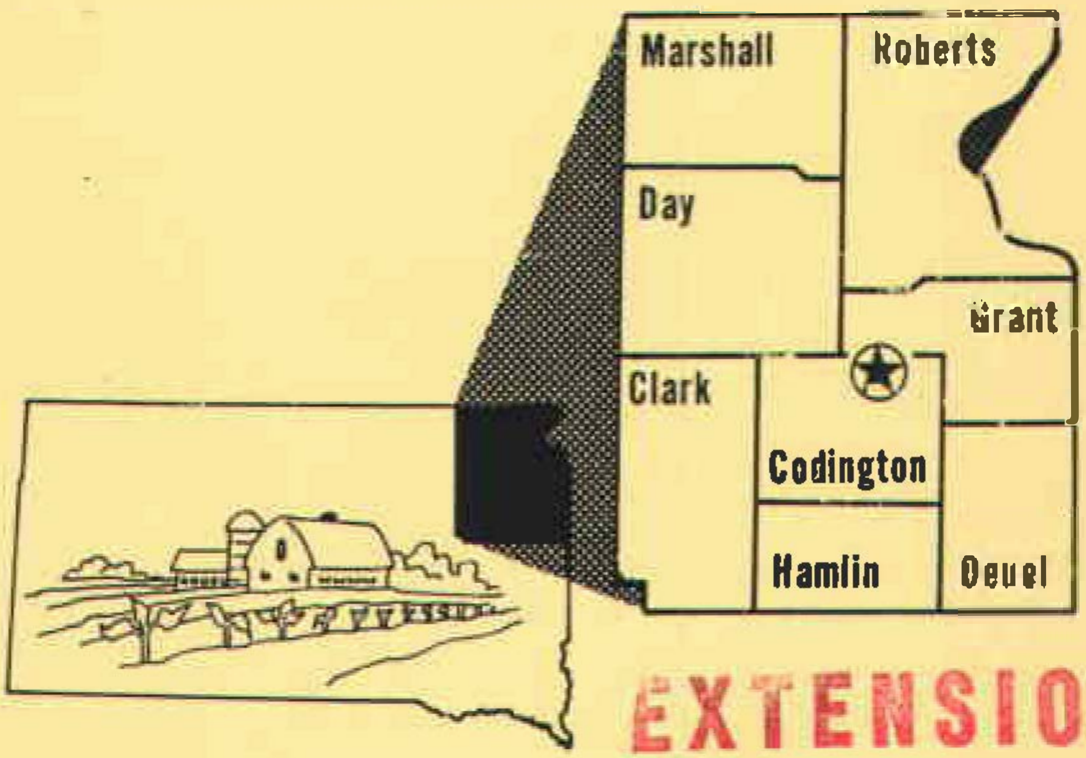
Plant Science Pamphlet No. 15

ANNUAL PROGRESS REPORT

January 1989

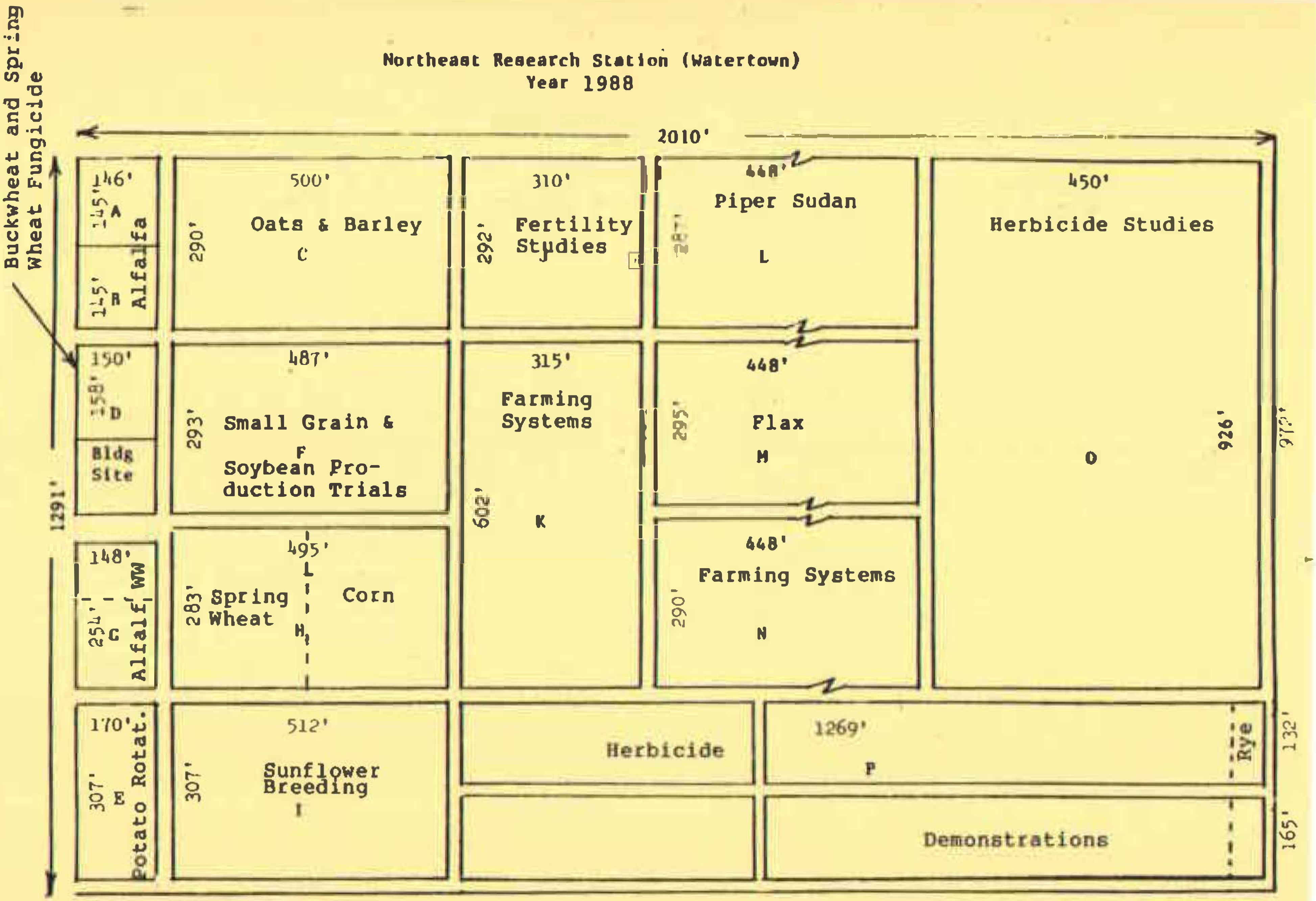
1988
ANNUAL PROGRESS REPORT
Northeast Research Station
Watertown, South Dakota



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

Northeast Research Station (Watertown)
Year 1988

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

TABLE OF CONTENTS

ANNUAL PROGRESS REPORT, 1988
Northeast Research Station
Watertown, South Dakota

Drought conditions prevailed throughout the 1988 growing season. Total precipitation for the months of April, May, June and July was only 4.90 inches, which was 6.59 inches below normal (Table 1). Early spring temperatures were much above normal which compounded the effects of the drought. Precipitation in August and September was slightly above normal, but arrived too late to benefit most crops. Over the entire growing season precipitation was 5.15 inches below normal. The drought, combined with comparatively low subsoil moisture reserves, resulted in severe reductions in crop yields. Small grain yields were reduced 35 to 65% compared to 1987. Corn and soybean yields were reduced 40 to 85%.

The dry conditions interfered with performance of some herbicides and grassy weeds were a problem in some studies. The drought halted the development of most fungal and bacterial diseases; however, some Sclerotinia wilt was present in sunflowers. As in 1987, the early spring apparently resulted in early northward movement of aphids carrying Barley Yellow Dwarf Virus (BYDV), and there were significant infection levels in oats, barley and wheat.

The summer field tour was very well attended. Tour topics included: small grain variety performance, small grain diseases, herbicide demonstrations, corn fertility studies, alfalfa varieties, farming systems studies, oat breeding, and spring wheat breeding. A meal sponsored by area Crop Improvement Associations was skillfully prepared by area County Agents. We wish to thank Ray Bundy and Richard Theye for furnishing wagons for use at the tour. We also thank Morris Gunderson for supplying water for use at the farm, and Orrin Korth for his harvesting assistance and equipment loans. Thanks also to the Crop Improvement Association for the purchase of a ridge-till cultivator and a Allis-Chalmers E combine. The 1989 tour will be held on July 11.

NOTE: Much of the information contained in this report is based on ongoing studies and results should therefore be considered tentative. This report does not contain detailed tabular information concerning small grain, flax and soybean performance. This information 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 1988 Herbicide Report (EC678).

AGRICULTURAL ADVISORY GROUP, 1988

Northeast Research Station, Watertown, SD
Harlan Haugen, Chairman; Jim Wilson, Secretary

Laird Larson	Clark County	86-89
Robert Lutkemeier	Roberts County	87-90
Lynn Eberhart	Marshall County	87-90
Mike Johnson	Day County	87-89
Greg Tolben	Deuel County	87-90
Randy Frederick	Hamlin County	87-90
Lyle Kriesel	Grant County	87-90
Harlan Haugen	Codington County	86-89
Orrin Korth	Codington County	Permanent
Maurice Horton	SDSU, Head, Plant Science Department	
Loyal Evjen	Ag. Technician	
Steve Werner	Summer Field Assistant	
Jeff Buchholz	Summer Field Assistant	
James Smolik	SDSU, Station Manager	

<u>Extension Service</u>

Chuck Langner	Clark County
Joe E. Schuch	Roberts County
Lorne Tilberg	Marshall County
Jim Wilson	Day County
Dale Wiitala	Deuel County
Donald Guthmiller	Hamlin County
Bob Schurrer	Codington County
Gail Dobbs	District Supervisor

Table 1. Growing season precipitation

Month	Amount (in.)	Normal	Departure	Greatest Amount	Date
April	0.59	2.10	-1.51	0.33	2
May	2.76	2.97	-0.21	0.75	21
June	0.69	3.75	-3.06	0.23	16
July	0.86	2.67	-1.81	0.36	13
August	4.03	2.78	+1.25	1.90	2
September	2.98	1.85	+1.13	1.37	20
October	0.22	1.16	-0.94	0.11	27
Total:	12.13	17.28	-5.15		

Temperatures: Last frost - 22° F, May 13
First frost - 20° F, October 4
Frost free period: 144 days

SPRING WHEAT BREEDING

F. Cholick, K. Sellers and E. Autrique

Experiments were planted April 25 and harvested July 25. Therefore, the length of the crop cycle was 91 days which was approximately 20 days less than normal for this site, and less than the typical cycle for western South Dakota. The reduction in crop cycle was nearly equally divided between the vegetative and reproductive stages of plant development. In my opinion the primary reason for the reduced life cycle was high temperature, and lack of available moisture was a contributing factor. The acceleration of the plant development during the vegetative stage reduced yield potential, and the continued high temperatures and lack of moisture did not allow the crop to recover. These factors resulted in a yield reduction of nearly 70 percent (14.2 bu/A) compared to the past several growing seasons. In general, the early varieties or experimental lines were in the top yielding group. The highest yielding varieties (checks) in the breeding nursery were Guard, Stoa, Butte-86, and Shield yielding 15.8, 15.4, 15.2, and 15.0 bu/A, respectively. There were four experimental lines that exceeded Guard and a total of 16 experimental lines that yielded more than Shield. Within this group several lines (SD2980, SD3000 and SD3000) are presently being considered for increase for release in 1990. The earliest line SD3005 was the highest yielding in 1988 producing 17.1 bu/A and heading four days earlier than Butte-86. The number of days from planting to heading ranged from 47 to 56. Test weight and kernel weight were also less than normal with test weight ranging from 50.9 to 58.2 lbs/bu. Protein content ranged from 17.2 to 19.9 percent which was approximately 3 percent higher than normal. This station is generally a site where the spring wheat breeding project can evaluate yield potential of experimental lines and their reaction to diseases. The primary evaluations in 1988 were for heat and moisture stress, and of 8 test locations it produced the lowest mean yields rather than the highest. The data from 1988 experiments aided in evaluating experimental lines for stress conditions rather than yield potential.

Blend Yield Trial 1988

As in 1987, a replicated yield trial was conducted at Brookings, Watertown, Redfield, Brentford and Selby to evaluate the effect of blending varieties on grain yield and protein content. Four varieties, Butte-86, Guard, Marshall and Stoa were grown as pure varieties and all possible two-way blends. The following table summarizes the grain yields and protein contents.

Table 2. Yield and protein results from blend experiment in 1988.

Variety	Brookings		Redfield		Watertown		Brentford		Selby		Average	
	yld bu/A	pro %	yld bu/A	pro %	yld bu/A	pro %	yld bu/A	pro %	yld bu/A	pro %	yld bu/A	pro %
Butte-86	20	17.8	20	17.2	19	17.1	18	17.4	24	16.6	20	17.2
Marshall	17	16.5	18	17.2	16	18.3	18	18.3	20	16.3	18	17.3
Guard	24	16.6	18	17.4	19	18.4	16	17.4	23	16.2	20	17.2
Stoa	20	16.7	21	16.9	19	19.0	18	18.0	24	16.6	20	17.4
B/G	20	16.6	22	17.0	21	17.8	16	17.9	23	17.3	20	17.3
B/M	20	16.8	19	17.3	16	18.5	17	18.2	21	16.5	18	17.5
B/S	22	17.3	21	17.3	18	18.6	19	18.6	25	16.2	21	17.6
G/M	19	16.3	17	17.1	17	18.0	17	18.1	22	16.5	19	17.2
G/S	22	15.9	19	16.8	18	18.7	17	17.8	22	16.4	20	17.1
M/S	20	16.6	19	17.1	18	18.1	17	18.1	22	16.4	19	17.3
LSD 0.05 yield	2.7		2.6		2.3		3.7		2.1		1.8	

The grain yields that are underlined are in the highest yielding group. Protein was determined on a composite of the three replications, therefore there is no LSD. These results were similar to 1987 and other composite or blend experiments. In general, there appears to be little or no advantage to blending varieties because the best blends grain yields were not superior to the best pure variety. In 1987 Butte-86 and Stoa and their blend were the top yielding treatments averaged over locations. In 1988 only the variety Marshall yielded less than the other three, and the three blends with Marshall were also lower yielding. The range among varieties for protein in 1988 was extremely small, and therefore it is difficult to evaluate this trait. However, as with yield there appears to be little advantage of blending varieties with high and low protein contents to maintain protein content.

Crossing Strategies to Introduce Non-adapted Germplasm

Incorporating genetic variability for agronomic characteristics is an important goal in breeding programs, and often requires the use of non-adapted germplasm. However, there are a number of possible approaches to introduce non-adapted germplasm, and evaluating these approaches may improve the efficiency of the overall breeding effort. The objectives of this study are to determine which type of cross produces the highest yielding lines, and if early generation testings are good predictors of yield in later generations. The three type of crosses used were single cross (adapted-1 X non-adapted), backcross (adapted-1 X non-adapted X adapted-1), and three-way cross (adapted-1 X non-adapted X adapted-2). Seven non-adapted and fourteen adapted parents were used. Preliminary results from the bulk populations indicated that the highest yielding cross was the two adapted parents (our check in this study), and the lowest yielding one is the cross between adapted and non-adapted. The-three way cross and the backcross ranked second and third, respectively. This experiment will be repeated in 1989. In addition, F_4 derived F_6 lines from these populations will be tested. This additional test will be conducted to determine the potential of these populations to produce high yielding segregates.

OAT RESEARCH

D. L. Reeves and L. Hall

Oat Breeding:

This station usually provides us with the best indication of grain quality so we rely on it quite heavily. In addition, our best yields are often here. Unfortunately, this year we obtained poor stands and got very limited information. There was considerable barley yellow dwarf virus (red leaf or BYDV) so readings were obtained to supplement our other locations. In our regular breeding program we had 220 different selections tested here this year.

There were three South Dakota entries in the Uniform Midseason Oat Performance nursery which has 36 entries and was grown here. Two of the three South Dakota entries are being increased and appear to have good potential for future release.

The Standard Variety Oat trial conducted by J. J. Bonnemann had 4 of our experimental lines which were tested statewide. In addition, 4 of the varieties in the test were developed in South Dakota.

Herbicide Tests:

A preliminary herbicide testing program was started in cooperation with the extension weed workers. There are three objectives to this program. One is to see how oats are reacting to environmental conditions when sprayed on a given year. The second is to see how our selections approaching release as a variety respond to commonly used herbicides. The third is to see what could be expected in the field if the spraying overlapped and doubled the application rate. The treatments included MCPA at 1/2 and 1 lb. rates, 2,4-D Amine at 1/2 and 1 lb., Bronate at 3/4 and 1 1/2 lb and a Banvel + MCPA mix. These plots were not harvested due to poor stands. We plan to continue this test next year.

Water Relations:

Nigatu Tadasse is looking at grain yield as related to various water relationships in 37 oat lines. Our ultimate objective in this work is to try to find some type of water-related measurement that is related to grain yield when moisture is limiting. The trait which appears to have the best potential for identifying lines tolerant to water stress is the ability of the leaf to retain water after being cut from the plant.

Designing Breeding Programs

Omar Kafawin had many small plots of 5 different crosses here this year. The objective of his study is to see if we can change our breeding program and make it more efficient. He subjected the first generations of these crosses to various stresses. The purpose was to eliminate the poorer plants so you could then select from only the better producing in each cross. Preliminary results indicate he was successful in removing some of the poorer producing lines by the treatments.

BARLEY AND RYE RESEARCH

D. L. Reeves and L. Hall

Rye

The rye yield test was grown at this station and three other locations in the state. This year's test included four released varieties, one experimental line from North Dakota and five selections we have developed from our crosses. This was grown on summer fallow, but received no fertilizer. Results of the test are in the following table.

Table 3. Rye yield tests.

