Area IV SCD Cooperative Research Farm
USDA-ARS Northern Great Plains Research Laboratory
2004 Research and Cropping Results
Twenty-first Annual Progress Report
February 22, 2005

Scientific Staff

Jon Hanson, Laboratory Director, Rangeland Scientist

John Berdahl, Research Geneticist
Holly Johnson, Rangeland Scientist
Scott Kronberg, Animal Scientist
Mark Liebig, Soil Scientist
Kris Nichols, Soil Microbiologist
Eric Scholljegerdes, Animal Scientist
Jason Gross, Soil Scientist
John Hendrickson, Rangeland Scientist
Joseph Krupinsky, Plant Pathologist
Steve Merrill, Soil Scientist
Donald Tanaka, Soil Scientist

Collaborators & Cooperators

Al Frank, NGPRL Plant Physiologist (retired)
Jim Karn, NGPRL Research Animal Scientist (retired)
Rich Cunningham, NGPRL Research Geneticist (retired)
Eric Eriksmoen, NDSU Research Agronomist, Hettinger Research Extension Center
Vern Hofman, NDSU Cooperative Extension Agricultural Engineer
Joel Ransom, NDSU Cooperative Extension Agronomist

Field Support Staff

Bruce Boehm, Justin Hartel, Marv Hatzenbuhler, Gordon Jensen, Curt Klein, Faye Kroh, Larry Renner, Delmer Schlenker, Mary Kay Tokach, and Dawn Wetch.

ACKNOWLEDGMENTS

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USDA-ARS Northern Great Plains Research Laboratory
PO Box 459 • Mandan, ND 58554-0459
Phone: 701/667-3000 • FAX: 701/667-3054 • www.mandan.ars.usda.gov

TABLE OF CONTENTS

AREA IV SCD COOPERATIVE RESEARCH FARM

The Area IV SCD Cooperative Research Farm is the result of a specific cooperative agreement between USDA-ARS and twelve Soil Conservation Districts (SCDs) that comprise the North Dakota Area IV Soil Conservation Districts. This agreement was put in place in 1984. Through this agreement, Area IV SCDs lease cropland from the Nelson estate for USDA-ARS Northern Great Plains Research Laboratory scientists to conduct cooperative research projects with the Area IV SCDs. Total cropland leased by Area IV SCDs is 382 acres. In addition, USDA-ARS has leased an additional 55 acres for long-term soil and water conservation research and, since 1989, another 26 acres for tree plantings. Total acreage leased for research purposes is 463 acres. The Area IV SCD Cooperative Research Farm is located southwest of the USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND.

MESSAGE FROM DR. JON HANSON

LABORATORY DIRECTOR

USDA-ARS Northern Great Plains Research Laboratory

Four years ago, we began to work on our current suite of projects emphasizing the development of cropping systems for the northern Great Plains. Our research centered on the cropping matrix and it eventually resulted in the development of the Crop Sequence Calculator. This year we passed a milestone by distributing our 10,000th copy of the computer program. Subsequently, we developed and are promoting the concept of Dynamic Agricultural Systems. All of this fundamental and important research has been accomplished because of the creation of the Area IV SCD Cooperative Research Farm created through the joint efforts between several North Dakota Soil Conservation Districts and the USDA Northern Great Plains Research Laboratory. This unique joint venture continues to allow USDA-ARS scientists to investigate current or potential economically important crops and crop management systems. Through conscientious use of the research farm, our scientists are able to provide scientifically acceptable natural resources investigation within the framework of real world farming practices.

We no longer live in the same world we did four years ago. Agriculture has successfully met the food and fiber needs of most of the world's population. Specifically, today's agriculture feeds a population of more than six billion people using only 2,000 m^2 of land per person. Despite these impressive achievements, there are concerns about the sustainability of modern agriculture. Intensive agriculture impacts the resource base and potentially reduces both its capacity and its sustainability. In the Great Plains, many cropping systems are characterized by a lack of diversity and declines in soil organic carbon. At the same time, beef production in the United States has done an excellent job of developing animals that can efficiently convert feed grains into meat acceptable for human consumption (i.e. feedlots), but as a result it is heavily dependent on fossil fuels.

We must continue to push the envelope of agricultural systems. We continue to strive to provide producers with alternatives in their management practices. That includes the use of a diversity of crops with the capacity to compensate for various climatic trends and innovative methods for improving and protecting the soil resource. Current federal funding proposals are beginning to impact our ability to continue conducting these very important research projects. Production agriculture is not receiving increased funding, even at the rate necessary to keep up with inflation. Thus,

- We must change our strategy for meeting the needs of future farmers.
- We must be prepared to examine innovative ways to integrate crop and crop products in enterprises on the farm.
- We must be creative in developing new research projects that fulfill our mission at the Area IV SCD Research Farm and also leverage us for enhanced funding.
- We must concentrate on the areas that are receiving enhanced federal funding as we consider our new projects over the next five years.

The proposed federal budget, released earlier this month for the ARS, targets the Nation's highest food and agricultural priorities. Nearly half of the increases for ARS are in homeland security research in the areas of food safety, emerging and exotic diseases of animals and crops, and for the National Plant Disease Recovery System. Other ARS program initiatives include research on genetics and genomics, bio-based products and bio-energy, air and water quality, and climate change. To best serve northern Great Plains producers, we will develop world-class research projects with emphasis in crop and food safety, biofuel development, and climate change.

By combining new lines of research with our current mission, our ongoing research will provide direction for future Agricultural policy decisions as well as help family farmers successfully thrive on the land and improve the resource for future generations. We will continue to strive to include the sustainability of the family farm in the research we conduct.

SCIENTIFIC RESEARCH STAFF
NORTHERN GREAT PLAINS RESEARCH LABORATORY

Dr. John Berdahl	Research Plant Geneticist: plant breeding and genetics of forage grasses and alfalfa. berdahlj@mandan.ars.usda.gov (701) 667-3004
Mr. Jason Gross	Soil Scientist: alternative cropping, forage, and tillage systems; soil quality. greenhouse gas flux, and carbon sequestration grossj@mandan.ars.usda.gov (701) 667-3006
Dr. Jon Hanson	Lab Director and Research Leader - Rangeland Scientist: integrated crop and forage/livestock systems; rangeland ecology; systems ecology. jon@mandan.ars.usda.gov (701) 667-3010 FAX (701) 667-3023
Dr. John Hendrickson	Rangeland Scientist: integrated crops/livestock/forage systems, range ecology, range management. hendricj@mandan.ars.usda.gov (701) 667-3015
Ms. Holly Johnson	Rangeland Scientist: rangeland ecology; biology. johnsonh@mandan.ars.usda.gov (701) 667-3003
Dr. Scott Kronberg	Research Animal Scientist: plant-animal interactions/nutrition/behavior/ rangeland ecology/rangeland management. kronberg@mandan.ars.usda.gov (701) 667-3013
Dr. Joe Krupinsky	Plant Pathologist, Tan spot and Septoria diseases of wheat and Sclerotinia (white mold) diseases on broadleaf crops. Minimizing disease risks in cropping systems with management practices (e.g. crop sequencing, biological control) krupinsj@mandan.ars.usda.gov (701) 667-3011
Dr. Mark Liebig	Soil Scientist: alternative cropping, forage, and tillage systems; soil quality, greenhouse gas flux, and carbon sequestration liebigm@mandan.ars.usda.gov (701) 667-3079
Dr. Steve Merrill	Soil Scientist: soil conservation, erosion, and hydrology in diverse soil and land production systems. merrills@mandan.ars.usda.gov (701) 667-3016
Dr. Kris Nichols	Soil Microbiologist: soil health; glomalin, biomass, switchgrass development; carbon sequestration. nicholsk@mandan.ars.usda.gov (701) 667-3008
Dr. Eric Scholljegerdes	Research Animal Scientist: plant-animal interactions/nutrition/ behavior/rangeland ecology/rangeland management. schollje@mandan.ars.usda.gov (701) 667-3059
Dr. Don Tanaka	Soil Scientist: high residue management, dryland crop production systems, soil quality, conversion of CRP to crop production. tanakad@mandan.ars.usda.gov (701) 667-3063

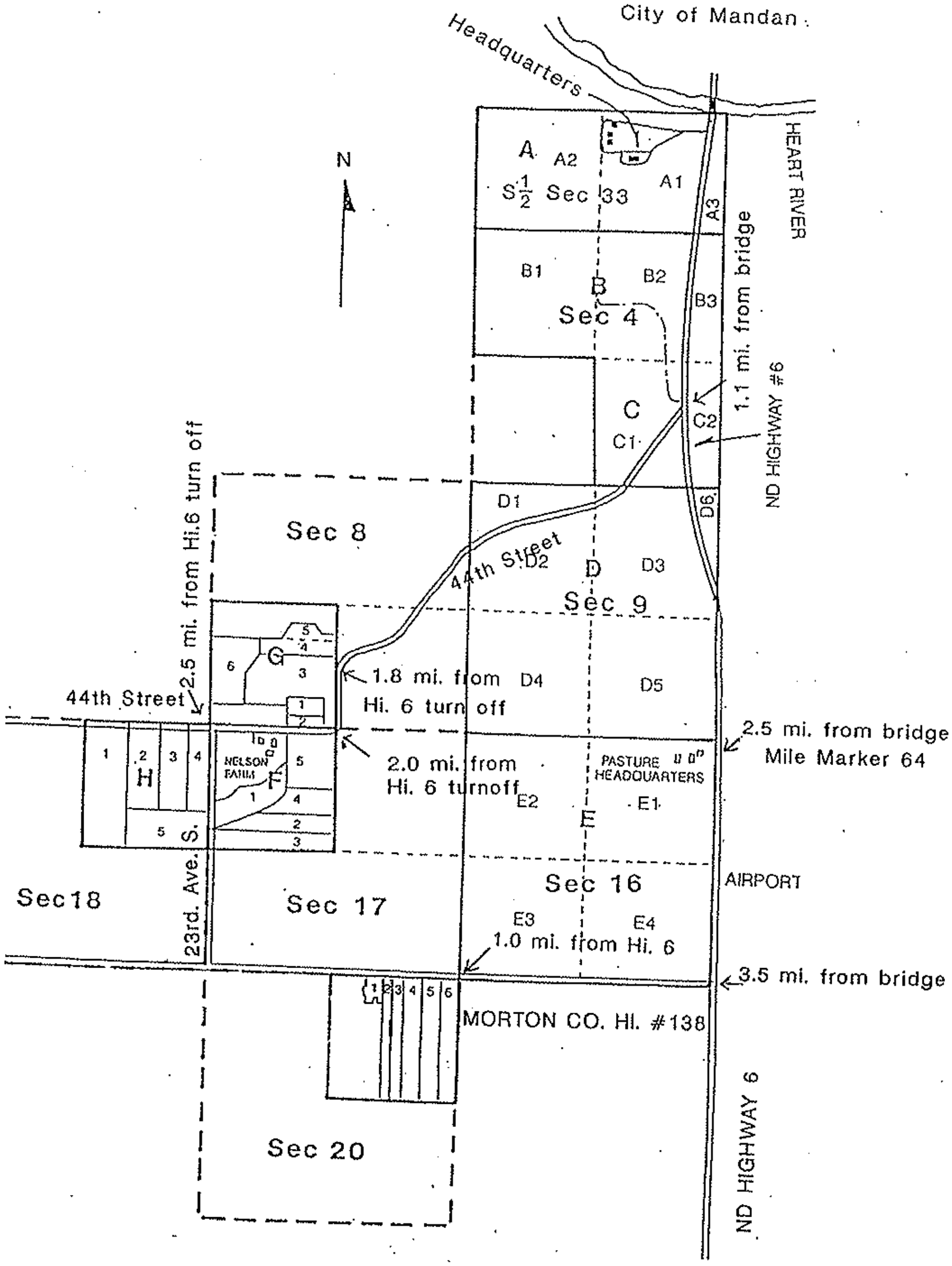
COLLABORATORS

Dr. Rich Cunningham	Research Geneticist (retired); Tree and Woody Ornamentals; Shelterbelts. cunningd@mandan.ars.usda.gov (701) 667-3025
Dr. Al Frank	Plant Physiologist (retired): forage physiology and the carbon cycle, carbon sequestration in grasslands, management and effects on species. franka@mandan.ars.usda.gov (701) 667-3007
Dr. Jim Karn	Research Animal Scientist (retired): range animal nutrition and forage quality karnj@mandan.ars.usda.gov (701) 667-3009

