more highly correlated with soil chloride, phosphate and sulfate levels than topography. Topography was more highly correlated than a 5 acre grid for P, S and Cl.

There were small net economic gains in using both the grid and topography sampling for the combination of fields. Hail damage on especially the center and east fields in 1996 may have interfered with a more realistic view of treatment effects on these fields.

This is year two of a project scheduled for at least two more years. The basic work will be repeated within the normal rotational crop sequence of the I4-I6 fields in 1997.

Acknowledgments

Thanks to Marvin Hatzenbuhler and Jim Harms for helping tool and run the seeding, harvesting, and fertilizer equipment necessary for this project. Also to Larry Renner for yield mapping services. Partial support for this project was provided by the Potash & Phosphate Institute, Agrium, Ltd., USEPA Regional 319 Water Quality funds, the Stutzman Co. SCD, Wild Rice SCD, Area IV SCD-ARS Research Farm, Concord/Case IH, NDSU Soils Dept., and USDA-ARS.

Figure 1. Mandan P levels, 1995 and 1996.

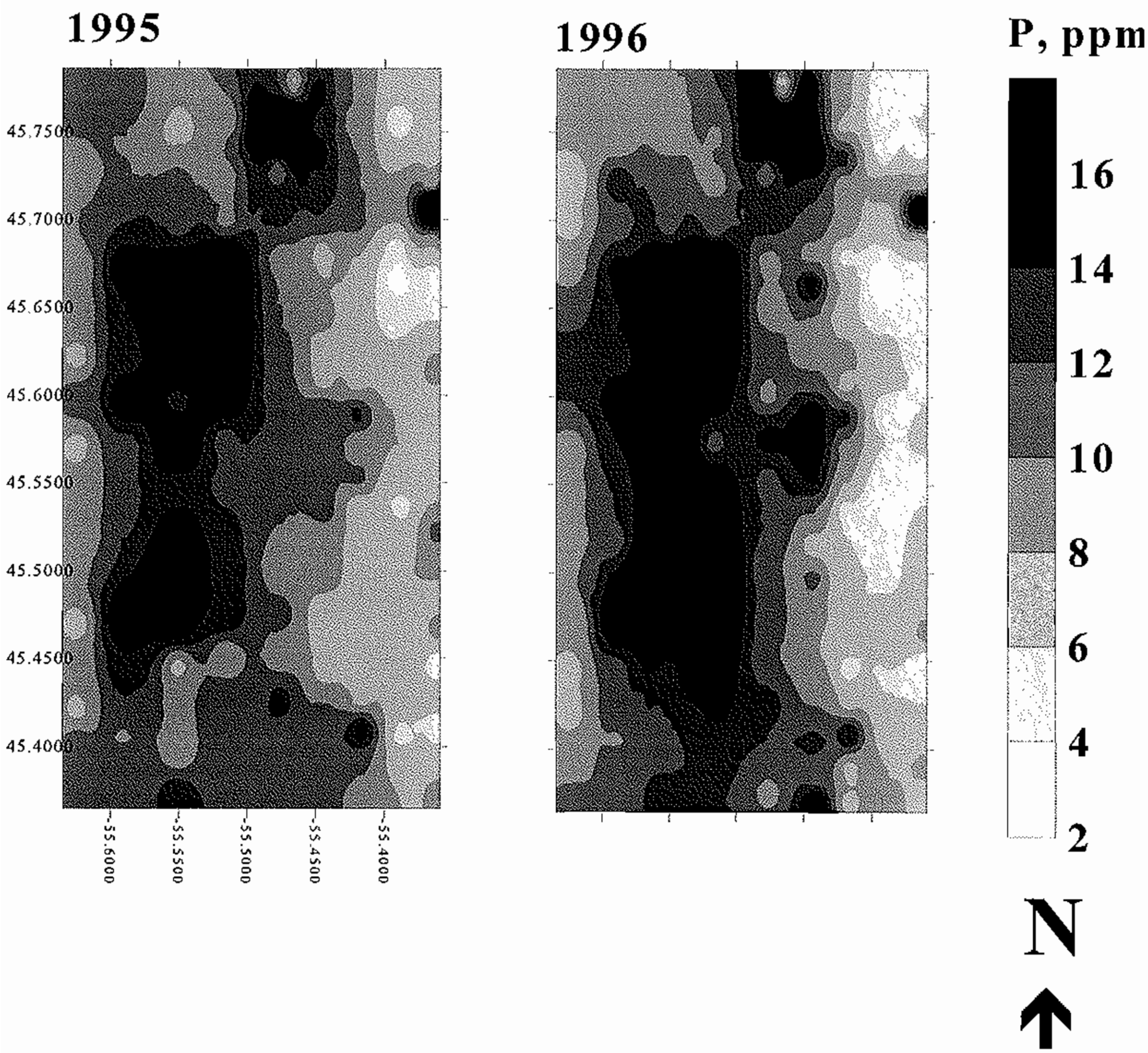

Figure 2. Mandan K levels, 1995 and 1996.

