

ANNUAL PROGRESS REPORT 2008

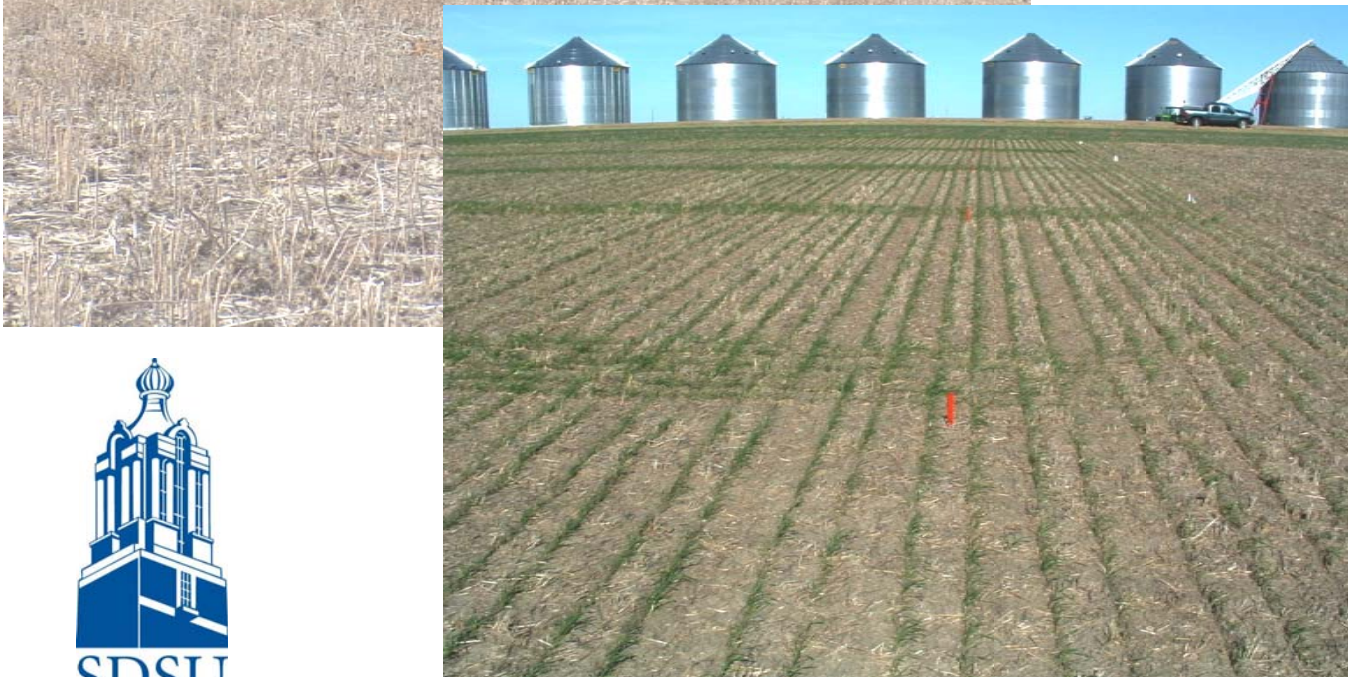
SOUTH DAKOTA STATE UNIVERSITY

WEST RIVER AG CENTER

CROPS AND SOILS RESEARCH

PLANT SCIENCE PAMPHLET #38

MARCH 2009



INTRODUCTION

This is an annual progress report of the West River Crops and Soils Research Projects, South Dakota Agricultural Experiment Station. The equipment storage and processing facilities are located approximately one mile southwest of Box Elder, SD at 22735 Radar Hill Road. The office facilities are located at 1905 North Plaza Boulevard; Rapid City, SD 57702-9302.

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This publication can be found on the internet at: <http://wrac.sdstate.edu/pubs/plant/plant.html>

The Research Projects serve the western part of South Dakota. They are unique in that all experimental plots are cooperatively located with farmers. All the studies are located on farmer fields rather than at a particular experiment station. This allows for more mobility and localized data collection. This system is very dependent upon farmer cooperators and local extension agronomy educators.

This research tests the adaptability of new crops, varieties and farming methods. This report does not include results of work conducted by SDSU projects headquartered on campus at Brookings, South Dakota.

FIELD PLOT COOPERATORS

Name	Address	County
Larry Novotny	Martin 57551	Bennett
Bill Greenough	Oelrichs 57763	Fall River
Lennis Erickson	Ralph 57650	Harding
Henry Roghair	Okaton 57562	Jones
Merle Aamot	Kennebec 57544	Lyman
Dave Wilson	Sturgis 57785	Meade
Pat Brown	Scenic 57780	Pennington
Merritt Patterson & Sons	Wall 57790	Pennington
Crown Partnership	Wall 57790	Pennington
James Talty	Scenic 57780	Pennington
Ron Seidel	Bison 57620	Perkins
Rex Haskins	Hayes 57537	Stanley
Mark Stiegelmeier	Selby 57472	Walworth

This is an annual report, some trials are ongoing and will require additional testing before final conclusions can be made.

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South Dakota State University, South Dakota Counties, and U.S. Department of Agriculture Cooperating.

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TESTING LOCATIONS



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Research was conducted by Thandiwe Nleya – Assistant Professor, John R. Rickertsen-Research Associate II, and Bruce A. Swan-Senior Ag Research Technician, in conjunction with John D Kirby – Director Ag Experiment Station, Sue Blodgett – Dept. Head Plant Science, Robert Hall, Neal Foster, Jack Ingemansen, Amir Ibrahim, Ron Gelderman, Michael Moechnig, and Karl Glover.

A special thank you is extended to Charlie Ellis and Michael Swan for their help during 2008.

This publication was written and edited by Thandiwe Nleya, John R. Rickertsen and Bruce A. Swan.

WEATHER SUMMARY

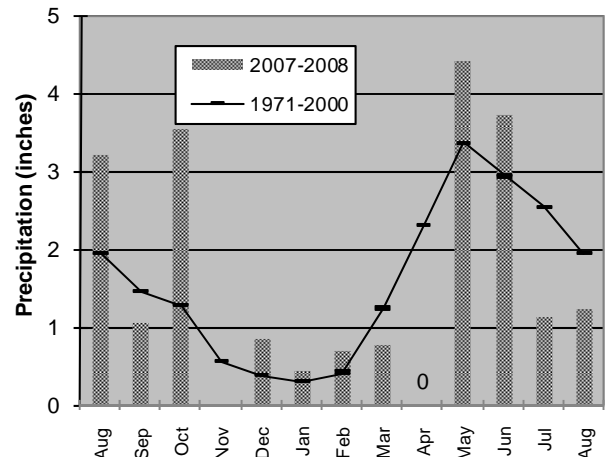
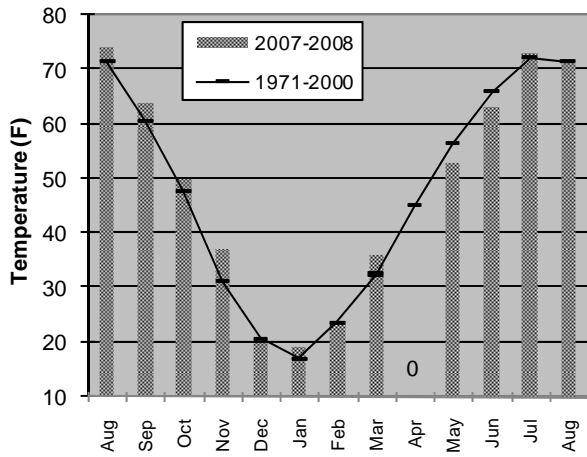
The data in the weather summaries presented in the following charts and table were obtained from the National Oceanic and Atmospheric Administration (NOAA) publication, Climatological Data – South Dakota; and from Dennis Todey, State Climatologist at South Dakota State University. Weather data were also collected from the weather station located at the Wall Rotation Study near Wall, South Dakota. For more information about South Dakota's climate, visit the South Dakota climate website climate.sdstate.edu

Precipitation was average in the southwest in September and dry in the northwest and far west. The trend continued in October with above average rainfall for the southwest and central parts of the state, but dry in the northwest. November thru March was below average at all locations. April was 1" or more below average at all locations. The spigot turned on in May with all locations 1 – 2" above average and that trend continued in June with totals 1 – 5" above average. July was more varied with totals 1½" below to 1½" above average. August was dry with most locations 1" below the average.

It was a warm fall in western South Dakota with temperatures above average for September thru November. December thru March were near the average, while late spring was cool with April thru June temperatures below normal. May and June were especially cool with readings 3 – 5 degrees below average. Conditions then warmed up with July and August being near the average.

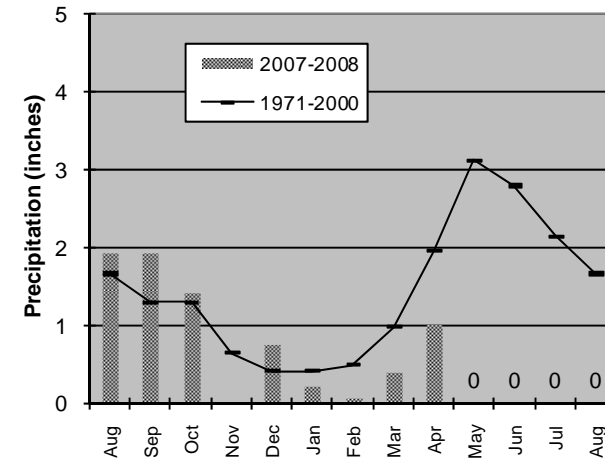
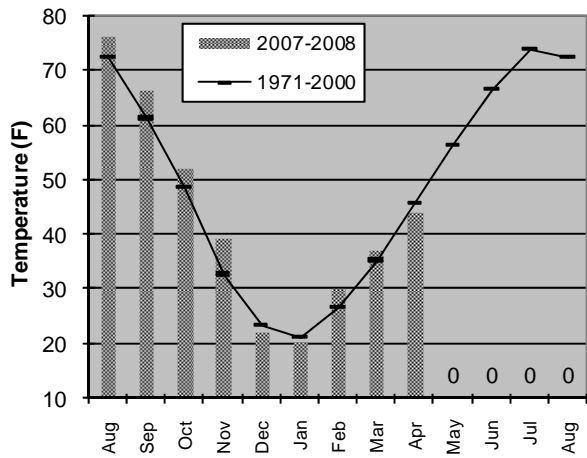
It was an excellent year for winter wheat and other cool season crops in most of western South Dakota with decent October rainfall and a cool wet spring. There was an area from Sturgis east to north of Phillip that had a very dry fall and winter which caused the winter wheat to fail. The summer annual crops like sunflower and millet also benefitted from the plentiful spring moisture and normal summer temperatures. Overall, it was a good year for crop production with much better moisture conditions than the past several years have seen.

Temperature and Precipitation Charts for Martin (Bennett County Reporting Station).



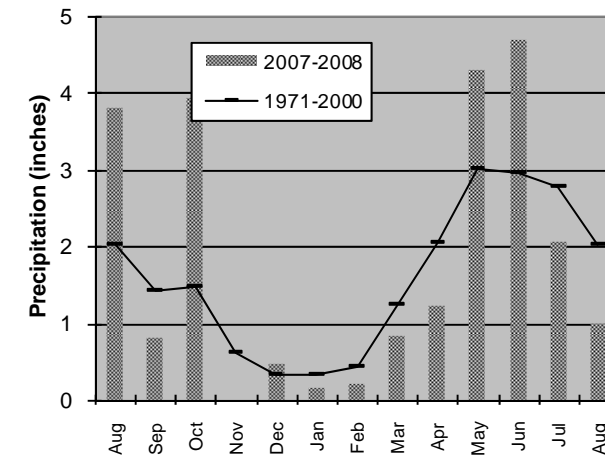
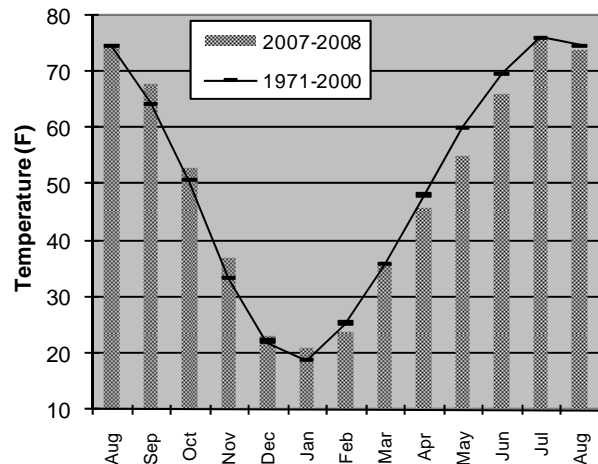
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Temperature and Precipitation Charts for Oelrichs (Fall River County Reporting Station).



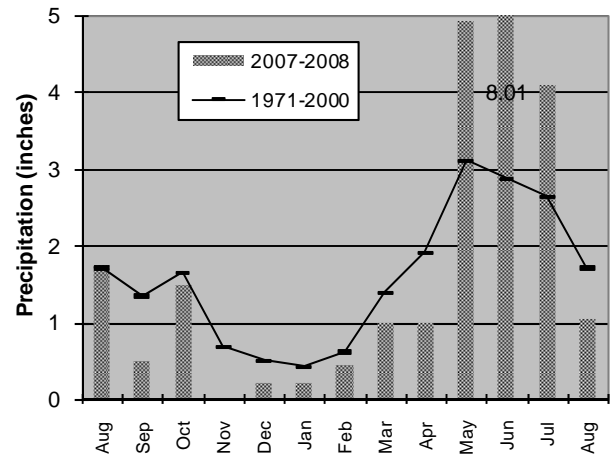
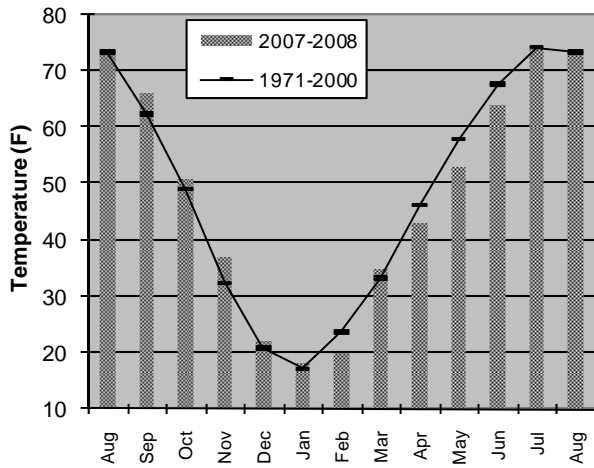
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Temperature and Precipitation Charts for Kennebec (Lyman County Reporting Station).

