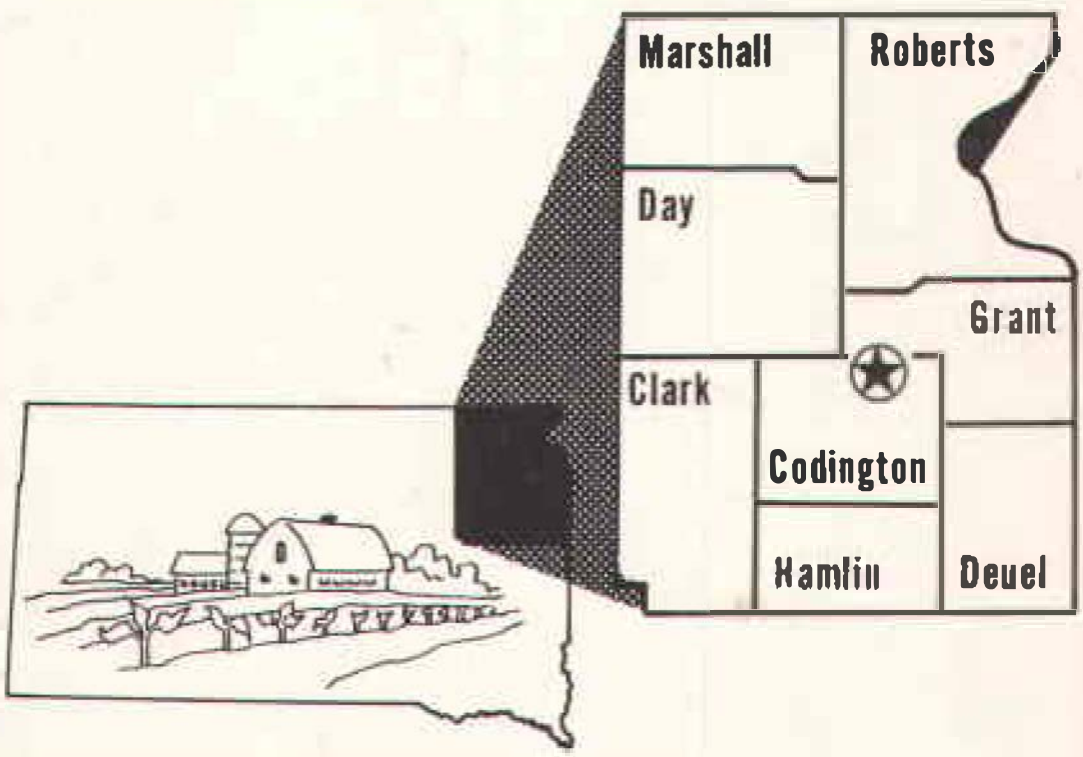
Plant Science Pamphlet No. 22
ANNUAL PROGRESS REPORT

January, 1990

1989 ANNUAL PROGRESS REPORT

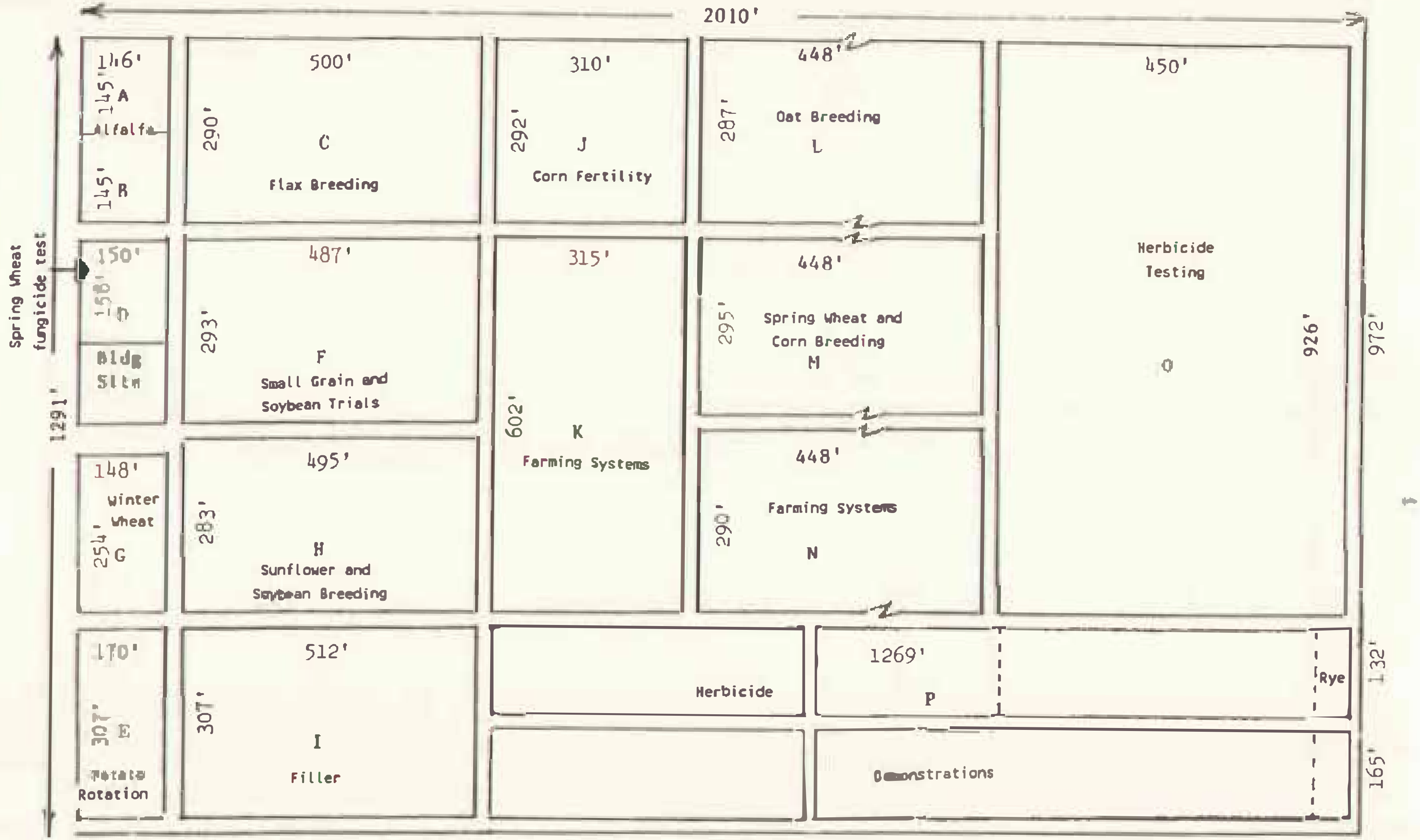
Northeast Research Station
Watertown, South Dakota



PLANT SCIENCE DEPARTMENT
South Dakota State University
Brookings, South Dakota 57007

Northeast Research Station (Watertown)
Year 1989

NORTH



Plot
ACREAGE

A	0.49
B	0.49
C	3.32
D	0.54
E	1.20
F	3.27
G	0.86
H	3.22
I	3.61
J	2.08
K	4.35
L	2.95
M	3.03
N	2.98
O	9.57
P	8.65

ROADWAYS
25 feet wide
Acreage in farm 59.6
Experimental Acreage 50.5

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The 1989 growing season was a substantial improvement over the 1988 season. Temperatures were more seasonal, and precipitation was only 2 1/3 inches below normal (Table 1). Soil moisture conditions at planting were excellent for all crops due to above normal April precipitation. The appearance of the small grain crops in early May indicated potential for excellent yields. However, precipitation in May end June was nearly 4 inches below normal, and rainfall in July occurred too late to benefit the small grains. As a result small grain yields were below the long-term station average. Precipitation in August was well above normal and greatly benefited the row crops. Corn yields were at or above long-term averages. In each of last three years August has been the wettest month. This rainfall distribution pattern has favored the row crops, but has resulted in generally below average small grain crops. The rainfall pattern has also changed weed populations, particularly foxtail. Foxtail is a warm-season grass, and the late summer rainfall has resulted in higher populations compared to previous years. The lack of rainfall in May and June has also interfered with performance of some herbicides resulting in further problems with foxtail.

The dry conditions in May and June slowed the development of most fungal and bacterial diseases, but some Sclerotinia was again present in sunflowers. The more seasonal early spring temperatures apparently resulted in more normal arrival times for aphids carrying Barley Yellow Dwarf Virus and, in contrast to the previous two years, BYDV was a minor problem in 1989.

Attendance at the summer field tour was excellent. Tour topics included herbicide trials, small grain varieties, small grain diseases, grasshopper control, sunflower and soybean breeding, corn breeding and fertility studies, spring wheat and alfalfa research, and farming systems studies. We thank the area Crop Improvement Associations for sponsoring the evening lunch. We also acknowledge the assistance of the area County Agents at the tour. We thank Nick Endres for furnishing a wagon for use at the tour and Morris Gunderson for supplying water used at the station. Thanks also to Orrin Korth and family for their harvesting assistance and equipment loans. Rural water was installed in October which should improve the efficiency and safety of operations at the station. We also installed an automated weather station in July which will aid greatly in interpreting climatic effects on plant growth and development. The weather station was jointly purchased by the Ag. Engineering Department and the Nematode Testing Service. An additional 10 acres of land will be rented in 1990. This additional land will allow an increase in soybean research and should also improve plot uniformity for the crop breeders.

-J D S-

NOTE: Much of the information contained in this report is based on ongoing studies and results should therefore be considered tentative. Additional information concerning small grain, flax and soybean performance is available in Extension Circulars EC 774 and EC 775, and is available at County Extension offices. A complete set of the results of the herbicide demonstrations is available in the 1989 Herbicide report (EC678).

We acknowledge the assistance of Deb Davis and Nancy Kleinjan in the preparation of this report.

AGRICULTURAL ADVISORY GROUP, 1989
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Table 1. Growing season precipitation.

Month	Amount (in.)	Normal	Departure	Greatest Amount	Date
April	2.95	2.10	+0.85	0.65	25
May	1.15	2.97	-1.82	0.32	4
June	1.74	3.75	-2.01	0.75	25
July	2.41	2.67	-0.26	1.50	28
August	4.58	2.78	+1.80	1.00	13
September	1.56	1.85	-0.29	0.92	3
October	0.56	1.16	-0.60	0.55	28
Total	14.95	17.28	-2.33		

Temperatures: Last Frost: 28° F May 1
First Frost: 26° F September 26
Frost free period: 147 days

1989 Performance Trials of Small Grain and Soybeans at the Northeast Experiment Farm

J. J. Bonnemann

The crop performance testing program at the Northeast Station included small grains, soybeans and corn in 1989. Small grains grown were barley, durum, oats and spring wheat. Soybean trials included Group 0 and Group I maturity groups. The corn trials were separated by company supplied classification into hybrids earlier or later than 95 days relative maturity. The proprietary entries of corn and soybeans are the choice of the company and included on a fee basis.

The small grain yields ranged from good to poor. Germination was uneven and precipitation limited during much of the early growing season. The soybean and corn yields also were variable depending partially upon maturity and timeliness of precipitation. Maturity was slowed in September as temperatures averaged nearly five degrees below normal.

The results of the small grain and soybeans trials and more agronomic data are reported in EC 774 (rev.) and EC 775 (rev.), respectively. The corn results are reported in Plant Science Pamphlet #20. The reports are available at the County Extension Office or from the Bulletin Room, SDSU, Brookings, SD 57007.

1989 Oat Trial, CPT, NE Farm, Watertown, SD.

	Variety Means	
Variety name	Yield	Test Weight
Don	83.3	35.7
Burnett	78.9	33.9
Settler	78.7	35.3
Horicon	78.0	30.7
Hamilton	77.4	32.2
Hytest	76.0	37.1
Lancer	74.2	32.9
Ogle	72.3	31.2
Webster	71.4	31.5
Kelly	71.2	35.5
Preston	69.5	35.4
Trucker	68.8	36.0
Valley	67.6	34.3
Sandy	64.9	34.6
Hazel	64.5	35.4
Starter	62.5	34.8
Proat	56.2	33.2
Moore	54.2	34.5
Porter	53.2	37.0
Wright	51.0	35.0
Steele	48.4	34.0
Lyon	48.0	31.8
Overall Mean	66.2	34.1
LSD (.05)	7.6	
C.V.	8.1%	

1989 CPT Durum and Barley Trials, NE Farm, Watertown, SD.

Variety name	Yield	Test weight	Variety name	Yield	Test weight
Stockholm	33.2	59.5	Bowman	67.3	52.7
Monroe	32.0	58.6	Gallatin	53.6	48.6
Ward	29.8	58.3	Azure	52.5	47.3
Rugby	29.8	58.9	Hazen	49.1	45.7
Vic (Chk)	29.7	59.0	Robust	45.1	47.8
Renville	28.9	57.1	M 52	40.0	46.5
Crosby	28.7	58.9	81602	40.0	44.6
Sceptre	27.7	58.0	Primus II	39.5	48.2
Fjord	27.4	59.3	Glenn	37.1	45.0
			Morex	37.0	46.0
Overall mean	29.7	58.6			
LSD (.05)	4.0		Overall Mean	46.1	47.3
C.V. - %	9.25%		LSD (0.05)	5.8	
			C.V.	7.6%	

1989 Spring Wheat Trial, CPT, NE Farm, Watertown, SD.

	Variety Means	
Variety name	Yield	Test Weight
Nordic	37.8	55.9
W2501	35.7	52.5
Shield	35.0	55.3
Butte 86	34.7	57.0
2375	34.1	58.0
Alex	33.9	55.9
Norseman	33.3	53.7
Celtic	32.7	55.6
Prospect	32.7	55.3
Stoa	32.3	56.2
W2592	32.3	52.1
2369	32.2	58.3
Len	31.6	54.8
Guard	31.2	56.3
Marshall	31.0	52.7
Fjeld	30.6	55.5
Angus	30.6	57.0
Amidon	30.2	55.0
Grandin	28.6	54.4
Telemark	27.9	53.9
(Minnpro)	27.8	54.4
Vance	26.7	53.9
Gus	25.6	54.2
Chris (Check)	23.1	55.6
Overall Mean	31.1	55.3
LSD (.05)	4.6	
C.V.	9.2%	

1989 Group 0 Soybean Trial, CPT, NE Farm, Watertown, SD.

Variety name	Yield	Plant height	Mature MO/DA
Sibley CK	42.3	32.0	9/24
Northrup King S 07-80	42.1	28.7	9/19
Pioneer 9061	41.0	28.3	9/18
Interstate IS715	40.5	31.3	9/24
Glenwood	39.6	26.7	9/18
Northrup King 8095	39.5	33.7	9/22
Dawson CK	39.3	29.3	9/19
Sands SOI 059	37.7	31.0	9/21
Interstate IS 546	37.5	30.7	9/21
CCS Rosen	37.5	29.7	9/19
Simpson	37.4	27.7	9/20
Mustang M-1000	37.4	29.3	9/22
Star EX811	36.8	28.0	9/23
Swift	36.7	32.0	9/19
Arrowhead 8450	36.7	31.3	9/21
CCS Exp-0222	36.5	29.7	9/18
Star EX8908	36.3	31.0	9/18
Dahlgren KC-60	35.6	28.3	9/20
Evans	35.5	29.7	9/15
Mustang M-1050	35.0	32.0	9/24
Pioneer 9091	34.7	28.0	9/19
Interstate IS529	34.3	31.3	9/18
Arrowhead 8300	33.4	30.7	9/19
Ozzie	32.5	28.0	9/17
Dassel	32.5	28.3	9/19
McCall CK	29.0	28.7	9/11
Overall Mean	36.3	29.5	9/19
LSD (0.05)	4.9		
C.V.	8.3%		

1989 Group I Soybean Trial, CPT, NE Farm, Watertown, SD.

Variety name	Yield	Plant height	Mature MO/DA
Hardin	43.2	34.3	9/29
Arrowhead 8600	42.3	29.0	9/29
Star EX8917	42.0	31.7	9/29
Star EX8815	41.9	27.3	9/26
Weber	40.5	31.3	9/28
Dawson CK	40.2	27.7	9/18
Mustang M-1140	40.1	31.3	9/29
Kato	39.7	31.0	9/27
Pioneer 9111	39.5	25.7	9/26
Star EX8916	39.1	27.0	9/30
Sexauer EX 1000	38.8	30.0	9/25
Sands Soi 166	38.8	30.7	9/29
CCS Summit	38.1	34.7	9/26
Stine 1820	37.9	29.7	9/28
Diamond Brand D150	37.8	30.7	9/30
Glenwood CK	37.8	27.3	9/18
Sturdy CK	37.7	31.7	10/2
Sibley CK	37.6	31.0	9/26
Schwitters Commanche	37.3	30.0	9/29
Schwitters Cherokee	36.9	31.7	9/28
Dekalb CX117	36.5	27.7	9/25
Sands Soi 195	36.0	28.7	9/29
Arrowhead 8650	35.8	31.7	9/30
Mustang M-1150	35.1	31.3	9/29
Hodgson 78	34.2	32.0	9/27
Golden Hv'st H1170 BL	34.0	31.3	9/28
Corsoy 79 CK	33.6	36.3	10/3
Dahlgren KC-81	33.0	30.7	10/1
Sexauer SRF 101	32.8	27.7	9/25
Hy-Vigor K-1880 (BL)	32.5	34.0	9/30
Arrowhead 8550	32.1	27.3	9/28
BSR 101	30.6	30.3	10/2
Overall Mean	36.1	30.4	9/28
LSD (0.05)	4.6		
C.V.	7.9%		

1989 Corn Performance Trial, Area D2 (early), Watertown, SD.

Brand and Variety	Yield B/A	Pct Stalk Lodged	Pct Moist	Perf Score Rating
Interstate IS463	102.8	0.6	17.6	1
Betagold Ingrid	102.1	0.0	17.4	2
Dahlgren DC-440	101.1	1.1	18.8	4
Golden Valley 282	100.9	0.0	17.3	3
Top Farm SX1195	98.1	1.1	18.1	5
Cenex/LOL 385	96.2	0.6	17.2	6
Interstate IS443	94.7	0.6	18.6	8
Sigco 1799	93.8	0.0	19.1	13
Tecnagene DF4894	93.8	0.0	18.2	10
Top Farm SX1195A	93.8	0.0	17.9	9
Northrup King N2440	93.5	0.0	16.9	7
Tecnagene DF4893	92.9	0.0	17.4	11
Golden Har'st H2327	92.8	0.6	19.0	16
Pioneer 3902	92.4	0.0	16.8	12
Betagold Gerda	91.9	0.0	17.4	14
Garst 8939	91.6	0.0	17.6	15
Terning Select	89.4	0.6	16.9	17
Tecnagene DF4890	89.1	0.0	16.8	18
Terning Primer+	89.1	0.0	19.1	24
Asgrow/O'Gold RX469	88.9	0.0	18.5	22
AgriPro AP077	88.7	0.6	16.2	19
Garst N6952	88.3	1.1	17.0	21
Asgrow/O'Gold RX337	88.3	0.0	16.6	20
Sigco 1973	88.0	0.6	17.5	23
Golden Har'st X783	88.0	1.1	17.3	25
DeKalb DK464	87.7	0.0	19.6	28
Betagold Irene	86.7	0.0	18.1	27
SeedTec ST7212	86.5	0.0	18.8	31
Top Farm SX1194	86.3	0.6	17.9	30
Asgrow/O'Gold PX406	86.2	0.6	16.9	26
Pioneer 3737	86.1	0.6	17.4	29
Pioneer 3790	85.6	0.0	18.4	33
AgriPro AP148	85.2	0.6	17.6	32
Dahlgren DC-492	83.3	0.0	18.9	36
Garst 8882	83.0	0.6	17.8	35
AgriPro AP097	82.3	0.6	16.3	34
Conti 8455	81.6	0.0	18.4	37
SeedTec ST7147	80.3	0.6	16.8	38
Tecnagene DF4992	76.8	0.6	17.8	41
Dahlgren DC-430	76.6	0.0	17.0	39
Interstate IS406	75.8	0.0	16.5	40
Conti 8304	75.6	0.0	16.9	42
Means	88.9	0.3	17.3	
LSD (0.05)	N.S.			
C.V.	11.7%			

1989 Corn performance trial, Area D2 (late), Watertown, SD.

Brand and Variety	Yield B/A	Pct Stalk Lodged	Pct Moist	Perf Score Rating
Cenex/LOL 432	109.8	0.0	20.2	1
Interstate 1S543	106.6	0.0	21.2	2
Tecnagene DF4898	102.8	0.0	20.8	4
Top Farm SX1101	101.5	0.0	20.9	5
Northrup King N3624	100.9	0.0	17.6	3
Golden Valley 2981	100.0	0.0	19.8	6
Cargill 4227	98.8	0.0	20.9	7
Top Farm SX1102	98.3	1.7	20.4	8
SeedTec ST7255	95.5	0.6	20.9	9
Betagold Karla	94.3	0.0	20.3	10
Interstate IS523	93.4	0.6	20.6	12
Terning Encore II	93.4	0.0	20.6	11
Dahlgren DC-502	92.3	1.1	20.2	13
Cargill 3627	91.5	0.0	20.6	14
Betagold Katrina	91.5	0.6	21.1	15
Dekalb DK524	90.3	0.0	20.5	16
Golden Valley 2960	87.7	0.0	19.2	17
Garst N6851	82.8	1.2	18.4	18
Cargill 4327	80.1	0.0	21.1	19
Cargill 5157	78.9	0.0	22.6	20
Means	94.5	0.3	20.4	
LSD .05	NS			
C.V.	9.5%			

SPRING WHEAT BREEDING

F. A. Cholick, K. M. Sellers, and E. J. Autrique

The experiments conducted in 1989 can be divided into the following general areas: 1) evaluation of new experimental lines developed by the breeding program, 2) evaluation of breeding methodology, and 3) purification and increase of experimental lines. All experiments were planted on May 3 into excellent soil moisture and harvested on August 2. Seeding rate was adjusted for kernel size and the rate was 28 seeds per square foot. All plots were fertilized according to soil tests for a yield goal of 55 bu/A. This station is one of 9 test sites used by the project and generally considered to be the site to evaluate high yield potential. However, in 1989 the average yield for all experiments was only 29 bu/A and five of the test sites averaged higher. The 1989 yields were more than doubled when compared to 1988 yields but only 62% when compared to the average yield from 1981-1987. In 1989 plant development from emergence to heading was excellent and the crop appeared to have good yield potential. One of the the indicators of this good development was the plant height. For example, the check variety Chris was 35 inches tall compared to 24 inches in 1988. However, in my opinion the lack of rain and/or stored soil moisture prevented the crop from realizing its potential. Two variables that illustrate that the potential was not realized were test weight and protein content. Test weight averaged 57.6 lbs/bu with a range of 52.3 to 61.1 lbs/bu. Protein content averaged 17.6% and ranged from 16.2 to 19.2%. The average test weight was lower than normal, and the protein was higher than normal. Therefore, as in 1988, the data from this site evaluated the response to stress rather than yield potential; however, the intensity, type, and timing of the stress were different in 1988 and 1989.