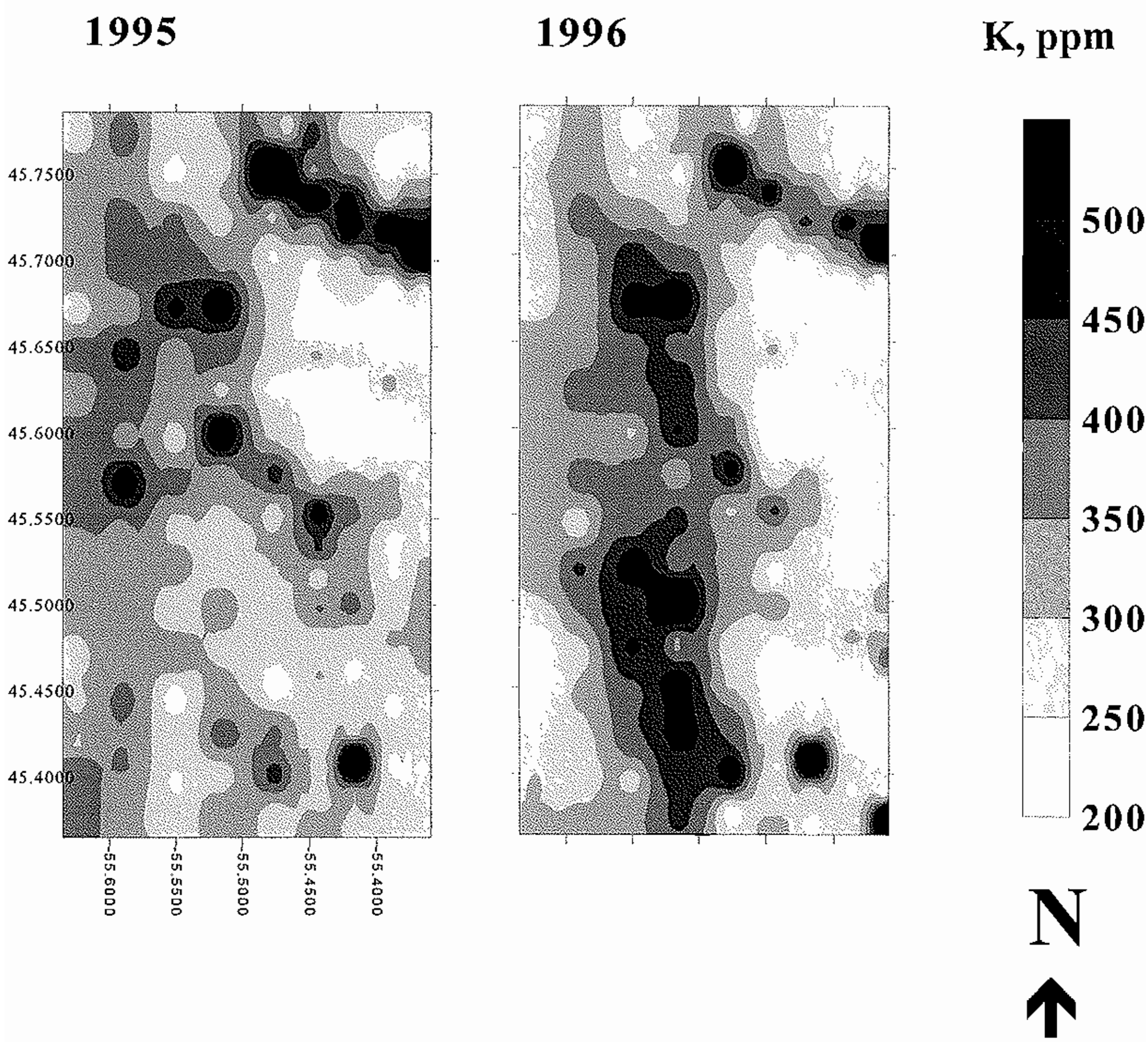

Figure 3. Mandan pH levels, 1995 and 1996.