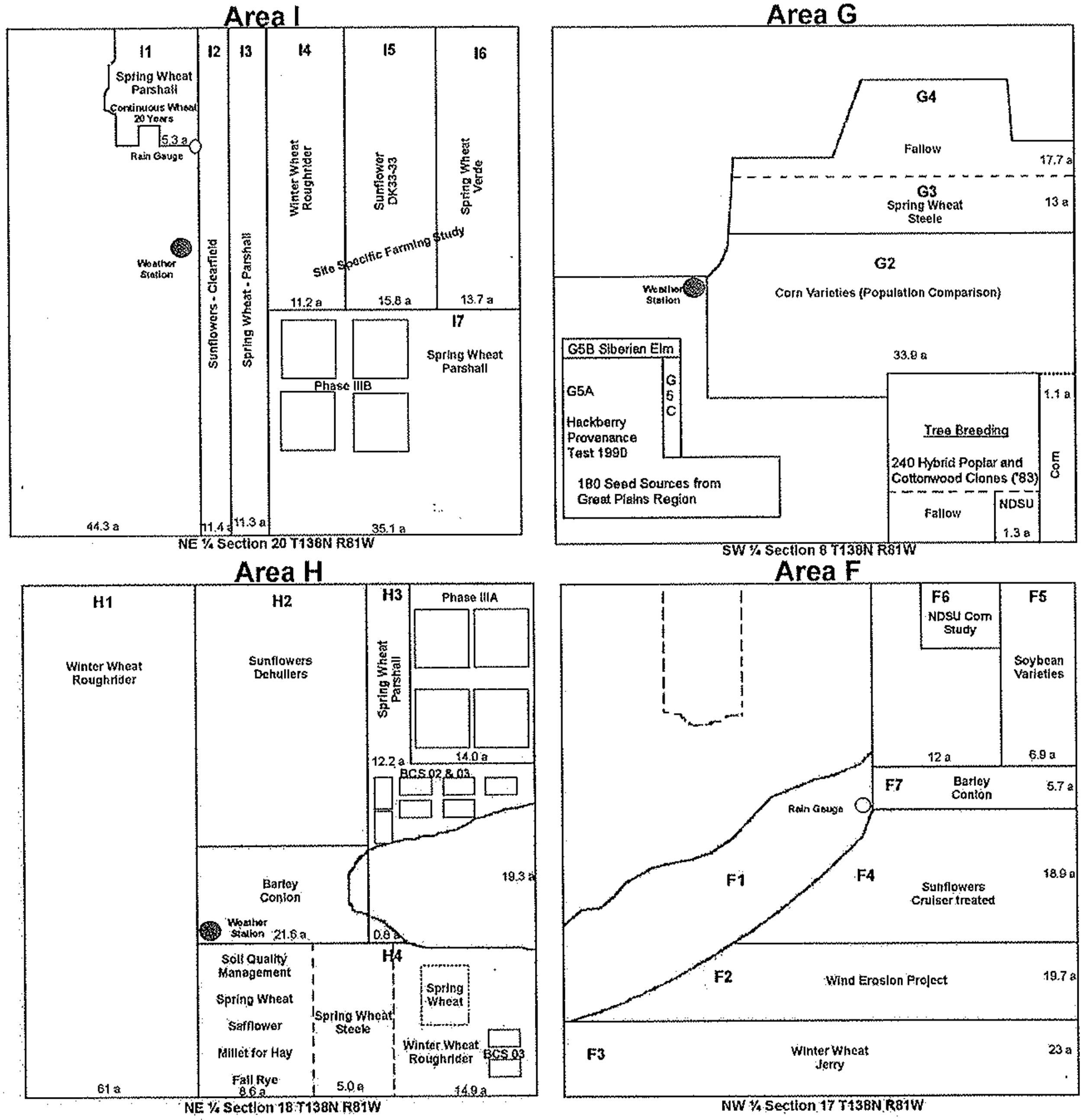
COOPERATORS

Dr. Randy Anderson	Research Agronomist, USDA-ARS Northern Grain Insects Laboratory, Brookings, SD. randerson@ngirl (605) 693-5229
Dr. Chihua Huang	Soil Scientist, USDA-ARS National Soil Erosion Research Laboratory, West Lafayette, IN. chihua@purdue.edu (765) 494-614
Mr. Eric Eriksmoen	Research Agronomist: NDSU Hettinger Research Extension Center. eericksmo@ndsuext.nodak.edu (701) 567-4325
Dr. Thomas Gulya, Jr.	Research plant pathologist, USDA-ARS Northern Crop Science Laboratory, Fargo, ND. gulyat@fargo.ars.usda.gov (701) 239-1316
Mr. Vern Hoffman	Agricultural Engineer: NDSU Cooperative Extension Service, Fargo, ND. vhofman@ndsuext.nodak.edu (701) 231-7240
Dr. Larry Hagen	Agricultural EngineerWind Erosion Research Unit USDA-ARS Manhattan, KS. hagen@weru.ksu.edu 785-537-5545
Dr. Joel Ransom	Extension Agronomist, NDSU Cooperative Extension Service, Fargo, ND. joel.ransom@ndsu.nodak.edu (701) 231-7405
Dr. Sara Wright	Soil Scientist, Sustainable Agricultural Systems Laboratory, Beltsville, MD. wrights@ba.ars.usda.gov (301) 504-8156
Dr. Ted Zobeck	Soil Scientist, USDA-ARS Wind Erosion and Water Conservation Research Center, Lubbock, TX. tzobeck@lbk.ars.gov (806) 749-5560

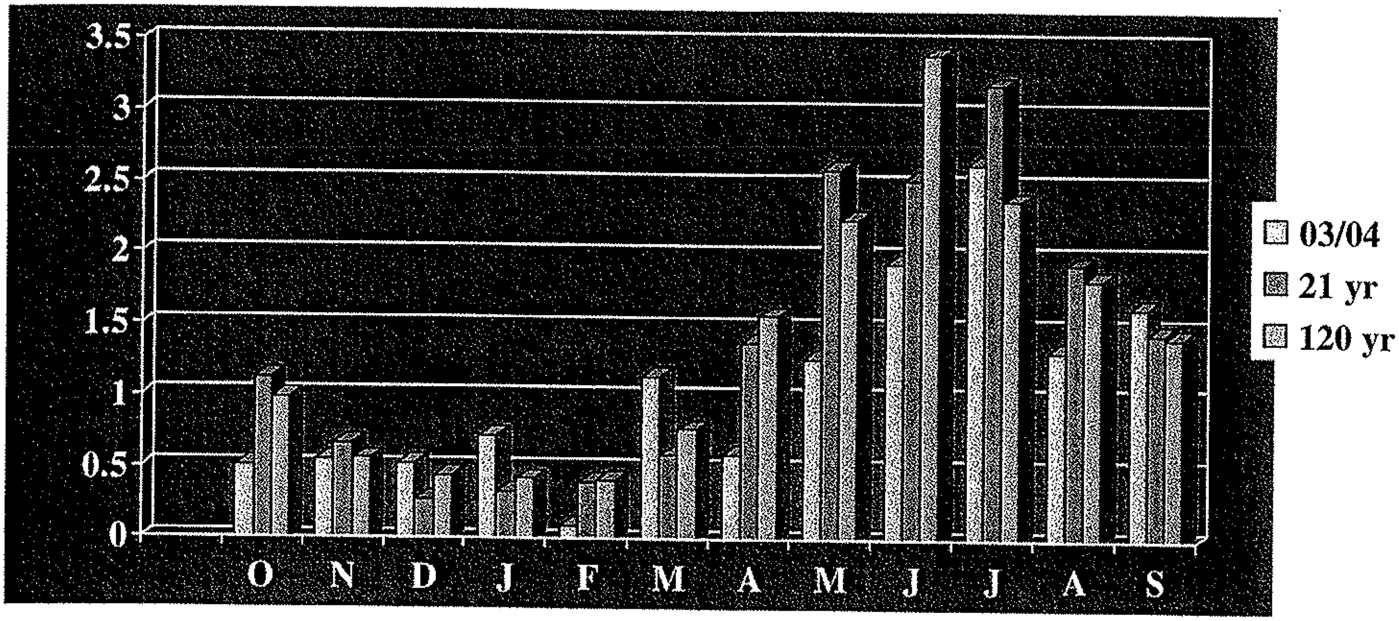
USDA-ARS LAND RESOURCES (FEDERAL & STATE) A, B, C, D, AND E
AREA IV SCD COOPERATIVE RESEARCH FARM


City of Mandan
Headquarters
HEART RIVER
N
A
A1
A2
A3
S½ Sec 33
B
B1
B2
B3
Sec 4
1.1 mi. from bridge
ND HIGHWAY #6
C
C1
C2
D1
D2
D3
D4
D5
D6
D
44th Street
Sec 8
Sec 9
2.5 mi. from Hi.6 turn off
44th Street
G
1.8 mi. from Hi. 6 turn off
2.5 mi. from bridge
Mile Marker 64
NELSON FARM
F
H
2.0 mi. from Hi. 6 turnoff
PASTURE HEADQUARTERS
E
E1
E2
E3
E4
23rd. Ave. S.
Sec18
Sec 17
Sec 16
AIRPORT
1.0 mi. from Hi. 6
3.5 mi. from bridge
MORTON CO. HI. #138
Sec 20
ND HIGHWAY 6

AREA IV COOPERATIVE RESEARCH FARM
2004 CROP PLAN

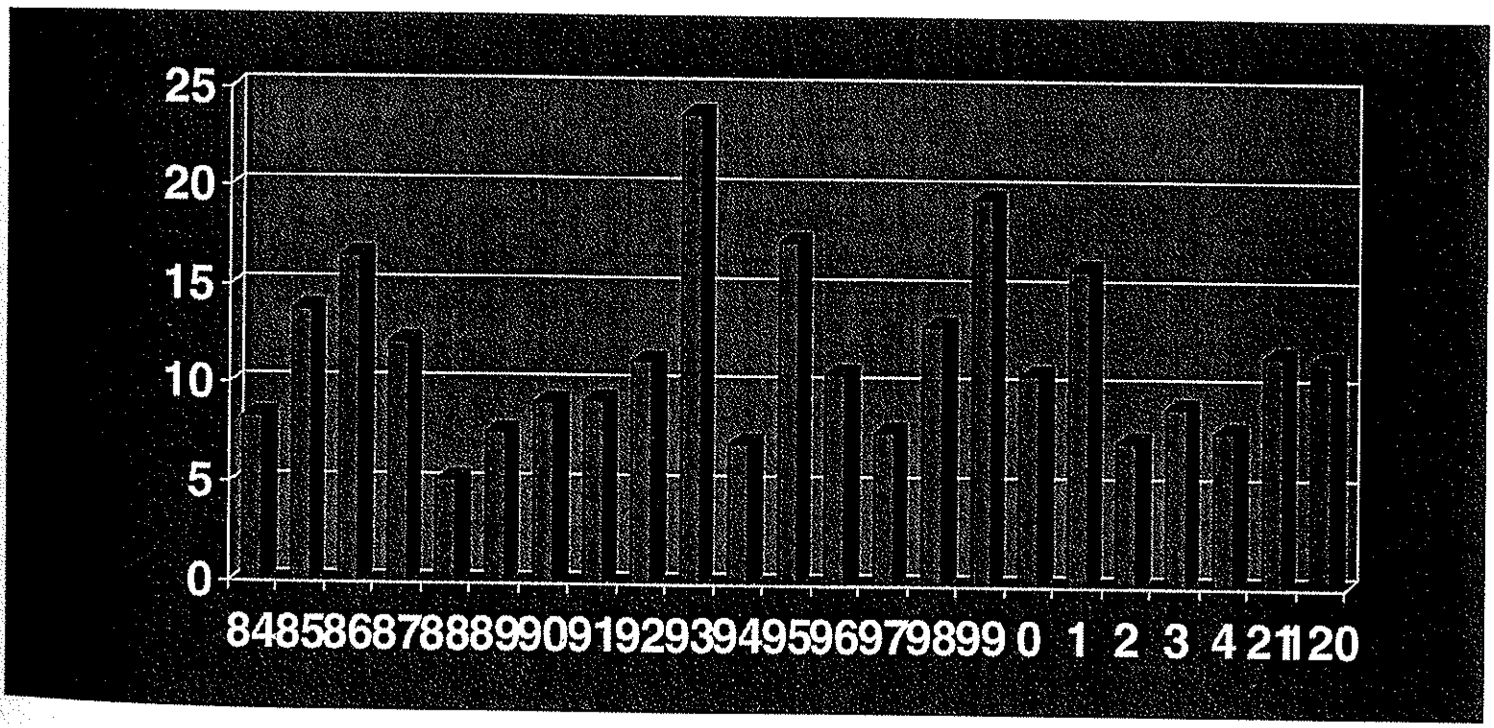


Monthly Precipitation (in.)
Oct-2003/Sep-2004
Area IV plots, Mandan, ND



Growing Season Precipitation (in.)
April, May, June, July, August 1984-2004
Area IV plots, Mandan, ND

Figure 4



MANAGEMENT PRACTICES ON THE AREA IV SCD COOPERATIVE RESEARCH FARM

F FIELD OPERATIONS, NW ¼ Section 17 T138N R81W

F1 This conservation bench terrace area has been excluded from the total acreage leased by AREA IV SCDs since 1987.

F2, FALLOW (WIND EROSION PROJECT – See Merrill et al. on page 24)

9/22/04 Field was sprayed with Glyphomax (32 oz/a), LV4 (16 oz/a) and ammonium sulfate.

9/22/04 Seeded Jerry winter wheat at a rate of 1.3 million seeds/a. East half of field was seeded using the JD 750 drill (7.5-inch row spacing) while the west half was seeded using the Bourgault air seeder (10-inch row spacing). Seed was treated with Raxil MD Extra and 50 lbs/a of 11-52-00 was put down with seed.

F3, JERRY WINTER WHEAT

9/22/03 Seeded Jerry winter wheat into fallow ground (2003 wind erosion project) with a Haybuster 8000 hoe drill (10-inch row spacing) at a rate of 1.3 million seeds/a. Seed was treated with Raxil MD and 50 lbs of 11-52-00 was put on at seeding.

3/31/04 Contractor bulk spread Urea at 70 lbs N/a.

5/6/04 Contractor sprayed Salvo at 12 oz/a.

8/31/04 Winter wheat was harvested and yielded 39.5 bu/a with a test weight of 57.9 and protein of 13.9%. It was\sold for $3.10/bu.

9/7/04 Sprayed field with 32 oz/a of Glyphomax and 16 oz/a of LV4.

F4, SUNFLOWERS (CRUISER VS. NON-CRUISER)

3/24/04 Contractor bulk spread Urea at 70 lbs N/a.

5/27/04 Field was sprayed with Prowl H_20 at 40 oz/a plus Bison at 24 oz/a.

6/4/04 Field was seeded to PS 9441 sunflowers, into winter wheat stubble, at a rate of 25,000 seeds/a with a JD Maxemerge II planter (30-inch row spacing). In half of the field the sunflowers were treated with Cruiser while the remaining have was not.

8/25/04 Asana was applied at 6 oz/a.

11/18/04 Sunflowers were harvested. Cruiser treated sunflowers had a combine yield of 1,418.4 lbs/a and the non-Cruiser sunflowers had a combine yield of 1,331.5 lbs/a.

F5, SOYBEAN VARIETIES

5/10/04 Sprayed Roundup Ultra Max (16 oz/a), LV4 (16 oz/a), and Harmony Extra (.30 oz/a) plus ammonium sulfate.

5/26/04 Seeded RR soybean varieties (Proseed 069, 20-05, 20-07, and 30-50), into corn stubble, at populations of 100,000 and 200,000 seeds/a using a JD 750 drill with 7.5" row spacing. 50 lbs of 11-52-00 was applied at seeding.

6/16/04 Sprayed field with Roundup Ultra Max at 16 oz/a plus ammonium sulfate.

7/16/04 Sprayed field with Roundup Ultra Max at 16 oz/a plus ammonium sulfate.

8/5/04 Liquid nitrogen (28-0-0) at 30 lbs N/a applied to selected areas post-emergence at growth stage R3-R4.

10/5-6/04 Combined ProSeed 069, 20-05, and, 20-07 (results below).

11/15/04 Combined ProSeed 30-50 (results below).

F6, NDSU CORN STUDY, JOEL RANSOM

3/24/04 Contractor bulk spread Urea at 80 lbs N/a and 50 lbs 11-52-00.

