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ANNUAL PROGRESS REPORT

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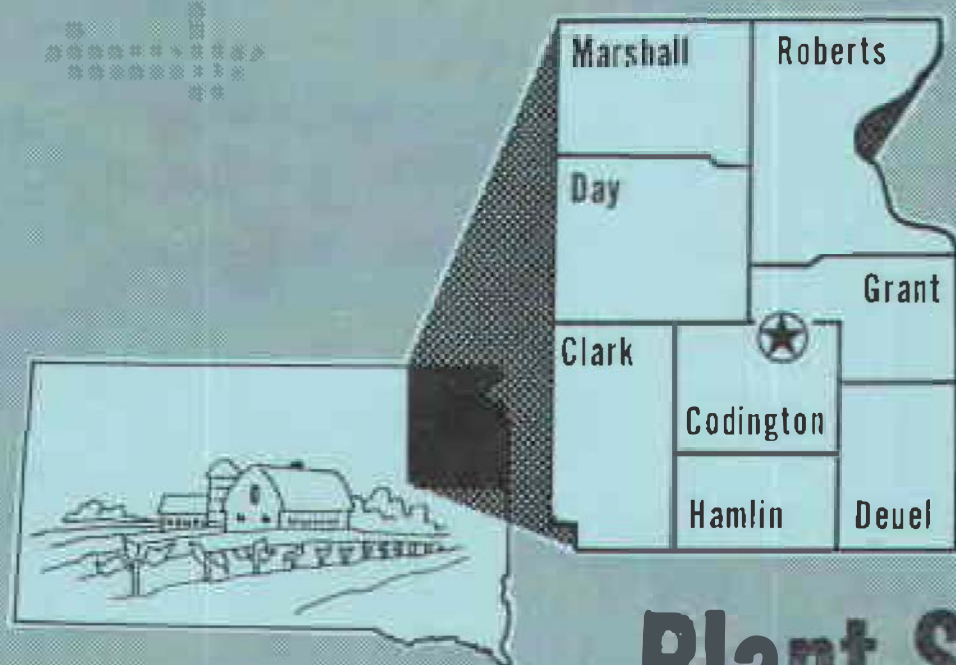
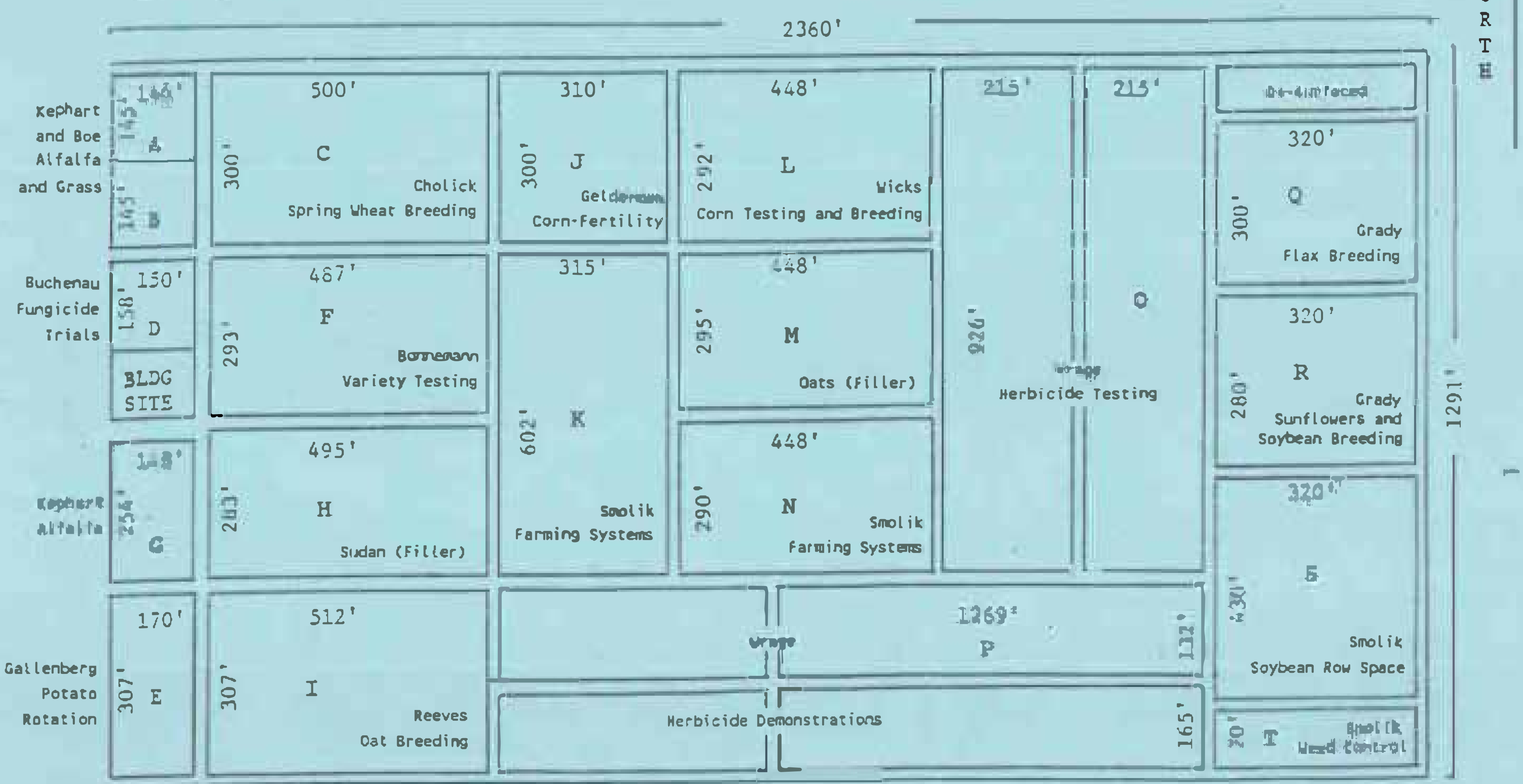
1990 ANNUAL PROGRESS REPORT

Northeast Research Station
Watertown, South Dakota



Plant Science Department
South Dakota State University
Brookings, South Dakota 57007

Northeast Research Station
1990 Land Use



PLOT ACREAGE:

A	0.49	H	3.22	O	9.57
B	0.49	I	3.61	P	8.65
C	3.44	J	2.13	Q	2.20
D	0.54	K	4.35	R	2.06
E	1.20	L	3.00	S	3.16
F	3.28	M	3.03	T	0.51
G	0.86	N	2.98		

Roadways: 25 feet wide
Acreage in farm: 70
Experimental Acreage: 59

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AGRICULTURAL ADVISORY GROUP, 1990
Northeast Research Station, Watertown, SD
Laird Larson, Chairman; Keith Zanter, Secretary

Laird Larson	Clark County	90-93
Arlin Thompson	Roberts County	87-90
Lynn Eberhart	Marshall County	87-90
Mike Johnson	Day County	87-90
Loron Krause	Deuel County	89-92
Paul Leiseth	Hamlin County	90-93
Lyle Kriesel	Grant County	87-90
Harlan Haugen	Codington County	90-93
Orrin Korth	Codington County	Permanent
Maurice Horton	SDSU, Head, Plant Science Dept.	
Loyal Evjen	Ag. Technician	
Steve Werner	Summer Field Assistant	
James Smolik	SDSU, Station Manager	

Extension Service

Chuck Langner	Clark County
Keith Zanter	Roberts County
Lorne Tilberg	Marshall County
Bob DeCock	Day County
Dale Wiitala	Deuel County
Tracey Larson	Grant County
Donald Guthmiller	Hamlin County
Bob Schurrer	Codington County
Bob Davis	District Supervisor

Table 1. Growing season precipitation.

Month	Amount (in.)	Normal	Departure	Greatest Amount	Date
April	1.04	2.10	-1.06	0.41	29
May	2.26	2.97	-0.71	0.95	19
June	5.13	3.75	+1.38	1.88	16
July	3.73	2.67	+1.06	1.28	19
August	2.58	2.78	-0.20	0.82	23
September	2.16	1.85	+0.31	0.69	18
October	1.78	1.16	+0.62	1.47	3
Total	18.68	17.28	+1.40		

Temperatures: Last Frost: 26° F May 10
First Frost: 24° F September 23
Frost Free Period: 136 days

SPRING WHEAT BREEDING

F. A. Cholick and B. G. Farber

Northeast Farm

The experiments conducted at the Northeast Farm in 1990 can be divided into two general categories: evaluation of experimental lines and purification/increase of experimental lines. All experiments were planted on April 23, 1990, fertilized for a 60 bu/A yield goal and harvested on August 10, 1990. During the evaluation step of variety development, it is extremely important that at least one location provides an estimate of yield potential. Traditionally, the spring wheat breeding project has used the Northeast Farm as the location to provide this essential information. Environmental conditions at the farm generally provide higher yields due to adequate moisture and lower temperatures during plant development when compared to most areas in the state where spring wheat is grown. However, in 1988 and 1989 the project did not have a test location that evaluated yield potential. In 1990, three test sites, including the Northeast Farm, provided data on yield potential. The average yield in 1990 was 58.6 bu/A which was more than double the yields of 1988 or 1989. Top yield check varieties across nurseries were Bergen, Butte 86, Prospect, Sharp, Stoa and 2375.

In the advanced yield trial, 7 experimental lines yielded equal to or superior to the top yielding check variety. Four of the 7 lines exceeded the yield of the best check with the highest yield being 66.2 bu/A for the experimental SD 8072. In the preliminary yield trial, 5 experimental lines exceeded the yield of the top check. The preliminary yield trial is made up of new lines which are being yield tested for the first time. One trial of material donated by Pioneer International was evaluated at this site in 1990. This nursery was made up of the most advanced lines donated by Pioneer and was comparable to the advanced yield trial. In this nursery 8 lines yielded equal to the top check. As a general observation the Pioneer material was shorter and later when compared to the material developed by the SDSU spring wheat breeding project.

Over the last several years the project has expanded the number of purification/increase plots at the farm. These plots are planted at reduced seeding rates (as low as 10 lbs/A) in order to maximize seed increase and for ease of purification. These increases were excellent in 1990 with the yields approaching those obtained from full seeding rates. The seed from these increases will be used for 1991 yield trials; therefore, it is critical that there is sufficient seed and good seed quality. A duplicate set of these increases was planted at the Brookings site; however, due to Head Scab, the seed quality was poor and yields in 1990 were low.

As a general summary, the data from the Northeast Farm was excellent in 1990. The data provided a good evaluation of yield potential and a differential among the material evaluated. In addition, there was adequate leaf rust to evaluate the material and finally, this site provided an evaluation of lodging resistance.

Day County

The breeding project has had a test location in Day County near Pierpont for nine years, in cooperation with Dean Johnson. Three yield trials planted here in 1990 were: 1) Advanced Yield Trial, 2) Elite Yield Trial, and 3) Uniform Regional Durum Yield Trial. These experiments were planted on April 19, 1990 and harvested on August 6th. The plots were fertilized for a 60 bu/A yield goal. The average yields (59 bu/A) for the bread wheat trials and durum trial were essentially equal.

The top check varieties in the bread wheat trials were Bergen, Butte 86, Prospect and Stoa. In the advanced yield trial, 5 experimental lines equaled or exceeded the yield of the best check. The top yielding line was SD 8072 which yielded 64.9 bu/A. In the elite yield trial, 3 of the lines donated by Pioneer yielded with the best checks. The top yielding durums were Rugby, Vic, and Ward. Stoa, a bread wheat, was included in the durum trial and it was also in the top yielding group. There were also several experimental durum lines (developed by the breeding program at North Dakota State University) in the top yielding group. Among these high yielding experimental lines were 5 semidwarfs and 3 lines as early as Monroe, the early check in the trial.

ORCHARDGRASS, TALL FESCUE, AND MEADOW BROMEGRASS FORAGE PRODUCTION EVALUATION

K. D. Kephart, A. Boe, and E. K. Twidwell

A cool-season forage grass experiment was established in early September 1989. Entries included three winterhardy orchardgrass (*Dactylis glomerata* L.) cultivars, three standard orchardgrass cultivars, seven tall fescue (*Festuca arundinacea* Schreb.) cultivars and 'Regar' meadow bromegrass (*Bromus riparius* Rehm & Schult.). Growth of all entries was exceptional prior to the onset of winter (1989-90). The only surviving entry the following spring was Regar meadow bromegrass. Late summer plantings of orchardgrass and tall fescue are particularly susceptible to death during severe winters.

ALFALFA CULTIVAR YIELD TEST

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

Three alfalfa cultivar yield experiments were conducted at the NE station during 1990. These tests were conducted to determine yield performance of various alfalfa cultivars and experimental lines when grown in NE South Dakota.

Three harvests were obtained from the 1987 planting. Average total yields ranged from 2.17 to 3.99 T/A, with significant differences detected among cultivars (Table 2). Yields obtained in 1990 were similar to those reported in 1989 and slightly less than those of 1988. Three year average yields ranged from 2.95 to 3.88 T/A with significant cultivar differences found. In 1990 significant differences among the cultivars were found for each cutting. The reason for these yield differences was probably due to extensive plant mortality that occurred during the winter of 1989-90. Only slight snow cover was present during the winter and extremely cold conditions in December coupled with fluctuating warm and cold temperatures in March were probably responsible for damage to the plots. In late April the plots were evaluated using a visual rating scale to estimate plant damage. The scale ranged from 1 (extreme damage) to 10 (no damage). Results indicate that there were significant differences among cultivars for winter damage (Table 2). This visual rating scale was compared to the fall dormancy rating given to each cultivar (Table 1) and correlation analysis was performed. For this experiment the correlation value was -0.59. Correlation analysis was also performed between winter injury and first-cut yields, and this value was 0.93. This suggests that cultivars that suffered the most winter damage had the lowest first-cut yields. As an example the cultivars Fortress and Eagle had a large amount of winter damage, and they also produced the lowest first-cut yields of 0.34 and 0.33 T/A, respectively. In contrast the experimental lines MTO S82 and MTO N82 had the least amount of winter damage and they produced the highest first-cut yields of 1.13 and 1.09 T/A, respectively.

Three harvests were obtained from the 1988 planting. Average total yields ranged from 2.48 to 4.33 T/A, with significant cultivar differences (Table 3). This experiment also suffered severe plant damage during the winter of 1989-90 and the previously described visual rating scale to estimate winter damage was also used here. The correlation coefficient between winter injury score and the fall dormancy rating (Table 2) of the cultivars was -0.72, which was slightly better than that found for the previous experiment. The correlation coefficient between winter injury score and first-cut yields was 0.90, similar to that found in the previous experiment. The experimental line MTO N82 had the least amount of winter damage and had the highest first-cut yield of 1.22 T/A. That was the only cultivar that produced over one ton per acre on the first cutting. This high first-cut yield allowed MTO N82 to have the highest total seasonal yield among the 28 cultivars. Two year average yields ranged from 2.97 to 4.08 T/A, with some significant cultivar differences. Yields in 1990 were similar to those in 1989. This experiment will be conducted for one more year and it will be interesting to observe the yield performance of these cultivars one year after a severe winter. Some of the plots that suffered severe damage may be overtaken by weeds.

One cutting was obtained for the 1990 planting. Yields ranged from 1.42 to 1.67 T/A, with no significant differences detected among cultivars (Table 4). Yield data taken from the seeding year is of limited use because differences associated with winterhardiness will not be expressed.

Table 2. Forage yield, apparent winter injury and fall dormancy rating of 31 alfalfa cultivars planted April 25, 1987 at the Northeastern Research Station, Watertown, South Dakota.

Cultivar	1990 Cut 1 6/21	1990 Cut 2 7/27	1990 Cut 3 9/11	1990 3-Cut Total	3 Year Avg.[a]	Relative Performance[b]	Winter kill[c]	FD
	----------tons DM/acre----------					%	score	
MTO S82[d]	1.13	1.49	1.36	3.99	3.88	112	8.5	1
120	0.80	1.33	1.38	3.51	3.81	110	5.8	3
526	0.92	1.41	1.45	3.78	3.78	109	6.8	2
Clipper	0.73	1.34	1.36	3.43	3.73	108	5.8	2
532	0.79	1.30	1.43	3.53	3.72	108	7.0	3
Arrow	0.71	1.32	1.35	3.38	3.67	106	3.6	3
Dart	0.64	1.23	1.33	3.19	3.67	106	4.9	3
WL 225	0.62	1.19	1.28	3.09	3.62	105	3.5	2
Cimarron	0.54	1.17	1.27	2.98	3.55	103	4.0	4
Big 10	0.74	1.23	1.32	3.29	3.54	102	3.9	3
Vernal	0.84	1.36	1.38	3.58	3.50	102	7.0	2
Dynasty	0.65	1.19	1.37	3.20	3.50	101	5.1	4
Iroquois	0.68	1.26	1.30	3.24	3.50	101	5.5	2
Apollo Supreme	0.78	1.32	1.34	3.44	3.50	101	5.9	4
Mohawk	0.70	1.18	1.26	3.13	3.48	101	5.3	2
Saranac	0.89	1.27	1.32	3.48	3.43	99	7.4	4
S432	0.71	1.18	1.29	3.18	3.43	99	4.3	4
Magnum III	0.57	1.13	1.29	2.99	3.40	99	3.6	4
Endure	0.68	1.21	1.23	3.11	3.38	98	4.6	3
SX 424	0.57	1.18	1.16	2.91	3.34	97	3.8	5
Blazer	0.64	1.21	1.18	3.03	3.33	96	4.1	3
MTO N82[d]	1.09	1.34	1.11	3.54	3.32	96	8.4	1
636	0.70	1.26	1.29	3.25	3.32	96	4.4	2
Commandor	0.59	1.27	1.30	3.16	3.31	96	5.4	4
SX 217	0.44	1.05	1.12	2.61	3.29	95	2.5	4
AF21	0.48	1.05	1.08	2.60	3.27	95	2.6	4
Fortress	0.34	0.97	0.99	2.30	3.26	95	1.3	4
Saranac AR	0.59	1.16	1.23	2.99	3.20	93	4.6	4
Cim 2000G[d]	0.47	1.05	1.15	2.68	3.17	92	2.9	4
DK-135	0.39	1.04	1.05	2.48	3.05	88	2.8	4
Eagle	0.33	0.95	0.90	2.17	2.95	86	1.6	
Average	0.67	1.21	1.25	3.14	3.45		4.7	
Maturity[e]		5.6	5.4	5.5				
LSD (0.05)	0.12	0.15	0.14	0.34	0.35		1.4	

[a] Three yr avg based on post-establishment yr yields, 1988, 1989 and 1990.

[b] % Relative Performance = ratio of cultivar 3-yr avg to 3-yr avg of all cultivars.

[c] Winter injury score, visual score conducted May 4, 1990. 1= plot completely dead; 10=solid and uniform stand.

[d] Experimental line, not currently marketed.

[e] Average harvest maturity. value based on Kalu and Fick (1983) mean-stage-by-count index.