Entry	Yield (Bu/A)	TW (lb/bu)	Height (in)	Protein (%)
Musketeer	38	49.5	42	14.6
Rymin	32	49.5	39	14.0
Chulipan	32	46.1	40	14.1
Prima	34	47.4	40	13.6
Frederick	35	50.0	41	15.8
ND 1	39	44.7	37	15.3
SD X85-5,6,7,8 T	31	47.8	40	14.1
SD X79-9	32	49.0	46	14.9
SD X85-5,6,7,8 S	26	46.9	35	15.3
SD X83-3	34	44.8	34	15.7
SD X84-2	30	47.3	36	16.6
Mean	33	47.6	39	14.9

Barley

The Mississippi Valley Barley test has been grown here the past five years. This is a regional test which is grown in several states and Canada. There were 20 entries in the test with most entries coming from Minnesota or North Dakota. These are primarily advanced lines being considered for possible release as varieties.

ALFALFA CULTIVAR YIELD TEST

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

Two alfalfa cultivar yield experiments were conducted at the NE station during 1988. The experimental objective was to determine the yield performance of various alfalfa cultivars and experimental lines when grown in NE South Dakota.

The first of these experiments was established in late April of 1987 and consisted of 31 cultivars. Average total dry matter yield obtained from three harvests was 3.88 tons per acre (Table 4). In spite of the season-long drought first harvest yields in mid-June were above 2 tons per acre (Table 4). As drought stress worsened, however, forage yields were reduced.

The second experiment consisted of 28 cultivars and was planted in late April 1988. A single harvest was obtained on 26 July which produced an average dry matter yield of 0.60 tons per acre with a range of about 0.3 tons per acre (Table 5). Drought caused the seeding year yield for this experiment to be about one-third of the seeding year yield for the first experiment (Table 4).

A yield test experiment which was planted in 1985 was concluded in 1987; however, all plots of this experiment were rated for stand vigor on 18 May 1988 (Table 6). The visual rating was based on a scale from 1 to 5 where the low rating represented a very deteriorated stand and the high rating represented a relatively vigorous and dense stand. Clearly, there were differences in stand vigor after enduring three winters. Rating values ranged from 5 to 1.7 (Table 6).

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

Table 4. Forage yield of 31 alfalfa cultivars planted April 25, 1987 at the Northeast Research Station, Watertown, SD.

	1987	1988 Forage Yield (tons DM/A)				2	%
	1-cut	Cut 1	Cut 2	Cut 3		Year	Relative
Cultivar	Total	6/13	7/26	8/31	Total	Avg.	Performance[a]
120	2.00	2.44	1.04	0.86	4.34	3.17	111
WL 225	2.11	2.40	0.95	0.86	4.21	3.16	111
Dart	1.93	2.43	0.97	0.88	4.28	3.10	109
Fortress	1.87	2.43	0.99	0.90	4.31	3.09	109
Cimarron	1.95	2.29	1.00	0.89	4.18	3.06	108
SX 217	2.05	2.09	1.05	0.90	4.04	3.04	107
MTO S82[b]	1.91	2.51	0.94	0.70	4.15	3.03	106
NAPB 31	2.03	2.34	0.85	0.84	4.02	3.02	106
532	1.77	2.38	0.92	0.86	4.16	2.96	104
Magnum III	1.86	2.07	0.95	0.90	3.92	2.89	102
526	1.66	2.37	0.91	0.82	4.10	2.88	101
Iroquois	1.84	2.15	0.87	0.84	3.86	2.85	100
Blazer	1.82	2.26	0.87	0.73	3.86	2.84	100
Big 10	1.74	2.12	0.92	0.88	3.92	2.83	99
Endure	1.81	2.15	0.91	0.77	3.83	2.82	99
Mohawk	1.68	2.24	0.92	0.78	3.94	2.81	99
Dynasty	1.82	2.13	0.81	0.82	3.76	2.79	98
Cim 2000C[b]	1.79	2.14	0.82	0.82	3.78	2.78	98
SX 424	1.65	2.07	0.91	0.90	3.88	2.76	97
Arrow	1.65	2.15	0.86	0.85	3.87	2.76	97
XPH 2001	1.69	2.02	0.95	0.86	3.82	2.76	97
DK 135	1.81	2.18	0.79	0.72	3.96	2.75	97
Eagle	1.72	2.06	0.86	0.86	3.78	2.75	97
Apollo Supreme	1.81	2.18	0.78	0.70	3.66	2.74	96
5432	1.72	1.98	0.89	0.86	3.73	2.72	96
Saranac AR	1.78	2.03	0.83	0.75	3.61	2.70	95
Vernal	1.83	2.05	0.78	0.71	3.55	2.69	95
Commandor	1.80	1.96	0.82	0.79	3.56	2.68	94
636	1.73	2.09	0.81	0.68	3.57	2.65	93
Saranac	1.60	2.11	0.80	0.67	3.57	2.58	91
MTO N82[b]	1.78	2.32	0.54	0.47	3.33	2.56	90
Average	1.81	2.20	0.88	0.80	3.88	2.85	
LSD (0.05)	ns	0.33	0.21	0.17	ns	0.37	

[a] % relative performance = cultivar 2-year average yield/2-year average of all cultivars.

[b] Experimental line, currently not marked.

Table 5. Forage yield of 28 alfalfa cultivars planted April 28, 1988 at the Northeast Research Station, Watertown, SD.

Cultivar	1988 Forage Yield (tons DM/A Cut 1 7/26	% Relative Performance[a]
Vernal	0.77	129
Big 10	0.76	127
120	0.71	118
FSRC 87N1[b]	0.70	117
AP 8620[b]	0.67	112
FSRC 87 M1[b]	0.67	112
DK 125	0.67	112
Cimarron	0.67	111
Vector	0.62	104
SX 424	0.62	103
Sure	0.61	102
SX 217	0.60	100
Kingstar	0.58	97
Chief	0.58	96
Arrow	0.57	96
Magnum III	0.57	96
FSRC 87N3[b]	0.57	95
Premier	0.57	94
526	0.56	94
AP 8531[b]	0.55	92
Dart	0.54	90
MTO N82[b]	0.54	90
WL 320	0.53	89
86639[b]	0.53	88
XAF62[b]	0.52	88
Magnum +	0.52	87
5432	0.49	82
WL 225	0.47	79
Average	0.60	
LSD (0.05)	ns	

[a] % relative performance = cultivar 1-cut total average/1-cut average of all cultivars.

[b] Experimental line, currently not marketed.

Table 6. 1985 Alfalfa Variety Trial vigor rating, Northeast Research Station, Watertown, SD, 1988.

Variety	Rating[1]	Variety	Rating[1]
526	5.00	Sparta	4.25
Mohawk	5.00	Epic	4.25
MN 5617	5.00	Peak	4.25
MN 6216	5.00	NY 8413	4.25
Iroquois	5.00	Agate	4.25
Saranac	5.00	Saranac AR	4.25
Oneida	5.00	Elevation	4.00
Thunder	4.75	XAF31	4.00
5432	4.75	Max 85	4.00
532	4.75	Kingstar	4.00
Oneida VR	4.75	8016 PCa3	4.00
Vernal	4.75	Big 10	3.75
Dawson	4.75	Baker	3.75
Surpass	4.50	120	3.50
Megaton	4.50	DK135	3.25
Futura	4.50	Endure	3.25
NY 8412	4.50	Spectrum	3.25
MN 6209	4.50	H 156	3.00
Vernema	4.50	Cimarron	3.00
Arrow	4.25	Blazer	2.25
		H 154	1.75
Horizon	4.25		
Maxim	4.25	Average	4.18
Magnum	4.25	LSD (0.05)	0.90
Magnum +	4.25		

[1] A rating of 5 is good and a rating of 1 is poor. The number decreases as the vigor of the stand decreases.

ORCHARDGRASS CULTIVAR EVALUATION

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

Orchardgrass (Dactylis glomerata L.) is a very productive cool-season forage grass used in many areas of the Upper Midwest. Vegetative shoots are culmless for this species giving it high forage quality and palatability. Most orchardgrass cultivars developed in the Midwest lack adequate winterhardiness and drought tolerance for South Dakota conditions. New cultivars released from Idaho and Canada, however, are reported to have improved winterhardiness. 'Regar' meadow bromegrass (Bromus biebersteinii Roem and Schult) is another high-quality cool-season grass which deserves testing for South Dakota forage producers.

The objectives of this study are to determine forage yield and stand longevity for several orchardgrass cultivars and 'Regar' meadow bromegrass. The experiment was planted 29 April 1988. Older orchardgrass cultivars with relatively low winterhardiness include 'Latar', 'Potomac', and 'Sterling'. Canadian orchardgrass cultivars include 'Kay' and 'Chinook'. 'Paiute', a new cultivar developed by the Soil Conservation Service is also included. 'Rebound' smooth bromegrass (Bromus intermis L.) is included as a check. All plots will be evaluated for heading date and forage yield in 1989 through 1991.

POTATO FUNGICIDE SEEDPIECE TREATMENTS - 1988

D. Gallenberg and L. Evjen

Plots of Kennebec and Red LaSoda were planted on May 31, 1988 in rows spaced approximately 48" with 12" between seedpieces in the row. Cut seed was treated with Captan plus streptomycin (dust), Mancozeb (slurry) or untreated prior to planting. Moisture was low during the season causing uneven and poor emergence and stand counts in all treatments in both varieties. Weeds were also a problem during the season. Plots were harvested on September 15, 1988. Average yields (across all seedpiece treatments) were 71.7 cwt/A for Red LaSoda and 76.2 cwt/A for Kennebec. Rhizoctonia was present throughout the plot. Fusarium incidence was high in Red LaSoda.

THE INFLUENCE OF ADDED NITROGEN ON DROUGHT AFFECTED CORN

R. Gelderman 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 in the southeastern corner of the Watertown Station on a Brookings soil. These soils are deep, silty clay loam loess over glacial till. Results of soil tests from samples taken in the spring of 1988 are shown in Table 7.

Table 7. Soil test results of nitrogen corn study at planting, Watertown Station.

NO_3-N					
0-24"	0-60"	O.M.	P	K	pH
lb/A		%	lb/A		
75	162	3.6	32	380	6.1

The soil tests for nitrate-nitrogen indicated a considerable quantity of nitrogen in the 2 to 5 foot depth (87 lb/A). Usually only 30-40 pounds are found at this depth. Phosphorus and potassium are considered adequate. The soil is slightly acidic in reaction.

The previous crop was sunflowers. The area was chiseled and disked before planting Pioneer 3790 on 5 May 1988 at a population of approximately 18,000 plants per acre. The fertilizer rate treatments were spread on the soil surface as ammonium nitrate about two weeks after planting. The rates used were 0, 30, 60, 90, and 120 lb of actual nitrogen per acre. Each treatment was replicated five times. The plots were harvested for silage on 31 August 1988.

Results and Discussion:

Because of the severe drought conditions at the station, grain yields were not taken. Visual observations indicated very little grain produced. The plants were from 30 to 48 inches tall at maturity.

The average silage yield, nitrate-nitrogen content of the unfermented silage material and percent of smut infected plants are given for each treatment in Table 8.

Table 8. Average silage yield, silage nitrate-nitrogen content and smut infected plants for the nitrogen rate experiment, 1988.

Rate of N	Silage yield*	Nitrate-N	Smut infected plants
----lb/A----		----%----	
0	3367	0.040	44
30	3751	0.039	36
60	3710	0.039	47
90	3567	0.047	58
120	3865	0.041	53
Sign. of F	0.60(NS**)	0.43(NS)	0.65(NS)

* Dry weight
** NS = nonsignificant

There was no influence of added nitrogen on silage yield. Water was limiting yield response to any additional nitrogen application. The available soil nitrate-nitrogen was adequate to produce the above silage yields.

High plant nitrate-nitrogen contents were a common occurance as a result of the drought conditions. High nitrogen applications can lead to higher plant nitrate contents under water stress. This was not the case at this site. Plant nitrate-N content of the whole plant sample did not change significantly with added rates of N (Table 8). Other water stressed locations did show some increase of plant nitrate-nitrogen with added N. However, all sites measured were well below critical levels (0.15% nitrate-N) even with 130 pounds of added nitrogen. With recommended levels of nitrogen, toxic levels of plant nitrate-N in corn were not a problem under these conditions in 1988. However, conditions vary enough where each producer should have feed levels checked if any concern exists.

Smut infected ears were very common in some drought affected fields. The development of common smut is favored by dry, warm conditions, conditions that were common for 1988. At this location, added nitrogen did not influence percent of smut infected plants (Table 8). The higher stressed plots (as indicated by lower yields) tended to have more smut (r = -0.65). In addition, some literature indicates a higher smut infection with higher soil nitrogen levels. The percent of smut infected plants was not correlated to rate of nitrogen application in this experiment (r = 0.25). However, the total nitrogen content of the whole plant was significantly correlated to percent smut infection (r = 0.75).

CROP PERFORMANCE TESTING - CPT

J. J. Bonnemann

The Crop Performance Testing Program continued trials with five small grains and two maturity groups of soybeans at the NE Farm in 1988. A new pair of trials with early and late corn hybrids was initiated in 1988 at the request of the Advisory Council. The trials will be continued for another year to determine whether adequate participation continues to support the expansion. The small grains were barley, durum, oats, spring wheat and triticale. Group 0 and Group I soybeans were in the two soybean trials. The corn trials were separated by company supplied classifications into hybrids earlier or later than 95 days relative maturity. Proprietary entries of corn and soybeans are the choice of the company and included on a fee basis.

Yields of the small grains were generally fair to poor. The soybean yields were fair to good and the corn yield quite variable; the heat and moisture stresses affecting both crops. Quality of most entries was fair to poor. The results of the small grains and soybeans and more agronomic details are reported in EC 774 (rev.) and EC 775 (rev.), respectively. The corn results are also reported in Plant Science Pamphlet #12. The reports are available at County Extension Offices or from the Bulletin Room, SDSU, Brookings, SD 57007.

Table 9. 1988 CPT barley, durum and triticale trials.

Entry	B/A	TW	B/A	B/A	TW
BARLEY			DURUM		
Azure	33.0	41	Crosby	20.6	58
Bowman	36.5	47	Fjord	21.6	59
Gallatin	28.0	44	Laker	18.1	57
Glenn	29.3	47	Monroe	23.4	57
Hazen	31.0	42	Renville	15.8	56
Morex	21.8	41	Rugby	19.5	58
Primus II	29.5	42	Stockholm	20.1	58
Robust	24.7	42	Vic	19.2	50
81602	24.0	41	Ward	19.2	58
			WPB 883-323(X)	18.7	57
Means	27.2	44			
LSD (.05)	5.6		Means	19.5	58
CV = %	12.4		LSD (.05)	2.1	
			CV = %	7.7	
TRITICALE					
Karl	15.8	46			
Kramer	15.3	46			
Marvel	11.4	43			
Grace	14.1	42			
"Tricale Victoria"	20.2	45			
Means	15.4	44			
LSD (.05)	2.6				
CV - %	11.6				

Table 10. 1988 CPT spring wheat and oat trials.

Entry	B/A	TW	Entry	B/A	TW
SPRING WHEAT			**OATS**		
TALLS			Benson	32.8	27
			Burnett	40.3	29
Alex	8.5	55	Don	64.1	32
Amidon	15.1	57	Hazel	65.5	30
Butte 86	16.6	55	Hytest	39.5	32
Chris	8.1	53	Kelly	42.2	33
Stoa	17.3	56	Lancer	33.6	27
Shield	17.2	55	Lyon	16.4	22
			Moore	23.2	26
SEMI-DWARFS			Nodaway 70	52.6	33
			Ogle	62.0	29
Angus	9.8	54	Otee	51.5	34
Celtic	14.7	54	Porter	29.5	30
Challenger	15.8	53	Preston	40.2	28
Guard	18.4	53	Proat	26.4	26
Leif	6.4	55	Sandy	10.1	28
Len	14.6	56	Starter	37.9	31
Leo 747	18.3	55	Steele	15.3	28
Marshall	13.8	55	Trucker	27.1	28
Nordic	18.7	58	Valley	28.5	30
Norseman	10.1	53	Webster	60.7	30
Prospect	18.5	55	Wright	26.7	27
Telemark	16.1	53			
Wheaton	12.2	51	Means	40.4	29
W2501	14.7	50	LSD (.05)	6.9	
W2502	17.2	53	CV - %	12.2	
2369	15.1	56			
2385	19.7	56			
2374(X)	19.3	56			
HS84-873(X)	18.6	54			
Westbred 926(X)	16.0	55			
Means	14.9	54			
LSD (.05)	4.1				
CV - %	7.0				

Table 11. Soybean trial, CPT, Group 0, Watertown, SD.

		VARIETY MEANS				
Variety name		Yield	Grams 100 NR	Plant Height	Lodging	MO/DA
Hy-Vigor EX-K-68T -BL	0	23.4	17.1	25.0	0.0	9/12
Mustang M-1000	0	22.5	15.0	22.7	0.0	9/12
Mustang M-1050	0	22.3	22.0	22.3	0.0	9/11
Northrup King 8095	0	21.3	16.3	23.3	0.0	9/10
Arrowhead 8450	0	21.2	17.4	22.0	0.0	9/6
Simpson	0	21.1	19.1	22.7	0.0	9/8
Schwitters Sioux	0	20.8	18.2	21.7	0.0	9/8
Interstate IS715	0	19.9	21.0	21.3	0.0	9/10
Dawson CK	0	19.4	17.9	20.7	0.0	9/6
Interstate 1S598 (BL)	0	19.4	17.9	22.3	0.0	9/8
Pioneer 9091	0	19.3	17.6	20.3	0.0	9/6
Sibley CK	I	19.2	19.9	21.0	0.0	9/10
Arrowhead 8300	0	18.9	18.7	22.7	0.0	9/7
Swift	0	18.0	17.5	22.0	0.0	9/5
Glenwood	0	17.9	19.2	18.3	0.0	9/6
Interstate IS546	0	17.2	16.6	20.7	0.0	9/5
Northrup King S 06-57	0	17.1	20.6	23.3	0.0	9/7
Dassel	0	16.7	17.3	20.3	0.0	9/5
Ozzie	0	14.4	17.5	19.0	0.0	9/3
Evans	0	12.2	17.1	21.0	0.0	9/1
Mc Call CK	0	10.2	17.0	19.0	0.0	8/26
Mean	0	18.7	18.1	21.5	0.0	9/7
LSD (.05)	0	3.4				
C.V. - %	0	11.2				

Table 12. Soybean trial, CPT, Group I, Watertown, SD.