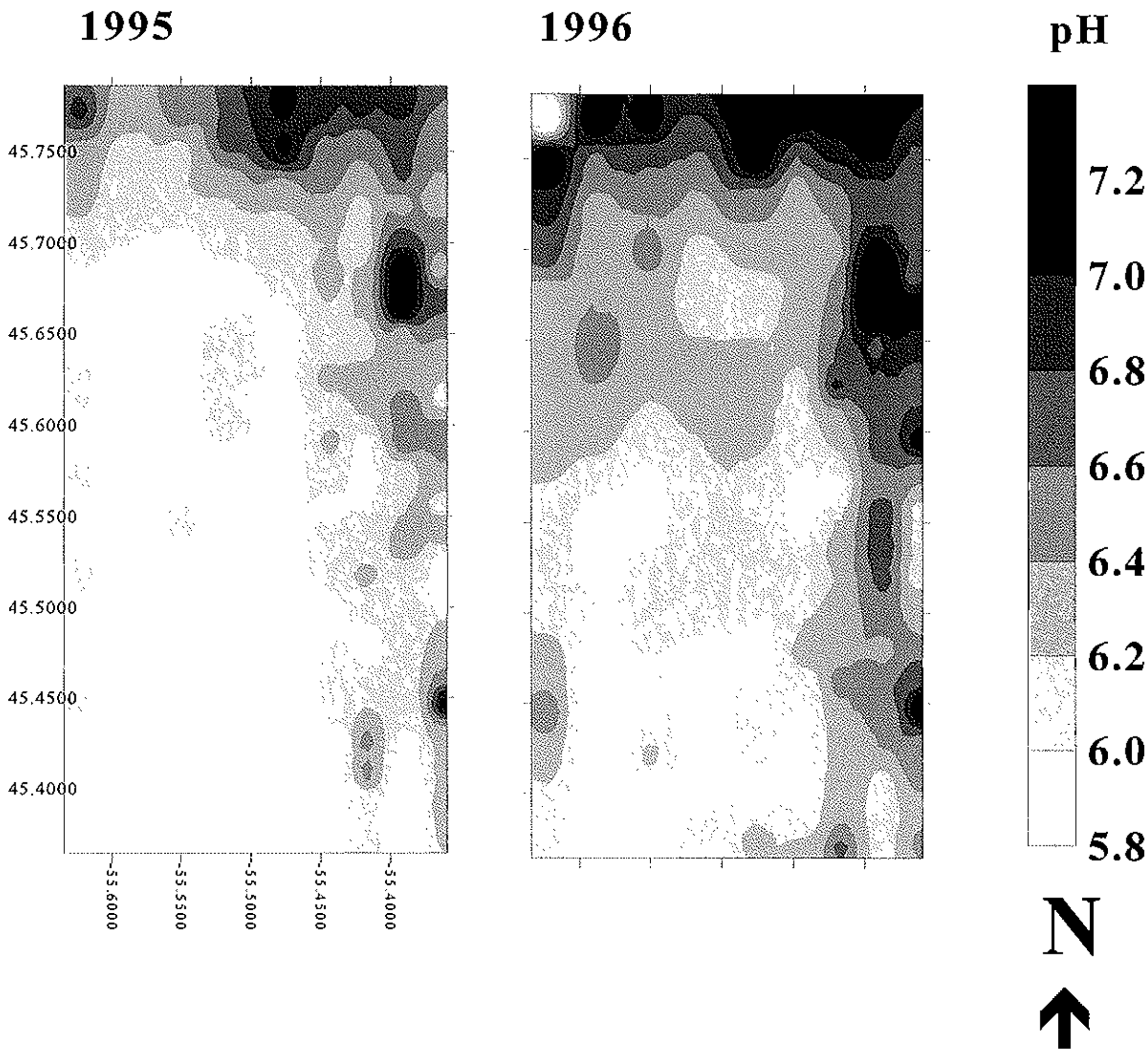

Figure 4. Mandan sulfate-S levels, 1995 and 1996.