Two trials were conducted to evaluate experimental lines - Advanced Yield Trial (AYT) and Preliminary Yield Trial (PYT). The AYT is made up of experimental lines that are in the second, third, fourth, or more years of state wide testing. These lines have performed equal to or superior to the best checks in previous years for yield, agronomic traits, disease resistance, and quality. In this trial, the top yielding checks were Shield, Butte 86 and Guard. Five new lines in their second year of state wide testing and the line SD2980, which is being increased for release, were in the top yielding group in 1989. This group averaged 31.1 bu/A compared to 28.6 bu/A for the trial and 21.8 bu/A for the variety Chris.

In the PYT, 35 new lines were compared to checks for the first time in state wide trails. As with the AYT, these new lines had been evaluated for yield, agronomic traits, disease, and quality but only at two sites, Brookings and Redfield. The top yield checks in this trial were Shield, 2375 and Butte 86. Eleven new lines were also in the top yielding group which averaged 32.6 bu/A, compared to 29.6 bu/A for the trail and 23.4 bu/A for Chris. These 11 new lines also had high test weight with one exception, and 7 were as early or earlier than Butte 86. However, only three lines were semi-dwarfs and the remainder were conventional plant height. There was a range in protein content but 9 of the 11 lines would be classified as medium-high or high.

A study was completed to evaluate breeding approaches to introduce non-adapted germplasm and to determine if early generations testing can be used as predictors for later generations. The introduction of non-adapted germplasm has been used successfully by the breeding program and the varieties Guard, Shield and Prospect are examples. This study was designed to evaluate the efficiency of different methods of incorporating non-adapted germplasm. The general conclusions from this study were: 1) the efficiency of introducing non-adapted germplasm differed with the different type of crosses, 2) the best by best crosses produced the highest proportion of superior lines, and 3) early generation testing was a relatively poor predictor of later generations for yield, and a relatively good predictor for protein, plant height, and maturity. The implications of this study for the breeding project are that different breeding methodology will be required to effectively exploit the genetic variability in crosses with winter wheats or other non-adapted germplasm.

THE USE OF SOIL TESTS TO PREDICT FERTILIZER NITROGEN NEEDS OF CORN

R. Gelderman, S. Swartos, and L. Evjen

Introduction

Approximately 50% of the total fertilizer nitrogen applied in South Dakota is used on corn. The need for efficient and profitable nitrogen recommendations for corn is apparent. The best guide available for recommending fertilizer is a soil test. Soil tests need to be correlated to field response data such as reported here.

The objective of this study is to determine the relationship of the nitrate-nitrogen soil test to yield response of corn to nitrogen fertilizer.

Methods

The study was located on the north side of the Watertown Station on a Brookings soil. These soils are deep, silty clay loam loess over glacial till. Results of the soil tests from samples taken in the spring of 1989 (just prior to planting) are shown in Table 2.

Table 2. Spring soil test results of nitrogen corn studies, Watertown Station, 1989.

NO_3-N 0-24"	NO_3-N 0-48"	O.M.	P	K	pH
lb/A	lb/A	%	lb/A	lb/A	
71	201	4.4	22	330	6.3

The soil tests for nitrate-nitrogen indicated moderate levels of nitrogen in the top two feet. A large quantity of available N is located in the two to four foot depth. A 'normal' level would be considered 20-30 lb/A at this depth.

Phosphorous is considered medium and additional phosphorus was applied to eliminate this as a limiting nutrient variable. Potassium is considered adequate here. The pH is slightly acid.

The previous crop was wheat. The area was field cultivated and disked before planting Pioneer 3790 on May 9, 1989 at a population of 18,700 plants per acre. The nitrogen fertilizer treatments were spread on the soil surface as ammonium nitrate five days after planting. The rates used were 0, 30, 60, 90 and 120 lbs of actual nitrogen per acre. Each treatment was replicated four times. The plots were hand harvested on October 5, 1989.

Results and Discussion

The average yields for the experiment are shown in Table 3. The grain yields were not influenced by nitrogen treatments. This is not surprising in that available soil nitrogen to four feet was well over the nitrogen required for 100 bushel corn (125 lb N/A).

Table 3. Average corn grown and stover yields for the nitrogen study, 1989.

Rate of N	Grain Yield	Stover Yield
lb/A	bu/A (15%)	lb/A (dry wt.)
0	101	4236
30	102	3940
60	102	3817
90	99	3462
120	100	3830
Sign. of F	0.89	0.13

The post harvest soil analysis is not yet complete. Therefore, estimates of how much nitrogen was extracted from the soil by the crop is not possible.

The stover yields show a slight downward trend due to added N, however this treatment is not significant at the 0.05 level.

The amount of soil nitrogen at the two-four foot depth is usually not very high under farmer fields. However, where deep nitrate-nitrogen is suspected this value can be useful in determining fertilizer N requirement for corn.

This study will be continued for at least one more year at the station.

1989 SOYBEAN BREEDING

Kathleen Grady and John Felton

A yield trial of soybean experimental lines and several named check varieties of similar maturity was seeded at the Northeast Research Station and one other location in 1989. The experimental lines were derived from graduate student K. P. Sharma's dissertation research on flower abortion and are being tested to determine if any warrant release. Lines were divided into three tests based on maturity (Group 0, Group I, and Group II). All three tests were planted on May 30, 1989 and harvested on October 6, 1989.

Yields of the Group 0 and Group I soybeans were good (Tables 4 and 5). The average yield across Group 0 and Group I entries was 30.0 bu/A and 31.1 bu/A, respectively. The highest testing Group 0 check was Simpson, with an average yield of 35.6 bu/A, and the best Group I check was Sibley, yielding 39.5 bu/A.

All Group II varieties were frosted before reaching maturity, considerably reducing yields. Mean yield across all entries was 21.0 bu/A (Table 6). The best Group II check was Sturdy, with a mean yield of 24.9 bu/A.

Table 4. 1989 Soybean Group 0 yield test at Northeast Research Station.

Variety	Maturity Group	Seed Yield (bu/A)	Plant Height (cm)
McCall	00	29.9	68
Glenwood	0	35.5	64
Dassel	0	32.3	61
Dawson	0	35.2	73
Simpson	0	35.6	68
Sibley	I	32.3	74
Experimentals:			
SD 87001	0	27.1	60
SD 87019	0	26.0	71
GM 87-54	0	23.9	65
GM 87-58	0	26.6	69
GM 87-63	0	27.9	65
GM 87-73	0	27.7	60
GM 87-74	0	29.8	65
Mean		30.0	66
LSD .05		2.7	5

Table 5. 1989 Soybean Group I yield test at Northeast Research Station.

Variety	Maturity Group	Seed Yield (bu/A)	Plant Height (cm)
Glenwood	0	40.0	57
Sibley	I	39.5	78
Hardin	I	36.1	83
Weber	I	37.0	75
Kato	I	38.6	71
Corsoy 79	II	26.2	86
Experimentals:			
84-30 LL	I	30.8	76
SD 87016	I	35.7	66
SD 87020	I	30.5	71
SD 87031	I	31.0	78
SD 87032	I	30.6	76
GM87-25	I	28.6	66
GM87-43	I	27.9	69
GM87-46	I	28.9	69
GM87-49	I	24.9	64
GM87-56	I	25.1	62
GM87-268	I	26.6	78
GM87-273	I	24.3	90
GM87-278	I	28.1	73
GM87-363	I	30.1	75
GM87-365	I	33.2	76
GM87-368	I	31.1	82
GM87-371	I	30.3	78
GM87-373	I	30.5	76
Mean		31.1	74
LSD .05		3.0	9

Table 6. 1989 Soybean Group II yield test at Northeast Research Station.

Variety	Maturity Group	Seed Yield* (bu/A)	Plant Height (cm)
Sibley	I	33.4	73
Corsoy 79	II	23.4	84
Elgin 87	II	21.0	75
Sturdy	II	24.9	75
Experimentals:			
SD 87005	II	22.5	76
SD 87006	II	25.5	77
SD 87009	II	22.5	69
SD 87026	II	25.8	73
GM87-132	II	16.8	74
" -148	II	19.4	83
" -151	II	17.4	81
" -170	II	24.3	83
" -173	II	17.0	80
" -188	II	20.8	77
" -222	II	21.1	69
" -223	II	17.9	77
" -225	II	19.5	73
" -226	II	21.4	69
" -228	II	18.9	72
" -229	II	19.2	79
" -231	II	21.3	70
" -234	II	15.0	73
" -235	II	23.4	74
" -239	II	20.2	75
" -247	II	13.5	77
" -249	II	24.2	73
" -252	II	24.4	73
" -347	II	14.5	74
Means		21.0	75
LSD .05		2.4	7

* All plots except Sibley were frosted before reaching maturity.

1989 Sunflower Hybrid Trial

Kathleen Grady and John Felton

A yield trial of sixteen commercial sunflower hybrids was conducted at the Northeast Research Station in 1989. Hybrids tested were the choice of the companies and were included on a fee basis.

The trial was seeded on May 30, 1989. Plots consisted of two rows thirty inches apart and twenty-two feet long. Plots were overplanted and thinned to 20,000 plants per acre. Yield, oil percent, oil yield and agronomic data are reported in Table 7. The average seed yield over all hybrids in 1989 was 2027 lbs/acre, which was slightly lower than the 1988 average of 2293 lbs/acre.

Table 7. 1989 South Dakota Hybrid Sunflower Trial grown at the Northeast Research Station.

Hybrid Identification	Seed Yield (lbs/A)	Oil Percent (%)	Oil Yield (lbs/A)	Plant Height (cm)	Lodging (%)
AgriPro 4200	1574	48.5	764	133	7.3
AgriPro 2057	1322	45.6	604	139	5.3
Contiseed Hysun 350	2306	47.4	1094	135	1.3
Contiseed Hysun 354	1928	48.1	927	136	3.3
Contiseed Sunbird II	1942	41.7	812	163	1.3
DATA 84109	1867	49.0	915	142	6.7
Genetic Res. CRI-SN881	2338	47.1	1103	143	1.3
Genetic Res. CRI-SN884	1977	48.8	964	137	10.7
Hybrid 894	1702	47.7	813	138	10.0
Interstate IS 3311	1856	47.7	886	141	1.3
Interstate IS EXP61121	2540	47.7	1216	145	2.7
Jacques Exp. 8713	2129	47.5	1010	128	4.7
Pioneer 6440	2625	48.6	1275	138	5.3
Seedtec ST-330	1490	47.9	713	136	3.3
Seedtec ST-317	2591	47.2	1225	143	6.7
Seedtec ST-314	2244	47.7	1070	141	5.3
Mean	2027	47.4	962	140	4.8
LSD .05	467	1.8	236	12	ns

1989 FLAX BREEDING

Kathleen Grady and John Felton

A yield trial of named flax varieties and advanced experimental lines was grown at the Northeast Research Station and two other South Dakota locations in 1989. The main objectives of this trial were to provide data on performance of released flax varieties to farmer/growers as well as to identify possible new varieties.

In 1989, 25 experimental lines from the SDSU flax breeding program were tested against 16 named varieties (checks) and 8 experimental lines from North Dakota or Canada (Table 8). The experiment was planted on May 3, 1989 in a 7 x 7 lattice design with 3 replications. The mean yield across all varieties was 15.9 bu/A. The highest yielding check variety at the Northeast Station was Rahab, with an average yield of 16.8 bu/A. The highest yielding experimental line was SD87467, which averaged 16.4 bu/A seed yield.

Table 8. Yield, rank, and plant height of flax varieties and experimental lines grown at the Northeast Research Station in 1989.

Variety	Origin -year	Seed Yield (bu/A)	Rank	Plant Height (cm)
Culbert	MN-75	15.0	39-40	53
Culbert 79	SD-79	16.3	15-16	52
Linott	CAN-66	14.6	46-47	56
Wishek	ND-79	14.9	41-43	57
Dufferin	CAN-75	15.3	35-36	54
Flor	ND-81	14.8	44	53
Clark	SD-83	15.6	27-28	54
NorLin	CAN-83	14.7	45	54
McGregor	CAN-82	14.3	48	54
Rahab	SD-85	16.8*	11-13	52
Linton	ND-85	15.4	32-34	51
NorMan	CAN-84	15.7	26	51
Verne	MN-87	15.6	27-28	56
Neche	ND-88	16.0	18-20	52
Vimy	CAN-86	15.4	32-34	54
Prompt	SD-89	15.9	21-23	52
CI 3243	SD-exp.	15.0	39-40	50
CI 3259	ND-exp.	13.2	49	53
CI 3261	"	15.1	37-38	58
CI 3266	SD-exp.	14.9	41-43	53
CI 3269	"	15.5	29-31	52
CI 3270	CAN-exp.	15.3	35-36	53
CI 3281	ND-exp.	15.9	21-23	59
CI 3282	"	14.6	46-47	53
CI 3283	"	15.4	32-34	55
CI 3284	"	15.9	21-23	54
CI 3285	"	14.9	41-43	56
SD 86327	SD-exp.	15.8	24-25	50
SD 86329	"	16.0	18-20	51

Table 8. (continued)

Variety	Origin -year	Seed Yield (bu/A)	Rank	Plant Height (cm)
SD 86331	SD-Exp.	17.7*	4	53
SD 86343	"	17.5*	5-7	53
SD 86344	"	17.5*	5-7	51
SD 87418	"	16.2	17	51
SD 87421	"	15.5	29-31	53
SD 87424	"	15.5	29-31	50
SD 87425	"	16.8*	11-13	52
SD 87426	"	17.5*	5-7	54
SD 87433	"	15.1	37-38	57
SD 87435	"	17.4*	8	54
SD 87438	"	16.3	15-16	54
SD 87449	"	15.8	24-25	53
SD 87450	"	16.0	18-20	52
SD 87462	"	16.8*	11-13	52
SD 87463	"	18.0*	3	53
SD 87464	"	17.2*	9	50
SD 87466	"	16.9*	10	51
SD 87467	"	18.4*	1	52
SD 87468	"	18.2*	2	52
SD 87470	"	16.4	14	53
Mean	"	15.9		53
LSD .05	"	1.8		4

* Indicates a variety was in the top yielding group based on the LSD.

POTATO ROTATION STUDY - 1989

D. Callenberg and L. Evjen

The rotation in this study is potato - spring wheat - corn. The study was initiated in 1986. Plots of Kennebec and Red LaSoda were planted on May 12, 1989 in rows spaced approximately 40", with 12" between seedpieces in the row. Cut seed was dusted with captan plus streptomycin prior to planting. Moisture was variable during the season, but emergence and stand counts were adequate in both varieties. Plots were harvested on September 14, 1989. Average yields were 121.4 and 104.5 cwt/A for Kennebec and Red LaSoda, respectively. _Rhizoctonia_ was observed throughout the plots at harvest, with some _Fusarium_ and _Erwinia_ also present, particularly in Red LaSoda.

LEGUME-SMALL GRAIN ROTATIONS

J. Smolik and L. Evjen

The objective of this study is to compare the agronomic performance of a minimum-till small grain rotation with legume-based rotations. 1989 was the second year of the study. The three-year min-till rotation is oats-barley-spring wheat. The legume rotations are oats/sweetclover-sweetclover (green manure) -spring wheat, and oats/medic/switchgrass-medic/switchgrass-spring wheat. Barley (var. Robust) was planted April 20. Seeding rate was 58 lb/A. Prior to planting the barley plot areas were field cultivated.

The medic (var. Virgo) stand obtained in 1988 was poor (approximately 3 plants per sq. ft.) and no switchgrass was present. In the fall of 1988 the dominant plants in these plots were volunteer oats and green and yellow foxtail. Inspection of the medic plots in spring 1989 revealed the medic had completely winter-killed. Because neither medic nor switchgrass were present this treatment was converted to fallow, and the plot areas were field cultivated in late May. The 1988 sweetclover stand was good, and spring 1989 growth was comparatively lush considering the general dry season. Sweetclover was mowed June 16. Forage was not removed. The estimated forage yield was 1.55 T/A dry matter. Forage tissue analysis (% N-P-K) was 2.75 - 0.27 - 2.22. Barley yielded 42.3 bu/A with a test weight of 43.9. Following barley harvest all plot areas were chisel plowed.

Soil moistures and nitrogen test results are presented in Table 9. As might be expected, soil moisture was higher in the fallow treatment. There was very little difference in soil moisture between the barley and sweetclover. Soil nitrate levels increased substantially in all treatments compared to 1988. Fifty lbs of N were applied in October 1988 to the barley plots. 1988 N levels following barley indicate approximately 50 lbs of N was mineralized in 1989. The highest soil nitrate levels occurred following sweetclover (Table 9). Nitrate levels are adequate in all plots for 1990, and no fertilizer will be added.

Table 9. Soil moisture and nitrogen levels.

Treatment	Soil Moisture (5)		lb NO_3-N to 2'	
(1988)	0-6"	6-24"	1988	1989
Min-till barley	16.7[a]	16.0	60.7	108
Sweetclover (green manure)	16.3	16.0	13.7	176
Fallow	17.7	17.7	11.3	144

[a] Avg. of three replications, sampled September 13.

GRASSHOPPER RESEARCH

D. D. WALGENBACH, B. W. FULLER and M. A. BOETEL

Introduction:

Grasshopper population densities varied greatly in eastern South Dakota during 1989. Grasshopper counts in ditch and field border areas ranged from less than 5 to more than 150 grasshoppers per square meter. Many farmers reported grasshoppers at levels which caused considerable field margin damage and necessitated the use of pesticides to avoid unacceptable economic losses. This report includes two separate tests which were designed to assist growers in battling future grasshopper outbreaks. In test #1, we investigated the use of Asana (Fenvalerate) and 3 rates of Sevin (Carbaryl) XLR to determine their residual control of grasshoppers in alfalfa and bromegrass. Test #2 involved the treatment of roadside ditches with poison bran baits to reduce grasshopper populations in these hatching areas prior to their movement into crop land.

Materials and Methods:

TEST #1: The alfalfa and bromegrass (ca. 1 m tall) field was divided into a checkerboard grid pattern and liquid sprays of the pesticides (Asana 0.03I lbs; Sevin 0.5, 0.75 1.0 lbs AI/ac) were applied in alternating blocks (4,047 square meters) which allowed for treated blocks to be surrounded on all four sides by untreated blocks. These untreated areas served as reservoirs for grasshoppers to move back into treated areas, thus allowing our assessment of residual control by these compounds. The fifth treatment in this study was an untreated check which was set up in the same manner as sprayed blocks. A randomized complete block design with four replications was utilized. Forty 1/10 square meter aluminum rings were placed in the central portion of each treatment block. Population estimates were taken by counting all grasshoppers within these rings on 0, 5, 12, 16, and 30 days post-application. Counts from the untreated blocks were used in Abbott's formula to adjust for natural fluctuation in grasshopper population dynamics and to calculate the mean percent reductions. Data were analyzed using the General Linear Model (GLM) procedure, and means were compared using Duncan's multiple range test (SAS Institute 1985).