Table 3. Forage yield, apparent winter injury and fall dormancy rating of 31 alfalfa cultivars planted April 28, 1988 at the Northeast Research Station, Watertown, South Dakota.

Cultivar	1990 Cut 1 6/21	1990 Cut 2 7/27	1990 Cut 3 9/11	1990 3-Cut Total	3 Year Avg.[a]	Relative Performance[b]	Winter kill[c]	FD
	---------tons DM/acre---------					%	score	
Big 10	0.68	1.59	1.44	3.71	4.08	118	3.4	3
MTO W82[d]	1.22	1.70	1.41	4.33	4.03	116	6.9	1
Vernal	0.80	1.60	1.47	3.87	3.93	113	5.9	2
5262	0.79	1.54	1.48	3.81	3.84	111	4.5	2
526	0.91	1.54	1.50	3.94	3.80	110	4.8	2
120	0.61	1.46	1.38	3.45	3.63	105	3.5	3
86639[d]	0.86	1.45	1.33	3.63	3.59	103	5.3	-
AP 8620[d]	0.61	1.42	1.25	3.29	3.57	103	2.9	-
Magnum	0.49	1.42	1.30	3.21	3.57	103	2.0	4
DK-125[+]	0.37	1.45	1.13	2.95	3.54	102	2.1	3
Magnum III	0.40	1.47	1.16	3.04	3.52	101	1.9	4
Arrow	0.47	1.45	1.16	3.09	3.51	101	2.4	3
5432	0.46	1.37	1.27	3.11	3.51	101	2.6	4
AP 8631[d]	0.52	1.40	1.22	3.13	3.48	100	3.1	-
Vector	0.30	1.39	1.13	2.83	3.44	99	1.3	4
87W1[d]	0.34	1.48	1.18	3.00	3.44	99	1.9	-
87W3[d]	0.45	1.38	1.15	2.98	3.42	99	3.9	-
Chief	0.27	1.38	0.99	2.64	3.40	98	1.3	4
SX 424	0.39	1.43	1.19	3.00	3.38	97	2.0	5
Dart	0.54	1.37	1.20	3.10	3.32	96	2.6	3
Sure	0.35	1.44	1.05	2.83	3.32	96	1.3	3
87W1[d]	0.47	1.34	1.21	3.01	3.31	95	2.6	-
Kingstar	0.47	1.38	0.95	2.81	3.17	91	2.4	3
Cimarron	0.30	1.32	1.09	2.71	3.14	90	1.8	4
WL 225	0.42	1.21	1.16	2.79	3.10	89	2.0	2
WL 320	0.20	1.39	0.96	2.55	3.09	89	1.6	4
SX 217	0.28	1.39	1.09	2.76	3.07	89	3.6	4
Premier	0.26	1.36	0.86	2.48	2.97	86	2.0	4
Average	0.51	1.43	1.20	3.15	3.47		2.9	
Maturity[e]	5.2	5.7	5.4					
LSD (0.05)	0.15	0.21	0.20	0.41	0.50		2.0	

[a] Three yr avg based on post-establishment yr yields, 1989 and 1990.
[b] % Relative Performance = ratio of cultivar to 2-yr avg of all cultivars.
[c] Winter injury score: 1= stand completely dead; 10=solid and uniform stand.
[d] Experimental line, not currently marketed.
[e] Average harvest maturity. Value based on Kalu and Fick (1983) mean-stage-by-count index.

Table 4. Forage yield of 36 alfalfa cultivars planted May 4, 1990 at the Northeast Research Station, Watertown, South Dakota.

Cultivar	1990: Cut 1 7/27 tons DM/acre
Multi-plier	1.67
VIP	1.66
VS888[a]	1.66
640	1.65
MultiKing 1	1.64
SDH56[a]	1.63
Flint	1.63
Crown II	1.63
G-2841	1.63
DK-122	1.59
AFYF 88[a]	1.59
Centurion	1.59
G-2833	1.59
5364	1.58
Baker	1.58
SK 217	1.58
8941N[a]	1.57
Dawn	1.56
W-154[a]	1.55
Perry	1.55
Vernal	1.54
120	1.54
8837W[a]	1.53
Wrangler	1.53
630	1.52
WL 225	1.52
SDHL1[a]	1.51
MTO 582[b]	1.50
5262	1.49
8832N[b]	1.49
H-174[b]	1.48
Allegiance	1.47
Aggressor	1.46
WL 317	1.45
MN GRN-14[a]	1.42
Saranac AR	1.42
Average	1.56
Maturity[b]	4.1
LSD (0.05)	NS[c]

[a] Experimental line, not currently marketed.
[b] Avg harvest maturity. Value based on Kalu and Fick (1983) mean-stage-by-count index.
[c] Cultivars not significantly different at the 0.05 level of probabilty.

1990 FLAX BREEDING

Kathleen Grady and John Felton

A yield trial of named flax varieties and experimental lines from SD, ND, and Canada was grown at the Northeast Research Station and two other South Dakota locations in 1990. The purpose of the trial was to provide performance data on released flax varieties to farmer/growers and compare performance of experimental lines to established checks in order to identify possible new varieties.

In 1990, 29 experimental lines from the SDSU flax breeding program were tested against 20 named varieties (checks) and 6 experimental lines from North Dakota and Canada. The trial was seeded on May 3, 1990 in a randomized complete block design with three replications. Yield, oil, flowering and height data on the 55 entries in the test are presented in Table 5. The overall mean yield across varieties was 29.4 bu/acre with 34.5% oil. The highest yielding check variety was Rahab, which averaged 34.5 bu/acre with 34.8% oil. The highest-yielding experimental line was SD87C24, which yielded 35.4 bu/acre and averaged 36.0% oil.

Table 5. Data on flax varieties and experimental lines grown at the Watertown NE Research Station in 1990.

Variety	Origin -year	Seed Yield	Rank	Oil Percent	Oil Yield	Days to Flower	Plant Height
		(bu/A)		(%)	(kg/ha)	(DAP)	(cm)
Clark	SD-83	30.5	15-17	34.1	650	56	57
Culbert	MN-75	29.4	25-27	33.7	620	54	57
Culbert 79	SD-79	31.3	8-9	33.4	652	54	57
Day	SD-90	29.2	30	35.3	643	54	56
Dufferin	CAN-75	29.4	25-27	34.1	626	57	58
Flanders	CAN-90	31.0	11-14	34.7	674	57	57
Flor	ND-81	28.8	34	33.2	598	56	59
Linott	CAN-66	27.4	46-47	33.5	573	55	58
Linton	ND-85	30.5	15-17	33.8	645	55	56
McGregor	CAN-82	27.6	45	33.5	579	58	60
Neche	ND-88	29.9	20-22	34.6	647	55	57
NorLin	CAN-83	31.1	10	33.9	660	56	59
NorMan	CAN-84	28.3	37-40	33.8	599	55	60
Omega	ND-90	25.4	55	34.1	539	57	58
Prompt	SD-89	31.0	11-14	34.2	654	55	60
Rahab	SD-85	34.5*	2	34.8	745*	56	59
Somme	CAN-90	29.0	32-33	33.2	601	56	59
Verne	MN-87	25.5	54	34.4	547	54	57
Vimy	CAN-86	28.0	43	35.2	615	55	58
Wishek	ND-79	28.3	37-40	33.2	583	55	58
CI 3269	SD-exp	29.0	32-33	34.2	620	53	54
CI 3270	CAN-exp	29.3	28-29	34.6	634	56	61
CI 3281	ND-exp	28.2	41	35.5	627	56	60
CI 3282	ND-exp	29.6	23-24	34.3	634	58	58
CI 3283	ND-exp	31.3	8-9	34.5	675	59	63
CI 3284	ND-exp	29.6	23-24	33.9	628	58	64
CI 3285	ND-exp	31.5	5-7	35.1	691	56	59

Table 5. (continued)

Origin	Seed	Oil		Days to	Plant		
Varietv	-year	Yield	Rank	Percent	Yield	Flower	Height
		(bu/A)		(%)	(kg/ha)	(DAP)	(cm)
CI 3294	SD-exp	29.9	20-22	34.1	636	55	59
CI 3295	SD-exp	29.9	20-22	34.3	641	54	57
CI 3296	SD-exp	28.1	42	34.0	598	54	56
CI 3297	SD-exp	30.5	15-17	35.6	677	55	59
CI 3298	SD-exp	29.3	28-29	35.1	642	56	58
CI 3299	SD-exp	30.3	18	34.4	650	54	59
SD 87425	SD-exp	28.4	35-36	34.2	606	53	55
SD 87467	SD-exp	31.5	5-7	34.7	683	55	57
SD 87468	SD-exp	28.3	37-40	34.2	605	56	63
SD 87A21	SD-exp	31.8	4	35.3	702	55	57
SD 87A44	SD-exp	31.5	5-7	36.9*	729*	56	57
SD 87B24	SD-exp	27.3	48	35.2	601	56	57
SD 87B54	SD-exp	27.1	50	34.0	575	55	58
SD 87C20	SD-exp	32.2	3	34.9	704	55	56
SD 87C24	SD-exp	35.4*	1	36.0*	796*	56	57
SD 87C85	SD-exp	26.9	51-53	34.8	584	55	52
SD 87D76	SD-exp	28.3	37-40	34.2	605	56	57
SD 87D81	SD-exp	27.7	44	34.4	595	54	60
SD 87E20	SD-exp	27.4	46-47	34.7	593	54	55
SD 87A90	SD-exp	26.9	51-53	32.5	544	56	58
SD 87B47	SD-exp	26.9	51-53	34.5	579	53	58
SD 87B62	SD-exp	27.2	49	35.8	607	56	59
SD 87E23	SD-exp	31.0	11-14	35.1	679	56	54
SD 87E88	SD-exp	29.1	31	35.5	647	56	59
SD 87F25	SD-exp	28.4	35-36	34.3	609	56	61
SD 87F36	SD-exp	31.0	11-14	34.8	676	54	56
SD 87F37	SD-exp	29.4	25-27	35.0	643	56	57
SD 87F98	SD-exp	30.2	19	35.3	667	55	59
Test mean		29.4		34.5	633	55	58
LSD .05		3.1		0.9	68	0.9	4
C.V.		6.6		1.7	6.7	1.0	3.8

*Indicates a variety in the top group based on the LSD .05.

OAT RESEARCH

Dale Reeves and Lon Hall

The preliminary herbicide screening test is a cooperative effort with the oat project and the extension weed staff to screen established varieties and promising lines for herbicide injury. Recommended and doubled rates are applied to six varieties or lines at the 3-4 leaf stage.

These data show MCPA amine, Bronate, and the low rate of MCPA and Dicamba cause the least injury; however, this may change with the variety, location, year, or stage of plant development. Generally, MCPA amine caused the least amount of injury. Other data has shown plants are more sensitive to Bronate and Dicamba applied at the 6-7 leaf stage.

				YIELD % OF CHECK		4 LOCATION AVERAGE	
	HERB	NORTHEAST		NORTH-EAST	4 LOC AVG		
TREATMENT	RATE ai lb/a	YIELD bu/a	TWT lb/bu	%	%	YIELD bu/a	TWT lb/bu
CHECK	----	127.0	36.9	100.0	100.0	91.3	34.6
MCPA am.	0.5	127.3	37.5	100.2	100.5	91.8	34.9
MCPA am.	1.0	125.5	37.5	98.8	99.3	90.7	34.8
2,4-D am.	0.5	114.3*	36.5	90.0	93.4	85.3	34.5
2,4-D am.	1.0	95.4*	35.6	75.1	83.7	76.4	34.0
BRONATE	.75	119.9	36.1	94.4	98.8	90.2	34.4
BRONATE	1.0	118.4	36.2	93.2	96.9	88.5	34.1
DICAMBA+MCPA am.	.125+.25	121.1	36.9	95.4	97.9	89.4	34.1
DICAMBA+MCPA am.	.25+.5	105.3*	35.2	82.9	89.2	81.4	33.5
LSD.05 = *		11.1					

Herbicidal injury varies with environmental conditions, therefore, several location-years are needed to show overall effects and interactions with variety, herbicide, and environment.

BREEDING NURSERY

The uniform mid-season nursery has 36 lines from several locations in the United States and Canada. The breeding nurseries consist of lines selected for this area. There are 68 bulk F_3, 85 F_5, and 123 F_6 lines tested with a total of 950 oat plots overall. The high yields were 156 bu/acre in the late F_6 nursery and 143.8 in the early. The means were 112.4 and 115.8 respectively. Eleven lines from the F_6's will be selected to be tested in the Tri-state nursery, at the same time they will increased and purified.

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

R. Gelderman, S. Drymalski, 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 from adding nitrogen fertilizer.

Methods

The study was located on the north side of the Watertown Station on a Brookings soil. These soils are deep, silty clay loam loess over glacial till. Results of the soil tests from samples taken in the spring of 1990 (just prior to planting) are shown in Table 6.

Table 6. Spring soil test results of nitrogen corn studies, Watertown Station, 1990.

NO_3-N					
0-24"	0-36"	O.M.	P	K	pH
lb/A		%	lb/A		
64	93	4.2	23	250	6.2

The soil tests for nitrate-nitrogen indicated moderate levels of nitrogen in the top two feet. Approximately 30 lbs/A of available N was located in the two to three foot depth. This is somewhat higher than average but not unusual. Very little soil moisture existed at planting especially in the two to three foot depth. If moisture doesn't move into this soil during the season, roots won't extract the available NO_3-N at this depth.

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

The previous crop was barley. The area was field cultivated and disked before planting Pioneer 3732 on May 10, 1990 at a population of about 19,000 plants per acre. The nitrogen fertilizer treatments were spread on the soil surface as ammonium nitrate twelve days after planting. The corn had still not emerged at this time. The rates used were 0, 30, 60, 90 and 120 lbs of actual nitrogen per acre. Each treatment was replicated four times. The plots were hand harvested on October 5, 1990.

Results and Discussion

Because of cool soil temperatures after planting, emergence was delayed for almost two weeks beyond normal. The cool wet temperatures caused poor germination resulting in a final stand count of 13,500 plants per acre. The average yields for the experiment are shown in Table 7.

Table 7. Average corn grain and stover yields for the nitrogen study, Watertown Station, 1990.

Rate of N	Grain Yield	Stover Yield
lb/A	bu/A (15%)	lb/A (dry wt.)
0	131	4824
30	131	4994
60	127	5323
90	126	5252
120	130	5435
Sign. of F	0.90	0.22

The grain yields were not influenced by nitrogen treatments. This is surprising in that available soil nitrogen to two feet was far below the estimated nitrogen required for 130 bushel corn (180 lb N/A). The lack of response here indicates breakdown of organic nitrogen must have been higher than expected. This value is usually from 30-60 lbs N/A per season. The estimated N mineralization from organic matter at this site would be 100-120 lbs N/A. The post harvest soil NO_3-N in the check treatment was only 17 and 34 lb/A for the 2 and 3 foot depths, respectively.

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

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

In summary, added nitrogen did not increase corn yields at this site in the 1990 growing season even though yield response would have been expected. Mineralization of organic nitrogen varies depending on weather conditions and is the biggest obstacle in predicting crop nitrogen needs. However, even with this limitation, the nitrate-nitrogen test can prevent excess nitrogen from being applied to fields where available soil nitrogen is well above crop N needs.

Table 15. Continued

Treatment	lb/A act.	1990 % Yeft	1990 % Rrpw	3-Year Ave. % Yeft	3-Year Ave. % Rrpw
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	4	58	55	81	49
Treflan	.75	74	78	76	71
Sonalan	1.1	76	86	84	86
Prowl	1.5	72	78	82	57
Treflan+Command	.75+.5	74	60	--	--
SHALLOW PREPLANT INCORPORATED					
Lasso	3	62	65	64	45
Dual	2.5	68	35	60	28
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan&Amiben	.75&2	93	98	90	88
Treflan&Pursuit	.75+.032	97	99	--	--
PREPLANT INCORPORATED & POSTEMERGENCE					
Treflan&Basagran+COC	.75&1+1 qt	78	94	82	96
POSTEMERGENCE					
Fusilade 2000+COC	.187+1 qt	96	0	84	0
Assure II	.0625	88	0	--	--
Assure II	.125	94	0	--	--
Poast+COC	.2+1 qt	96	0	92	0
Poast+Basagran+COC	.3+1+1 qt	96	90	--	--
Poast+Blazer+COC	.3+.38+1 qt	96	96	--	--
LSD (.05)				20	30

Table 16. Alfalfa Establishment Evaluation

Previous Crop: Small grain
Planting Date: 5/9/90
PPI: 5/9/90
POST: 6/26/90
Evaluated: 7/10/90
Soil: Silty clay loam; % OM 3.2; pH 6.3

Precipitation: 1st week 0.56 inches
2nd week 1.38 inches

Weeds: Yeft - Yellow foxtail
Rrpw - Redroot pigweed

COMMENTS: Grass density heavy; moderate broadleaf pressure. Alfalfa stand excellent. All PPI treatments provided excellent grass control, but were not effective on broadleaf control. Postemergence combinations were excellent. New experimental treatments show promise.

Table 16. Continued

Treatment	lb/A act.	1990 % Yeft	1990 % Rrpw	2-Year Ave. % Gr	2-Year Ave. % Bdif
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	2.5	98	25	72	13
Balan	1.25	86	52	75	59
Treflan	.75	92	48	85	50
Prowl	1	90	20	78	25
POSTEMERGENCE					
Buctril	.38	0	96	0	96
2,4-DB	1	0	89	0	92
Buctril+2,4-DB	.25+.5	0	96	--	--
Poast+Dash	.15+1 qt	98	0	97	0
Fusilade+COC	.187+1 qt	98	0	--	--
Buctril+Poast+Dash	.38+.15+1 qt	95	92	88	93
Pursuit+X-77	.063+.25%	95	78	89	81
Oats+Poast+Dash	.15+1 qt	98	81	94	40
LSD (.05)		4	13	14	12

Table 17. Flax Demonstration

Previous Crop: Small grain
Planting Date: 5/9/90
PPI: 5/9/90
POST: 6/29/90
Evaluated: 7/16/90
Soil: Silty clay loam; % OM 3.2; pH 6.3

Precipitation: 1st week 0.56 inches; 2nd week 1.38 inches

Weeds: Grft - Green foxtail
Wioa - Wild oat
Kocz - Kochia
Wimu - Wild mustard

COMMENTS: Moderate grass and broadleaf pressure. Grass control was the primary factor on yield. Postemergence treatments were applied at maximum development stage for most treatments. Tordon was beyond treatment stage and produced significant injury.