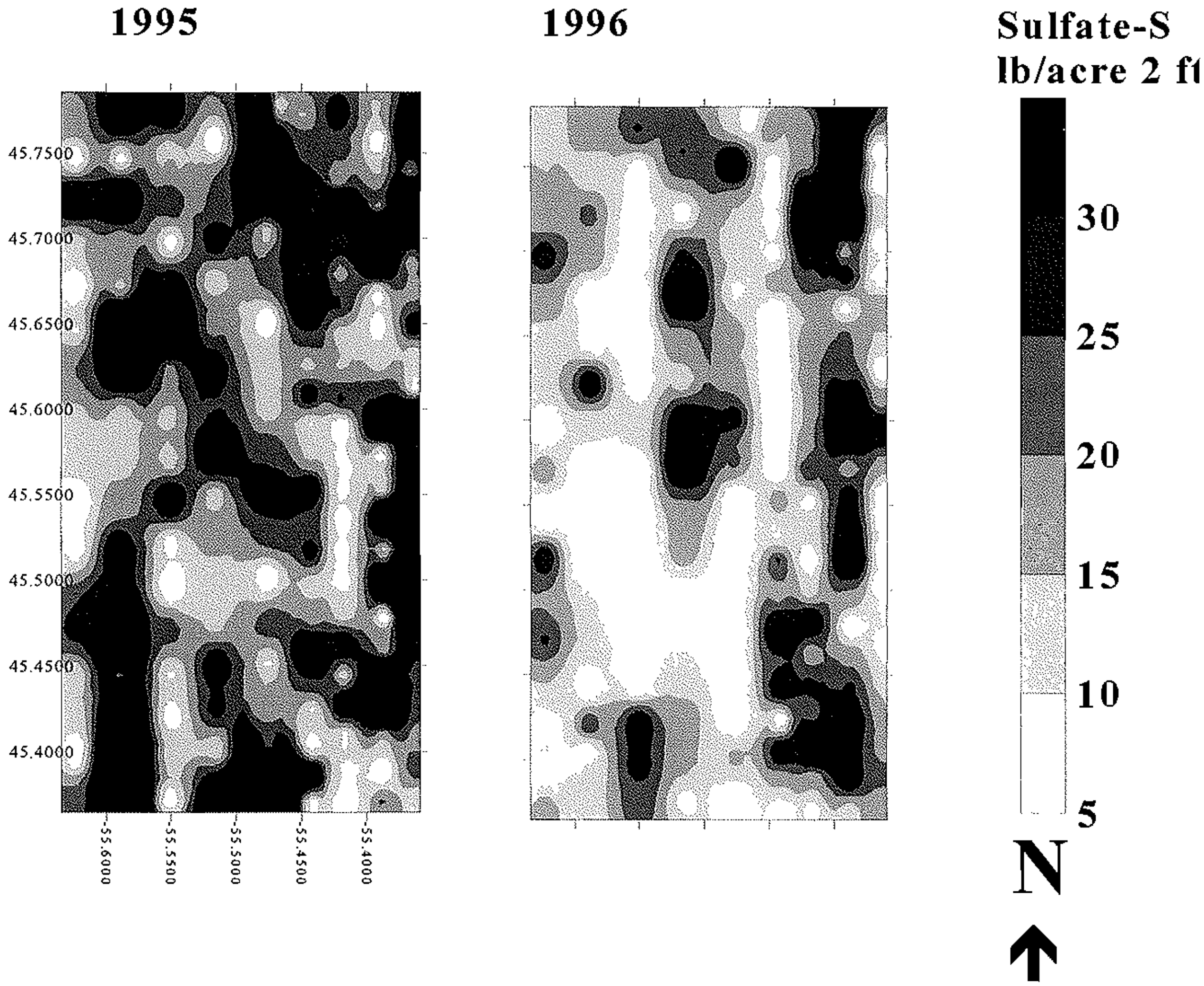

Figure 5. Mandan chloride levels, 1995 and 1996.