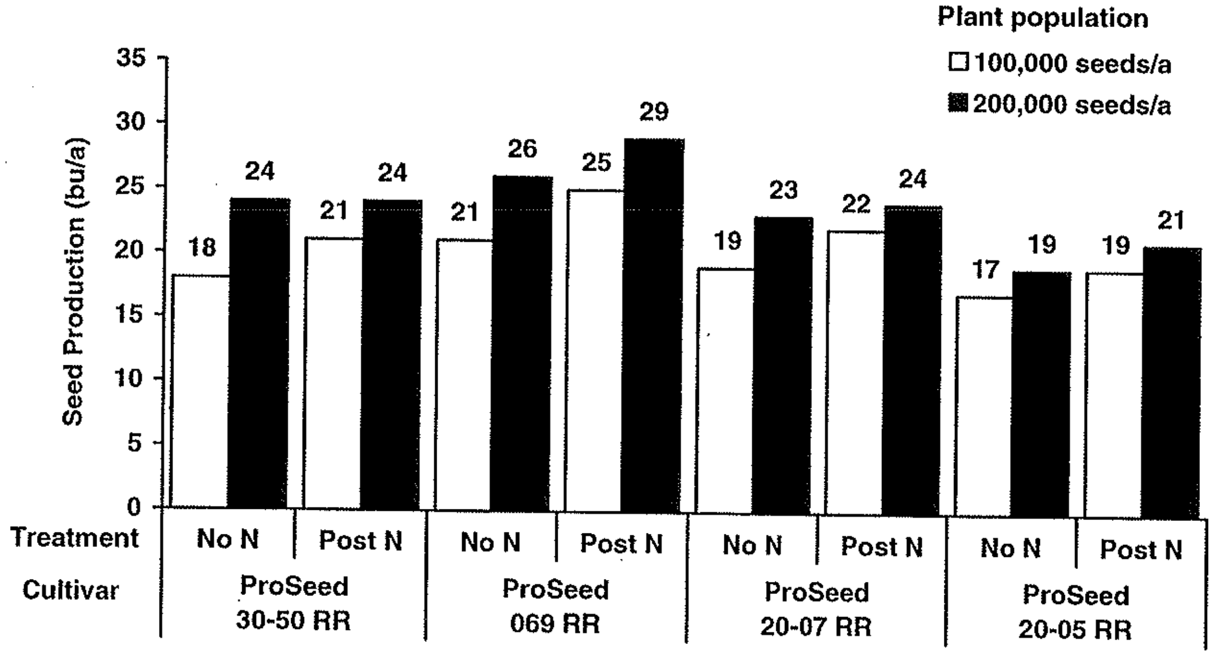
5/4/04 Seeded corn varieties into winter wheat stubble at rates of 12,000 and 24,000 seeds per acre for each variety using a JD Maxemerge II planter with 30-inch row spacing.

5/10/04 Sprayed Roundup Ultra Max (16 oz/a), LV4 (16 oz/a), and Harmony Extra (.30 oz/a) plus ammonium sulfate.

6/16/04 Sprayed Option (1.5 oz/a), Sterling (4 oz/a), UAN 28% (48 oz/a), and Destiny (24 oz/a).

10/13/04 Corn varieties were hand harvested by NDSU.

2004 Soybean Varieties (F5)



Summary

- The 200,000 seed/a produced a greater yield than the 100,000 seeds/a.
- Post N application increased seed yield up to 4 bu/a.
- Response to post N depends on cultivar.
- Cultivar 30-50 was frosted on 6-18-04 and had a large percentage of green seeds.

FIELD F6, SOYBEAN PROTEIN AND OIL ENHANCEMENT

5/10/04	Sprayed Roundup Ultra Max (16 oz/a), LV4 (16 oz/a), and Harmony Extra (.30 oz/a) plus ammonium sulfate.
5/20/04	Seeded soybean varieties (Top Farm 6052, Legend 522RR, Top Farm 6002RR and Gold Country 3250RR) into winter wheat stubble at a rate of 200,000 seeds/a using a JD 750 no-till drill (7.5-inch row spacing). Nodulator soybean inoculant was put down with the seed.
6/18/04	Study Terminated due to killing frost.

FIELD F7, CONLON BARLEY

4/22/04	Contractor sprayed with Roundup Ultra Max (16 oz/a) and Harmony Extra (.30 oz/a).
5/4/04	Seeded field to Conlon barley, into sunflower stubble, using JD 750 drill (7.5-inch row spacing) at a rate of 1.3 million seeds/a. Seed was treated with Raxil MD. 70 lbs of N/a (Urea) and 50 lbs/a of 11-52-00 were put down at time of seeding.
6/8/04	Field was sprayed with Puma (5.3 oz/a) and Bison (24 oz/a).
8/19/04	Barley was harvested and had a combine yield of 34.0 bu/a with a test weight of 49.0. Barley was sold for feed at $1.40/bu.
9/7/04	Sprayed field with 32 oz/a of Glyphomax and 16 oz/a of LV4.
9/10/04	Soil analysis showed Nitrates at 20 lbs/ac (0-24"), and Phosphorus at 22 ppm.
9/20/04	Jagalene winter wheat was seeded using the Haybuster 8000 hoe drill (10-inch row spacing) at 1.3 million seeds/a. Seed was treated with Enhance and south half of field was treated with Jumpstart. 50 lbs/a of 11-52-00 was put down with seed.
9/22/04	Sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

2004 Corn Variety Population - Field G2

Variety	Maturity	Population (thousands)	Moisture (%)	TW (lbs/bu)	Grain Yield (bu/a)*
Dairy Land 66-85	85	15	18.8	42.4	70.7
Dairy Land 66-85	85	25	18.7	42.4	75.4
DeKalb 35-51	85	15	14.7	49.6	58.4
DeKalb 35-51	85	25	17.4	44.1	57.0
DeKalb 37-14	87	15	17.0	46.4	61.5
DeKalb 37-14	87	25	17.0	45.1	75.1
Legend 9482	82	15	17.5	43.5	60.8
Legend 9482	82	25	18.2	42.1	67.5
Proseed 3-Way X	87	15	22.7	30.7	43.3
Proseed 3-Way X	87	25	26.1	30.2	42.2
Top Farm 8385	83	15	15.5	50.2	40.8
Top Farm 8385	83	25	15.0	50.9	51.8
Top Farm 8480	80	15	16.8	44.0	58.0
Top Farm 8480	80	25	18.1	43.8	63.6

*Grain Yield (bu/a) is based on standard TW of 56 lbs/bu.

Summary

- The 25,000 population had higher grain yield except for hybrids Dekalb 35-51 and Proseed 3-way cross.
- Visual observations at harvest suggested that the ear height on the 25,000 population was higher than the 15,000 population.

AREA-G FIELD OPERATIONS, SW ¼ Section 8 T138N R81W

FIELDG2, CORN VARIETIES (POPULATION COMPARISON)

3/24/04 Contractor bulk spread Urea at 80 lbs N/a and 50 lbs 11-52-00.

5/10/04 Field was sprayed with Roundup Ultra Max (16 oz/a), LV4 (16 oz/a) plus ammonium sulfate.

5/10/04 Seeded corn varieties, into proso millet and sunflower stubble, Top Farm 8385, and Dekalb 35-51 with a no-till JD Maxemerge II planter (30-inch row spacing).

5/17/04 Seeded corn varieties Top Farm 8480, Legend 9482, Dairy Land 66-85, Dekalb 37-14, and ProSeed 3-Way X using a JD Maxemerge II planter (30-inch row spacing). Half, of each variety, was planted at a rate of 15,000 seeds/a and half at a rate of 25,000 seeds/a.

6/24/04 Contractor sprayed field with Roundup Ultra Max (16 oz/a) plus ammonium sulfate.

11/29/04 Corn was combined. See table below for results.

FIELD G3, STEELE SPRING WHEAT

4/21/04 Seeded Steele spring wheat into chemical fallow ground at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). Seed was treated with Raxil MD. 70 lbs N/a (Urea) and 50 lbs/a of 11-52-00 were put done at seeding.

6/6/04 Field was sprayed with Salvo (10 oz/a) and Harmony Extra (0.4 oz/a).

8/20/04 Spring wheat was harvested and had a combine yield of 53.8 bu/a with test weight of 59.5 and 15.2% protein. Wheat was sold for $4.94/bu.

9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

FIELD G4, FALLOW

5/20/04 Field was sprayed with Roundup Ultra Max (16 oz/a), Bison (16 oz/a), and ammonium sulfate.
9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

AREA-H FIELD OPERATIONS, NE ¼ Section 18 T138N R81W

FIELD H1, ROUGHRIDER WINTER WHEAT

9/24/03 Seeded Roughrider winter wheat, treated with Raxil MD, into oat stubble at a rate of 1.3 million seeds/a along with 50 lbs/a of 11-52-00. The western 1/3 of the field was seeded using a Haybuster 8000 hoe drill (10-inch row spacing) and the rest of the field was seeded with a JD 750 no-till drill (7.5-inch row spacing).
3/31/04 Contractor bulk spread Urea at 70 lbs N/a.
5/6/04 Contractor sprayed Salvo at 12 oz/a.
8/17/04 Field was harvested with the western 1/3 of the field yielding 33.7 bu/a and the rest of the field yielding 40.9 bu/a. Test weights were 59.0 and protein was 14.5%. The wheat was sold for $3.10/bu.
9/14/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

FIELD H2 NORTH, SUNFLOWER DEHULLERS

3/24/04 Contractor bulk spread Urea at 70 lbs N/a.
5/27/04 Field was sprayed with Prowl $H_2 0$ at 40 oz/a plus Bison at 24 oz/a.
6/8/04 Field was seeded to sunflower dehuller varieties, Hysun 525 and CL 345, at a rate of 25,000 seeds/a using the JD Maxemerge II planter (30-inch row spacing). Previous crop residue was winter wheat. Field was split with the west half being Hysun 525 and the east half being CL345.
8/25/04 Asana was applied at 6 oz/a.
11/19/04 The Hysun 525 sunflowers were combined, having a combine yield of 1,412.2 lbs/a
11/22/04 The CL345 sunflowers were combined, having a combine yield of 1,482.4 lbs/a.

FIELD H2 SOUTH, CONLON BARLEY

3/24/04 Contractor bulk spread Urea at 70 lbs N/a.
4/22/04 Contractor sprayed field with Roundup Ultra Max (16 oz/a) and Harmony Extra (.30 oz/a).
5/4/04 Seeded field to Conlon barley, into winter wheat stubble, using JD 750 drill (7.5-inch row spacing) at a rate of 1.3 million seeds/a. Seed was treated with Raxil MD. 50 lbs/a of 11-52-00 was put down at time of seeding.
6/8/04 Field was sprayed with Puma (5.3 oz/a) and Bison (24 oz/a).
8/19/04 Barley was harvested and had a combine yield of 52.1 bu/a with a test weight of 49.0. Barley was sold for feed at $1.40/bu.
9/14/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

FIELD H3, PARSHALL SPRING WHEAT

4/22/04 Contractor sprayed field with Roundup Ultra Max (16 oz/a) and Harmony Extra (.30 oz/a).
5/4/04 Field was seeded to Parshall spring wheat at a rate of 1.3 million viable seeds/a using a JD 750 no-till drill (7.5-inch row spacing) drill. Previous crop residue was winter wheat. Seed was treated with Raxil MD. 70 lbs N/a (Urea) and 50 lbs 11-52-00 were put down at seeding.
6/6/04 Field was sprayed with Salvo (10 oz/a) and Harmony Extra (0.4 oz/a).
8/20/04 Spring wheat was harvested and had a combine yield of 28.5 bu/a. Wheat was sold for $3.94/bu. .
9/14/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

FIELD H3, CROP SEQUENCE PROJECT, PHASE III A

See 'Crop Sequence Project' page 14
4/13/04 Seeded Amidon spring wheat at rate of 1.3 million seeds/a using the JD 750 no-till drill (7.5-inch row spacing). 70 lbs N/a (ammonium nitrate) and 50 lbs/a of 11-52-00 were put down at seeding. Seed was treated with Enhance drill box treat.

FIELD H4, SOIL QUALITY MANAGEMENT

See 'Management Strategies for Soil Quality' on page 20

FIELD H4, STEELE SPRING WHEAT

4/22/04 Contractor sprayed field with Roundup Ultra Max (16 oz/a) and Harmony Extra (.30 oz/a).

4/21/04 Seeded Steele spring wheat into soybean stubble at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). Seed was treated with Raxil MD. 70 lbs N/a (Urea) and 50 lbs/a of 11-52-00 were put down at seeding.

6/4/04 Field was sprayed with Bison at 24 oz/a.

8/20/04 Spring wheat was harvested and had a combine yield of 32.6 bu/a. Wheat was sold for $3.94/bu.

9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

9/10/04 Soil analysis showed Nitrates at 64 lbs/ac (0-24"), and Phosphorus at 21 ppm.

FIELD H4 EAST. SCLEROTINIA BIOLOGICAL CONTROL STUDIES

See 'Sclerotinia (White Mold) as Influenced by Crop Sequence and Biological Control" Page 22

FIELD H4, ROUGHRIDER WINTER WHEAT

9/22/03 Field was seeded to Roughrider winter wheat (treated with Raxil MD) with the JD 750 no-till drill (7.5-inch row spacing). Previous crop residue was barley. Seed rate was 1.3 million viable seeds/a and 50 lbs/a of 11-52-00 was put down at seeding.

3/31/04 Contractor bulk spread Urea at 70 lbs N/a.

5/6/04 Contractor sprayed Salvo at 12 oz/a.

8/31/04 Winter wheat was harvested. No yields were taken. It was sold for $3.10/bu.

9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

AREA-I FIELD OPERATIONS, NE ¼ Section 20 T138N R81W

FIELD I1, PARSHALL SPRING WHEAT

4/26/04 Seeded Parshall spring wheat into spring wheat residue at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). 70 lbs N/a (Urea) and 50 lbs/a of 11-52-00 were applied at seeding. Seed was treated with Raxil MD Extra.

6/4/04 Field was sprayed with Bison at 24 oz/a.

8/23/04 Spring wheat was combined and had a combine yield of 39.4 bu/a with a test weight of 59.0 and protein at 15.9%. Wheat was sold for $3.94/bu.

9/30/04 Field was sprayed with Glyphomax (32 oz/a), LV4 (16 oz/a), and ammonium sulfate.

FIELD I2, CLEARFIELD SUNFLOWERS

3/24/04 Contractor bulk spread Urea at 70 lbs N/a.

5/27/04 Field was sprayed with Prowl H_20 at 40 oz/a plus Bison at 24 oz/a.

6/8/04 Field was seeded to Clearfield sunflower variety CL 55-15 at a rate of 25,000 seeds/a using the JD Maxemerge II planter (30-inch row spacing). Previous crop was corn.

8/25/04 Asana was applied at 6 oz/a.

11/10/04 Sunflowers were combined and had a combine yield of 1,731.4 lbs/a and a test weight of 29.0. They were sold for $12.00 cwt.

FIELD I3, PARSHALL SPRING WHEAT

4/26/04 Seeded Parshall spring wheat into spring wheat stubble at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). 70 lbs N/a (Urea) and 50 lbs/a of 11-52-00 were applied at seeding. Seed was treated with Raxil MD Extra.

6/4/04 East half of the field was sprayed with Bison at 24 oz/a and the west half of the field was sprayed with Bison at 24 oz/a plus Headline fungicide at 3 oz/a.

8/23/04 Spring wheat was combined with the east half of the field having a combine yield of 28.4 bu/a and the west half having a combine yield of 30.7 bu/a. Test weights were 57.0 and protein was at 15.3% for both halves. Wheat was sold for $3.94/bu.

9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

9/10/04 Soil analysis showed Nitrates at 51 lbs/ac (0-24"), and Phosphorus at 13 ppm.

9/20/04 Roughrider winter wheat was seeded at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). 50 lbs/a of 11-52-00 was applied at seeding. Seed was treated with Raxil MD Extra.

FIELD I4, ROUGHRIDER WINTER WHEAT

9/22/03 Seeded Roughrider winter wheat, treated with Raxil MD, at a rate of 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). Previous crop residue was spring wheat. At seeding, 60 lbs/a of 11-52-00 was applied.

9/23/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (16 oz/a) plus ammonium sulfate.

3/31/04 Contractor bulk spread Urea at 70 lbs N/a.