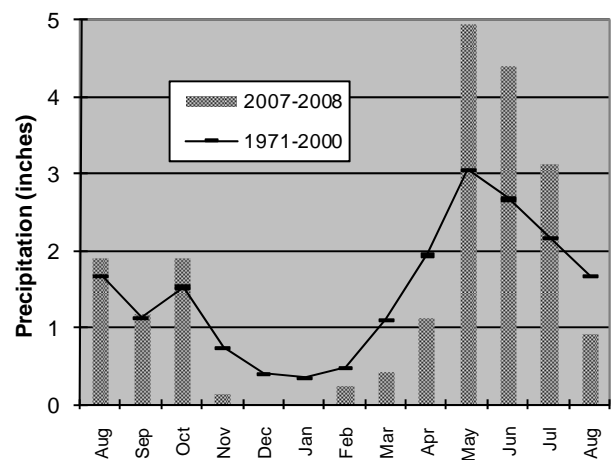
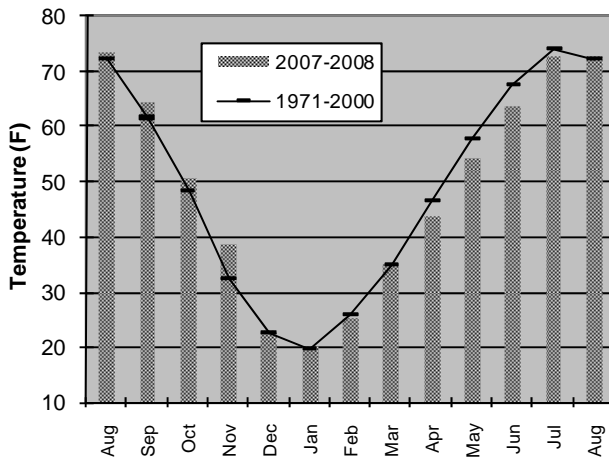


Average temperatures and precipitation obtained from NOAA Climatological Data. Weather data is collected from the reporting station nearest the experimental sites.

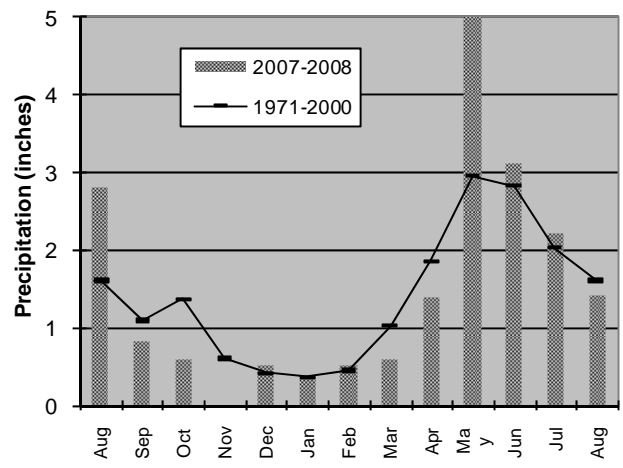
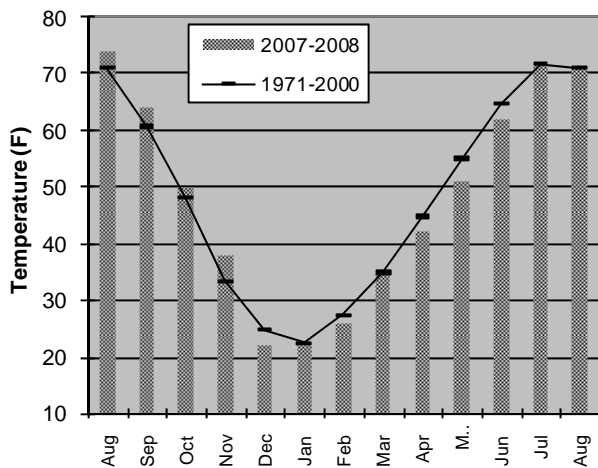
Temperature and Precipitation Charts for Kirley (Haakon County Reporting Station).



Temperature and Precipitation Charts for Wall (Rotation Study Site).

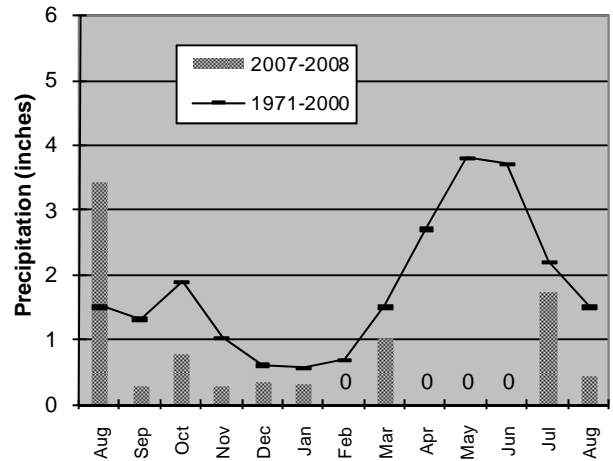
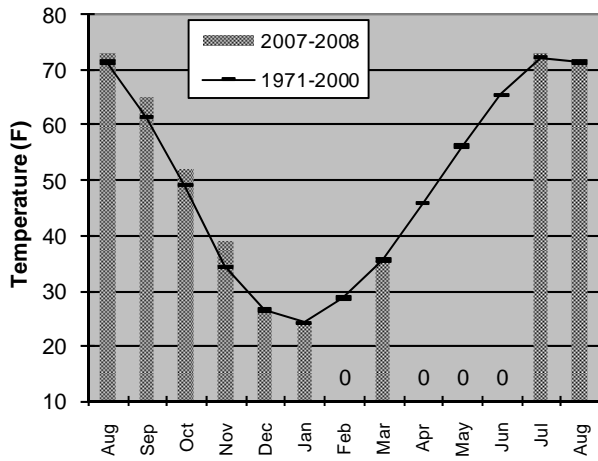


Temperature and Precipitation Charts for Rapid City Airport (Pennington County Reporting Station).



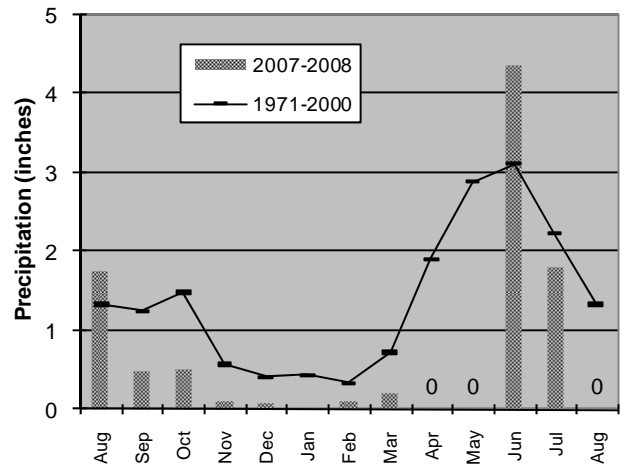
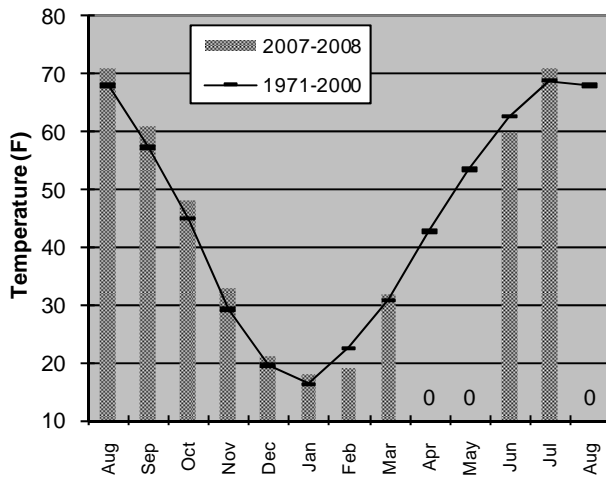
Average temperatures and precipitation obtained from NOAA Climatological Data. Weather data is collected from the reporting station nearest the experimental sites.

Temperature and Precipitation Charts for Fort Meade (*Sturgis*) (Meade County Reporting Station).



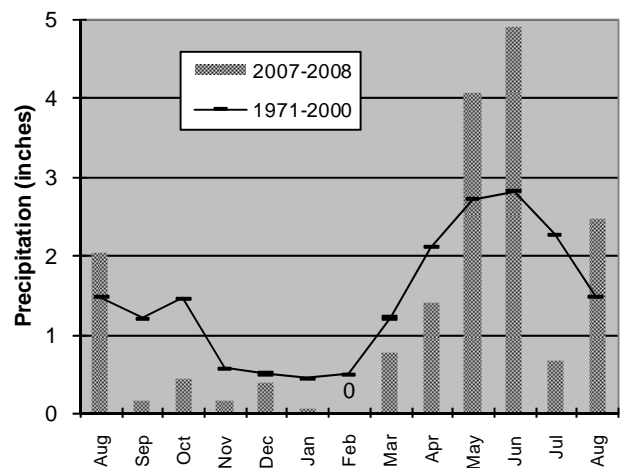
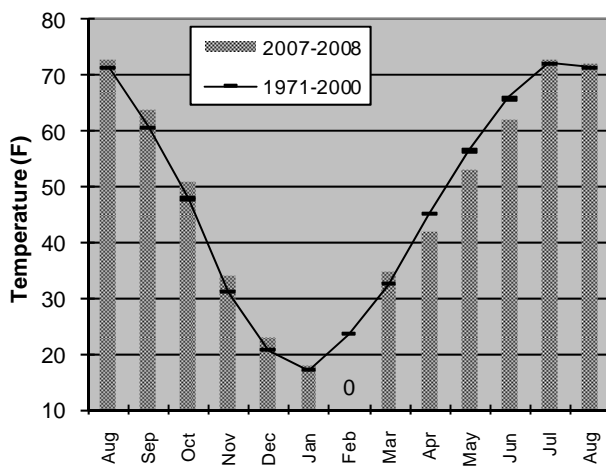
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Temperature and Precipitation Charts for Ludlow (Harding County Reporting Station).



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Temperature and Precipitation Charts for Bison (Perkins County Reporting Station).



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Average temperatures and precipitation obtained from NOAA Climatological Data. Weather data is collected from the reporting station nearest the experimental sites

Table 1. Weather Data – Date of Critical Temperatures and Total Useable Precipitation in Counties with Experimental Plots (2007-2008).

Location	Date of Freeze*		Total Moisture [#]	Total Useable Precipitation**	
	First	Last		Aug. 07-July 08	April 08-July 08
Bennett County (Martin)	Sept 14, 2007 26 ^o F	May 11, 2008 22 ^o F	19.80" M	12.18"	6.57"
Fall River County (Oelrichs)	Missing	Missing	4.58" M	5.92" M	2.80" M
Harding County (Ludlow)	Sept 14, 2007 25 ^o F	Missing	9.38" M	5.21" M	3.94" M
Jones County (Murdo)	Nov 3, 2007 28 ^o F	April 28, 2008 28 ^o F	23.65"	15.42"	8.83"
Meade County (Ft. Meade)	Sept 14, 2007 28 ^o F	Missing	8.16" M	4.15" M	1.00" M
Pennington County (Rapid City AP)	Oct 22, 2007 28 ^o F	May11, 2008 28 ^o F	20.18"	13.57"	11.23"
Pennington County (Wall)	Oct 27, 2007 28 ^o F	April 28,2008 27 ^o F	17.51" M	12.21" M	9.32" M
Perkins County (Bison)	Sept 14, 2007 27 ^o F	May 1, 2008 28 ^o F	15.07" M	8.89" M	7.53"
Haakon County (Kirley)	Oct 27, 2007 28 ^o F	April 29,2008 28 ^o F	23.73"	16.45"	13.88"
Butte County (Newell)	Oct 22, 2007 28 ^o F	April 29, 2008 26 ^o F	21.29"	14.47" M	13.08" M
Lyman County (Kennebec)	Sept 14, 2007 28 ^o F	May 11, 2008 27 ^o F	22.47"	15.05"	8.45"

* = First 28^o temperature in Fall or last 28^o temperature in Spring, reported in degrees Fahrenheit.

** = Sum of all precipitation where amounts were in excess of .25 inch per day or totaled over .25 inch in two contiguous days.

= Total moisture from August 1, 2007 to July 31, 2008.

M = partial missing data from weather station site.

WINTER WHEAT VARIETY TRIALS

Objective: To evaluate standard and experimental hard red and hard white winter wheat varieties for yield, agronomic characteristics and adaptation to western South Dakota.

Procedure: Plots were seeded at seven locations in September 2007 with a John Deere 610 double disk (conventional fallow) or John Deere 750 (no-till) plot drills with 10 inch spacing. The experimental design was a randomized complete block with four replications. The seeding rate was 960,000 seeds per acre (60 Lb/A). The plots received 7.4 lbs N and 25 lbs P₂O₅ per acre as 10-34-0 with the seed. Herbicides were applied in either the fall or spring and varied according to weeds present. Visual stand ratings were taken in October 2007 and April 2008. The plots were trimmed to 5' x 25' after heading. The wheat was harvested in July with a small plot combine. Height, shatter, and lodging notes were taken at the time of harvest. Protein content was determined with a Near Infrared Spectrophotometer (Technicon InfraAlyzer 400).

Location Summaries:

Fall River County – Oelrichs

Planted: September 18, 2007 Herbicide: Cleanwave (14 oz/A)
Harvested: July 22, 2008 Additional Nitrogen: 80 Lb/Ac
Previous crop: Conventional fallow

Yields at Oelrichs were decent in 2008 averaging 44 Bu/A. The top yielding varieties in 2008 were Hatcher, Wahoo, Overland, Ripper and Jagalene. Top varieties over the past three years were . Results are presented in Table 2.

Bennett County – Martin

Planted: October 1, 2007 Herbicide: Harmony GT (1/2 oz/A)
Harvested: July 31, 2008 Additional Nitrogen: 50 Lb/A
Previous crop: Millet stubble, no-till planted

Martin had excellent yields in 2008 with an average yield of 63 Bu/A recropped behind millet. The top yield group in 2008 consisted of Hatcher, Infinity CL, Wahoo, Expedition, Settler CL, Lyman and Wesley. The best varieties over the past three years were Hatcher, Wesley, Wahoo, Darrell and Arapahoe. Results are presented in Table 3.

Lyman County – Kennebec

Planted: September 21, 2007 Herbicide: Amber (0.4oz/A)
Harvested: July 21, 2008 Additional Nitrogen: 50 Lb/A
Previous crop: Conventional fallow

Yields were excellent at Kennebec averaging 81 Bu/A. The top yielding varieties in 2008 were Lyman, Overland, Millennium and Arapahoe. There are no three year averages for Kennebec. Results are presented in Table 4.

Table 2. Hard Winter Wheat Variety Trial – Fall River County (Oelrichs), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein Percent
<i>Hard Red</i>					
ALLIANCE	34	0	58.3	45	12.0
ARAPAHOE	36	0	57.8	42	14.5
BUTEO	35	0	59.2	43	12.4
DARRELL	34	0	59.9	43	12.2
EXPEDITION	31	0	58.8	41	12.6
HARDING	35	0	57.3	42	12.4
HATCHER	30	0	60.7	53	10.8
JAGALENE	32	0	63.5	47	11.1
JERRY	36	0	57.4	41	13.6
MILLENNIUM	34	0	61.0	44	13.1
OVERLAND	35	0	61.5	48	11.0
OVERLEY	32	0	61.6	40	13.1
RIPPER	29	0	61.4	49	12.4
TANDEM	34	0	60.8	46	12.2
WAHOO	33	0	58.6	52	10.9
WESLEY	29	0	58.4	45	13.1
<i>Hard White</i>					
ALICE	30	0	61.4	39	13.3
DANBY	31	0	53.9	37	12.8
NUDAKOTA	28	0	58.3	45	12.7
WENDY	30	0	61.2	39	13.0
Average	32.3	0.0	59.5	44.0	12.5
LSD (P=.05)	1.8	0.0	2.0	6.2	.
CV	3.9	0.0	2.4	10.0	.