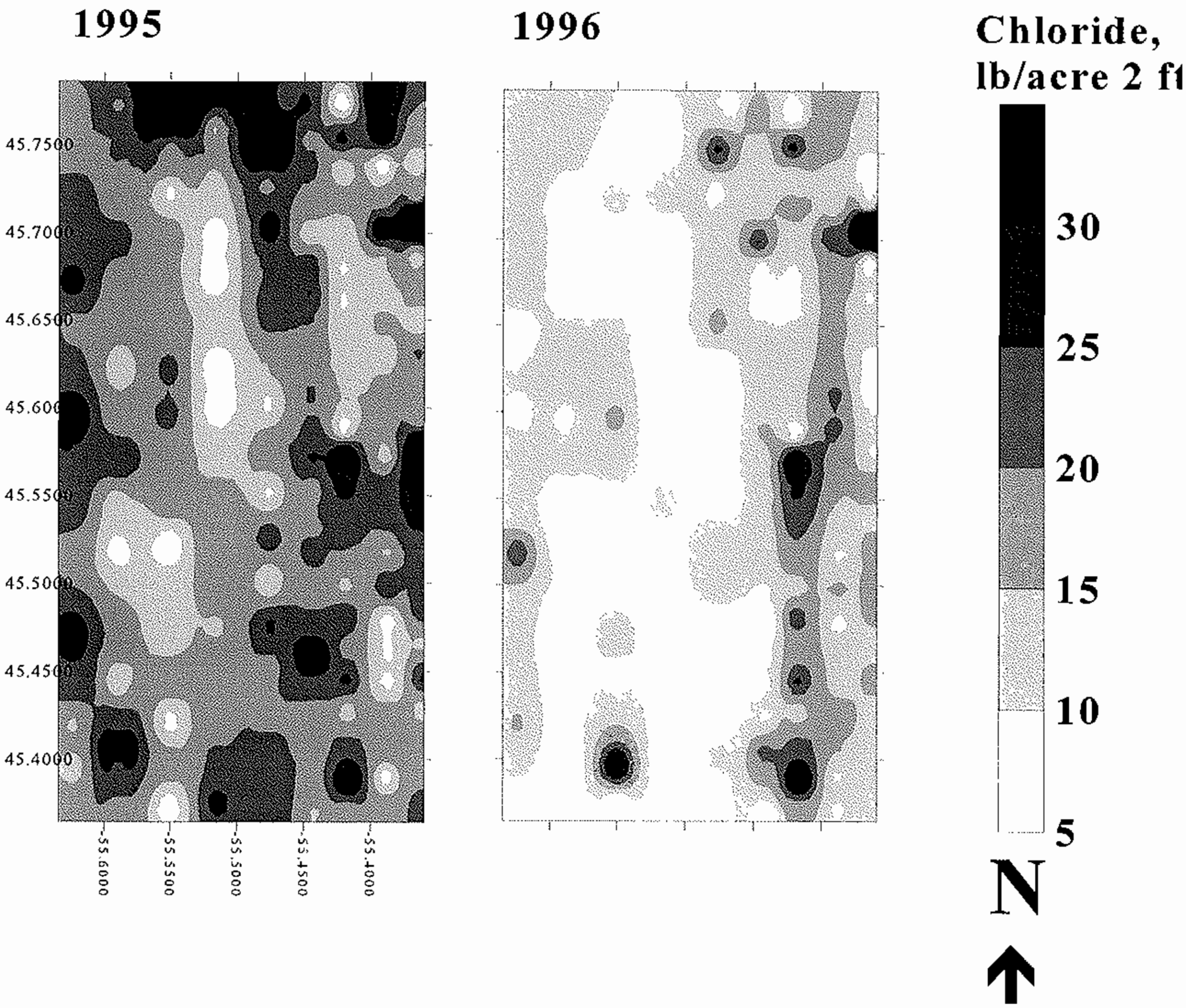

Figure 6. Mandan 0-2 ft. nitrate-N levels, 1995 and 1996.