TEST #2: Roadside ditches which bordered corn or soybeans were sampled for grasshoppers. Treatments of several pesticides and application rates were used with a Brie-mar Model 60 bran bait applicator which was mounted in the back of a pickup truck. Two locations were chosen for the study. A completely random design with 4 replications was used. These treatments were applied in the direction of the wind (less than 5 mph) to insure a uniform dispersal of bran flakes and to produce a swath of approximately 13 m. Pre- and posttreatment counts were made using 8 sweeps with a standard collection net to approximate one square meter of area. The foliage height varied greatly (0.3 to 1 m), however, no mowed roadside areas were chosen. <u>Melanoplus bivittatus</u> (Say) was the dominant species present during both ditch studies. Care was taken to locate ditches which contained a minimum of 20 grasshoppers per square meter. Individual treatments were applied in a 13m swath for a length of 61.5 m. Low wind (less than 10mph) and warm temperatures (above 16 degrees C) were required for accurate counts since grasshopper activity is important when sampling with sweep nets. Thus, posttreatment sampling dates varied due to weather conditions but were normally 4 to 7 days following bran application. Data were subjected to the analysis procedures as previously described in Test #1.

Results and Discussion:

TEST 1: Grasshopper control was evidenced with all spray applications (Table 10). The 3 rates of Sevin XLR were significantly different (P < 0.05) during the earlier sampling dates, however, acceptable control was apparent with all rates through 30 days postapplication. This would promote the possibility of using a reduced rate of Sevin, thus allowing it to become more competitive with other pesticides on a cost per acre basis.

Table 10. Mean percent grasshopper reduction from preceeding counts in untreated controls using four treatments to control *M. bivittatus*, *M. differentialis*, and *M. femurrubrum*, Bruce, SD, 1989.

Treatment	Rate (lb/ac)	Live grasshoppers/m² (Percent reduction) 0	5	12	16	30
Untreated	-----	49.0	28.1	26.2	25.2	16.2
Asana	0.031	46.1	0.8 (96.8a)	1.1 (96.6a)	2.5 (93.6a)	4.4 (80.5a)
Sevin	1.000	41.9	1.6 (91.4ab)	2.7 (90.4ab)	3.6 (89.7a)	5.3 (79.5a)
Sevin	0.750	42.2	2.7 (83.8bc)	4.1 (85.5bc)	6.4 (79.8b)	6.4 (72.1a)
Sevin	0.500	40.9	3.6 (80.8c)	6.5 (81.2c)	9.4 (70.6c)	4.6 (80.8a)

Means within columns followed by the same letter are not significantly ($P \geq 0.05$) different using Duncan's multiple range tests.

TEST #2: The amount of control provided by bran bait treatments to ditch and border areas varied greatly and may have been strongly affected by the plant canopy present at a test site. At the first test location, 4 pounds per acre of bran flakes provided greater control with 1% Lorsban and 2% Sevin than was observed with the 2 pounds per acre treatment, however, this was not true for 3% Lorsban (Table 11).

Table 11. Mean percent grasshopper reduction for controlling primarily M. bivittatus in a ditch area near White, South Dakota, 1989.

Treatment	Rate (lbs/ac)	Formulation (%)	Precount (sq m)	Percent grasshopper reduction
Lorsban	2.0	1.0	17.5	22.3 a
Lorsban	4.0	1.0	15.0	61.6 a
Lorsban	2.0	3.0	25.5	78.3 a
Lorsban	4.0	3.0	24.8	75.5 a
Sevin	2.0	2.0	24.0	57.9 a
Sevin	4.0	2.0	18.5	71.5 a

The second ditch study (Table 12) data was more erratic and control varied greatly. We feel this may have related to a greatly increased amount of grass foliage present in these ditch areas. The more dense canopy may have provided a more accessible food source for the foraging grasshoppers, thus reducing the likelihood of a grasshopper encountering the toxic bran flakes.

Table 12. Mean percent grasshopper reduction (7 d posttreatment) for controlling primarily M. bivittatus in a ditch area near White, South Dakota, 1989.

Treatment	Rate (lbs/ac)	Formulation (%)	Precount (sq m)	Percent grasshopper reduction
Dimilin	2.0	1.0	74.3	38.6 a
Dimilin	4.0	1.0	55.3	42.3 a
Sevin	2.0	2.0	40.3	------ *
Sevin	4.0	2.0	39.3	7.6 a
Sevin	2.0	5.0	79.8	33.1 a
Sevin	4.0	5.0	46.8	------ *

*No measured reduction.

COMPARATIVE EFFICACY OF CORN ROOTWORM INSECTICIDES AND APPLICATION RATES, 1989

D. D. Walgenbach, M. A. Boetel, and B. W. Fuller

INTRODUCTION

Three studies were conducted during the 1989 growing season to evaluate the efficacy of commonly used corn rootworm insecticides. A site at Rutland and one at Nunda served as locations for the studies. All three trials were conducted in dryland cornfields that had high (>5/plant) adult corn rootworm populations during the fall of the previous season.

The first study was established to compare the standard recommended application rates with reduced rates of presently registered granular compounds. Our intention in this experiment was to provide the grower with a reasonable margin of safety against losses due to corn rootworm damage while, at the same time, reducing insecticide application costs and minimizing the adverse effects of pesticides upon the environment. The second and third studies were set up to evaluate a number of new compounds against some of the standard commercially-available products.

MATERIALS AND METHODS

The experimental design for all three studies was a randomized complete block with four replications. Insecticide treatments were applied using both banded (B) and in-furrow (F) placement methods. Individual treatment plots consisted of single rows, 50 feet in length, with 38 inch row spacing. Granular formulations of insecticides were applied with modified Noble metering units mounted on a specially-adapted Kinze, 4-row corn planter. The metering units were ground-driven, and all units were calibrated on the planter. Insecticide granules were applied in a 7-inch band in front of the furrow-closing wheels and incorporated by the wheels and drag chains. In-furrow applications were directed immediately between the double disk furrow openers. Wilson brand 1100 was the corn variety utilized, and it was seeded at a rate of 22,100 kernels per acre at both study locations. Five roots per replication were dug from each treatment. Roots were washed, examined for rootworm feeding damage, and rated in accordance to the Iowa 1 to 6 scale. These ratings were used to calculate the percent root protection provided by each insecticide treatment.

RESULTS AND DISCUSSION

Sufficient levels of soil moisture were present at both locations. Rootworm infestations ranged from moderate to heavy which resulted in corn roots within untreated rows being heavily damaged in most test plots.

In the first study, significant differences in efficacy were not detected between 1/2 of, 3/4 of, or the full recommended rate of Counter, Dyfonate, Thimet, and Force at the Rutland study site (Table 13). Additionally, the three rates of Lorsban, Dyfonate, and Thimet were not significantly different from each other at Nunda. This provides evidence that the recommended application rates of some of these compounds may be more than necessary for adequate control of corn rootworms. As mentioned earlier, a safety factor for crop protection must be established. This may be difficult to achieve at 1/2 of the recommended rate of these compounds due to problems associated with equipment failure and calibration error. However, using 3/4 of the normal application rate may be a more realistic approach. When statistical comparisons were made between 3/4 of, and the full recommended rate of these compounds, significant differences in percent root protection did not exist at either of the study sites for Counter, Lorsban, Dyfonate, Thimet, or Force.

These results suggest that the grower must consider the compound being applied when choosing application rates. A savings of 25% in application costs may be achieved while maintaining excellent crop protection by using 3/4 of the recommended rate of Counter, Lorsban, Dyfonate, Thimet, or Force.

Table 13. Percent root protection of 22 granular corn rootworm insecticides at two locations in east central South Dakota (Study 1).

Insecticide	Placement	Pounds AI/acre	Percent Root Protection		
			Nunda	Rutland	Ave.
Counter 15G	F	0.750	80.4	73.8	77.1
Counter 15G	B	0.500	70.6	80.0	75.3
Counter 15G	B	0.750	89.0	85.0	87.0
Counter 15G	B	1.000	87.7	85.0	86.4
Lorsban 15G	F	0.750	66.9	67.5	67.2
Lorsban 15G	B	0.500	57.1	57.5	57.3
Lorsban 15G	B	0.750	69.4	70.0	69.7
Lorsban 15G	B	1.000	58.3	67.5	62.9
Dyfonate II 20CM	B	0.500	63.2	71.2	67.2
Dyfonate II 20CM	B	0.750	66.9	62.5	64.7
Dyfonate II 20CM	B	1.000	63.2	71.2	67.2
Thimet 20G	B	0.500	48.5	70.0	59.3
Thimet 20G	B	0.750	44.9	76.3	60.6
Thimet 20G	B	1.000	44.9	78.8	61.9
Force 1.5G	F	0.075	79.2	70.0	74.6
Force 1.5G	B	0.050	89.5	68.8	79.2
Force 1.5G	B	0.075	73.0	68.8	70.9
Force 1.5G	B	0.100	68.1	68.8	68.5
Fortress 10G	F	0.200	86.5	70.0	78.3
Fortress 10G	F	0.250	87.7	83.8	85.8
Fortress 10G	F	0.300	90.2	87.5	88.9
Fortress 10G	B	0.250	66.9	83.8	75.4

Moderate to heavy rootworm beetle populations were also present in the second and third studies. As is presented in Table 14, many differences in percent root protection were detected between compounds, rates, and placement (band vs. in-furrow) methods.

Table 14. Percent root protection of granular corn rootworm insecticides at two locations in east central South Dakota.

(Study 2):

Insecticide	Place-ment	Pounds AI/acre	Percent Root Protection		
			Nunda	Rutland	Ave.
Lorsban 15G	F	1.000	59.2	78.3	68.8
Lorsban 15G	B	1.000	63.4	85.0	74.2
Counter 15G	F	0.500	88.7	93.3	91.0
Counter 15G	F	1.000	74.6	96.7	85.7
Counter 15G	B	0.500	73.2	91.7	82.5
Counter 15G	B	1.000	78.9	96.7	87.8
Brace 10G	F	0.500	84.5	85.0	84.8
Brace 10G	B	0.500	74.6	95.0	84.8
Brace 4E	F	0.500	64.8	93.3	79.1
Brace 4E	B	0.500	63.4	81.7	72.6
Brace 4E	B	1.000	83.1	96.7	89.9

(Study 3):

Broot 15G	B	1.000	83.3	56.8	70.1
Counter 15G	F	0.500	73.6	83.8	78.7
Counter 15G	F	0.750	81.9	79.7	80.8
Counter 15G	F	1.000	90.3	83.8	87.1
Counter 15G	B	1.000	88.9	91.9	90.4
Fortress 5G	F	0.250	77.8	70.3	74.1
Fortress 5G	B	0.150	59.1	44.6	51.9
Fortress 5G	B	0.250	72.2	56.8	64.5
Fortress 5G	B	0.300	73.6	64.9	69.3
Fortress 5GM	F	0.250	68.1	64.9	66.5
Fortress 5GM	B	0.250	54.2	51.4	52.8
Fortress 10G	B	0.250	63.9	67.6	65.8
Furadan 15G	F	0.500	85.4	44.6	65.0
Furadan 15G	F	0.750	78.1	54.1	66.1
Furadan 15G	F	1.000	80.6	48.6	64.6

ALFALFA CULTIVAR YIELD TEST

Edward K. Twidwell, Kevin D. Kephart, and Robin Bortnem

Two alfalfa cultivar yield experiments were conducted at the NE station during 1989. These tests were conducted to determine yield performance of various alfalfa cultivars and experimental lines when grown in NE South Dakota.

The first study was planted in late April of 1987 and consisted of 31 cultivars (Table 15). Three harvests were obtained during the 1989 growing season. Average total dry matter yield was 3.33 tons per acre. There were some significant differences detected among the cultivars as yields ranged from 2.91 to 3.77 tons per acre. Significant cultivar differences were also found for the 2-year average yield. Average total dry matter yields obtained in 1989 were approximately 0.5 ton per acre lower than in 1988. Precipitation received at the station was below normal in May, June, and July, and normal in August and September. A similar rainfall pattern occured in 1988, and that is probably the reason that yields are similar for the two years.

The second experiment consisted of 28 alfalfa cultivars and was planted on April 28, 1988 (Table 16). Three harvests were obtained during the 1989 growing season. Average total dry matter yield was 3.80 tons per acre and no significant differences detected among the cultivars. The 2-year average yield was 2.20 tons per acre with no significant differences found among the cultivars. This result is not surprising since this average includes seeding year and only one production year of data. This longterm average yield will become more meaningful as the trial continues through 1991.

These results are useful in selection of alfalfa cultivars for forage production. Measurements of forage yield taken over several harvests and years are usually more useful than are averages from a single harvest. Also, yield data taken from the seeding year is of limited use because differences associated with winterhardiness will not be expressed.

Table 15. Forage yield of 31 alfalfa cultivars planted April 25, 1987, at the Northeast Research Station, Watertown, South Dakota.

Rel. Cultivar	1987 1-Cut Total	1988 3-Cut Total	1989 Cut 1 6/16	1989 Cut 2 7/25	1989 Cut 3 8/24	1989 3-Cut Total	2 Year Avg.[a]	Performance[b]
	---------------- tons / acre							-- % --
120	2.00	4.34	1.47	1.14	0.97	3.58	3.96	110
Dart	1.93	4.28	1.40	1.24	0.90	3.54	3.91	108
Clipper	2.03	4.02	1.58	1.21	0.95	3.74	3.88	108
WL 225	2.11	4.21	1.47	1.17	0.91	3.55	3.88	108
Cimarron	1.95	4.18	1.37	1.25	0.88	3.50	3.84	106
MTO S82[c]	1.91	4.15	1.69	1.03	0.79	3.50	3.83	106
532	1.77	4.16	1.39	1.11	0.97	3.48	3.82	106
Arrow	1.65	3.87	1.52	1.24	1.01	3.77	3.82	106
526	1.66	4.10	1.33	1.20	0.92	3.45	3.77	105
Fortress	1.87	4.31	1.24	1.09	0.85	3.17	3.74	104
Big 10	1.74	3.92	1.40	1.09	0.91	3.40	3.66	102
Mohawk	1.68	3.94	1.35	1.11	0.92	3.38	3.66	101
Dynasty	1.82	3.76	1.37	1.23	0.95	3.54	3.65	101
Iroquois	1.84	3.86	1.33	1.16	0.90	3.39	3.63	101
SX 217	2.05	4.04	1.18	1.14	0.88	3.21	3.63	101
Magnum III	1.86	3.92	1.27	1.03	1.00	3.30	3.61	100
XPH 2001	1.69	3.82	1.32	1.14	0.91	3.38	3.60	100
SX 424	1.65	3.88	1.26	1.12	0.85	3.23	3.55	99
5432	1.72	3.73	1.31	1.11	0.95	3.37	3.55	98
Apollo Supreme	1.81	3.66	1.38	1.12	0.90	3.39	3.52	98
Endure	1.81	3.83	1.35	0.97	0.88	3.20	3.51	98
Blazer	1.82	3.86	1.31	0.97	0.81	3.09	3.47	96
Vernal	1.83	3.55	1.38	1.13	0.87	3.38	3.47	96
Cim2000C	1.79	3.78	1.18	1.05	0.83	3.07	3.42	95
Saranac	1.60	3.57	1.36	1.03	0.85	3.24	3.41	95
Commandor	1.80	3.56	1.26	1.09	0.87	3.21	3.38	94
636	1.73	3.57	1.32	1.00	0.82	3.14	3.36	93
Eagle	1.72	3.78	1.08	1.02	0.82	2.91	3.35	93
DK 135	1.81	3.69	1.17	1.00	0.81	2.98	3.33	92
Saranac AR	1.78	3.61	1.20	1.00	0.79	3.00	3.30	92
MTO N82[c]	1.78	3.33	1.48	0.91	0.72	3.10	3.21	89
Average	1.81	3.88	1.34	1.10	0.88	3.33	3.60	
Maturity[d]			4.3	6.0	4.3			
LSD(0.05)	NS	NS	0.18	NS	0.12	0.46	0.36	

[a] Two year average based on post-establishment year yields, 1988 and 1989.
[b] % Relative Performance = (cultivar 2-yr-average yield)/(2-yr-average of all cultivars.
[c] Experimental line, not currently marketed.
[d] Average harvest maturity. Value based on Kalu and Fick (1983) Index, mean-stage-by-count.

Table 16. Forage yield of 28 alfalfa cultivars planted April 28, 1988, at the Northeast Research Station, Watertown, South Dakota.

Cultivar	1988 1-Cut Total	1989 Cut 1 6/16	1989 Cut 2 7/25	1989 Cut 3 8/24	1989 3-Cut Total	2 Year Avg.[a]	Relative Performance[b]
	tons / acre						%
Big 10	0.76	2.02	1.27	1.17	4.45	2.61	119
DK 125	0.67	1.74	1.18	1.20	4.12	2.40	109
Vernal	0.77	1.75	1.10	1.15	4.00	2.38	109
Chief	0.58	1.77	1.23	1.16	4.15	2.37	108
Vector	0.62	1.67	1.22	1.18	4.06	2.34	107
FSRC 87N1[c]	0.70	1.61	1.20	1.07	3.88	2.29	104
Magnum III	0.57	1.75	1.19	1.06	4.00	2.29	104
AP 8620[c]	0.67	1.68	1.10	1.08	3.86	2.26	103
120	0.71	1.68	1.06	1.07	3.81	2.26	103
Arrow	0.57	1.75	1.13	1.06	3.94	2.26	103
Magnum +	0.52	1.65	1.12	1.15	3.92	2.22	101
FSRC 87N3[c]	0.57	1.65	1.14	1.07	3.86	2.22	101
Sure	0.61	1.62	1.14	1.05	3.81	2.21	101
XAF62[c]	0.52	1.68	1.01	1.18	3.87	2.20	100
5432	0.49	1.52	1.20	1.19	3.91	2.20	100
AP 8631[c]	0.55	1.66	1.11	1.06	3.84	2.19	100
SX 424	0.62	1.60	1.09	1.07	3.75	2.19	99
MTO N82[c]	0.54	1.76	0.98	0.99	3.73	2.13	97
FSRC 87M1[c]	0.67	1.59	1.00	1.00	3.60	2.13	97
526	0.56	1.60	0.93	1.13	3.66	2.11	96
Cimarron	0.67	1.38	1.15	1.03	3.56	2.11	96
WL 320	0.53	1.48	1.10	1.03	3.62	2.07	94
Kingstar	0.58	1.59	0.99	0.95	3.53	2.06	94
Dart	0.54	1.58	0.95	1.02	3.55	2.04	93
86639[c]	0.53	1.60	0.98	0.96	3.54	2.03	92
Premier	0.57	1.46	0.99	1.01	3.46	2.01	92
SX 217	0.60	1.44	0.92	1.03	3.39	1.99	91
WL 225	0.47	1.63	0.80	0.99	3.41	1.94	88
Average	0.60	1.64	1.08	1.08	3.80	2.20	
Maturity[d]		3.7	6.1	4.1			
LSD (0.05)	NS	NS	NS	NS	NS	NS	

[a] Two year average based on yields for 1988 and 1989.
[b] % Relative Performance = (cultivar 2-yr-average yield)/(2-yr-average of all cultivars.
[c] Experimental line, not currently marketed.
[d] Average harvest maturity. Value based on Kalu and Fick (1983) Index, mean-stage-by-count.

RYE AND BARLEY RESEARCH

D. L. Reeves and Lon Ball

RYE

Twelve rye entries were teated at this location and three other locations in the state. This years test included six varieties and six experimental lines. Five of the experimental lines were developed in our program and one was from North Dakota. This test was grown on summer fallow but was quite dry in the spring.

Table 17. Rye yield tests.

Entry	Yield (bu/A)	Tw. (lb/bu)	Ht. (in)
Musketeer	35	53.3	45
Rymin	38	54.4	43
Prima	42	53.0	43
Frederick	36	53.3	44
Puma	33	54.3	44
Dakold	36	49.2	36
ND 4	37	50.6	40
Puma/Chulipan	37	53.5	49
Tall Chulipan	37	52.6	47
SD X83-3	37	50.9	33
SD X85-9	34	51.9	39
SD X85-10,11,12	35	51.3	43
Mean	36	52.4	42

LSD .05 = 5

The major problem we've had with the semi-dwarf rye was evident again this year. Test weights of most semi-dwarfs are two to three pounds per bushel less than standard height rye. Yields of the semi-dwarfs are now quite similar to *tall* rye, so our next step is to improve the test weight.

BARLEY

The Mississippi Valley Barley test is a regional test grown at 12 locations in the United States and three in Canada. This year there were 25 entries with the experimental lines coming from six different places. The experimental lines in this test are those being considered for release as a variety.

The best yielder at this location was a North Dakota line which produced 58 bushel/acre compared to 43 for Morex.

OAT RESEARCH

D. L. Reeves and Lon Hall

This was our second year of our preliminary herbicide tests. This is a cooperative test with the extension weeds staff which was grown at four locations this year. Six different varieties were used in this test. All plots were sprayed at the recommended stages.