* 0=No lodging, 9 = 100% lodged.

Table 3. Hard Winter Wheat Variety Trial - Bennett County (Martin), 2006-2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Protein Percent	Yield Bu/A 2008	3 - Year Bu/A
<i>Hard Red</i>						
ARAPAHOE	37	0	59.6	9.2	61	49
DARRELL	37	0	60.7	9.3	68	49
EXPEDITION	34	0	60.5	10.3	68	48
FULLER	32	0	59.9	9.1	62	--
HARDING	39	0	60.1	8.6	59	44
HATCHER	34	0	59.4	8.6	71	52
HAWKEN	30	0	61.6	8.7	63	--
JAGALENE	33	0	61.5	8.9	54	39
JERRY	39	0	60.3	10.1	55	43
LYMAN	37	0	60.3	8.2	66	--
MILLENNIUM	38	0	61.4	8.1	63	47
OVERLAND	34	0	61.7	9.6	59	47
SMOKY HILL	32	0	61.9	8.8	58	--
TANDEM	37	0	61.4	10.4	62	46
WAHOO	36	0	57.6	9.1	69	50
WESLEY	30	0	59.2	9.4	64	52
INFINITY CL	33	0	59.7	8.7	67	--
SETTLER CL	36	0	61.7	9.9	69	--
SD01058	37	0	60.3	8.8	64	--
SD01273	36	0	61.9	10.5	67	--
<i>Hard White</i>						
ALICE	32	0	61.6	10.5	63	48
NUDAKOTA	29	0	60.0	9.4	58	47
RONL	34	0	60.6	10.5	60	--
WENDY	29	0	62.5	9.8	60	48
THUNDER CL	31	0	60.0	8.1	62	--
SD98W175-1	31	0	61.9	10.8	58	--
SD05118	35	0	61.6	9.2	69	--
SD05210	36	0	60.5	8.7	56	--
SD05W012	36	0	59.5	8.9	68	--
SD05W018	36	0	61.1	9.7	71	--
Average	34.2	0.0	60.7	9.3	63.0	63
LSD (P=.05)	2.1	0.0	1.4	.	7.5	8
CV	4.3	0.0	1.7	.	8.4	8

* 0=No lodging, 9 = 100% lodged.

Table 4. Hard Winter Wheat Variety Trial - Lyman County (Kennebec), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Protein Percent	Yield Bu/A
<i>Hard Red</i>					
ARAPAHOE	43	0	62.0	12.0	86
DARRELL	39	0	63.2	11.5	81
EXPEDITION	40	0	59.8	10.6	77
FULLER	37	0	61.6	12.8	75
HARDING	43	0	63.4	11.5	86
HATCHER	35	0	61.6	10.6	73
HAWKEN	33	0	62.3	12.4	78
JAGALENE	37	0	59.4	11.8	62
JERRY	42	0	62.3	12.3	76
LYMAN	43	0	63.1	11.7	95
MILLENNIUM	43	0	63.8	11.2	89
OVERLAND	41	0	63.9	11.7	91
SMOKY HILL	36	0	63.0	11.7	84
TANDEM	45	0	63.0	11.3	82
WAHOO	41	0	58.4	12.2	82
WESLEY	36	0	59.7	11.7	76
INFINITY CL	37	0	59.7	10.6	75
SETTLER CL	42	0	63.0	11.0	82
SD01058	39	0	61.4	12.1	79
SD01273	42	0	62.9	10.9	83
<i>Hard White</i>					
ALICE	36	0	62.3	10.7	77
NUDAKOTA	34	0	60.9	11.1	84
RONL	38	0	60.7	11.0	79
WENDY	35	0	61.5	11.9	79
THUNDER CL	35	0	57.9	11.3	68
SD98W175-1	39	0	63.8	11.9	78
SD05118	39	0	63.9	10.5	92
SD05210	41	0	62.8	11.4	88
SD05W012	41	0	62.3	11.2	88
SD05W018	40	0	63.5	11.0	85
Average	39.0	0.0	61.9	11.5	80.9
LSD (P=.05)	2.3	0.0	1.3	.	5.8
CV	4.1	0.0	1.4	.	5.1

* 0=No lodging, 9 = 100% lodged.

Stanley County - Hayes

Planted: September 17, 2007 Herbicide: Widematch
Harvested: July 25, 2008 Additional Nitrogen: 60 lb/A
Previous crop: Wheat, no-till planted

Hayes had yields averaging 76 Bu/A with the varieties Smoky Hill, Wendy, Tandem, Expedition, Darrell, Settler CL and Overland showing top yields in 2008. There are no three year averages for Hayes. Results are presented in Table 5.

Pennington County - Wall

Planted: September 15, 2007 Herbicide: None
Harvested: July 20, 2008 Additional Nitrogen: 80 lb/A
Previous crop: Chemical fallow, no-till planted

The good moisture at Wall in 2008 led to an average yield of 74 Bu/A. The best yielding varieties at Wall were Overland, Wendy, Smoky Hill, Expedition, Hawken and Wesley. The best yielding varieties the past three years were Wendy, NuDakota, Overland, Expedition Wesley, Alice, Wahoo and Jagalene. The results are presented in Table 6.

Meade County - Sturgis

Planted: September 20, 2007 Herbicide: Amber (0.4 oz/A)
Harvested: August 12, 2008 Additional Nitrogen: 80 lb/A
Previous crop: Wheat, no-till planted

Dry conditions continued at Sturgis in 2008 with limited fall moisture leading to less than ideal stands and tillering. These conditions limited yields to 37 Bu/A. The varieties with the best yields in 2008 were Overland, Hatcher, Smoky Hill, Darrell and Alice. The varieties in the top yield group over the past three years were Darrell, Millenium, Overland, Wahoo and Wesley. The results are presented in Table 7.

Perkins County - Bison

Planted: September 19, 2007 Herbicide: None
Harvested: August 13, 2008 Additional Nitrogen: 80 lb/A
Previous crop: Wheat, no-till planted

Though Bison was also dry again this year, winter wheat yields averaged 47 Bu/A, good for recrop wheat. Because of the variability in the plot no yield comparisons can be made in 2008. There are no three year averages for Bison. Results are presented in Table 8.

Table 5. Hard Winter Wheat Variety Trial - Stanley County (Hayes), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Protein Percent	Yield Bu/A
<i>Hard Red</i>					
ARAPAHOE	40	8	56.8	13.0	73
DARRELL	39	1	59.4	11.9	79
EXPEDITION	37	1	60.2	12.2	81
FULLER	35	0	58.6	11.3	76
HARDING	42	2	58.6	13.5	71
HATCHER	33	2	57.7	10.2	71
HAWKEN	32	1	59.0	12.9	73
JAGALENE	36	3	59.3	11.1	70
JERRY	44	4	59.0	11.1	66
LYMAN	38	1	60.1	12.3	75
MILLENNIUM	41	3	60.1	12.2	77
OVERLAND	39	2	59.9	10.5	78
SMOKY HILL	35	1	60.0	12.4	85
TANDEM	39	3	61.3	12.5	82
WAHOO	40	6	55.0	11.9	75
WESLEY	34	3	58.2	11.8	77
INFINITY CL	36	1	58.6	12.8	79
SETTLER CL	37	5	60.0	12.0	78
SD01058	38	2	59.0	11.3	72
SD01273	39	3	61.2	10.8	77
<i>Hard White</i>					
ALICE	35	4	61.4	10.7	74
NUDAKOTA	33	3	58.9	11.6	75
RONL	36	2	60.6	9.7	75
WENDY	34	1	61.0	12.2	83
THUNDER CL	35	5	58.8	11.6	76
SD98W175-1	37	2	60.5	12.6	73
SD05118	38	5	58.8	11.9	78
SD05210	40	2	56.8	13.8	69
SD05W012	35	2	59.8	11.1	73
SD05W018	38	1	59.5	11.9	74
Average	37.1	2.6	59.3	11.8	75.5
LSD (P=.05)	2.4	.	2.1	.	6.8
CV	4.6	.	2.5	.	6.4

* 0=No lodging, 9 = 100% lodged.

Table 6. Hard Winter Wheat Variety Trial - Pennington County (Wall), 2006-2008.

Variety	Yield Bu/A	
	2008	3 - Year
<i>Hard Red</i>		
ARAPAHOE	71	56
DARRELL	73	55
EXPEDITION	80	61
FULLER	78	--
HARDING	67	52
HATCHER	65	56
HAWKEN	79	--
JAGALENE	77	58
JERRY	62	49
LYMAN	72	--
MILLENNIUM	76	56
OVERLAND	85	61
SMOKY HILL	81	--
TANDEM	68	55
WAHOO	75	58
WESLEY	79	61
INFINITY CL	72	--
SETTLER CL	75	--
SD01058	67	--
SD01273	71	--
<i>Hard White</i>		
ALICE	77	60
NUDAKOTA	78	62
RONL	71	--
WENDY	84	64
THUNDER CL	75	--
SD98W175-1	74	--
SD05118	75	--
SD05210	71	--
SD05W012	69	--
SD05W018	82	--
Average	74	57
LSD (P=.05)	7	7
CV	6	10

Table 7. Hard Winter Wheat Variety Trial - Meade County (Sturgis), 2006-2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Protein Percent	Yield Bu/A 2008	3 - Year
<i>Hard Red</i>						
ARAPAHOE	32	0	57.3	14.0	28	32
DARRELL	31	0	57.2	9.9	40	37
EXPEDITION	31	0	58.7	10.1	41	34
FULLER	28	0	57.2	8.5	38	--
HARDING	35	0	56.6	11.4	34	33
HATCHER	29	0	57.2	9.9	45	40
HAWKEN	27	0	56.5	10.8	35	--
JAGALENE	29	0	57.2	9.8	38	34
JERRY	33	0	55.2	11.6	33	32
LYMAN	34	0	60.0	10.6	40	--
MILLENNIUM	32	0	59.4	9.4	45	36
OVERLAND	28	0	58.9	11.2	41	36
SMOKY HILL	35	0	57.2	10.3	37	--
TANDEM	31	0	56.1	11.8	39	35
WAHOO	28	0	57.0	8.4	39	36
WESLEY	32	0	56.7	11.0	38	36
INFINITY CL	27	0	56.5	11.8	33	--
SETTLER CL	31	0	58.8	11.2	33	--
SD01058	32	0	59.2	10.8	39	--
SD01273	33	0	61.0	10.7	40	--
<i>Hard White</i>						
ALICE	28	0	58.0	11.5	40	35
NUDAKOTA	26	0	56.8	10.0	38	33
RONL	31	0	58.4	11.1	37	--
WENDY	27	0	58.5	11.0	30	30
THUNDER CL	28	0	58.2	11.3	36	--
SD98W175-1	29	0	58.9	9.3	35	--
SD05118	30	0	58.5	10.0	35	--
SD05210	31	0	57.0	10.0	32	--
SD05W012	30	0	56.1	11.8	26	--
SD05W018	31	0	58.2	10.9	36	--
Average	30.4	0.0	57.7	10.7	36.7	35
LSD (P=.05)	3.0	0.0	2.8	.	8.5	5
CV	6.0	0.0	2.9	.	14.3	9

*0=No lodging, 9 = 100% lodged.

Table 8. Hard Winter Wheat Variety Trial - Perkins County (Bison), 2008.

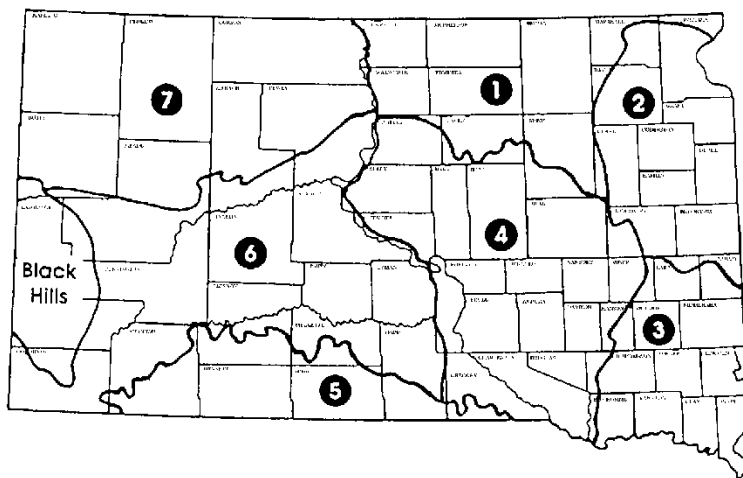
Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Protein Percent	Yield Bu/A
<i>Hard Red</i>					
ARAPAHOE	34	0	53.3	12.9	37
DARRELL	35	0	55.4	13.0	49
EXPEDITION	35	0	55.9	12.4	56
FULLER	33	0	55.0	13.0	53
HARDING	38	0	53.8	14.0	37
HATCHER	32	0	54.7	11.8	48
HAWKEN	32	0	56.4	13.0	52
JAGALENE	34	0	56.7	13.1	48
JERRY	38	0	54.5	14.3	36
LYMAN	36	0	52.0	14.0	43
MILLENNIUM	37	0	56.2	12.8	46
OVERLAND	34	0	58.0	12.1	49
SMOKY HILL	31	0	56.8	13.3	46
TANDEM	39	0	56.1	13.5	42
WAHOO	34	0	52.1	12.5	47
WESLEY	31	0	54.2	14.0	49
INFINITY CL	36	0	54.2	12.6	48
SETTLER CL	32	0	53.9	13.6	45
SD01058	37	0	54.4	12.7	48
SD01273	39	0	56.6	13.0	52
<i>Hard White</i>					
ALICE	30	0	58.3	13.3	43
NUDAKOTA	30	0	54.4	12.3	49
RONL	34	0	57.3	12.4	51
WENDY	33	0	56.6	12.8	55
THUNDER CL	34	0	55.4	12.8	48
SD98W175-1	34	0	56.7	12.8	47
SD05118	37	0	54.0	13.3	50
SD05210	34	0	52.9	13.2	41
SD05W012	34	0	54.5	12.7	48
SD05W018	34	0	55.1	12.8	42
Average	34.3	0.0	55.2	13.0	46.8
LSD (P=.05)	3.7	0.0	2.2	.	NS
CV	6.6	0.0	2.4	.	18.1

* 0=No lodging, 9 = 100% lodged.