Treatment	lb/A act.	Percent Weed Control % Grft	% Wioa	% Kocz	% Wimu	Yield bu/A	Test Wt. lb/bu
PREPLANT INCORPORATED							
Check	----	0	0	0	0	13.4	54.8
Treflan	.5	94	65	40	18	23.9	54.9
Ramrod	4	88	48	0	95	17.8	53.8
POSTEMERGENCE							
MCPA amine	.5	0	0	50	98	11.0	52.8
MCPA ester	.5	0	0	62	98	13.6	52.7
Buctril	.25	0	0	94	98	16.6	54.4
MCPA ester+Tordon	.5+.0156	0	0	55	98	0.6	----
Poast+COC	.2+1 qt	96	99	0	0	16.4	53.4
Poast+Buctril+COC	.2+.25+1 qt	94	97	94	98	20.2	53.6
Fusilade 2000+COC	.187+1 qt	94	98	0	0	14.4	54.9
LSD (.05)		3	3	6	7	4.9	2.0

1990 Potato Rotation Study

D. J. Gallenberg, L. Evjen

The long-term objective of this study is to determine the effects of rotation and other factors on disease development and pathogen populations. This particular study follows a potato-spring wheat-corn rotation schedule. Plots of Kennebec and Red Pontiac were planted on May 18 in 40 inch rows with approximately 12 inches between seed pieces within the row. Plots were observed during the season for disease development, which was generally absent. No significant disease was observed at harvest although the plot area has in the past shown activity of *Rhizoctonia* and *Fusarium*. Plots were harvested on September 24. Overall converted yields were 155 cwt/acre for Kennebec and 141 cwt/acre for Red Pontiac.

1990 South Dakota Fungicide Trials on Spring Wheat

G.W. Buchenau, D.E. Gallenberg and S.S.A. Rizvi

INTRODUCTION

Fungicide trials were conducted at three locations in 1990: the SDSU Plant Science Farm at Brookings, the Northeast Experiment Farm near South Shore, and at the Dean Johnson farm near Pierpont. Although rainfall patterns were favorable for development of tanspot caused by *Pyrenophora tritici-repentis*, the low level of inoculum due to the dry season of 1989 resulted in a relatively mild epidemic in spite of the weather. At Brookings, head scab caused by *Fusarium graminearum* was a major factor affecting yield and grain quality. At Pierpont, bacterial blight caused by *Xanthomonas campestris* pv. *translucens* (syn *X. translucens*) caused substantial leaf necrosis, but yields at that location were excellent. At the Northeast Farm, some bacterial blight developed and yields were moderate. Cultivars used were resistant to moderately resistant to leaf rust, and little rust developed in the tests. All experiments had a common objective of testing spray advisory systems. Evaluation of fungicides was a secondary objective in certain experiments.

MATERIALS AND METHODS

At Brookings, two experiments were conducted. In the first experiment, 9001, the cultivar Prospect was planted on ground previously cropped to wheat. In the second, 9002, the cultivar Marshall was planted on ground previously cropped to potato. Both were chisel-plowed in the fall, and conventional disk-harrowed prior to spring planting with a conventional drill on 9 April in rows 6" apart. Each plot consisted of 6 rows with 12" between adjacent plots. The plots were planted on 20 ft centers and later trimmed to a length of 15 ft. Curtail-M was applied to control broadleaf weeds on 22 May (4-leaf stage). Each experiment was arranged in a randomized complete block design with 5 replications. Treated plots were bordered by untreated buffer plots and separated end to end by 6 ft alleyways of spring-planted winter wheat. The plots were harvested on 30 July. A similar experiment (9003) was planted to Marshall at the northeast farm on 12 April and harvested on 10 August. The previous crop in experiment 9003 was wheat. Hoelon and Buctril were applied for weed control. The experiment in Day county (9004) was of a similar design, except that the plots were 7 rows wide (harvested area of 57.2 ft^2 per plot), planted with a plot drill, and did not have untreated buffers between treatments.

Fungicides were applied with a CO_2 pressurized plot sprayer calibrated to deliver 30 gpa at 30 psi. Applications were made according to schedules noted in the tables below. Growth stage was estimated from growing degree days at the sites and verified in the field. Favorable periods for tanspot infection were judged according to modified EPINFORM periods which are based on temperature, rainfall, and a temperature driven 'clock' that estimated the latent period between cycles. The original system, developed in Montana for Septoria diseases, was modified for South Dakota conditions. The modifications included a shorter 'cycle clock' of 50, and minimum average temperatures of 46, and minimum low temperatures of 33 F. In addition, rainfall >0.1" was required to reset the cycle clock to zero when the other requirements were met. Where indicated, chloride was applied as a preplant broadcast treatment at the rate of 1.251 g of KCl per square foot (120 lb KCl/A).

Some of the fungicide treatments were designed to be 'standard' treatments, eg Tilt at growth stage 8 (flag leaf emergence), Mancozeb at boot (stage 10) and 10 days later. Other treatments were based on one or more prediction schemes. In experiment 9001 these were planned as follows: Treatments 4 and 9-Mancozeb after 4 favorable periods (FP's) and again 10 days later, Treatment 5-Mancozeb applied after FP 4 and again after FP 5 if FP 5 occurred at least 7 days after FP 4 and before the milk stage of development, Treatment 6- Mancozeb applied after FP 5. However, an error in determining FP 4 occurred, and the initial application of treatments 4, 5, and 9 were applied after FP 3 but before FP 4.

At the northeast farm 'predicted' applications triggered by FP 4 or FP 5 were not applied since only three favorable periods occurred prior to the milk stage of development. Similarly, in the Day county experiment, planned applications triggered by infection levels of 1 tan spot lesion per penultimate leaf or 1 lesion per flag leaf were not applied because disease never reached these levels.

RESULTS

A. Brookings, experiment 9001

Growing degree days were used to estimate leaf emergence and crop maturity. These estimates were generally in agreement with actual crop maturity.

Although 6 EPINFORM infection periods occurred in the 1990 season, tan spot developed slowly, probably because of very light primary inoculum from the droughty 1989 crop. The 6 infection periods occurred on 12 May (3-4 leaf stage), 26 May (6-leaf stage), 3 June (pre-flag leaf), 16 June (early heading), 28 June (1/2 berry) and 5 July (milk stage). Tan spot reached a level of about one lesion per tiller (an average of about 0.25 lesions per living leaf) on 11 June (early boot), and 2 more favorable periods resulted in 16 lesions per tiller (an average of 5 lesions/living leaf) on 3 July (full berry). Of these lesions, 12 occurred on leaf 6, 3 on leaf 7 and 1 on the flag leaf. This level of disease should not reduce yield appreciably. This hypothesis was supported by both yield and kernel weight data (Table 18). Neither was there any effect of fungicide on the amount of dead leaf tissue at the early dough stage (13 July, Table 18).

Scab ratings from untreated wheat outside the plot area indicated that about 1% of the florets were scabby on 13 July. No effect of treatment on scab was obvious although no data were taken. This disease apparently was favored by the warm humid weather of the last two weeks of July and spread through the heads rapidly, since many of the harvested seed were shriveled and/or discolored.

B. Brookings, experiment 9002

Growth of cultivar Marshall was similar to that of Prospect in 9001, except that Marshall was somewhat later. Boot stage occurred on 19 June instead of 13 June, heading occurred on 23 June instead of 18 June, and the milk stage was reached on 13 July. Disease development also was similar to that on Prospect. Tan spot was rated at approximately 0.05 lesions per tiller on 5 June, 1 lesion per plant on 11 June, and by mid-berry (3 July), had reached levels of 0.4, 5, and 10 lesion on flag, 7th and 6th leaves, respectively. This compares with 1, 3 and 12 lesions on Prospect at the same sampling date. Laboratory isolation confirmed the presence of tan spot in specimens collected on 22 June. This level of disease was not expected to affect either yield or kernel weight and the data of table 2 supports this. None of the fungicides affected the number of flag leaves dead on 13 July (Table 19).

Scab ratings on this cultivar on 13 July also indicated about 1% of the florets scabbed. Considerable spread must have also occurred on this cultivar in the 2 weeks prior to maturity.

C. Northeast Farm, experiment 9003

The weather in May and especially late June was considerably drier than at Brookings, and the EPINFORM system indicated that only 3 favorable periods for tan spot infection occurred, compared to 6 at Brookings. These occurred on 15 May, 3 June and 13 June. Trace levels of tanspot were observed on 18 June, and by 6 July the disease was common on lower leaves, but virtually none occurred on flag or penultimate leaves at any time. Reference growth stages developed as follows: boot - 19 June, 50% heading - 23 June, milk - 11 June. Neither fungicide nor chloride application had a significant effect on yield or seed weight (Table 20).

D. Day County, experiment 9004

These plots were virtually free of tanspot throughout the growing season in spite of very favorable weather for crop growth. The plots were on soybean ground, and the background levels of tan spot inoculum obviously were very low. Early boot occurred on 18 June, 50% heading on approximately 23 June, and milk stage on 11 July. Although precise weather data were lacking, thereby negating EPINFORM, infection periods were probably similar to those at Brookings. Again, neither fungicide treatment nor chloride application resulted in significant differences in yield or seed weight (Table 21).

Table 18. Yield, seed weight and dead leaf data from Prospect spring wheat, experiment 9001.

Fungicide and chloride treatment	Yield bu/A	Kernel wt mg	Dead leaves on 13 July %
1. No Fungicide	23.9	38.40	83
7. Chloride Soil Treatment, No fungicide	22.6	38.66	91
2. Tilt, Stage 8-9 (12 June)	28.0	36.98	86
8. Chloride soil treatment, Tilt, Stage 8-9 (12 June)	24.8	44.05	89
3. Mancozeb, 12 June & 25 June	26.7	38.79	80
4. Mancozeb, 15 June & 25 June	24.9	37.15	81
9. Chloride soil treatment, Mancozeb-15 June & 25 June	24.1	40.78	85
5. Mancozeb-15 June & 3 July	28.4	42.98	82
6. Mancozeb-3 July	26.5	42.62	80
$LSD_{.05}$	4.3	7.84	12

Table 19. Yield, seed weight and dead leaf data of Marshall spring wheat in experiment 9002.

Fungicide and chloride treatment	Yield bu/A	Kernel wt mg	Dead leaves on 13 July %
1. No Fungicide	34.0	23.1	86
2. No Fungicide, Chloride soil treatment	32.4	17.0	84
3. Tilt, Stage 8 (12 June)	35.1	19.6	82
4. Mancozeb, 12 June & 25 June.	35.1	17.2	82
5. Mancozeb, Predict 1	33.5	14.9	81
6 DuPont Exp[a], 2 oz/A, Stage 8, 12 June	34.9	16.2	85
7. DuPont Exp, 4 oz/A, Stage 8, 12 June	35.5	17.0	84
8. DuPont Exp, 8 oz/A, Stage 8, 12 June	32.8	19.1	85
9. DuPont Exp, 12 oz/A, Stage 8, 12 June.	36.9	16.8	81
$LSD_{.05}$	4.3	5.8	9

[a]Experimental fungicide - DPX-H6573-208 ("Punch")

Table 20. Yield and seed weight of Marshall spring wheat in fungicide trials at the Northeast Farm in 1990, experiment 9003.

Fungicide	KCl lb/A	Yield bu/A	Kernel weight mg
None	None	54.0	34.6
None	120	50.4	31.2
Tilt, 11 June	None	48.8	32.5
Tilt, 11 June	120	53.6	33.4
Mancozeb, 18 June + 28 June	None	58.8	33.3
$LSD_{.05}$		6.9NS	4.8NS

Table 21. Yield and seed weight of Marshall spring wheat in fungicide plots in Day county, experiment 9004.

Fungicide	KCl lb/A	Yield bu/A	Kernel Weight mg
None	None	70.2	34.9
None	120	70.9	34.2
Tilt, 11 June	None	69.4	33.5
Tilt, 11 June	120	72.4	31.8
Mancozeb, 18 June + 28 June	None	71.9	32.9
$LSD_{.05}$		3.8 NS	6.0 NS

Winter Wheat Variety Trial

J. Smolik and L. Hall

Objectives: Compare yield and overwinter survival of ten winter wheat varieties.

Methods: The plot area was chiseled, field cultivated and harrowed prior to planting on 12 September 1989. The experimental design was a randomized complete block with four replications.

Results: The winter of 1989 was generally open and severe winter injury occurred in some of the varieties. The highest yielding varieties were Roughrider and Seward, followed by Rose (Table 22). Agassiz, Arapahoe and Norstar suffered some winter injury and yielded about half of the top varieties. Abilene, Quantum 562, Siouxland and TAM 107 were severely injured and yields were very low (Table 22). These last four varieties appear poorly adapted to this area of South Dakota, at least when seeded under low residue conditions.

Table 22. Winter Wheat Variety Trial, N.E. Station

Variety	Yield (Bu/A)
Roughrider	33.2[a]
Seward	32.4
Rose	22.8
Agassiz	16.2
Norstar	14.6
Arapahoe	14.1
Quantum 562	8.4
Abilene	7.8
Siouxland	5.9
Tam 107	1.7
	$Lsd_{.05}$ = 6.2

[a]Avg. of 4 replications.

Soybean Row Space Study - N.E. Station

J. Smolik, L. Evjen and S. Werner

Objectives: Compare effects of row spacing and plant population on yield of three soybean varieties.

Methods: The previous crop in the study area was winter wheat. The stubble had been chisel plowed the previous fall. Sonalan was applied at 1½ pints (actual) and incorporated by discing, and field cultivating and harrowing. Soybeans were planted on 22 May. Two Group 0 varieties (Glenwood and Simpson) and a Group I variety (Hardin) were planted in 7-, 21-, and 36-inch rows at 150,000 or 180,000 seeds/A. A press drill was used to seed the 7- and 21-inch rows, and the 36-inch rows were seeded with a plateless planter. The 36-inch row plots were cultivated once. The 7- and 21-inch row plots were 14 feet wide and the 36-inch were 12 feet wide. All plots were 50 feet long. Plots were harvested on 2 October. The experiment was a 3 x 3 x 2 factorial arranged in a randomized complete block design with four replications.

Results: A late July thunderstorm caused some lodging in the plot area, however no difficulty was experienced in harvesting. The highest plant population (180,000) resulted in significantly higher yields for all varieties at all row spacings (Table 23). With the exception of variety Glenwood, the 7- and 36-inch row spacings yielded significantly higher than the 21-inch spacing. The variety Glenwood did not respond in a consistent manner to row spacing effects. Hardin planted in 36-inch rows at 180,000 seeds/A was the highest yielding variety. However, because of the generally short growing season at the N.E. Station, the planting of Group I varieties can be risky in some years. Overall, this study indicated that planting soybeans at higher plant populations may result in significant yield increases.

Table 23. Yield of three soybean varieties at three row spacings and two populations, N.E. Station.

Row Spacing	7 inch		21 inch		36 inch	
Population/A (Thousands)	150	180	150	180	150	180
Variety and Yield (Bu/A)						
Simpson:	37.3[a]	39.5	31.3	33.9	38.5	38.9
Glenwood:	36.7	37.6	33.1	35.7	34.6	36.4
Hardin:	37.2	38.2	35.0	38.3	38.2	42.0

[a]Avg. of four replications.

Hay Millet and Forage Sudan Study

J. Smolik and L. Evjen

Objectives: Measure forage production of three hay millets and two forage sudans.

Methods: Plots were seeded 21 June. Millets were seeded at 15 lbs/A and sudans at 20 lbs/A. Plots were 7' wide and 40' long. The five treatments (Piper sudan, "True" hybrid sudan, Pearl Millet, Foxtail millet, and Siberian hay millet) were arranged in a randomized complete block design with four replications. Forage was harvested twice, and the first cutting was obtained 30 July and the second cutting on 17 September.

Results: There were no significant differences in forage yields on the first cutting date (Table 24). On the second cutting date, Piper and True sudan and Pearl millet significantly out-yielded Foxtail and Siberian millet. Regrowth of Foxtail millet was only moderate and Siberian millet regrowth was very poor. Total forage yield was highest for Pearl millet followed by True and Piper sudan.

Table 24. Forage production of millet and sudan, N.E. Station.

Entry:	Piper Sudan	True Hybrid Sudan	Pearl Millet	Foxtail Millet	Siberian Hay Millet
1st Cutting: (30 July)	1.05[a]	0.96	1.12	1.09	1.19
2nd Cutting: (17 September)	2.64	2.92	2.83	1.22	0.36
Total:	3.69	3.88	3.95	2.31	1.55
	$FLSD_{.05} = 0.36$				

[a]Avg. of four replications -- Tons/A dry matter.

Legume-Small Grain Rotations

J. Smolik and L. Evjen

The objectives of this study were to compare the agronomic performance of a minimum-till small grain rotation, a legume-based small grain rotation and a small-grain fallow rotation. The study was established in 1988 and originally two legume-based rotations were planned, however, the medic/switchgrass stand obtained in the 1988 drought year was very poor and the treatment was converted to fallow. The three three-year rotations were: Minimum-till, oats - barley - spring wheat; Legume-based, oats/sweet clover - sweet clover (green manure) - spring wheat; Small grain-fallow, oats - fallow - spring wheat. In the fall of 1988 the minimum-till oat stubble was chisel plowed and 50 lbs of N were applied to the minimum-till plots. In 1989 the fallow plots were field cultivated in late May, the sweet clover was cut in mid-June (forage not removed), and all plots were chisel plowed in mid-August. The estimated sweet clover forage yield in 1989 was 1.55 T/A dry matter, and tissue analysis was 2.75-0.27-2.22 (% N-P-K). Minimum-till barley yielded 42.3 Bu/A in 1989. Prior to planting in 1990, all plots were field cultivated once. Plots were planted with Marshall spring wheat at 70 lb/A on 19 April. Hoelon and Buctril at 2 pt and 1 pt (actual/A) were applied to the minimum-till spring wheat. The experimental design was a randomized complete block with three replications. Plots were 14' wide and 30' long.

Results: Oat yields in 1988 and spring wheat yields, test weights and protein levels in 1990 were not significantly different between treatments (Table 25). The very good spring wheat yields reflect the 1990 growing season in which both moisture and temperature were nearly ideal for small grain development at the N.E. Station -- a marked contrast to the 1988 drought and the 1989 near-drought conditions. Post-harvest soil nitrate levels in 1990 were not different between treatments (Table 26). N-uptake was roughly what might be expected with the 1990 yields.

This study indicates that sweet clover handled as a lightly incorporated green manure crop may be a viable alternative to fallow, even in dry years. It also appears that sweet clover grown under near-drought conditions will still provide adequate amounts of nitrogen for a subsequent spring wheat crop.

Table 25. Spring wheat yields, test weights and protein levels in 1990, and 1988 oat yields.

Treatment	Yield (Bu/A)	T.W.	Protein (%)	Oats (1988) (Bu/A)
Minimum-Till	51.2[a]	53.5	12.7	36.4
Sweet Clover (1989)	58.6	51.8	13.5	39.4
Fallow (1989)	54.9	52.8	12.6	40.0

[a]Avg. of 3 replications.

Table 26. Soil nitrate levels and growing season precipitation, 1988-1990.

Treatment	lbs NO_3-N to 2'		
	1988	1989	1990
Minimum-Till	60.7[a]	108	11.7
Sweet clover (1989)	13.7	176	12.0
Fallow (1989)	11.3	144	10.7
Growing Season Precipitation (April - Oct, Normal = 17.28)	12.13"	14.95"	18.68"

[a]Avg of 3 replications; Sampling dates: 1988 - 11 October, 1989 - 13 September, 1990 - 8 August.