The high rate of each treatment shows what would happen when a sprayer overlaps. In addition we hope the high rates will help identify oats sensitive to specific herbicides. The high rates of 2,4-D and Dicamba reduced yields 10% more than the low rates when averaged over the four locations this year. Dicamba treatments also had the greatest effect on test weight.

Treatment	Rate Ai lb/A	Yield bu/A	Yield % of check NE Farm	Yield % of check Avg. 4 locations	Test Weight lb/bu
Unsprayed	--	57	--	--	35.6
MCPA amine	.5	56	99	99	35.6
" "	1.0	55	98	101	35.5
2,4-D amine	.5	51	90	93	35.7
" "	1.5	47	83	83	35.3
Bronate	.75	54	95	94	35.9
"	1.5	51	90	93	35.7
Dicamba + MCPA am	.125 + .25	52	92	91	35.0
" "	.25 + .5	47	83	79	33.7

LSD .05 = 5 bu.

The test was conducted at four locations so we can gain an idea of how spraying affected the oats in different environmental conditions. Yield reductions at this location were often smaller than at other locations. The difference between locations emphasizes the importance of the growing conditions when determining how herbicides affect oats.

OTHER TESTS: The uniform midseason regional test is grown here. It had 36 entries and included lines developed in New York, Ohio, Ottawa and Winnipeg. This test points out some of the progress made in oat breeding as two older varieties averaged 47 bushels/acre while the test average was 62 bushels and the highest yielder 71 bushels this year. These yields are low due to the very limited rainfall this year.

Four other tests with 220 other South Dakota selections were also grown here this year. These vary from new material which we were just seeing in the field for the second time to advanced lines which may be in regional tests next year.

W.E.E.D. PROJECT DEMONSTRATIONS

Leon J. Wrage, Paul O. Johnson and David A. Vos

Weed evaluation and extension demonstration plots at the Northeast Experiment Station provide data for northeastern South Dakota. The program includes demonstrations of labeled treatments. The W.E.E.D. Project program at the station was expanded to include evaluation tests of experimental herbicides in corn, flax, sunflower, and edible beans. These are evaluated and will be included in future demonstration plots if commercial development based on performance is promising.

Demonstration plots provide side-by-side comparison of herbicides. Rates used are those best suited for the weed and soil type. The plots are evaluated visually for weed control and crop tolerance. Data collected are summarized over several years to provide a more accurate measurement of expected performance. These plots are used for tours and form the basis for educational material.

Data for demonstration plots are reported. Tests in 1989 included all major crops for the area. The station provides the only test site for evaluating weed control in sunflowers, potatoes, and edible beans.

The crops included in 1989 are listed below:

1989 Evaluation/Demonstration Tests

1. Corn Demonstration
2. Foxtail Removal Timing - Corn
3. Soybean Weed Control Demonstration
4. Foxtail/Wild Oat Evaluation - Spring Wheat
5. Potato Weed Control Evaluation
6. Sunflower Demonstration
7. Edible Bean Demonstration
8. Alfalfa Establishment Evaluation

Experimental Herbicide Evaluation Tests

- Postemergence Grass and Broadleaf Control in Flax
- Experimental Preplant Incorporated and Postemergence Weed Control in Sunflowers
- Postemergence Herbicides for Broadleaf Control in Edible Beans
- Evaluation of Clopyralid in Corn
- Postemergence Weed Control in Corn
- Acetachlor Performance in Corn

Performance in 1989 reflected weather conditions typical of the Northeast area this year. The affect of early season competition was evident in most tests. Early removal was critical. Early planted crops received approximately 1.5 inches of rain during the first or second week after planting. The exceptionally dry conditions for the remainder of the season reduced crop recovery after early season weeds were controlled. Soil applied treatments on early planted crops were 10 to 30% less effective than for the average.

The cooperation and assistance from station personnel is acknowledged. Extension agents have helped identify needs, assisted with tours, and utilize the data in producer programs.

Table 18. Corn Demonstration

Treatment	lb/A act.	Percent Weed Control 1989 Gr	Percent Weed Control 1989 Bdlf	Percent Weed Control 3-Yr. Avg. Gr	Percent Weed Control 3-Yr. Avg. Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eradicane	4	60	20	74	44
Eradicane+atrazine	4+1	78	65	--	--
Eradicane+Bladex	4+2	64	55	--	--
Eradicane+Bladex+ atrazine	4+.5+1.5	75	82	88	81
Sutan+	4	68	10	79	50
SHALLOW PREPLANT INCORPORATED					
Dual	2.5	58	10	68	38
Lasso	3	52	44	66	50
PREEMERGENCE					
Atrazine	2.5	20	58	57	81
Bladex	3	30	70	58	60
Dual	2.5	40	30	66	40
Dual	1.65	20	25	--	--
Lasso	3	50	40	70	59
Lasso	2	33	42	--	--
Prowl	1.5	64	15	72	35
Ramrod	6	74	35	81	39
*Harness	2.5	77	58	87	70
Lasso+atrazine	2+1	40	82	71	83
Lasso+Bladex	2+2	58	65	74	75
Dual+atrazine	2+1	36	46	69	73
Dual+Bladex	2+2	30	74	--	--
Atrazine+Bladex	.75+2.25	35	85	63	81
Ramrod+Bladex	4+2	74	88	81	70
Lasso+Bladex+atrazine	2+1.5+.5	49	87	71	87
EARLY POSTEMERGENCE					
Prowl+atrazine	1.5+1	68	96	68	91
Prowl+Bladex	1.5+1.5	72	90	74	80
Atrazine+COC	1.5+1 qt	30	95	51	93
Bladex+X-77	2+.5%	20	90	46	73
Tandem+Bladex+ atrazine+X-77	.5+1+.5+.5%	63	94	73	89
PREEMERGENCE & POSTEMERGENCE					
Ramrod&Tough+atrazine	4&.45+.6	77	96	--	--
Ramrod&Banvel	4&.5	55	97	70	92

Table 18. Continued

Treatment	lb/A act.	Percent Weed Control 1989 Gr	1989 Bdlf	3-Yr. Avg. Gr	3-Yr. Avg. Bdlf
PREEMERGENCE & POSTEMERGENCE					
Ramrod&Banvel	4&.25	46	97	66	88
Ramrod&Banvel	4&.5	58	87	71	85
Ramrod&Basagran+ atrazine+COC	4&.52+.52+1 qt	68	96	--	--
Ramrod&Buctril	4&.38	48	82	65	89
Ramrod&Buctril+atrazine	4&.25+.5	67	94	77	95
Ramrod&Banvel+atrazine	4&.25+.5	48	92	69	92
EARLY POSTEMERGENCE & POSTEMERGENCE					
Banvel&Exp+COC	.5&.0313&.75 qt	88	98	--	--

* Experimental herbicide

Evaluated: 7/11/89, PPI&PRE: 5/8/89, EPOS: 6/1/89, POST: 6/15/89
Planting Date: 5/8/89
Rainfall: 1st week .00 inches, 2nd week .36 inches

Table 19. Foxtail Removal Timing in Corn

Treatment	lb/A act.	Percent Weed Control % Grft	% Colq	% Ruth	Yield bu/A
PREPLANT INCORPORATED					
Check	---	0	0	0	5.5
Eradicane	4	94	82	64	92.0
PREEMERGENCE					
Dual	2.5	32	8	5	4.1
EARLY POSTEMERGENCE					
Tandem+Bladex+atrazine	.5+1+.5	73	96	90	81.6
*Accent+COC	.0312+.75 qt	52	63	71	52.9
POSTEMERGENCE					
*Accent+COC	.0312+.75 qt	92	75	76	74.0
LATE POSTEMERGENCE					
*Accent+COC	.0312+.75 qt	61	49	52	18.0
LSD (.05)		18.2	20.5	21.2	23.0

* Experimental herbicide

Evaluated: 7/18/89, PPI&PRE: 5/8/89, EPOS: 6/1/89, POST: 6/15/89,
LPOS: 6/29/89
Planting Date: 5/8/89
Rainfall: 1st week .00 inches, 2nd week .36 inches

Table 20. Soybean Weed Control Demonstration

Treatment	lb/A act.	Percent Weed Control 1989 Yeft	Ruth	3-Yr. Avg. Gr	Bdif
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Vernam	2.5	45	56	57	57
Treflan	.75	82	80	76	78
Sonalan	1	86	88	83	86
Prowl	1.25	81	82	74	75
Treflan+Sen/Lex	.75+.38	82	90	80	88
Commence	1.31	86	82	--	--
Treflan+Pursuit	.75+.063	94	95	--	--
Treflan+Scepter	.75+.125	95	96	--	--
Prowl+Pursuit	.875+.063	95	98	--	--
SHALLOW PREPLANT INCORPORATED					
Lasso	3	83	92	82	82
Dual	2.5	73	60	79	53
Lasso+Treflan	2+.5	64	80	--	--
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan+Sen/Lex&Sen/Lex	.75+.25&.38	91	97	93	94
Treflan&Sen/Lex	.75&.5	94	96	93	92
PREEMERGENCE					
Amiben	3	82	78	85	65
Lasso	3	54	40	73	58
Dual	2.5	38	32	64	45
Pursuit	.063	80	55	--	--
Lasso+Sen/Lex	2+.5	38	62	69	81
Dual+Sen/Lex	2+.5	36	62	66	75
Lasso+Pursuit	2+.063	81	56	--	--
Lasso+Amiben	2+2	62	45	80	72
Lasso+Lorox	2+1	51	42	70	50
PREEMERGENCE & POSTEMERGENCE					
Lasso&Pursuit+X-77	2&.063+.25%	95	84	--	--
Lasso&Basagran+COC	2&1+1 qt	48	94	72	90
Lasso&Blazer/Tackle+X-77	2&.5+.5%	52	57	74	82
Lasso&Cobra+X-77	2&.2+.125%	40	88	--	--
*Lasso&M6316+X-77	2&.0625+.25%	42	98	--	--
Lasso&Blazer/Tackle+ Basagran+X-77	2&.38+.25+.5%	25	91	--	--
Lasso&Classic+X-77	2&.016+.25%	28	60	--	--
Lasso&Pinnacle+ Classic+X-77	2&.0039+.0039+.25%	45	97	--	--

Table 20 Continued

Treatment	lb/A act.	Percent Weed Control 1989 Yeft	Percent Weed Control 1989 Ruth	3-Yr. Avg. Gr	3-Yr. Avg. Bdlf
POSTEMERGENCE					
Fusilade 2000+COC	.187+1 qt	94	0	79	0
Poast+COC	.2+1 qt	96	0	--	--
Whip/Option+COC	.15+1 qt	81	0	--	--
Assure+COC	.0875+1 qt	83	0	--	--
Pursuit+X-77+28% N	.063+.25%+ 1 qt	80	87	--	--
Poast+Blazer/Tackle+ Basagran+COC	.3+.25+.5+1 qt	86	86	82	79
LSD (.05)		9.7	8.8	22.5	23.5

* Experimental herbicide

Yeft = Yellow foxtail
Ruth = Russian thistle

Evaluated: 7/17/89, PPI&PRE: 5/22/89, POST: 6/29/89
Planting Date: 5/22/89
Rainfall: 1st week .01 inches, 2nd week .19 inches

Table 21. Alfalfa Establishment Evaluation

Treatment	lb/A act.	1989 % Wioa	1989 % Grft	1989 % Bdlf	3-Yr Avg. Gr	3-Yr Avg. Bdlf
PREPLANT INCORPORATED						
Check	----	0	0	0	0	0
Eptam	2.5	84	48	0	76	42
Balan	1.25	47	64	66	74	78
Treflan	.75	70	79	52	81	73
Prowl	1	69	65	30	74	61
POSTEMERGENCE						
Buctril	.38	0	0	94	2	92
2,4-DB	1	0	0	96	--	--
Poast+Dash	.15+1 qt	97	96	0	--	--
Buctril+Poast+Dash	.38+.15+1 qt	94	80	94	84	84
2,4-D+Poast+Dash	1+.15+1 qt	94	82	89	90	74
Buctril+2,4-DB+ Poast+Dash	.187+.5+.15+1 qt	96	87	97	89	73
Pursuit+X-77	.063+.25%	80	82	85	--	--
Oats+Poast+Dash	.15+1 qt	98	91	0	--	--
LSD (.05)		18.5	14.6	17.5	10.0	23.3

Wioa = Wild oat
Grft = Green foxtail

Evaluated: 7/28/89, PPI: 5/8/89, POST: 6/15/89
Planting Date: 5/8/89
Rainfall: 1st week .64 inches, 2nd week .75 inches

Table 22. Foxtail/Wild Oat Evaluation - Spring Wheat

Treatment	lb/A act.	% Grft	% Wioa	Yield bu/A	Test Wt.
FALL					
Check	--	0	0	9.3	51.6
Treflan	.75	74	50	22.3	54.9
Treflan 10G	.75	74	28	19.7	56.3
Far-go	1.25	67	38	20.8	56.5
Far-go 10G	1.25	67	52	24.6	56.3
Treflan+Far-go	.75+1.25	79	53	28.0	55.0
Buckle	1.63	85	65	23.7	55.0
PREPLANT INCORPORATED					
*Treflan	.75	88	41	18.6	54.4
POSTPLANT INCORPORATED					
Treflan	.75	80	13	13.5	54.5
Far-go	1.25	30	37	20.0	55.7
Treflan+Far-go	.75+1.25	75	40	23.4	56.5
2-LEAF					
Hoelon	.75	72	75	22.9	57.4
Hoelon+COC	.75+.5	81	92	28.3	57.8
Hoelon	1	83	95	27.0	56.5
Tiller	.33	86	83	29.3	56.4
Tiller	.39	95	90	27.9	57.1
*Hoe 7113-04	.08	90	88	26.8	56.4
Assert	.38	55	74	23.1	55.7
TILL					
Hoelon+COC	.75+1 pt	91	77	20.6	56.0
Tiller	.39	93	90	21.2	56.1
LSD (.05)		16.9	17.4	6.1	3.0

* Experimental herbicide

Grft = Green foxtail
Wioa = Wild oat

Evaluated: 7/11/89, FALL: 10/20/88, PPI&POPI: 5/3/89,
2-4 LEAF: 6/1/89
TILLER: 6/15/89
Rainfall: 1st week .63 inches, 2nd week .00 inches

Table 23. Potato Weed Control Evaluation

Treatment	lb/A act.	1989 % Yeft	1989 % Rrpw	1989 Yield cwt/A	3-Yr Avg. Gr	3-Yr Avg. Bdlf
PREPLANT INCORPORATED						
Check	----	0	0	54.59	0	0
Eptam	4	88	60	49.98	87	54
Eptam+Sen/Lex	3+.5	87	84	58.21	87	84
Eptam+Sen/Lex	4+.75	92	92	60.56	88	93
POSTPLANT INCORPORATED						
Treflan	1	80	52	35.21	48	47
Prowl	1.25	72	42	29.89	51	34
PREEMERGENCE						
Dual	2.5	62	65	42.81	59	45
Dacthal	7.5	50	50	32.87	34	51
Sen/Lex	.75	76	45	39.40	62	75
Dual+Sen/Lex	2+.75	82	59	39.76	69	76
Dual+Lorox	2+1	71	85	53.60	62	66
Prowl+Sen/Lex	1.25+.75	52	69	47.56	64	73
PREPLANT INCORPORATED & PREEMERGENCE						
Eptam+Sen/Lex& Sen/Lex	3+.5&.5	78	96	45.65	84	95
POSTEMERGENCE						
Sen/Lex	1	86	97	57.36	65	83
Poast+COC+Sen/Lex	.15+1 qt+.5	98	99	64.03	92	72
Poast+Dash+Sen/Lex	.15+1 qt+.5	95	98	64.95	--	--
Poast+Sen/Lex+ Dash+28% N	.15+.5+1 qt+1 gal	96	98	64.67	--	--
*Fusilade+ Sen/Lex+COC	.187+.5+1 qt	98	99	67.44	--	--
LSD (.05)		14.9	18.5	19.47	17.1	18.6

* Experimental herbicide

Yeft = Yellow foxtail
Rrpw = Redroot pigweed

Evaluated: 7/14/89, PPI&POPI&PRE: 5/22/89, POST: 6/29/89,
Planting Date: 5/22/89
Rainfall: 1st week .01 inches, 2nd week .19 inches

Table 24. Sunflower Demonstration

Treatment	lb/A act.	1989 Gr	1989 Bdlf	3-Year Avg. Gr	3-Year Avg. Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	3	76	84	80	52
Sonalan	1	91	93	88	88
Treflan	.5	62	86	66	71
Treflan	.75	82	92	81	79
Treflan	1	85	90	86	85
Prowl	1.25	70	80	76	72
SHALLOW PREPLANT INCORPORATED					
Lasso	3	52	68	66	70
Prowl	1.25	68	78	63	60
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan&Amiben	.75&2	81	88	87	89
PREEMERGENCE					
Amiben	3	49	82	64	79
Lasso	3	51	60	67	69
Prowl	1.25	58	72	51	40
Lasso+Amiben	2+2	77	62	77	76
POSTEMERGENCE					
Poast+Dash	.2+1 qt	94	0	--	--
Fusilade 2000+COC	.187+1 qt	82	0	--	--
LSD (.05)		22.6	15.5	11.6	17.3

Evaluated: 7/18/89, PPI&PRE: 5/22/89, POST: 6/29/89,
Planting Date: 5/22/89
Rainfall: 1st week .01 inches, 2nd week .19 inches

Table 25. Edible Bean Demonstration

Treatment	lb/A act.	1989 % Grft	1989 % Ruth	3-Year Avg. Gr	3-Year Avg. Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	4	92	0	91	51
Eptam+Amiben	3+2	78	62	87	77
Treflan	.75	70	50	76	70
Treflan+Amiben	.75+2	83	82	89	90
Sonalan	1.1	84	81	86	86
Prowl	1.5	86	10	81	52
SHALLOW PREPLANT INCORPORATED					
Lasso	3	45	10	67	44
Dual	2.5	35	10	60	32
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan&Amiben	.75&2	81	68	84	85
PREPLANT INCORPORATED & POSTEMERGENCE					
Treflan&Basagran+COC	.75&1+1 qt	78	96	82	90
POSTEMERGENCE					
Fusilade 2000+COC	.187+1 qt	82	0	--	--
Assure+COC	.0875+1 qt	90	0	--	--
Poast+COC	.2+1 qt	92	0	--	--
Poast+Basagran+COC	.3+1+1 qt	85	86	--	--
LSD (.05)		14.8	23.4	10.1	18.4

Grft = Green foxtail
Ruth = Russian thistle

Evaluated: 7/28/89, PPI&PRE: 5/22/89, POST: 6/29/89
Planting Date: 5/22/89
Rainfall: 1st week .01 inches, 2nd week .19 inches

MECHANICAL WEED CONTROL IN CORN

J. Smolik, L. Evjen, K. Lewis, D. Rickerl, and L. Wrage

Objective: Compare effectiveness of several weed control implements in corn and effects on corn yield.

Methods: Corn (Pioneer hybrid 3790) was planted May 26. Plots were 2 rows x 30'. Three weeks before planting the plot area was field cultivated and harrowed. Immediately prior to planting the plot area was again field cultivated and harrowed. The experiment included seven treatments in a randomized complete block design with four replications. Treatments were: (1) Check; (2) Cultivate once; (3) Cultivate twice; (4) Drag once, cultivate twice; (5) Rotary hoe once, cultivate twice; (6) Rotary hoe twice, cultivate twice; and (7) drag once, rotary hoe once, cultivate twice. Disc-hillers were used at second cultivation.

Timing of post-plant mechanical operations was as follows: First hoeing May 30; Second hoeing June 7; Drag June 2; First cult. June 12; Second cult. June 27. Harvested October 12.

Results: There were no significant differences in corn yield, or numbers and biomass of foxtail between the check and one cultivation (Table 26). Corn yields in the remaining five treatments were significantly higher than the check and one cultivation; however, differences in yield between the five were not significant. Also, differences in numbers and biomass of foxtail between the five were not significant. Visual estimates of foxtail control indicated a significant difference between the check and one cultivation (Table 26). Visual estimates also indicated the Drag 1X,cult 2X treatment provided significantly poorer weed control than the Cult 2X, hoe 2X-cult2X, and Drag 1X-hoe 1X-cult 2X treatments. The lack of correlating yield differences in each of the above instances indicates visual estimates are not as precise a measure of weed populations as counts or weights. However, both weed counts and weed biomass are very labor-intensive methods of estimating weed populations.

The relationship between foxtail number, biomass and percent control is depicted in Figs 1, 2, and 3. The regression equation for biomass indicated that a bushel of corn was lost for each 128 lbs of foxtail produced.

This experiment was conducted in the herbicide testing area, and this area has been deliberately managed to maintain moderate to high weed populations. These populations were reflected in the foxtail biomass estimates of over 1 T/A in several treatments. Broadleaf counts are not presented because of very low populations. Foxtail simply out-competed the broadleaves under the conditions of this study.