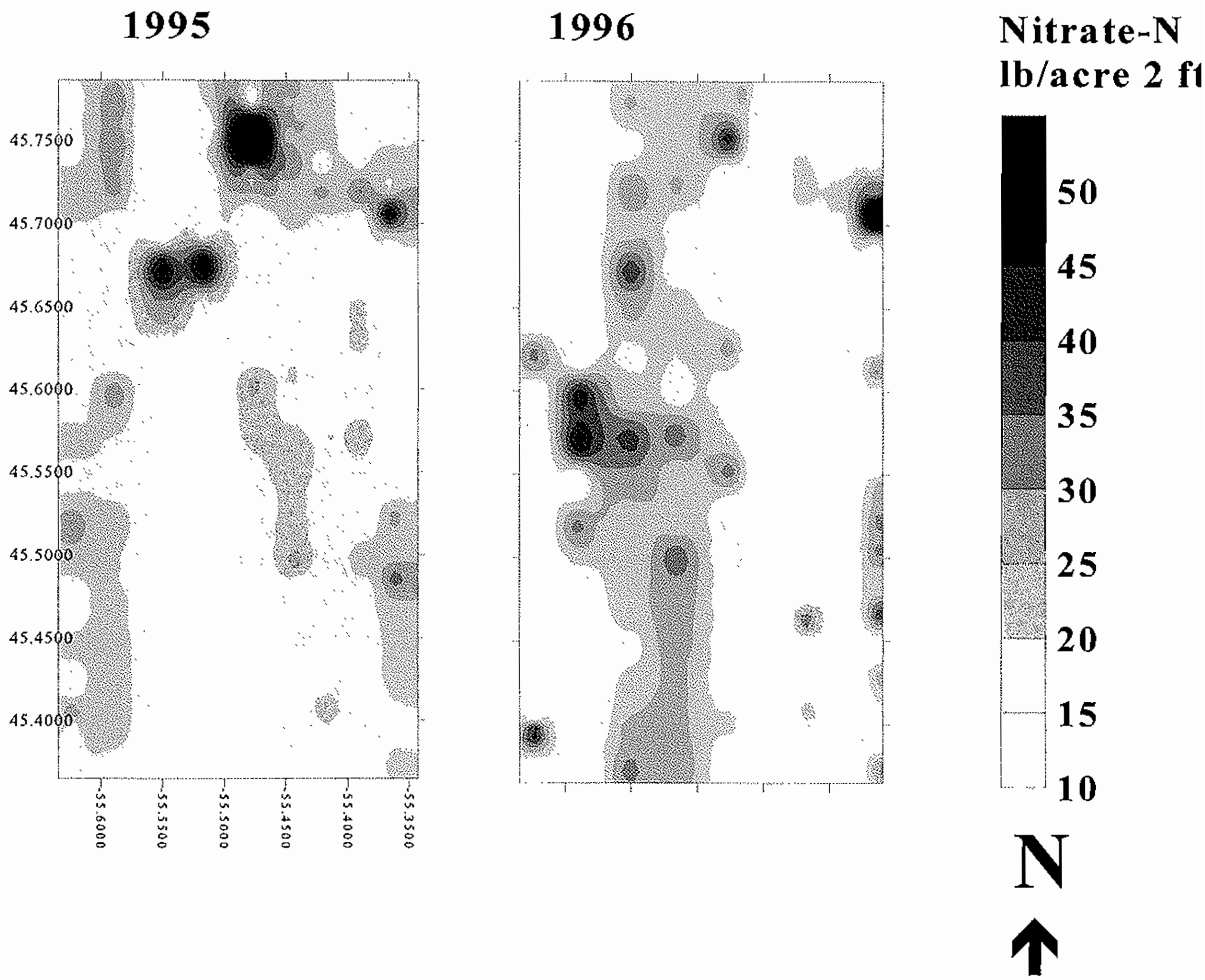

Figure 7. Mandan organic matter levels.