Mechanical and Chemical Weed Control in Spring Wheat

J. Smolik, L. Evjen, K. Lewis and P. Wieland

Objectives: Compare effects of mechanical and chemical weed control methods on weed populations and yield of spring wheat.

Methods: The previous crop in the study area was winter wheat; the stubble had been fall chisel plowed. The plot area was field cultivated and harrowed prior to planting on 12 April. Spring wheat (Butte 86) was seeded at 70 lb/A. Individual plots were 14' wide and 28' long. Treatments were arranged in a randomized complete block design with four replications. The four treatments were: Control; Rotary hoe once (2 weeks after emergence); Rotary hoe twice (2 and 4 wks after emergence); Hoelon 2 pt plus Buctril at 1 pt (actual/A). An eight-foot wide swath was harvested from the center area of each plot for yield determination.

Results: There was no significant difference in yield between the Control, Hoeing once or the Hoelon + Buctril treatments (Table 27). Rotary hoeing twice reduced yield - possibly because of mechanical damage to the young wheat plants. The Hoelon + Buctril treatment provided significantly superior weed control in terms of both weed numbers and biomass (Table 27). Neither mechanical treatment significantly reduced weed numbers, however, both mechanical treatments appeared to increase grassy weed biomass. There was not a significant correlation between spring wheat yield and either weed numbers or biomass, which suggests that weeds did not exceed the damage threshold in any of the treatments.

Table 27. Effect of weed control on yield of spring wheat - N.E. Station.

		Weed Number/3 ft^2			Weed biomass lb/A dry wt.		
Treatment	Yield (Bu/A)	Grass	Bdlf	Total	Grass	Bdlf	Total
Control	48.4[a]	92[b]	36[b]	128	137	235	373
Rotary hoe 1x	49.0	130	34	164	387	294	681
Rotary hoe 2x	43.1	83	23	106	343	186	530
Hoelon 2 pt + Buctril 1 pt	48.3	30	2	32	74	4	78
$FLSD_{.10}$ =	3.9						
$FLSD_{.05}$ =		47	15	57	109	174	176

[a]Avg. of four replications.
[b]Grasses were primarily yellow foxtail, broadleaves (Bdlf) were primarily wild buckwheat and pigweed.

Mechanical and Chemical Weed Control in Soybean and Effect on Soybean Yield

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

Objectives: Compare effectiveness of mechanical and chemical weed control methods in soybean and effect on soybean yield.

Methods: The previous crop in the study area was winter wheat, and the stubble had been fall chisel plowed. The plot area was disced, field cultivated and harrowed prior to planting on 22 May. Soybeans (var. Simpson) were seeded in 36" rows at 150,000 seeds/A. Plots were 4 rows wide and 45' long. The ten treatments were arranged in a randomized complete block design with four replications. Treatments were: Control; Cultivate once (late); Cultivate twice; Rotary hoe once, cult 2x; Hoe 2x, cult 2x; Drag 1x, cult 2x; Drag 1x, hoe 1x, cult 2x; Hoe 2x, cult 1x (late); Hoe 2x, cult 2x, walk; Lasso II, 7 lbs banded (actual/A), cult 1x. The first pass with the rotary hoe or drag harrow was 2 days after planting, the second rotary hoeing was 7 days after planting. The first cultivation was 11 June and second or (late) cultivation on 27 June. Weed populations were estimated on 8 Aug and 7 Sept. Visual estimates of weed control were obtained on 10 August.

Results: All weed control treatments significantly increased soybean yields compared to the control (Table 28). Highest yields were obtained in the Hoe 1x or 2x or Drag 1x, plus 2 cultivations. In most instances cultivating twice plus an early hoeing or dragging significantly increased yields compared to a single cultivation.

There were no significant differences in weed numbers or biomass between any of the weed control treatments, although all treatments significantly reduced weed populations compared to the Control (Table 28). Numbers and biomass of grasses and numbers of broadleaves were not significantly different between sampling dates, however, biomass of broadleaves increased significantly from August to September. Visual estimates of grassy weed control were in general agreement with grass biomass estimates, but not with grass counts. The regression equation relating yield and visual estimates of yellow foxtail control indicated yield increased 1.6 Bu/A for each 10% increase in foxtail control. The regression equation for foxtail biomass in August indicated a yield loss of 1 bu/A for each 230 lb/A (dry wt) of foxtail produced.

Results of this study indicate mechanical methods can provide acceptable levels of weed control in soybean.

Table 28. Effect of mechanical and chemical weed control methods on soybean yield and weed populations -- N.E. Station.

Trt	Yield (Bu/A)	Date	Weed number/3 sq ft			% grass control (visual est)	Weed biomass lb/A dry wt		
			Grass	Bdlf	Total		Grass	Bdlf	Total
Control	20.5	Aug	58	7	65	0	2642	569	3198
		Sept	31	5	36		1826	1643	3486
Cult 1x (late)	32.8	Aug	3	1	3	83.3	19	3	22
		Sept	5	1	6		243	1960	2238
Cult 2x	34.5	Aug	8	.3	9	91.8	77	22	98
		Sept	2	.3	2		61	170	230
Hoe 1x, Cult 2x	37.2	Aug	4	0	4	91.8	96	0	96
		Sept	4	.3	4		45	1075	1119
Hoe 2x, Cult 2x	36.0	Aug	6	.3	6	92.5	80	19	99
		Sept	4	1	4		75	240	316
Drag 1x, cult 2x	36.4	Aug	6	0	6	86.3	511	0	511
		Sept	3	1	4		140	198	342
Drag 1x, hoe 1x, cult 2x	32.9	Aug	14	1	15	88.0	214	3	218
		Sept	6	0	6		281	0	281
Hoe 2x, cult 1x	32.9	Aug	5	1	6	85.8	182	1	182
		Sept	9	1	10		791	10	812
Hoe 2x, cult 2x, walk	37.3	Aug	1	0	1	96.0	3	0	3
		Sept	1	0	1		6	0	6
Lasso II, band, cult 1x	33.9	Aug	6	.3	6	82.8	118	1	119
		Sept	27	0	27		351	0	351
$FLSD_{.05}$ = (Trt)	3.1		21	1.3	22	4.5	451	N.S.	1154

Average of four replications. Grass was primarily yellow foxtail. Broadleaves (Bdlf) were primarily Russian thistle, redroot pigweed and kochia.

Mechanical and Chemical Weed Control in Corn and Effect on Corn Yield

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

Objectives: Compare chemical and mechanical methods of weed control in corn and effects on corn yield.

Methods: The previous crop in the study area was winter wheat. The wheat stubble was fall chisel plowed. The plot area was field cultivated and harrowed prior to planting. Corn (Pioneer hybrid 3790) was planted 11 May in 36" rows. The eight treatments were arranged in a randomized complete block design with four replications. Treatments were: Control; Cultivate once (late); Cultivate twice; Rotary hoe once, cultivate 2x; Rotary hoe 2x, cultivate 2x; Drag once, cultivate 2x; Drag 1x, hoe 1x, cultivate 2x; Lasso II, 7 lb band (actual/A) + cultivate 1x. Plots were 4 rows wide and 28' long. The middle two rows were harvested for yield determinations. The first rotary hoeing or drag harrowing was 5 days after planting, the second hoeing was 13 days after planting. The first cultivation was 8 June and second cultivation on 25 June. Weed counts and biomass estimates were obtained on 2 August and 9 September. Visual estimates of weed control were made on 10 August.

Results: The control yielded significantly less than one cultivation, and both of these treatments yielded less than the remaining treatments. There was no statistically significant difference in yield between the other six treatments (Table 29).

All of the weed control methods significantly reduced weed numbers and biomass compared to the control (Table 29). There was generally no significant difference in grass control among any of the weed control treatments. Broadleaf numbers were significantly different between the control and one cultivation, and between one cultivation and the remaining six treatments. Grassy weed biomass (primarily yellow foxtail) was higher in August than September, as might be expected since seed heads were nearly empty on the September sampling. Broadleaf weeds continued to develop and their biomass was highest in September. With the exception of the Lasso + Cultivate 1x treatment, the visual estimates of grassy weed control related well to grass counts and biomass.

In general, grassy weed populations were well correlated with corn yield losses while broadleaf populations were not. The regression equation for visual estimates of grass control indicated corn yields were increased approximately 6 bu/A for each 10% improvement in weed control. The regression equation for foxtail biomass in August indicated a bushel of corn was lost for each 100 lbs/A (dry weight) of foxtail produced. This compares well with the relationship between foxtail biomass and corn yield loss based on a similar study in 1989 in which a bushel of corn was lost for each 128 lbs/A of foxtail.

Based on results of this and the similar study in 1989, it appears that properly timed mechanical weed control methods will provide very good weed control in corn.

Table 29. Effect of mechanical and chemical weed control treatments on corn yields and weed populations -- N.E. Station.

Treatment	Yield (Bu/A)	Date	Weed number/3 ft^2 Grass	Bdlf	Total	% grass control (Visual est.)	Weed biomass (lbs/A) Grass	Bdlf	Total
Control	43.0	Aug	73	8.6	90.0	0	4664	558	5222
		Sept	36	3.5	39.5		2671	1116	3786
Cult 1x (late)	69.1	Aug	26	4.0	30.0	59.5	1695	206	1903
		Sept	16	3.0	19.0		1366	2607	3966
Cult 2x	99.9	Aug	11	0.5	11.5	80.0	768	121	886
		Sept	2	0.5	2.5		432	2	432
Hoe 1x, Cult 2x	91.2	Aug	5	0.5	6.0	79.3	77	0	77
		Sept	6	0.3	6.3		435	1	438
Hoe 2x, Cult 2x	95.8	Aug	17	0.5	18.0	75.0	384	4	391
		Sept	12	0.3	12.5		764	29	768
Drag 1x, Cult 2x	88.1	Aug	9	0.3	10.0	78.0	416	1	417
		Sept	5	0.5	5.7		579	1	582
Drag 1x, Hoe 1x, Cult 2x	95.2	Aug	13	1.3	14.5	78.5	896	5	901
		Sept	5	0	5.5		409	0	409
Lasso + Cult 1x	101	Aug	10	0.8	10.5	89.5	528	761	1301
		Sept	5	0.5	5.5		435	26	438
$FLSD_{.05}$ (Trt)	13.1		14	2.2	15	9.3	1019	N.S.	2161

Average of four replications.
Grass was primarily yellow foxtail, Broadleaves (Bdlf) were primarily Russian thistle, kochia and redroot pigweed.

Costs and Returns Associated with the 1989 Mechanical Weed Control Study in Corn

J. Smolik and S. Van Der Werff

The agronomic methods employed in the study were generally similar to those previously described for the 1990 mechanical/chemical weed control study in corn. All of the mechanical treatments except one cultivation resulted in increased income (Table 30). Income from one cultivation was slightly less than the control. The highest return occurred in the Rotary hoe 1x cult 2x treatment, however, there was little difference in returns between this treatment and the Cult 2x and Drag 1x, hoe 1x, cult 2x treatments. Results of this study indicated mechanical methods can provide acceptable levels of weed control, and also are economically competitive with other weed control methods.

Table 30. Costs and returns, corn yields and foxtail control in 1989 mechanical weed control study.

Treatment	Corn Yield (Bu/A)	lbs. Foxtail/A	Weed Control Cost/A[c]	Income/A Minus Weed Control Costs[d]
Control	58.9[a]	2105[b]	$ 0.00	$120.75
Cultivate 1x	60.8	2242	$ 4.26	$120.38
Cultivate 2x	78.9	114	$ 8.52	$153.23
Drag 1x Cult 2x	77.9	464	$11.46	$148.24
Rotary Hoe 1x Cult 2x	81.2	50	$10.89	$155.57
Rotary Hoe 2x Cult 2x	79.6	25	$13.26	$149.92
Drag 1x Hoe 1x Cult 2x	81.8	6	$13.83	$153.86
$FLSD_{.05}$	7.9	799		

[a]Avg of four replications
[b]Includes both green and yellow foxtail-plants clipped at ground level and oven dried - Sampled August 24.
[c]Costs include fuel, lubricants, repairs, labor and fixed costs.
[d]Assumes corn selling price of $2.05/bu - no deficiency payments included.

The Effect of Weed (proso millet) Competition on the Growth and Production of 6 Maize Hybrids

M.J. Foley, Z.W. Wicks and S.A. Clay

In the spring of 1990, six maize hybrids were chosen for this experiment based on their performance in Line Source Irrigation experiments during the 1986-89 cropping years. The top performers in those experiments during those years were (1) A632 x LH8, (2) A632 x W64A, (3) CM105 x FR23, (4) CM105 x LH38, (5) FR23 x A632, (6) H99 x A632.

The purpose of this experiment was to see how these 6 hybrids perform under weed stress. Red Proso Millet was planted within the corn plots to act as a weed population to put stress on the hybrids.

The experiment was designed as split-split plot design with corn plant density as the main plot, weeds or no weeds as the sub-plot, and hybrids as the sub-sub-plot in a total of 6 replications. The corn was planted on May 7, 1990 at the rate of 24,000 plants per acre with a 2-row Kinze Max-emerge corn planter. The weed (proso millet) was planted over the top three days later with a grain drill. 4 weeks after planting, the corn plant densities were thinned to 18,000 (3 reps) and 21,000 (3 reps) plants per acre. Each plot was 4 rows wide and 15 feet long.

During the growing season, notes that were taken on each plot included stand count of corn plants, height of corn at maturity, harvest index, stalk lodging, grain moisture and yield of the middle 2 rows of the 4 row plots. Analysis of data is currently incomplete, and results will be reported at a later date.

1990 PERFORMANCE TRIALS OF CORN, SMALL GRAINS AND SOYBEANS AT THE NORTHEAST RESEARCH STATION

J. J. Bonnemann

The crop performance testing program at the Northeast Station included small grains, soybeans and corn in 1990. The small grains under trial were barley, durum, oats, spring wheat, and triticale. Soybean trials grown at the farm included Group 0 and Group I maturity groups. The corn trials were separated into early and later maturity yield trials based on relative days to maturity information supplied by the participating companies. The arbitrary division was set at earlier or later than 95 days. The proprietary entries included are the choice of the participating companies and included on a fee basis.

The small grain yields were good to excellent in all trials. Temperatures did not reach high extremes and adequate precipitation was timely. Soybean yields were excellent to good with a few exceptions due to poor germination and subsequent stand problems. The corn yields were generally good. The results of the small grain and soybean trials and more agronomic data are reported in EC 774 (rev.) and EC 775 (rev.), respectively. The corn results are reported in Plant Science Pamphlet #41. The publications are available from County Extension Offices or from the Bulletin Room, SDSU, Brookings, SD 57007.

Table 31. 1990 Corn Performance Trial, Area D2 (late), Northeast Farm, Watertown, SD.

Brand and Variety	Yield B/A	Test Weight Lb/B	% Stalk Lodged	% Moist	Performance Score
Supercrost 1867	122.0	53.8	1.2	21.5	1
Terning Encore II	119.0	50.6	2.4	23.6	3
Top Farm SX1101A	118.7	51.6	0.6	23.7	2
Funks 4299	118.5	51.3	2.5	23.6	4
Funks 4260	114.0	50.1	2.4	22.6	5
Golden Harvest H2404	113.8	48.1	1.9	24.9	7
Asgrow RX469	113.1	49.2	4.2	23.1	6
Interstate IS523	110.3	47.4	1.9	25.4	8
Northrup King N4350	106.7	48.9	3.6	23.2	10
Northrup King N3624	106.3	59.5	2.1	22.9	9
Tecnagene DF4898	106.1	48.0	6.8	24.8	13
Top Farm SX1101	104.9	48.2	1.6	24.9	12
Tecnagene DF4897	104.1	51.5	0.7	22.4	11
Interstate IS543	100.8	48.4	1.3	25.2	14
Horizon 6101	96.9	48.9	2.7	25.8	15
Garst 8708	87.6	46.5	4.9	26.3	16
Means	108.9	50.1	2.5	24.0	

LSD (.05) 16.8 C.V. - 9.4%

Table 32. 1990 Corn Performance Trial, Area D2 (early), Northeast Farm, Watertown, SD.

Brand and Variety	Yield B/A	Test Weight lb/B	% Stalk Lodged	% Moist	Performance Score
Garst 8952	133.7	58.3	0.6	19.1	1
Golden Harvest H2295	132.4	55.3	0.6	22.3	2
Supercrost 1900	126.5	50.8	1.2	22.5	4
Betagold Gerda	125.2	56.8	1.7	19.9	3
Cargill 3637	125.2	51.2	1.8	21.4	5
DeKalb DK485	123.9	47.6	2.9	23.4	7
Pioneer 3921	123.3	56.6	2.4	21.8	6
Pioneer 3787	120.5	55.7	1.9	20.9	8
Cargill 5327	120.4	47.3	0.0	25.6	10
Asgrow RX337	118.4	54.9	0.6	20.9	9
Cenex/LOL 432	114.9	54.9	2.0	20.8	12
Top Farm SX1097	114.3	57.8	2.0	19.1	11
Sigco 1099	114.2	49.1	3.9	22.5	14
Cenex/LOL 385	113.4	55.3	1.8	20.0	13
Golden Harvest H2266	111.7	54.1	0.0	21.4	15
Cargill 4227	111.3	59.5	1.2	23.3	16
Tecnagene DF4897	107.7	51.3	0.6	22.8	19
Asgrow RX406	106.0	53.8	3.1	19.5	18
DeKalb DK421	105.9	52.7	1.9	19.2	17
Funks 4150	105.8	51.9	0.0	21.9	20
Interstate IS463	104.1	53.2	3.4	20.6	21
DeKalb DK372	102.4	56.6	0.7	21.4	22
Terning Select	101.7	55.9	2.6	20.1	23
Interstate IS549	101.6	49.1	4.3	22.2	24
Top Farm SX1195A	99.8	53.0	3.0	22.7	
Supercrost 1594	99.5	53.6	0.7	21.5	27
Interstate IS443	98.9	53.8	3.2	21.2	25
Terning Excell	97.8	52.2	2.5	22.4	26
Horizion 7082	97.3	58.4	0.7	21.4	29
Cargill 4327	95.9	48.0	0.7	24.1	28
					31
Betagold Ida	95.2	54.5	4.5	19.4	
Betagold Ingrid	93.0	53.3	3.5	21.6	30
Top Farm SX1195	91.5	53.3	5.5	21.0	33
Pioneer 3788	91.3	52.5	2.4	20.9	35
Horizon 8095	89.6	54.3	4.8	17.0	34
Sigco 1793	82.1	52.2	2.1	22.8	32
Sigco 1799	82.1	51.3	4.8	22.6	36
Tecnagene DF4894	78.4	51.0	1.8	23.0	37
Tecnagene Ex105-19	77.5	51.9	1.6	22.1	39
Funks 4140	72.0	49.5	2.7	20.8	38
					40
Means	103.7	53.3	2.1	21.4	

LSD (.05) 19.4 C.V. - 11.5%

Table 33. 1990 Small Grain Trials, Northeast Station, Watertown, SD

Variety Name	Yield	Test Weight	Variety Name	Yield	Test Weight
	Spring Wheat			Oats	
Stoa	66.7	60.3	Valley	165.8	36.8
Bergen	66.1	60.9	Newdak	153.0	34.8
2375	66.0	63.0	Horicon	152.2	36.4
Butte 86	64.3	62.1	Porter	152.1	36.7
W2502	63.5	58.8	Ogle	149.5	33.5
Nordic	63.2	58.0	Dane	144.6	32.8
Shield	63.1	61.7	Don	141.3	37.1
Grandin	62.4	60.6	Settler	139.5	37.3
Norseman	62.2	57.4	Sandy	138.5	36.5
Marshall	61.7	56.9	Hamilton	135.7	34.0
Fjeld	61.5	59.8	Hazel	135.2	36.3
Sharp	61.3	62.7	Premier	130.1	39.3
Prospect	61.2	58.1	Steele	127.6	33.5
Celtic	60.7	60.0	Webster	125.5	35.0
W2501	59.5	56.2	Moore	125.0	35.0
Guard	59.2	59.5	Burnett	118.2	36.3
Gus	58.8	59.9	M-120	117.7	36.2
Telemark	58.5	57.9	Wright	115.7	37.2
2370	57.4	60.5	Starter	114.9	37.2
Amidon	57.0	59.0	Hytest	109.1	39.0
2369	55.5	60.3	Trucker	106.9	36.6
Minnpro	51.7	58.2	Kelly	93.7	37.0
Vance	49.9	54.9			
Chris (check)	38.0	56.1			
Means	59.5	59.7		129.3	36.2
LSD (.05)	1.6			2.9	
C.V. - %	4.6			3.8	
	Barley			Durum	
Gallatin	78.3	45.8	Vic	69.8	63.1
Hazen	77.9	43.6	Stockholm	67.1	59.0
Bowman	77.5	47.8	Monroe	66.3	61.6
Azure	75.7	44.1	Ward	66.0	62.1
Excel	75.1	42.1	Renville	65.7	62.3
B1602	72.2	42.2	Fjord	65.2	63.6
Robust	68.0	43.0	Sceptre	64.8	61.2
Morex	62.1	42.6			
Means	75.3	44.4	Means	66.4	61.9
LSD	2.7		LSD (.05)	1.2	
C.V. - %	6.3		C.V. - %	3.2	
	Triticale				
Kramer	72.7	46.2			
Marvel	65.6	43.6			
Trical Victoria	56.1	45.3			
Means	64.8	45.0			
LSD	1.5				
C.V. - %	4.6				

Table 34. 1990 Group 0 Soybean Performance Trial, CPT, Northeast Station, Watertown, SD.