Table 26. Effect of mechanical weed control treatments on yield of corn and foxtail populations.

Treatment	Corn Yield (Bu/A)	No. Foxtail per 3 sq. ft.	lbs. Foxtail/A	Percent Foxtail Control (Visual)
Check	58.9[a]	27.8[b]	2105[c]	0[d]
Cultivate 1X	60.8	30.3	2242	22.5
Cultivate 2X	78.9	10.5	114	90.3
Drag 1X Cult 2X	77.9	16.3	464	79.8
Rotary Hoe 1X Cult 2X	81.2	6.8	50	84.5
Rotary Hoe 2X Cult 2X	79.6	13.4	25	94.5
Drag 1X Hoe 1X Cult 2X	81.8	8.5	6	94.0
$FLSD_{.05}$	7.9	11.7	799	9.5

[a] Avg of four replications
[b] Includes both green and yellow foxtail - sampled August 24
[c] Plants clipped at ground level and oven dryed - sampled August 24.
[d] Estimated July 17.

Figure 1

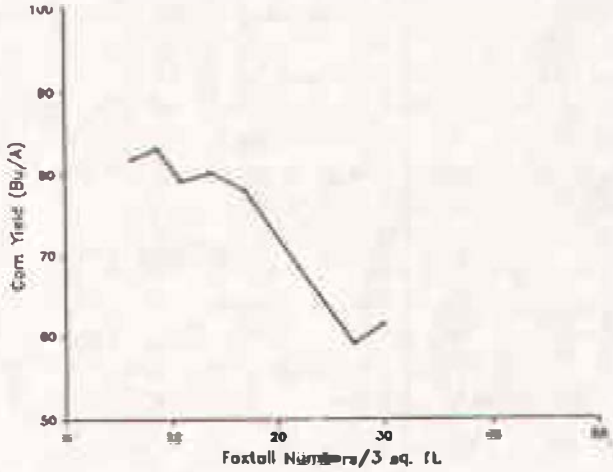


Figure 2

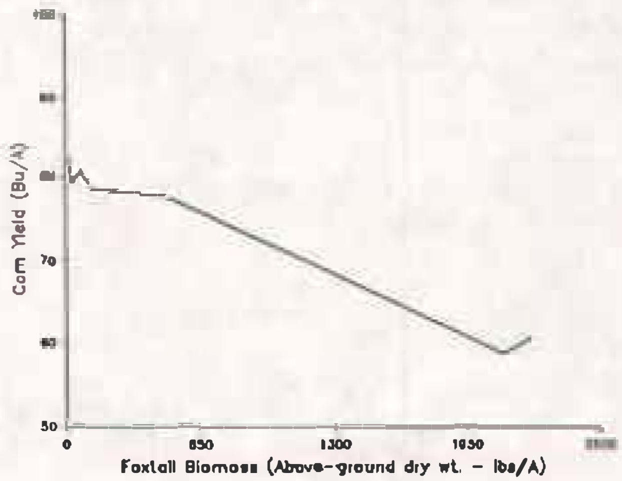
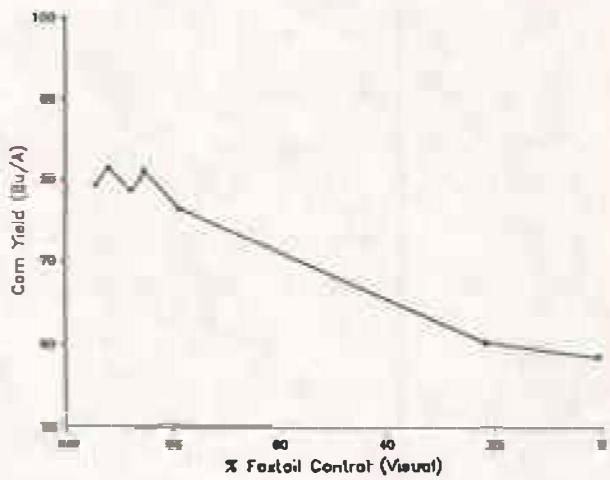


Figure 3



CONTROL OF FOLIAGE DISEASES OF WHEAT WITH FUNGICIDES AT THE NORTHEAST FARM IN 1989

G. W. Buchenau and S. A. Rizvi

Fungicide trials were conducted on spring and winter wheat at the Northeast Farm in 1989 to develop a more extensive data base for such trials and also to test disease prediction methods. Due to the dry season, very little disease developed. All of the prediction methods were adequate for the 1989 season.

Data from the winter wheat tests indicated that there was no yield or kernel weight loss due to foliage disease and no differences between the fungicide treatments (Tables 27 - 29). Fungicides reduced disease significantly below that of the untreated checks on 2nd leaves of Siouxland, but the great variation in disease made other conclusions very tentative.

Progress of tanspot and leaf rust during the season is shown in Table 29. After disease was first detected on 26 May on 4th leaves, (data not shown), progress was slow until about mid-June. After this, tanspot slowly progressed and leaf rust developed fairly rapidly after a slow start.

Spring wheat yield was not significantly affected by fungicide treatment, but Tilt slightly reduced seed size in the absence of measurable disease (Table 30).

Table 27. Effect of fungicides on tanspot and leaf rust on Roughrider winter wheat in 1989.

Treatment	Yield	1000 seed wt	Tanspot on Flag	Tanspot on 2nd leaf	Leaf rust on Flag	Leaf rust on 2nd leaf
	bu/A	g	lesions or pustules per leaf			
1. Untreated	26.6	23.58	0.9	5.4	9.3	126
2. Mancozeb, 2 lb/A Boot & 10 days	27.9	23.98	0	1.3	1.3	8
3. Tilt, 4 oz/A Stage 8	27.5	23.06	1.5	2.5	8.8	93
7. Bayleton + mancozeb 2 oz + 2 lb/A	27.7	23.50	0	0	0	15
LSD.05	(3.1)	(1.5)	(3.6)	(8.9)	(13)	(167)

Table 28. Effect of fungicides on tanspot and leaf rust on Siouxland winter wheat in 1989.

Treatment	Yield g/plot bu/A	1000 seed wt g	Tanspot on Flag	Tanspot on 2nd leaf	Leaf rust on Flag	Leaf rust on 2nd leaf
			-----lesion or pustules/leaf-----			
1. Untreated	26.7	26.1	7	20	31	200
2. Mancozeb, 2 lb/A Boot & 10 days	29.5	26.8	5	5[a]	1	4[a]
3. Tilt, 4 oz/A Stage 8	29.4	26.6	6	4[a]	8	64[a]
4. Bayleton + mancozeb 2 oz + 2 lb/A	23.3	26.2	3	4[a]	9	62[a]
LSD.05	(8.7)	(0.9)	(8)	10**	(65)	(220)

[a] Means in the same column with the same letter are not significantly different at P < .05.

Table 29. Disease progress of Tanspot and Leaf rust on untreated Roughrider and Siouxland winter wheat at the Northeast Farm in 1989.

Disease	Cultivar	Leaf	Date: 26 May (Stage 7-8)	2 June (Stage 8)	15 June (Anthesis)	23 June Head + 14 days
Tanspot	Roughrider	F	0	0	1.1	0.9
		2	0	0.1	3.3	5.4
		3	0	0.23	6.1	--
	Siouxland	F	0	0	0.8	6.7
		2	0	0	6.0	20.0
		3	0	0.33	6.1	--
Leaf rust	Roughrider	F	0	0	0	9.3
		2	0	0	0.1	126
		3	0	0	0.18	--
	Siouxland	F	0	0	0	31
		2	0	0	0.1	200
		3	0	0	0.18	--

Table 30. Effect of fungicide on yield and seed weight of Butte 86 spring wheat at the Northeast Farm in 1989.

Fungicide	Yield (bu/A)	1000 K weight(g)
1. Unsprayed	22.4	28.57[a]
2. Mancozeb	23.0	28.47[a]
3. Tilt	22.2	27.75[b]
4. Mancozeb + Bayleton	21.9	28.40[a]
FLSD.05	1.8	0.67*

[a] Means in same columns with the same letter are not significantly different at P < 0.05.

FARMING SYSTEMS STUDIES, 1989

Principal Investigators:

Jim Smolik (Project Leader), George Buchenau, Jim Gerwing, Bob Hall, Diane Rickerl, and Leon Wrage; Technicians: Loyal Evjen, Kristi Lewis and Pat Wieland; Graduate student: Seetha Ananth

Cooperators:

Fred Cholick, Tom Dobbs, Paul Evenson, Brad Farber, Paul Johnson, Kevin Kephart, Clarence Mends, and Don Taylor.

Objectives:

A. Measure yields and economic returns.

B. Determine influence of farming system on soils' ability to supply plants with mineral nutrients.

C. Measure effect of farming system on soil temperatures, bulk density, residue cover, frost depth, and snow catch.

D. Measure beneficial and harmful arthropod populations and measure insect damage.

E. Compare populations of plant feeding, predaceous and microbial feeding nematodes.

F. Determine populations of fungi and bacteria, and measure mycorrhizal associations and soil fungistatic properties.

G. Determine effect of farming systems on earthworm populations.

H. Determine weed species present and densities.

I. Measure effect of farming systems on soil water contents.

The farming systems studies were established in 1985. The systems consist of three or four year rotations. These are comparatively long-term studies (min. 8 years) since the effects of rotations are best measured after completion of at least two cycles. The plots are relatively large scale (3000 sq. ft. in Study I and 2000 sq. ft. in Study II) in an attempt to minimize border effects. The systems and rotation schedules in Study I are: ALTERNATE (no commercial fertilizer or pesticide and no moldboard plow), oats/alfalfa - alfalfa - soybean - corn; CONVENTIONAL, corn - soybean - spring wheat; RIDGE-TILL, corn - soybean - spring wheat. The systems in Study II are: ALTERNATE, oats/clover - clover(green manure)- soybean - spring wheat; CONVENTIONAL, soybean - spring wheat - barley; MINIMUM-TILL, soybean - spring wheat - barley. The 1988 and 1989 studies were supported in part by USDA LISA Grant L1-88-89-12.

Cultural Practices

Fertilizer and pesticide inputs in the conventional, ridge-till, and minimum-till systems are based on current Plant Science Department recommendations. The cultural practice information for the various systems is listed in Tables 31-34.

Table 31. Cultural practice information - farming systems studies, 1989.

Study I	Planting date	Fertilizer N-P-K (lb/A)	Manure	Herbicide (Actual/A)	Hand weeding (hr/A)
Corn					
Alternate	May 9	--		--	--
Conventional	May 9	--		Lasso II, 7 lb. band	--
Ridge-till	May 9	--		Lasso II, 7 lb. band	--
Soybean					
Alternate	May 16	--		--	2.1
Conventional	May 16	--		Treflan 1 1/2 pt.	1.5
Ridge-till	May 16	--		Lasso II, 7 lb band, Poast 1 pt + Crop oil 1 1/2 pt.	1.9
Spring Wheat					
Conventional	April 18	115-20-0		Hoelon 2 pt. + Buctril 1 pt.	--
"Ridge"-till	April 20	115-20-0		Hoelon 2 pt. + Buctril 1 pt.	--
Oats/Alfalfa	April 21	--	2.79 T/A dry matter (1.89-0.53-1.38% N-P-K)	--	--
Alfalfa		--		--	--

NOTE: Seeding rates (lbs/A); Oats 50, Alfalfa 9.5, Spring Wheat 70: Corn-18,500 seeds/A, Soybean-150,000 seeds/A.

Table 32. Cultural practice information - farming systems studies.

Study I	Tillage: Pre-Plant	Tillage: Post-Plant
Corn		
Alternate	Field cultivate + harrow,	Rotary hoe 2X and Cultivate 2X, fall disc
Conventional	Field cultivate + harrow	Cultivate 2X, fall disc
Ridge-till	--	Cultivate 2X, ridge at last cultivation, Chop stalks after harvest
Soybean		
Alternate	Field cultivate + harrow	Rotary hoe 2X and Cultivate 2X
Conventional	Disc 1X, Field cultivate + harrow 1X	Cultivate 1X
Ridge-till	--	Cultivate 2X
Spring Wheat		
Conventional	Field cultivate and harrow	Fall plow
"Ridge"-till	Field cultivate	Ridge-till Cultivate (Build ridges for 1990)
Oats/Alfalfa	Field cultivate + harrow,	--
Alfalfa	--	Chisel plow 1X and disc 1X in Sept.

Note: The "ridge"-till spring wheat was seeded with a hoe-drill. All row crops in these studies are planted in 36" rows. Field packer was used after seeding Oats/Alfalfa. Ridges were formed after harvest of "ridge"-till spring wheat using the ridge-till cultivator.

Table 33. Cultural practice information - farming systems studies.

Study II	Planting date	Fertilizer N-P-K (lb/A)	Herbicide (Actual/A)	Hand weeding (hr/A)
Spring Wheat				
Alternate	April 18	--	--	--
Conventional	April 18	80-20-0	Hoelon 2 pt + 1 pt. Buctril	--
Minimum-till	April 20	115-20-0	Hoelon 2 pt + 1 pt. Buctril	--
Soybean				
Alternate	May 16	--	--	2.9
Conventional	May 16	--	Treflan 1 1/2 pt	1.9
Minimum-till	May 16	--	Lasso 3 qt.	2.1
Barley				
Conventional	April 20	0-20-0	Bronate, 1 pt.	--
Minimum-till	April 20	0-20-0	Bronate, 1 pt.	--
Oats/Clover	April 21	--	--	--
Clover		--	--	--

NOTE: Seeding rates (lbs/A); Oats 50, Sweet Clover 4.5, Red Clover 4.5, Spring Wheat 70, Barley 58, Soybean-150,000 seeds/A.

A 50:50 mix of sweetclover and red clover has been used since 1987 in the alternate system. The clover weevil has been a problem on sweetclover in previous years, and we feel it has reduced stand vigor, which results in poorer weed competition in this treatment. Red clover is not attacked by this insect.

Table 34. Cultural practice information - farming systems studies.

Study II	Tillage: Pre-Plant	Tillage: Post-Plant
Spring Wheat		
Alternate	Field cultivate + harrow	Rotary hoe 1X, fall chisel plow
Conventional	Field cultivate + harrow	Fall plow
Minimum-till	Harrow 1X	Fall chisel plow
Soybean		
Alternate	Field cultivate 1X, and field cultivate + harrow 1X	Rotary hoe 2X, Cultivate 2X
Conventional	Field cultivate + harrow	Cultivate 1X
Minimum-till	--	Cultivate 2X
Barley		
Conventional	Field cultivate + harrow	Fall plow
Minimum-till	Field cultivate	Fall chisel plow
Oats/Clover	Field cultivate + harrow	Fall mow 1X
Clover	--	Mow and chisel plow in July

NOTE: The min-till spring wheat and barley were seeded with a hoe-drill. The min-till soybeans were seeded with a ridge-till planter. A field packer was used after seeding Oats/Clover.

Small Grain Yields

Small grain yields were below normal, but substantially improved over the previous year. The above average rainfall in April was followed by generally dry conditions in May and June, however, temperatures were near normal which reduced moisture stress compared to 1988.

Spring wheat yields were approximately 10 bu/A higher in 1989 compared to 1988. There were no significant differences in spring wheat yields, test weights or 1000 kernel weights between systems in either study (Table 35). However, protein levels were significantly higher in conventional spring wheat compared to ridge-till in Study I. In Study II protein was higher in both conventional and minimum-till compared to alternate. Also, as was noted in 1988, the conventional and minimum-till spring wheat was significantly shorter at harvest than the alternate. This stunting was apparently due to the herbicides applied in the conventional and minimum-till systems.

Oat yields were 7-14 bu/A higher than in 1988. Barley yields were 10-19 bu/A higher than the previous year, and yield and test weights in the conventional treatment were significantly higher than minimum-till (Table 35). Barley Yellow Dwarf was a minor problem in 1989 in contrast to the previous two years.

Table 35. Small grain yields, farming systems studies.

Spring wheat var. Butte 86

Study I	Yield (Bu/A)[a]	Test wt.	Protein %	1000 Kernel wt (g)
Conventional	28.8	57.6	18.2	23.75
"Ridge"-till	26.5	57.4	17.5	24.23
$FLSD_{.05}$	N.S.	N.S.	0.6	N.S.

Oats var. Don

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)
Oats/Alfalfa	46.5	37.4		25.32

-----continued----

Table 35. (continued)

Study II

Spring wheat var. Butte 86

	Yield (Bu/A)	Test wt.	Protein %	Height at Harvest (in.)	1000 Kernel wt (g)
Conventional	28.3	58.3	17.8	28.0	24.86
Alternate	30.0	57.7	17.2	30.7	25.28
Minimum-till	27.3	56.6	18.1	28.1	24.06
$FLSD_{.05}$	N.S.	N.S.	0.3	0.9	N.S.

Barley var. Robust

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)
Conventional	47.0	44.3	13.9	25.17
Minimum-till	38.5	40.6	13.7	23.03
$FLSD_{.05}$	2.8	3.3	N.S.	N.S.

Oats var. Don

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)
Oats/Clover	50.4	37.9		24.69

[a] Avg. of four replications.

Row Crop Yields

Row crop yields were much improved over the previous year, and corn yields were above the long-term average for the N.E. Station. Although the early part of the growing season was generally dry, the above average rainfall in August greatly benefited the row crops. The yield of conventional and ridge-till corn was significantly higher than alternate (Table 36). In the ridge-till treatment 1000 kernel weight was significantly lower than conventional and alternate.

Soybean yields were 50-100% higher than the previous year. There were no significant differences in soybean yields or 1000 seed weight between systems in either study (Table 36). The generally higher soybean yields in Study II compared to Study I was also noted last year. Study II emphasizes small grains, and the resulting higher soil moisture reserves (Table 43) appear to be responsible for the improved soybean yields in Study II in years with below average precipitation.

Table 36. Row crop yields - farming systems studies.

Study I	Corn - Pioneer Hybrid 3790 Yield (Bu/A) No. 2	1000 Kernel wt (g)
Conventional	89.7	238.29
Ridge-till	87.1	218.81
Alternate	79.0	230.29
FLSD .05 =	6.5	10.8
	Soybeans - Simpson Yield (Bu/A) 13% Moisture	1000 Seed wt (g)
Conventional	24.5	151.89
Ridge-till	23.1	151.79
Alternate	20.6	152.01
FLSD .05 =	N.S.	N.S.
Study II	Soybeans - Simpson	1000 Seed wt (g)
Conventional	27.1	145.60
Minimum-till	24.2	147.99
Alternate	24.6	146.20
FLSD .05 =	N.S.	N.S.

[a] Avg of four replications.

Forage Yields

Alfalfa yields were approximately 10% lower than the previous year, apparently in response to the very low soil moisture reserves as well as the poorer stand obtained in 1988. Clover yields were one-third lower compared to 1988, also apparently a response to the conditions noted above. The 50:50 mix of red clover and yellow sweetclover initiated in 1987 appears to have reduced clover weevil damage on sweetclover. However, the overriding factor in clover yields in each of the past two years has been precipitation.

Table 37. Forage crop yields - farming systems studies.

	1st Cutting (June 16)	2nd Cutting (July 18)	3rd Cutting (Aug 24)	Total (T/A) Dry Matter
Study I				
Alfalfa - Vernal	0.75[a]	0.99	0.90	2.64
Study II				
Clover[b]	0.61			0.61

[a] Avg of four replications.
[b] Forage not removed.

Tissue analysis (% N-P-K):		
Alfalfa	1st cutting,	2.48-0.12-1.80
	2nd cutting,	2.71-0.14-1.74
	3rd cutting,	3.44-0.40-2.82
Clover		2.08-0.14-1.50

Five-Year Yield Summary

Growing season precipitation has been the major factor influencing yields of nearly all crops in all systems over the past five years. Precipitation was well above normal in 1985 and 1986, near normal in 1987 and well below normal in 1988 and 1989 (Fig. 1). Spring wheat yields in both Study I and II have followed precipitation trends very well (Figs. 2 and 3). In Study I the conventional treatment has consistently out-yielded the "ridge"-till (Fig. 2), while in Study II there has generally been little difference between systems (Fig 3). The lower spring wheat yields in the ridge system may be a result of the higher levels of root rot recorded in this system (Table 63). Barley yields also reflect precipitation trends (Fig 4), and in most years the conventional treatment has significantly out-yielded the minimum-till.

Oat yields in general did not follow precipitation trends (Fig. 5). Oats function as a nurse crop for alfalfa or clover in the alternate systems, and follow corn in Study I and spring wheat in Study II. Both corn and spring wheat have high nitrogen requirements, and the generally low oat yields are in part a result of their position in the rotations. The highest oat yields occurred in the first year of the studies, and reflect the generally high soil nutrient levels at the initiation of these studies. Weed populations have been comparatively high in oats, and they too have probably contributed to lower yields. The consistent decline in winter wheat yields (Fig. 6) was primarily a result of the increasing infestation of downy brome recorded in this system. The no-till winter wheat system was discontinued in 1988 because downy brome had become the dominant plant. Approximately 100 brome plants per square foot were present at mid-season in this system in 1988.