WHEAT VARIETY RECOMMENDATIONS FOR 2008

Crop Adaptation Areas for South Dakota

(Revised 1992)



WINTER WHEAT

Recommended:

<i>Variety</i>	<i>Crop Adaptation Area</i>
Alice (white) ^{PVP}	1 ^{pc} , 4 ^{pc} , 5, 6, 7 ^{pc}
Expedition ^{PVP}	1 ^{pc} , 4, 5, 6, 7 ^{pc}
Harding ^{PVP}	1 ^{pc} , 2 ^{pc} , 4, 7
Millennium ^{PVP}	1 ^{pc} , 4 ^{pc} , 5, 6, 7 ^{pc}
NuDakota ^{PVP}	5, 6, 7 ^{pc}
Overland ^{PVP}	1 ^{pc} , 3, 4 ^{pc} , 5, 6, 7 ^{pc}
Wendy (white) ^{PVP}	5, 6, 7 ^{pc}
Wesley	5, 6, 7 ^{pc}

Acceptable/Promising:

<i>Variety</i>	<i>Crop Adaptation Area</i>
Arapahoe ^{PVP}	1 ^{pc} , 3, 4 ^{pc} , 5, 6, 7 ^{pc}
Darrell ^{PVP}	1 ^{pc} , 4 ^{pc} , 5, 6, 7 ^{pc}
Hatcher ^{PVP}	5, 6, 7 ^{pc}
Hawken ^{PVP}	3, 4 ^{pc} , 5, 6

SPRING WHEAT

Recommended:

<i>Variety</i>	<i>Crop Adaptation Area</i>
Briggs ^{PVP}	All except 3
Faller ^{PVP}	Statewide
Howard ^{PVP}	Statewide
Granger ^{PVP}	All except 3
RB07 ^{PVP}	All except 3
Steele-ND ^{PVP}	All except 3
Traverse ^{PVP}	Statewide

Acceptable/Promising:

<i>Variety</i>	<i>Crop Adaptation Area</i>
Glenn ^{PVP}	Statewide
Tom ^{PVP}	3, 4

DURUM WHEAT

Durum wheat is not part of the statewide CPT program, so no recommendations are made. There were trials planted at Bison and Ralph with the results presented on page 19.

^{PVP} U.S. Plant Variety Protection applied for and/or issued; seed sales of these varieties are restricted to classes of certified seed.

^{pc} Plant into protective cover.

Source - Small Grains and Field Peas, 2009 Variety Recommendations, EC774, South Dakota State University. (<http://plantsci.sdstate.edu/varietytrials/vartrial.html>)

SPRING WHEAT VARIETY TRIALS

Objective: To evaluate standard and experimental hard red spring wheat varieties for yield, agronomic characteristics and adaptation to western South Dakota.

Procedure: Plots were seeded at three locations in April 2008 with a John Deere 750 plot drill with 10 inch spacing. The experimental design was a randomized complete block with four replications. The seeding rate was 1,220,000 seeds per acre (90 Lb/A). The plots received 7.4 lbs N and 25 lbs P₂O₅ per acre as 10-34-0 with the seed. Herbicides were applied in May and varied according to weeds present. Plots were trimmed to 5' x 25' after heading. The wheat was harvested in July with a small plot combine. Height, shatter, and lodging notes were taken at the time of harvest.

Location Summaries:

Locations not Harvested

Location	Reason
Harding County – Ralph	Hail

Perkins County – Bison

Planted: April 17, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 13, 2008 Additional Nitrogen: 50 lb/A
Previous crop: Wheat, no-till planted

The growing conditions at Bison were somewhat dry in 2008 with yields averaging 28 Bu/A with test weights averaging 58.1 Lb/Bu. There was too much variation in the plot for valid yield comparisons to be made in 2008 (CV = 17.2). There are no three year averages for Bison. Results are shown in Table 9.

Pennington County - Wall

Planted April 15, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 5, 2008 Additional Nitrogen: 30 lb/A
Previous crop: Chemical fallow

Wall had good growing conditions for spring wheat with yields averaging 44 Bu/A with light test weights averaging 55.6 Lb/Bu. Top yielding varieties in 2008 were Tom, Granger, Samson, Traverse, Faller and Briggs. There are no three year averages for Wall. Results are shown in Table 10.

Table 9. SDSU Hard Red Spring Wheat Variety Trial – Perkins County (Bison), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt. Lb/Bu	Yield Bu/A	Protein %
ADA	28	0	57.4	26.4	14.5
ALBANY	27	0	54.0	29.6	14.6
ALSEN	31	0	54.5	28.5	13.6
BRIGGS	32	0	47.8	28.2	14.3
CHRIS	35	0	50.4	22.2	15.1
FALLER	31	0	49.4	25.7	14.6
GLENN	33	0	46.9	25.4	14.6
GRANGER	35	0	56.2	30.7	17.0
HAT TRICK	29	0	57.4	30.1	15.5
HOWARD	31	0	51.0	26.1	14.8
KELBY	27	0	56.9	32.8	14.1
KUNTZ	27	0	55.6	24.6	13.7
RB07	30	0	57.1	33.8	14.5
REEDER	29	0	54.1	25.5	15.0
SAMSON	29	0	53.4	28.8	13.7
STEELE-ND	32	0	47.2	26.7	14.0
TOM	29	0	51.2	23.6	14.4
TRAVERSE	34	0	53.6	30.1	14.5
ND 901CL	31	0	49.0	25.4	15.3
01S0042-10	26	0	57.8	27.8	14.5
ND SW0449	29	0	53.8	25.5	16.6
ND 806	32	0	53.7	24.8	15.2
ND 809	31	0	55.8	25.7	13.6
MN 03358-4	31	0	54.4	33.4	14.3
SD 3851	34	0	51.2	33.4	14.3
SD 3948	34	0	53.3	28.8	13.6
SD 3983	35	0	52.4	29.9	13.3
SD 3997	35	0	57.4	31.9	12.5
SD 4007	31	0	51.3	30.4	13.6
SD 4018	32	0	52.8	30.4	14.7
SD 4024	27	0	54.2	24.8	13.8
SD 4027	34	0	57.7	30.4	13.6
SD 4036	29	0	55.6	29.2	16.7
SD 4073	32	0	51.3	29.0	13.9
Average	31	0.0	53.4	28.2	14.5
LSD (P=.05)	2.7	0.0	2.8	6.7	.
CV	6.2	0.0	3.7	17.0	.

* 0=No lodging, 9 = 100% lodged.

Table 10. Hard Red Spring Wheat Variety Trial – Pennington County (Wall), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt. Lb/Bu	Yield Bu/A	Protein %
ADA	31	0	58.3	42.5	14.4
ALBANY	31	0	53.6	46.0	15.0
ALSEN	31	0	55.7	42.7	13.9
BRIGGS	35	0	55.8	47.6	14.7
CHRIS	40	0	54.3	35.3	15.4
FALLER	34	0	53.9	47.9	15.1
GLENN	37	0	57.8	35.0	14.9
GRANGER	37	0	58.7	49.5	15.1
HAT TRICK	32	0	55.7	46.7	15.7
HOWARD	32	0	53.9	42.0	15.1
KELBY	30	0	57.6	45.5	13.8
KUNTZ	29	0	57.5	42.8	14.3
RB07	30	0	56.3	46.4	14.3
REEDER	32	0	35.2	37.7	15.3
SAMSON	29	0	55.0	48.3	13.7
STEELE-ND	33	0	55.3	40.6	14.1
TOM	33	0	58.5	50.3	14.9
TRAVERSE	36	0	54.8	48.1	14.4
ND 901CL	35	0	53.8	37.2	15.6
01S0042-10	29	0	59.0	45.9	15.0
ND SW0449	33	0	55.6	33.6	16.5
ND 806	36	0	56.4	42.0	15.1
ND 809	35	0	57.0	43.3	14.3
MN 03358-4	33	0	56.5	48.6	13.4
SD 3851	36	0	57.0	43.7	14.2
SD 3948	37	0	57.7	44.4	13.4
SD 3983	37	0	56.3	42.6	13.5
SD 3997	38	0	57.8	49.2	12.4
SD 4007	33	0	55.1	44.3	13.7
SD 4018	34	0	55.1	45.6	14.7
SD 4024	29	0	57.0	42.8	14.4
SD 4027	36	0	58.8	48.4	13.7
SD 4036	29	0	56.3	46.9	16.1
SD 4073	33	0	53.9	50.3	14.0
Average	33.3	0.0	55.6	44.2	14.5
LSD (P=.05)	2.6	0.0	6.7	7.5	.
CV	5.6	0.0	8.5	12.0	.

* 0=No lodging, 9 = 100% lodged.

DURUM WHEAT VARIETY TRIALS

Objective: To evaluate standard and experimental durum wheat varieties for yield, agronomic characteristics and adaptation to northwestern South Dakota.

Procedure: Plots were seeded at two locations in April 2008 with a John Deere 750 plot drill with 10 inch spacing. The experimental design was a randomized complete block with four replications. The seeding rate was 1,220,000 seeds per acre (90 Lb/A). The plots received 7.4 lbs N and 25 lbs P₂O₅ per acre as 10-34-0 with the seed. Herbicides were applied in late May and varied according to weeds present. Plots were trimmed to 5' x 25' after heading. The wheat was harvested in July with a small plot combine. Height, shatter, and lodging notes were taken at the time of harvest.

Location Summaries:

Locations not Harvested

Location	Reason
Harding County – Ralph	Hail

Perkins County – Bison

Planted: April 17, 2008 Herbicide: Starane NXT (20oz/A)
 Harvested: August 14, 2008 Additional Nitrogen: 50 lb/A
 Previous crop: Wheat, no-till planted

Durum wheat yields averaged 26 Bu/A at Bison with light test weights averaging 50.6 Lb/Bu. There were little significant differences in yield among the varieties tested with only Alkabo yielding less than the others. There are no three year averages at Bison. Results are shown in Table 11.

Table 11. Durum Wheat Variety Trial – Perkins County (Bison), 2008.

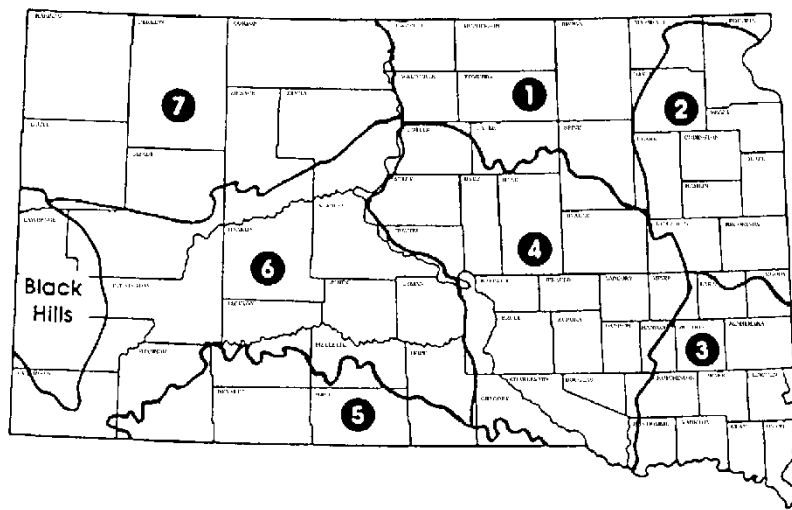
Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein %
ALKABO	30	0	52.2	22.3	15.8
BEN	35	0	49.5	27.1	14.0
DIVIDE	32	0	51.5	24.9	13.3
GRENORA	29	0	49.8	27.7	15.3
LEBSOCK	33	0	53.0	28.3	15.3
MOUNTRAIL	31	0	47.5	27.9	14.7
Average	32	0.0	50.6	26.4	14.7
LSD (P=.05)	2.3	0.0	2.4	3.3	--
CV	4.1	0.0	2.6	6.9	--

* 0 = no lodging, 9 = 100% lodged.

OAT AND BARLEY VARIETY RECOMMENDATIONS FOR 2008

Crop Adaptation Areas for South Dakota

(Revised 1992)



OATS

Recommended:

<u>Variety</u>	<u>Crop Adaptation Area</u>
Beach	5,6,7
Jerry ^{PVP (non-title V status)}	5,6,7
Morton	1,2,7
Souris ^{PVP}	Statewide
Stallion	Statewide

Acceptable/Promising:

<u>Variety</u>	<u>Crop Adaptation Area</u>
Don	5,6,7
HiFi ^{PVP}	1,2,7
Reeves	5,6,7
Buff (hull-less)	Statewide

SPRING BARLEY

Recommended:

<u>Variety</u>	<u>Crop Adaptation Area</u>
<u>6 Row</u>	
Lacey ^{PVP}	Statewide
Tradition ^{PVP}	Statewide
<u>2 Row</u>	
Conlon ^{PVP}	1,4,6,7
Eslick ^{PVP (feed)}	6,7
Rawson (feed)	1,2,7

Acceptable/Promising:

<u>Variety</u>	<u>Crop Adaptation Area</u>
<u>6 Row</u>	
Drummond ^{PVP}	Statewide
Rassmusson ^{PVP}	Statewide
<u>2 Row</u>	
Pinnacle	1,2,7

Conlon, Drummond, Lacey, Legacy, Robust, Stellar-ND and Tradition are approved American Malting Barley Association varieties for South Dakota - 2008.

^{PVP} U.S. Plant Variety Protection applied for and/or issued; seed sales of these varieties are restricted to classes of certified seed.

Source - Small Grains and Field Peas 2009 Variety Recommendations, EC774, South Dakota State University. (<http://plantsci.sdstate.edu/varietytrials/vartrial.html>)

OAT VARIETY TRIALS

Objective: To evaluate standard and experimental oat varieties for yield, agronomic characteristics and adaptation to western South Dakota.

Procedure: Plots were seeded at three locations in April 2007 with a John Deere 750 plot drill with 10 inch spacing. The experimental design was a randomized complete block with four replications. The seeding rate was 1,220,000 seeds per acre (64 Lb/A). The plots received 7.4 lbs N and 25 lbs P₂O₅ per acre as 10-34-0 with the seed. Herbicides were applied in May and varied according to weeds present. Plots were trimmed to 5' x 25' after heading. The oats were harvested in July with a small plot combine. Height, shatter, and lodging notes were taken at the time of harvest.

Location Summaries:

Perkins County – Bison

Planted: April 17, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 20, 2008 Additional Nitrogen: 50 lb/A
Previous crop: Wheat, no-till planted

The trial at Bison averaged 70 Bu/A with test weights averaging 38.5 Lb/Bu. The top yield group in 2008 consisted of Souris, Jerry, Morton and Don. There are no three year averages for Bison. Among the hull-less varieties, Buff and Streaker performed significantly better than Stark in 2008. Results are presented in Table 12.

Jones County - Okaton

Planted: April 9, 2008 Herbicide: None
Harvested: July 30, 2008 Additional Nitrogen: 80 lb/A
Previous crop: Proso millet

Oat yields were tremendous at Okaton this year averaging 142 Bu/A with average test weights of 39.7 Lb/Bu. The best yielding varieties in 2008 were Souris, Stallion, Beach and HiFI. There are no three year averages for Okaton. Results are presented in Table 13.

Pennington County - Wall

Planted April 15, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 5, 2008 Additional Nitrogen: 30 lb/A
Previous crop: Chemical fallow

The yields at Wall averaged 57 Bu/A with average test weights of 36.9 Lb/Bu. The best yielding varieties in 2008 were Souris, Jerry and HiFI. There are no three year averages for Wall. Results are presented in Table 14.

Table 12. Oat Variety Trial - Perkins County (Bison), 2008.