Variety Name	Yield	Plant Height	Mature Mo-Day
Hillcrest HC091	43.2	30	9/25
DeKalb CX096	43.2	31	9/25
Interstate IS622	43.0	31	9/28
Dahlgren D3050	42.9	29	9/28
Sibley (check)	42.5	32	9/27
Mustang M-1000	41.9	31	9/25
Pioneer 9091	41.3	28	9/22
Sands SOI 059	41.0	28	9/27
Top Farm 0100	41.0	33	9/25
Dawson (check)	41.0	30	9/22
Mustang M-1050	40.9	34	9/26
Sigco 80	40.8	31	9/24
GCS Brandt	40.7	28	9/25
Simpson	40.5	30	9/23
Arrowhead 8450	40.4	32	9/25
Tecnagene SB095	39.7	32	9/24
Swift	38.9	38	9/21
Northrup King B095	38.8	33	9/25
Interstate IS715	38.8	30	9/28
GCS Badger	38.6	28	9/24
Glenwood	38.5	28	9/22
Interstate IS546	38.2	30	9/24
Northrup King S07-80	38.1	29	9/22
AgriPro AP0919	37.8	32	9/22
GCS Baker	37.8	29	9/22
Pioneer 9061	37.1	31	9/20
Hy-Vigor Ex:P33	36.4	31	9/27
Sansgaard Exp085	35.5	34	9/21
Sigco HP71	35.5	30	9/24
Dassel	35.2	30	9/23
Evans	34.8	31	9/19
Ozzie	32.7	29	9/20
Dahlgren KG-60	29.8	32	9/20
McCall	23.6	34	9/6
Means	38.7	31	9/23
LSD (.05)	5.2		
C.V. - %	8.3		

Table 35. 1990 Group I Soybean Performance Trial, CPT, Northeast Station, Watertown, SD.

Variety Name	Yield	Plant Height	Mature Mo-Day
Pioneer 9152	45.0	26	9/27
Star Ex8916	42.2	28	9/28
Kasota	41.8	29	9/28
Stine 1820	40.9	28	9/28
Profiseed PS2198	40.7	31	9/27
Arrowhead 8700	40.6	30	9/27
Supercrost SC192	40.4	28	9/29
AgriPro AP1347	40.3	36	9/24
Hardin	40.3	36	9/28
Arrowhead 8500	40.2	29	9/26
Profiseed PS1130	40.2	33	9/29
Arrowhead 8600	40.1	30	9/28
Hodgson 78	40.0	33	9/28
Golden Harvest H1150	39.6	34	9/28
Funks 3197	38.9	30	9/28
Sibley (check)	38.8	32	9/27
Sands SOI166	38.5	31	9/27
Pioneer 9111	38.3	26	9/24
Funk 3185	38.1	33	9/30
Mustang M-1140	38.0	28	9/27
Kato	37.9	32	9/27
Dawson (check)	37.6	30	9/21
Tacnagene SB179	37.6	37	9/28
Tecnagene SB175	37.4	30	9/27
Star Ex9015	36.3	27	9/29
Bell	36.1	28	9/30
BSR 101	36.1	34	9/30
Weber	36.1	33	9/28
Sexauer SX1005	35.8	33	9/29
DeKalb CX117	35.0	28	9/24
Mustang M-1150	34.9	29	9/26
Corsoy 79 (check)	34.5	34	10/1
Top Farm 1406	33.5	26	9/29
Sturdy (check)	33.2	32	10/2
Sexauer SX1020	32.8	31	9/30
Hy-Vigor Ex:220	31.4	38	9/29
Glenwood (check)	31.0	28	9/21
Hy-Vigor Rocker 9	30.8	32	9/28
Sexauer SX1000	30.4	27	9/25
Hillcrest HC262	26.4	32	10/4
Dahlgren KG-81	23.7	27	10/2
Means	36.7	31	9/28
LSD (.05)	6.1		
C.V. - %	10.3		

FARMING SYSTEMS STUDIES, 1990

Principal Investigators:

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

Cooperators:

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

Introduction:

The farming systems studies were established in 1985. The systems consist of three or four year rotations. These are comparatively long-term studies (min. 8 years) since the effects of rotations are best measured after completion of at least two cycles. The plots are relatively large scale (3000 sq. ft. in Study I and 2000 sq. ft. in Study II) in an attempt to minimize border effects. The systems and rotation schedules in Study I are: ALTERNATE (no commercial fertilizer or pesticide and no moldboard plow), oats/alfalfa - alfalfa - soybean - corn; CONVENTIONAL, corn - soybean - spring wheat; RIDGE-TILL, corn - soybean - spring wheat. The systems in Study II are: ALTERNATE, oats/clover - clover (Green manure) - soybean - spring wheat; CONVENTIONAL, soybean - spring wheat - barley; MINIMUM-TILL, soybean - spring wheat - barley. The 1988, 1989, and 1990 studies were supported in part by USDA LISA Grant LI-88-12.

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, soil strength, bulk density, residue cover, 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.

Cultural Practices

Fertilizer and pesticide inputs in the conventional, ridge-till, and minimum-till systems are based on current Plant Science Department recommendations. The cultural practice information for the various systems is listed in Tables 36-39.

Table 36. Cultural practice information - farming systems studies, 1990.

Study I	Planting date	Fertilizer N-P-K (lb/A)	Manure	Herbicide (Actual/A)	Hand weeding (hr/A)
Corn					
Alternate	May 11	--		--	--
Conventional	May 11	55-0-0		Lasso II, 7 lb. band	--
Ridge-till	May 11	72-0-0		Lasso II, 7 lb. band, spot sprayed 2.5% w/Roundup at 2 qt/A preplant	--
Soybean					
Alternate	May 22	--		--	0.2
Conventional	May 22	--		Treflan, 2 pt.	0.3
Ridge-till	May 24	--		Lasso II, 7 lb. band, spot sprayed 2% w/Roundup at 2 qt/A preplant	1.2
Spring Wheat					
Conventional	April 12	--		MCPA, 1 pt	--
"Ridge"-till	April 13	35-0-0		Hoelon, 2 pt. + Buctril, 1 pt.	--
Oats/Alfalfa	April 19	--	2.60 T/A dry matter	--	--
Alfalfa		--	3.07-0.91-2.49 (%N-P-K)	--	--

NOTE: Seeding rates lbs/A); Oats 74, Alfalfa 9.5, Spring Wheat 70, Corn 18,500 seeds/A, Soybean 150,000 seeds/A. Spot spraying was used in spring, 1990, for quackgrass control in the Ridge-till system.

Table 37. Cultural practice information - farming systems studies.

	Tillage	
Study I	Pre-Plant	Post-Plant
Corn		
Alternate	Harrow 1x, field cultivate + harrow	Rotary hoe 2X and cultivate 2X, fall chisel plow
Conventional	Field cultivate + harrow	Cultivate 2X, fall chisel plow
Ridge-till	--	Cultivate 2X, ridge at last cultivation, chop stalks after harvest
Soybean		
Alternate	Harrow 1X, field cultivate + harrow	Rotary hoe 2X and cultivate 2X
Conventional	Disc 2X + harrow 1X	Cultivate 2X
Ridge-till	--	Cultivate 2X
Spring Wheat		
Conventional	Field cultivate and harrow	Fall plow
"Ridge"-till	Field cultivate	Ridge-till Cultivate (Build ridges for 1991)
Oats/Alfalfa	Disc 2X, harrow 1X	--
Alfalfa	--	Chisel plow 1X in September

Note: The "ridge"-till spring wheat was seeded with a hoe-drill. All row crops in these studies are planted in 36" rows. Field packer was used after seeding Oats/Alfalfa. Ridges were formed after harvest of "ridge"-till spring wheat using the ridge-till cultivator. The spring-tooth harrow was used early preplant in the alternate corn and soybean as an aid in stimulating early weed growth, and thereby improving weed control with the final pre-plant tillage operation.

Table 38. 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 12	--	--	--
Conventional	April 12	11-0-0	MCPA, 1 pt.	—
Minimum-till	April 12	56-0-0	Hoelon, 2 pt. + 1 pt. Buctril	--
Soybean				
Alternate	May 16	--	--	0.4
Conventional	May 16	—	Treflan 2 pt.	0.2
Minimum-till	May 16	--	Lasso 3 qt., spot sprayed 6% w/Roundup at 2 qt./A preplant	3.0
Barley				
Conventional	April 18	16-0-0	MCPA, 1 pt.	--
Minimum-till	April 18	68-0-0	MCPA, 1 pt.	--
Oats/Clover	April 19	--	--	--
Clover		--	--	--

NOTE: Seeding rates (lbs/A); Oats 74, Sweet Clover 4.5, Red Clover 4.5, Spring Wheat 70, Barley 58, Soybean-150,000 seeds/A. A 50:50 mix of sweet clover and red clover has been used since 1987 in the alternate system.

Table 39. Cultural practice information - farming systems studies.

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

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.

Table 40. Small grain yields, farming systems studies.

Spring wheat var. Butte 86

Study I	Yield (Bu/A)[a]	Test wt.	Protein %	1000 Kernel wt (g)
Conventional	54.6	56.7	14.3	34.63
"Ridge"-till	48.3	58.5	14.7	33.22
$FLSD_{.05}$	N.S.	N.S.	N.S.	0.73

Oats var. Don

	Yield (Bu/A)	Test wt.	1000 Kernel wt (g)
Oats/Alfalfa	92.7	39.2	31.55

Spring wheat var. Butte 86

Study II	Yield (Bu/A)	Test wt.	Protein %	Height at Harvest (in.)	1000 Kernel wt (g)
Conventional	52.0	60.1	14.9	32.2	33.75
Alternate	54.2	60.3	13.8	34.9	34.38
Minimum-till	55.6	59.9	14.9	32.9	34.00
$FLSD_{.05}$	2.8	N.S.	0.4	1.5	N.S.

Barley var. Robust

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)
Conventional	62.4	41.9	13.1	31.60
Minimum-till	53.3	41.6	13.2	32.17
$FLSD_{.05}$	5.5	N.S.	N.S.	N.S.

Oats var. Don

	Yield (Bu/A)	Test wt.	1000 Kernel wt (g)
Oats/Clover	86.0	38.9	30.83

[a]Avg. of four replications.

Table 41. Row crop yields - farming systems studies.

Study I	Corn - Pioneer Hybrid 3790		
	Yield (Bu/A) No. 2		
Conventional	107.6		
Ridge-till	100.7		
Alternate	80.5		
FLSD $_{.05}$ =	8.0		
	Soybeans - Simpson		
	Yield (Bu/A) 13% Moisture	Plant Height at Harvest (in)	Internode Length at Harvest (in)
Conventional	30.7	28.9	3.7
Ridge-till	32.3	26.4	2.8
Alternate	28.7	30.3	3.9
FLSD $_{.05}$ =	N.S.	2.3	0.5
Study II	Soybeans - Simpson		
	Yield (Bu/A) 13% Moisture	Plant Height (in)	Internode Length (in)
Conventional	30.4	30.8	3.9
Minimum-till	32.7	24.3	3.2
Alternate	35.4	31.4	4.5
FLSD $_{.05}$ =	N.S.	1.9	0.6

[a]Avg of four replications

Table 42. Forage crop yields - farming systems studies.

Study I	1st Cutting (June 25)	2nd Cutting (July 30)	3rd Cutting (Sept 17)	Total (T/A) Dry Matter
Alfalfa - Vernal	1.29[a]	1.38	0.93	3.60
Study II				
Clover[b]	1.51			1.51

[a]Avg of four replications

[b]Forage not removed.

Tissue analysis (% N-P-K):

Alfalfa	1st cutting,	3.40-0.22-1.80
	2nd cutting,	3.37-0.27-2.04
	3rd cutting,	3.56-0.19-2.17
Clover		3.10-0.26-2.20

1990 Crop Yields

Both temperature and moisture were nearly ideal for small grain development, and yields were very good. Spring wheat yields were significantly higher in the Conv system in Study I (Table 40). This continues the pattern of previous years (Fig 1). Levels of common root rot have generally been higher in the R-T system, which may account for a portion of the yield difference. Oat yields in both studies were higher than in most previous years (Fig 1), which reflects the very good growing conditions. Also, oats were seeded at a higher rate in 1990 compared to the past several years. Spring wheat yields in Study II were highest in the M-T system followed by the Alt and Conv (Table 40). Protein levels were higher in the M-T and Conv. Spring wheat at harvest was significantly taller in the Alt system, which continues the trend observed in previous years. Yield of Conv barley was significantly higher than M-T (Table 40), which has generally been the case in most previous years (Fig 1). Barley in both systems was heavily infected with stem rust late in the 1990 growing season, and yield loss was estimated at 10%. With the exception of oats, small grain yields have continued to follow precipitation trends very well (Fig 1), indicating precipitation, not farming system, has been the dominant factor influencing yields.

Corn yields were higher in the Conv and R-T systems compared to Alt (Table 41), which has been observed in most previous years (Fig 2). Soybean yields were not significantly different between systems in either study (Table 41). Both the R-T and M-T soybeans appeared stunted from mid-season through maturity. Soybean height and internode length at harvest were both significantly less in the R-T and M-T systems (Table 41). Cooler soil temperatures are often associated with reduced-till systems which may account for the shorter soybeans observed in these systems. Overall, row crop yields were very good and 1990 soybean yields in particular were excellent. Precipitation, not farming system, has been the primary factor influencing soybean yields (Fig 2). Both alfalfa and clover yields were considerably improved over 1989 (Fig 2). Nearly all of the red clover stand was lost due to winterkill and clover yield in Table 42 is primarily yellow sweet clover.