5/6/04 Contractor sprayed Salvo at 12 oz/a.

8/16/04 Field was harvested and winter wheat had a combine yield of 29.9 bu/a with 57.9 test weight and 14.5% protein. Wheat was sold for $3.10/bu.

9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

FIELD I5, DK30-33 SUNFLOWER

5/27/04 Field was sprayed with Prowl H_20 at 40 oz/a plus Bison at 24 oz/a.

6/3/04 Field was seeded to DK33-33 sunflowers 25,000 seeds/a using the JD Maxemerge II planter (30-inch row spacing). Previous crop residue was winter wheat.

4/15/04 Variable rate fertilizer was applied at rates of 15 to 75 lbs N/a (Urea), with the average application for the whole field being 45 lbs N/a, and 11-52-00 at 50 lbs/a using the Concord Air Seeder.

8/25/04 Asana was applied at 6 oz/a.

11/9/04 Sunflowers were harvested and combine yield was 1,957.8 lbs/a and the test weight was 32.0. Sunflowers were sold for $12.00 cwt.

FIELD I6, VERDE SPRING WHEAT

4/22/04 Contractor sprayed field with Roundup Ultra Max (16 oz/a) and Harmony Extra (.30 oz/a).

4/22/04 Seeded Verde spring wheat, treated with Raxil MD, at a rate of 1.3 million seeds/a, using the Concord air seeder with 10-inch row spacing hoe openers. Previous crop was sunflower. 60 lbs N/a (Urea) and 30 lbs/a of 11-52-00 were applied at seeding.

6/6/04 Field was sprayed with Salvo (10 oz/a) and Harmony Extra (0.4 oz/a).

8/25/04 Spring wheat was harvested and had a combine yield of 29.0 bu/a with test weight of 57.0 and 16.2% protein. Spring wheat was sold for $3.94/bu.

9/7/04 Contractor sprayed field with Glyphomax at 32 oz/a and LV4 at 16 oz/a.

9/10/04 Soil analysis showed Nitrates at 111 lbs/ac (0-24"), and Phosphorus at 13 ppm.

9/20/04 Roughrider winter wheat was seeded at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). 50 lbs/a of 11-52-00 was applied at seeding. Seed was treated with Raxil MD Extra.

FIELD I7, PARSHALL SPRING WHEAT

4/26/04 Seeded Parshall spring wheat into spring wheat stubble at 1.3 million seeds/a using the Bourgault air seeder (10-inch row spacing). 70 lbs N/a (Urea) and 50 lbs/a of 11-52-00 were applied at seeding. Seed was treated with Raxil MD Extra.

6/4/04 West half of the field was sprayed with Bison at 24 oz/a.

6/6/04 East half of field was sprayed by contractor with Salvo (10 oz/a) and Harmony Extra (0.4 oz/a).

8/25/04 Field was harvested and had a combine yield of 28.0 bu/a. Wheat was sold for $3.94/bu.

FIELD I7 CROP SEQUENCE PROJECT, PHASE III B

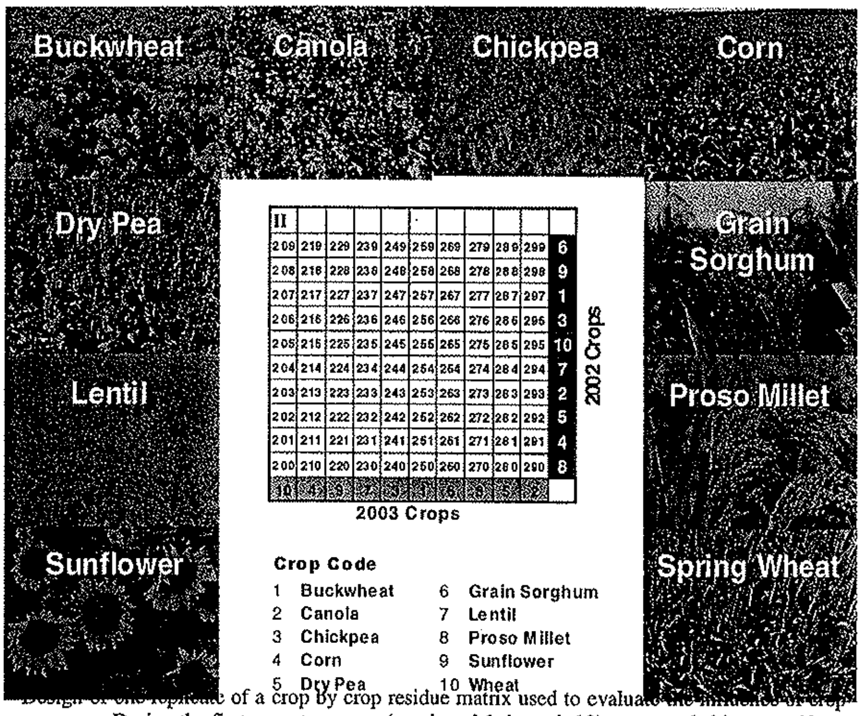
See 'Crop Sequence Project' page 14

INTRODUCTION TO CROP SEQUENCE PROJECT

Contact Information: J.M. Krupinsky krupinskj@mandan.ars.usda.gov (701) 667.3011

Figure 1

Crop Sequence Project, Phase III



Design of one replicate of a crop by crop residue matrix used to evaluate the influence of crop sequence. During the first year, ten crops (numbered 1 through 10) were seeded into a uniform crop residue. During the second year, the same crops were no-till seeded perpendicular over the residue of the previous year's crop. Individual plot numbers were assigned for each of the four replications.

A multi-disciplinary team of scientists is conducting a multi-phased project with early- and late-season grass and broad leaf crops to develop diverse cropping systems. The team is evaluating the components of crop production, crop residue, plant disease, weeds, root growth, crop-water use, soil quality, and economics to develop guidelines for long-term diversified crop production systems and to provide producers with management flexibility for developing their own cropping systems.

PHASE II OF THE CROP SEQUENCE PROJECT, EARLY SEASON CROPS

Phase II of the Diverse Cropping Systems Project, was initiated in 1998 to determine the sequence crops should follow to take advantage of the previous crop and crop residues. Ten crops were included (barley, dry bean, canola, crambe, flax, dry pea, safflower, soybean, oil seed sunflower, and hard red spring wheat). A crop by crop residue matrix was evaluated in 1999 and 2000. Following the crop by crop-residue matrix, a uniform wheat crop was grown in 2000 and 2001 over the crop matrix to determine how wheat performs after all crop sequences. A sunflower crop followed the wheat crop in 2001 and 2002. The Crop Sequence Calculator (version 2.2.5) provides an introduction to Phase II of the cropping system project and information on crop production, economics, plant diseases, weeds, insects, water use, and surface soil properties to aid producers in their evaluation of management risks associated with different crop sequences.

PHASE III OF THE CROP SEQUENCE PROJECT, LATE SEASON CROPS (FIGURE 1.)

Phase III of the Diverse Cropping Systems Project, was initiated in 2002 to continue determining the sequence crops should follow to take advantage of the previous crop and crop residues. Field plots were located on the Area IV ARS/SCD Research Farm located near the Northern Great Plains Research Laboratory, southwest of Mandan, ND. For Phase IIIa, ten crops (canola, dry pea, oil seed sunflower, hard red spring wheat, proso millet, grain sorghum, chickpea, lentil, corn, buckwheat) were direct seeded in an east-west direction with a JD 750 no-till drill in strips into wheat stubble in each of four replications in 2002. In 2003 all ten crops were again randomized and direct seeded into stubble from the previous crops in a north-south direction, perpendicular to the 2002 crop. This allowed every crop to be seeded on the residue of all the other crops (100 treatments per replication). At another field site, Phase IIIb, the same ten crops were seeded in an east-west direction in 2003. The same crops will be seeded in a north-south direction in 2004, again allowing every crop to be seeded on the residue of the ten previous crops creating 100 treatment combinations for evaluation.

DIVERSE CROPPING SYSTEMS
CROP SEQUENCE PROJECT

Dr. Donald Tanaka, Joe Krupinsky, Steve Merrill, Mark Liebig, and Jon Hanson

INTRODUCTION

A multi-disciplinary team of scientists is conducting a multi-phased project with early- and late-season grass and broad leaf crops to develop diverse cropping systems. The team is evaluating the components of crop production, crop residue, plant disease, weeds, root growth, crop-water use, soil quality, and economics to develop guidelines for long-term diversified crop production systems and to provide producers with management flexibility for developing their own cropping systems.

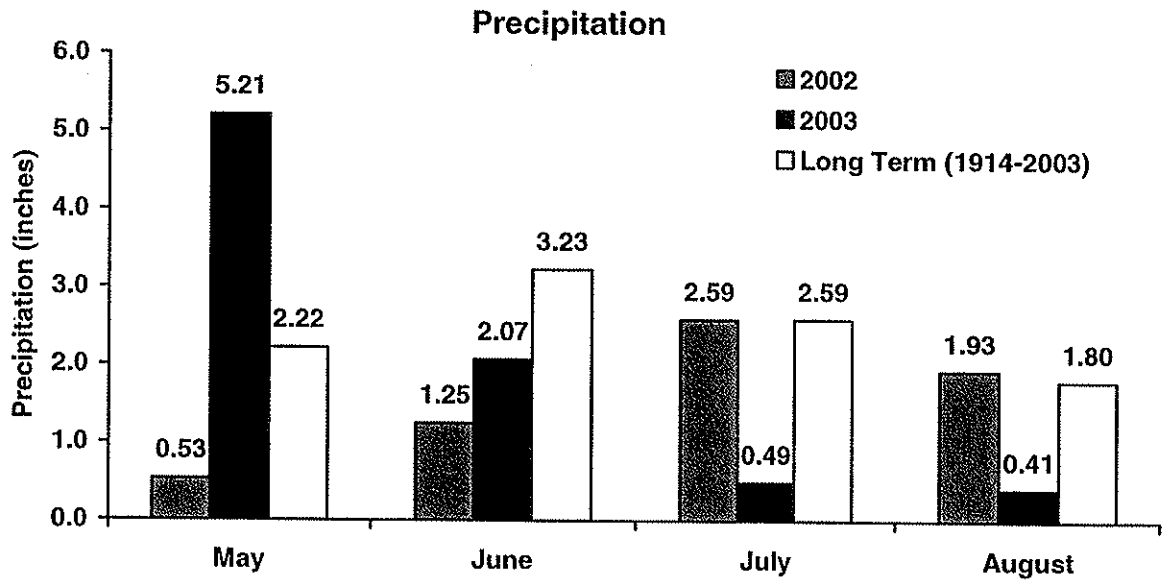


Figure 1. Growing season precipitation (May – August) for 2003 and long-term average growing season precipitation at Mandan, ND.

Table 1. Crop information for Phase IIIA crops planted in 2003 at Mandan, ND.

2003 Crop (Variety)	Seeding Date	Harvest Date	Target Population (Seeds/acre)	Actual Fertilizer Rates N (lbs/a)	P (lbs/a)	S (lbs/a)	Row Space (in)
Buckwheat (Koto)	6-11-03	10-23-03	1.0 Million	70	10	0	7 ½
Canola (357RR)	5-21-03	8-15-03	800,000	70	10	10	7 ½
Chickpea (B-90)	5-21-03	8-28-03	200,000	0	10	0	7 ½
Corn (TF2183)	5-30-03	10-22-03	25,000	70	10	0	30
Dry Pea (DS Admiral)	5-16-03	8-11-03	350,000	0	10	0	7 ½
Grain Sorghum (DK28E)	6-11-03	10-23-03	200,000	70	10	0	7 ½
Lentil (Richlea)	5-20-03	8-22-03	686,000	0	10	0	7 ½
Proso Millet (Earlybird)	6-11-03	10-2-03	1.5 Million	70	10	0	7 ½
Sunflower (63M91)	6-17-03	10-21-03	25,000	70	10	0	30
Spring Wheat (Amidon)	5-21-03	8-19-03	1.3 Million	70	10	0	7 ½

Table 2. Spray operations for Phase IIIA crops in 2003 at Mandan, ND.

Crop	Date	Chemical/a	Date	Chemical/a	Date	Chemical/a	Date	Chemical/a
Buckwheat (Koto)	6/13/2003	Roundup Ultra Max (1.5pt) + Bison (1pt)						
Canola (357RR)	5/22/2003	Roundup Ultra Max (1pt) + Bison (1pt)	6/18/2003	Roundup Ultra Max (1pt)	10/6/2003	Roundup Ultra Max (1pt) + LV4 (1pt)		
Chickpea (B-90)	5/22/2003	Roundup Ultra Max (1pt) + Bison (1pt)	6/18/2003	Poast (1pt) + Preference (2pt)	6/27/2003	Tough 5EC (1.5pt)	8/18/2003	Gramoxone Extra (1.5pt) + Preference (1pt)
Corn (TF2183)	5/22/2003	Roundup Ultra Max (1pt) + Bison (1pt)	6/27/2003	Option (1.5oz) + Banvel (4oz) + UAN 28% (3pt) + MSO (1.5pt)				
Dry Pea (DS Admiral)	5/22/2003	Roundup Ultra Max (1pt) + Bison (1pt)	6/18/2003	Poast (1pt) + Preference (2pt)	10/6/2003	Roundup Ultra Max (1pt) + LV4 (1pt)		
Grain Sorghum (DK28E)	6/13/2003	Roundup Ultra Max (1.5pt) + Bison (1pt)						
Lentil (Richlea)	5/22/2003	Roundup Ultra Max (1pt) + Bison (1pt)	6/18/2003	Poast (1pt) + Preference (2pt)	6/18/2003	Sencor DF (77g) (on buckwheat residue)	8/18/2003	Gramoxone Extra (1.5pt) + Preference (1pt)
Proso Millet (Earlybird)	6/13/2003	Roundup Ultra Max (1.5pt) + Bison (1pt)						
Sunflower (63M91)	6/13/2003	Roundup Ultra Max (1.5pt) + Bison (1pt)	7/9/2003	Poast (1.5pt) + Preference (2pt)				
Wheat (Amidon)	5/22/2003	Roundup Ultra Max (1pt) + Bison (1pt)	6/13/2003	Puma (0.5pt) + Bison (1pt)	10/6/2003	Roundup Ultra Max (1pt) + LV4 (1pt)		
Ammonium Sulfate @ 2.5 gal/60 gal H_2O was applied with all Roundup Herbicide								

SUMMARY

Relative Seed Yield (Figure 2)

1. During the 2003 growing season, growing season precipitation (May through August) was 83% of the long-term average 9.84 inches. Precipitation in May accounted for 64% of the growing season precipitation.