		VARIETY MEANS				
Variety name		Yield	Grams/ 100 KR	Plant Height	Lodging	Mature MO/DA
AgriPro AP1968	I	28.2	18.0	22.0	0.0	9/12
Peterson FRS119	I	25.6	16.9	22.7	0.0	9/20
Sibley CK	I	24.2	16.2	22.7	0.0	9/12
Hy-Vigor K-1980 (BL)	I	24.2	15.9	26.3	0.0	9/13
Weber 84	I	23.8	14.6	23.3	0.0	9/14
AgriPro AP1650	I	23.7	20.1	22.0	0.0	9/10
Mustang M-1150A (BL)	I	23.7	17.4	24.7	0.0	9/15
SeedTec 6208 (BL)	I	23.2	16.7	25.3	0.0	9/16
AgriPro AP1776	I	23.2	16.6	21.0	0.0	9/10
Hardin	I	23.2	16.1	23.7	0.0	9/15
Star 8815	I	22.7	16.0	21.7	0.0	9/14
Corsoy 79 CK	II	22.7	15.9	26.3	0.0	9/17
Lakota	I	22.4	16.0	25.7	0.0	9/11
Mustang M-1120A	I	21.9	16.7	21.7	0.0	9/12

Table 12. (Continued).

Variety name		Yield	Grams/ 100 KR	Plant Height	Lodging	Mature MO/DA
		VARIETY MEANS				
Schwitters Commanche	I	21.7	18.5	21.0	0.0	9/16
Stine 1820	I	21.6	18.6	22.3	0.0	9/13
Arrowhead 8550	I	21.5	20.9	21.0	0.0	9/11
Arrowhead 8600	I	20.9	20.6	21.7	0.0	9/11
Sexauer SRF101	I	20.8	17.8	21.3	0.0	9/11
SeedTec 1157	I	20.5	17.3	20.7	0.0	9/15
Interstate 1S5758 (BL)	I	20.3	18.6	18.7	0.0	9/14
Interstate 1S5622	I	20.3	20.4	23.7	0.0	9/14
Schwitters Cherokee	I	20.2	18.9	23.3	0.0	9/14
Mustang M-1150	I	20.1	19.6	20.7	0.0	9/10
DeKalb CX117	I	19.8	17.8	19.3	0.0	9/10
Hodgeson 78	I	19.7	17.5	22.3	0.0	9/11
Lincoln LS7122	I	19.6	19.6	21.3	0.0	9/16
Schwitters Iroquois	I	19.0	20.5	22.7	0.0	9/11
Pioneer 9111	I	18.8	20.7	18.7	0.0	9/12
Sexauer EX 1050	I	18.8	19.7	22.3	0.0	9/14
BSR 101	I	18.1	17.0	24.3	0.0	9/16
Sands SOI 142	I	17.9	21.6	20.3	0.0	9/15
Dawson CK	I	17.4	17.0	21.0	0.0	9/5
Arrowhead Exp-555	I	17.2	18.2	19.3	0.0	9/10
Mean		21.4	18.3	22.2	0.0	9/13
LSD (.05)		2.9				
C.V. - %		8.4				

Table 13. 1988 Corn performance trial, area D2(early), Watertown, SD.

Brand and Variety	Type and	Cross	Yield B/A	Pct Stalk Lodged	Pct Moisture	Perform. Score Rating
SeedTec ST7212	E	2X	69.9	2.9	23.7	1
Northrup King N4350	E	2X	68.9	0.0	31.7	2
Dahlgren DC-440	E	2X	67.9	1.8	29.7	3
Betagold Ingrid	E	2X	65.9	0.6	31.1	5
Sigco 1793	E	2X	64.7	0.0	27.2	4
Interstate IS463	E	2X	59.8	1.2	27.4	6
Pioneer 3737	E	2X	59.1	1.7	34.0	10
Tecnagene DF4894	E	2X	58.0	0.0	32.1	9
Pioneer 3772	E	2X	57.5	0.6	24.8	7
AgriPro 270	E	2X	56.9	0.6	25.3	8
AgriPro AP148	E	2X	56.5	1.1	29.1	11
Phoenix PH2391	E	2X	54.0	0.0	30.7	12
Cargill 3027	E	2X	51.5	0.0	29.4	13

Table 13. (Continued).

Brand and Variety	Type and Cross		Yield B/A	Pct Stalk Lodged	Pct Moisture	Perform. Score Rating
Garst 8882	E	2X	48.9	1.7	34.7	15
Garst 8939	E	2X	48.3	2.3	32.8	17
Cargill 3477	E	2X	45.9	1.1	25.4	14
Conti 8304	E	2X	45.7	2.9	29.4	16
Northrup King N3624	E	2X	44.8	0.0	31.3	19
Interstate IS406	E	2X	44.3	0.6	30.0	18
Pioneer 3751	E	2X	43.3	0.6	35.9	23
Tecnagene DF4893	E	2X	42.5	1.8	31.4	21
Cargill 3327	E	2X	41.8	0.6	34.4	24
Interstate IS443	E	2X	39.8	0.0	34.2	26
Dahlgren DC-430	E	2X	39.8	0.0	26.0	20
Sigco 1588	E	2X	38.7	0.0	26.3	22
AgriPro AP077	E	2X	38.6	0.6	28.9	25
Tecnagene DF4890	E	2X	35.8	0.6	29.0	27
SDAES Check 10	E	2X	33.5	0.6	33.7	29
Tecnagene DF2856	E	2X	33.3	0.0	26.8	28
Conti 8455	E	2X	32.3	0.0	35.1	30
Means			49.5	0.8	30.1	
LSD (.05)			17.2			
CV - %			24.9			

Table 14. 1988 Corn performance trial, area D2(late), Watertown, SD.

Brand and Variety	Type and Cross		Yield B/A	Pct Stalk Lodged	Pct Moisture	Perform. Score Rating
Interstate 543	M	2X	94.7	0.6	35.0	1
Interstate 523	M	2X	84.5	0.0	32.7	2
Cargill 4227	M	2X	80.6	0.6	34.2	3
Cargill 5157	M	2X	79.5	0.0	35.0	4
Betagold Karla	M	2X	77.5	0.0	35.3	5
SeedTec ST7255	M	2X	72.6	1.7	35.3	7
Garst 6808	E	2X	72.1	0.0	29.2	6
Tecnagene DF6802	M	2X	67.1	1.9	35.4	9
Dahlgren DH-502	M	2X	66.7	0.0	32.3	8
Betagold Kristine	M	2X	48.0	0.7	39.4	10
SDAES Check 9	L	2X	40.3	1.3	49.7	11
Means			71.2	0.6	35.7	
LSD (.05)			20.5			
CV - %			20.2			

YIELD PERFORMANCE OF TWO BUCKWHEAT AND TWO AMARANTH VARIETIES

R.C. Hall, L.A. Evjen, and J.D. Smolik

Objective: To compare the yields of two buckwheat and two amaranth varieties at the Northeast Farm.

A. Methods and Procedures

1. Buckwheat: Varieties Mancan and Manor, planted at 50 lb/A on 2 June, harvested 26 September. Plots 7'x30' with 7-in row spacing.

   Planting: Plots were replicated four (4) times in a completely randomized block design. Seeding was accomplished with a press-drill having 7-inch row spacings. No herbicide was used. Plots were swathed into a windrow and later harvested with a small Allis-Chalmer E combine. Within each variety two (2) replicates were combined and a final combined weight of two replicates were determined.

2. Amaranth: Varieties K432 and MT3, planted at 0.73 lbs/A on 2 June and harvested 26 September. Plots were 9'x30' on 36 inch rows.

   Plots were replicated four (4) times in a completely randomized block design. Seeding was accomplished by a hand-pushed garden planter on 36-inch row spacings. Weed Control: one cultivation. A 5 ft. section of the middle row of each replicate was harvested and threshed by hand.

B. Results:

1. Buckwheat - Analysis of variance indicated there was no difference in yields between the varieties Mancan and Manor. Mancan averaged 393 lbs/acre while Manor averaged 296 lbs/acre. These yields were lower than expected. Drought stress experienced at the Northeast Farm was a major factor in the low yields obtained.

2. Amaranth - Analysis of variance indicated there was no variety yield differences between K432 and MT3 at the Northeast Farm. K432 averaged 401 lbs/acre while MT3 averaged 584 lbs/acre. Yields of both varieties were less than their potential as a result of pre-harvest and harvest shattering. Proper harvest time in 1988 was uncertain because there was uneven maturity in both varieties. Drought stress in 1988 also limited their yield potential. Stress likely also contributed to the uneven ripening of both varieties. In a similiar unharvested test of amaranth varieties at Brookings in 1987 the varieties were much more even in ripening as they approached maturity.

SOYBEAN SEED FIELD PERFORMANCE

J. W. Schneider and T. J. Gutormson

Introduction:

This study was conducted to evaluate how well the standard germination test (SG) and the accelerated aging test (AA) predict field performance of soybean seed. The standard germination test which is required for labeling seed indicates the maximum germination potential under optimal laboratory conditions. The accelerated aging test is a stress test designed to predict soybean seed emergence under field conditions. Soybean seed emergence is influenced by field conditions, maturity of the seed, seed moisture during harvest and subsequent handling, variety and age of the seed. Usually seed over one year old since harvest (carry-over) is not recommended for planting due to low seed vigor.

Materials and Methods:

Twelve soybean seed lots of the Foundation seed class were evaluated including 9 lots of the 1987 harvest and 3 lots of the 1986 harvest (carry-over). Field emergence for two planting dates (5/6/88 and 5/24/88) were evaluated. A randomized complete block design was used with 4 replications of two 15 foot rows for each seed lot. Rows were spaced at 36 inches, planting rate was 10 seeds per foot of row, and planting depth was 1.5 inches. Emergence counts were taken on 10 feet of each row every 3-4 days until final emergence was reached. Standard germination tests were performed in the laboratory in accordance with the Association of Official Seed Analysts (AOSA) Rules for Testing Seeds. Accelerated aging tests were conducted according to the recommended procedure obtained from the AOSA Vigor Testing Handbook.

Results:

Significant differences were found between seed lots for standard germination; however, no trends were observed (Table 15). All seed lots including the carry-over lots germinated above 93%. Significant accelerated aging differences were observed among seed lots (Table 15). All carry-over lots were significantly lower in germination than 1987 harvested seed.

Field emergence results were indicative of the performance that may be expected from carry-over seed lots. Conditions for the early planted study were dry. The average soil temperature at planting depth for two weeks following planting was 57°F with a range of 42 to 84°F. These conditions are not typical of cool wet conditions which normally cause emergence stress in early May. However, there was enough stress to cause significant differences in emergence between seed lots (Table 15). All carry-over seed lots except the Glenwood (1986) lot were significantly lower than 1987 seed lots. The Glenwood (1986) was not significantly different than the Sibley (1987) seed lot.

The late planted study field conditions were favorable for emergence of all seed lots. Soil moisture was adequate and soil temperatures during the two week period averaged 74°F with a range of 57 to 93°F. Emergence

percentages narrowed between carry-over and new crop seed compared to the early study (Table 15). All 1987 seed lots were higher in field emergence percentage than all carry-over seed lots; however, several 1986 and 1987 seed lots were not significantly different in emergence.

The correlation values show relationships between field emergence and laboratory test percentages presented in Table 16. A value of 1 would indicate a perfect match between the results of the field and laboratory test in question. Conversely, a value of 0 would indicate that there is no relationship between test results. The values indicate that field emergence is more closely associated with accelerated aging than standard germination (Table 16). Standard germination was significantly correlated with field emergence only for the later (less stressful) planting date.

Coefficients of determination (R^2) show the percentage of variation in field emergence explained by the laboratory tests. These values indicate that for the early planted study standard germination predicted field emergence only 25 percent of the time while accelerated aging predicted field emergence 80 percent of the time (Table 16). Accelerated aging was also a better predictor of field emergence for the later study with a prediction rate of 79 percent as compared to a 65 percent prediction rate by the standard germination test (Table 16).

Conclusions:

The accelerated aging test did predict field emergence with more accuracy than the standard germination test. The standard germination information is important in providing a producer an estimate of the maximum potential emergence when determining planting rates.

Table 15. Mean percentages of standard germination, accelerated aging and two field emergence studies.

		Mean Percentages			
		Laboratory Tests		Field Emergence	
Seed lot	Year produced	Standard germination	Accelerated aging	Planted 5/6/88	Planted 5/24/88
Corsoy 79	1986	93	31	67	73
Dassel	1987	99	97	85	96
Dawson	1986	97	24	58	78
Dawson	1987	98	91	85	96
Elgin 87	1987	97	87	88	89
Glenwood	1986	97	33	75	80
Glenwood	1987	98	95	85	88
Hardin	1987	99	95	86	94
Sibley	1987	97	93	82	85
Simpson	1987	98	93	85	91
Weber	1987	99	91	91	94
Weber 84	1986	98	49	62	83
LSD (5%)		2.686	9.455	9.380	7.623

Table 16. Correlations and coefficients of determination (R^2) of standard germination and accelerated aging with field emergence for 12 seed lots at 2 planting dates.

Planting Date	Standard Germination	Accelerated Aging
5/6/88	.4978^{NS} (R^2 = .2478)	.8955** (R^2 = .8019)
5/24/88	.8077** (R^2 = .6524)	.8874** (R^2 = .7875)

t = (5%)

NS Indicates a nonsignificant relationship.

R^2 (coefficient of determination) indicates the percentage rate for prediction of field emergence by standard germination or accelerated aging.

** Indicates highly significant relationships.

1988 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 three other South Dakota locations in 1988. 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 1988, 48 experimental lines from the SDSU flax breeding program were tested against fifteen named varieties (checks) and eleven experimental lines from North Dakota or Canada (Table 17). The experiment was planted on April 19, 1988 and harvested on July 28, 1988. The mean yield across all varieties was 12 bu/A. The mean oil percent across varieties was 38.8%. The highest yielding check varieties at the Northeast Station were Culbert 79, Culbert, and Verne, with an average yield of 14 bu/A. The highest-yielding experimental lines were CI 3269, SD 87418, SD 87425, SD 87428, SD 87435, SD 87438, SD 87441, SD 87446, SD 87449, and SD 87450, all averaging 14 bu/A seed yield. CI 3269 had the highest oil yield, obtained by multiplying seed yield by seed oil percent. This line is currently being increased for possible release in 1990.

Table 17. Yield, oil percent, oil yield, and plant height of flax varieties grown at the Northeast Research Station, Watertown, SD in 1988.

Variety	Origin -Year	Pedigree	Seed Yield (bu/A)	Oil Pct (%)	Oil Yield (kg/ha)	Rank[1]	Plant Height (cm)
Culbert	MN-75	CI 2776	14	38.9	337	10	43
Culbert 79	SD-79	CI 2838	14	39.0	343	5	44
Linott	CAN-66	CI 2522	12	37.5	276	54	45
Wishek	ND-79	CI 2822	10	38.4	247	67	41
Dufferin	CAN-75	CC 2814	12	38.9	300	31	44
Flor	ND-81	CI 2896	10	37.6	233	70	46
Clark	SD-83	CI 2925	12	38.1	296	37	43
NorLin	CAN-83	CI 2935	9	35.9	199	73	40
McCregor	CAN-82	CI 2921	11	37.3	247	65	48
Rahab	SD-85	CI 2943	12	38.8	287	47	40
Linton	ND-85	CI 2934	13	38.1	312	24	45
NorMan	CAN-84	CI 3065	13	37.3	313	22	45
Verne	MN-87	CI 2938	14	39.2	336	11	44
Neche	ND-88	CI 3096	12	39.0	297	34	42
Vimy	CAN-86	CI 3108	11	39.2	267	59	43
CI 3131	SD-exp.	BFP/Culb	13	38.7	317	19	44
CI 3243	SD-exp	N707//CI2777/N419	12	40.2	293	40	42
CI 3246	ND-exp.	Z1153/Duff	12	37.8	282	51	46
CI 3253	CAN-exp.	STS	12	37.3	279	53	47
CI 3258	ND-exp.	Nored M3P3	11	39.0	265	61	42
CI 3259	ND-exp.	CI3036/Flor	10	38.5	233	69	45
CI 3260	ND-exp.	CI3025/605 M3P3 Cul/Bis	9	.38.5	229	72	45
CI 3261	ND-exp.	Cul M3P3//Cul/Bis M3P3	12	38.5	282	50	48
CI 3263	"	ND614	11	37.4	258	64	44
CI 3264	"	ND615	10	37.4	229	71	46
CI 3265	"	ND616	10	37.5	243	68	47
CI 3266	SD-exp.	Culb 79//Lnt/SD1374	12	38.9	294	38	44
CI 3267	"	M409/N415//M905	12	39.4	285	48	44
CI 3268	"	"	12	39.5	306	29	44
CI 3269	"	"	14	39.0	348	1	44
CI 3270	CAN-exp.	Lnt/NorM	11	38.6	262	62	45
CI 3271	CAN-exp.	McGreg/Culb79	10	38.1	247	66	44
SD 86322	SD-exp.	Rahab selection	8	39.1	199	74	52
SD 86323	"	"	13	38.7	307	28	42
SD 86327	"	"	13	39.0	314	21	43
SD 86329	"	"	12	39.7	290	44	43
SD 86331	"	"	13	38.6	313	23	42
SD 86337	"	"	11	39.3	265	60	40
SD 86339	"	"	12	39.2	292	41	46
SD 86343	"	"	13	39.8	324	15	43
SD 86344	"	"	11	38.5	276	55	43
SD 86346	"	"	10	40.2	259	63	45
SD 86349	"	"	12	39.8	294	39	44

Table 17. (Continued)

Variety	Origin -Year	Pedigree	Seed Yield (bu/A)	Oil Pct (%)	Oil Yield (kg/ha)	Rank[1]	Plant Height (cm)
SD 87418	SD-exp.	Verne selection	14	39.1	340	8	47
SD 87421	"	"	13	39.0	323	17	48
SD 87422	"	"	13	38.5	321	18	45
SD 87424	"	"	13	38.7	323	16	48
SD 87425	"	"	14	38.6	344	3	41
SD 87426	"	"	12	39.2	291	43	43
SD 87428	"	"	14	39.0	338	9	43
SD 87433	"	"	13	39.0	315	20	48
SD 87435	"	"	14	38.6	336	12	43
SD 87438	"	"	14	39.3	341	7	46
SD 87441	"	"	14	38.6	344	4	46
SD 87444	"	"	13	40.0	327	14	46
SD 87446	"	"	14	39.1	342	6	44
SD 87449	"	"	14	39.8	347	2	44
SD 87450	"	"	14	38.8	329	13	47
SD 87451	"	"	12	39.2	297	35	45
SD 87460	"	Rahab selection	11	39.6	272	56	43
SD 87461	"	"	12	39.1	284	49	42
SD 87462	"	"	12	39.3	299	33	43
SD 87463	"	"	13	38.7	310	26	42
SD 87464	"	"	13	38.8	303	30	43
SD 87466	"	"	12	38.8	297	36	39
SD 87467	"	"	13	39.1	308	27	40
SD 87468	"	"	12	39.4	288	46	48
SD 87470	"	"	12	38.8	300	32	43
SD 87472	"	"	12	39.3	292	42	39
SD 87474	"	"	11	40.1	281	52	43
SD 87476	"	"	13	38.7	311	25	42
SD 87477	"	"	12	39.2	289	45	43
SD 87480	"	"	11	38.8	271	57	41
SD 87481	"	"	11	39.1	269	58	43
Mean			12	38.8	293		44
LSD .05			2	0.8	48		5

[1] Rank based on oil yield.