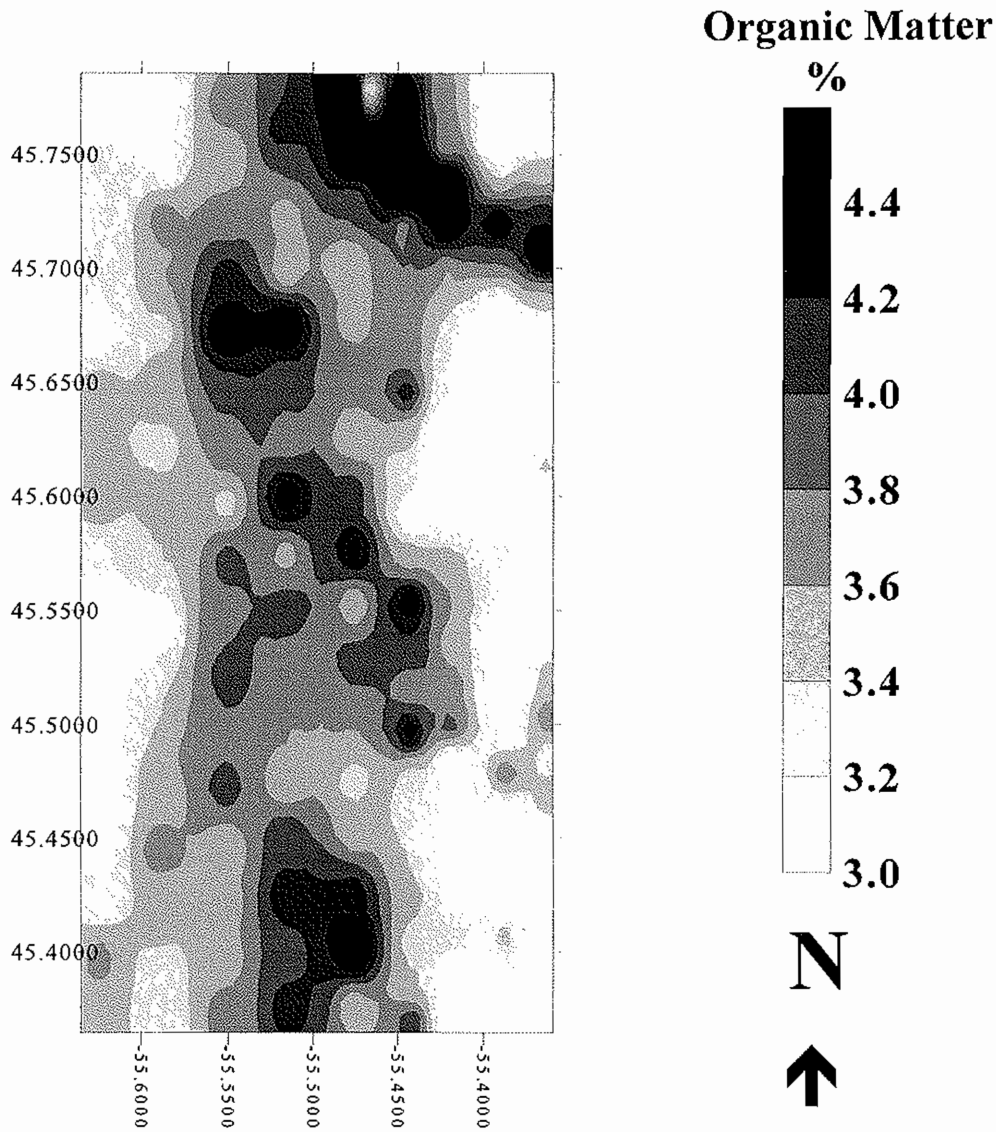

Figure 8. Mandan residue levels, 1996.