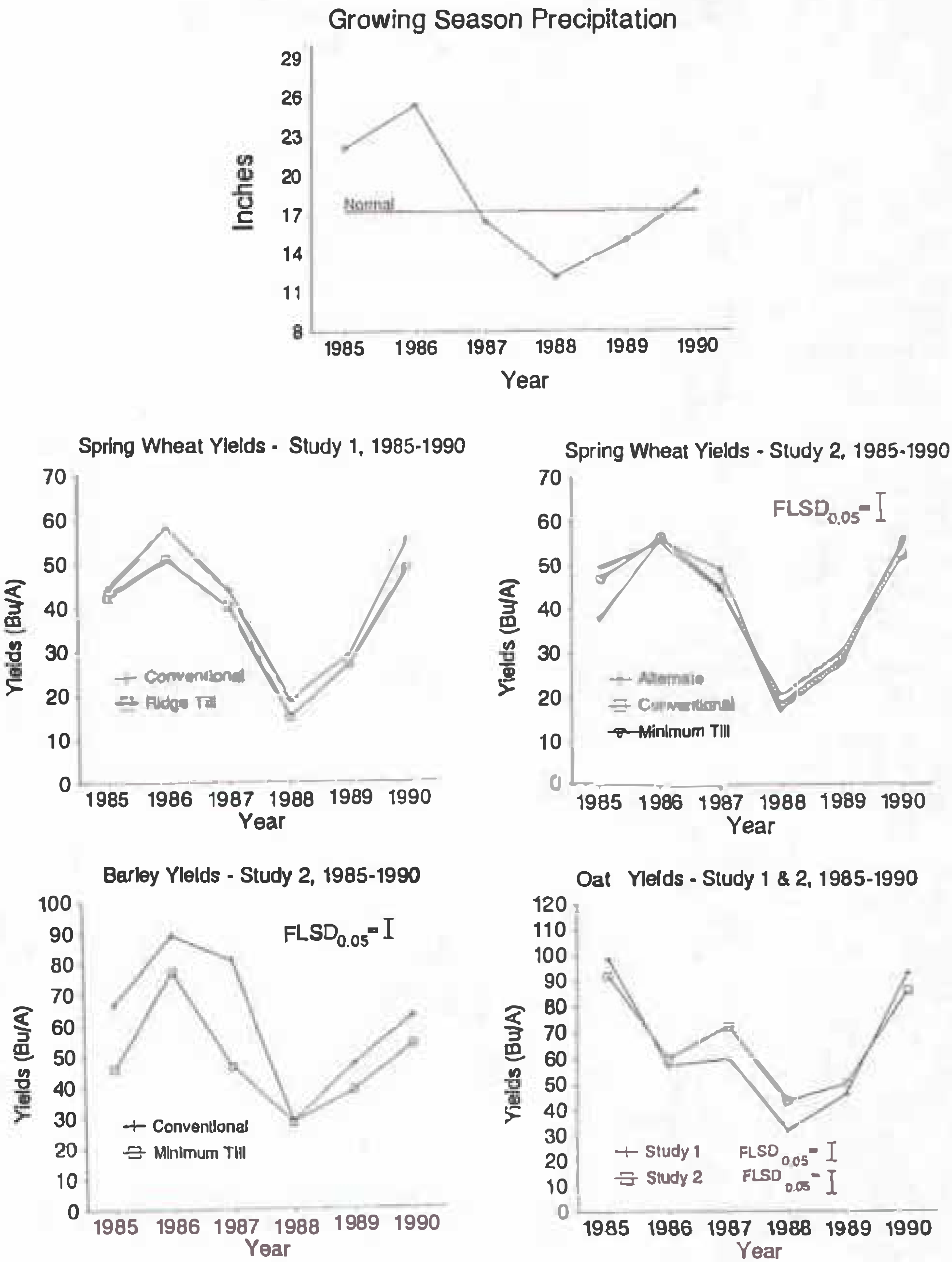
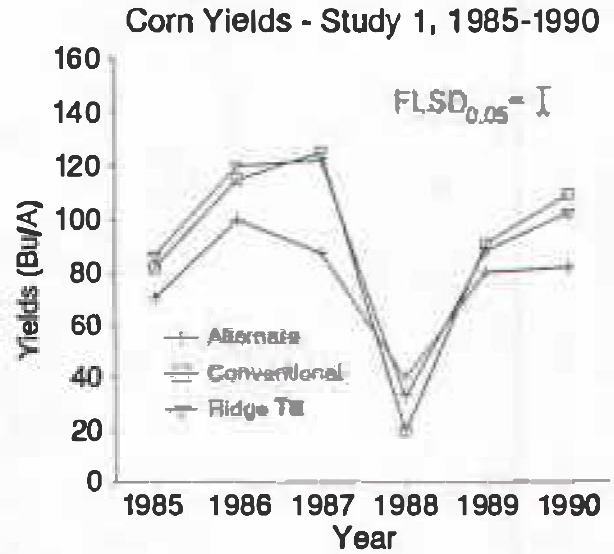
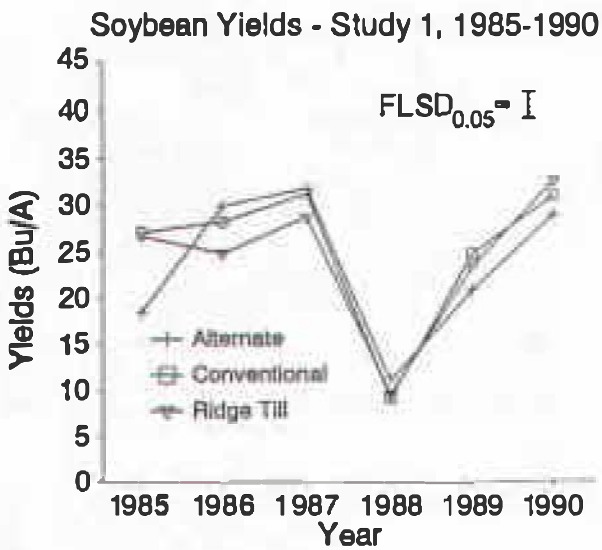
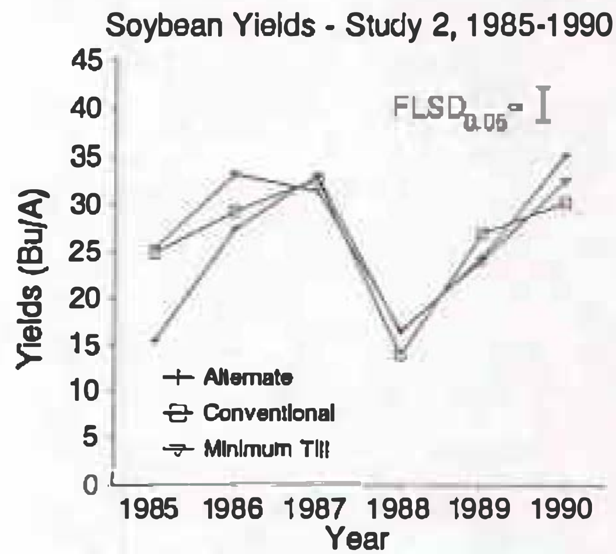


Fig. 1. Growing season precipitation and small grain yields, Farming System Studies, 1985-1990.







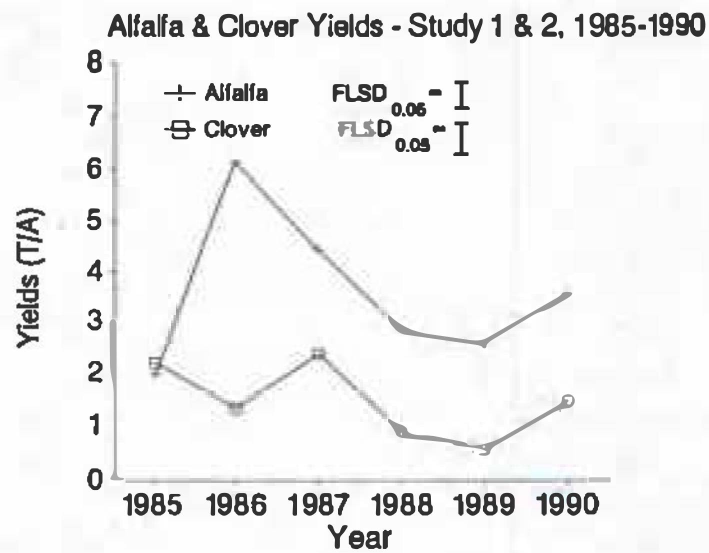


Fig. 2. Row crop and forage yields, Farming System Studies, 1985-1990.

Comparative Productivity of Farming Systems over the Six-Year Study Period

Alternative (Low-input/Sustainable) systems have been criticized as being low-output. Also, a recent report predicted drastic reductions in American agricultural output following widespread adoption of Alternative systems. Based on results obtained in the farming systems studies over the past six years such drastic reductions do not appear likely to occur, at least not in this region of the U.S. However, because the Alt systems under study are legume-based (alfalfa or clover) rotations, the amount of land devoted to a particular crop is reduced, this in turn would reduce output of a given crop. For instance, the data in Tables 43 and 44 is based on a 640-acre farm and assumes a 15% set-aside each year. Therefore the acreage planted to a particular crop in the four-year Alt system in Study I is 136 as compared to 181 acres planted in the Conv and reduced-till systems (3-yr rotations). The four-year Alt system in Study II includes clover handled as a green manure crop, which would more than meet set-aside requirements, and acreage planted to a given crop is 160.

The production of both corn and soybeans is substantially reduced in the Alt system in Study I compared to the Conv and R-T systems (Table 43). However, when the total biomass (dry weight of grain and/or forage) removed from a system is compared, the total production from the Alt system exceeds the Conv and R-T by approximately 3 million pounds. The increased productivity of the Alt system is due primarily to the alfalfa. If such alternative systems were widely adopted the reduced amount of corn and soybeans available for livestock feed could be at least partially offset by increased use of alfalfa in cattle and swine rations. Such a substitution might also result in a leaner product currently in demand by consumers. In terms of inputs, the Conv and R-T systems used approximately twice as much nitrogen (77 and 85 tons vs. 38 tons in Alt) and nearly 10 times as much herbicide (1.7 and 2.0 tons of active ingredient in Conv and R-T vs 0.2 ton in Alt).

Total biomass removed from a system on a yearly basis in Study I was similar for the Conv and R-T systems (Fig 3a). The greatest disparity in production between the Alt system and the Conv and R-T systems occurred in the above average precipiation year 1986 and the drought year, 1988. In terms of cumulative biomass removed from the systems (Fig 3b) the Alt system appears to have gained in productivity during the first four years, while in each of the last two the advantage has simply been maintained.

In Study II the reduction in output of spring wheat and soybeans in the Alt system was not as great as reduction in corn and soybean output in Study I (Tables 43 and 44). In terms of total biomass (dry weight of grain) removed from a system, the Alt system produced approximately 1 million pounds less than the Conv and M-T. The output of the Alt system in Study II is surprisingly high, particularly considering the drastic reductions in nitrogen and herbicides applied in the system (3.5 tons of N in Alt vs. 67 and 78 tons of N applied in Conv and M-T, and 0.24 ton of active ingredient of herbicide in Alt vs. 1.3 and 2.2 tons in Conv and M-T).

In Study II the productivity of the Alt system remained fairly flat over the first three years, was nearly equal during the 1988 drought and increased substantially in 1989 and 1990 (Fig 3c). The Conv system has generally been most productive in Study II (Fig 3c). Relative to cumulative biomass (Fig 3d), the reduced production of the Alt system appears to be due primarily to the comparatively low production in this sytem in 1986, in subsequent years

(1987-1990) the difference between the systems has remained nearly constant.

The increased amount of herbicides applied in the reduced-till systems in both studies is in agreement with the generally held belief that such systems require greater amounts of herbicide. Also, the reduced-till systems used greater amounts of nitrogen, particularly the M-T in Study II. Overall, both the Conv and reduced-till systems used large amounts of purchased nitrogen. The raw feedstock for most nitrogen fertilizer is natural gas -- a nonrenewable resource. Basing the productivity of these systems on such a resource calls into question their long-term sustainability.

Table 43. Total yields, and nutrients and herbicides applied, 1985-1990, Study I -- Assuming a 640-acre farm with 15% set-aside each year.

System	Crop	Yield	Total Nutrients Applied (lbs) N	P	K	Herbicides (active ingredient)
Alt	Corn	61,948 Bu				
	Soybean	19,040 Bu				
	Oats	52,645 Bu				
	Alfalfa	2,955 Tons				
			76,111[a]	22,542	93,882	408 lbs[b]
Total Biomass Removed (dry wt):		11,300,904 lbs[c]				
Conv	Corn	97,270 Bu				
	Soybean	27,205 Bu				
	Sp Wheat	44,817 Bu				
			154,574	6,227	--	3,419 lbs
Total Biomass Removed (dry wt):		8,362,364 lbs				
R-T	Corn	99,026 Bu				
	Soybean	26,173 Bu				
	Sp Wheat	40,309 Bu				
			169,416	6,227	--	4,015 lbs
Total Biomass Removed (dry wt):		8,156,271 lbs				

[a]Applied as feedlot manure to oat/alf in fall of each year.
[b]Eptam applied to clear-seeded alfalfa in initial year (1985) of study.
[c]Total dry weight of plant material (grain and/or forage) removed from system over six-year period. Assumes corn at 15.5% moisture and soybeans and small grains at 13% moisture.

Economic Results for Farming Systems Trials at SDSU's Northeast Station in 1990 Crop Year

C. Mends and T. L. Dobbs[1]

One of the components of the SDSU Economics Department's sustainable agriculture studies has been the yearly economic analyses of the Farming Systems trials at the Northeast Station. This evaluation of research trials within a whole-farm budgeting framework is carried out by economists, working as a part of a multidisciplinary research team. Low chemical input (alternative), conventional, and reduced tillage farming systems are compared in two sets of trials (Studies I and II) at the Northeast Station. This report contains a brief summary of the preliminary economic findings for the 1990 crop year. The agricultural economics research at the Northeast Station is supported by SDSU Agricultural Experiment Station Project No. H-076 and by U.S.D.A. Low-input/Sustainable Agriculture (LISA) Grant LI-88-12.

The details of various cultural practices and crop yields for each farming system included in Studies I and II can be found elsewhere in this annual report. Extensive use was made of those yields and cultural practices in developing the 1990 crop enterprise budgets.

Certain cost components and spread sheet procedures were updated prior to developing the 1990 crop enterprise budgets. Machinery and labor costs were brought up to 1988 levels, by using costs contained in recent reports by Becker, et al. (1990)[2] and Cole and Dobbs (1990)[3]. Crop insurance assumptions and calculations were also updated. Fuel and fertilizer prices were updated to Spring 1990 levels, with nitrogen being priced at 20¢/lb. Herbicide prices used in the budget calculations also reflect Spring 1990 levels; they were taken from SDSU CES Extension Extra 8012 (Wrage and Johnson, 1990)[4]. Therefore, since some of our calculation procedures (e.g., for crop insurance) and costs for the 1990 crop year differ from those for the previous 5 years, caution should be exercised in making direct comparisons with results for the 1985-1989 time period. (Land costs in the 1990 budgets were left the same as in the previous 5-year period, however.)

Federal farm program provisions (target prices, loan rates, set aside requirements) and estimated crop product selling prices and federal deficiency

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[1]Mends is a Research Associate and Dobbs is a Professor of Agricultural Economics, both in the Economics Department at South Dakota State University. We appreciate Scott Van Der Werff's assistance with the crop enterprise budgets.

[2]D. L. Becker, T.L. Dobbs, and D.C. Taylor. Crop enterprise and principal rotation budgets for sustainable agriculture case farms in South Dakota. Econ. Res. Rpt. 90-2, S. Dak. State Univ., Brookings, May 1990.

[3]J.D. Cole and T.L. Dobbs. Crop enterprise and whole-farm budgets for "conventional" farming systems in five areas of South Dakota. Econ. Res. Rpt. 90-3, S. Dak. State Univ., Brookings, July 1990.

[4]L.J. Wrage and P.O. Johnson. Herbicide price list: March, 1990. Ex Ex 8012, S. Dak. State Univ., Brookings, March 1990.

payment levels used in our budget calculations for the 1990 crop year are shown in Table 45. No selling price was assigned to clover in the alternative system of Study II, because the clover is not harvested.

Table 46 contains summary results of preliminary whole-farm analyses for each of the farming systems in Studies I and II. The first five columns show various cost and return measures for each system on a per acre basis. The last column shows net income for each system on a whole farm basis, assuming a farm with 540 tillable acres.

An examination of the alternative systems in both studies shows the alternative systems exhibiting the lowest "direct costs other than labor" per acre in the 1990 crop year. This has also been the pattern during the previous 5 years. The alternative systems are followed, in order, by the conventional systems and the reduced till (ridge till in Study I and minimum till in Study II) systems.

Comparisons of "gross income" per acre show the alternative systems to be the lowest in both studies in 1990. However, gross incomes for each of the systems were higher in 1990 than in any of the previous 5 years (1985 to 1989). Relatively high crop yields helped boost gross income of all systems in 1990. Also, farm program set aside requirements were relatively low in 1990.

When net income measures in columns three, four, and five are examined in Table 46, all systems come out positive. Net incomes for the conventional systems are the highest in both studies. They are followed first by the alternative systems and then by the reduced till systems in both studies. By comparison, during the initial 5 years of this study (what we have referred to as a transition period), the alternative systems had the highest average "net income over all costs except management" in both Study I and Study II[5].

The final net income measure in column six of Table 46 illustrates the same net income as in the preceding (fifth) column, except that the sixth column shows results on a whole farm (540-acre) basis.

The above summary indicates that conventional systems were the most profitable in both studies in 1990. In Study I, both the conventional and the ridge till systems had high proportions of the land in corn and soybeans, but the conventional system had a higher gross income and lower direct costs than the ridge till system. The reduced till systems were the least profitable in both studies. They had the highest direct costs in both studies. Gross income was highest for the reduced till (minimum till) system in Study II, but this was not enough to offset its high costs.

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[5]J.D. Smolik and T.L. Dobbs. Crop yields and economic returns accompanying the transition to alternative farming systems. Accepted for publication in Journal of Production Agriculture.

Table 45. Assumptions about Federal Farm Program and market prices used in the 1990 budgets.

Crop	Assumption
Corn	
Codington County loan rate ($/bu.)	1.43
Target price ($/bu)	2.75
Acreage reduction program (%)	10.0
Deficiency payments ($/bu.)	.45*
S.D. selling price ($/bu)	2.10
Spring Wheat	
Codington County loan rate ($/bu)	1.90
Target price ($/bu)	4.00
Acreage reduction program (%)	5.0
Deficiency payments ($/bu)	1.40*
S.D. selling price ($/bu)	2.35*
Oats	
Codington County loan rate ($/bu)	.76
Target price ($/bu)	1.45
Acreage reduction program (%)	0
Deficiency payments ($/bu)	.30*
S.D. selling price ($/bu)	1.10*
Barley	
Codington County loan rate ($/bu)	1.14
Target price ($/bu.)	2.36
Acreage reduction program (%)	10.0
Deficiency payments ($/bu.)	.24*
S.D. Selling price ($/bu)	1.85*
Soybeans	
Codington County loan rate ($/bu)	4.50
S.D. selling price ($/bu)	5.80
Alfalfa	
S.D. selling price ($/ton)	65.00*

*Estimates for marketing year.

Table 46. Results of Farming Systems analyses based upon 1990 yields, farm program, and prices.

System[a]	Dollars/Acre: Direct Costs Other Than Labor	Gross Income	Net Income Over: All Costs Except Land, Labor, and Management	All Costs Except Land and Management	All Costs Except Management	Whole Farm, Net Income over all Costs Except Management[b] ($)
Study I						
1. Alternative (oats-alfalfa-soybeans-corn)	48	172	91	80	54	29,150
2. Conventional (corn-soybeans-spring wheat)	58	190	99	89	63	34,033
3. Ridge Till (corn-soybeans-spring wheat)	66	183	86	76	50	26,843
Study II						
1. Alternative (oats-clover-soybeans-spring wheat)	33	120	63	55	29	15,738
2. Conventional (soybeans-spring wheat-barley)	42	146	73	64	38	20,410
3. Minimum Till (soybeans-spring wheat-barley)	57	148	61	48	22	12,041

[a]Crops are shown in the order in which they occur in each rotation.
[b]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.

Crop Residues and Snow Cover

D. Rickerl, K. Lewis and L. Evjen

Crop residues were measured in each plot in both the spring after planting small grains and oat/legume and in the fall following tillage (Table 47). Many of the spring residues were inadequate (even prior to planting) to meet the 30% requirement for conservation compliance. Wheat stubble and oat/legume residues were the most efficient at trapping snow. Snow depths measured on the same day varied from 4.6" with oat/alfalfa residue to 0.5" in tilled areas. It is apparent that both the amount of residue and its characteristics are important factors in obtaining snow cover.

Table 47. Effect of cropping system on surface residue and snow depth.

Study	System	1989 Crop	1990 Crop	1990 Percent Residue Cover: Spring	1990 Percent Residue Cover: Fall	Snow Depth
				%		inches
I	Alt	Oat/Alfalfa	Alfalfa	100[a]	20[b]	4.6[c]
		Alfalfa	Soybean	5	88	1.5
		Soybean	Corn	24	70	1.4
		Corn	Oat/alfalfa	26	100	1.9
			Mean	38	69	2.4
	Conv	Corn	Soybean	34	6	1.6
		Soybean	Wheat	10	78	0.9
		Wheat	Corn	4	62	0.5
			Mean	16	49	1.0
	R-T	Corn	Soybean	52	88	1.9
		Soybean	Wheat	8	31	0.8
		Wheat	Corn	60	87	2.6
			Mean	40	69	1.8
II	Alt	Oat/clover	Clover	99	33	2.0
		Clover	Soybean	14	82	1.1
		Soybean	Wheat	59	88	1.4
		Wheat	Oat/clover	68	100	1.4
			Mean	60	76	1.5
	Conv	Wheat	Barley	5	13	0.5
		Barley	Soybean	9	77	0.5
		Soybean	Wheat	26	3	0.9
			Mean	13	31	0.6
	M-T	Wheat	Barley	68	88	2.4
		Barley	Soybean	81	73	1.9
		Soybean	Wheat	36	83	1.0
			Mean	62	81	1.8

[a]Residue was measured on May 30, 1990.
[b]Residue was measured on October 26, 1990.
[c]Snow depth was measured on March 15, 1990.