CORN BREEDING AND RESEARCH

Z. W. Wicks, III and G. Scholten

The Northeast Research Station is one of our locations for conducting advanced yield trials of our early maturity corn lines.

We also continued our white corn yield trials. Twenty-six entries were evaluated with Armstrong SX95, CD16, and CD26 serving as checks. The mean of the whole trial was 19.56 bu/Acre. The table below shows some of the results of the most promising lines.

	1988	Moist	1986-88 Avg.	Moist
SD65 X SD55	29.76	22.3	75.85	24.4
SD56 X SD58	27.42	23.2	60.46	22.0
SD56 X SD65	26.80	24.8	--	--
SD56 X SD59	25.86	27.7	--	--
SD63 X SD65	24.10	28.8	72.63	25.4
SD63 X SD62	24.08	23.6	--	--
SD71 X SD65	23.86	28.1	72.98	26.8
SD63 X SD59	23.90	28.0	73.35	29.5
Armstrong SX 95	18.69	25.9	--	--
CD16	13.48	33.6		
CD20	8.64	34.1		

Plant population was 17,500 plants/A so this was a factor in the low yields. Also, due to vandalism, only the outside two reps were harvested for yield. Those two reps were more susceptible to the hot drying winds than the middle rep which was destroyed and not available for yield comparison.

A second experiment evaluated a mixture of double-cross hybrid seed for yield. The objective is to study the possibility of growing a mixture of double-cross hybrid seed instead of a single-cross hybrid seed in the state's lower producing areas.

Fifteen single crosses were used in making three separate double-cross hybrid populations (using a combination of six single cross hybrids of approximately the same maturity). The entries consisted of 18 single cross hybrids, a double-cross population with 1/6 of the mixture selfed seed, and a double-cross population containing no selfed seed. The results are below.

		bu/A	bu diff	% diff	3 yr Avg bu/A
Pop 1	6 hybrids	39.75			
	DC pop no selfs	34.43	-5.32	-13.4	--
Pop 2	6 hybrids	59.13			117
	DC pop (w/selfs)	43.44	-15.69	-26.5	112
	DC pop (no selfs)	50.76	-8.37	-14.2	
Pop 3	6 hybrids	48.88			103.0
	DC pop (w/selfs)	29.87	-19.00	-38.9	82.3
	DC pop (no selfs)	39.23	-9.65	-19.7	

Pop 2 appears to have the most promise although this might not be the best hybrid combination that could potentially be produced.

METHOD OF PREDICTING SEED YIELD TESTED ON FLAX

C. Dean Dybing and Kathleen Grady
USDA-ARS and South Dakota State University

How much a crop yields is determined in three separate but overlapping phases of growth. Each of these phases is affected by stress like the high temperature and low moisture conditions of 1988. The first phase is the formation of fruits. Fruits are formed from flowers, so number of flowers should estimate number of fruits except that stress during flowering may cause many flowers to abort. The second important growth phase is seed set, and hot dry weather will reduce yield in this phase by causing seed abortion. The final phase is seed growth. Long duration of seed growth makes for large seeds and high yield, but stress during seed fill reduces yield by reducing seed size.

An experiment that we conducted on Flax at Watertown and Brookings this year was concerned with predicting seed yield from measurements made during flowering. The ability to predict how much a crop will yield early in the growing season should be advantageous because it would help in making management and marketing decisions. In serious stress years, measurements that predict yield should also help to determine which phases of growth are most affected by stress and whether there is hope that the effects can be reduced through plant breeding.

One procedure for predicting yield is to collect environmental and plant growth data daily or hourly from date of planting or earlier and calculate yield from mathematical equations that are able to use these large amounts of data. Our procedure is less laborious since our past work has shown that the speed at which flowers are formed during the bloom stage can estimate vigor of growth in the same manner as continuous growth and weather records. The work is being done on flax, because the short life of each blossom greatly simplifies the measurement of flower formation rate. Procedures developed for flax will later be adapted to other crops where flower formation is more difficult to observe.

The method being tested at the NE field station is very simple. First, a 6-inch section of a row is identified within each 7-row plot on the first day of blossoming. Then, new flowers opening on that subplot on the 14th day of the flowering period are counted, along with the total number of fruits that have formed from flowers opening prior to day 14. Equations developed in previous studies require only these two data points for calculation of predicted yield. At Watertown, 19 varieties being tested in the SD tri-state test were measured. Flowering began on June 7th, and the counts on 18 inches of row (6 inches per replication times 3 reps) were taken on June 20th for each variety.

Yield values predicted for the 19 varieties on June 20th were 18.0 bu/acre. Actual yields at harvest were 11.7 bu/A, 35% lower than predicted. Closest fit was a 27% overestimation of yield for Clark, Culbert, McGregor, Verne, and Nored. Poorest fits were a 50% overestimate for Linott and Flor and a 72% underestimation for an experimental line.

A fit of 35% under predicted yield can be considered both bad and good.

Obviously, it would be nice to have a closer prediction. However, even values with this level of accuracy contain a lot of information. As early as June 20th, a full month before harvest, it was clear that yield of flax in this drought year was going to be better than the worst year in the data base from which calculations were based (8 b/A in 1982). Such information, obtained as simply as counting a few flowers and fruits on a single predetermined day, would have been very important if available for a crop like soybean where futures markets were highly unstable in early summer due to uncertainty about expected yields at harvest. Moreover, the data show that stresses occurring during seed set and seed fill were very serious in 1988. For most varieties, and especially for Linott and Flor, flower production apparently proceeded well but seed growth was affected, since yield was overestimated from flower counts. For the experimental line, stress apparently reduced flowering more than seed growth, since yield was underestimated. This knowledge that varieties differ in response to the stresses of 1988 should be useful as breeders seek future varieties more tolerant to stress.

1988 SUNFLOWER HYBRID TRIAL

Kathleen Grady and John Felton

A yield trial of thirty commercial sunflower hybrids was conducted at the Northeast Research Station during the 1988 growing season. The test was seeded on June 3, 1988 and harvested on October 28, 1988. Yield, oil percent, oil yield and agronomic data are reported in Table 18.

Sunflower yields were not as depressed by the heat and drought as were many small grains. Averaged over 6 locations in South Dakota, yield was down 5% from 1987 levels. However, due to the large variations in rainfall amounts across the state, yields were very dependent on location. At the Northeast farm, yield was 13% higher in 1988 than in 1987, averaged over hybrids. At other locations, however, yields ranged from down 26% at Wessington to up 14% at Redfield.

Table 18. 1988 South Dakota Hybrid Sunflower Trial grown at the Northeast Research Station at Watertown, SD.

Hybrid Identification	1988 Seed Yield (lbs/A)	1988 Oil Percent (%)	1988 Oil Yield (lbs/A)	1988 Days to Flower (DAP)	1988 Plant Height (cm)	1988 Lodging (%)	1988 Harvstd plants/A (x 1000)	Seed Yield 1987 (lbs/A)	Seed Yield 1986 (lbs/A)	% Oil 1987 (%)	% Oil 1986 (%)	Oil Yield 1987 (lbs/A)	Oil Yield 1986 (lbs/A)
ACRIPRO 4200	2141	48.6	1039	60	124	2	16.4	--	--	--	--	--	--
" 4040	2561	49.2	1259	60	125	0	16.6	--	--	--	--	--	--
CENEX 6101	1952	47.9	938	58	135	0	16.4	1656	1274	43.2	41.8	719	533
" 7101	2351	46.1	1082	60	141	3	16.1	1887	--	40.0	--	759	--
" 8101	2233	48.5	1084	61	136	2	14.8	1695	982	42.5	42.2	717	414
CONTI HYSUN 340	2372	46.8	1113	60	132	0	17.7	--	--	--	--	--	--
" " 350	2265	47.4	1070	61	143	0	16.6	--	--	--	--	--	--
" " 354	2505	47.3	1183	61	135	0	17.7	2575	1623	43.4	41.9	1121	684
" SUNBIRD 11	2204	35.8	789	65	157	3	17.2	--	--	--	--	--	--
DAHLGREN DO 855	2245	46.2	1039	58	139	2	16.4	2122	1270	40.9	41.1	868	522
DEKALB G100	2044	48.0	981	62	128	3	16.4	1908	--	42.5	--	818	--
" G101	2100	46.6	977	63	122	8	18.5	2061	--	42.8	--	877	--
" G103	2581	46.8	1208	62	139	0	18.2	--	--	--	--	--	--
HYBRID 894	2520	45.5	1144	60	139	2	17.2	1928	1302	40.0	38.6	775	504
INTERST IS3001	2237	48.1	1075	61	136	0	16.6	1792	1410	43.7	43.2	783	610
" IS7116	2473	47.1	1165	61	127	3	17.2	--	1352	--	41.0	--	554
" IS31007	2320	46.5	1078	63	139	2	15.8	--	--	--	--	--	--
JACQUES CAPRI	1884	47.9	903	57	126	5	15.8	--	--	--	--	--	--
" E8713	2295	46.0	1055	60	127	0	15.8	--	--	--	--	--	--
NK SUNBRED 256	1895	45.1	854	60	132	0	17.4	--	--	--	--	--	--
" " 277	2375	47.7	1134	62	144	2	15.6	2207	1715	41.8	41.4	920	709
" " 281	2389	49.5	1182	62	143	2	16.9	1675	--	43.2	--	713	--
" S1296	1996	47.0	939	57	124	4	18.7	--	--	--	--	--	--
" S1888	2505	46.4	1161	61	140	2	16.6	--	--	--	--	--	--
PIONEER 6440	2492	47.0	1172	61	133	2	16.1	2244	--	42.9	--	959	--
SEEDTEC ST 314	2511	46.2	1159	62	135	0	17.7	--	--	--	--	--	--
" ST 317	2666	47.9	1277	61	135	0	16.6	2667	1726	42.7	42.4	1142	732
" ST 330	2014	45.3	916	60	136	2	16.9	1877	--	41.3	--	772	--
SIGCO 465A	2390	46.1	1102	59	129	2	17.4	1904	1710	40.5	40.9	769	701
" 475	2260	45.2	1022	62	126	5	15.6	2526	2234	41.1	40.1	1026	897
Hybrids tested	30	30	30	30	30	30	30	56	42	56	42	56	42
Test average	2293	46.7	1070	61	134	2	16.8	2035	1356	41.9	41.3	852	559
LSD (.05)	453	1.6	213	1	11	ns	ns	447	206	1.2	1.0	191	86

Seeding date: 6/3/88 Date harvested: 10/28/88
Design (1988): RCB

LEGUME - SMALL GRAIN ROTATIONS

J. Smolik and L. Evjen

This study is a part of a cooperative project with researchers in North Dakota. The objectives are to compare the agronomic performance of a minimum-till rotation, using recommended inputs of fertilizer and herbicides, with legume-based rotations. The three-year min-till rotation is oats-barley-spring wheat. The legume-based rotations are oats/sweetclover - sweetclover - spring wheat and oats/black medic/switchgrass - medic/switchgrass (harvest seed) - spring wheat.

Plots were planted 19 April, 1988. Oats were seeded at 50 lb/A, sweetclover at 9.5 lb/A, medic at 10 lb/A and switchgrass at 6 lb/A. Legumes and switchgrass were seeded with the oats, and a field packer was used after planting. Treatments were in a randomized complete block design with 3 replications, and plots are 14' x 36'. Oat variety was Centennial. After oat harvest the min-till treatment was chisel plowed and 50 lb/A of nitrogen was applied October 28.

Oat yields, test weights and protein did not differ significantly between treatments (Table 19). Percent soil moisture in the 6-24 inch layer was lower in oats overseeded with legumes (Table 20), and soil N levels were also lower in these treatments.

Table 19. Oat yields, test weights and protein.

Treatment	Yield (Bu/A)	T.W.	Protein (%)
Min-till	36.4[a]	33.8	21.5
Oats/sweetclover	39.4	34.4	20.7
Oats/medic/switchgrass	40.0	35.5	21.9

[a] Avg of 3 replications.

Table 20. Soil moisture and nitrogen levels.

Treatment	Soil moisture (%)		lbs N to 2'
	0-6"	6-24"	
Min-till	16.6[a]	17.1	60.7
Oats/sweetclover	15.6	13.6	13.7
Oats/medic/switchgrass	16.6	14.8	11.3

[a] Avg of 3 replications. Samples collected October 11, 1988.

NOTE: Sweetclover stand 24 August was 9.3 plants/sq. ft., Medic was 3 plants/sq. ft.

WEED CONTROL DEMONSTRATIONS

Leon Wrage, Paul Johnson and Eugene Lurz

The weed control evaluation and demonstration programs at the Northeast Experiment Farm provides data for northeastern South Dakota. The program was continued at the expanded level in 1988 to include all major crops in the area. The station provides the only site for evaluating herbicide performance on sunflower, potatoes, and edible beans.

Demonstration plots provide side-by-side comparisons of herbicides under similar conditions. 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. Rates used are those best suited for the weed and soil type. These plots are used for tours and form the basis for educational material.

The crops included in 1988 are listed below:

1. Corn Demonstration
2. Soybean Demonstration
3. Foxtail Screening - Spring Wheat
4. Potato Weed Control
5. Sunflower Weed Control
6. Edible Bean Demonstration
7. Corn Herbicide - Fertilizer Impregnation

Performance in 1988 reflected weather conditions typical of the Northeast area this year. 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 late weed flushes and reduced crop recovery after early season weeds were controlled. Soil applied and postemergence treatments on late planted crops were 10 to 30% less effective. High temperatures and low humidity reduced postemergence herbicide effectiveness.

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

Table 21. Corn herbicide demonstration.

		Percent Weed Control			
		1988*		3-Yr. Ave.	
Treatment	lb/A act.	Gr	Bdlf	Gr	Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eradicane	4	81	65	83	71
Eradicane+atrazine	4+1	90	90	--	--
Eradicane+Bladex	4+2	88	85	--	--
Eradicane+Bladex+atrazine	2+1.6+.5	91	89	--	--
Eradicane+Bladex+atrazine	4+1.5+.5	96	88	93	89
Sutan+	4	90	61	85	60
SHALLOW PREPLANT INCORPORATED					
Lasso	3	84	70	82	75
Dual	2.5	88	57	84	64
PREEMERGENCE					
Atrazine	2.5	79	91	87	95
Bladex	3	83	79	84	79
Dual	2.5	87	58	88	71
Lasso	3	92	63	86	78
Prowl	1.5	82	45	79	65
Ramrod	6	90	45	80	63
+Tophand	2.34	96	63	--	--
Lasso+atrazine	2+1	93	79	92	89
Lasso+Bladex	1.25+2	82	80	--	--
Lasso+Bladex	2+2	88	84	84	86
Dual+atrazine	2+1	90	79	91	91
Atrazine+Bladex	.75+2.25	84	78	83	89
Ramrod+Bladex	4+2	94	76	89	75
Lasso+Bladex+atrazine	2+1.5+.5	91	87	91	93
EARLY POSTEMERGENCE					
Prowl+atrazine	1.5+1	77	91	81	96
Prowl+Bladex	1.5+1.5	78	89	83	86
Atrazine+COC	1.5+1 qt	74	93	78	95
Bladex+X-77	2+.5%	80	93	77	79
Tandem+Bladex+atrazine+X-77	.5+1+.5+.5%	86	95	86	92

Table 21. (Continued)

Treatment	lb/A act.	Percent Weed Control 1988* Gr	Bdlf	3-Yr. Ave. Gr	Bdlf
PREEMERGENCE & POSTEMERGENCE					
Ramrod&Banvel	4&.5	84	95	82	89
Ramrod&Banvel	4&.25	79	74	82	86
Ramrod&2,4-D amine	4&.5	84	89	81	84
Ramrod&Basagran+atrazine+COC	4&.52+.52+1 qt	81	96	--	--
Ramrod&Buctril	4&.38	74	93	74	88
Ramrod&Buctril+atrazine	4&.25+.5	76	97	77	95
Ramrod&Banvel+atrazine	4&.25+.5	68	88	76	92
Ramrod&Buctril+Bladex	4&.25+.5	72	94	--	--
+Ramrod&M6316+COC	4&.0039+1 qt	76	97	--	--
EARLY POSTEMERGENCE & POSTEMERGENCE					
+Banvel&Exp I+X-77	.5&.0625+.25%	94	99	--	--
LSD (.05)				8.5	14.2

+ Experimental

* Average 3 ratings/plot

Evaluated: 7/7/88
PPI&PRE: 5/16/88
EPOS: 6/2/88
POST: 6/10/88
Rainfall: 1st week: 1.51 inches
2nd week: .31 inches

Gr=Green foxtail 85/ft sq
Bdlf=Redroot pigweed 24/ft sq

Table 22. Soybean herbicide demonstration.