2. Crop sequence influenced spring wheat and chickpea the least.

3. Warm season crops such as corn, grain sorghum, and sunflower were the most responsive to crop sequence.

Precipitation-Use Efficiency (Figure 3)

1. Crop sequences that had a large relative yield were not necessarily the most efficient system in using precipitation.

2003 Phase IIIA Relative Seed Yield

2003 Crop

2002 Crop	Buckwheat	Canola	Chickpea	Corn	Dry Pea	Grain Sorghum	Lentil	Proso Millet	Sunflower	Wheat
Buckwheat	1.00	1.27	0.83	1.42	1.00	2.05	1.12	1.42	3.37	1.07
Canola	1.05	1.00	0.95	3.44	1.14	3.04	1.13	1.41	3.59	1.05
Chickpea	1.41	1.16	1.00	3.78	1.38	2.86	1.03	1.53	2.31	1.02
Corn	1.12	1.05	0.93	1.00	1.09	1.52	1.20	1.03	1.82	1.09
Dry Pea	1.90	1.02	0.97	3.70	1.00	3.87	1.20	1.66	3.09	1.09
Grain Sorghum	1.01	1.18	1.01	2.19	0.96	1.00	0.86	0.89	2.84	1.01
Lentil	1.29	0.94	1.03	3.36	1.38	3.94	1.00	1.62	3.74	1.10
Proso Millet	1.32	1.16	1.09	1.00	1.23	0.95	1.32	1.00	2.67	1.02
Sunflower	0.93	0.82	0.81	1.77	1.21	1.36	0.83	1.33	1.00	0.89
Wheat	1.02	1.04	1.08	2.20	1.19	2.94	1.28	1.13	3.54	1.00
LSD 0.05	0.65	0.20	0.14	1.84	0.24	1.69	0.26	0.54	2.43	0.65

Figure 2. Relative yield of ten crops grown on ten crop residues in 2003 at Mandan, ND.
(Largest relative seed yield – bold underlined; smallest relative seed yield – bold)

2003 Phase IIIA Precipitation-Use Efficiency (lbs/a/inch)

2002 Crop \ 2003 Crop	Buckwheat	Canola	Chickpea	Corn	Dry Pea	Grain Sorghum	Lentil	Proso Millet	Sunflower	Wheat
Buckwheat	18.23	87.30	118.88	34.34	98.21	75.97	83.55	107.23	64.54	153.10
Canola	17.32	68.82	136.17	**78.72**	116.06	97.41	85.78	107.35	**67.87**	149.78
Chickpea	19.90	70.37	128.49	74.58	122.76	102.86	69.63	105.49	45.22	131.41
Corn	18.88	79.23	147.54	37.20	121.30	51.37	100.35	88.25	52.77	**173.65**
Dry Pea	**22.97**	57.88	114.82	76.45	84.25	105.81	73.41	108.61	49.02	129.51
Grain Sorghum	18.41	**90.15**	158.41	62.91	105.82	65.30	70.00	87.79	53.43	161.30
Lentil	21.07	57.72	131.28	73.15	121.72	**117.81**	68.44	**112.02**	65.70	142.40
Proso Millet	21.25	80.99	**159.14**	35.91	121.48	42.34	**100.89**	86.82	54.57	149.65
Sunflower	16.82	62.45	128.46	44.82	**133.30**	61.12	69.54	108.92	28.87	140.86
Wheat	16.25	63.61	137.33	52.18	105.53	96.67	85.30	82.49	61.81	127.97
LSD 0.05	7.15	13.85	19.07	27.96	22.83	36.09	19.39	32.38	32.59	18.44

Figure 3. Crop sequence influences on precipitation-use efficiency of ten crops in 2003 at Mandan, ND.
(Largest precipitation-use efficiency – bold underlined; smallest precipitation-use efficiency – bold)

CROP SEQUENCE CALCULATOR, VERSION 2.2.5

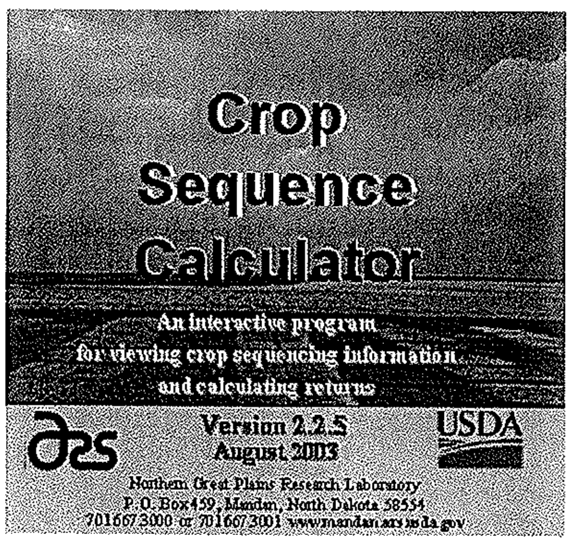
A REVISED COMPUTER PROGRAM TO ASSIST PRODUCERS

Dr. Joe. Krupinsky

ARS researchers were challenged by users of ARS research technology to make research results available in timely manner and in a format that could be readily accessed. Researchers took the initiative by producing the "Crop Sequence Calculator" (CSC), an interactive computer software program on a user-friendly CD-ROM. The CSC provides information from the Cropping Sequence Project (Phase II), which is described elsewhere in this report. The CSC provides crop production information and the potential returns of crops in a diverse cropping system, especially the influence of crop sequence (crop rotation). The CSC can calculate the expected yield of ten crops (barley, bean, canola, crambe, flax, pea, safflower, soybean, sunflower, and wheat) grown in any two-year combination. Expected crop prices and expected loan deficiency payments (LDP) can be input to provide rapid calculations of potential returns. Summary statements on crop production, plant diseases, insects, weeds, crop water use, and surface soil properties are automatically provided for each of the 100 possible crop sequence combinations to aid users in their evaluation of management risks associated with different crop sequences. In addition, by selecting the 'More Info' buttons adjacent to each summary statement, numerous photos, graphs, management principles, and internet resources are easily accessed. For example, 'More Info' concerning plant diseases includes graphs and photos of plant disease research results, an introduction to plant diseases, websites for plant disease information, and a gallery of plant disease photographs. The numerous photographs of diseases, weeds, and insects aid producers in identification of possible pests. The user-friendly CSC runs directly from a CD-ROM eliminating the need for additional disk space or installation procedures. The CSC, version 1, was released in January, 2001 and over 2,300 copies of the Crop Sequence Calculator were distributed within nine months. The expanded version 2 of the CSC was released in January, 2002 and over 7,391 copies were requested and distributed.

The Crop Sequence Calculator was revised (version 2.2.5) to provide a more user-friendly computer environment. Although the basic data remains the same in this version, editorial changes were made and numerous websites were added.

Copies of the Crop Sequence Calculator can be obtained from the Northern Great Plains Research Lab website: www.mandan.ars.usda.gov



The underlying data were generated with the supplemental support of the Area IV Soil Conservation District, The National Sunflower Association, The North Dakota Oilseed Council, and the Northern Canola Growers Association. No material in this CD may be copied and distributed in part or whole without permission of the research scientists involved.

MANAGEMENT STRATEGIES FOR SOIL QUALITY

Dr. Donald Tanaka, Steve Merrill, Mark Liebig, and Joe Krupinsky

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 residue were all in the appropriate places in 1994. Treatments for the 2004 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 (cv. Parshall) was seeded on April 27 at 1.3 million viable seeds per acre. Safflower (cv. Montola 2003) was seeded on April 27 at 200,000 viable seeds per acre. Millet for hay was seeded at 4 million viable seeds per acre on June 8. Residue from previous crops was uniformly distributed at harvest. All no-till plots were sprayed with Roundup (0.375 lb ai/a) prior to seeding while minimum-till plots were tilled with an undercutter about 3 inches deep prior to seeding. Spring wheat, safflower, and millet were seeded with a JD750 no-till drill with N fertilizer banded at seeding and P applied with the seed at seeding. Recrop plots received 60 lb N/a and 10 lb P/a while fallow or partial fallow plots received 30 lb N/a and 10 lb P/a at seeding. Rye was seeded on September 29, 2003 at 1.3 million viable seeds per acre with a Haybuster 8000.

Summary:

1. Growing season precipitation (May through August) for 2004 was 73% of the long-term average 9.90 inches.
2. Spring wheat grain yields decreased as cropping intensity increased. This was due to below-average precipitation for the fall of 2003 and for the growing season.
3. Safflower seed yield was greater for SW-S-R than SW-S-F.

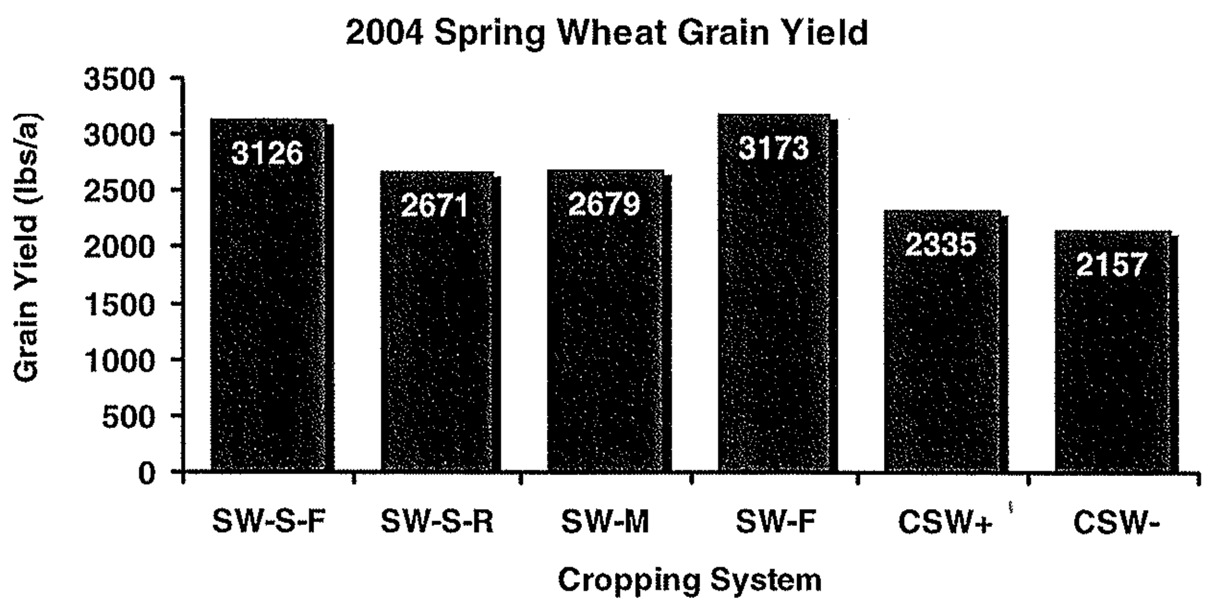


Figure 1. Spring wheat grain yield as influenced by cropping system. Yields are the average of minimum and no-till.

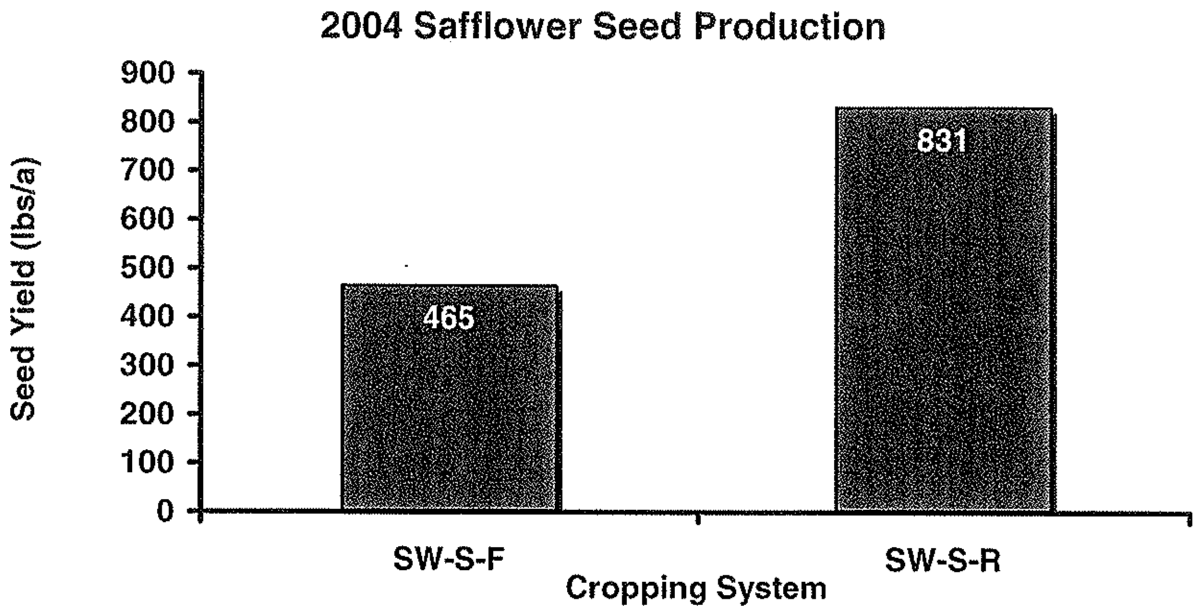


Figure 2. Safflower seed yield as influenced by cropping system. Yields are the average of minimum and no-till.

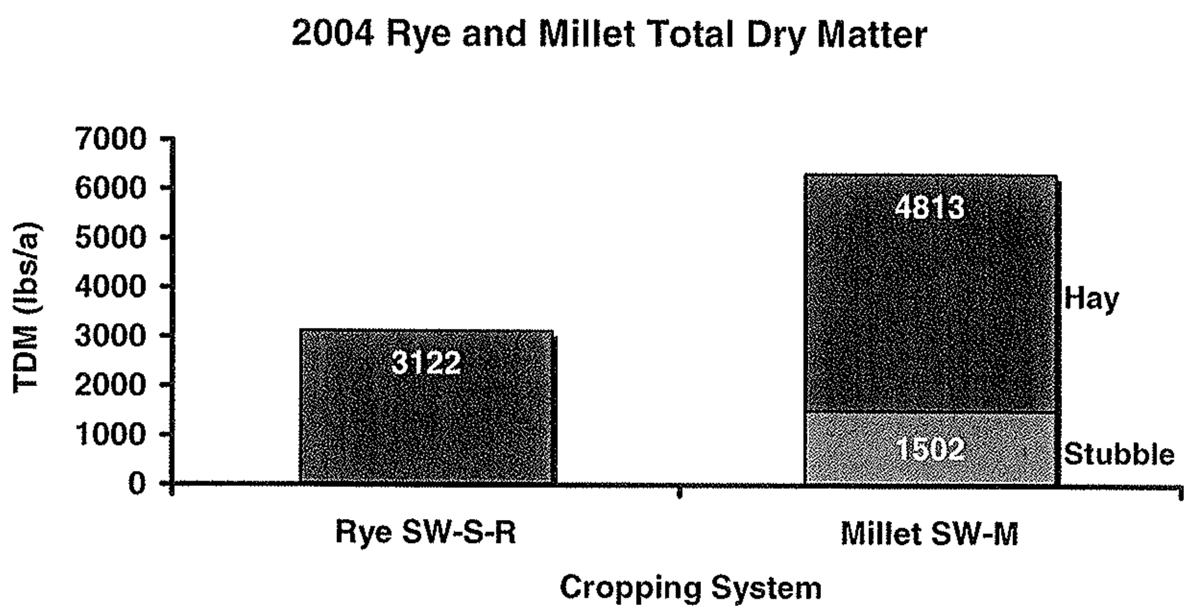


Figure 3. Total dry matter production for rye used as partial fallow and Siberian millet used for hay.