Plant Nutrition Report -- Farming System Studies

H. Woodard, D. Winther and D. Claypool

Study I

Corn shoot N concentrations at the V6 stage were significantly higher for the Conv and R-T systems when compared to the Alt system (Table 48). Fertilizer N was applied on the R-T and Conv treatments. The N from the fertilizer was apparently more available than the N from the previous alfalfa crop in the Alt system. However, grassy weed populations were higher in the Alt corn and they no doubt were also competing for available N. There was no difference observed in corn shoot P concentration at the V6 stage across any of the systems. Corn shoot K at the V6 stage was highest in the Conv system and lowest in the R-T system. Shoot K levels have been shown to be lower in R-T systems than in Conv systems. The trends in this study are consistent with those findings. Apparently there are factors in the R-T systems such as compaction, soil moisture, temperature or pathogen differences within the ridge itself which affect root growth and nutrient uptake and thus lower K uptake. Shoot K concentrations for corn grown in the Alt system was also lower than in the Conv system.

The trends observed in shoot N, P and K concentrations for the various systems were also reflected in the concentrations in the ear leaf tissue (Table 48). Ear leaf N was above the critical concentration for the R-T and Conv systems but below the 2.75% concentration considered to be adequate for corn in the Alt system. Ear leaf P concentrations indicate that corn growing in all three systems was at a sufficient concentration (> 0.25%). Ear leaf K concentrations for all three systems indicated that the available K was at inadequate levels. Fertilizer K was not applied before planting since the soil test levels indicated that extractable K levels were adequate. Perhaps fertilizer K should be applied in the R-T and Conv systems next year regardless of the soil test level.

Shoot N concentrations for wheat sampled at jointing were higher in the R-T system than in the Conv system (Table 48). This reflects the trend observed in corn shoot N concentrations. Shoot P and K concentrations were not significantly different in either the Conv or the R-T system indicating that uptake of P and K was not affected.

Study II

Barley shoot N, P or K concentrations at jointing were not significantly different across systems (Table 49). Spring wheat shoot N and P concentrations were higher in the M-T system than in the Conv or Alt systems. The levels of shoot N, P and K in barley and spring wheat appear to be adequate to support normal yield goals.

Table 48. Nutrient concentrations in corn and spring wheat, Study I.

Crop	Growth Stage	System	Plant Concentrations (%) N	P	K
Corn	V-6	Alt	3.50[b]	.355[a]	3.030[b]
		Conv	3.83[a]	.478[a]	3.765[a]
		R-T	3.90[a]	.345[a]	2.235[c]
	Ear Leaf	Alt	2.58[b]	.214[b]	1.425[a]
		Conv	2.89[a]	.270[a]	1.485[a]
		R-T	3.04[a]	.246[a]	1.275[b]
Spring Wheat	Jointing	Conv	4.23[b]	.328[a]	3.480[a]
		R-T	4.62[a]	.318[a]	3.555[a]

Table 49. Nutrient concentrations in barley and spring wheat, Study II.

Crop	Growth Stage	System	Plant Concentrations (%) N	P	K
Barley	Jointing	Conv	5.19[a]	.285[a]	3.135[a]
		M-T	5.40[a]	.233[a]	3.255[a]
Spring Wheat	Jointing	Alt	4.33[b]	.293[b]	3.180[a]
		Conv	4.34[b]	.278[b]	3.075[a]
		M-T	4.82[a]	.333[a]	3.255[a]

Soil Test Results

D. Rickerl and P. Wieland

Soil test results from 1990 fall samples for Studies I and II are listed in Tables 50 and 51. Nitrate-N in the top 24 inches ranged from 14-113 pounds per acre. This illustrates the variability in the crop production systems. In Study I, next year's corn would need 82 pounds of additional nitrogen (N) in the Alt system, 88 pounds in the Conv system and 80 pounds in the R-T system based on soil test recommendations at a 100 bushel yield goal. In Study II a wheat crop of 50 bu/A would require 60, 62, and 83 pounds of N in the Alt, Conv and M-T respectively. Phosphorus and potassium levels were generally in the high to very high range and additional applications would probably be minimal.

Table 50. Soil test results from farming system Study I, 1990.

	NO_3-N		---------------- 0-6" ----------------				
System/Crop	0-6"	6-24"	Organic Matter	P	K	pH	Salts
	lbs/A		%	lbs/A			mmho/cm
Alt							
Oat/Alfalfa	4	11	3.2	52	377	6.2	0.4
Alfalfa	10	15	3.3	38	308	6.3	0.5
Soybean	11	32	3.2	39	368	6.3	0.5
Corn	5	9	3.2	39	338	6.3	0.5
Conv							
Corn	7	78	3.4	40	360	6.2	0.4
Soybean	8	34	3.2	42	332	5.9	0.5
Spring Wheat	6	31	2.8	41	392	6.3	0.4
R-T							
Corn	5	45	2.8	28	325	6.3	0.4
Soybean	6	15	3.0	42	375	6.1	0.4
Spring Wheat	6	39	2.8	28	400	6.2	0.4

Table 51. Soil test results from farming system Study II, 1990.

System/Crop	NO_3-N 0-6"	NO_3-N 6-24"	0-6" Organic Matter	0-6" P	0-6" K	0-6" pH	0-6" Salts
	lbs/A		%	lbs/A			mmho/cm
Alt							
Oat/clover	4	10	4.0	38	312	5.8	0.4
Clover	33	62	3.8	54	365	6.0	0.6
Soybean	5	55	3.6	35	337	6.1	0.4
Spring Wheat	5	12	3.5	33	310	6.2	0.5
Conv							
Soybean	7	51	3.8	48	335	5.9	0.4
Spring Wheat	13	100	3.5	42	312	6.0	0.5
Barley	18	62	3.6	40	330	6.1	0.5
M-T							
Soybean	9	28	3.8	42	325	6.0	0.4
Spring Wheat	4	26	3.4	32	288	6.1	0.5
Barley	6	29	3.8	35	328	6.2	0.5

Soil Test Results - 1985 Compared to 1990

Maintaining crop yields requires adequate levels of soil fertility. Table 52 compares soil test levels in 1985 when the studies began with levels from 1990. One and a half rotations have been completed in the Alt system and two complete rotations have been completed in all other systems. Average nitrate levels have increased in all systems with increases ranging from 10% in M-T to more than 140% in Alt and Conv systems in Study II. In Study I, percent increases in nitrates were 60, 129, and 26 for Alt, Conv and R-T systems, respectively. Organic matter increases show similar trends to those of nitrates. The largest increases in organic matter content were in Study II and the smallest were in Study I - R-T.

Phosphorus and potassium levels, however, have generally decreased over the last 5 years. The percent decrease in phosphorus was greatest for Study I - R-T (28) and least for Study II - Conv (6). Decreases in soil potassium levels ranged from 2 to 29%. It is evident from these results that R-T and M-T have contributed the least to the nitrogen levels in the soil and have taken the most from soil phosphorus reserves. Both the Alt and Conv systems have increased nitrogen and organic matter reserves, but the Conv system in Study I has had a more negative impact on soil P and K than the Alt system. These data suggest that alternate farming systems are not mining soil P and K or organic matter to any greater extent than conventional systems and are probably superior to ridge or min-till systems in the study.

Table 11. Average soil test values in 1985 and 1990 for systems in Studies I and II.

System	NO_3-N 0-24		% change	Organic matter		% change	P		% change	K		% change	pH		Salts	
	1985	1990		1985	1990		1985	1990		1985	1990		1985	1990	1985	1990
STUDY I																
Alt	15	24	+60	2.8	3.2	+14	48	42	-12	384	347	-10	6.1	6.3	0.3	0.5
Conv	24	55	+129	2.7	3.2	+18	55	41	-25	510	362	-29	6.1	6.2	0.3	0.4
R-T	31	39	+26	2.8	2.9	+4	46	33	-28	374	366	-2	6.1	6.2	0.3	0.4
STUDY II																
Alt	19	46	+142	2.8	3.7	+32	45	40	-11	358	331	-8	6.1	6.0	0.3	0.5
Conv	34	84	+147	2.8	3.6	+29	46	43	-6	377	325	-14	6.1	6.0	0.3	0.5
M-T	31	34	+10	2.8	3.7	+32	47	36	-23	367	313	-15	6.0	6.1	0.3	0.4

Fall Soil Moisture

D. H. Rickerl

In Study I, fall soil moisture ranged from 20-24% in the 0-6" depth and from 10-17% in the 6-24" depth (Table 53). Soil moisture differences in the 0-6" depth were not significantly different from each other. In the lower depth, alfalfa decreased soil moisture compared to other crops.

In Study II, the Conv system had significantly more moisture than the M-T system. This difference was due to a crop x system interaction. The small grain crop soils in the M-T had less water than the small grain crop soils in the Conv system.

Both studies had less moisture in the subsoil than the topsoil. The lack of subsoil moisture reflects the limited rainfall of the last two years.

Table 53. Fall soil moisture at 0-6" and 6-24" depths in Farming Systems Studies I and II.

Study I				Study II			
		Depth				Depth	
System	Crop	0-6"	6-24"	System	Crop	0-6"	6-24"
		----%----				----%----	
Alt	Oat/alfalfa	21[a]	11	Alt	Oat/clover	21	11
	Alfalfa	21	10		Clover	25	21
	Soybean	23	15		Soybean	24	17
	Corn	24	16		Wheat	23	14
	Average	22.4	13.3		Average	23.0	15.7
Conv	Corn	23	14	Conv	Wheat	24	17
	Soybean	24	17		Barley	23	16
	Wheat	22	16		Soybean	24	17
	Average	22.9	15.7		Average	23.8	16.5
Ridge	Corn	22	14	Min-Till	Wheat	20	12
	Soybean	24	17		Barley	20	12
	Wheat	20	13		Soybean	23	17
	Average	22.0	15.0		Average	20.9	13.7
Study Average		22.4	14.6	Study Average		22.6	15.4

[a]Percent soil moisture (gravimetric) sampled October 12, 1990.

Nematode and Oligochaete Populations

J. Smolik, K. Lewis

Populations of dagger nematode (Xiphinema americanum) at harvest have significantly increased over the six-year study period in the Alt and R-T systems in Study I (Fig. 4 a,e). Populations in these two systems are currently at levels that very likely will reduce plant growth. Pin nematode (Paratylenchus projectus) populations have not responded in a consistent manner to system or year effects (Fig 4b), although populations in general have been highest in soybean (data not shown). Predaceous nematode populations at harvest have been little influenced by system or year (Fig. 4c). Populations of microbial feeding nematodes have increased significantly over the study period in all systems (Fig. 4d). Oligochaete (tiny earthworms) populations have not been influenced by system or year (Fig. 4f).

Dagger nematode populations in Study II were about half of those in Study I. The generally lower populations in Study II are apparently due to the lower amount of full-season crops. However, they have followed similar trends and populations were significantly higher in the Alt and M-T systems (Fig 5a,e). The use of the moldboard plow in the conventional system in both studies is apparently responsible for the low populations of dagger nematodes in this system. Pin nematode populations were highest in the Alt system in 1990 (Fig. 5b). Predaceous nematode numbers were highest in the Alt and M-T systems in 1989 (Fig. 5c). Microbial feeding nematode populations were highest in the Alt system in 1986 and 1987 (Fig. 5d). Oligochaete populations have not been significantly different between systems (Fig. 5f).

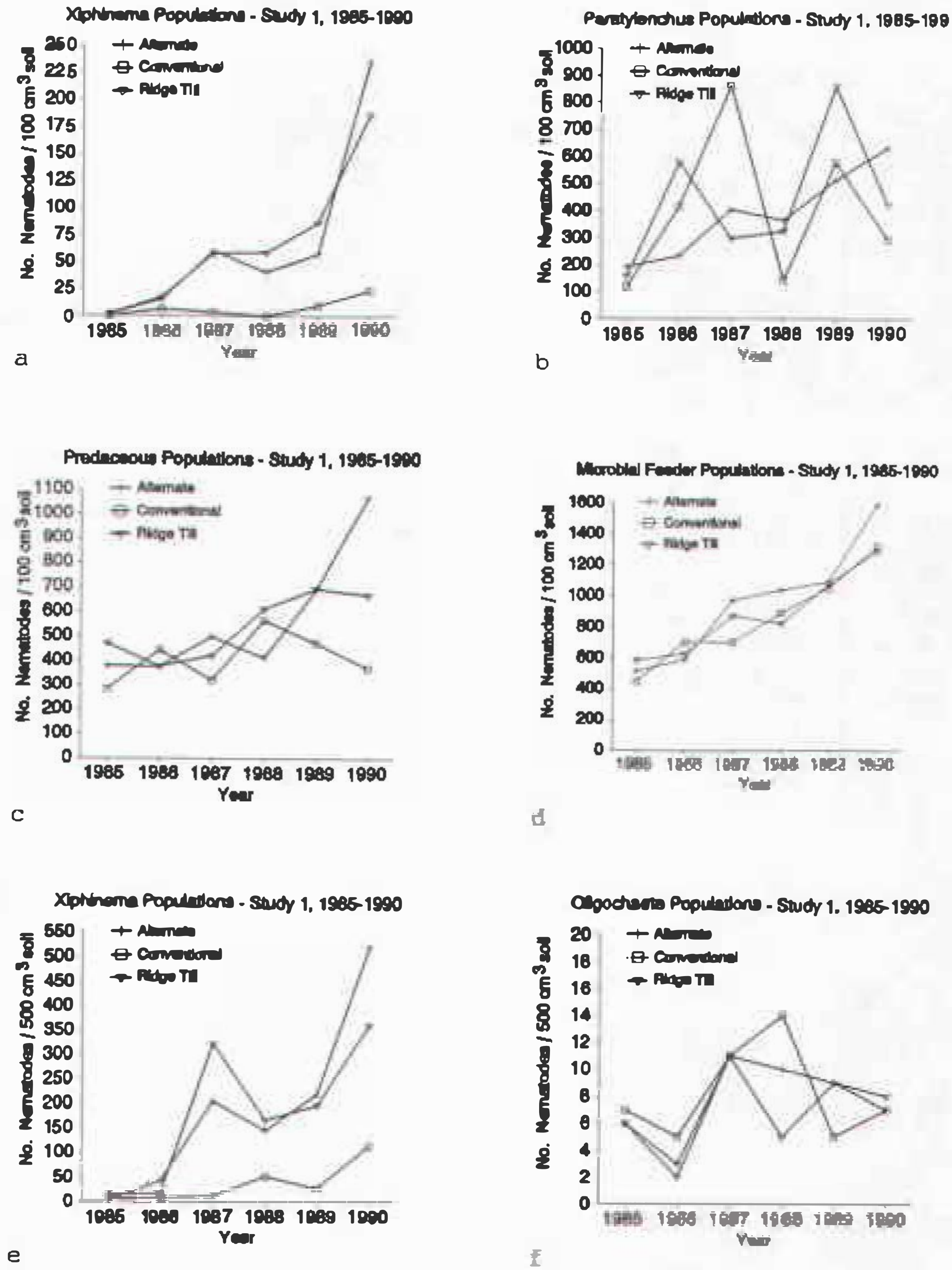

Fig. 4 a-f. Nematode and oligochaete populations at harvest in Study I - System Averages, 1985-1990.

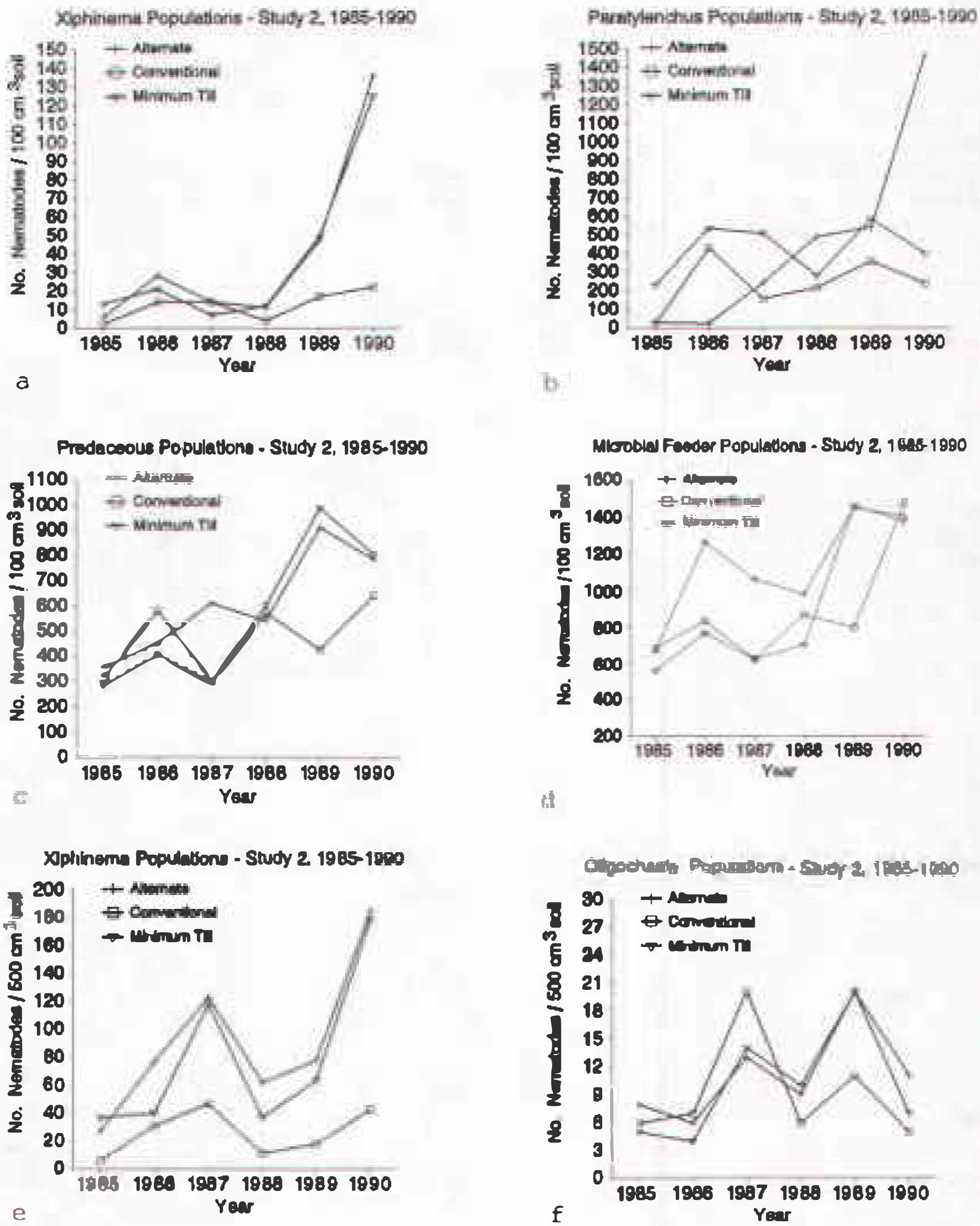

Fig. 5 a-f. Nematode and oligochaete populations at harvest in Study II - System Averages, 1985-1990.