		Percent Weed Control			
		1988[a]		3-Yr. Ave.	
Treatment	lb/A act.	Gr	Bdlf	Gr	Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Vernam	2.5	65	80	64	57
Sonalan	1	85	89	84	85
Treflan	.75	79	77	77	75
Prowl	1.25	75	73	75	76
Treflan+Sencor/Lexone	.75+.38	78	89	82	89
Treflan+Command	.75+.75	82	73	--	--
+Treflan+Scepter	.75+.067	87	93	--	--
+Treflan+Scepter	.75+.125	91	98	--	--
+Prowl+Pursuit	1+.078	93	99	--	--
+Sonalan+Scepter+Sencor/Lexone	.75+.067+.25	87	98	--	--
+Sonalan+Scepter+Command	.75+.067+.5	88	98	--	--
SHALLOW PREPLANT INCORPORATED					
Lasso	3	82	82	84	80
Dual	2.5	79	55	85	59
Lasso+Treflan	2.5+.5	84	65	--	--
+Lasso+Pursuit	2+.078	92	93	--	--
+Lasso+Scepter	2+.125	89	91	--	--
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan+Sencor/Lexone & Sencor/Lexone	.75+.25&.38	93	87	94	94
Treflan&Sencor/Lexone	.75&.5	94	88	94	93
PREEMERGENCE					
Amiben	3	91	32	86	66
Lasso	3	94	63	85	74
Dual	2.5	92	47	82	60
Lasso+Sencor/Lexone	2+.5	94	89	87	89
Dual+Sencor/Lexone	2+.5	90	81	84	86
+Lasso+Scepter	2+.125	95	95	--	--
+Lasso+Pursuit	2+.063	89	91	--	--
Lasso+Amiben	2+2	94	87	89	87
Lasso+Lorox	2+1	88	43	82	65

Table 22. (Continued)

Treatment	lb/A act.	Percent Weed Control 1988* Gr	Bdlf	3-Yr. Ave. Gr	Bdlf
PREEMERGENCE & POSTEMERGENCE					
+Lasso&Pursuit+X-77	2&.063+.25%	93	88	--	--
Lasso&Basagran+COC	2&1+1 qt	91	81	82	90
Lasso&Blazer/Tackle+X-77	2&.5+.5%	87	95	85	95
Lasso&Cobra+X-77	2&.2+.125%	84	99	--	--
Lasso&Classic+X-77	2&.012+.25%	87	86	--	--
+Lasso&M6316+X-77	2&.0625+.25%	87	93	--	--
POSTEMERGENCE					
Fusilade 2000+COC	.187+1 qt	52	0	76	0
Poast+COC	.2+1 qt	68	0	--	--
Whip+COC	.15+1 qt	61	0	--	--
Poast+Blazer/Tackle+ Basagran+COC	.3+.25+.5+1 qt	83	96	77	79
LSD (.05)				13.0	19.3

+ Experimental

* Average 2 ratings/plot

Evaluated: 6/30/88
PPI&PRE: 5/16/88
POST: 6/17/88
Planting Date: 5/16/88
Rainfall: 1st week: 1.51 inches
2nd week: .31 inches

Gr=Yellow foxtail; 256/sq ft
Bdlf=Redroot pigweed; 26/sq ft

Table 23. Foxtail/spring wheat screening.

Treatment	lb/A act.	% Control 1/ Gr	Bdlf	VCRR 2/	Test Weight lbs.	Yield bu/A
FALL PREPLANT INCORPORATED						
Check	----	0	0	0.0	53.4	6.2
Treflan 4L	.75	87	80	2.6	53.7	9.3
Treflan 10G	.75	89	85	4.9	53.8	7.9
+Treflan+Far-go	.75+1.25	88	77	2.4	41.3	9.7
+Buckle	1.25	89	76	5.3	52.5	7.0
PREPLANT INCORPORATED						
+Treflan	.75	84	74	2.4	53.7	9.8
POSTPLANT INCORPORATED						
Treflan	.75	66	58	1.5	53.8	9.6
+Treflan+Far-go	.75+1.25	57	54	1.7	53.0	8.5
2-4 LEAF						
Hoelon	.75	63	0	2.3	53.1	8.6
Hoelon+COC	.75+1 pt	75	12	1.7	53.2	8.8
Hoelon	1	73	8	1.2	53.0	10.3
Check	----	0	0	0.0	53.8	7.3
+Tiller	.33	58	57	0.9	54.3	8.5
+Tiller	.39	59	55	1.2	54.1	9.1
Check	----	0	0	0.0	53.6	8.1
+Hoe 7113-04	.08	74	23	0.9	54.1	10.4

+ Experimental

FALL: 10/13/87
PPI&POPI: 4/14/88
2-4 LEAF: 5/19/88
Planting Date: 4/14/88
Rainfall: 1st week: 1.21 inches
2nd week: 1.01 inches

1/ Average 3 reps
2/ VCRR = Visual Crop Response Rating
0 = no effect
10 = complete kill/loss

Gr=Green foxtail; 1-2 in.
Bdlf=Redroot pigweed; 2-4 leaf

Table 24. Sunflower herbicide screening.

Treatment	lb/A act.	Percent Weed Control 1988* Grft	Percent Weed Control 1988* Colq	3-Yr. Ave. Gr	3-Yr. Ave. Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	3	70	64	84	41
Sonalan	1	86	86	87	87
Treflan	.5	69	60	67	64
Treflan	.75	75	74	81	73
Treflan	1	84	84	86	81
Prowl	1.25	76	69	76	61
SHALLOW PREPLANT INCORPORATED					
Lasso	3	74	74	69	65
Prowl	1.25	62	49	66	49
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan&Amiben	.75&2	85	88	91	90
PREEMERGENCE					
Amiben	3	70	72	67	76
Lasso	3	70	74	74	67
Prowl	1.25	63	25	54	32
Lasso+Amiben	2+2	82	80	78	80
POSTEMERGENCE					
Poast+COC	.2+1 qt	72	8	--	--
+Fusilade 2000+COC	.187+1 qt	65	0		
LSD (.05)		15.5	28.8	9.4	14.2

Evaluated: 6/30/88
PPI&SPPI: 5/27/88
PRE: 5/29/88
POST: 6/17/88
Planting Date: 5/27/88
Rainfall: 1st week: 1.4 inches
2nd week: 0.0 inches

* Average 2 reps

Grft=Green foxtail
Colq=Common lambsquarters

Table 25. Potato herbicide screening.

Treatment	lb/A act.	Percent Weed Control 1988* Yeft	Rrpw	3-Yr. Ave. Gr	Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	4	82	64	88	42
Eptam+Sencor/Lexone	3+.5	82	82	86	83
Eptam+Sencor/Lexone	4+.75	82	96	--	--
POSTPLANT INCORPORATED					
Treflan	1	18	50	50	57
Treflan+Eptam	.75+3	32	30	58	42
Prowl	1.25	58	15	48	38
PREEMERGENCE					
Dual	2.5	52	13	62	36
Dacthal	7.5	25	48	33	44
Sencor/Lexone	.75	42	87	65	90
Dual+Sencor/Lexone	2+.75	62	79	72	86
Dual+Lorox	2+1	62	45	63	57
Prowl+Sencor/Lexone	1.25+.75	62	65	76	81
PREPLANT INCORPORATED & POSTEMERGENCE					
Eptam+Sencor/Lexone& Sencor/Lexone	3+.5&.5	84	92	--	--
POSTEMERGENCE					
Sencor/Lexone	1	28	56	59	82
PREEMERGENCE & POSTEMERGENCE					
+Sencor/Lexone& Poast+COC	.5&.2+1 qt	82	64	--	--
+Sencor/Lexone& Fusilade 2000+COC	.5&.187+1 qt	87	40	--	--
+Sencor/Lexone& Assure+COC	.5&.0875+1 qt	94	30	--	--
LSD (.05)		26.3	30.2	16.9	17.7

+ Experimental

* Average 2 reps

PPI&POPI: 5/27/88
PRE: 5/29/88
POST: 6/10/88
Planting Date: 5/27/88
Rainfall: 1st week: 1.4 inches
2nd week: 0.0 inches

Yeft=Yellow foxtail; 135/sq ft
Rrpw=Redroot pigweed; 13/sq ft

Table 26. Edible bean screening.

Treatment	lb/A act.	Percent Weed Control 1988* Gr	Bdlf	3-Yr. Ave. Gr	Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	4	92	92	87	79
Eptam+Amiben	3+2	94	94	90	85
Treflan	.75	84	86	80	79
Treflan+Amiben	.75+2	94	96	92	92
Sonalan	1.1	92	91	87	87
Prowl	1.5	88	82	81	73
SHALLOW PREPLANT INCORPORATED					
Lasso	3	84	61	79	64
Dual	2.5	78	39	75	55
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan&Amiben	.75&2	96	98	--	--
PREEMERGENCE & POSTEMERGENCE					
Treflan&Basagran+COC	.75&1+1 qt	90	98	84	87
POSTEMERGENCE					
+Fusilade 2000+COC	.187+1 qt	73	0	--	--
+Assure+COC	.0875+1 qt	85	0	--	--
+Poast+COC	.2+1 qt	88	0	--	--
LSD (.05)		5.4	2.3	4.4	9.7

+Experimental

* Average 2 reps

PPI&PRE: 5/27/88
POST: 6/10/88
Planting Date: 5/27/88
Rainfall: 1st week: 1.4 inches
2nd week: 0.0 inches

Gr=Green foxtail
Bdlf=Redroot pigweed

Table 27. Corn herbicide/fertilizer impregnation study.

Treatment	Growth Stage	lb/A act.	% Control Yellow foxtail
Eradicane	PPI	4	96
Eradicane+200 lb N	PPI	4	97
Lasso	SPPI	3	80
Lasso+200 lb N	SPPI	3	71
Lasso	PRE	3	68
Lasso+200 lb N	PRE	3	74
Dual	SPPI	2.5	89
Dual+200 lb N	SPPI	2.5	85
Dual	PRE	2.5	79
Dual+200 lb N	PRE	2.5	72

Application & Planting: 5/12/88
Evaluated: 6/10/88
Rainfall: 1st week: .01 inches
2nd week: 1.51 inches

FARMING SYSTEMS STUDIES, 1988

Principal Investigators:

Jim Smolik (Project Leader), George Buchenau, Paul Fixen, Jim Gerwing, Bob Hall, Diane Rickerl, and Leon Wrage; Ag. Technician: Loyal Evjen

Cooperators:

Fred Cholick, Tom Dobbs, Paul Evenson, Brad Farber, Paul Johnson, Kevin Kephart, Eugene Lurz, 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. We envision these as comparatively long-term studies (6 - 8 years) since the effects of rotations are best measured after completion of at least one cycle. 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 synthetic 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 - soybean - spring wheat; CONVENTIONAL, soybean - spring wheat - barley; MINIMUM-TILL, soybean - spring wheat - barley.

Cultural Practices

Fertilizer and pesticide inputs in the conventional, ridge-till, min-till and winter wheat systems are based on current Plant Science Department recommendations. The cultural practice information for the various systems is listed in Tables 28-31.

Table 28. Cultural practice information - farming systems studies, 1988.

Study I	Planting date	Fertilizer N-P-K (lb/A)	Manure	Herbicide (Actual/A)	Hand weeding (hr/A)
Corn					
Alternate	May 4	--		--	--
Conventional	May 4	75-30-0		Lasso II, 7 lb. band	--
Ridge-till	May 4	105-30-0		Lasso II, 7 lb. band	--
Soybean					
Alternate	May 10	--		--	1.06
Conventional	May 10	--		Treflan 1 1/2 pt.	1.25
Ridge-till	May 10	--		Lasso II, 7 lb. band,	1.12
Spring Wheat					
Conventional	April 11	105-30-0		Hoelon 2 pt. + Buctril 1 pt.	--
"Ridge"-till	April 11	105-30-0		Hoelon 2 pt. + Buctril 1 pt.	--
Oats/Alfalfa	April 12	--	2.66 T/A dry matter (2.12-0.36-2.23% N-P-K)	--	--
Alfalfa		--		--	--

NOTE: Seeding rates (lbs/A); Oats 48, Alfalfa 9.5, Spring Wheat 70; Corn 18,500 seeds/A, Soybean 150,000 seeds/A.

Table 29. 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	Harrow	Cultivate 2X, ridge at last cultivation
Soybean		
Alternate	Disc and field cultivate	Rotary hoe 1X and Cultivate 2X
Conventional	Disc 2X	Cultivate 1X
Ridge-till	--	Cultivate 2X
Spring Wheat		
Conventional	Field cultivate and harrow	Fall plow
"Ridge"-till	Harrow	Fall chisel plow
Oats/Alfalfa	Field cultivate 2X + harrow,	--
Alfalfa	--	Chisel plow and field cultivate 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.

Table 30. 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 7	--	--	--
Conventional	April 7	50-30-0	Hoelon 2 pt + 1 pt. Buctril	--
Minimum-till	April 7	75-30-0	Hoelon 2 pt + 1 pt. Buctril	--
Soybean				
Alternate	May 10	--	--	1.25
Conventional	May 10	--	Treflan 1 1/2 pt	0.53
Minimum-till	May 10	--	Lasso 3 qt.	1.32
Barley				
Conventional	April 11	0-30-0	Bronate, 1 pt.	--
Minimum-till	April 11	0-30-0	Bronate, 1 pt.	--
Oats/Clover	April 12	--	--	--
Clover		--	--	--
No-Till Winter Wheat		75-0-0	system discontinued	--

NOTE: Seeding rates (lbs/A); Oats 40, 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 was used in 1987 and 1988 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 31. Cultural practice information - farming systems studies.

Study II	Tillage: Pre-Plant	Tillage: Post-Plant
Spring Wheat		
Alternate	Field cultivate 2X + harrow	Rotary hoe 1X, fall chisel
Conventional	Field cultivate 2X + harrow	Fall plow
Minimum-till	Harrow 1X	Fall chisel plow
Soybean		
Alternate	Disc and field cultivate + harrow	Rotary hoe 2X, Cultivate 2X
Conventional	Disc 1X, Harrow 2X	Cultivate 1X
Minimum-till	Harrow 1X	Cultivate 1X
Barley		
Conventional	Field cultivate 1X + harrow	Fall plow
Minimum-till	Harrow 1X	Fall chisel plow
Oats/Clover	Field cultivate + harrow	--
Clover	--	Fall chisel 1X field cultivate 1X
No-Till Winter Wheat	--	--

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

Spring wheat yields in both studies were approximately 60% lower in 1988 compared to the previous near normal precipitation year. Spring wheat yields in the ridge-till system were significantly lower than conventional in Study I (Table 32). Soil moisture was low in the 0 - 6 inch layer in the ridge-till spring wheat treatment at planting, which apparently resulted in the poorer stand observed in this treatment. In Study II there were no significant differences between systems in spring wheat yields, test weights or protein (Table 32). However, the conventional and minimum-till spring wheat was significantly shorter than the alternate. This stunting may have been due to the herbicides applied in the conventional and minimum-till treatments.

Yields of continuous no-till winter wheat were reduced by 70% compared to 1987. Drought was no doubt a factor in this reduction in spite of the moisture-conserving abilities of this system; however, of equal or greater importance was the increasing populations of downy brome. This weed had become the dominant plant in this system in 1988 with approximately 100 brome plants per square foot. Because there currently are no labeled herbicides for control of downy brome in winter wheat, this system was discontinued in 1988. The failure of this monoculture after only three years of production is evidence of the value of rotation.

Oat yields were also substantially reduced, but the magnitude of reduction (approximately 40%) was less than that for spring wheat. Barley yields were reduced 39 - 65% compared to 1987. Again, drought was an important factor in these reductions, but infection levels of Barley Yellow Dwarf Virus were high, which contributed to yield losses.

Table 32. Small grain yields, farming systems studies.

Spring wheat var. Butte 86			
Study I	Yield (Bu/A)[a]	Test wt.	Protein %
Conventional	18.6	57.8	17.7
"Ridge"-till	14.8	58.4	17.9
$FLSD_{.05}$	2.3	N.S.	N.S.
Oats var. Don			
	Yield (Bu/A)	Test wt.	Protein %
Oats/Alfalfa	32.3	38.9	19.0

-----continued-----

Table 32. (continued)

Study II	Spring wheat var. Butte 86			
	Yield (Bu/A)	Test wt.	Protein %	Height (in) Harvest
Conventional	18.3	58.6	17.8	25.13
Alternate	20.0	57.8	17.2	27.25
Minimum-till	17.0	57.4	17.0	24.75
$FLSD_{.05}$	N.S.	N.S.	N.S.	1.79

	Winter Wheat var. Roughrider		
	Yield (Bu/A)	Test wt.	Protein %
Continuous, no-till winter wheat	10.0	53.6	17.5

	Barley var. Robust		
	Yield (Bu/A)	Test wt.	Protein %
Conventional	28.5	41.8	18.1
Minimum-till	28.3	40.9	17.2

	Oats var. Don		
	Yield (Bu/A)	Test wt.	Protein %
Oats/Clover	43.8	36.9	19.5

[a] Avg. of four replications.

Row Crop Yields

Row crop yields were reduced 47 - 87% compared to 1987. The greatest yield reductions occurred in the conventional systems in both studies. The moldboard plow is used only in the conventional systems, and the moisture loss associated with use of this implement was likely responsible for the greater yield reductions under 1988 drought conditions. In Study I corn yields were significantly lower in the conventional system compared to alternate and

ridge-till (Table 33). Soybean yields over all systems were higher in Study II compared to Study I, however, within a study there were no significant differences in yield between systems. Study II, with a greater emphasis on small grains, was designed to require less water, and the generally higher soybean yields in this study may have been due to higher moisture reserves. The overall performance of the alternative systems was comparatively good in 1988. Improved performance of legume-based (alternative) rotations under droughty growing conditions has been noted in other studies.

Table 33. Row crop yields - farming systems studies.

Study I	Corn - Pioneer Hybrid 3790	Yield (Bu/A) No. 2
Conventional		19.0
Ridge-till		31.7
Alternate		39.0
FLSD .05 =		11.1
	Soybeans - Simpson	Yield (Bu/A) 13% Moisture
Conventional		9.0
Ridge-till		9.4
Alternate		10.9
FLSD .05 =		n.s.
Study II	Soybeans - Simpson	
Conventional		14.1
Minimum-till		16.8
Alternate		16.5
FLSD .05 =		n.s.

[a] Avg of four replications.