SCLEROTINIA (WHITE MOLD) AS INFLUENCED BY CROP SEQUENCE AND BIOLOGICAL CONTROL, 2004

J.M. Krupinsky, D.L. Tanaka, M.A. Liebig, S.D. Merrill, J.D. Hanson and T.J. Gulya,

Sclerotinia sclerotiorum is a destructive fungal pathogen that has a wide host range causing Sclerotinia diseases (white mold) on many broadleaf crops and weeds. Crop diversification has increased the risk of Sclerotinia diseases by bringing more broadleaf crops into traditional cereal-growing regions. The influence of the previous crop and crop residues on Sclerotinia needs to be more fully understood in order to develop effective crop sequences for cropping systems that minimize risk for Sclerotinia. In an earlier phase of the Crop Sequence Project which included ten crops (safflower, canola, crambe, dry pea, dry bean, flax, soybean, sunflower, spring wheat, and barley) the number of sunflower plants (used as an indicator crop) infected with Sclerotinia basal stalk rot in 2002 was related to the crops grown in 2000. The highest level of Sclerotinia basal stalk rot was associated with plots where crambe was grown.

The ongoing Crop Sequence Project (Phase III), which includes a crop by crop residue matrix (buckwheat, chickpea, corn, lentils, proso millet, grain sorghum, canola, dry pea, sunflower, and wheat), is being evaluated to determine the impact of previous crops and crop residue on Sclerotinia diseases of chickpea, canola, dry pea, lentil, and sunflower. With the exception of Sclerotinia basal stalk rot on sunflower, Sclerotinia diseases were not detected in 2004 probably because of the dry conditions early in the growing season. Sclerotinia basal stalk rot was present on sunflower and increased during the three evaluations (3,000 plants per evaluation) but because of the low number of sunflower plants infected, the incidence of disease could not be statistically related to the ten crops grown in 2003. Seed yield and yield components were determined for all plots. A susceptible sunflower crop, used as an indicator crop, will be seeded over a crop by crop residue matrix site (100 crop sequence treatments) in 2005 and 2006 to determine if the incidence of Sclerotinia stalk rot can be related to the chickpea, canola, dry pea, lentil, and sunflower crops grown earlier. The objective of this project is to determine the effect of management practices, such as crop sequence on minimizing the risk to Sclerotinia diseases.

BIOLOGICAL CONTROL OF SCLEROTINIA WITH A MYCOPARASITE

Sclerotinia sclerotiorum produces sclerotia, hard fungal bodies, which give this organism the ability to survive for years in the soil. A mycoparasite of *S. sclerotiorum* is *Coniothyrium minitans* a fungus which has the potential of reducing soil contamination by destroying sclerotia. Management practices that degrade the number of sclerotia in the field would be beneficial to producers by reducing the number of years a producer would have to wait before going back to a Sclerotinia susceptible crop. The objective of this project is to determine the effect of using a biological control agent for minimizing the risk to Sclerotinia diseases.

The use of *Coniothyrium minitans* (Intercept WG®) in reducing the risk to Sclerotinia disease was evaluated in a Biological Control Project in 2004 at site one. Treatments after the uniform application of sclerotia included: the growing of susceptible and resistant crops, and varying the timing of Intercept WG® applications. Influence of crop sequences and biological control on development of Sclerotinia was evaluated twice with sunflower, an indicator crop (9,500 plants per evaluation). Low numbers of sunflower plants were infected with Sclerotinia basal stalk rot probably making it difficult to statistically relate disease levels to treatments. Seed yield and yield components were determined for all plots. Plots will be reseeded to a susceptible crop in 2005 for further evaluation. Soil coverage by crop residue was measured with a transect technique. Higher values of soil coverage by crop residue were associated with small grain species. Soil water was measured with the neutron moisture meter method throughout the growing season. Surface soil properties were characterized by analyzing for soil pH, electrical conductivity, and extractable N, P, Ca, Mg, K, and Na. Minor differences were detected among plots with soil water measurements and analyses of soil properties indicating that the site was relatively uniform. At site two, treatments will be evaluated with a susceptible crop in 2005. At site three, another experiment using *C. minitans* was established. At site four, an experiment was established to evaluate the impact of sclerotia density on Sclerotinia disease severity and possible economic losses under dryland no-till field conditions.

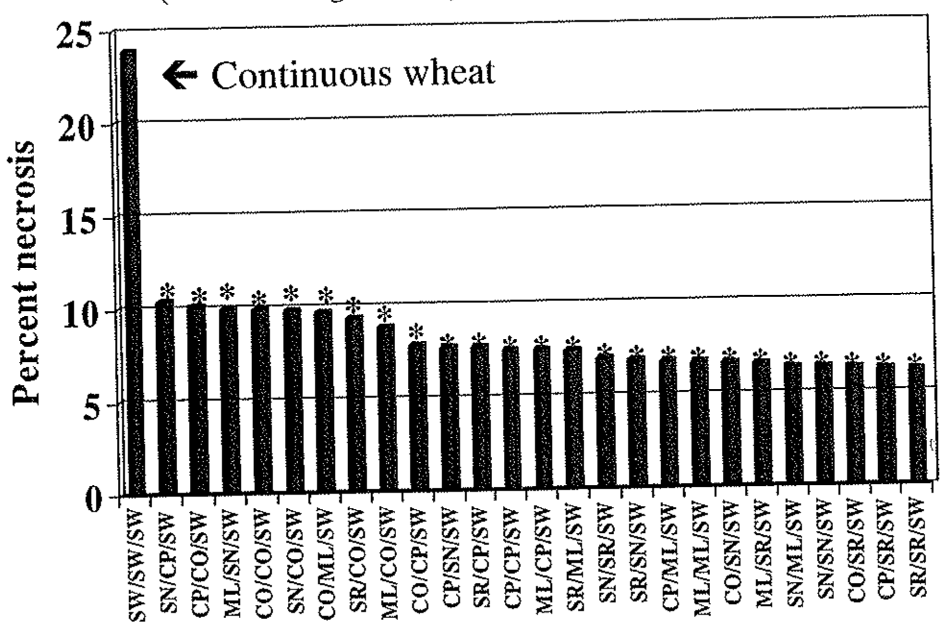
INFLUENCE OF PREVIOUS CROP SEQUENCES ON LEAF SPOT DISEASES OF WHEAT EARLY IN THE GROWING SEASON

J.M. Krupinsky, D.L. Tanaka, S.D. Merrill, M.A. Liebig, and J.D. Hanson

Crop diversification and crop sequencing can influence plant disease risks in cropping systems through crop selection and interruption of disease cycles. Spring wheat is a major crop in the northern Great Plains area and can be impacted by leaf spot diseases. The influence of previous crops and crop residues on plant diseases should be more fully understood in order to develop effective crop sequences that minimize leaf spot diseases on spring wheat in diverse cropping systems. The objective of the study was to determine the influence of crop sequences on the initial development of leaf spot diseases on wheat early in the season under the semi-arid conditions of central North Dakota and no-till management. The effect of crop sequences on leaf spot diseases of hard red spring wheat was determined in a crop sequence project by direct seeding (no till, April 13, 2004) spring wheat (Amidon) into the crop residue of 100 crop sequence treatments. Spring wheat was evaluated for leaf spot diseases. Both percentage necrosis of spring wheat leaves and the number of lesions per leaf were used as indicators of disease severity. In 2004, there were obvious differences in disease severity among spring wheat plots following crop sequences with alternative crops compared to continuous wheat. Differences in percent necrosis and number of lesions per leaf were evident over a series of evaluations (e.g. Figure). The use of crop sequences with alternative crops lower the risk for leaf spot diseases early in the growing season. The major leaf spot diseases on wheat in this area are tan spot and stagonospora (Septoria) nodorum blotch. These evaluations will continue in 2005.

Percent necrosis on continuous wheat compared with other crop sequences on June 16, 2006

(* indicates significantly less necrosis than sw/sw/sw)



WIND EROSION ON SUNFLOWER STUBBLE LAND AS AFFECTED BY TILLAGE AND SUMMER-FALLOWING

Steve Merrill, Don Tanaka, and Ted Zobeck (ARS Lubbock TX)

Recent decades have seen the introduction of a diversity of crop species into the northern Great Plains. A number of these crops, such as pulse legumes (beans, pea, soybean, others) and sunflower, have non-durable residues, and there is concern that the combination of these crops with tillage, summer-fallowing, and relative drought conditions will result in lower residue coverage of soil and elevated wind erosion hazard. Therefore, we designed a study with the objective of determining the interactive effects of tillage and chemical fallow management on wind erosion occurring on sunflower stubble land that had been under no-till management. The agronomic scenario was that pre-plant tillage occurred in early spring. The land was then chemically fallowed through the rest of the season until winter wheat seeding in September. Sunflower has been shown to use significantly more water than some other crops, and summer fallowing is a possible response to low soil water and lack of precipitation.

Three tillage treatments were applied in mid-April followed by multiple applications of glyphosate until winter wheat seeding near September 20. Tillage treatments were (a) No-Till; (b) Med-Till - single pass with a tandem disk; and (c) Max-Till, double passage with an offset disk followed by a single pass with a rotary harrow/residue manager. The principal measurement devices used were sediment samplers, which trapped eroding soil particles at a height of about 3 inches above the soil surface.

Sunflower stalks in the No-Till treatment were mostly standing in April, and the tilled treatments had different degrees of surface roughness. By August, a considerable fraction of sunflower stalks had been downed, and soil roughness had been considerably attenuated by precipitation, greatly increasing soil erodibility. Soil surface roughness affects erodibility, with smooth soils having high wind erosion hazard. The Med-Till treatment had the greatest roughness, followed by the Max-Till treatment, while the No-Till treatment was nearly smooth. By late June, soil roughness in Med-Till had decayed to about half its initial value.

The top 5 storm periods for wind erosion losses occurred after July 1 in both 2003 and 2004. Much lower erosion in springtime was mainly due to the lower erodibility of tillage-generated roughness and standing sunflower stalks in No-Till. Soil losses in 2003 were roughly 10-fold greater than in 2004, with losses for the top 5 storm periods amounting to about 40 Mg/ha (18 tons/acre) in 2003. This is an unacceptable level of erosion, and represents a hazard to long term soil health if allowed to run unchecked. The principal reason for the much greater soil losses in 2003 compared to 2004 was the considerably greater degree of weed growth between applications of glyphosate (5 times in 2004), which was generated by the precipitation pattern in 2004, compared to a drier summer in 2003. Glyphosate-killed grassy weeds present in 2004 were relatively durable and were responsible for lowering wind erodibility.

Soil losses in the No-Till treatment were significantly lower than in the tilled treatments. The ratios of Max-Till and Med-Till soil losses to No-Till losses for the top 5 storm periods were considerably greater in 2003, compared to 2004 ratios, 13.2 and 3.9 in the former year compared to 2.8 and 1.6, respectively. This is believed to be due to the relatively lower erodibility in the tilled treatments in 2004 resulting from considerably more weed growth.

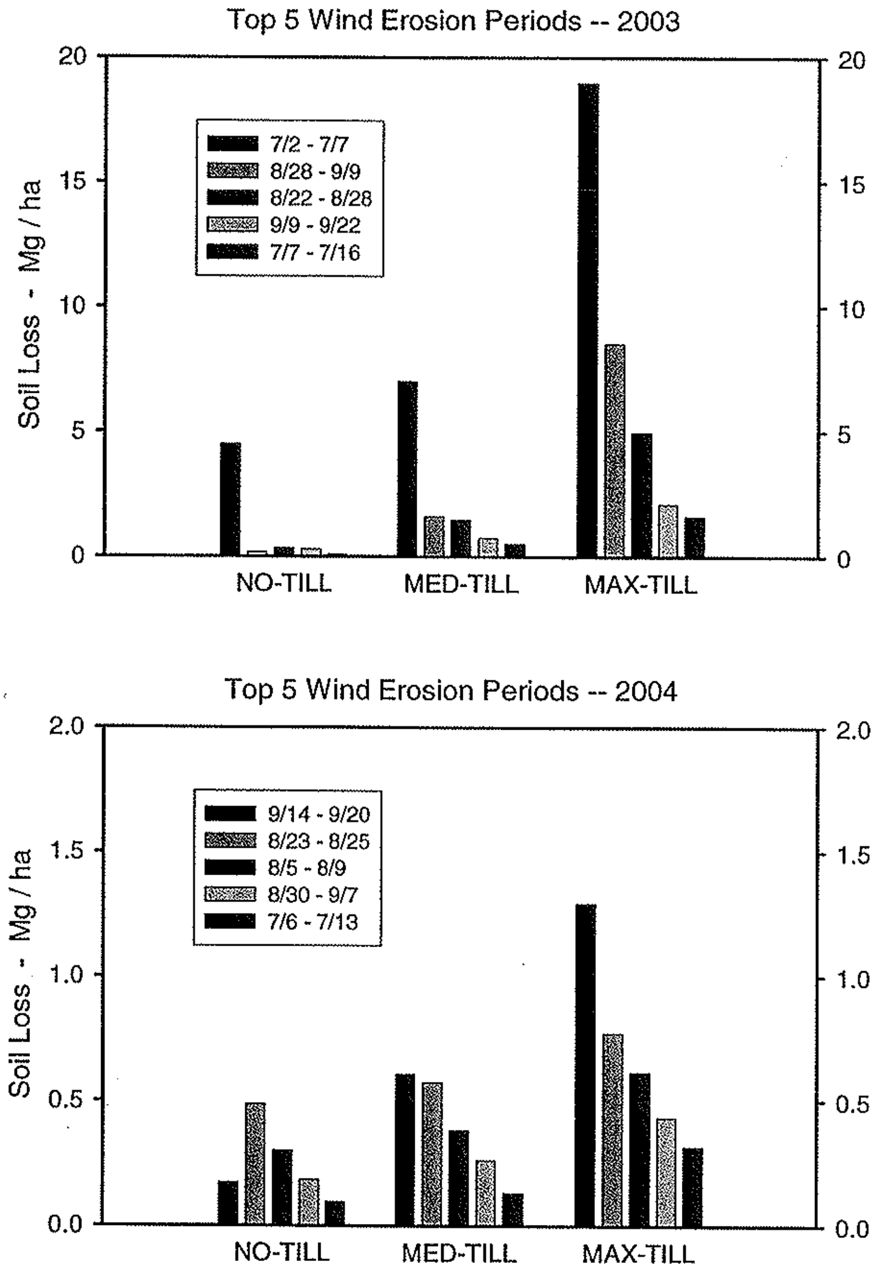


Figure 1. Soil losses calculated from eroded mass measurements for top 5 windstorm periods. Note the change of scale between 2003 and 2004.