Corn yields in Study I and soybean yields in both studies have generally followed a similar pattern, with yields increasing over the first three years, dropping severely in the 1988 drought, and recovering in 1989 (Figs. 7, 8, and 9). This pattern was different from that noted above for spring wheat and barley, and also for precipitation trends. Total growing season precipitation masks seasonal effects, and when monthly totals are examined reasons for the different row crop responses become more apparent. Rainfall distribution was nearly normal in 1985 and 1986, however, in each of the next three years the wettest month was August. This late-season precipitation favored row crop development over that of small grains. The change in rainfall distribution has also affected weed populations, particularly foxtail. Foxtail is a C_4 (warm-season) grass and the late-season precipitation has resulted in increased numbers of this weed compared to earlier years.

Corn yields have generally been significantly higher in the conventional and ridge-till systems compared to alternate except for 1988. Several factors appear responsible for the lower yields in the alternate system. In the initial years of the study (1985 and 1986) symptoms of nitrogen deficiency were apparent in the alternate corn. Also, the alternate corn was planted 1-2 weeks later in each of the first three years to allow for a later pre-plant tillage operation for weed control. This practice was adopted from producers in the southern part of the state, where it has been useful in weed control. However, in the more northerly areas of S.D. it appears to be important to take full advantage of the growing season. An additional factor was the earlier maturing hybrid planted in the alternate system in 1986 and 1987 which may have reduced yield potential. This hybrid was also severely infected by common smut in several S.D. locations in 1987, including the N. E. station, which further reduced yield.

Soybean yields were significantly lower in the alternate systems in both studies in 1985 (Figs 8 and 9), principally as a result of a delay in planting. In most subsequent years soybeans were planted on the same date, and there has not been a consistent difference in soybean yields between systems in either study.

Alfalfa forage yields were highest in 1986, and have declined in all subsequent years (Fig. 10). The alfalfa and red clover yields for 1985 are not comparable to subsequent years because both crops were clear-seeded with the aid of a herbicide. Also, the alfalfa was harvested only once in 1985 and the clover was cut once but not removed. Both of the stands were undercut and fall chisel-plowed. Clear-seeding was used so that all crops would be present in all rotations the initial year of the studies. Yellow sweetclover was used in 1985 and 1986, however, in 1987-1989 a 50:50 mix of yellow sweetclover and red clover was used in an attempt to reduce clover weevil damage. The effectiveness of the mix in reducing weevil damage has been difficult to judge, primarily as a result of lower rainfall in each of the last two years. Clover yields were estimated, but forage was not removed after cutting. Clover was cut once prior to seed set, followed by chisel plowing several weeks later.

Fig. 1. Growing Season Precipitation
April-October - NE Research Station

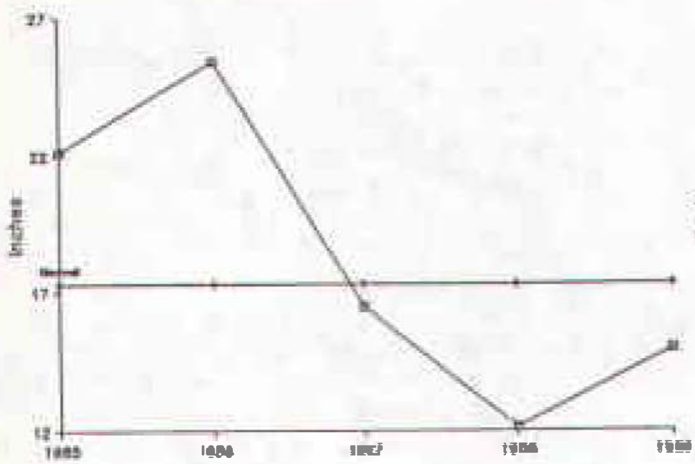


Fig. 2. Spring Wheat - Study I

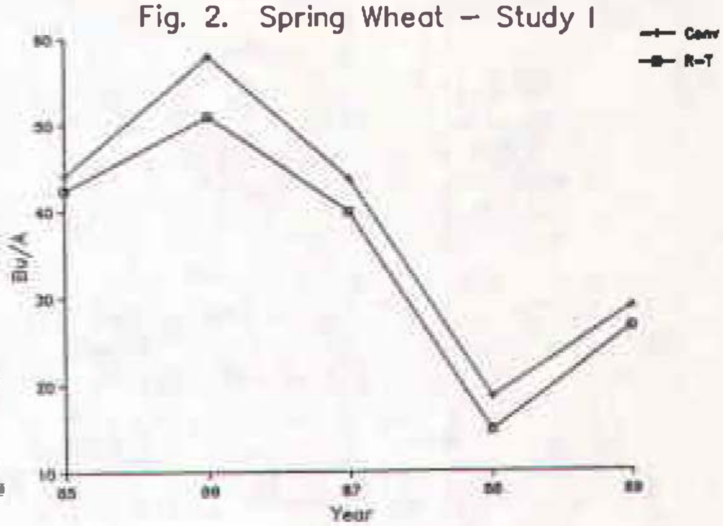


Fig. 3. Spring Wheat Yields - Study II

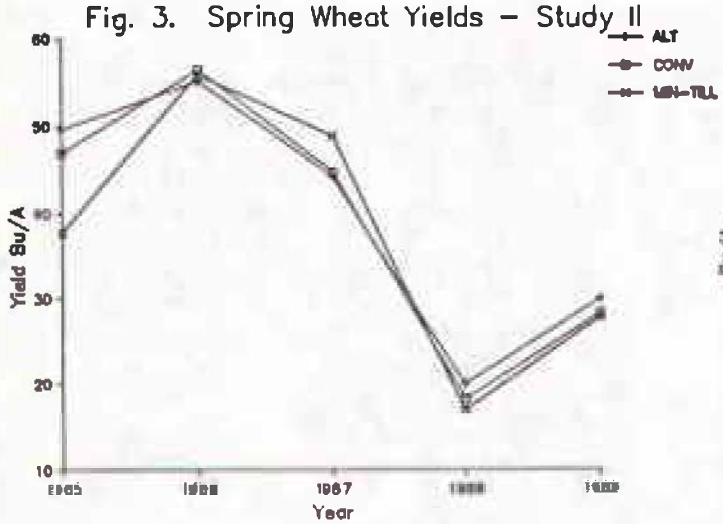


Fig. 4. Barley Yields - Study II

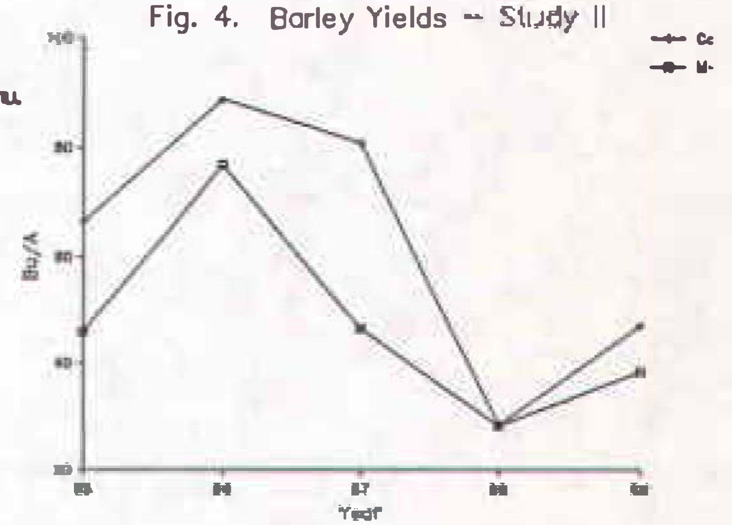


Fig. 5. Oat Yields - Study I and II

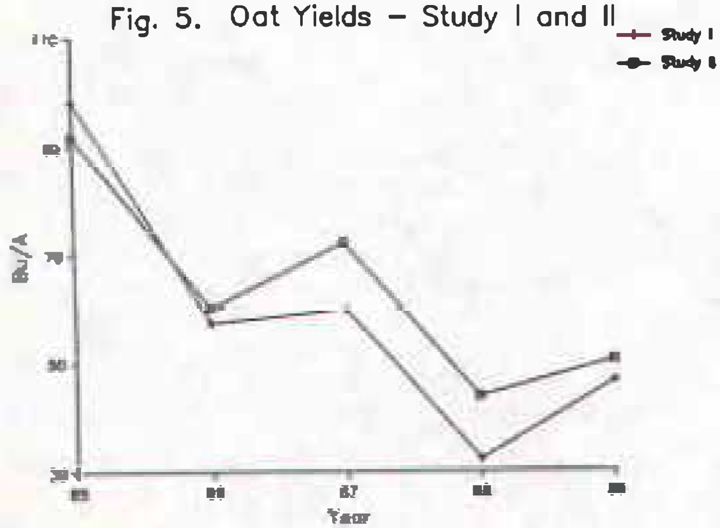


Fig. 6. Winter Wheat Yields - Study II

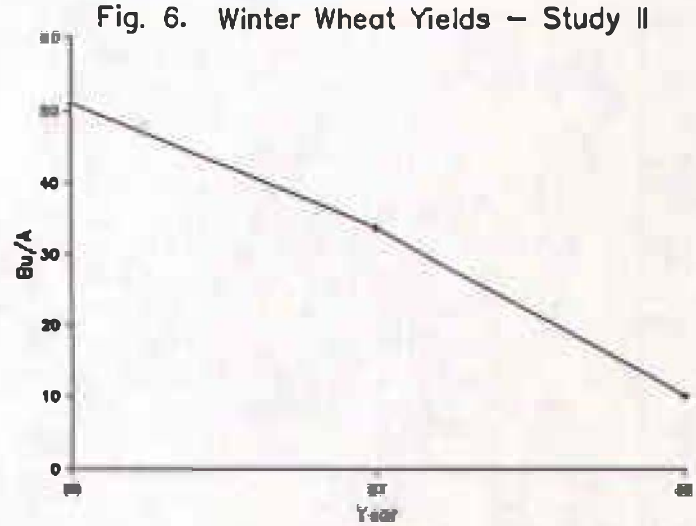


Fig. 7. Corn Yields – Study I

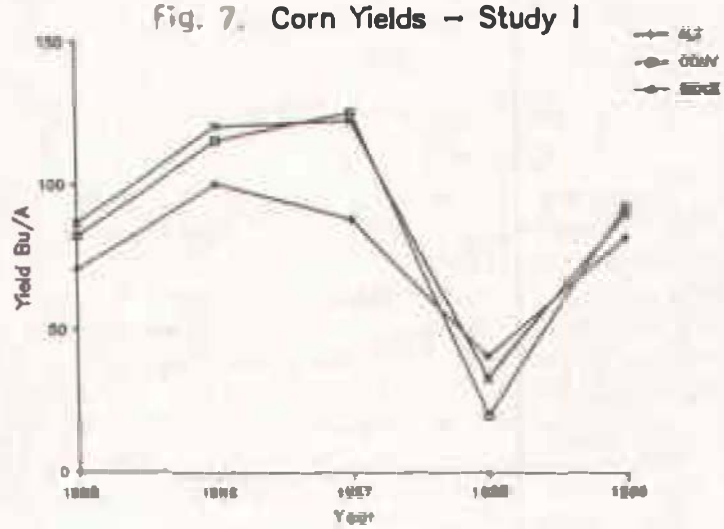


Fig. 8. Soybean Yields – Study I

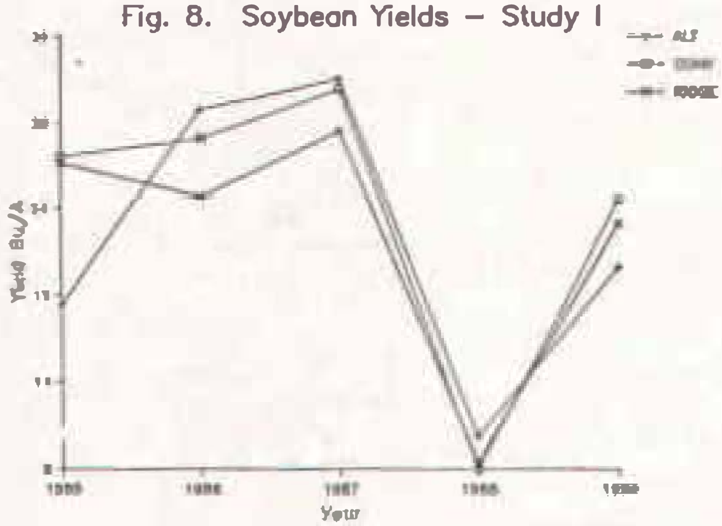


Fig. 9. Soybean Yields – Study II

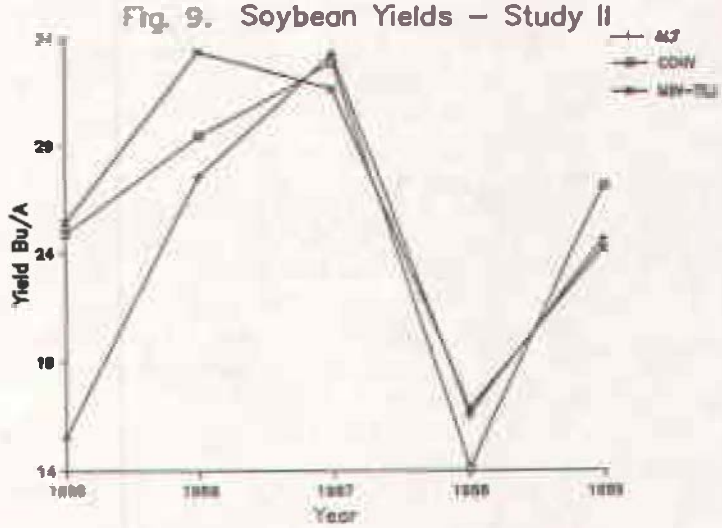
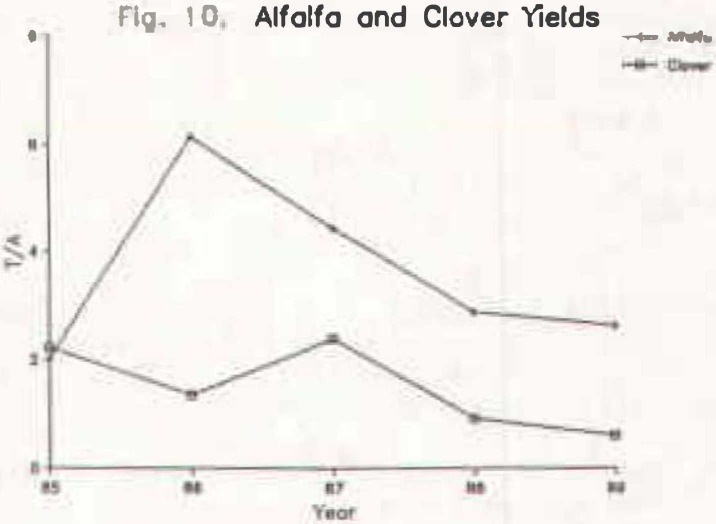


Fig. 10. Alfalfa and Clover Yields



Soil Physical Properties

Frost depth

Soil frost depth was monitored from December 9, 1988 through April 19, 1989 (Table 38). During February of 1989 soil frost depth in all treatments was greater than the depth of frost tube placement. Only the Alternate alfalfa soils thawed upward to detectable levels before frost tubes were removed in April. Fall frost readings were less deep in the Alternate oat/alfalfa than other treatments. Oat/alfalfa treatments also had 100 percent ground cover (Table 40) and generally caught more snow (Table 39). In the Ridge system, corn producing soils had less frost than spring wheat or soybean until December 29, when snowfall eliminated significant differences among Ridge crops.

Snow depth

Average snow depth ranged from 0-4", with the least cover occurring in late January (Table 39). Surface residues such as the Alternate oat/alfalfa and/or corn stubble were effective in trapping snow. The ridges also helped to maintain snow cover. Generally the least amount of snow cover occurred in the conventional system. On January 20th, when Conventional treatments had no snow, the Ridge system averaged 1.3 inches of snow cover.

Crop residue

Crop residues in the spring of 1989 ranged from 100% in the oat/alfalfa to 6% in the plowed spring wheat treatment (Table 40). The winter loss of residue between the fall of 1988 and spring of 1989 was higher for corn and wheat than it was for soybean and oat/alfalfa. Although soybean plots had a high residue percentage, they were not successful in trapping snow. The coarser corn stubble covered a smaller percentage of the soil, but offered more protection and better snow catch. The fall 1989 residue percentages reflect both the fall tillage and the nature of the crop.

Spring soils

Residues which insulated the soil also decreased spring soil temperatures (Table 41). However, moldboard plowing (Conventional wheat) which left soils unprotected also resulted in low soil temperatures. The warmest soils at the 6" depth were found in treatments with residues between 20 and 50 percent.

Spring (May 19) soil moisture in 1989 (Table 41) was greater than soil moisture during the fall of 1988. Soils producing a small grain in 1988 had consistently lower levels of soil moisture than other crops in their system.

Differences in bulk density were slight. Soils producing alfalfa in 1988 were more dense (1.4 g/cc) in the spring of 1989 than soils producing row crops or small grains.

Summer soils

By mid-summer, soil temperatures ranged from 81°F in Conventional or Ridge corn to 90°F in Conventional soybean (Table 42). Soil moisture levels had decreased with crop uptake and summer drought conditions. The greatest decrease (between May 19 and July 12) in the 0-6" depth soil moisture content was 15% in the Ridge-till soybean. The slightest decrease occurred in the Conventional corn. Soil bulk densities in July ranged from 1.1 to 1.3, but no consistent treatment trends were observed.

Fall soil moisture profile

Soil moisture in the fall of 1989 ranged from 11-21% in the 0-6" increment for Farming Studies I and II (Table 43). At the 6-24" depth, soil moisture ranged from 9-17%. In the Alternate systems, alfalfa and sweet clover had the highest soil moisture in the 0-6" increment and the oat nurse crop treatment with these legumes had the lowest. Small grain crops which were used more frequently in Farming System II than I resulted in 16.3% soil moisture in 0-6" compared to 14.4% soil moisture in Farming System I, and 12.7% compared to 10.6% at the 6-24" depth. Differences in soil moisture due to systems within each study were slight.

Table 38. Freeze and thaw depth during the 1988-89 winter as affected by system and previous crop residue in Study I.

		Month and Day													
1988		December				January				February	March		April		
System/Residue		9	16	23	29	6	13	20	27	8	23	30	6	13	19
Alt/Oat/Alfalfa	F[+]	9	15	19	23	26	29	31	31	35	*	*	*	*	*
	T										0	7	12	6	19
Alfalfa	F	12	20	23	26	*	*	*	*	*	*	*	*	*	*
	T										1	8	14	16	out
Soybean	F	11	18	22	26	31	28	36	36	39	*	*	*	*	*
	T										0	9	14	15	26
Corn	F	11	18	22	27	32	33	39	39	*	*	*	*	*	*
	T										0	9	14	14	28
Conv/Corn	F	11	19	21	26	31	33	37	35	*	*	*	*	*	*
	T										0	9	13	11	26
Soybean	T	12	19	22	26	32	35	39	39	*	*	*	*	*	*
	F										1	9	12	10	20
Wheat	T	11	17	20	24	27	31	*	*	*	*	*	*	*	*
	F										2	9	12	13	17
Ridge/Corn	F	10	16	19	23	30	35	36	35	38	*	*	*	*	*
	T										0	8	11	12	17
Soybean	F	11	17	21	25	29	33	35	35	37	*	*	*	*	*
	T										0	8	13	14	20
Wheat	F	11	18	21	24	28	31	35	36	39	*	*	*	*	*
	T										0	8	13	11	18
$LSD_{.05}$	F	1.2	1.9	2.0	2.4	2.4	NS	NS	NS	NS					
	T										1.1	NS	NS	4.6	5.4

[+] F = Frost depth, T = Thaw depth

* Frost depth reached bottom of frost measuring tube.

Table 39. Snow depth in farming system Study I as affected by system and previous crop residue.

System	1988 Residue	Dec 29	Jan 6	Jan 13	Jan 20	Feb 8	Feb 15	Mar 8	Mar 16
		- - - - - - - -	- - - -	- - - -	inches	- - - -	- - - -	- - - -	- - - -
Alt	Oat/Alfalfa	4	3	3	1	2	4	4	2
	Alfalfa	2	1	1	0	1	2	3	1
	Soybean	4	3	4	1	2	4	4	3
	Corn	3	2	2	0	1	4	4	2
Conv	Corn	3	2	2	0	1	3	3	2
	Soybean	2	2	2	0	1	2	4	1
	Wheat	1	1	2	0	1	1	2	0
Ridge	Corn	4	2	1	1	2	3	3	2
	Soybean	4	4	3	1	2	3	4	3
	Wheat	4	4	4	2	3	4	4	2
	$LSD_{.05}$	0.8	1.8	1.6	0.7	1.1	1.0	0.9	1.0

Table 40. Effect of cropping system on surface residue in Study I.