Forage Yields

Alfalfa yields were reduced by 35% compared to 1987. Alfalfa was a valuable commodity last year, and even though yields were down it substantially improved the profitability of the alternate system (Table 61). Clover yields were 62% lower than 1987 yields. Clover in 1988 was approximately a 50:50 mix of red clover and yellow sweetclover. This mix was initiated in 1987 in an attempt to reduce clover weevil damage noted on sweetclover in previous years. It appeared clover weevil damage was reduced last year, but we will need additional observations. Clover is not harvested in this system since it's primary purpose is to improve soil nutrient levels and tilth. Both clover and alfalfa also aid in weed control.

Table 34. Forage crop yields - farming systems studies.

	1st Cutting (June 13)	2nd Cutting (July 25)	3rd Cutting (Aug 31)	Total (T/A) Dry Matter
Study I				
Alfalfa - Vernal	1.56[a]	0.67	0.66	2.89
Study II				
Clover[b]	0.92			0.92

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

Tissue analysis (% N-P-K):

Alfalfa	1st cutting,	2.54-0.20-2.10
	2nd cutting,	2.21-0.09-1.44
	3rd cutting,	3.38-0.19-2.46
Clover		2.60-0.18-1.50

Weed Populations

Populations of weeds indicate advantages and disadvantages of each system. Perennial broadleaves are increasing in all systems that have reduced tillage. It has been shown in other studies that over time perennials will increase in reduced tillage systems. With the dry season, all treatments with preplant incorporated herbicides had superior weed control. Also, some postemergence treatments may have been benefited due to weeds being under severe stress. Compared to last year, foxtail populations are up in all systems, however, the alternate system had the largest increase. On the first sampling date the conventional systems had the lowest weed populations followed by minimum till, ridge till and alternate systems (Tables 35 and 36). On the second sampling date in Study I weed populations generally decreased in the alternate and ridge-till systems and increased in the conventional. In Study II (Table 36) weed populations in small grain stubble decreased in all systems. In a dry year like 1988, weeds can have an effect on potential yields. Herbicides can also induce stress, particularly in a dry, warm year. This study points out the importance of rotations when we look at the monoculture of winter wheat and see how one weed species (downy brome) can move in and become a severe problem in only a few years.

Table 35. Weed populations.

Study I	Alternate		Conventional		Ridge-Till	
CORN						
Green foxtail	22[a]	16	3	27	11	9
Redroot pigweed	1	3	1	1	1	1
Perennial broadleaf	0		0		1	
SOYBEANS						
Green foxtail	36	24	0	7	23	25
Redroot pigweed	6	8	0	2	1	3
Perennial broadleaf	0		0		0	
SPRING WHEAT						
Green foxtail			44	0	81	2
Redroot pigweed			5	0	3	2
Perennial broadleaf			1		1	
OATS/ALFALFA						
Green foxtail	165	31				
Redroot pigweed	8	7				
Perennial broadleaf	2					
ALFALFA						
Green foxtail	86	4				
Redroot pigweed	0	7				
Perennial broadleaf	2					
SYSTEM AVERAGE						
Green foxtail	77	18	16	2	38	12
Redroot pigweed	4	6	2	1	2	2
Perennial broadleaf	1		0		1	

[a] Number/3 sq ft - avg of four replications. Perennial broadleaves were dandelion, swamp smartweed and Canada thistle. Sampled 6/10/88, and 8/17/88. (All broadleaves combined in second sampling, also spring wheat stubble was plowed prior to sampling.)

Table 36. Weed populations.

Study II	Alternate		Conventional		Minimum-Till	
SOYBEANS						
Green foxtail	10[a]		0		0	
Redroot pigweed	0		0		0	
Perennial broadleaf	0		0		0	
SPRING WHEAT						
Green foxtail	108	37	4	0.25	36	5
Redroot pigweed	11	1	3	1	18	4
Perennial broadleaf	3	0	0	0	2	0
BARLEY						
Green foxtail			28	18	24	13
Redroot pigweed			3	0.5	4	2
Perennial broadleaf			0	0	0	0
OATS, CLOVER						
Green foxtail	89	34				
Redroot pigweed	18	7				
Perennial broadleaf	7	0				
SWEET & RED CLOVER						
Green foxtail	9					
Redroot pigweed	0					
Perennial broadleaf	8					
CONTINUOUS NO-TILL WINTER WHEAT						
Green foxtail					1	0
Redroot pigweed					1	0
Downy brome					305	0
Perennial broadleaf					3	1
SYSTEM AVERAGE (Excluding Winter Wheat)						
Green foxtail	54		11		20	
Redroot pigweed	7		3		7	
Perennial broadleaf	4		0		1	

[a] Number/3 sq ft - avg of four replications. Perennial broadleaves were dandelion, swamp smartweed and Canada thistle. Sampled 6/10/88, and 7/22/88. Second sampling was in small grains only.

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 37 and 38). Higher populations of foxtail in ridge-till soybeans compared to conventional was also similar to the field counts.

Table 37. Greenhouse evaluations of soil weed seed populations.

Study I	Alternate	Conventional	Ridge-Till
CORN			
Green foxtail	47[a]	2	3
Redroot pigweed	2	3	6
Perennial broadleaf	0	0	1
SOYBEANS			
Green foxtail	15	4	18
Redroot pigweed	2	1	2
Perennial broadleaf	0	0	0
SPRING WHEAT			
Green foxtail		4	2
Redroot pigweed		1	1
Perennial broadleaf		0	0
OATS/ALFALFA			
Green foxtail	71		
Redroot pigweed	2		
Perennial broadleaf	0		
ALFALFA			
Green foxtail	43		
Redroot pigweed	4		
Perennial broadleaf	1		
SYSTEM AVERAGE			
Green foxtail	44	3	8
Redroot pigweed	3	2	3
Perennial broadleaf	0	0	0

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

Table 38. Greenhouse evaluations of soil weed seed populations.

Study II	Alternate	Conventional	Minimum-Till
SOYBEANS			
Green foxtail	12[a]	1	3
Redroot pigweed	3	1	6
Perennial broadleaf	0	0	0
SPRING WHEAT			
Green foxtail	14	9	2
Redroot pigweed	3	2	4
Perennial broadleaf	1	1	1
BARLEY			
Green foxtail		8	2
Redroot pigweed		2	5
Perennial broadleaf		0	0
OATS, CLOVER			
Green foxtail	50		
Redroot pigweed	5		
Perennial broadleaf	0		
SWEET & RED CLOVER			
Green foxtail	40		
Redroot pigweed	7		
Perennial broadleaf	1		
CONTINUOUS NO-TILL WINTER WHEAT			
Green foxtail			0
Redroot pigweed			14
Downy brome			40
Perennial broadleaf			1
SYSTEM AVERAGE (Excluding Winter Wheat)			
Green foxtail	29	6	2
Redroot pigweed	5	2	5
Perennial broadleaf	1	0	0

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

Soil Nutrients

A general soil sampling of both farming system studies was undertaken in the spring of 1985 to determine baseline or initial soil test values for each of the experiments. Samples were again collected in the fall of 1985, spring and fall of 1987, and fall of 1988 to determine changes which may have occurred. Plant samples were also collected from both studies in 1988 to determine influences of cropping systems on early growth of corn and soybeans and for nutrient analyses.

Samples were collected from corn and soybean plots in mid-June to determine cropping system effects on early growth. In Study I, conventional corn plots showed significantly greater early dry matter production than either the ridge-till or alternate system (Table 39). Both conventional and ridge-till corn plots received 30 lbs P_2O_5/A as a starter in 1988, so the increase in growth in the conventional system cannot be attributed solely to starter phosphorous. This early growth response did not, however, result in a yield increase. Ridge-till and alternate systems, which are more moisture conserving systems, significantly outyielded the conventional system in 1988 (Table 33). Corn starter fertilizer studies across eastern South Dakota in 1988 showed that cultural practices that conserved water during the early part of the growing season had dramatic effects on grain yield in 1988.

Early growth of soybeans in Study I was not different between cropping systems in 1988. However, conventional and minimum tilled soybeans in Study II showed more early growth than the alternate system. Early growth differences in Study II did not follow through to yield differences between systems (Table 33).

Table 39. Early growth of corn and soybeans as influenced by cropping systems.

Cropping System	Crop: Corn[a]	Crop: Soybeans[b]
	---------grams--------	
Study I		
Alternative	101	19.2
Conventional	139	18.9
Ridge-till	101	17.4
$LSD_{.10}$	21	NS
CV, %	14	15
Study II		
Alternative	--	18.0
Conventional	--	24.7
Min.-till	--	22.0
$LSD_{.10}$		3.5
CV, %		12

[a] Dry weight of 10 plants at V7 growth stage on 6/17/88.
[b] Dry weight of plants from 12" of row taken on 6/17/88.

Phosphorus (P) soil test results for the first three years showed that P levels were dropping at the unusually high rate of 16-19% each year in both studies and across all farming systems (Table 40 and 41). Since P levels had moved into deficient regions, the decision was made in 1988 to apply 30 lbs P_2O_5/A as a starter to corn, wheat, and barley in conventional, ridge-till and minimum till systems in both studies. Soybeans and all alternate farming system crops did not receive starter P in either study.

Soil samples taken in the fall of 1988 indicate that P levels may be reaching an equilibrium level in these studies since levels are nearly the same or slightly higher than 1987 levels. However, the drought of 1988 may have had an impact on soil test P levels since mineralization of organic P is decreased less by drought than crop growth. This would result in a small net increase in soil test P due to severely reduced uptake by drought stressed crops.

Phosphorus levels in Study I in the fall of 1988 were significantly higher following soybeans in the alternate system (Table 40). (Please note high CV's that occurred in Study I in 1988 indicating a high degree of sampling variability.) This same effect occurred in the alternate system of Study II in 1987 (Table 41). No differences were detected in conventional or ridge-till systems in Study I and soil test P levels were not significantly different in any cropping system in Study II in 1988.

Organic matter (O.M.) levels in Study I were not different in the fall of 1988 in any system (Table 1). There appears to be some year-to-year fluctuations of O.M. levels but no definite trends can be established for cropping systems in either study. Study II shows similar year-to-year fluctuations, but in 1988 the alternate system showed higher levels of O.M. following soybeans than those following oats, spring wheat or clover (Table 41). Minimum tilled soybeans also showed higher O.M. levels than spring wheat plots in the fall of 1988.

Soil nitrate values and applied nitrogen rates for Study I are shown in Table 42. These data indicate that the highest soil NO_3 levels in the fall of 1988 occurred following spring wheat and corn in both the conventional and ridge-till systems. This is not unusual since the drought severely limited corn and small grain yields and crops couldn't make use of nitrogen applied in the spring of 1988. Some mineralization likely occurred after wheat harvest as well. In Study II, (Table 43) conventional spring wheat and barley and minimum tilled spring wheat plots had the highest levels of NO_3 in the fall of 1988. All crops in the conventional systems in Study II were 30 pounds or more greater in soil nitrate than the respective crops in the minimum till system. This same effect occurred in 1987 in Study II. Decreased nitrate levels under reduced tillage compared to plowed systems have been observed in several other studies in South Dakota and elsewhere. Generally, soil nitrate levels have been higher in the fall following wheat than either barley or soybeans. This occurred in fall 1985, fall 1987, and fall 1988 samplings.

<u>Summary</u>

The 1988 soil test results from these studies serve as an excellent example of the critical importance of soil testing in crop management programs

regardless of the system utilized. Several of the 1989 non-legume crops will not require any fertilizer N due to the large pool of residual N indicated by the soil nitrate test. Figure one shows that for the conventional and reduced-till systems, the nitrate levels measured this fall reflected 1988 fertilizer additions and 1987 legume credits from soybeans. The obvious difference between studies is not surprising since they are located on different sites that have had different histories. The cropping systems differences between studies could also cause part of the contrast in N relationships. These site differences illustrate the field-specific nature of nitrate accumulations and the difficulty involved in attempting to predict what fall nitrate levels will be without actually measuring them with a soil test. Due to the effects of the 1988 drought, it is vital that fields to be planted to non-legumes be sampled for nitrate before fertilizer rate decisions are made for 1989.

Table 40. Soil test phosphorus and organic matter in Study I, 1985-1987.

		Phosphorus					Organic Matter				
		1985		1987		1988	1985		1987		1988
System	Crop	Spring	Fall	Spring	Fall	Fall	Spring	Fall	Spring	Fall	Fall
		ppm					%				
ALT.	oats/alfalfa	30	21#	14	16	15	3.9	3.7	3.4	4.0	3.6
	alfalfa	30	21	21	20	17	3.9	3.7	3.5	3.8	3.8
	soybeans	30	24	16	15	35	3.9	3.7	3.3	3.9	3.9
	corn	30	29	18	16	17	3.9	3.9	3.5	3.8	3.8
	Avg.	30	24	17	17	21	3.9	3.8	3.4	3.9	3.8
CONV	corn	30	30	19	21	26	3.9	3.7	3.4	3.8	3.6
	soybeans	30	30	18	19	22	3.9	3.6	3.7	3.9	3.5
	wheat	30	23	19	22	22	3.9	3.7	3.4	3.6	3.7
	Avg.	30	28	19	21	23	3.9	3.7	3.5	3.8	3.6
R.T.	corn	30	19	23	17	18	3.9	3.5	3.8	4.2	3.7
	soybeans	30	30	18	15	18	3.9	3.9	3.9	4.0	3.9
	wheat	30	21	14	12	23	3.9	3.7	3.6	3.5	3.9
	Avg.	30	23	18	15	20	3.9	3.7	3.8	3.9	3.8
	LSD .10	--	7	5	5	9	--	NS	0.3	0.3	NS
	CV %	--	25	23	23	36	--	6	7	6	11

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

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

Table 41. Soil test phosphorus and organic matter in Study II, 1985-1987.

System	Crop	Phosphorus					Organic Matter				
		1985		1987		1988	1985		1987		1988
		Spring	Fall	Spring	Fall	Fall	Spring	Fall	Spring	Fall	Fall
		ppm					%				
CONV.	soybean	34	26	18	14	20	4.0	4.0	4.0	3.9	3.7
	sp. wheat	34	22	21	15	18	4.0	4.0	3.9	3.9	3.7
	barley	34	20	17	12	16	4.0	3.9	3.8	3.6	3.6
	Avg.	34	23	19	14	18	4.0	4.0	3.9	3.8	3.7
MIN.	soybean	34	26	17	13	19	4.0	4.0	3.9	4.3	4.0
	sp. wheat	34	22	19	14	16	4.0	3.9	4.3	4.0	3.7
	barley	34	23	17	12	19	4.0	3.9	3.8	4.1	3.9
	Avg.	34	24	18	13	18	4.0	3.9	4.0	4.1	3.9
ALT.	oats/s. clover	34	21#	22	14	16	4.0	4.0	3.9	4.0	3.9
	s. clover	34	21	20	14	15	4.0	3.8	4.0	4.1	3.9
	soybean	34	27	27	20	21	4.0	4.0	4.0	4.1	4.2
	sp. wheat	34	27	19	12	22	4.0	3.8	4.0	3.8	3.9
	Avg.	34	23	22	15	19	4.0	3.9	4.1	4.2	4.0
CONT.	w. wheat	34	26	21	17	15	4.0	4.0	4.1	4.2	3.8
	LSD .10	--	3	--	4	NS	--	NS	--	NS	0.3
	CV %	--	12	--	20	21	--	5	--	9	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.

FIG.1 EFFECT OF PAST N MANAGEMENT AND TILLAGE ON SOIL NITRATE IN THE FALL OF 1988, BOTH STUDIES.

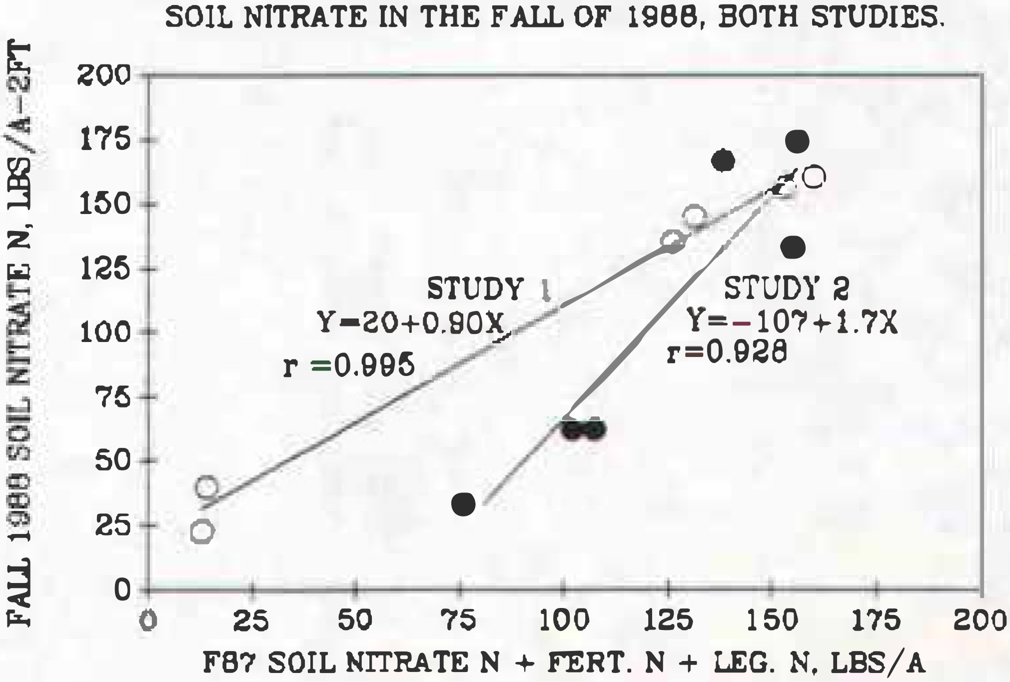


Table 42. Soil and applied N in Study I, 1985-1987.