Soil Strength, Bulk Density and Water Content

T. Schumacher and K. Lewis

Soil strength, bulk density and volumetric water content were measured in Study I and Study II of the farming systems project on August 7 and 8, 1990. Soil strength was measured using a recording cone penetrometer with a 130 mm^2 cone. Measurements were taken in the row and repeated six times in each plot. Bulk density and volumetric water content measurements were taken with a core sampler. The core samples were sectioned by depth and composited into samples of 170 cm^3 volume. The core samples were taken concurrently with penetrometer readings at the same measurement site.

In both studies and for all systems soil strength increased with depth. The increase in bulk density with depth is the most likely cause for this observation. Volumetric water content was relatively constant with depth and unaffected by the farming systems. The Alt system had the highest soil strength of the three systems in Study I. Soil strength was higher in the top 20 cm (8 inches) of the soil profile for the Alt system compared to the other systems. This did not appear to be related to soil moisture or bulk density (Fig. 6). Possible explanations include the minimal use of primary tillage operations in this system combined with possible compaction from secondary tillage operations and accumulated wheel traffic. Tillage operations in the Alt row crop consisted of shallow surface tillage and two passes with a rotary hoe. Row crops in all systems in Study I were cultivated twice. Soil strength was higher for the Alt system even when the current crop was common between systems. Soil strength in the top 20 cm was higher in the Alt system compared to the other two farming systems under corn (Fig. 6).

All systems responded the same in Study II (Fig. 7). Soil strength of the top 20 cm was comparable to soil strength measurements on the Conv and R-T systems of Study I.

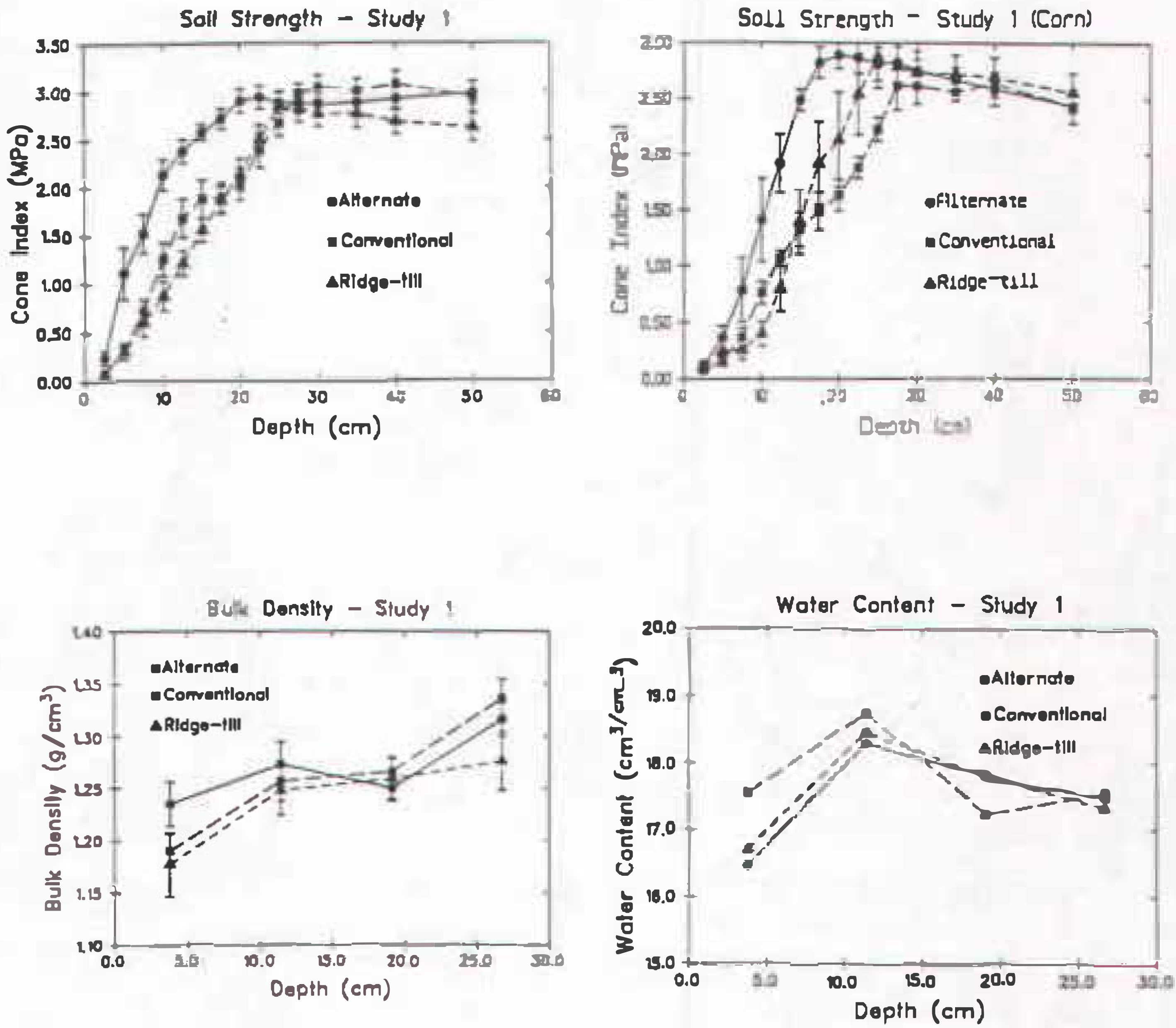

Figure 6. Soil strength, bulk density and volumetric water content for Study 1. Bars represent standard error of the mean. Water content standard errors were large and are not included on the graph.

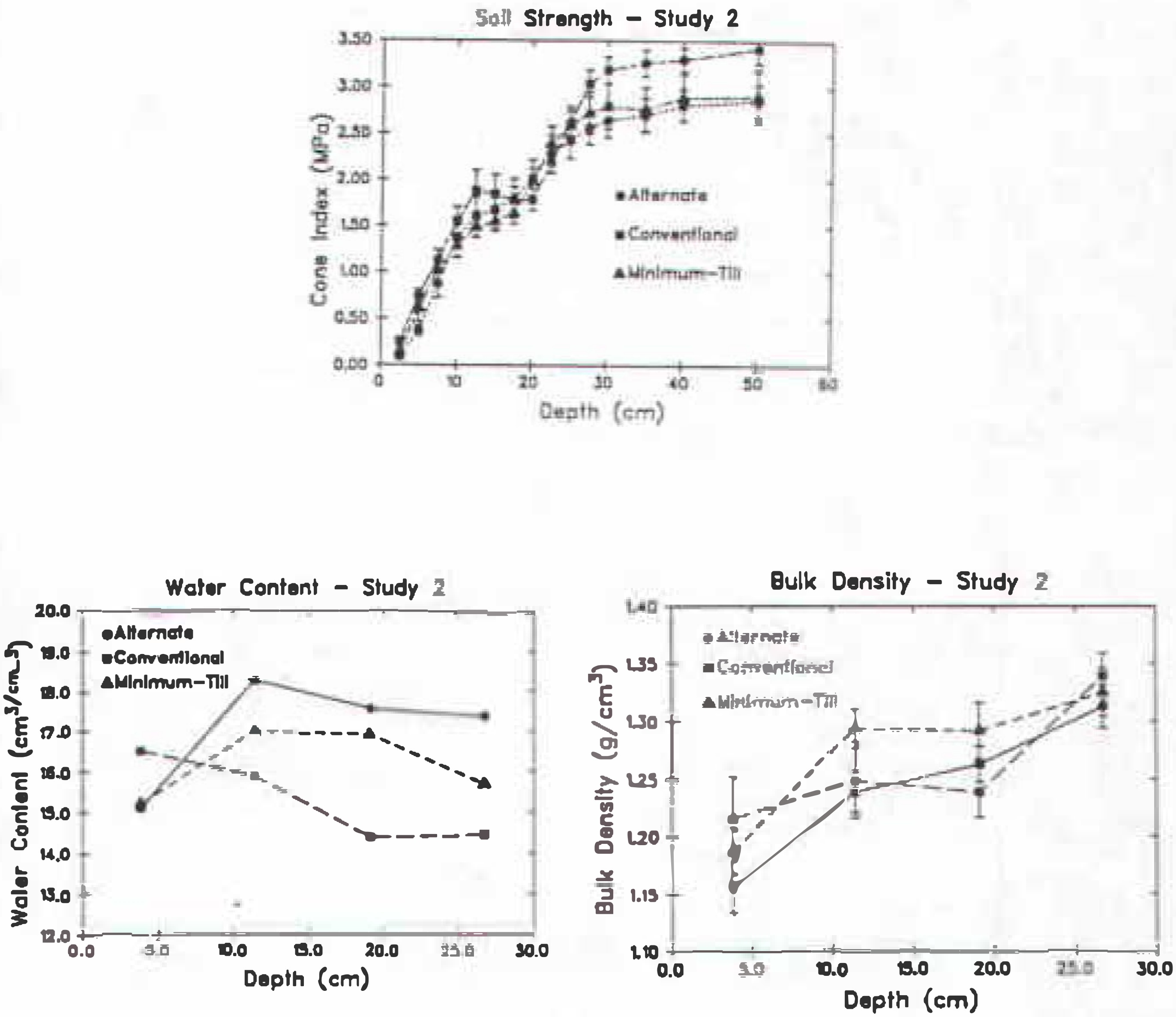

Figure 7. Soil strength, bulk density, and volumetric water content for Study 2. Bars represent standard error of the mean. Water content standard errors were large resulting in no statistical differences between treatments.

Weed Populations - Farming Systems Studies

D. Rickerl, K. Lewis, J. Smolik and P. Wieland

Study I - Field weed counts were taken in June, July, and August (Table 54). In the Alternate system, foxtail and Russian thistle counts in the oat/alfalfa and alfalfa represented the germination and seedling growth of soil seed banks. Rotating to soybean and corn reduced the populations considerably. Foxtail populations were higher in Alt corn than those measured in previous years. The higher populations were apparently a result of the high foxtail populations in the 1989 soybeans, which were due in part to a reduced soybean stand resulting from mechanical problems with the planter. The conventional system's highest weed counts were due to foxtail in the spring wheat. Rotation and weed control practices reduced the foxtail levels in conventional corn and soybean when compared to conventional wheat. Foxtail was also the major weed problem in the ridge-till system. However, rotation and weed control practices in the ridge-till system did not reduce row-crop infestations of foxtail.

Foxtail populations in spring wheat in Study II were highest in the Alt system, particularly on the first two sampling dates (Table 55). Weed populations in soybeans were generally low in all systems, and no weeds were detected in the Conv system on any of the sampling dates. Compared to 1989, weed populations, particularly Russian thistle, increased in all systems with the greatest increase in the Alt.

Table 54. Weed populations on 3 dates in Farming Study I.

Study 1	Alternate			Conventional			Ridge-Till		
	6/4	7/18	8/2	6/4	7/18	8/2	6/4	7/18	8/2
CORN									
Foxtail	303[b]	82	141	9	2	7	62	7	10
Wild Buckwheat	0	0	1	0	0	0	0	0	0
Perennial Broadleaf[a]	0	0	2	0	0	0	0	1	0
Russian thistle	0	0	0	0	0	32	2	1	0
SOYBEANS									
Foxtail	57	13	10	2	0	2	63	13	24
Wild Buckwheat	0	0	0	0	0	0	0	0	0
Perennial Broadleaf	0	0	0	0	0	0	2	0	0
Russian thistle	0	0	0	0	0	0	12	0	0
SPRING WHEAT									
Foxtail	-	-	-	13	20	19	25	3	7
Wild Buckwheat	-	-	-	0	0	1	0	0	4
Perennial Broadleaf	-	-	-	0	1	2	7	2	1
Russian thistle	-	-	-	2	3	2	2	1	0
OATS / ALFALFA									
Foxtail	754	795	-						
Wild Buckwheat	0	2	-						
Perennial Broadleaf	5	0	-						
Russian thistle	10	3	-						
ALFALFA									
Foxtail	730	169	-						
Wild Buckwheat	0	2	-						
Perennial Broadleaf	5	0	-						
Russian thistle	558	310	-						
SYSTEM AVERAGE									
Foxtail	461	265	-	8	7	9	50	8	14
Wild Buckwheat	0	1	-	0	0	0	0	0	1
Perennial Broadleaf	3	3	-	0	0	1	3	1	0
Russian thistle	142	78	-	1	1	2	5	1	0

[a]Perennial broadleaves were primarily dandelion.
[b]Number per 3 sq. ft.

Table 55. Weed populations on 3 dates in Study II.

Study 2	Alternate			Conventional			Minimum-Till		
	6/4	7/18	8/2	6/4	7/18	8/2	6/4	7/18	8/2
SPRING WHEAT									
Foxtail	480[b]	702	54	27	29	50	13	1	10
Redroot pigweed	11	1	0	8	3	0	10	0	0
Perennial Broadleaf[a]	11	8	6	1	1	4	1	3	1
Russian thistle	5	1	5	10	8	17	11	1	2
SOYBEANS									
Foxtail	7	7	7	0	0	0	5	0	0
Redroot pigweed	2	0	0	0	0	0	1	0	0
Perennial Broadleaf	1	0	1	0	0	0	0	0	0
Russian thistle	1	0	0	0	0	0	6	2	0
BARLEY									
Foxtail	-	-	-	21	17	-	6	6	-
Redroot pigweed	-	-	-	16	0	-	16	3	-
Perennial Broadleaf	-	-	-	1	1	-	2	1	-
Russian thistle	-	-	-	9	11	-	9	15	-
OATS/ CLOVER									
Foxtail	26	61	-						
Redroot pigweed	8	5	-						
Perennial Broadleaf	4	2	-						
Russian thistle	35	24	-						
CLOVER									
Foxtail	230	192	-						
Redroot pigweed	0	4	-						
Perennial Broadleaf	0	1	-						
Russian thistle	830	300	-						
SYSTEM AVERAGE									
Foxtail	186	241	-	16	15	-	8	2	-
Redroot pigweed	5	3	-	8	1	-	9	1	-
Perennial Broadleaf	4	3	-	1	1	-	1	1	-
Russian thistle	218	81	-	6	6	-	9	6	-

[a]Perennial broadleaves were primarily dandelion.
[b]Number per 3 sq. ft.

Data collected in the mechanical/chemical weed control studies in corn in 1989 and 1990 and in soybeans in 1990 (see Tables 28, 29 and 30) was used to estimate yield losses in corn and soybeans. The weed biomass estimates in the Farming Systems Studies were obtained at approximately the same time (early August) as in the above studies. The highest foxtail biomass occurred in the Alt system in both studies (Table 56). Corn yield loss estimates ranged from 3 bushels in the R-T system to 15 in the Alt. In Study I, soybean yield losses due to foxtail were approximately 2 bushels in both the Alt and R-T systems. Foxtail biomass in soybeans was low in all systems in Study II, and did not result in appreciable yield loss (Table 56).

Table 56. Foxtail biomass in corn and soybeans and estimated yield loss. Study I and II.

	Study I			
	Corn		Soybean	
System	Foxtail Biomass	Est. Yield Loss	Foxtail Biomass	Est. Yield Loss
Alt	1711[a]	15 Bu[b]	512	2[c]
Conv	432	4 Bu	4.5	0
R-T	381	3 Bu	446	2

	Study II	
	Soybean	
	Foxtail Biomass	Est. Yield Loss
Alt	122	0.5
Conv	3.2	0
M-T	0	0

[a]Foxtail (primarily yellow foxtail) weight - lbs/A, data collected 2 August, 1990.
[b]Yield loss estimate based on 1 bushel lost for each 114 lbs of foxtail.
[c]Yield loss estimate based on 1 bushel lost for each 230 lbs of foxtail.

Estimating Erosion - Farming System Studies

M.A. Nelson, SCS, Mitchell, and D. Rickerl

Soil erosion predictions can be obtained by calculating wind and water erosion losses. The Universal Soil Loss Equation (A=RKLSCP), is used to estimate water erosion. A is the predicted annual soil loss expressed in tons of soil per acre per year. R is the rainfall factor which is the erosion-index measure of the erosion force of a specific rainfall. K is the soil-erodibility factor. It is the erosion rate per unit of erosion index. LS is a predetermined number used to figure soil erosion loss according to percent of steepness and length of slope involved. The cropping management factor, C, deals with the type of cropping and management systems used and their effects of the soil loss equation. P is the erosion control factor which compares conservation practice farming to straight row up and down farming.

The wind erosion equation, E=f(IKCLV), predicts soil loss by wind erosion. The estimated average annual soil loss, E, is expressed by tons per acre per year. f indicates a functional relationship between the rest of the factors. I is the potential annual wind erosion for a given soil under given conditions. The ridge roughness factor, K, measures the effect of ridges made by the tillage and planting implements. The climatic factor, C, measures erosion from the climate, specifically wind speed and surface moisture. L is the unsheltered distance facing the prevailing wind direction across the field. V is the vegetative cover factor which considers the kind, amount, and orientation of vegetation on the surface. It is expressed in 'small grain equivalent lbs/acre.'

Erosion estimations were calculated from the Farming Systems Studies. From the cropping history information, 1985-1989, and the number of tillage passes, both spring and fall. Crop and yield data were also obtained. As might be expected, estimated erosion on the small, flat plots involved in this study were minimal. The highest erosion occurred in the conventional systems. The data obtained was expanded by extending the slope length and steepness factors. For water erosion estimations, the LS factor was extended. Unsheltered distances were extended for the wind erosion predictions. The following information is a prediction of the amounts of wind and water erosion one could reasonably expect to find on Kransburg, Brookings, or other similar soils in fields of any size.

Brookings and Kransburg soils are deep, well-drained soils formed in loess over glacial till. Although Brookings is rarely, if ever, found on slopes greater than 2%, Kransburg and some similar soils can be found on the slopes projected in this study.

When predicting water erosion, increasing any one of the R, K, LS, or C factors meant increased erosion. Decreasing any of those same factors meant decreased water erosion. In the prediction of wind erosion the increase of any one of the K, C, L, or V factors also meant increased erosion and the decrease of any of the factors lead to a decrease in erosion. Therefore, it should be obvious that to accurately predict either wind or water erosion on a field, the calculations must be made from data provided for that field individually.

The wind and water erosion predictions were calculated from field data obtained at the Northeast Research Station, and from Soil Conservation charts.

As the slopes get steeper and longer the number of tons of soil lost per