System	1988 Residue	1989 Crop	Residue: Spring 1989[a]	Residue: Loss	Residue: Fall 1989
			- - - - - -	%	- - - - - -
Alt	Oat/Alfalfa	Alfalfa	100	0	50
	Alfalfa	Soybean	38	3	89
	Soybean	Corn	43	3	78
	Corn	Oat/Alfalfa	33	13	100
Conv	Corn	Soybean	23	4	56
	Soybean	Wheat	33	4	22
	Wheat	Corn	6	9	70
Ridge	Corn	Soybean	35	13	52
	Soybean	Wheat	54	7	62
	Wheat	Corn	54	14	73

[a] Residue measured as percent ground cover on May 19 (spring) and October 23 (fall). Loss = Fall 1988 residue minus spring 1989 residue.

Table 41. Effect of crop residue on various soil properties in Study I during the spring of 1989.

System	1988 Residue	1989 Crop	Soil Properties[a] Temperature	Moisture	Bulk Density
			- - °F - -	- - % - -	- - g/cc - -
Alt	Oat/alfalfa	Alfalfa	45	21	1.3
	Alfalfa	Soybean	46	24	1.4
	Soybean	Corn	50	22	1.3
	Corn	Oat/Alfalfa	48	23	1.3
Conv	Corn	Soybean	48	22	1.2
	Soybean	Wheat	48	23	1.2
	Wheat	Corn	45	21	1.3
Ridge	Corn	Soybean	50	26	1.2
	Soybean	Wheat	46	24	1.3
	Wheat	Corn	46	23	1.3

[a] Measured on May 19 in the 0-6" depth averaged over 4 replications.

Table 42. Effect of crop and residue on various soil properties in Study I during mid summer of 1989.

System	1988 Residue	1989 Crop	Soil Properties[a] Temperature	Moisture	Bulk Density
			- - °F - -	- - % - -	- - g/cc - -
Alt	Oat/alfalfa	Alfalfa	86	12	1.2
	Alfalfa	Soybean	82	15	1.1
	Soybean	Corn	84	13	1.1
	Corn	Oat/Alfalfa	88	11	1.1
Conv	Corn	Soybean	90	13	1.3
	Soybean	Wheat	84	14	1.1
	Wheat	Corn	81	17	1.2
Ridge	Corn	Soybean	88	11	1.2
	Soybean	Wheat	82	16	1.2
	Wheat	Corn	81	15	1.1

[a] Measured on July 12 in the 0-6" depth averaged over 4 replications.

Table 43. Fall soil moisture at 0-6" and 6-24" depths in farming system Study I and II.

Study I				Study II			
		Depth				Depth	
System	Crop	0-6"	6-24"	System	Crop	0-6"	6-24"
		- - - % - -				- - - % - -	
Alt	Oat/Alfalfa	11[a]	9	Alt	Oat/Clover	13	11
	Alfalfa	17	9		Sweet Clover	21	17
	Soybean	15	11		Soybean	16	12
	Corn	15	10		Spring Wheat	15	12
	Average	14.5	9.8			16.2	13.0
Conv	Corn	14	11	Conv	Spring Wheat	18	13
	Soybean	16	12		Barley	19	14
	Wheat	14	10		Soybean	14	12
	Average	14.6	11.0			17.0	13.0
Ridge	Corn	15	12	Min-Till	Spring Wheat	14	10
	Soybean	11	10		Barley	15	12
	Wheat	16	12		Soybean	18	14
	Average	14.0	11.3			15.6	12.0
	Study Average	14.4	10.6			16.3	12.7

[a] Percent soil moisture (gravimetric) sampled October 23, 1989.

Weed Populations

The dominant weeds in all systems in both studies were green and yellow foxtail (Tables 44 and 45). The highest foxtail populations occurred in the alternate systems in both studies. The high numbers of foxtail in the alfalfa (Table 44) were apparently a result of the less vigorous stand obtained in the previous drought year. Foxtail populations in the conventional and reduced-till systems were similar to those measured in 1988, while in the alternate systems they nearly doubled. The increased populations in the alternate systems are an area of concern, and appear to be due to precipitation patterns and reduced pre-plant tillage. The practice of two shallow pre-plant tillage operations used in previous years of these studies may be resumed in 1990.

Table 44. Weed populations.

Study I	Alternate			Conventional			Ridge-Till		
	6/30	7/29	8/4	6/30	7/29	8/4	6/30	7/29	8/4
CORN									
Foxtail	16[a]	36	8	1	3	4	1	10	7
Wild buckwheat	0	.25	0	0	.25	0	0	2	0
Perennial broadleaf	0	.25	0	0	0	0	0	1	1
Russian thistle	-	0	-	-	.25	-	-	.25	-
SOYBEANS									
Foxtail	30	23	21	0	2	1	3	0	0
Wild buckwheat	0	1	0	0	0	0	0	1	0
Perennial broadleaf	0	.50	1	0	0	0	0	0	1
Russian thistle	-	0	-	-	0	-	-	.25	-
SPRING WHEAT									
Foxtail				12	11	-	92	64	-
Wild buckwheat				0	0	-	0	.25	-
Perennial broadleaf				0	0	-	2	0	-
Russian thistle				-	0	-	-	1	-
OATS/ALFALFA									
Foxtail	109	82	110						
Wild buckwheat	0	7	0						
Perennial broadleaf	9	0	3						
Russian thistle	-	5	-						
ALFALFA									
Foxtail	249	151	187						
Wild buckwheat	0	4	0						
Perennial broadleaf	1	1	3						
Russian thistle	-	13	-						
SYSTEM AVERAGE									
Foxtail	101	73	82	4	5	3	32	25	4
Wild buckwheat	0	3	0	0	0	0	0	1	0
Perennial broadleaf	3	.40	2	0	0	1	1	.5	1
Russian thistle	-	4.5	-	-	0	-	-	.5	-

[a] Number/3 sq ft - avg of four replications. Sampled 6/30/89, 7/29/89 and 8/4/89. Spring wheat stubble was tilled prior to August sampling.

Table 45. Weed populations.

Study II	Alternate			Conventional			Minimum-Till		
	6/30	7/29	8/4	6/30	7/29	8/4	6/30	7/29	8/4
SOYBEANS									
Green foxtail	16[a]	24	94	1	3	2	0	1	25
Redroot pigweed	0	0	0	0	0	0	0	0	0
Perennial broadleaf	1	.25	0	0	0	0	0	0	0
Russian thistle	-	0	-	-	0	-	-	1	-
SPRING WHEAT									
Green foxtail	92	38	-	0	0	-	5	5	-
Redroot pigweed	0	1	-	0	0	-	0	0	-
Perennial broadleaf	2	0	-	0	0	-	1	.25	-
Russian thistle	-	1	-	-	0	-	-	0	-
BARLEY									
Green foxtail				7	16	-	2	7	-
Redroot pigweed				0	0	-	0	0	-
Perennial broadleaf				0	0	-	0	0	-
Russian thistle				-	0	-	-	0	-
OATS, CLOVER									
Green foxtail	32	15	289						
Redroot pigweed	0	2	3						
Perennial broadleaf	6	2	0						
Russian thistle	-	14	-						
SWEET & RED CLOVER									
Green foxtail	77	-	-						
Redroot pigweed	0	-	-						
Perennial broadleaf	4	-	-						
Russian thistle	-	-	-						
SYSTEM AVERAGE									
Green foxtail	54	25	128	3	6	2	2	4	25
Redroot pigweed	0	1	1	0	0	-	2	0	-
Perennial broadleaf	3	1	0	0	0	-	0	0	-
Russian thistle	-	4	-	-	0	-	-	.25	-

[a] Number/3 sq ft - avg of four replications. Sampled 6/30/89, 7/28/89 and 8/4/89, Spring Wheat and Sweet Clover were tilled prior to August sampling.

Greenhouse evaluations of soil weed seed populations were initiated in 1988. Soil samples were removed after harvest from each plot, placed in flats in the greenhouse and watered regularly. Emerged weeds were recorded after two months. The counts for green foxtail reflected the field data with higher populations in the alternate system in both studies (Tables 46 and 47). Use of the oat/legume treatment followed by a year of legume, however, substantially reduced grass populations in the Alternate system in both studies.

Table 46. Greenhouse evaluations of soil weed seed populations in 1988 & 1989.

Study I	Alternate		Conventional		Ridge-Till	
	1988	1989	1988	1989	1988	1989
CORN						
Green foxtail	45[a]	161	0	13	4	3
Yellow foxtail	8	3	3	1	1	4
Redroot pigweed	1	1	0	0	1	0
Perennial broadleaf	0	0	0	0	2	0
SOYBEANS						
Green foxtail	11	104	3	1	14	14
Yellow foxtail	7	12	4	1	12	0
Redroot pigweed	0	1	0	1	0	1
Perennial broadleaf	0	0	0	0	1	0
SPRING WHEAT						
Green foxtail			4	1	1	9
Yellow foxtail			12	0	4	2
Redroot pigweed			0	0	0	0
Perennial broadleaf			0	0	0	0
OATS/ALFALFA						
Green foxtail	72	152				
Yellow foxtail	25	8				
Redroot pigweed	0	7				
Perennial broadleaf	0	0				
ALFALFA						
Green foxtail	10	51				
Yellow foxtail	36	5				
Redroot pigweed	1	1				
Perennial broadleaf	1	1				
SYSTEM AVERAGE						
Green foxtail	35	117	2	5	6	9
Yellow foxtail	19	7	6	1	5	2
Redroot pigweed	1	2	0	0	0	0
Perennial broadleaf	0	0	0	0	1	0

[a] Soil was removed, October 19 in 1988 and October 26 in 1989, from each plot, mixed and placed in two 5" x 8" flats. Emerged weeds were counted after two months. Avg of 4 replications.

Table 47. Greenhouse evaluations of soil weed seed populations 1988 and 1989.

Study II	Alternate		Conventional		Minimum-Till	
	1988	1989	1988	1989	1988	1989
SOYBEANS						
Green foxtail	12[a]	30	1	1	2	3
Yellow foxtail	3	6	0	0	1	0
Redroot pigweed	2	3	0	0	1	2
Perennial broadleaf	1	0	0	0	0	0
SPRING WHEAT						
Green foxtail	14	4	7	0	1	1
Yellow foxtail	3	0	5	0	1	0
Redroot pigweed	0	1	0	1	3	1
Perennial broadleaf	1	0	1	0	1	0
BARLEY						
Green foxtail			6	0	3	2
Yellow foxtail			3	0	1	0
Redroot pigweed			0	0	0	1
Perennial broadleaf			0	0	1	1
OATS, CLOVER						
Green foxtail	56	22				
Yellow foxtail	4	2				
Redroot pigweed	0	1				
Perennial broadleaf	1	0				
SWEET & RED CLOVER						
Green foxtail	23	3				
Yellow foxtail	31	0				
Redroot pigweed	2	4				
Perennial broadleaf	1	0				
SYSTEM AVERAGE						
Green foxtail	26	15	5	0	2	2
Yellow foxtail	10	2	3	0	1	0
Redroot pigweed	1	2	0	0	1	0
Perennial broadleaf	1	0	0	0	1	0

[a] Soil was removed, November 17 in 1988 and October 26 in 1989, from each plot, mixed and placed in two 5" x 8" flats. Emerged weeds were counted after two months. Average of 4 replications.

Nematodes and Earthworms

Dagger nematode populations increased over the growing season on most crops. The highest populations occurred in Study I in alternate and ridge-till soybeans at harvest, and likely were responsible for some yield reduction. This nematode prefers relatively undisturbed soil, and the lower populations recorded in the conventional systems in both studies (Tables 48 and 49) may be due to the use of the moldboard plow in these systems. Lance nematode numbers did not increase substantially over the growing season in any of the systems.

Earthworm populations (Oligochaeta: Family Naididae) recorded in these studies are the tiny (approximately 1/8") members of this group. In general the highest populations occurred at planting or mid-season with a decline in numbers at harvest (Tables 48 and 49). Interestingly, populations in many instances were substantially lower than those measured in 1988.

Populations of total plant feeding nematodes were generally higher in all systems in 1989 compared to 1988 (Tables 50 and 51). The dominant members of the plant feeding group in soybeans were pin nematodes. These nematodes are not as damaging as dagger nematodes, but at high populations they will reduce plant growth. Populations of predaceous nematodes were generally higher than the previous years; however, they did not respond in a consistent manner to tillage or seasonal effects. The highest populations of microbial feeding nematodes usually occurred at mid-season. Microbial feeding nematodes aid in the decomposition of plant residues, and thus are important in nutrient cycling.

Table 48. Nematode and earthworm populations - farming systems studies.

Study I	Sampling date	Dagger	Lance	Earthworm
Corn				
Alternate	May	83[a]	20	10
	July	16	35	27
	October	214	23	4
Conventional	May	12	27	35
	July	14	32	10
	October	18	8	2
Ridge-till	May	30	20	8
	July	27	26	19
	October	40	35	11
Soybean				
Alternate	May	116	13	3
	July	136	49	21
	October	441	21	24
Conventional	May	5	2	3
	July	6	3	10
	October	26	5	5
Ridge-till	May	11	4	5
	July	79	4	18
	October	525	5	6
Spring Wheat				
Conventional	May	71	11	3
	June	42	31	8
	July	43	36	2
"Ridge"-till	May	27	27	3
	June	26	10	9
	July	199	13	2
Oats/Alfalfa	May	76	7	8
	June	47	16	7
	July	33	5	2
Alfalfa	May	56	14	5
	July	140	19	3
	October	162	17	5

[a] Number/500 cc soil - Average of four replications.

Table 49. Nematode and earthworm populations, farming systems studies.

Study II	Sampling date	Dagger	Lance	Earthworm
Spring Wheat				
Alternate	May	56[a]	12	16
	June	154	14	34
	July	85	5	7
Conventional	May	32	6	11
	June	16	10	9
	July	17	5	4
Minimum-till	May	32	10	9
	June	18	6	9
	July	106	5	3
Soybean				
Alternate	May	35	38	7
	July	20	53	26
	October	101	50	11
Conventional	May	14	13	15
	July	15	19	20
	October	25	6	8
Minimum-till	May	32	31	10
	July	15	15	12
	October	150	11	7
Barley				
Conventional	May	17	17	12
	June	13	12	17
	July	40	12	12
Minimum-till	May	40	10	17
	June	23	7	43
	July	85	12	7
Oats/Clover	May	8	14	8
	June	7	21	19
	July	36	14	3
Clover	May	90	6	8
	July	106	3	5
	October	49	15	16

[a] Number/500 cc soil - Average of four replications.

Table 50. Plant feeding, predaceous and microbial feeding nematode populations, farming systems studies.

Study I	Sampling date	Plant Feeding	Predaceous	Microbial Feeding
Corn				
Alternate	May	860[a]	280	630
	July	353	568	570
	October	230	625	750
Conventional	May	245	238	835
	July	194	380	525
	October	439	275	616
Ridge-till	May	925	214	385
	July	683	364	704
	October	537	545	1008
Soybean				
Alternate	May	581	596	755
	July	1146	863	1496
	October	1314	1038	1438
Conventional	May	111	155	888
	July	94	268	763
	October	1592	709	1478
Ridge-till	May	156	168	385
	July	996	1063	1525
	October	3023	993	633
Spring Wheat				
Conventional	May	259	164	643
	June	329	438	1058
	July	374	560	543
"Ridge"-till	May	830	134	368
	June	279	550	1588
	July	492	645	946
Oats/Alfalfa	May	178	298	755
	June	529	718	1696
	July	653	970	1596
Alfalfa	May	668	542	1070
	July	1403	808	1226
	October	258	388	483

[a] Number/100 cc soil - Average of four replications.

Table 51. Plant feeding, predaceous and microbial feeding nematode populations, farming systems studies.

Study II	Sampling date	Plant Feeding	Predaceous	Microbial Feeding
Spring Wheat				
Alternate	May	1195[a]	901	1045
	June	607	1208	1643
	July	407	888	1125
Conventional	May	291	218	526
	June	207	339	795
	July	394	593	713
Minimum-till	May	1173	655	988
	June	379	609	1150
	July	539	593	671
Soybean				
Alternate	May	395	318	730
	July	559	680	1346
	October	1498	935	1378
Conventional	May	60	260	738
	July	136	325	1118
	October	855	671	988
Minimum-till	May	379	318	605
	July	481	548	950
	October	1857	938	1550
Barley				
Conventional	May	278	313	630
	June	214	268	598
	July	416	476	533
Minimum-till	May	190	485	546
	June	874	1413	1683
	July	393	493	755
Oats/Clover	May	331	275	947
	June	199	738	1778
	July	452	468	693
Clover	May	390	530	1025
	July	591	298	838
	October	1119	755	996

[a] Number/100 cc soil - Average of four replications.

Soil Nutrients

Farming Systems Studies I & II were soil sampled in the spring of 1985 to determine initial soil test values as baselines for each experiment (Tables 52, 53, 55, and 56). Soil samples were taken in the fall of 1985, spring and fall of 1987, and fall of 1988 and 1989. Samples to a depth of 42 inches were also obtained in Study I in spring, 1989 (Table 54). In Farming System Study I, fall sampling in 1989 indicated that there were no significant differences in phosphorus or organic matter content among the three cropping systems (Table 52). In Farming System Study II, soil P levels were highest in the ALT. oats/clover and lowest in the minimum till small grain (Table 53). When averaged over systems, P levels were not significantly different from each other. Study II also had differences in organic matter content. The ALT. oats/clover had the highest level of organic matter (3.6%), but all levels were lower than 1988 values.

In the spring of 1989 soil nitrate levels were highest in the conventional system followed by ridge and alternate (Table 54). The lowest N levels occurred in the alfalfa which had been chisel-plowed the previous fall, and was planted to soybean in 1989. The highest N levels followed the drought-stressed 1988 spring wheat and corn crops in both the conventional and ridge systems. In general, soil nitrate levels at the 24 - 42 inch sampling depth were higher in the conventional and ridge systems compared to alternate.

Soil nitrate levels in Farming System Study I were quite variable in the fall of 1989 (Table 55). Levels were generally lower in 1989 than in 1988 except in conventional and ridge-till soybeans and Alternate alfalfa. The application of manure and fertilizer N were not consistently reflected in the 0-24" nitrate levels.

In Farming System Study II, soil nitrate values ranged from 14 to 124 lbs/A (Table 56). Soils producing small grains had lower nitrate levels in 1989 than in 1988, however, legume crops generally increased soil nitrates in the fall of 1989.

Table 52. Soil test phosphorus and organic matter in Study I, 1985-1989.

System/ Crop	Phosphorus 1985 S	F	1987 S	F	1988 Fall	1989 Fall	Organic Matter 1985 S	F	1987 S	F	1988 Fall	1989 Fall
	ppm						%					
ALT./												
Oats/Alfalfa	30	21#	14	16	15	20	3.9	3.7	3.4	4.0	3.6	3.5
Alfalfa	30	21	21	20	17	15	3.9	3.7	3.5	3.8	3.8	3.2
Soybeans	30	24	16	15	35	18	3.9	3.7	3.3	3.9	3.9	3.1
Corn	30	29	18	16	17	19	3.9	3.9	3.5	3.8	3.8	3.2
Avg.	30	24	17	17	21	18	3.9	3.8	3.4	3.9	3.8	3.2
CONV./												
Corn	30	30	19	21	26	25	3.9	3.7	3.4	3.8	3.6	3.2
Soybeans	30	30	18	19	22	21	3.9	3.6	3.7	3.9	3.5	2.9
Wheat	30	23	19	22	22	20	3.9	3.7	3.4	3.6	3.7	3.1
Avg.	30	28	19	21	23	22	3.9	3.7	3.5	3.8	3.6	3.1
R.T./												
Corn	30	19	23	17	18	15	3.9	3.5	3.8	4.2	3.7	3.1
Soybeans	30	30	18	15	18	19	3.9	3.9	3.9	4.0	3.9	3.4
Wheat	30	21	14	12	23	18	3.9	3.7	3.6	3.5	3.9	3.4
Avg.	30	23	18	15	20	17	3.9	3.7	3.8	3.9	3.8	3.3
LSD .10	--	7	5	5	9	NS	---	NS	0.3	0.3	NS	NS
CV %	_	25	23	23	36	30	---	6	7	6	11	7

\# Manure P_2O_5 applied, oats/alfalfa:
1985 24 lbs/A (after sampling)
1986 30 lbs/A
1987 64 lbs/A
1988 44 lbs/A
1989 46 lbs/A

Fertilizer P_2O_5 applied as starter at 30 lbs/A to Conventional and Ridge-till corn and spring wheat - Spring 1988.

Fertilizer P_2O_5 applied at 20 lbs/A to Conventional and Ridge-till spring wheat 1989.

Soil sampling dates: 4/1/85, 9/17/85, 4/15/87, 9/21/87, 10/11/88, 10/23/89.