System	Crop	Soil NO_3-N 1985 Spring#	1985 Fall	1987 Spring	1987 Fall	1988 Fall	Applied N** Fertilizer 85	86	87	88	Manure 85	86	87	88
		---------lbs/A 2'-----------					-----------lbs/A-----------							
ALT.	Oats/alfalfa	18	13	76	9	31	0	0	0	0	44	33	105	113
	Alfalfa	18	14	60	38	29	0	0	0	0	0	0	0	0
	Soybeans	18	18	111	23	89	0	0	0	0	0	0	0	0
	Corn	18	15	77	21	51	0	0	0	0	0	0	0	0
CONV.	Corn	18	33	95	14	145	110	110	37	75	0	0	0	0
	Soybeans	18	21	84	24	40	0	0	0	0	0	0	0	0
	Wheat	18	18	86	56	160	110	90	77	105	0	0	0	0
R.T.	Corn	18	22*	90	13	135	110	110	37	105	0	0	0	0
	Soybeans	18	21	94	19	23	0	0	0	0	0	0	0	0
	Wheat	18	17	72	21	156	110	90	77	105	0	0	0	0
	LSD .10	--	6	NS	8	32								
	CV %		25	32	28	31								

0-6" only. * Plot 40 excluded ** 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.

Table 43. Soil and applied N in Study II. 1985-1987.

System	Crop	Soil NO_3-N 1985 Spring#	1985 Fall	1987 Spring	1987 Fall	1988 Fall	Applied N* Fertilizer 85	86	87	88	Manure 85	86	87	88
		---------lbs/A 2'-----------					-----------lbs/A-----------							
CONV.	Soybean	31	17	72	73	62	0	0	0	0	0	0	0	0
	Sp. wheat	31	55	51	138	174	110	90	108	50	0	0	0	0
	Barley	31	30	73	107	167	110	70	37	0	0	0	0	0
MIN.	Soybean	31	17	42	48	33	0	0	0	0	0	0	0	0
	Sp. wheat	31	44	47	102	133	110	90	108	75	0	0	0	0
	Barley	31	33	44	76	62	110	70	77	0	0	0	0	0
ALT.	Oats/s. clov.	31	18	47	52	12	0	0	0	0	44	0	0	0
	S. clover	31	19	25	99	82	0	0	0	0	0	0	0	0
	Soybean	31	18	100	61	52	0	0	0	0	0	0	0	0
	Sp. wheat	31	21	64	53	47	0	0	0	0	0	0	0	0
CONT.	W. wheat	31	63	46	81	82	110	90	108	75	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.

Soil Temperature, Moisture, Bulk Density and Residue Cover

Soil frost depth is influenced by air temperature, soil moisture, and insulators such as snow or crop residue. During the 1987-88 winter, frost in Study I was deepest in the ridge - corn treatment and most shallow in the alternate - oat/alfalfa treatment (Table 44). In late February and through most of March, soil frost was deeper than the frost measurement tubes (four feet). Thawing occurs from the surface downward and also from the bottom upward. Oat/alfalfa soils, which froze the least deep, were also the first to thaw.

Snow cover was recorded from January 8th to February 9th in Study 1 (Table 45). Snow catch related well to percent ground cover (Table 46). Oat/alfalfa in the alternate system and wheat stubble in the ridge system averaged 4.0 and 3.8 inches of snow respectively. Residues decreased from fall 1987 to spring 1988 in all treatments except alternate - oat/alfalfa. The conventional corn was the only treatment with residue inadequate to meet the conservation program requirement of 30%. Grain crop residues were generally less in the fall of 1988 than in the previous year and reflected drought reduced production.

Soil temperatures among treatments varied only a few degrees after spring planting (Table 47). Corn residues in the soybean-ridge treatment kept furrow temperatures 6^{o}F cooler than ridge tops and oat/alfalfa residues reduced temperatures in alfalfa producing soils. On October 19th, soil temperatures ranged from 43 - 46^{o}F (Table 48).

Soil moisture in the top 6 inches on April 25th was highest for conventional wheat and lowest for ridge wheat (Table 47). Soil moisture limited wheat stands in the ridge system. By mid-July, soil surface moisture was similar in conventional and ridge wheat (Table 48) and the ridge soybean with corn residues retained more moisture than other treatments. Bulk densities varied little among treatments and decreased slightly from April to July (Tables 47 and 48).

After harvest, soil moisture was measured in each plot at 0-6, 6-24, and 24-48" increments in Study I (Table 47). The alternate system had the highest soil surface moisture (corn at 0-6 inches was 21.9%) and the lowest sub-surface moisture (alfalfa 24-48 inches was 6.3%). The conventional and ridge systems averaged 18.9% at the 0-6 inch depth, 14.6% at the 6-24 inch depth and 10.1% at the 24-48 inch depth. These compare to 14.9% at 0-6, 14.1% at 6-24, and 10.4% at 24-48 inch depths in 1987.

Soil moisture in Study II was measured at 0-6 and 6-24" depths on November 17th after the first snow and melt (Table 50). Continuous winter wheat had higher surface and subsoil moisture than other treatments.

Table 44. Freeze and thaw depth during the 1987-88 winter as affected by system and previous crop residue in Study I.

			Month and Day														
	1987		December		January				February			March				April	
System	Residue		8	17	8	11	21	26	2	9	17	2	10	16	30	5	12
			inches														
ALT.	Corn	F[+]	8	11	24	33	38	38	39	39	42*	*	*	*	39	38	38
		T											4		8	14	25
	Soybean	F	8	11	22	32	37	38	39	40*	*	*	*	*	39	39	39
		T											4		7	12	20
	Oat/Alfalfa	F	5	8	13	24	28	27	28	31	35	34	34	31	28	No Frost	
		T											3		7	11	
	Alfalfa	F	9	10	20	30	34*	*	*	*	*	*	*	*	34	34	32
		T											4		7	11	18
CONV.	Corn	F	9	12	24	33	36	37	37	38*	*	*	*	*	37	36	36
		T											3		6	10	20
	Soybean	F	8	10	20	29	33	34	35	37*	*	*	*	*	37	36	36
		T											5		7	12	20
	Wheat	F	8	11	21	31	37	37	39	40*	*	*	*	*	40	39	39
		T											3		6	8	17
RIDGE	Corn	F	6	8	19	30	33*	*	*	*	*	*	*	*	*	*	*
		T											4		8	14	29
	Soybean	F	7	11	22	31	36	37	38	40*	*	*	*	*	39	38	38
		T											4		7	11	19
	Wheat	F	6	9	18	24	28	30	30	33*	*	*	*	*	34	29	28
		T											4		8	12	19

[+]F = frost depth T = thaw depth
* = Frost depth reached bottom of frost measuring tube.

Table 45. Snow depth in farming system Study 1 as affected by system and previous crop residue.

	1987	Date				
System	Residue	January 8	January 21	January 26	February 2	February 9
		inches				
ALT.	Corn	1.4	1.1	1.4	0.3	1.9
	Soybean	0.5	0.8	1.4	0.6	2.4
	Oat/Alfalfa	1.6	4.4	5.0	3.1	5.7
	Alfalfa	1.7	2.8	3.3	0.9	3.3
CONV.	Corn	0.9	1.3	1.4	0.3	1.6
	Soybean	1.1	1.4	1.9	0.3	2.8
	Wheat	1.6	2.0	2.4	1.2	3.2
RIDGE	Corn	1.6	3.6	1.9	1.9	2.8
	Soybean	0.5	0.8	0.9	0.3	2.0
	Wheat	3.0	4.1	4.4	2.7	4.9

Table 46. Effect of cropping system on surface residue in Study I.

1988 Crop	System: 1987 Residue	Spring 1988[a] Alt	Spring 1988[a] Conv	Spring 1988[a] Ridge	Loss Alt	Loss Conv	Loss Ridge	Fall 1988 Alt	Fall 1988 Conv	Fall 1988 Ridge
		%			%			%		
Corn	Wheat/ Soybean[b]	45	15	75	21	11	16	45	30	50
Soybean	Corn/ Alfalfa	30	50	50	1	16	16	45	40	60
Wheat	Soybean	--	45	50	--	33	19	--	15	70
Oat/ Alfalfa	Corn	40	--	--	21	--	--	99	--	--
Alfalfa	Oat/ Alfalfa	99	--	--	0	--	--	40	--	--

[a] Residue measured as percent ground cover on May 23 (Spring) and October 19 (Fall). Loss = Fall 1987 residue minus Spring 1988 residue.
[b] Residue for Conv and Ridge/Alt.

Table 47. Effect of crop and residue on various soil properties in Study I, Spring 1988[a].

1988 Crop	System: 1987 Residue	Temperature[a] Alt	Temperature[a] Conv	Temperature[a] Ridge	Moisture Alt	Moisture Conv	Moisture Ridge	Bulk Density Alt	Bulk Density Conv	Bulk Density Ridge
		°F			%			g/cc		
Corn	Wheat/ Soybean[b]	68[c]	67	67	17.4	18.6	18.7	1.3	1.3	1.3
Soybean	Corn/ Alfalfa	69	67	66/60[d]	17.6	17.8	18.4	1.3	1.4	1.3
Wheat	Soybean	--	68	68	--	19.8	5.8	--	1.4	1.4
Oat/ Alfalfa	Corn	69	--	--	14.7	--	--	1.4	--	--
Alfalfa	Oat/ Alfalfa	64	--	--	19.0	--	--	1.3	--	--

[a] Measured temperature May 23; moisture and bulk density April 25.
[b] Residue for Conv and Ridge/Alt.
[c] 0 - 6" depth averaged over 4 replications.
[d] Ridge/Furrow temperatures.

Table 48. Effect of crop and residue on various soil properties in Study I Fall, 1988.[a]

1988 Crop	1987 Residue	Temperature[a] Alt	Conv	Ridge	Moisture Alt	Conv	Ridge	Bulk Density Alt	Conv	Ridge
		---°F---			---%---			---g/cc---		
Corn	Wheat/ Soybean[b]	45	46	43	7.6[c]	6.2	7.6	1.2	1.2	1.2
Soybean	Corn/ Alfalfa	44	45	46	8.7	8.5	9.4	1.2	1.2	1.2
Wheat	Soybean	--	44	44	--	7.0	7.1	--	1.2	1.3
Oat/ Alfalfa	Corn	46	--	--	6.4	--	--	1.2	--	--
Alfalfa	Oat/ Alfalfa	45	--	--	7.8	--	--	1.2	--	--

[a] Sampled temperature October 19, moisture and density July 21.
[b] Residue for Conv and Ridge/Alt.
[c] Average of four replications, moisture and density at 0 - 6" depth.

Table 49. Fall soil moisture to a depth of four feet in Study I.

1988 Crop	Depth	System Alternate	Conventional	Ridge-till
	inches	---%---		
Corn	0 - 6	21.9[a]	19.6	19.2
	6 - 24	12.7	12.7	13.2
	24 - 48	9.0	9.3	11.1
Soybean	0 - 6	19.4	18.7	19.6
	6 - 24	14.3	15.6	16.0
	24 - 48	9.6	9.9	11.6
Spring Wheat	0 - 6	--	17.5	19.0
	6 - 24	--	13.1	16.9
	24 - 48	--	10.5	8.4
Oat/Alfalfa	0 - 6	17.9	--	--
	6 - 24	12.5	--	--
	24 - 48	8.6	--	--
Alfalfa	0 - 6	18.5	--	--
	6 - 24	12.3	--	--
	24 - 48	6.3	--	--

[a] Percent soil moisture (gravimetric) on November 2, 1988, average of four replications.

Table 50. Fall soil moisture in farming system Study II.

Crop	Depth	System: Alternate	Conventional	Minimum-till
	inches	-------------------	%	-------------------
Spring Wheat	0 - 6	24.9[a]	22.2	21.2
	6 - 24	12.7	16.1	15.1
Barley	0 - 6	--	23.7	21.4
	6 - 24	--	17.0	15.8
Soybean	0 - 6	24.2	24.5	24.1
	6 - 24	14.3	13.4	15.0

Depth (inches)	Alt. Oats/Clover	Alt. Clover	Continuous Winter Wheat
0 - 6	23.9	23.6	25.5
6 - 24	11.9	17.3	20.5

[a] Percent soil moisture (gravimetric) sampled November 17. Average of four replications.

Nematodes and Earthworms

Sampling intensity was increased in 1988 in order to gain a better understanding of the population dynamics of these groups. In general, dagger nematode populations at harvest were substantially lower than those measured last year, apparently a response to the dry season. Also, dagger nematode numbers tended to be lower in the conventional systems in both studies (Tables 51 and 52). This was also noted last year, and may be due to the use of the moldboard plow in the conventional systems. Populations of dagger nematodes generally increased over the growing season on corn, soybean, alfalfa and clover and tended to decline on small grains. Lance nematode numbers were comparatively low in all systems.

Nearly all the earthworms (Oligochaeta) measured in these studies are the very tiny (ca. 1/8") members of this group. Their populations were usually highest at midseason (Tables 51 and 52). In Study I the lowest populations occurred in the ridge-till systems. The ridge-till system leaves much of the crop residue on the soil surface, and the lack of residue incorporation combined with last years low rainfall may have reduced the food base for this group of organisms. Highest populations occurred in alternate soybeans in both studies.

Populations of total plant feeding nematodes were generally highest in soybean in both studies (Tables 53 and 54). Overall, populations of this group were similar to those measured in 1987. The populations of predaceous and microbial-feeding nematodes did not respond in a consistent manner to either tillage or seasonal effects.

Table 51. Nematode and earthworm populations - farming systems studies.

Study I	Sampling date	Dagger	Lance	Earthworm
Corn				
Alternate	May	58[a]	4	29
	July	60	5	53
	October	246	3	14
Conventional	May	18	9	41
	July	9	2	38
	October	27	0	3
Ridge-till	May	91	1	19
	July	25	3	20
	October	256	0	5
Soybean				
Alternate	May	104	71	11
	July	100	13	60
	October	60	11	22
Conventional	May	22	55	3
	July	35	7	19
	October	109	1	6
Ridge-till	May	43	37	7
	July	112	63	12
	October	149	10	2
Spring Wheat				
Conventional	May	13	9	19
	June	21	10	34
	July	5	40	13
"Ridge"-till	May	381	17	9
	June	95	1	8
	July	116	7	10
Oats/Alfalfa	May	49	4	18
	June	29	1	2
	July	20	1	2
Alfalfa	May	140	27	6
	July	64	18	10
	October	251	13	4

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

Table 52. Nematode and earthworm populations, farming systems studies.

Study II	Sampling date	Dagger	Lance	Earthworm
Spring Wheat				
Alternate	May	38[a]	4	7
	June	0	1	1
	July	32	3	4
Conventional	May	56	5	26
	June	3	4	7
	July	49	8	23
Minimum-till	May	82	2	17
	June	1	0	6
	July	65	5	14
Soybean				
Alternate	May	99	10	37
	July	141	7	77
	October	170	5	25
Conventional	May	15	4	37
	July	1	0	22
	October	31	9	8
Minimum-till	May	17	3	9
	July	11	3	29
	October	101	5	9
Barley				
Conventional	May	22	7	53
	June	0	5	3
	July	25	8	9
Minimum-till	May	37	7	27
	June	9	4	14
	July	79	4	12
Oats/Clover	May	115	5	22
	June	1	0	2
	July	8	1	18
Clover	May	51	93	6
	July	38	77	3
	October	76	103	8
No-Till Winter Wheat	May	143	5	22
	June	49	0	1
	July	49	54	8

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

Table 53. Plant feeding, predaceous and microbial feeding nematode populations, farming systems studies.

Study I	Sampling date	Plant Feeding	Predaceous	Microbial Feeding
Corn				
Alternate	May	406[a]	543	768
	July	590	398	526
	October	638	406	689
Conventional	May	190	388	772
	July	153	426	893
	October	274	393	739
Ridge-till	May	236	385	662
	July	744	979	948
	October	717	768	876
Soybean				
Alternate	May	103	96	397
	July	373	573	1168
	October	1167	568	1550
Conventional	May	486	276	568
	July	553	655	759
	October	345	644	1026
Ridge-till	May	308	321	463
	July	178	870	293
	October	916	811	1018
Spring Wheat				
Conventional	May	131	176	496
	June	449	825	905
	July	434	605	770
"Ridge"-till	May	745	913	1159
	June	269	264	580
	July	338	580	868
Oats/Alfalfa	May	80	143	418
	June	103	289	1088
	July	244	468	747
Alfalfa	May	437	434	651
	July	1369	889	1025
	October	599	430	818

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

Table 54. Plant feeding, predaceous and microbial feeding nematode populations, farming systems studies.

Study II	Sampling date	Plant Feeding	Predaceous	Microbial Feeding
Spring Wheat				
Alternate	May	448[a]	414	645
	June	164	350	1100
	July	235	559	554
Conventional	May	523	686	925
	June	73	284	604
	July	478	630	693
Minimum-till	May	379	584	968
	June	269	318	905
	July	279	630	789
Soybean				
Alternate	May	190	405	567
	July	383	904	843
	October	1878	748	909
Conventional	May	279	384	1054
	July	236	592	689
	October	674	683	1276
Minimum-till	May	189	496	589
	July	214	684	1158
	October	1034	930	896
Barley				
Conventional	May	84	198	918
	June	89	114	651
	July	128	401	623
Minimum-till	May	199	405	664
	June	169	475	884
	July	131	243	414
Oats/Clover	May	339	629	1255
	June	148	530	1113
	July	115	285	804
Clover	May	566	480	1096
	July	958	593	825
	October	258	567	1641
Continuous No-Till Winter Wheat	May	383	614	793
	June	123	255	489
	July	249	605	598

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

Soil Microorganisms and Disease Suppression

Tillage systems can affect crop yields through their influence on various soil microorganisms which may cause root disease, or conversely,inhibit the growth of root disease agents thereby controlling these diseases 'biologically'. To establish a microbiological profile of the various tillage systems, the populations of selected genera of soil fungi and bacteria 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.

All treatments were assayed in May and August, plots with small grain were also sampled in June and plots with row crops were also sampled in October. Data from the August 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 August results are discussed.

In study I, soil from wheat was more suppressive to Fusarium disease of wheat than was soil under corn (Table 55, contrast 5). In the tables, suppressiveness is indicated by higher values, and low values indicate conducive (more disease) situations. The inoculated check means (without the soil sample added) also provide a baseline on which to judge suppressiveness, i.e., true suppression must increase plant health above that of the inoculated check. Contrast 5 using healthy plants inoculated with Fusarium was statistically significant at the 1% level, and further, has protection at the 5% level based on Bonferroni's procedure.