Variety	Relative Heading	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein %
BUFF (hulless)	3	33	0	42.6	60.8	19.4
STARK (hulless)	6	32	0	36.4	44.5	20.7
STREAKER (hulless)	3	38	0	42.8	61.1	19.9
BEACH	6	37	0	36.6	73.8	16.1
COLT	1	35	0	39.9	70.1	17.7
DON	1	32	0	37.8	59.7	16.8
HIFI	8	36	0	33.8	77.5	16.8
HYTEST	4	39	0	40.7	58.9	18.6
JERRY	5	37	0	37.0	81.1	17.7
MORTON	7	38	0	35.6	79.7	16.3
REEVES	2	40	0	38.1	49.3	17.7
SOURIS	6	33	0	35.6	84.2	16.7
STALLION	8	36	0	36.2	70.1	17.0
SD 020883-109	--	35	0	40.7	71.8	17.8
SD 031128-245	--	38	0	39.9	83.4	16.9
SD 031128-330	--	38	0	39.6	74.1	16.6
SD 041405	--	34	0	38.3	78.6	16.8
SD 060966	--	33	0	41.1	76.3	17.7
Average	--	36	0.0	38.5	69.7	17.6
LSD (P=.05)	--	3.0	0.0	1.6	7.5	--
CV	--	5.0	0.0	3.0	7.6	--

* Heading Date, relative difference in days compared to Don.

** 0 = No Lodging, 9 = 100% lodged.

Table 13. Oat Variety Trial – Jones County (Okaton), 2008.

Variety	Leaf Disease 0-9	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein %
BUFF (hulless)	2	40	0	42.1	110.9	18.8
STARK (hulless)	0	44	0	35.6	95.2	20.3
STREAKER (hulless)	5	43	0	43.4	114.7	19.2
BEACH	1	48	0	38.7	155.5	15.2
COLT	2	40	0	40.5	138.9	17.2
DON	1	37	0	38.7	146.9	15.3
HIFI	0	48	0	37.2	154.5	16.8
HYTEST	3	46	0	41.5	121.5	18.3
JERRY	2	46	0	39.5	150.4	18.2
MORTON	1	47	0	38.0	151.7	16.8
REEVES	1	45	0	40.1	132.6	16.7
SOURIS	0	40	0	38.2	162.1	17.2
STALLION	5	46	0	38.4	160.7	15.4
SD 020883-109	1	42	0	40.7	140.2	16.4
SD 031128-245	0	44	0	40.7	150.3	17.2
SD 031128-330	0	44	0	40.8	149.5	16.2
SD 041405	1	39	0	39.3	159.1	16.3
SD 060966	2	39	0	41.1	154.2	16.3
Average	1.4	43.1	0.0	39.7	141.6	17.1
LSD (P=.05)	0.7	2.1	0.0	0.7	8.7	--
CV	37.7	3.5	0.0	1.3	4.3	--

* 0 = No disease, 9 = leaf gone.

** 0 = No Lodging, 9 = 100% lodged.

Table 14. Oat Variety Trial – Pennington County (Wall), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein %
BUFF (hulless)	32	0	41.5	49.9	19.5
STARK (hulless)	39	0	32.5	42.6	20.2
STREAKER (hulless)	36	0	39.7	58.8	20.0
BEACH	40	0	38.2	63.8	16.4
COLT	35	0	37.8	48.7	17.6
DON	30	0	36.1	47.2	16.7
HIFI	37	0	34.7	66.9	18.2
HYTEST	38	0	36.3	39.6	18.5
JERRY	40	0	35.1	66.0	18.5
MORTON	40	0	35.5	48.9	17.3
REEVES	38	0	35.4	51.8	17.3
SOURIS	33	0	36.3	76.4	18.0
STALLION	36	0	36.6	57.6	17.2
SD 020883-109	36	0	38.1	54.5	18.0
SD 031128-245	40	0	38.0	71.0	17.1
SD 031128-330	37	0	37.6	68.5	16.7
SD 041405	34	0	36.6	61.5	17.3
SD 060966	32	0	37.9	49.7	18.2
Average	36.1	0.0	36.9	56.9	17.9
LSD (P=.05)	2.9	0.0	1.6	9.2	--
CV	5.8	0.0	3.0	11.4	--

* 0 = No Lodging, 9 = 100% lodged.

SPRING BARLEY VARIETY TRIALS

Objective: To evaluate standard and experimental spring barley varieties for yield, agronomic characteristics and adaptation to western South Dakota.

Procedure: Plots were seeded at three locations in April 2008 with a John Deere 750 plot drill with 10 inch spacing. The experimental design was a randomized complete block with four replications. The seeding rate was 1,220,000 seeds per acre (117 Lb/A for two row, 83 Lb/A for six-row). The plots received 7.4 lbs N and 25 lbs P₂O₅ per acre as 10-34-0 with the seed. Herbicides were applied in May and varied according to weeds present. Plots were trimmed to 5' x 25' after heading. The barley was harvested in July and August with a small plot combine. Height, shatter, and lodging notes were taken at the time of harvest.

Location Summaries:

Locations not Harvested

<u>Location</u>	<u>Reason</u>
Harding County – Ralph	Hail

Perkins County – Bison

Planted: April 17, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 20, 2008 Additional Nitrogen: 50 lb/A
Previous crop: Wheat, no-till planted

At Bison, yields averaged 33 Bu/A and test weights averaged 45.8 Lb/Bu. There was a fair amount of variation in the plot (CV =15.1) so yield comparisons are difficult. Also the varieties Conlon and Rawson suffered from wildlife damage which greatly reduced their yields. There are no three year averages for Bison. Results are shown in Table 15.

Pennington County - Wall

Planted April 15, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 5, 2008 Additional Nitrogen: 30 lb/A
Previous crop: Chemical fallow

Yields averaged 51 Bu/A at Ralph with a 47.1 Lb/Bu average test weight. The Wall location was also somewhat variable and yields were similar for most varieties There are no three year averages for Wall. There are no three year averages for Wall. Results are shown on Table 16.

Table 15. Spring Barley Variety Trial - Perkins County (Bison), 2008.

	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein %
TWO ROW					
CONLON +	32	0	**	13.4	11.5
ESLICK	26	0	43.4	60.8	12.3
PINNACLE	31	0	46.6	38.5	10.9
RAWSON +	33	0	**	10.1	11.3
SIX ROW					
LACEY	31	0	48.7	19.0	11.9
TRADITION	33	0	48.3	41.3	11.5
STELLAR-ND	31	0	44.6	36.7	10.9
DRUMMOND	34	0	45.7	21.0	11.9
RASMUSSEN	31	0	46.3	34.2	11.2
ROBUST	34	0	45.9	23.6	12.2
M122	33	0	46.0	35.0	11.1
Average	31	0.0	45.8	32.9	11.6
LSD (P=.05)	2.2	0.0	2.5	8.8	--
CV	7.0	0.0	3.2	15.8	--

+ Colon and Rawson yields were adversely affected by wildlife damage.

* 0 = no lodging, 9 = 100% lodged.

** Not enough sample for a test weight.

Table 16. Spring Barley Variety Trial – Pennington County – (Wall), 2008.

	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A	Protein %
TWO ROW					
CONLON	32	0	51.0	31.5	11.0
ESLICK	27	0	48.1	54.6	10.7
PINNACLE	32	0	47.0	46.3	9.3
RAWSON	34	0	46.6	27.9	10.9
SIX ROW					
LACEY	33	0	47.2	59.4	11.0
TRADITION	32	0	47.0	55.4	11.3
STELLAR-ND	33	0	45.8	64.7	11.2
DRUMMOND	34	0	45.7	54.3	11.0
RASMUSSEN	32	0	46.4	59.4	11.0
ROBUST	36	0	46.9	42.3	12.3
M122	35	0	46.4	56.7	11.5
Average	32.2	0.0	47.1	50.8	11.0
LSD (P=.05)	2.7	0.0	1.7	11.1	--
CV	5.8	0.0	2.5	15.1	--

* 0 = no lodging, 9 = 100% lodged.

SPRING TRITICALE VARIETY TRIAL

Objective: Spring Triticale varieties have done well in North Dakota trials and have potential as use for flour in certain bread products. This trial was initiated to evaluate standard and experimental spring triticale varieties for yield, agronomic characteristics and adaptation to western South Dakota.

Procedure: Spring triticale varieties and two spring wheat checks (Briggs and Glenn) were planted near Bison, South Dakota. The experimental design was a randomized complete block with four replications. A seeding rate of 1,390,000 seeds per acre was used and liquid starter fertilizer (10-34-0 at 6.3 gal/A) applied at 7.4-25-0 pounds per acre. Plots were trimmed to 5' x 25' after heading. The plot was harvested in July and August with a small plot combine. Height, shatter, and lodging notes were taken at the time of harvest.

Summary:

Perkins County –Bison

Planted: April 17, 2008 Herbicide: Starane NXT (20oz/A)
Harvested: August 14, 2008 Additional Nitrogen: 50 lb/A
Previous crop: Wheat, no-till planted

Like the other crops at Bison, the triticale yields were below average at Bison due to the dry conditions. The plot averaged 2119 Lb/A, with the better triticale varieties yielding 30% more than the spring wheat checks. The newer varieties targeted for grain production are much shorter, have better seed quality and test weight than the older varieties that have been tested in the past. The results are shown in Table 17.

Table 17. Spring Triticale Variety Trial – Perkins County (Bison), 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Lb/A	Protein %
TRICAL 96	26	0	47.9	2226	12.5
TRICAL 98	28	0	43.1	2518	12.5
TRICAL 116	28	0	43.2	2494	12.8
TRIMARK 118	29	0	50.0	2761	12.5
03T63063	28	0	42.3	1934	13.0
03T63111	29	0	45.7	2165	13.5
01T40264	28	0	48.1	2226	14.2
03T63037	25	0	44.6	2153	12.7
03T63053	26	0	49.1	2214	12.5
02T71211	26	0	45.6	1764	13.0
37812	27	0	45.4	2323	13.0
MAH 2601	33	0	41.4	2129	13.4
FL9707-01H1	32	0	43.3	1764	13.7
MAH20555-8/	34	0	39.2	2019	13.6
MAH28246	38	0	41.1	2177	12.0
177956	41	0	43.0	1727	13.9
163927	36	0	42.3	2153	12.8
180476	29	0	40.7	1776	14.2
BRIGGS (Spring Wheat)	35	0	46.4	1958	14.7
GLENN (Spring Wheat)	36	0	50.4	1897	14.5
Average	31	0.0	44.7	2119	13.3
LSD (P=.05)	3.0	0.0	3.4	355	.
CV	5.8	0.0	4.7	10.1	.

* 0=No lodging, 9 = 100% lodged.

SAFFLOWER VARIETY TRIAL

Objective: To evaluate safflower varieties for yield and adaptation to western South Dakota.

Procedure: Safflower varieties were planted at 18 Lb/A in a randomized complete block experiment with four replications near Wall, South Dakota. The trial was planted on April 15, 2008 with a John Deere 750 drill set to 10-inch row spacing. The plots received 7.4 lbs N and 25 lbs P₂O₅ per acre as 10-34-0 with the seed. Plots were trimmed to 5' x 25' before harvest. Height, shatter, and lodging notes were taken at the time of harvest.

Pennington County - Wall

Planted: April 16, 2008

Herbicide: Prowl H₂O (3 pt/A)

Harvested: Not harvested

Additional Nitrogen: None

Previous crop: Winter Wheat

Discussion: The safflower trial suffered from severe weed pressure, especially from kochia, and was abandoned prior to harvest.

SUNFLOWER VARIETY TRIAL

Objective: To evaluate sunflower varieties for yield and adaptation to western South Dakota.

Procedure: Plots of four rows, 30 feet long, spaced 30 inches apart were planted on June 16, 2008 with a no-till planter into wheat stubble. The plot layout was in a randomized complete block design with four replications. The experiment was randomized for a nearest neighbors statistical analysis, which removes effects of field trends. Seed of most of the hybrids entered in the trials were pre-treated with Cruiser insecticide, and most were also treated with fungicide. Spartan herbicide was applied for weed control. Plots were overseeded and thinned to a plant population of 17,400 plants/acre. The center two rows of each plot were harvested with a Wintersteiger Delta small plot combine on October 30, 2008. Oil content was determined by NMR analysis. Oil values for NuSun and high oleic hybrids were adjusted for oleic acid content.

Discussion: Yields at Bison averaged 1727 lbs/acre and 42.4% oil content. Because of the uneven and poor stands, which caused a large amount of plot variability (CV = 20%) yield comparisons are difficult to make. Information on the statewide trials this location was part of can be found in the publication "Sunflower, South Dakota Hybrid Performance Trials, EC909", which can be found at the following website <http://plantsci.sdstate.edu/varietytrials/> Results are presented in Table 18.

Table 18. Oilseed Sunflower Hybrid Trial - Perkins County (Bison), 2007 - 2008.

Brand	Hybrid	Type*	Seed Yield			Oil %	Height cm	Lodg %	Moist %	Tst Wt lb/bu	Pop 1000 plt/ac
			2008	2007	2-Yr						
Advanta Pacific LLC	F30008NS,CL	NS/CL	1858	--	--	39.8	156	0	15.1	25.7	15
Croplan Genetics	CG 306 DMR NS	NS	1868	--	--	42.6	145	2	14.0	27.6	11.8
Croplan Genetics	CG 3080 DMR NS	NS	2006	--	--	47.2	136	0	10.0	27.5	15.3
Croplan Genetics	CG 325 DMR NS	NS	1448	--	--	42.4	138	0	10.2	26.9	11.0
Croplan Genetics	CG 356 NS	NS	1931	--	--	43.1	144	0	16.6	28.4	13.7
Croplan Genetics	CG 369 DMR NS	NS	1512	--	--	42.6	156	1	15.4	26.6	10.6
Croplan Genetics	CG 378 DMR NS	NS	1878	--	--	41.1	152	0	15.3	25.8	10.4
Croplan Genetics	CG 528 CL NS	NS/CL	1912	--	--	42.7	146	1	11.5	28.1	13.2
Croplan Genetics	CG 551 CL NS	NS/CL	1317	--	--	40.3	157	0	14.5	24.8	12.1
Croplan Genetics	CG 564 CL NS	NS	1531	--	--	41.0	148	8	23.2	27.2	11.1
Dekalb	DKF 29-30	NS	1059	1235	1147	43.6	139	0	7.1	29.0	12.7
Dekalb	DKF 34-33	NS	1577	850	1213	42.9	136	4	13.8	26.8	8.5
Dekalb	DKF 34-80CL	NS/CL	1630	1345	1487	42.6	140	0	11.2	26.6	11.8
Dekalb	DKF 37-31	NS	1256	1411	1333	44.7	134	0	14.9	28.7	10.0
Dekalb	DKF 38-45	NS	1963	1865	1914	45.5	146	0	7.8	28.2	14.4
Dekalb	DKF 3875	Trad.	2012	1679	1845	42.8	145	0	13.5	29.7	12.5
Dekalb	DKF 39-80CL	NS/CL	1666	--	--	38.9	169	0	14.3	25.4	10.2
Dekalb	IS 7120	HO	1671	1255	1463	43.1	133	0	11.7	27.2	12.2
Garst Seed Co.	4651NS	NS	1846	--	--	40.7	161	2	15.8	25.9	10.1
Garst Seed Co.	NX43489	NS	1799	--	--	42.2	148	0	12.7	29.7	12.5
Garst Seed Co.	NX44166	HO	1790	--	--	43.4	152	1	14.6	29.9	10.6
King Seed Inc.	SunKing 4404 NSCL	NS/CL	2246	--	--	37.8	153	0	16.3	26.1	15.2
King Seed Inc.	SunKing 4505	Trad.	1754	--	--	44.4	161	1	9.9	28.6	10.8
Monsanto	MH6640	NS	1604	--	--	44.0	140	2	13.6	29.7	11.0
Monsanto	MH6643	NS	1414	--	--	44.5	143	0	11.7	27.6	10.9
Monsanto	MH7632	NS	2008	--	--	43.3	141	0	14.9	28.9	14.0
Monsanto	MH7633	NS	1550	--	--	40.5	150	3	15.1	28.3	9.2
Mycogen Seeds	8D481	NS	1803	--	--	39.9	146	0	13.1	30.5	10.5
Mycogen Seeds	8H449DM	HO	2129	1273	1701	45.6	142	3	20.2	27.7	12.7
Mycogen Seeds	8N187	NS	1811	--	--	39.3	119	1	17.9	27.0	12.1
Mycogen Seeds	8N270	NS	1722	1454	1588	40.8	123	0	11.4	27.9	13.7
Mycogen Seeds	8N358CL	NS/CL	1881	666	1273	43.7	141	0	15.6	27.2	13.5
Mycogen Seeds	8N453DM	NS	1766	1815	1790	46.9	137	0	18.9	27.4	13.4
Mycogen Seeds	8N510	NS	1587	1630	1609	41.2	140	0	17.6	27.3	11.6
Pannar	Pan 7813	NS	1844	2008	1926	41.2	146	1	21	27.6	10.7
Pannar	Pan 7924	NS	1820	1704	1762	38.7	159	4	23.8	24.9	10.5
Pannar	Pan 7986	NS	1911	--	--	40.2	154	1	15.0	28.5	15.1
Pannar	Pan 9501	Trad.	1680	1525	1602	38.4	158	1	14.0	27.5	14.8
Triumph Seed Co.	s678	NS	1783	1650	1717	42.7	140	0	21.4	26.3	14.7
Triumph Seed Co.	s671	NS	1978	--	--	43.5	118	0	21.2	26.7	15.9
USDA (check)	USDA 894	Trad.	1094	867	980	44.0	141	0	16.7	26.8	10.9
USDA (check)	cms HA412/RHA 377	Trad.	1610	--	--	48.2	145	2	12.7	27.7	12.8
Grand Mean			1727	1385	1550	42.4	145	0.9	14.9	27.5	12.2
LSD 5%			484	574	395	1.7	12	NS	3.4	2.3	NS
C.V.			20.0	20.4	19.9	2.9	6.1	298	16.3	5.9	25.6