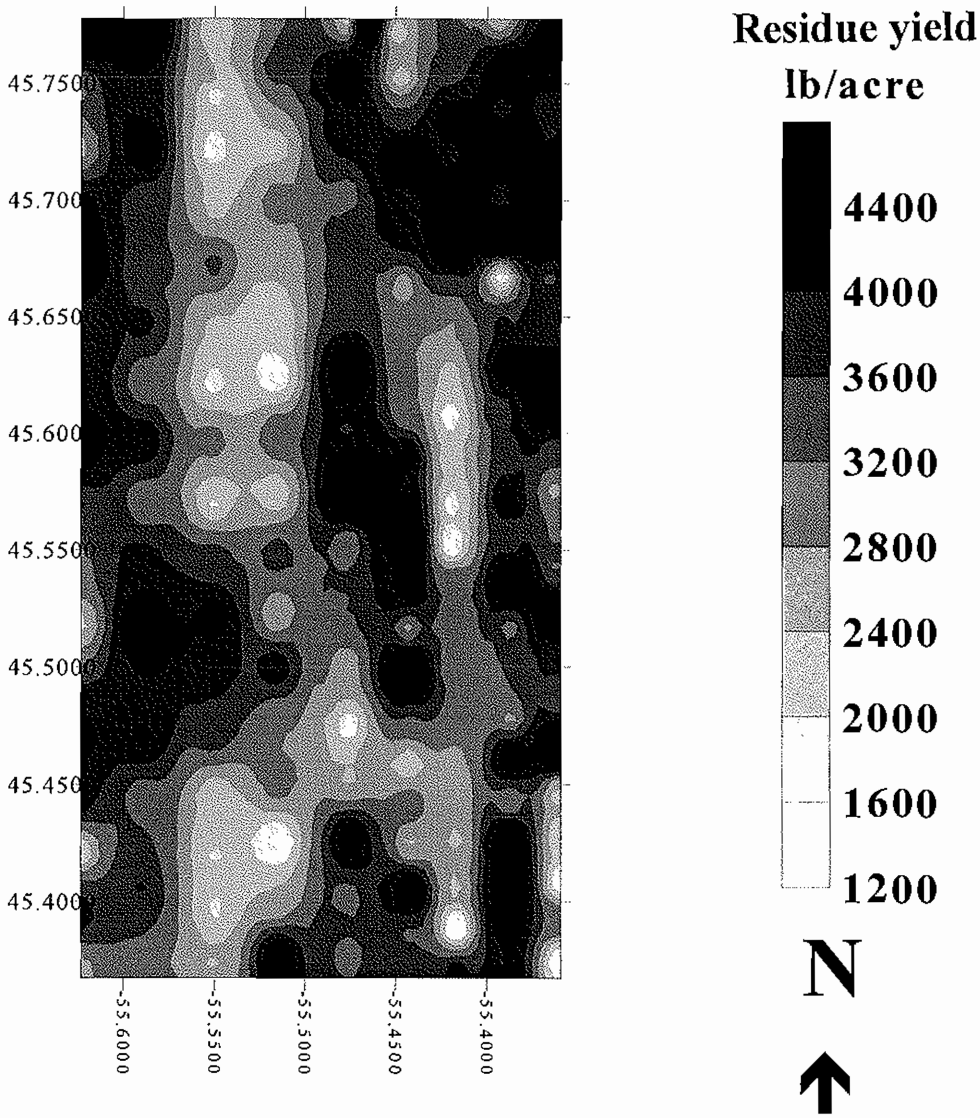

Figure 9. Mandan 0-2 ft. nitrate-N levels at selected grid spacings compared to topography sampling using 14 sample points, 1995.