SOIL WATER DEPLETION IN PHASE III CROP SEQUENCE EXPERIMENT

Steve Merrill, Don Tanaka, and Joe Krupinsky

We have summarized three years of seasonal soil water depletion data for the Phase III crop sequence experiment in Table A. By comparing the soil water depletions of the different crops, we can compare their water use, which is the sum of soil water depletion and precipitation during the cropping season. In using these data, we make the assumption that there is no runoff and no deep drainage below the root zone. The neutron moisture meter technique was used to take these measurements, which were made over a soil depth of 6 ft. The measurements shown here were made in the second growing season of crop sequences consisting of spring wheat followed by the various alternative crops.

The Phase III crop sequence experiment (CSE) featured more warm-season crops than the Phase II CSE, including such crops as corn, sorghum, and millet. Four of the crops were in common between the two crop sequence experiments, canola, dry pea, spring wheat, and sunflower. Two-year and 3-year water depletion averages (Table A) show that sunflower had the highest water depletions (and hence, the highest water use), and corn the second highest. Both crops have longer growing seasons and are relatively deeply rooted, especially sunflower. Crops depleting, and hence using the least water were dry pea, followed by lentil. Both of these crops have shorter growing seasons, and are relatively shallow rooted. These results showing sunflower as having the greatest water depletion and dry pea the least are in accord with results from our completed Phase II crop sequence experiment.

Seasonal precipitation was lower than average for all three years of the study (Table A), but was considerably better distributed in 2004. The greater effective availability of within-season precipitation in 2004 greatly reduced soil water depletion that year compared with 2002 and 2003.

What is important for producers is the amount of water left in the soil profile in the spring following growth of various crops during the previous year. Crops that deplete the greatest amount of soil water tend to leave the least available the next spring, but snow capture and spring snowmelt can modify this. The pulse legumes (dry pea, lentil, and chickpea here) are know from prior observations to capture and hold less snow over winter compared with other crops under observation. Sunflower left the least amount of water in the soil in spring 2004, but had the second smallest amount in spring 2003 (Table B), a result attributable to poor sunflower growth (and hence less water use) in 2003. The low amount of water use by dry pea in 2002 resulted in that crop having the greatest amount of soil water in spring 2003. However, the greatest amount of water in spring 2004 was found following spring wheat, a result that could be attributable to better show capture overwinter by spring wheat compared with dry pea.

Table A. Growing season soil water depletion (inches) measured to depth of 6 feet in the Phase III crop sequence experiment.

Crop or quality	2002	2003	2004	2-yr avg. '02-'03	Rank, 2-yr	3-yr avg. '02-'04	Rank, 3-yr
Buckwheat	5.15	4.79	1.03	4.97	8	3.66	6
Canola	7.47	3.91	0.39	5.69	3	3.92	5
Chickpea	5.46	4.83	-0.30	5.15	6	3.33	8
Corn	7.04	6.20	1.62	6.62	2	4.95	2
Dry pea	4.11	4.51	-2.68	4.31	10	1.98	10
Grain sorghum	6.05	5.28	1.68	5.67	4	4.34	3
Lentil	4.34	4.98	0.27	4.66	9	3.20	9
Proso millet	5.25	4.97	0.39	5.11	7	3.54	7
Spring wheat	5.03	5.90	1.61	5.47	5	4.18	4
Sunflower	8.36	5.98	1.20	7.17	1	5.18	1
Average	5.83	5.14	0.52				
Period	5/13 to 9/24	5/15 to 9/18	5/14 to 9/17				
6-mo. precip. (Apr. -Sep) avg. = 12.9 in	7.64	10.65	9.40				

Table B. Soil water amounts (inches) measured in the spring after growth of various crops the previous year.

CROP	April 10, 2003		rank 03	rank 02	April 19, 2004		rank 04	rank 03
	total inches per 6 ft	greater than sunfl.	low soil water	high water deplet.	total inches per 6 ft	greater than sunfl.	low soil water	high water deplet.
Buckwheat	18.62	3.55	9	7	16.68	3.11	6	8
Canola	16.18	1.11	2	2	18.27	4.70	9	10
Chickpea	17.56	2.49	4	5	14.71	1.14	2	7
Corn	17.35	2.28	3	3	15.57	2.00	3	1
Dry pea	19.32	4.25	10	10	17.18	3.61	8	9
Grain sorghum	17.59	2.52	5	4	16.06	2.49	5	4
Lentil	18.36	3.29	8	9	15.83	2.26	4	5
Proso millet	18.12	3.05	7	6	16.83	3.26	7	6
Spring wheat	17.86	2.79	6	8	18.33	4.76	10	3
Sunflower	15.07	0.00	1	1	13.57	0.00	1	2

IMPROVING THE BOTTOM LINE WITH CARBON SEQUESTRATION

Dr. Mark Liebig

Since the beginning of the 19th century the concentration of carbon dioxide (CO_2) in the earth's atmosphere has increased from about 280 ppm to a current value of 376 ppm. Much of this increase has been attributed to the industrialization of human society, which has increased in population from 1.1 to 6.4 billion during the same time period. Because CO_2 is a greenhouse gas, it has been implicated in global climate change. A doubling of atmospheric CO_2 over pre-industrial levels is predicted to lead to global warming from 3 to 8°F. This magnitude of change in temperature could result in movement of vegetation zones poleward and increase the frequency of severe weather events.

Reducing emissions of CO_2 and other greenhouse gases is a primary strategy to mitigate global climate change. Increasing the quantity of carbon sequestered in soils and biomass, however, is another important strategy, and one directly affected by agricultural management.

In the northern Great Plains, cropping systems must have a resilient soil resource in order to be sustainable. Central to this resiliency is maintaining and/or increasing soil organic carbon (SOC) by minimizing soil disturbance and providing organic inputs to the soil. These criteria are best reflected through reduced till, continuous cropping management systems (Figure 1).

No-till, continuous crop management systems have been shown to improve soil quality, resulting in enhanced nutrient cycling potential, greater erosion resistance, and faster infiltration rates. These benefits to the soil from improved management also affect agronomic performance, with long-term grain yields greater in the continuous crop, no-till systems as compared to crop-fallow, conventional tillage systems. Increases in crop yield have been found to range from 14 to 35 lbs/ac for spring wheat for each 1 Mg/ha increase in SOC (1 Mg/ha = 1000 kg/ha = 893 lbs/ac). Over time, these increases add up, resulting in improved yields and greater income to producers.

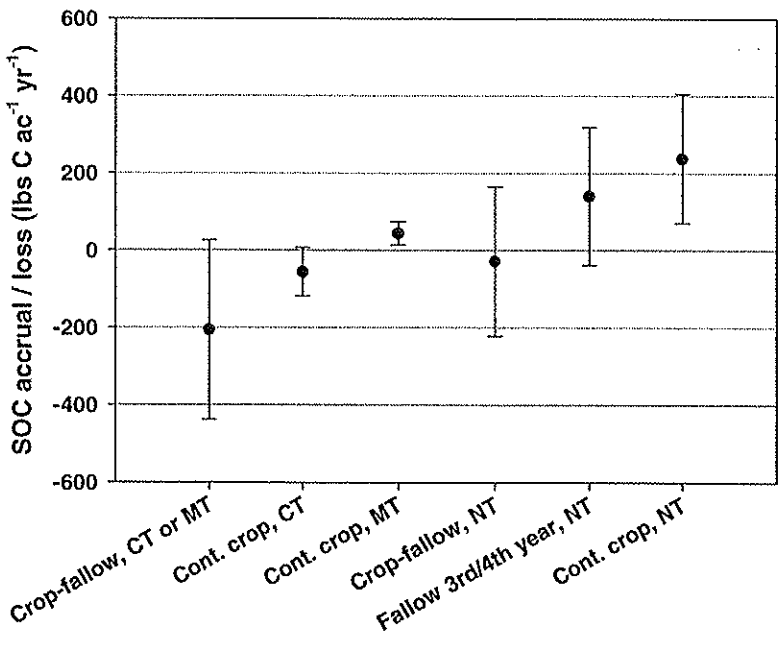


Figure 1. Accrual / loss rates of soil organic carbon (SOC) for six dryland cropping systems, +/- one standard error.

Management practices that increase SOC in cropland can: a) mitigate atmospheric CO_2 increase and its contribution to global climate change, b) improve soil quality, and 3) increase crop yields. As a result, benefits from soil carbon sequestration are accrued across multiple spatial scales by both agricultural producers and society. Recognition of cropland as a significant carbon sink and development of public and/or private reimbursement mechanisms for carbon sequestration can enhance adoption of improved management practices on cropland. Within semiarid regions, continuous cropping with no-till appears to be the most effective dryland cropping system to increase SOC. The agronomic and environmental benefits associated with this cropping system improve agroecosystem performance, thereby increasing agricultural sustainability.

Portions of this article were taken from *Liebig, M.A., and H.T. Gollany. 2004. Sequestering carbon in cropland: Effects of management in semiarid regions of northwestern USA and western Canada. p. 32-36. In Proc. of the Alberta Reduced Tillage Linkages, Direct Seeding Advantage 2004. 16-17 Nov. 2004, Nisku, Alberta, Canada*

PRECISION FARMING IN WESTERN NORTH DAKOTA

Vern Hofman, Extension Ag Engineer
North Dakota State University

Site-specific farming means directing soil and crop management inputs to fit the different conditions found in each field. Site-specific farming is sometimes called "prescription farming," "precision farming," or "variable rate technology." It has caused a focus on the use of three technologies - remote sensing, geographic information systems (GIS), and global positioning systems (GPS). GPS makes use of a series of military satellites that identify the location of farm equipment within a field. The value of knowing a precise location within inches is that 1) location of soil samples and the laboratory results can be compared to a soil map, 2) fertilizer and pesticides can be prescribed to fit soil properties (clay and organic matter content) and soil conditions (relief and drainage), and 3) one can monitor and record yield data as ones goes across the field.

The site-specific farming project in western North Dakota has been conducted in cooperation with the Area IV Soil Conservation District, USDA-ARS Mandan, and North Dakota State University. This project has conducted intensive soil sampling, variable rate fertilizer application, yield monitoring, and map interpretation on about 47 acres that has been split into three fields of nearly equal size.

This project was designed to demonstrate sit-specific farming techniques and to gather data to support soil sampling techniques, profitability and changes in soil test levels at varying soil depths through a cropping rotation. Another objective is to monitor nitrogen (N) movement through the soil profile to determine if N may pose a hazard to underground water supplies.

Work on this demonstration project has found some important findings, which include:

1. Soil sampling based on topographic zones provides soil fertility accuracies similar to intensive grid sampling. Zone sampling requires fewer samples, which is more economical and identifies variability almost as well as grid sampling.
2. Profitability of variable fertilizer application has been variable. Some year's variable fertilizer application has shown a profitable return, while in other years it is less. For profitable fertilizer application, residual N fertilizer needs to vary by more than 30 lbs/ac across fairly large areas of a field. Site-specific application is able to take advantage of the variability with the use of a prescription map for the field that includes a projected crop yield, along with the soil type variability and the residual soil N.
3. In years of good crop yields, residual soil N is reduced to very low levels (20 to 30 lbs. N/ac.). This is due to the crop using the nutrients for growth. In years of dry weather or poor growing conditions, all N is not used and a portion remains in the soil. With variable applications, the residual N is used for the next year's crop. This results in very low N levels, unless an unforeseen crop production variable reduces crop yield.
4. Variable fertilizer application is excellent for the environment. This study has found less residual soil N from variable application as compared to uniform application. Less N in the soil will reduce the potential for polluting ground water supplies. Variable application allows a producer to apply fertilizer based on the crop production capabilities of the soil while utilizing plant nutrients already in the soil.
5. This demonstration has shown that sunflower does an excellent job of removing soil N from the two to six foot soil depths. The sunflower taproot is able to pull soil N from lower depths to reduce the potential of N moving down to underground water supplies. A rotation with a tap root crop is excellent for retrieving N from to the two to six foot soil depths.
6. Yield monitoring is an excellent means of determining crop variability. It gives the producer a chance to see how production practices affect crop yield. Yield monitoring with a GPS receiver is probably the first thing a producer should do when starting site-specific farming.

Producers are aware of variation across fields. Many farmers are combining fields together to facilitate larger machinery that results in more efficient operation. So, with larger fields the variability increases. Site-specific farming is capable of directing crop inputs to small, localized areas of a field with large equipment. An input prescription map is produced from various topographical maps, satellite images, and yield maps. Some of these methods have proven to be very successful, whereas other methods may need more experience to become useful.

DEMONSTRATION PROJECT ON THE AREA IV SCD COOPERATIVE RESEARCH FARM

The past six growing seasons have been directed to rotating three crops on three fields. The crops are hard red spring wheat (SW), hard red winter wheat (WW), and sunflower (SF). These crops were selected as they are commonly grown in western North Dakota. This project was conducted over six years to obtain a variety of growing conditions, including years with good rainfall as well as dry years.

Sunflower was selected so a deep-rooted (Tap root) crop was used in the rotation. Table 1 and 2 present the residual nitrogen remaining in the soil after the crop was harvested. Table 1 presents the field identification in the first column, which is I-4, I-5 and I-6. Column one also indicates the nitrogen sampling depths in two-foot increments down to six feet. The next six columns present the average pounds of N left in the soil at the various depths. Also included is the average crop yield for the year.

During the first three years of the demonstration, rainfall at Mandan was good. But, the last three years rainfall was below normal. During 2002, a rainfall occurred too late for the cereal crops, but helped produce an excellent crop of sunflower. During the last two years of the demonstration, rainfall was below normal and below average yields was produced.

FERTILIZER N APPLIED TO THE CROPS

The crops in this demonstration were fertilized at a rate usually slightly higher than most producers would do. The crops were fertilized for target yields at between 50 and 60 bu/ac for the wheat crops, and over 2,000 lbs/ac for sunflower. This was done to determine if residual N would remain in the soil or leach down through the soil profile and potentially cause groundwater pollution. Usually, residual N fertilizer amounts are considered low if the amount is between 20 and 30 lbs per acre. During the first two years of the demonstration, residual fertilizer amounts are fairly low except for two or three instances. In 2001, the winter wheat had severe winterkill, yielded poorly, and left considerable N in the soil. The remaining N varied across the field and variable rate application was used to adjust N rates so the residual N would be utilized efficiently for the next crop. In the year 2000, soil tests after WW harvest, the high rate of 66 lbs/ac was due to a high rate of N being applied in the fall of 1999 at seeding time.

In 2002, the high N fertilizer rates left in soil were due to an extremely dry year. But, the sunflower crop yield was very good due to a timely rain. As a result, the residual N amounts were fairly low. In 2002 and 2003, the residual amounts went up as N fertilizer was applied for 50+ bu/ac wheat yields, and a 2,000+ lb/ac SF yield. In 2004, fertilizer rates were reduced slightly, and yields were below target amounts due to another below normal rainfall year, but, residual soil N rates were reduced to near the 20 to 30 lb/ac rate.

Variable rate fertilizer application is an excellent method to make use of residual soil N. This allows feeding a crop for a yield potential without applying excessive amounts to low producing areas and allowing one to apply more fertilizer to higher producing areas of the field. It is a great way to efficiently use expensive fertilizer inputs.