* NS=NuSun, HO=High Oleic, Trad.=Traditional linoleic, CL=Clearfield, DM=downy mildew resistant, SU=Express-resistant. Yield is reported at 10% moisture. Oil % is adjusted for oleic acid content.

CAMELINA VARIETY TRIAL

Objective: To evaluate Camelina (*Camelina sativa*) varieties for yield, agronomic characteristics and adaptation to western South Dakota.

Procedure: Camelina, also known as falseflax, is an oilseed crop with potential for biodiesel production. Prowl H₂O was applied just after planting at a location near Wall, South Dakota. The plots were seeded on March 26, 2008 with a John Deere 750 plot drill with 10 inch spacing. The experimental design was a randomized complete block with four replications. The seeding rate was 3 pounds per acre. Plots were trimmed to 5' x 25' after heading.

Summary: The camelina trial had very poor stands and then was devastated by grasshoppers in 2008. Therefore there are no results to report in 2008. The average yield for camelina the previous three years was 265 Lb/A. From our observations it appears that camelina is not well adapted to the typical hot weather that starts in mid June in southwestern South Dakota.

FIELD PEA VARIETY TRIALS

Objective: To evaluate field pea varieties for yield and adaptation to western South Dakota.

Procedure: Field peas were planted in a randomized complete block experiment with four replications near Selby, Wall and Bison, South Dakota. The seeding rate was 300,000 seeds/A (90 - 220 Lb/A) and the peas were inoculated with a granular pea inoculum (*Rhizobium leguminosarium* biovar *viceae*) just prior to planting. A John Deere 750 drill with 10-inch spacing was used to plant the trials in April 2008. The peas were harvested for grain in July with a small plot combine equipped with vine lifters and a pickup reel.

Location Information:

Pennington County – Wall

Planted: April 15, 2008 Herbicide: Prowl H₂O (3pint/A)
Harvested: July 23, 2008 Additional Nitrogen: Inoculated
Previous crop: Wheat, no-till planted

Perkins County - Bison

Planted: April 17, 2008 Herbicide: Prowl H₂O (3pint/A)
Harvested: August 20, 2008 Additional Nitrogen: Inoculated
Previous crop: Wheat, no-till planted

Walworth County - Selby

Planted: April 23, 2008 Herbicide: Spartan
Harvested: July, 2008 Additional Nitrogen: Inoculated
Previous crop: Soybeans, no-till planted

Summary: Yields at Wall and Bison were near average for West River, with Wall averaging 26 Bu/A and Bison 33 Bu/A. The yields East River averaged 26 and 62 Bu/A at Selby and South Shore respectively. The Selby location suffered from hail damage in early June which adversely affected plant growth and yields. Top yielding varieties at South Shore were Spider, Cooper, Arcadia and Eclipse. There was little difference in yields of the varieties tested over the past two years. The Bison location had a planting error and too many plots were missing to do variety comparisons. The top yielding varieties at Wall in 2008 were Polestead, K2, DS-Admiral, Cooper and CDC Striker. Variety characteristics are presented in Table 19 and yield results in Table 20. Table 21 presents the results of the USDA-ARS Western Regional Field Pea Variety Trial, which consists of experimental varieties from the USDA dry pea breeding program.

Table 19. Field Pea Characteristics.

Variety	Seed Color	Maturity*	Height Inches	Lodging (0-9)~	Protein Percent	Fusarium Wilt®	Mycosphaerella Blight®	Powdery Mildew®
Arcadia	Green	M	20	7	24.5	--	--	--
Camry	Green	M	16	8	25.7	F	F	VG
CDC Striker	Green	M	19	2	29.1	F	F	P
Cooper	Green	L	20	5	25.7	F	F	VG
K2	Green	E	17	1	25.6	F	F	P
CDC Golden	Yellow	M	18	2	27.1	F	F	VG
CDC Meadow	Yellow	E	20	3	25.3	F	F	VG
DS Admiral	Yellow	E	20	2	25.7	F	F	VG
Eclipse	Yellow	M	21	7	28.4	F	F	VG
Fusion	Yellow	M	19	6	24.2	P	P	VG
Polestead	Yellow	M	17	4	27.9	P	P	VG
Spider	Yellow	--	21	7	28.2	--	--	--
SW Midas	Yellow	E	18	7	24.2	F	F	VG
Tudor	Yellow	M	20	4	26.3	F	P	VG

* Maturity rating E = early, M = medium, L = late.

~ 0=No lodging, 9 = 100% lodged.

® VG - Very good, G - good, F - fair, P - poor disease resistance.

Table 20. Field Pea Variety Trial Yields (Bu/A), 2007 - 2008.

Variety	South Shore		Selby		Wall		Average	
	2008	2 Yr	2008	2 Yr	2008	2 Yr	2008	2 Yr
Green Cotyledon								
Arcadia	68	.	22	.	27	.	39	.
Camry	60	.	26	.	21	.	36	.
CDC Striker	63	50	28	40	28	29	40	40
Cooper	69	66	28	45	28	27	42	46
K2	55	45	23	37	29	30	36	37
Yellow Cotyledon								
CDC Golden	63	66	26	43	26	27	38	45
CDC Meadow	63	59	27	42	26	30	39	44
DS Admiral	60	60	28	40	28	32	39	44
Eclipse	66	66	22	41	25	29	38	45
Fusion	55	60	20	36	24	29	33	42
Polestead	61	.	26	.	35	.	41	.
Spider	74	.	37	.	23	.	45	.
SW Midas	51	56	25	42	18	26	31	41
Tudor	64	.	27	.	26	.	39	.
Average	62	59	26	41	26	29	38	43
LSD (P=.05)	9	20	4	NS	4	NS	--	--
CV	10	9	11	7	10	7	--	--

Table 21. USDA-ARS Western Regional Field Pea Variety Trial - Wall, South Dakota 2008.

Variety	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Bu/A
PS02100026	16	8	57.2	14.1
PS03101445	17	4	52.5	23.4
PS04100328	19	5	49.0	18.6
PS04100462	15	8	57.2	13.0
PS04100505	15	8	58.0	15.9
PS01102958	18	5	57.8	31.4
PS03101822	16	7	57.6	20.3
PS04100710	17	8	51.6	15.1
PS04100910	14	7	51.5	13.4
PS04100922	15	3	55.1	23.2
Stirling	15	6	58.2	18.2
DS Admiral	19	1	55.5	26.7
CDC Mozart	15	7	60.9	16.5
Grande	22	4	57.6	32.3
Average	16.6	5.9	55.7	20.2
LSD (P=.05)	2.3	1.4	4.5	6.2
CV	8.4	13.8	4.4	18.3

* 0=No lodging, 9 = 100% lodged.

CHICKPEA VARIETY TRIAL

Objective: To evaluate chickpea varieties for yield and adaptation to western South Dakota.

Procedure: Chickpea varieties were planted in a randomized complete block experiment with four replications near Wall, South Dakota. Most of the varieties are large kabuli types, which are grown for the large seeded garbanzo bean market. One of the varieties (Amit) is a smaller sized kabuli for export into the desi market. The variety CDC Anna is a desi type, which accounts for 85-90% of the market outside the United States and is grown as a protein source for humans and livestock. A planting rate of 174,000 was used (75-180 Lb/A) and the seed was inoculated with chickpea inoculum (*Mesorhizobium* sp. *ciceri*) prior to planting. The plots were planted in April with a John Deere 750 drill set to 10-inch rows. The plots were harvested with a small plot combine.

Pennington County - Wall

Planted: April 15, 2008 Herbicide: Prowl H₂O (3pint/A)
Harvested: September 15, 2008 Additional Nitrogen: Inoculated
Previous crop: Wheat, no-till planted

Discussion: Chickpea yields were hurt by weed competition in 2008. The trial averaged only 747 Lb/A, but quality and seed size were excellent. For chickpeas, the best varieties should yield well and have large seed size. Preferred varieties should grade out 80% or better larger than 22/64, as this is the size that is worth the most. The best large kabuli varieties are Dwelly, Dylan, Sierra and CDC Xena. These varieties have shown good yield potential and large seed size in trials over the past several years. Other varieties have yielded as well or better but do not have large enough seed to grade well. Table 22 shows chickpea agronomic characteristics and yields.

Table 22. Chickpea Variety Trial, Pennington County(Wall) 2008.

Variety	Seed Color	Height Inches	Lodging 0-9*	Test Wt Lb/Bu	Yield Lb/A	Seed Size Seeds/Oz
Large Kabuli						
Dwelly	Cream	14	0	58.7	987	50
Sierra	Cream	13	0	58.7	755	55
Troy	Cream	13	0	54.8	523	50
CDC Xena	Cream	12	0	58.9	953	53
CDC Yuma	Cream	14	0	61.0	720	59
Small Kabuli						
Amit (B-90)	Cream	14	0	61.0	499	99
Desi						
CDC Anna	Brown	13	0	59.1	778	153
Large Kabuli experimentals						
CA0090B347C	Cream	13	0	59.8	825	65
CA0390B007C	Cream	14	0	59.5	697	56
CA0469C020C	Cream	14	0	60.3	662	69
CA0469C025C	Cream	12	0	59.3	685	69
CA04900443C	Cream	12	0	56.4	743	51
CA04900612C	Cream	13	0	56.8	685	53
CA04900716C	Cream	13	0	58.3	929	51
CA04900851C	Cream	14	0	58.5	923	49
CA04900509C	Cream	13		57.0	581	53
Average		13	0.0	58.6	747	65
LSD (P=.05)		1.7	0.0	.	253.7	.
CV		6.2	0.0	.	20.3	.

*0=No lodging, 9= 100% lodged.

Table 23. Chickpea Seed Size Grades, Pennington County(Wall) 2008.

Variety	under 18/64"	over 18/64"	over 20/64"	over 22/64"
Large Kabuli				
Dwelly	0%	1%	3%	97%
Sierra	2%	2%	4%	92%
Troy	0%	1%	3%	96%
CDC Xena	1%	1%	4%	95%
CDC Yuma	1%	2%	9%	88%
Small Kabuli				
Amit (B-90)	12%	62%	24%	2%
Desi				
CDC Anna	52%	44%	4%	0%
Large Kabuli experimentals				
CA0090B347C	0%	3%	15%	82%
CA0390B007C	0%	1%	3%	96%
CA0469C020C	1%	4%	29%	66%
CA0469C025C	1%	3%	22%	74%
CA04900443C	2%	2%	5%	92%
CA04900612C	1%	0%	2%	97%
CA04900716C	0%	1%	2%	97%
CA04900851C	0%	1%	1%	98%
CA04900509C	1%	1%	4%	93%

WINTER PEA AND WINTER LENTIL VARIETY TRIALS

Objective: To evaluate winter field pea varieties for yield and adaptation to western South Dakota.

Procedure: Winter field pea and lentil varieties from Washington State University were planted in a randomized complete block experiment with four replications near Wall, South Dakota. The seeding rate was 520,000 seeds/A (115 - 150 Lb/A for peas 25 – 35 Lb/A for lentils) and the seeds were inoculated with a granular pea/lentil inoculum (*Rhizobium leguminosarium* biovar *viceae*) just prior to planting. A John Deere 750 drill with 10-inch spacing was used to plant the trial on September 27, 2007.

Location Information:

Pennington County – Wall

Planted: September 26, 2007 Herbicide: Pursuit (3 oz/A)
Harvested: Not harvested Additional Nitrogen: Inoculated
Previous crop: Spring wheat, No-till planted

Summary: Both the peas and lentils did not survive through the winter in 2008. This is the sixth year we have grown winter peas and lentils in western South Dakota. Three of those years the winter pulse trials have winterkilled, on the other years, yield of the winter peas have been less than spring peas planted at the same location. The lentils look more promising than the peas, but neither looks readily adaptable until winter hardiness can be improved. This year we are looking to see if planting the first of September will improve winter survivability.

EVALUATION OF COOL AND WARM SEASON ANNUAL FORAGES

Objectives: To evaluate warm and cool season crops for forage yield and quality.

Background: Perennial forages provide most of the supplemental livestock feed in western South Dakota, a major livestock producing region. The frequent occurrence of drought in the past few years has resulted in shortage of livestock feed, driving a high demand for alternative sources of forages. Annual crops can be of great value in developing a year round forage system. They can be used to provide early grazing before perennials are available, extend the grazing period or increase hay and silage production. Annual crops differ in growth habit and in forage quality. The selection of a particular crop for forage should be based on intended end use. There is a lack of detailed information on yield and quality of some of the forage species for our region.