Table 53. Soil test phosphorus and organic matter in Study II, 1985-1989.

System/ Crop	Phosphorus 1985 S	1985 F	1987 S	1987 F	1988 Fall	1989 Fall	Organic Matter 1985 S	1985 F	1987 S	1987 F	1988 Fall	1989 Fall
	ppm						%					
CONV./												
Soybean	34	26	18	14	20	20	4.0	4.0	4.0	3.9	3.7	3.2
Sp. Wheat	34	22	21	15	18	17	4.0	4.0	3.9	3.9	3.7	3.0
Barley	34	20	17	12	16	21	4.0	3.9	3.8	3.6	3.6	3.4
Avg.	34	23	19	14	18	19	4.0	4.0	3.9	3.8	3.7	3.2
MIN./												
Soybean	34	26	17	13	19	18	4.0	4.0	3.9	4.3	4.0	3.3
Sp. Wheat	34	22	19	14	16	14	4.0	3.9	4.3	4.0	3.7	3.0
Barley	34	23	17	12	19	14	4.0	3.9	3.8	4.1	3.9	3.0
Avg.	34	24	18	13	18	15	4.0	3.9	4.0	4.1	3.9	3.1
ALT./												
Oats-Clover	34	21#	22	14	16	23	4.0	4.0	3.9	4.0	3.9	3.6
Clover	34	21	20	14	15	15	4.0	3.8	4.0	4.1	3.9	3.0
Soybean	34	27	27	20	21	17	4.0	4.0	4.0	4.1	4.2	3.2
Sp. Wheat	34	27	19	12	22	16	4.0	3.8	4.0	3.8	3.9	3.0
Avg.	34	23	22	15	19	18	4.0	3.9	4.1	4.2	4.0	3.2
LSD .10	--	3	--	4	NS	8	--	NS	--	NS	0.3	0.2
CV%	--	12	--	20	21	22	--	5	--	9	6	6

\# Manure P_2O_5 applied to 1985 oats/sw clover after sampling = 24 lbs/A.
Soil sampling dates: 4/1/85, 9/18/85, 5/4/87, 10/1/87, 10/11/88, 10/23/89.
Fertilizer P_2O_5 applied as starter at 30 lbs/A to Conventional and Minimum-till spring wheat and barley - 1988.
Fertilizer P_2O_5 applied at 20 lbs/A to conventional and Minimum-till spring wheat and barley - 1989.

Table 54. Spring 1989 soil nitrate levels to 42 inches in Study I.

System/ 1988 Crop	Sampling depth (in.) and lbs NO_3-N/A 0-6	6-12	12-18	18-24	24-30	30-36	36-42	Total
Alternate/								
Oats/alfalfa	13[a]	7	7	6	11	14	20	78
Alfalfa	13	11	10	9	6	4	4	57
Soybeans	10	18	19	28	19	17	23	134
Corn	17	27	23	17	17	21	24	146
						System Avg:		103
Conventional/								
Corn	16	32	55	30	30	41	42	246
Soybean	11	15	15	21	13	20	31	126
Spring Wheat	30	50	54	37	23	37	41	272
						System Avg:		215
Ridge-Till/								
Corn	14	29	30	37	41	30	31	212
Soybean	12	12	9	10	8	9	9	69
Spring Wheat	15	33	44	70	29	29	37	257
						System Avg:		179

[a] Avg of four replications

Table 55. Soil and applied N in Study I, 1985-1989.

System/	Soil NO_3-N						Applied N**									
	1985		1987		1988	1989	Fertilizer					Manure				
Crop	S#	F	S	F	Fall	Fall	85	86	87	88	89	85	86	87	88	89
ALT./																
Oats/alfalfa	18	13	76	9	31	19	0	0	0	0	0	44	33	105	113	105
Alfalfa	18	14	60	38	29	34	0	0	0	0	0	0	0	0	0	0
Soybeans	18	18	111	23	89	40	0	0	0	0	0	0	0	0	0	0
Corn	18	15	77	21	51	31	0	0	0	0	0	0	0	0	0	0
CONV./																
Corn	18	33	95	14	145	74	110	110	37	75	0	0	0	0	0	0
Soybeans	18	21	84	24	40	131	0	0	0	0	0	0	0	0	0	0
Wheat	18	18	86	56	160	69	110	90	77	105	115	0	0	0	0	0
R.T./																
Corn	18	22	90	13	135	94	110	110	37	105	0	0	0	0	0	0
Soybeans	18	21	94	19	23	74	0	0	0	0	0	0	0	0	0	0
Wheat	18	17	72	21	156	53	110	90	77	105	115	0	0	0	0	0
LSD .10	--	6	NS	8	32											
CV%		25	32	28	31											

0-6" only. ** Based on following yield goals: corn= 100 bu/A, wheat = 65 bu/A. Soil Sampling dates: 4/1/85, 9/17/85, 4/15/87, 9/21/87, 10/11/88, 10/23/89.

Table 56. Soil and applied N in Study II, 1985-1989.

System/	Soil NO_3-N						Applied N**									
	1985		1987		1988	1989	Fertilizer					Manure				
Crop	S#	F	S	F	Fall	Fall	85	86	87	88	89	85	86	87	88	89
	lbs/A 2"						lbs/A									
CONV./																
Soybean	31	17	72	73	62	96	0	0	0	0	0	0	0	0	0	0
Sp. Wheat	31	55	51	138	174	124	110	90	108	50	80	0	0	0	0	0
Barley	31	30	73	48	33	39	0	0	0	0	0	0	0	0	0	0
MIN./																
Soybean	31	17	42	48	33	39	0	0	0	0	0	0	0	0	0	0
Sp. Wheat	31	44	47	102	133	84	110	90	108	75	115	0	0	0	0	0
Barley	31	33	44	76	62	44	110	70	77	0	0	0	0	0	0	0
ALT./																
Oats-Clover	31	18	47	52	12	14	0	0	0	0	0	44	0	0	0	0
Clover	31	19	25	99	82	104	0	0	0	0	0	0	0	0	0	0
Soybean	31	18	100	61	52	46	0	0	0	0	0	0	0	0	0	0
Sp. wheat	31	21	64	53	47	35	0	0	0	0	0	0	0	0	0	0
LSD .10	--	19	--	29	24											
CV%	--	53	--	29	24											

0-6" only. *Based on following yield goals: wheat = 65 bu/A, barley = 80 bu/A.

Soil Sampling dates: 4/1/85, 9/18/85, 5/4/87, 10/1/87, 10/11/88, 10/23/89.

Soil Microorganisms and Disease Suppression

Farming systems can affect crop yields through their influence on various soil microorganisms which either cause root disease, or which inhibit the growth of such root disease agents thereby controlling these diseases 'biologically'. To establish a microbiological profile of the various systems, the populations of selected genera of soil fungi were determined, and in addition, the soil samples were tested for their ability to suppress two diseases, common root rot of wheat, and root rot (seedling blight phase) of alfalfa.

The suppressiveness tests were conducted by adding soil from the various test plots to soil artificially infested with the pathogen under test, and determining the amount of disease that developed on wheat and/or alfalfa. The level of disease was then compared to the level of disease that developed in the absence of the plot soil. A significant reduction in disease when the plot soil was present indicated that the plot soil suppressed the pathogen. Sometimes the addition of plot soil increased the amount of disease. In such cases, the plot soil was considered to be conducive to disease, or perhaps simply more toxic to the test plant, possibly as a result of herbicide residue.

All treatments were assayed in May and July, plots with small grain were sampled in June and plots with row crops were sampled in October. Data from the July samples will be detailed below, but space limitations preclude inclusion of detailed data from the other sample dates. However, some of the statistically significant results are presented after the July results are discussed. In addition, selected data from the May samples are presented in relation to common root rot in study 1 (K-series).

Soil samples taken in June from the K-series were tested for suppressiveness to selected wheat pathogens (Table 57). Single degree of freedom statistical comparisons indicated that none of the systems were significantly suppressive to any of the pathogens tested. Some differences due to crop were obtained. Corn soil was more suppressive to Fusarium than soybean or wheat soil and also was more suppressive to Helminthosporium than wheat soil. Previous wheat soil was more suppressive to Fusarium and Helminthosporium than soil that had been in soybeans the previous year. In addition, wheat soil was more suppressive than soybean to Pythium and previous soybean soil was more suppressive than previous corn.

In tests of suppressiveness to alfalfa pathogens (Table 58), the conventional system was more suppressive to Fusarium than ridge-till. Also, conventional and alternate systems were more suppressive Pythium than ridge-till. Some treatments were more conducive to Fusarium than others, that is, they had significantly lower emergence or fewer healthy plants. In particular, the ridge-till soil mentioned above appeared to be conducive. Corn soil was more suppressive to Pythium than soybean, and wheat soil was more suppressive to Rhizoctonia than soybean soil.

Microbial profiles of the K-series soils indicated that Pythium spp were more numerous in ridge-till than in the alternate system (Table 59). No other system effects were noted. A number of significant differences were related to current and previous crops. The conduciveness of ridge-till to Fusarium noted previously, may be an artifact due to Pythium populations in this soil. The relatively small number of Pythium propagules would not be expected to affect the behavior of the artificially infested Pythium suppressiveness test.

In study II (N-series), the alternate system was more suppressive to Rhizoctonia on wheat than conventional or min-till (Table 60). This was the only effect detected against the wheat pathogens. Several crop effects were noted: 1) wheat soil was more suppressive to Fusarium on wheat than soybean soil, 2) previous soybean soil was more suppressive than previous wheat soil to Fusarium, and 3) soybean soil was more suppressive to Rhizoctonia than wheat soil. It appears that some treatments were more conducive than others' to Helminthosporium.

Against alfalfa pathogens in study II (N-series), conventional was more suppressive than alternate to Rhizoctonia, and alternate more suppressive than conventional to Pythium (Table 61). No other effects were noted.

A few significant differences in Microbial populations were detected in study II (N-series) soils (Table 62). Min-till had more Fusaria than conventional tillage, and plots with soybeans had more fluorescent Pseudomonads and Pythium spp than did wheat plots.

During the growing season, a high incidence of common root rot of wheat was noted in some of the plots, and samples were taken from selected treatments for laboratory ratings. Ridge-till in the K-series had considerably more root rot than did conventional (Table 63). One possible explanation for increased common root rot in ridge-till was the low number of fluorescent pseudomonads in this system in May (Table 64). In the N-series, no system effects on common root rot were noted, but high root rot levels prevailed.

Table 57. Wheat disease suppression July samples 1989 K-series.

				Suppressiveness* to			
				Fusarium		Helminthosporium	
System	89 Crop	88 Crop	Trmt	Emerg	Healthy	Emerg	Healthy
Alternate	Oat/alf	Corn	1	1	0	1	0
Alternate	Alfalfa	Oat/alf	2	2	-1	0	0
Alternate	Soybean	Alf	3	0	-2	1	0
Alternate	Corn	Soybean	4	-1	2	-1	-1
Conventional	Soybean	Corn	5	1	1	-1	0
Conventional	S. Wheat	Soybean	6	-1	-2	-3	1
Conventional	Corn	S Wheat	7	0	4	0	1
Ridge-till	Soybean	Corn	8	2	1	-2	-1
Ridge-till	S Wheat	Soybean	9	0	0	-1	1
Ridge-till	Corn	S Wheat	10	1	0	1	1
		FLSD.05		(4)	4+	(4)	(3)
Significant Contrasts							
4 Corn vs soybean				-	+	-	-
5 Corn vs wheat				-	*	+	-
9 Wheat vs soybean (prev crop)				-	+	+	-

Table 57. (wheat disease suppression, K series, continued)

				Suppressiveness to			
				Rhizoctonia		Pythium	
System	89 Crop	88 Crop	Trmt	Emerg	Healthy	Emerg	Healthy
Alternate	Oat/alf	Corn	1	0	0	1	1
Alternate	Alfalfa	Oat/alf	2	3	0	0	1
Alternate	Soybean	Alfalfa	3	-2	0	1	1
Alternate	Corn	Soybean	4	0	0	1	1
Conventional	Soybean	Corn	5	0	0	0	-1
Conventional	S Wheat	Soybean	6	-1	0	-2	3
Conventional	Corn	S Wheat	7	1	0	0	0
Ridge-till	Soybean	Corn	8	0	0	-1	0
Ridge-till	S Wheat	Soybean	9	0	0	0	0
Ridge-till	Corn	S Wheat	10	0	0	0	1
		FLSD.05		(3)	-	(4)	(3)
Significant Contrasts							
6 Wheat vs soybean				-	-	-	*
7 Corn vs soybean (prev crops)				-	-	-	*

* Suppressiveness is indicated by numbers greater than zero.

#1 Negative numbers indicate that a soil is detrimental to plant growth compared to pathogen infested soil without the test soil.

Table 58. Alfalfa disease suppression, July samples 1989 K series.

			Suppressiveness to					
			Fusarium		Rhizoctonia		Pythium	
System	89 Crop	Trmt	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy
Alternate	Oat/alf	1	4	1	-3	0	0	-2
Alternate	Alfalfa	2	-3	-2	1	0	3	-3
Alternate	Soybean	3	3	-2	3	0	3	-2
Alternate	Corn	4	3	1	0	0	2	3
Conventional	Soybean	5	2	0	-3	0	0	-3
Conventional	S Wheat	6	1	4	2	0	4	0
Conventional	Corn	7	-3	1	2	0	2	-2
Ridge-till	Soybean	8	2	-3	-1	0	-2	-2
Ridge-till	S Wheat	9	0	-1	3	0	-1	-3
Ridge-till	Corn	10	1	-1	3	0	2	0
		FLSD.05	(7)	(5)	(6)	-	4+	(5)
Significant Contrasts								
1. Conventional vs alternate			-	+	-	-	-	-
2. Conventional vs ridge			-	*	-	-	+	-
3. Alternate vs ridge			-	-	-	-	*	-
4. Corn vs soybean			-	+	-	-	+	*
6. Wheat vs soybean			-	*	+	-	-	-
7. Corn vs soybean (prev crops)			-	+	*	-	+	+
8. Corn vs wheat (prev crops)			-	+	-	*	-	-
9. Wheat vs soybean (prev crops)			-	-	-	-	-	-

* Suppressiveness is indicated by numbers greater zero.

#1 Negative numbers indicate that a soil is detrimental to plant growth compared to pathogen infested soil without the test soil.

Table 59. Microbial analysis of soils, July samples 1989 K series.

				Colonies per plate on			
System	89 Crop	88 Crop	Trmt	Kings	Martins	PCNB	$P_{10}VP$
Alternate	Oat/alf	Corn	1	36	151	91	21
Alternate	Alfalfa	Oat/alf	2	117	113	103	28
Alternate	Soybean	Alf	3	163	331	166	27
Alternate	Corn	Soybean	4	64	188	174	31
Conventional	Soybean	Corn	5	106	289	198	43
Conventional	S Wheat	Soybean	6	53	157	138	21
Conventional	Corn	S Wheat	7	93	132	121	30
Ridge-till	Soybean	Corn	8	162	202	256	37
Ridge-till	S Wheat	Soybean	9	66	230	98	24
Ridge-till	Corn	S Wheat	10	164	159	151	36
			FLSD.05	(104)	(207)	85**	13*
Significant Contrasts							
3 Alternate vs ridge				-	-	-	+
4 Corn vs soybean				-	+	*	-
5 Corn vs wheat				+	-	-	*
6 Wheat vs soybean				*	-	**	**
7 Corn vs soybean (prev crop)				-	-	+	*
8 Corn vs wheat (prev crop)				-	-	**	-
9 Wheat vs soybean (prev crop)				+	-	-	*

Table 60. Wheat disease suppression July samples 1989 N-series.

				Suppressiveness* to			
				Fusarium		Helminthosporium	
System	89 Crop	88 Crop	Trmt	Emerg	Healthy	Emerg	Healthy
Conventional	S. Wheat	Soybean	1	1	2	1	0
Conventional	Barley	S Wheat	2	-1	1	0	0
Conventional	Soybean	Barley	3	0	3	1	1
Minimum-till	S. Wheat	Soybean	4	0	5	0	1
Minimum-till	Barley	S Wheat	5	2	3	3	-1
Minimum-till	Soybean	Barley	6	-1	2	1	0
Alternate	Oat/clover	S Wheat	7	-3	-1	-1	-1
Alternate	Clover	Oat/clover	8	4	6	-5	0
Alternate	Soybean	Clover	9	1	0	3	0
Alternate	S. Wheat	Soybean	10	2	4	-2	0
		FLSD.05		(4)	4+	(4)	(2)
Significant Contrasts							
4 Soybean vs wheat				-	+	-	
5 Soybean vs wheat (prev crop)				-	*	-	*

* Suppressiveness is indicated by numbers greater than zero.
#1 Negative numbers indicated that a soil is detrimental to plant growth compared to pathogen infested soil without the test soil.

Table 60. (wheat disease suppression, July 89 N series, continued)

				Suppressiveness to			
				Rhizoctonia		Pythium	
System	89 Crop	88 Crop	Trmt	Emerg	Healthy	Emerg	Healthy
Conventional	S. Wheat	Soybean	1	-4	0	3	1
Conventional	Barley	S Wheat	2	0	0	2	0
Conventional	Soybean	Barley	3	1	0	3	1
Minimum-till	S. Wheat	Soybean	4	-2	0	1	0
Minimum-till	Barley	S Wheat	5	-1	0	3	0
Minimum-till	Soybean	Barley	6	0	0	1	1
Alternate	Oat/clover	S Wheat	7	-2	0	4	1
Alternate	Clover	Oat/clover	8	-2	0	4	1
Alternate	Soybean	Clover	9	2	0	2	1
Alternate	S. Wheat	Soybean	10	1	0	-1	0
		FLSD.05		(4)	-	(4)	(2)
Significant Contrasts							
2 Conventional vs alternate (soy,wht)				*			
3 Alternate vs min-till (soy,wht)				+			
4 Soybean vs wheat				*			

* Suppressiveness is indicated by numbers greater than zero.
#1 Negative numbers indicate that a soil is detrimental to plant growth compared to pathogen infested soil without the test soil.

Table 61. Alfalfa disease suppression, July samples 1989 N series.

			Suppressiveness to					
			Fusarium		Rhizoctonia		Pythium	
System	89 Crop	Trmt	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy
Conventional	S. Wheat	1	1	-2	3	0	-2	-1
Conventional	Barley	2	0	0	5	0	2	-1
Conventional	Soybean	3	0	4	6	0	0	-1
Minimum-till	S. Wheat	4	1	2	2	0	2	0
Minimum-till	Barley	5	1	-2	4	0	-1	-2
Minimum-till	Soybean	6	-3	3	4	0	-4	-2
Alternate	Oat/clover	7	1	1	6	0	5	-2
Alternate	Clover	8	1	-1	2	0	2	-1
Alternate	Soybean	9	1	1	-4	0	5	3
Alternate	S. Wheat	10	-3	-2	1	0	4	-2
		FLSD.05	(6)	(7)	2*	-	(10)	(4)
Significant Contrasts								
2. Conventional vs alt (soy,wht)					*			

* Suppressiveness is indicated by numbers greater zero.
#1 Negative numbers indicate that a soil is detrimental to plant growth compared to pathogen infested soil without the test soil.

Table 62. Microbial analysis of soils, July samples 1989 N series.

				Colonies per plate on			
System	89 Crop	88 Crop	Trmt	Kings	Martins	PCNB	$P_{10}VP$
Conventional	S Wheat	Soybean	1	20	85	101	22
Conventional	Barley	S Wheat	2	206	75	110	28
Conventional	Soybean	Barley	3	258	87	105	27
Minimum-till	S Wheat	Soybean	4	7	91	73	21
Minimum-till	Barley	S Wheat	5	34	103	110	28
Minimum-till	Soybean	Barley	6	393	120	87	30
Alternate	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Economic Comparisons of Farming Systems: SDSU's Northeast Station in 1989

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The SDSU Economics Department is currently involved in several investigations of alternative or sustainable agricultural practices. Among these is an ongoing economic comparison of the alternative, conventional, and reduced till cropping systems being investigated by plant scientists at SDSU's Northeast Research Station. The agricultural economics research at the Northeast Station is supported by Agri. Exp. St. Project No. 7207-076 and by a U.S.D.A. Low-Input/Sustainable Agriculture (LISA) multidisciplinary research grant. Preliminary economic results for the 1989 crop year are reported here.

Economic results depend critically on the cultural practices and crop yields for each system. The practices and yields for 1989 at the Northeast Station have been presented earlier in this annual report. Note that yields recovered some in 1989, in comparison to levels during the severe drought conditions of 1988. However, yields in most cases were not at the levels of 1986 and 1987.

Assumptions about Federal farm program support levels and market prices reflected 1989 conditions in our economic analyses of 1989 system performance. For individual commodities, the support and/or market price assumptions used in computing gross returns were: (1) corn - 10% non-paid acreage set aside, [illegible] and $0.70/bu. deficiency payment; (2) wheat - 10% [illegible] deficiency payment;