Table 2 indicates the variability of residual soil N and crop yield across the six years of the trial. The listed information is obtained from Table 1 and is arranged across the page based upon crop grown. During dry years, residual soil N increased, but at the end of the study after several dry years, fertilizer N amounts were reduced and residual soil N amounts were also reduced. The year 2004 was below normal in rainfall, but with reduced applied N, soil residual amounts decreased.

Table 1: Residual lbs of Soil Nitrogen After Cropping Season*

Field		1999	2000	2001	2002 (Dry Year Early)	2003	2004	Average lb N
I-4	0-24 24-48 48-72	26 14 (SF = 26 2230 lb/ac)	27 14 (SW = 21 56 bu/ac)	37 (WW = 93 16 bu/ac) 30 (winter kill)	13 41 (SF = 27 2112 lb/ac)	9 49 (SW = 31 26 bu/ac)	18 24 (WW = 21 30 bu/ac)	22 39 26
I-5	0-24 24-48 48-72	26 17 (SW = 17 52 bu/ac)	66 17 (WW = 22 57 bu/ac)	24 26 (SF = 27 1768 lb/ac)	112 29 (SW = 29 7 bu/ac)	50 40 (WN = 31 36 bu/ac)	19 26 (SF = 13 1938 lb/ac)	49 26 23
I-6	0-24 24-48 48-72	30 18 (WW = 25 46 bu/ac)	20 12 (SF = 13 2217 lb/ac)	40 15 (SW = 15 56 bu/ac)	74 19 (WW = 15 15 bu/ac)	51 40 (SF = 31 1500 lb/ac)	38 35 (SW = 23 29 bu/ac)	42 21 20
All Fields	0-24 24-48 48-72	27 16 22	38 14 19	37 45 24	66 30 24	37 43 31	25 25 19	38 29 23

Table 2: Nitrogen Left After the Harvested Crop*

Crop		1999	2000	2001	2002 (Dry Spring)	2003	2004	Average lb N
Spring Wheat	0-24 24-48 48-72	26 17 (52 bu/ac) 17	27 14 (56 bu/ac) 21	40 15 (51 bu/ac) 15	112 29 (7 bu/ac) 29	9 49 (26 bu/ac) 31	38 25 (29 bu/ac) 23	43 25 23
Winter Wheat	0-24 24-48 48-72	30 18 (46 bu/ac) 25	66 17 (57 bu/ac) 22	37 93 (16 bu/ac) 30 winter kill	74 19 (15 bu/ac) 15	50 40 (36 bu/ac) 31	18 24 (30 bu/ac) 21	51 37 25
Sun Flower	0-24 24-48 48-72	26 14 (2230 lb/ac) 26	20 12 (2217 lb/ac) 13	24 26 (1728 lb/ac) 27	13 41 (2112 lb/ac) 27	51 40 (1500 lb/ac) 31	19 26 (1938 lb/ac) 13	27 27 25

* **Note: SF=Sunflower, SW=Hard Red Spring Wheat, WW=Winter Wheat Yields: Wheat=bu/ac, Sunflower=lb/**

FORAGE BREEDING AND GENETICS RESEARCH

J.D. Berdahl, J.R. Hendrickson, J.M. Krupinsky, and S.L. Kronberg

GRAZING-TYPE ALFALFA

Development of a long-lived grazing-type alfalfa for dryland pasture in the northern Great Plains is a major objective of the forage breeding and genetics project. Six experimental strains are currently being evaluated in standard performance tests at Mandan, Streeter, and Dickinson, and a grazing trial is underway at Mandan. Seed of a promising experimental strain, Mandan A1991, is being increased in eastern Oregon for possible cultivar release. Parentage of these experimental strains is approximately 60 to 75% yellow-flowered *Medicago falcata* and 25 to 40% purple-flowered *Medicago sativa*. All of these experimental strains have high levels of drought- and cold-induced plant dormancy and a fibrous root system, similar to a grass plant, instead of a tap root that is typical of purple-flowered, hay-type alfalfa. In years with average April through June precipitation, these grazing-type alfalfas would produce approximately 2 tons of dry matter per acre from a mid- to late-June cutting at early bloom. Regrowth is much slower than typical hay-type cultivars. Private seed companies have not developed cultivars with similar, high levels of hardiness due to inadequate potential seed sales. Dry matter yields at Mandan on a sandy-loam soil over a 3-year period are shown in Table 1.

Table 1. Dry matter yields of alfalfa experimental strains and cultivars at Mandan from 2002 to 2004.

Entry	6-28-04	7-21-03	6-19-02	3-yr Total	% of Vernal 02-04
	----------tons dry matter/acre----------				
Mandan A1991	1.46	2.09	1.45	5.00	133
Mandan A1992	1.25	1.73	1.48	4.46	118
Mandan A1993	1.14	1.59	1.58	4.31	114
Mandan A1994	1.05	1.59	1.29	3.93	104
Mandan A1961	1.22	1.66	1.60	4.48	118
Mandan A3851	1.66	1.60	2.06	5.32	140
Travois	1.25	1.64	1.37	4.26	113
Rangelander	1.11	1.52	1.61	4.24	112
Spredor 3	1.27	1.78	1.46	4.51	119
Vernal	1.10	1.45	1.24	3.79	100
Mean	1.25	1.66	1.51	4.43	
LSD (0.05)	0.24	0.29	0.28	.55	

VARIETY TRIALS
ON THE AREA IV COOPERATIVE RESEARCH FARM

Eric Eriksmoen, Agronomist
NDSU Research Extension Center, Hettinger, ND

BARLEY VARIETY TRIAL - CONTINUOUSLY CROPPED - NO-TILL

Variety	Plant Height	Test Weight	% Plump	Grain Protein	---- Grain Yield ---- 2001	2003	2004	Average Yield 2 yr	3 yr
	inches	Lbs/bu	>6/64	%	----------- Bushels per acre -----------				
Conlon	24	47.5	92	12.8	104.9	42.9	24.7	33.8	57.5
Robust	26	48.2	85	12.6	85.8	43.5	43.2	43.4	57.5
Haxby	23	49.8	84	12.6			56.1		
Drummond	27	47.0	91	11.9			48.1		
Tradition	23	47.1	89	12.6			41.3		
Trial Mean	24	47.7	89	12.4	87.6	45.2	43.6	--	--
C.V. %	10.3	1.1	3.1	2.5	5.9	11.7	16.3	--	--
LSD .05	NS	1.0	5	0.6	11.8	NS	12.9	--	--
LSD .01	NS	1.4	7	0.8	NS	NS	18.4	--	--

Planting Date: April 13, 2004
Harvest Date: August 13, 2004
Seeding Rate: 750,000 live seeds / acre (approx. 1.4 bu/A).
Previous Crop: 2000 – 2003 = Barley.
NS = no statistical difference between varieties.
Notes: The 2004 trial sustained moderate moisture stress.

DURUM VARIETY TRIAL - CONTINUOUSLY CROPPED - NO-TILL

Variety	Plant Height	Test Weight	Grain Protein	---- Grain Yield ---- 2001	2003	2004	Average Yield 2 yr	3 yr
	inches	Lbs/bu	%	----------- Bushels per acre -----------				
Mountrail	27	55.2	17.9	50.3	42.4	37.6	40.0	43.4
Ben	32	56.3	17.7	42.8	44.9	34.4	39.6	40.7
Pierce	31	56.6	17.8	43.4	42.2	31.9	37.0	39.2
Lebsock	27	57.0	17.4	43.1	40.4	32.6	36.5	38.7
Maier	30	56.2	18.4	37.3	39.4	35.9	37.6	37.5
Dilse	30	56.4	18.4		40.4	32.8	36.6	
Renville	30	55.7	18.0			34.4		
Trial Mean	29	56.2	17.8	43.4	41.7	34.8	--	--
C.V. %	6.4	0.9	2.1	6.9	2.8	13.5	--	--
LSD .05	NS	0.9	0.7	5.4	1.7	NS	--	--
LSD .01	NS	NS	0.9	7.7	2.4	NS	--	--

Planting Date: April 13, 2004
Harvest Date: August 13, 2004
Seeding Rate: 1.25 million live seeds / acre (approx. 2.2 bu/A).
Previous Crop: 2000 – 2003 = Barley.
NS = no statistical difference between varieties.
Notes: The 2004 trial sustained moderate moisture stress.

OAT VARIETY TRIAL - CONTINUOUSLY CROPPED - NO-TILL

Variety	Plant Height	Test Weight	---- Grain Yield ---- 2001	2003	2004	Average Yield 2 yr	3 yr
	inches	Lbs/bu	----------- Bushels per acre -----------				
Killdeer	31	34.6	89.2	92.5	86.1	89.3	89.3
HiFi	34	35.5	98.9	81.0	68.8	74.9	82.9
Morton	36	37.2	82.2	77.5	60.8	69.2	73.5
Beach	36	37.9		85.4	64.2	74.8	
Otana	34	36.9			71.5		
Stark*	38	38.3			50.4		
Trial Mean	35	36.7	89.2	80.8	67.0	--	--
C.V. %	7.1	1.5	20.8	6.3	9.5	--	--
LSD .05	NS	1.0	NS	7.9	11.6	--	--
LSD .01	NS	1.4	NS	11.0	16.5	--	--

*Naked (hulless) type.
Planting Date: April 13, 2004
Harvest Date: August 13, 2004
Seeding Rate: 750,000 live seeds / acre (approx. 1.7 bu/A).
Previous Crop: 2000 – 2003 = Barley.
NS = no statistical difference between varieties.
Notes: The 2004 trial sustained moderate moisture stress.

HARD RED SPRING WHEAT - CONTINUOUSLY CROPPED - NO-TILL

Variety	Plant Height	Test Weight	Grain Protein	---- Grain Yield ---- 2001	2003	2004	Average Yield 2 yr	3 yr
	inches	Lbs/bu	%	----------- Bushels per acre -----------				
Mercury	25	56.0	16.0	52.3	42.3	43.5	42.9	46.0
Reeder	29	57.3	16.2	48.6	40.7	45.0	42.8	44.8
Oxen	29	55.9	15.9	45.0	45.8	41.7	43.8	44.2
Parshall	34	57.6	16.3	45.6	40.5	42.0	41.2	42.7
Alsen	28	57.2	16.1	42.9	38.0	41.5	39.8	40.8
Keene	35	57.7	16.2	40.6	39.2	39.8	39.5	39.9
Briggs	31	55.6	16.3		40.8	45.7	43.2	
Dapps	35	56.6	17.2		37.5	33.3	35.4	
Butte 86	34	56.5	16.2			38.7		
Granite	27	56.9	18.0			32.2		
Trial Mean	30	56.9	16.4	45.9	40.5	40.1	--	--
C.V. %	8.7	1.5	2.6	8.3	7.3	9.4	--	--
LSD .05	5	1.4	0.7	6.4	4.3	6.4	--	--
LSD .01	6	NS	1.0	8.7	NS	8.6	--	--

Planting Date: April 13, 2004
Harvest Date: August 13, 2004
Seeding Rate: 1.1 million live seeds / acre (approx. 1.6 bu/A).
Previous Crop: 2000 – 2003 = Barley.
NS = no statistical difference between varieties.
Notes: The 2004 trial sustained moderate moisture stress.

HARD READ WINTER WHEAT VARIETY TRIAL CONTINUOUSLY CROPPED – NO-TILL

Variety	Winter Kill	Plant Height	Test Weight	Grain Protein	Grain Yield
	%	inches	lbs/bu	%	bu/A
Millenium	2	25	56.3		55.0
Jerry	4	28	56.0		54.3
CDC Raptor	10	29	56.9		53.3
Harding	7	26	56.3		52.6
Jagalene	3	27	57.0		52.2
Elkhorn	5	30	56.8		52.0
Arapahoe	1	27	57.2		51.9
Nekota	2	25	55.5		51.7
Nuplains	2	25	57.1		51.1
Ransom	3	29	54.7		51.1
Expedition	4	22	55.2		50.0
Wahoo	6	27	54.8		50.0
Wesley	2	22	54.0		49.5
CDC Falcon	3	23	55.0		48.0
Roughrider	10	32	57.7		44.2
Trial Mean	4	26	56.1		51.0
C.V. %	121	9.3	1.3		6.7
LSD .05	NS	4	1.2		5.7
LSD .01	NS	6	1.6		7.6

Planting Date: September 25, 2003
Harvest Date: August 13, 2004
Seeding rate: 1 million live seeds/A (approx. 1.2 bu/A).
Previous Crop: Barley
NS = no statistical difference between varieties.

AREA IV SCD COOPERATIVE RESEARCH FARM DIRECTORS

Burleigh County SCD.........................Gabe Brown, Bismarck ND
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Emmons County SCD.........................Leo Kiefer, Hague ND
Kidder County SCD...........................Marvin Halverson, Tappen ND
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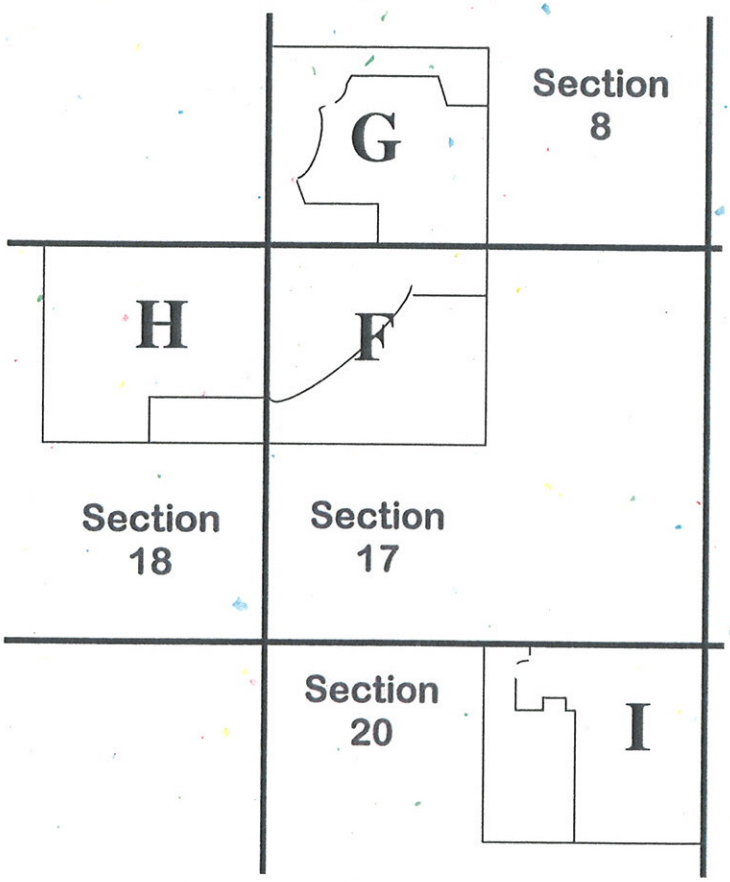

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*McIntosh County SCD, Burleigh County SCD, Oliver County SCD, West McLean County SCD, Stutsman County SCD, Emmons County SCD, Sheridan County SCD, Morton County SCD, Cedar SCD, Kidder County SCD, South McLean County SCD, & Logan County SCD

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