Procedures:

Cool Season Annual Forages: The study had ten entries which are listed in the table below. The experimental design was a randomized complete block with four replications. The study was conducted at three locations, Ralph, Oelrichs and Wall, South Dakota. The oats, barley and spring triticale were also grown in a mixtures with Arvika pea at a seeding rate of 60% of recommended seeding rate for the cereal crop and 40% of the recommended seeding rate for the forage pea at each location. Entries were planted in six-row plots, 5 ft. wide by 30 ft. long using a John Deere 750 drill with 10-inch row spacing. Glyphosate herbicide was applied as a burn down just prior to planting; otherwise no other herbicides were applied to the plots. Nitrogen fertilizer as 28-0-0 was applied at 50 Lb/A actual N to all locations. The study was planted during the first week of April. At Ralph only three harvesting dates starting July 2 and weekly thereafter were done on the cool season study before it was destroyed by a hail storm. At each harvest date, forage yield was determined by harvesting four center rows five feet long with a Jeri mower. At Wall and Oelrichs, the entire plot was harvested on the same day with a small plot forage harvester. A subsample of about 500 g was randomly selected from the harvested sample and dried determine forage yield on a dry matter basis. The same sample was used to determine ADF, NDF and protein content.

Cool Season Annual Forages - 2008

<i>Crop (Variety)</i>	<i>Seeding Rate (lbs / acre)</i>
Pea (Arvika)	96
Pea (Mozart)	150
Hairy Vetch	20
Oat (Troy)	75
Oat/Pea (60% Troy / 40%Arvika)	45 / 38
Barley (Haybet)	119
Barley/Pea (60% Haybet / 40% Arvika)	71 / 38
Spring Triticale (Common)	84
Spring Triticale / Pea (60% <i>s.trit</i> /40%Arvika)	50 / 38
Spring Wheat (Traverse)	97

Warm-Season Annual Forages : This study had ten entries planted in a randomized complete block design with four replications at Wall, Oelrichs and Ralph, South Dakota. The entries and seeding rates are listed in the table below. Entries were planted in six-row plots, 5 ft. wide by 30 ft. long using a John Deere 750 drill with 10-inch row spacing. Glyphosate herbicide was applied as a burn down just prior to planting, otherwise no other herbicides were applied to the plots. Nitrogen fertilizer as 28-0-0 was applied at 50 Lb/A actual N to all locations. The Ralph location was intended to be harvested at five dates to evaluate forage maturity vs. feed value, but was heavily damaged by a hailstorm. Therefore the Wall location was harvested over five dates instead. At each harvest date, four center rows by five feet long were harvested with a Jari Mower for forage yield determination. At Ralph and Oelrichs the entire plot was harvested with a small plot forage harvester. Forage samples were collected for ADF, NDF, protein and moisture content determination at each harvest date.

Warm Season Annual Forages - 2008

<i>Crop (Variety)</i>	<i>Seeding Rate (lbs / acre)</i>
Teff Grass (Tiffany)	8
Foxtail Millet (Manta)	12
Foxtail Millet (Golden German)	12
Foxtail Millet (White Wonder)	12
Proso Millet (Sunup)	15
Pearl Millet (Producers Pro Millet)	12
Sorghum Sudan (Honey Sweet)	20
Sorghum Sudan (Honey Sweet 2)	20
Sorghum Sudan (Honey Sweet BMR)	20
Cowpea (Red Ripper)	35

Planting and Harvest Dates - 2008

Trial	Planting Date	Harvest Date
Wall Cool Season	April 15	July 3
Oelrichs Cool Season	April 16	July 8
Ralph Cool Season	April 17	July 2, 9, 16
Wall Warm Season	June 9	August 11, 18, 25, Sept 2, 8
Oelrichs Warm Season	June 11	August 26
Ralph Warm Season	June 17	August 17

Definition of Forage Quality Values: *Crude Protein (CP):* Laboratories measure the nitrogen (N) content of the forage and calculate crude protein using the formula: $CP = \% N \times 6.25$. Crude protein will include both true protein and non-protein nitrogen. Cattle can use both types to some varying degree. Crude protein values give no indication if heat damage has occurred, which may alter protein availability.

Neutral Detergent Fiber (NDF): Structural components of the plant, specifically cell wall. NDF is a predictor of voluntary intake because it provides bulk or fill. In general, low NDF values are desired because NDF increases as forages mature.

Acid Detergent Fiber (ADF): The least digestible plant components, including cellulose and lignin. ADF values are inversely related to digestibility, so forages with low ADF concentrations are usually higher in energy.

Relative Feed Value (RFV): A prediction of feeding value that combines estimated intake (NDF) and estimated digestibility (ADF) into a single index. The RFV system was developed using legume forages and intake responses of lactating dairy cows, it works best when applied to that situation. RFV is often used as a benchmark of quality when buying or selling alfalfa hay. While RFV works to some extent with alfalfa, it is absolutely useless for comparing alfalfa with either alfalfa-grass or pure grass. If RFV is used to compare forages, then 150 RFV alfalfa (optimum quality) is approximately equivalent to 115 RFV grass (optimum quality).

Results and Discussion: First year results from the cool season study at Ralph showed greater forage yield as harvesting date was delayed to later maturity stages of the crops. The first harvesting was done at heading for cereal grains and flowering –to- early podding for legume crops. The latest harvesting was conducted at milk-to-soft dough stage for the cereal grains and late podding for the legume crops (Table 26). On average, forage yield increased from 1.5 t/acre at the first harvesting date to 2.1 t/acres at the third harvesting date. When individual entries were compared, barley had the greatest yield for the first and second harvesting dates and tied for greatest yield with spring triticale for the third harvesting date. Forage yield averaged 1.6 t/a at Wall and 1.9 t/a at Oelrichs. Barley also had the greatest forage yield at Wall and Oelrichs. The two pea entries performed similarly and had lower forage yield than cereal crops. The other legume crop in the study, hairy vetch, had a slow start in spring and had barely covered the ground during the first harvesting date. Forage yield for hairy vetch was the lowest for all entries.

Forage quality measured by crude protein content decreased with delayed harvesting to later maturity stages for all crops (Table 27). Hairy vetch forage had the highest crude protein at all harvest dates. Crude Protein was improved significantly by adding a legume to the cereal forage. Relative Feed Value (RFV) generally improved as the legume portion was added to the forage.

The diversity of crops used in the warm season study made it difficult to match individual harvesting dates to the same maturity stage for all crops. For example, at the first harvesting date, foxtail millets were at early grain filling stage, pearl millet was at early heading stage and the sorghum hybrids were at pre-heading stage. On average at Wall, forage yield increased as harvesting date was delayed to later maturity stages for all crops with the lowest forage yield of 2.1 t/ha recorded for the August 11 harvesting date and the highest forage yield of 3.5 t/ha recorded for the September 8 harvesting date. When individual crops were compared, the sorghum hybrids gave the greatest yields while cowpea had the lowest forage yield for all harvesting dates. Teff grass had poor yield earlier in the season but gave similar yields to foxtail millets later in the season. At Ralph forage yields were low due to hailstorm damage from which the cowpea crop did not recover.

Crude protein content was the same for the first two harvest dates but decreased with delayed harvesting to later maturity dates. When individual crops were compared, cowpea had the highest crude protein at all harvest dates. Among cereal crops, Teff grass had the highest crude protein content. Relative feed value was greatest for cowpea.

Table 24. Forage Yield (Tons/Acre) of Cool Season Crops at Ralph, Wall, and Oelrichs, SD in 2008.

Crop (Variety)	Ralph			Wall	Oelrichs	Average
	July 2, 2008	July 9, 2008	July 16, 2008	July 8, 2008	July 3, 2008	
Pea (Arvika)	1.2	1.7	1.3	0.5	2.0	1.3
Pea (Mozart)	1.2	1.8	1.4	0.6	2.0	1.4
Hairy Vetch	0.2	0.4	0.5	0.2	0.2	0.3
Oat (Troy)	1.9	2.5	2.8	2.2	2.4	2.3
Oat/Pea (60% Troy / 40%Arvika)	1.7	2.2	2.3	1.8	2.0	2.0
Barley (Haybet)	2.1	3.0	2.9	2.4	2.6	2.6
Barley/Pea (60% Haybet / 40% Arvika)	2.0	2.2	2.5	2.1	2.3	2.2
Spring Triticale (Common)	1.8	2.6	2.9	2.0	1.8	2.1
Spring Triticale / Pea (60% s.trit/40%Arvika)	1.3	2.0	2.1	2.0	1.7	1.8
Spring Wheat (Traverse)	1.7	2.3	2.5	2.2	1.8	2.1
Mean	1.5	2.1	2.1	1.6	1.9	1.8
LSD (.05)	0.3	0.5	0.4	0.3	0.3	--
CV	15.2	17.2	14.1	14.8	12.3	--

Table 25. Forage Yield (Tons/Acre) of Warm Season Crops at Ralph, Wall, and Oelrichs, SD in 2008.

Crop (Variety)	Ralph	Wall					Oelrichs	Average
	Aug 27, 2008	Aug 11, 2008	Aug 18, 2008	Aug 25, 2008	Sept 2, 2008	Sept 8, 2008	Aug 26, 2008	
Teff Grass (Tiffany)	0.9	1.0	1.3	2.1	2.3	2.2	0.9	1.2
Foxtail Millet (Manta)	1.3	1.1	1.3	1.4	1.7	1.7	1.5	1.4
Foxtail Millet (Golden German)	1.3	1.8	2.1	2.6	2.2	3.3	1.4	1.7
Foxtail Millet (White Wonder)	1.0	1.8	2.2	2.2	2.3	2.7	1.6	1.6
Proso Millet (Sunup)	1.2	1.6	1.6	1.6	1.5	2.2	1.5	1.5
Pearl Millet (Producers Pro Millet)	0.9	2.6	2.9	3.1	3.3	3.5	1.4	1.8
Sorghum Sudan (Honey Sweet)	1.3	4.0	3.6	4.5	3.4	5.5	1.5	2.3
Sorghum Sudan (Honey Sweet 2)	1.0	3.0	2.9	3.9	2.8	6.2	1.1	2.0
Sorghum Sudan (Honey Sweet BMR)	0.9	4.0	4.3	4.6	3.6	7.0	2.3	2.6
Cowpea (Red Ripper)	0.0	0.5	0.6	0.7	0.8	1.1	0.3	0.3
Mean	1.0	2.1	2.3	2.7	2.4	3.5	1.4	1.6
LSD (.05)	0.3	0.8	1.2	0.9	0.8	1.3	0.6	--
CV	18.4	25.6	37.5	23.7	24.0	25.8	28.7	--

Table 26: Harvest Date, Moisture and Crop Stage of Cool Season Crops at Ralph, SD in 2008.

Crop (Variety)	July 2, 2008		July 9, 2008		July 16, 2008	
	Mois % *	Crop Stage	Mois % *	Crop Stage	Mois % *	Crop Stage
Pea (Arvika)	78	Flowering	75	Late bloom/early pod fill	70	Pods green, leaves turning yellow
Pea (Mozart)	80	Early pod	74	Mid pod fill	70	Pods yellow, leaves turning yellow
Hairy Vetch	79	No blooms	75	10% bloomed	73	80% bloom to early podding
Oat (Troy)	76	Headed	68	Late anthesis	61	Late milk stage
Oat/Pea (60% Troy / 40% Arvika)	77		70		64	
Barley (Haybet)	73	Headed	61	Late milk to soft dough	54	Soft dough
Barley/Pea (60% Haybet / 40% Arvika)	73		66		59	
Spring Triticale (Common)	79	Early heading	64	Anthesis	57	Late anthesis
Spring Triticale / Pea (60% s.trit/40% Arvika)	77		69		61	
Spring Wheat (Traverse)	74	Headed	56	Late anthesis	53	Late milk stage
Mean	76		68		62	
LSD (P=.05)	3.0		5.1		4.8	
CV	2.7		5.2		5.2	

*Moist % = Moisture percent at harvest.

Table 27. Forage Quality Analysis of Cool Season Crops by Harvest Date at Ralph, SD in 2008.

Crop (Variety)	July 2, 2008				July 9, 2008				July 16, 2008			
	Crude Protein (%)	NDF (%)	ADF (%)	RFV	Crude Protein (%)	NDF (%)	ADF (%)	RFV	Crude Protein (%)	NDF (%)	ADF (%)	RFV
Pea (Arvika)	19.6	31.7	21.8	211	17.4	28.2	22.0	237	12.7	34.4	24.2	191
Pea (Mozart)	19.7	27.8	20.3	247	14.9	28.0	20.6	242	12.4	30.7	20.9	222
Hairy Vetch	26.3	34.8	26.6	182	27.1	35.6	27.3	177	23.3	38.0	26.0	169
Oat (Troy)	11.6	52.5	30.4	116	10.4	55.1	31.0	110	10.2	54.8	30.3	111
Oat/Pea (60% Troy / 40%Arvika)	14.9	45.4	26.5	141	11.6	48.6	28.3	129	9.8	53.2	29.2	116
Barley (Haybet)	11.7	52.9	30.2	115	7.6	55.5	31.7	108	6.1	61.4	34.3	94
Barley/Pea (60% Haybet / 40% Arvika)	12.8	50.4	28.8	123	11.7	48.2	28.0	130	8.2	56.5	32.6	105
Spring Triticale (Common)	14.0	50.9	29.2	121	11.6	57.8	33.0	102	9.7	58.7	32.0	102
Spring Triticale / Pea (60% s. Trit/40%Arvika)	17.3	44.2	26.2	145	14.7	48.8	28.8	128	9.4	58.8	32.5	101
Spring Wheat (Traverse)	13.4	51.4	29.0	120	8.3	54.6	31.0	111	6.8	59.9	33.2	98
Mean	16.1	44.2	26.9	152	13.5	46.0	28.2	147	10.8	50.7	29.5	131
LSD	2.9	5.7	2.7	29	2.5	6.2	3.2	21	2.0	4.7	4.1	30
CV (%)	8.0	5.7	4.5	8.4	8.3	6.0	5.0	6.3	8.2	4.1	6.2	10.2

NDF = Neutral detergent fiber.

ADF = Acid detergent fiber.

RFV = Relative feed value

Table 28. Forage Quality of Cool Season Crops at Wall and Oelrichs in 2008.

Crop (Variety)	Wall					Oelrichs				
	Crude Protein (%)	Mois (%)	NDF (%)	ADF (%)	RFV	Crude Protein (%)	Mois (%)	NDF (%)	ADF (%)	RFV
Pea (Arvika)	20.4	81	30.1	23.0	222	19.6	69	37	25	177
Pea (Mozart)	19.1	82	28.2	21.2	247	19.0	66	36	24	182
Hairy Vetch	24.7	82	40.7	28.6	154	26.2	76	42	27	151
Oat (Troy)	10.9	74	52.5	30.7	116	11.5	66	57	31	106
Oat/Pea (60% Troy / 40%Arvika)	12.1	74	49.6	29.5	125	12.0	66	57	32	106
Barley (Haybet)	8.9	69	55.1	32.0	109	8.9	59	61	34	96
Barley/Pea (60% Haybet / 40% Arvika)	12.4	73	48.5	30.1	128	10.4	58	58	32	103
Spring Triticale (Common)	11.4	71	58.3	34.9	99	13.0	64	62	34	94
Spring Triticale / Pea (60% s. Trit/40%Arvika)	12.4	72	56.5	30.5	109	14.3	64	58	32	102
Spring Wheat (Traverse)	9.8	69	54.4	32.5	109	11.3	59	61	34	97
Mean	14.2	75	47.4	29.3	142	14.6	65	53	31	121
LSD	1.8	1.7	3.6	3.8	24	1.7	6.9	3.5	2.4	16.5
CV (%)	8.9	1.6	5.2	9.0	11.7	8.0	7.3	4.6	5.4	9.3

Mois (%) = moisture % at harvest.