Conventional tillage was more suppressive than ridge-till to Pythium on alfalfa, but none of the treatments were better than the inoculated checks, hence the suppressed agent was not the Pythium used as inoculum (Table 56). Similar results in which conventional tillage was more suppressive than either alternate or ridge-till occurred with Helminthosporium (emergence) in this test ($p < .11$), and reduced disease was not due to Helminthosporium suppression.

Microbial analyses indicated that conventional tillage had fewer total fungi than alternative or ridge-till systems, and also somewhat fewer Fusarium isolates. Fusarium was especially abundant on ridge-till corn (Table 57).

In Study II, soil previously cropped to wheat was more suppressive to Fusarium on wheat than was soil previously in soybeans (contrast 5, Table 58), but none of the other comparisons were near significance at the 5% level.

Soil previously cropped to wheat was more suppressive than soil from soybeans to "Helminthosporium" on alfalfa, but the inoculated checks indicated that this suppression was not to Helminthosporium, but to some other component of the soils (Table 59, contrast 5). This comparison was significant at the 1% level and also had 5% protection using Bonferroni's procedure.

An undefined component of the soil also was operating in contrast 3 (Table 59) that indicated the alternative system was more suppressive than min-till to "Pythium".

Microbial analyses in Study II indicated that 1) conventional tillage had fewer total fungi than min-till, 2) alternative systems had more fluorescent pseudomonads than either conventional or min-till systems, 3) min-till had more Pythium than alternative systems, and 4) there were more fluorescent pseudomonads in soybean soil than in wheat soil (Table 60). Fluorescent pseudomonads are well-known biological control agents in soils.

Miscellaneous statistically significant findings from other sampling dates: Study I: May samples

a. Alternative systems were more suppressive to Helminthosporium on wheat than conventional tillage.
b. Soils previously in soybean were more suppressive to wheat Rhizoctonia than were previous corn/wheat soils.
c. Conventional and ridge-till soils were more suppressive to alfalfa pythium than were soils from alternative systems.
d. More fusaria were present in alternative than in conventional systems.

Study I: June samples

Conventional tillage was somewhat suppressive to Fusarium, and also had lower populations of Fusarium than did soils from alternative or min-till.

Study I: October samples

Conventional tillage was more suppressive to Fusarium than alternative or ridge-till (Bonferroni significant at 5%).

Study II: May samples

a. Conventional and especially alternative soils were more suppressive to Pythium on wheat than were min-till soils.

Study II: June samples

a. Soil from previous wheat was more suppressive than previous soybeans to Pythium (Bonferroni significant at 5%).
b. Conventional tillage had more total fungi, but fewer fusaria than min-till soil.

Study II: October samples

a. Conventional tillage was more suppressive to Helminthosporium than was min-till.
b. Min-till was more suppressive than conventional and alternative systems to unidentified pathogens.

Table 55. Wheat disease suppression, August samples, 1988, Study I, K-series.

		Fusarium		Helminthosporium		Rhizoctonia		Pythium	
Tillage	88 Crop	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy
Alt	Corn	11.5	11.3	13.0	11.5	11.5	0	13.8	9.8
Alt	Oat/alf	13.5	12.3	14.0	11.8	12.3	0.3	15.0	9.5
Alt	Alfalfa	11.5	10.0	13.5	10.8	14.0	0	13.8	8.5
Alt	Soybean	15.0	13.3	13.5	10.3	11.5	0	11.0	7.8
Conv	Corn	12.8	8.3	13.8	8.5	12.5	0	14.3	9.5
Conv	Soybean	13.8	12.8	13.5	8.8	14.3	0	14.0	10.5
Conv	S. wheat	14.3	12.3	14.0	9.8	9.0	0	13.3	10.3
R-till	Corn	13.8	10.5	14.0	10.3	10.8	0	14.8	10.0
R-till	Soybean	13.5	11.8	11.3	9.3	11.5	0	14.5	12.3
R-till	S. wheat	15.0	13.3	12.5	9.3	12.8	0	14.0	8.3
	$FLSD_{.05}$	(2.4)	(3.1)	(2.2)	(4.7)	(3.4)	(0.2)	(2.2)	(4.8)
Inoculated check means (no sample soil)		13.5	11.6	8.9	5.3	10.2	0	13.2	10.5
	Significant contrasts	3+	4+,5** 7*	2+,7+	none	none	none	3+	none

Contrast 2 = Conv vs Ridge: HE p = .067
3 = Alt vs Ridge: FE p = .07, PE p = .084
4 = Corn + wheat vs soy (current) FH p = .067
5 = Corn vs wheat (current) FH p = .004 (Boni)
7 = Corn vs wheat (prev) FN p = .012, NE p = .056

Table 56. Alfalfa disease suppression, August samples 88, Study I, K-series.

		Fusarium		Helminthosporium		Rhizoctonia		Pythium	
Tillage	88 Crop	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy
Alt	Corn	15.7	1.0	15.3	0	10.5	0	10.3	0.5
Alt	Oat/alf	16.0	1.3	11.3	2.3	13.0	1.0	17.3	1.3
Alt	Alfalfa	15.0	0.8	12.0	2.5	18.0	0	12.5	1.3
Alt	Soybean	18.5	1.5	11.5	2.8	12.3	0	11.5	1.0
Conv	Corn	16.0	1.0	16.3	1.5	15.3	0	14.8	1.0
Conv	Soybean	14.5	2.5	16.3	1.5	12.3	0.5	13.3	3.0
Conv	S. wheat	15.5	1.8	17.3	1.3	11.5	0	17.8	2.5
R-till	Corn	14.3	3.3	14.3	7.8	12.3	0	13.5	1.3
R-till	Soybean	15.8	1.5	14.3	1.5	11.5	0	14.0	1.0
R-till	S. wheat	11.0	0.5	11.5	2.5	11.3	0	9.3	0
	$FLSD_{.05}$	(6.8)	(2.7)	(7.8)	(5.3)	(6.5)	(0.7)	(6.9)	(2.5)
Inoculated check means (no sample soil)		21.9	19.9	13.1	9.8	15.8	1.3	16.2	11.1
	Significant contrasts	none	none	1+	7+	none	6+	none	2*

Contrast 1 = Conv vs Alt: HE p = .057
3 = Conv vs Ridge: HH p = .103, PH p = .05
6 = Corn + wheat vs soy (prev) RH p = .090
7 = Corn vs wheat (prev) HH p = .096

Table 57. Microbial assays, August 1988, Study I, K-Series.

Tillage	88 Crop	87 Crop	Trt	Colonies per plate: Total Fungi	PS	Fus	Pythium
Alternate	Corn	Soybean	1	235[a]	381	43	21
Alternate	Oat/alf	Corn	2	217	189	65	19
Alternate	Alfalfa	Oat/alf	3	186	265	54	16
Alternate	Soybean	Alfalfa	4	177	627	73	20
Conventional	Corn	Sp. wheat	5	126	48	39	9
Conventional	Soybean	Corn	6	85	370	41	18
Conventional	Sp. wheat	Soybean	7	209	2	38	17
Ridge-till	Corn	Sp. wheat	8	210	328	75	34
Ridge-till	Soybean	Corn	9	205	295	39	14
Ridge-till	Sp. wheat	Soybean	10	210	250	48	16
			$FLSD_{.05}$	(102)	(607)	(30)	(16)
			Contrasts	1*,2*, 4+,6+	none	1*,2+ 7+	none

[a] Comparisons valid within columns only due to different dilutions used.

Contrast 1 = Conv vs alt: TOTF p = .025, Fus p = .019
2 = Conv vs ridge: TOTF p = .025, Fus p = .087
4 = Corn + wheat vs soy (current) TOTF p = .108
6 = Corn + wheat vs soy (prev): TOTF p = .062
7 = Corn vs wheat (prev): Fus p = .105

Table 58. Wheat disease suppression, August 88, Study II, N-series.

Tillage	88 Crop	Fusarium Emerg	Fusarium Healthy	Helminthosporium Emerg	Helminthosporium Healthy	Rhizoctonia Emerg	Rhizoctonia Healthy	Pythium Emerg	Pythium Healthy
Conv	Soybean	14.5	8.5	14.0	10.0	13.0	0.3	12.8	6.5
Conv	Sp. wheat	13.3	8.3	12.3	5.3	13.0	0	14.5	7.3
Conv	Barley	14.5	12.3	14.0	5.3	12.3	0	12.5	7.3
M-till	Soybean	13.8	8.8	13.8	5.3	12.3	0	14.0	6.0
M-till	Sp. wheat	13.3	8.0	13.3	6.3	11.8	0	12.8	4.3
M-till	Barley	13.8	10.8	13.8	9.0	13.0	1.0	13.3	11.8
Alt	Sp. wheat	13.5	11.0	14.8	12.5	12.5	0	13.5	7.3
Alt	Oat/clover	14.0	12.3	12.8	6.8	12.8	0	13.3	6.5
Alt	Clover	13.3	9.0	13.8	3.8	12.3	0	14.8	5.3
Alt	Soybean	14.8	10.5	13.0	8.8	13.5	0	13.5	6.0
Cont	W. wheat	13.8	8.5	13.0	6.3	12.8	0	13.5	5.8
	$FLSD_{.05}$	(1.7)	(4.8)	(1.8)	(5.1)	(3.0)	(0.9)	(2.2)	(6.3)
Inoculated check means (no sample soil)		13.7	11.9	13.6	10.3	12.4	0	13.4	11.9
	Significant contrasts	none	5+	none	none	none	none	none	none

Contrast 5 = Soybean vs wheat (prev): FN p = .057

Table 59. Alfalfa disease suppression, gust 88 samples. Study 11, N-series.

		Fusarium		Helminthosporium		Rhizoctonia		Pythium	
Tillage	88 Crop	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy	Emerg	Healthy
Conv	Soybean	13.8	0.8	12.3	0.5	10.8	0	13.3	0.3
Conv	Sp. wheat	14.5	0.5	13.8	2.3	14.0	0.5	14.0	4.8
Conv	Barley	14.5	4.8	15.5	2.3	13.0	3.3	17.0	4.3
M-till	Soybean	15.3	1.5	16.8	4.5	13.8	0	11.3	6.0
M-till	Sp. wheat	14.0	1.0	11.3	0.3	7.5	0.3	15.0	5.8
M-till	Barley	13.3	0	14.5	6.5	13.3	0.5	10.3	3.3
Alt	Sp. wheat	13.8	1.0	10.3	2.0	10.0	1.3	14.5	0.8
Alt	Oat/clover	18.3	6.0	17.3	1.5	13.8	0	16.5	0.8
Alt	Clover	14.5	3.5	12.5	0.5	13.3	0.8	19.5	4.5
Alt	Soybean	13.5	4.5	10.5	4.5	10.8	0.8	10.8	4.3
Cont	W. wheat	16.0	1.0	11.5	0	8.3	0	11.3	0.8
	$FLSD_{.05}$	(5.4)	(8.5)	4.6	(5.7)	(6.8)	(2.9)	(5.5)	(6.1)
Inoculated check means (no sample soil)		19.8	18.9	19.0	17.5	13.3	1.2	20.1	18.1
	Significant contrasts	none	none	5**	none	none	none	3*	none

Contrast 3 = Alt vs min-till: PE p = .037
5 = Soy vs wheat (prev): HE p = .005 (Boni)

Table 60. Microbial soil assays, August 1988, Study 11, N-Series.

			Colonies per plate			
Tillage	88 Crop	Trt	Total Fungi*	PS	Fus	Pythium
Conventional	Soybean	1	46	72	28	23
Conventional	Sp. wheat	2	65	23	24	29
Conventional	Barley	3	75	11	30	28
Minimum-Till	Soybean	4	109	176	24	32
Minimum-Till	Sp. wheat	5	60	23	27	33
Minimum-Till	Barley	6	79	148	30	29
Alternate	Sp. wheat	7	62	48	31	27
Alternate	Oat/clover	8	85	150	39	25
Alternate	Clover	9	88	530	21	25
Alternate	Soybean	10	76	408	40	23
Continuous	W. wheat	11	74	329	29	29
		$FLSD_{.05}$	(35)	(369)	(14)	(12)
		Contrasts	1*, 2+, 5+	2*, 3+, 4*	none	3*

* Comparisons valid within columns only due to different dilutions used.

Contrast 1 = Conv vs min-till: TOTF p = .049 - not convincing
2 = Conv vs alt: TOTF p = .104, PS p = .016
3 = Alt vs min-till: PS p = .096, Pythium = .05
4 = Soy vs wheat (current): PS p = .045
5 = Soy vs wheat (prev): TOTF p = .085

Economic Results in 1988 for Northeast Station Alternative Farming System Studies

Thomas Dobbs and Clarence Mends*

Economics Department research on Northeast Research Station alternative farming system trials continued during 1988, as part of a companion research project (Agri. Exp. St. Project No. 7207-076) and a U.S.D.A Low-Input/ Sustainable Agriculture (LISA) multidisciplinary research grant. A uniform set of crop enterprise budgets have been developed for the first 4 years (1985 through 1988) of alternative farming system trials at the Northeast Station. These budgets will be used extensively during 1989 to analyze the economics of making a transition from "conventional" to "alternative" ("low-input/ sustainable") agriculture.

Much more work is yet to be done in refining these budgets and conducting sensitivity analyses with them. However, we briefly report here the preliminary economic results for the 1988 crop year. The results are subject to revision and qualification as more extensive analyses proceed over the coming months.

The drought-impacted 1988 crop yields for "alternative", "conventional", "ridge till", and "minimum till" systems included in Study I and Study II were presented earlier in this annual report, as were the cultural practices employed during 1988. Those yields and cultural practices formed the basis for data and assumptions used in the 1988 crop enterprise budgets. Assumptions about Federal farm program support levels and market prices also reflected 1988 conditions. For individual commodities, the support and/or market price assumptions used in computing gross returns were: (1) corn-20% non-paid acreage set aside, $2.50/bu. selling price, and $0.38/bu. deficiency payment; (2) wheat-27 1/2% non-paid set aside, $3.95/bu. selling price, and $0.58/bu. deficiency payment; (3) oats-5% non-paid set aside, $2.60/bu selling price, and no deficiency payment; (4) barley-20% non-paid set aside, $2.50/bu. selling price, and no deficiency payment; (5) soybeans--no set aside requirement and $7.65/bu. selling price; and (6) alfalfa-$70/ton selling price. Clover in the alternative rotation of Study II is unharvested, so no market value was assigned to that crop.

Crop insurance and special drought disaster assistance payments many South Dakota farmers received in 1988 were not included in these enterprise budgets. For this preliminary analysis, we wanted to isolate the net returns associated with each system that are attributable only to the "regular" 1988 Federal farm program and to the market prices prevailing for 1988 crops. Subsequent analyses will give more attention to crop insurance payments and to the portions of "advance" deficiency payments which did not have to be repaid in 1988 due to emergency drought legislation.

* We appreciate Brent Van Der Werff's assistance with the crop enterprise budgets.

Results of preliminary whole farm analyses for the various systems in Studies I and II are shown in Table 61. The first five columns indicate various cost and return measures for each system on a per acre basis. The last column indicates net income for each system on a whole farm basis, assuming a farm with 540 tillable acres.

As is normally the case, the alternative systems again showed the lowest "direct costs other than labor" in 1988. In contrast to previous years, however, those systems also produced the highest "gross income" per acre, under 1988's drought conditions. In part, this was due to the fact that corn and spring wheat in the alternative systems had higher per bushel yields in 1988 than did their conventional and reduced till counterparts. Alternative system soybeans had the highest yields in Study I; in Study II, the alternative system soybeans yielded more bushels than did the conventional system and nearly as much as the minimum till system.

Another factor contributing to relatively high gross income for the alternative system in Study I was the drought-induced alfalfa prices. The $70/ton alfalfa price used in our 1988 budgets is at least twice as high as we have assumed for more "normal" years. In many cases during 1988 in South Dakota, alfalfa hay commanded even more than $70/ton.

We can see in Table 61 that the alternative system was the only one in Study I producing positive "net income over all costs except land, labor, and management" in 1988. By that same measure, all systems in Study II provided positive net income, but the net income for the alternative system was by far the highest.

Proceeding to the fourth column of data, in which labor costs are added to the net income calculations, only the alternative systems in either Study I or Study II showed positive net income in 1988. In the next (fifth) column, addition of land charges to the calculations causes net income in the alternative system of Study II to drop to zero (after rounding); i.e., all costs except management were just barely covered in 1988. "Net income over all costs except management" is positive for the alternative system in Study I.

The final (sixth) column of data in Table 61 represents the same net income measure as the preceding (fifth) column, except that final column is on a whole farm (540-acre) basis. Slight differences (e.g., for the alternative system in Study II) are due to rounding. What this final column shows is substantial whole farm losses in 1988 to all except the alternative farming systems. We have not yet analyzed the extent to which crop insurance and Federal drought disaster assistance payments make up those losses for particular systems. One must keep in mind, however, that such insurance and disaster assistance payments would also enhance net income for the alternative systems--which are positive (Study I) or roughly break-even (Study II) without inclusion of those payments.

Other economic studies of "alternative" ("low-input/sustainable") farming systems are also underway at S.D.S.U. The results of those ongoing studies under the direction of Thomas Dobbs and Donald Taylor, are being reported elsewhere.

Table 61. Results of Farming Systems Analyses Based upon 1988 Yields, Farm Program, and Prices.

	Dollars/Acre					
	Direct Costs Other Than Labor	Gross Income	---------Net Income Over------- All Costs Except Land, Labor & Mgmt.	All Costs Except Land & Mgmt.	All Costs Except Mgmt.	Whole Farm, Net Income Over All Costs Except Management[2]
Study I[1]						
Alternative (oats-alfalfa-soybean corn)	37	114	46	35	9	4,894
Conventional (corn-soybeans s. wheat)	50	63	-13	-21	-47	-25,274
Ridge Till (corn-soybeans-s. wheat)	53	69	-10	-17	-43	-23,100
Study II						
Alternative (oats-clover-soybean-sp. wheat)	27	84	34	26	0	46
Conventional (soybeans-s. wheat barley)	41	74	7	- 1	-27	-14,808
Minimum Till (soybeans-s. wheat-barley)	47	78	6	- 2	-28	-14,882

1 Crops are shown in the order in which they occur in each rotation.
2 For farm with 540 tillable acres. Figures in this column are equivalent to 540 multiplied by "prerounded" figures in the "all costs except management" column.