NDF = neutral detergent fiber.

ADF= acid detergent fiber.

RFV=Relative Feed Value.

Table 29: Harvest Date, Moisture and Crop Stage of Warm Season Crops at Wall, SD in 2008.

Crop (Variety)	August 11		August 18		August 25		Sept 2		Sept 11	
	Mois % *	Crop Stage	Mois % *	Crop Stage	Mois % *	Crop Stage	Mois % *	Crop Stage	Mois % *	Crop Stage
Teff Grass (Tiffany)	71	Early heading	67	Heading	63	Headed	60	Hard dough	61	Boot stage – grasshopper damage
Foxtail Millet (Manta)	70	Grain filling – grasshopper damage	65	Soft dough	64	Soft to hard dough	59	Hard dough	61	Hard dough
Foxtail Millet (Golden German)	76	Early grain filling	68	Late anthesis	63	Hard dough	57	Hard dough	59	Hard dough
Foxtail Millet (White Wonder)	77	Early grain filling	70	Late anthesis	65	Soft to hard dough	59	Hard dough	59	Hard dough
Proso Millet (Sunup)	71	Soft dough	68	Hard dough	65	Hard dough	63	Hard dough	64	Hard dough
Pearl Millet (Producers Pro Millet)	78	Early heading	73	Early heading	71	Early heading	71	Soft to hard dough	62	Soft dough
Sorghum Sudan (Honey Sweet)	69	Early heading	70	Late anthesis	64	Milk stage	67	Soft to hard dough	56	Milk to soft dough
Sorghum Sudan (Honey Sweet 2)	70	Pre-heading	71	Jointing to pre-heading	64	Boot stage	70	Heading	51	Boot to early heading
Sorghum Sudan (Honey Sweet BMR)	66	Pre-heading	68	Early heading	65	Early heading	73	Milk stage	52	Heading
Cowpea (Red Ripper)	86	Pre-flowering	85	Pre-flowering	81	Vegetative	80	Vegetative – grasshopper damage	76	Vegetative
Mean	73		71		67		66		60	
LSD (P=.05)	3.1		5.8		4.0		4.0		3.0	
CV	2.9		5.6		4.1		4.2		3.4	

* Mois % = Moisture percent at harvest.

Table 30. Forage Quality Analysis of Warm Season Crops by Harvest Date at Wall, SD in 2008.

Crop (Variety)	August 11				August 18				August 25				September 2				September 8			
	CP (%)	NDF (%)	ADF (%)	RFV	CP (%)	NDF (%)	ADF (%)	RFV	CP (%)	NDF (%)	ADF (%)	RFV	CP (%)	NDF (%)	ADF (%)	RFV	CP (%)	NDF (%)	ADF (%)	RFV
Teff Grass (Tiffany)	11.0	67.5	37.1	83	11.7	69.0	37.4	81	10.2	67.5	37.1	83	9.1	65.8	39.0	83	8.2	66.6	35.5	86
Foxtail Millet (Manta)	7.9	63.6	35.9	89	8.5	63.7	34.8	91	7.3	63.6	35.9	89	6.4	63.7	35.3	90	5.5	64.5	34.9	89
Foxtail Millet (Golden German)	6.8	65.0	37.5	86	8.4	64.1	36.2	88	6.1	65.0	37.5	86	5.1	66.6	39.1	82	5.4	63.7	35.7	90
Foxtail Millet (White Wonder)	7.3	54.4	37.6	107	8.9	64.5	35.1	89	6.7	54.4	37.6	107	5.5	64.9	37.7	86	5.0	65.2	36.3	87
Proso Millet (Sunup)	9.1	61.4	33.1	96	10.2	60.0	29.9	102	7.3	61.4	33.1	96	7.4	61.0	31.1	99	7.6	59.5	30.1	103
Pearl Millet (Producers Pro Millet)	9.1	63.3	34.6	92	10.0	63.6	34.2	91	8.7	63.3	34.6	92	7.2	60.9	32.7	97	6.3	62.9	33.8	93
Sorghum Sudan (Honey Sweet)	6.9	57.8	32.8	102	10.7	61.5	33.4	96	7.3	57.8	32.8	102	5.9	58.1	32.2	103	5.1	60.9	33.4	97
Sorghum Sudan (Honey Sweet 2)	7.1	57.8	31.6	104	8.1	61.8	32.7	96	6.7	57.8	31.6	104	6.1	58.8	31.9	102	5.2	47.3	24.8	137
Sorghum Sudan (Honey Sweet BMR)	8.2	59.2	33.8	99	8.3	60.9	33.2	96	6.9	59.2	33.8	99	6.9	59.5	33.2	99	6.8	53.2	29.4	118
Cowpea (Red Ripper)	16.6	45.9	32.7	131	16.6	39.2	28.7	158	13.8	45.9	32.7	131	13.1	46.5	31.9	128	13.0	46.8	32.6	127
Mean	9.0	59.6	34.7	99	10.1	60.8	33.6	99	8.1	59.6	34.7	99	7.3	60.6	34.4	97	6.8	59.0	32.7	102
LSD	3.8	14.2	4.0	33	4.0	2.5	2.4	6.0	3.4	14.2	4.0	33	2.1	4.9	4.4	13	3.6	9.4	31.6	45
CV (%)	18.6	10.6	5.2	14.6	17.3	1.8	3.1	2.7	18.7	10.6	5.2	14.6	12.7	3.6	5.6	6.1	23.4	7.1	38.9	20.0

CP = Crude protein.

NDF = Neutral detergent fiber.

ADF = Acid detergent fiber.

RFV = Relative feed value.

Table 31. Harvest Date and Crop Stage of Warm Season Crops at Wall, Oelrichs and Ralph, SD in 2008.

Crop (Variety)	Wall (Aug 25)		Oelrichs (Aug 26)		Ralph (Aug 27)	
	Mois % *	Crop Stage	Mois % *	Crop Stage	Mois % *	Crop Stage
Teff Grass (Tiffany)	63	Headed	54	Some seed	65	Hard dough to ripe
Foxtail Millet (Manta)	64	Soft to hard dough	43	Mature	55	Hard dough to ripe
Foxtail Millet (Golden German)	63	Hard dough	59	Dough	72	Dough
Foxtail Millet (White Wonder)	65	Soft to hard dough	60	Dough	71	Dough
Proso Millet (Sunup)	65	Hard dough	63	Half ripe	62	Tops ripe
Pearl Millet (Producers Pro Millet)	71	Early heading	71	Flowering	73	Early heading
Sorghum Sudan (Honey Sweet)	64	Milk stage	66	Flowering	72	Heading to flower
Sorghum Sudan (Honey Sweet 2)	64	Boot stage	64	Flowering	71	No heads
Sorghum Sudan (Honey Sweet BMR)	65	Early heading	67	Flowering	73	No heads
Red Ripper (Cowpea)	81	Vegetative	73	Stunted	0	Hailed out
Mean	67		62		62	
LSD	4.0		6.4		3.0	
CV (%)	4.1		7.1		3.4	

* Mois % = moisture percent at harvest.

Table 32. Forage Quality Analysis of Warm Season Crops at Oelrichs and Ralph, SD in 2008.

Crop (Variety)	Oelrichs				Ralph			
	CP (%)	NDF (%)	ADF (%)	RFV	CP (%)	NDF (%)	ADF (%)	RFV
Teff Grass (Tiffany)	14.7	55	24	119	13.8	63	30	97
Foxtail Millet (Manta)	12.3	55	26	117	12.1	59	30	104
Foxtail Millet (Golden German)	13.5	51	23	130	13.3	54	27	118
Foxtail Millet (White Wonder)	13.2	50	22	134	14.1	56	27	113
Proso Millet (Sunup)	12.3	55	25	120	12.5	55	27	114
Pearl Millet (Producers Pro Millet)	13.1	55	24	119	15.2	59	28	106
Sorghum Sudan (Honey Sweet)	10.9	53	23	124	13.3	57	27	111
Sorghum Sudan (Honey Sweet 2)	13.1	52	21	131	14.5	58	27	109
Sorghum Sudan (Honey Sweet BMR)	11.6	56	25	116	14.3	57	29	108
Cowpea (Red Ripper)	18.8	43	22	161	0.0	0	0	0
Mean	13.4	52	24	127	12.3	52	25	98
LSD	3.3	5.2	3.6	20.3	0.9	2.2	1.4	5.7
CV (%)	17.2	6.8	10.5	11.0	5.1	2.9	3.8	4.0

CP = Crude protein.

NDF = Neutral detergent fiber.

ADF= Acid detergent fiber.

RFV = Relative feed value.

TIME OF NITROGEN APPLICATION FOR NO-TILL WHEAT

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Introduction

Application of nitrogen (N) for wheat production in South Dakota has historically occurred in the spring. Winter wheat producers would typically wait until potential winter injury has been assessed before applying nitrogen in late winter or early spring. Spring wheat producers would generally wait until just prior or after planting.

No-till wheat production has increased dramatically in the last 10 – 15 years, especially in Western and Central areas of South Dakota. Time savings, better equipment and herbicides have been major drivers in this change. Urea is the primary N source used by South Dakota producers. It is economical, and can be handled easily and safely. However, application of urea to a soil/residue surface (without tillage) can lead to potential N volatilization (N gas loss). High temperatures, low precipitation, and heavy residue conditions can lead to estimated losses of 25 to 35% of the applied N under worst case scenarios. One management tool to limit potential N volatilization is time of N application. Applying urea in the early spring when the probability for low temperatures and higher rainfall are highest should limit potential gaseous N loss. However, a number of producers wanting to decrease spring workloads and take advantage of lower urea prices will apply urea in late-fall. Late winter (Feb.-Mar.) application has also been used by a number of producers when snow conditions allow field access. Effectiveness of urea when applied to frozen soils or upon snow is still a question. Much producer interest has been shown in delaying at least part of the nitrogen until after tillering. With N prices at record highs, increasing N efficiency is a necessity to maintain profitability in wheat production.

Objective

Determine time to apply nitrogen for most efficient N utilization for no-till winter and spring wheat production.

Table 33. Materials and Methods

Location	Location	
	Cresbard	Sturgis
Wheat type	Spring	Winter
N Application Timing Trts.		
Planting = P	4-18-08	9-20-07
Late Fall = LF	11-8-07	12-17-07
Winter = W	na	1-24-08
Early Spring = ES	2-27-08	4-3-08
Sub-Surface = SS	4-18-08	9-20-07
Feekes 5.5 = F5	6-13-08	na
Foliar N application rate	30 lbs N/a	na
Foliar N application timing	7-11-08	na
Variety	Traverse	Expedition
N Rates	0 at P and SS 50 at LF,P,ES,SS,F5 100, 150, and 200 at P	0 at P and SS 50 at P, LF, W, ES 100, 150 at P
N Sources	urea and ammonium nitrate (AMN)	
Replications	4	
Split plot design (RCBD)	Main block = N timing, Split = N source and rate	
Statistics	SAS, ANOVA	

note: Environmentally Smart Nitrogen (ESN) use at Sturgis only.

Results and Discussion

N Rate: Carryover soil nitrogen was low at each site, Cresbard (52 lbs NO₃-N/a) and Sturgis (28 lbs NO₃-N/a). Applied N significantly increased grain yield at Sturgis and Cresbard (Tables 34 and 38). Maximum yield was attained with 50 and 100 lbs N/a at Cresbard and Sturgis, respectively.

N Timing: The time of nitrogen application had a significant influence on grain yield at Cresbard ($Pr > F = 0.02$) and somewhat at Sturgis ($Pr > F = 0.11$) (Tables 35 and 36). At Cresbard, applying N at F5 (Feekes 5.5) significantly reduced yield (Table 35) and probably associated with very dry surface soil conditions that made the N positionally unavailable. At Sturgis, the late fall (LF) and winter (W) application timings had reduced yields.

N Source: Nitrogen source significantly influenced grain yield at Cresbard (Table 35) but not at Sturgis (Table 39). The urea N source, applied at the early spring timing at Cresbard which had 3-4 inches of snow ground cover, had significantly lower yield when compared to AMN (Table 39). All other urea and AMN comparison yields were very similar. There are differences between urea and AMN yields at Sturgis but no trend in the data could explain these differences (Table 39). Possible volatilization of N may have existed at the early spring application at both Cresbard and Sturgis. However, volatilization loss was not high enough to quantify with the sensitivity of the studies.

N Placement: Possible immobilization of N in residue did not seem to be a problem at either site because the sub-surface and surface broadcast placements of N produced similar yields (Tables

36 and 40). There was a trend for yield improvement with sub-surface urea and AMN application at Cresbard because the Pr>F statistic was nearing a significant level (80% confidence). ESN did not significantly influence grain yield when compared to urea or AMN at Sturgis (Table 40).

Protein: Nitrogen rate significantly influenced both spring and winter wheat grain protein (Tables 42 and 43). However, the effects were opposite between the sites. Increase N rate increased spring wheat grain protein while decreasing winter wheat protein. With the spring wheat, N was non-limiting beyond the 50 lb. N/a rate which provided extra N to increase grain protein levels. In contrast, the winter wheat grain yield responded to the incremental increase in soil applied N, resulting in less N available for grain protein partition at the higher N rates. Foliar application of N on spring wheat plots further increased spring wheat grain protein (Table 42). It is speculated that foliar N application on the winter wheat would have greatly increased grain protein.

Precipitation: For both sites, precipitation frequency increases as we move from late fall to planting (Tables 37 and 41).

Conclusions: Soil applied N increased wheat grain yield at each site. Grain yield was maximized with 50 and 100 lbs N/a for the spring and winter wheat, respectively. The spring wheat site had 50 lbs NO₃-N/a residual N while the winter wheat site had 28. Grain yield was significantly reduced by applied N at the Feeke's 5.5 (F5.5) stage for spring wheat and the late fall (LF) and winter (W) applications for winter wheat. Dry soil conditions at the spring wheat site during the F5.5 stage kept applied N at the soil surface mostly unavailable for the wheat plant root systems. Grain protein positively responded to increased N rate and foliar application at the spring wheat site. In contrast, increasing N rate applications were more limiting to grain protein partitioning with the winter wheat because N was more limiting and required for grain yield (dry matter) response.

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Table 34. Nitrogen rate influence on spring wheat grain yield near Cresbard SD, in 2008.

N rate	Grain Yield
lbs/a	bu/a
0	40.7
50	47.2
100	45.1
150	45.2
200	44.7
Pr>F	0.44
LSD(.10)	NS
CV %	10.6
Orthogonal No N vs N (Pr>F)	0.07

sunflower was previous crop

lbs NO₃-N/a = 52 lbs/a sampled before planting

N applied at planting (4-18-08)

Table 35. Influence of N source and N application timing on spring wheat grain yield at Cresbard SD, in 2008.

Time of N Application	N Source		N Source Statistics for N timing	
	Ammonium Nitrate	Urea	Pr>F	CV
	----- bu/a -----			
Late Fall	47.3 a	47.9 a	0.50	2.2
Early Spring	44.6 a	41.2 b	0.01	2.1
Planting	47.2 a	45.7 a	0.15	2.4
5 Leaf Stage	39.9 b	40.2 b	0.75	2.2
Pr>F	0.03	0.02		
LSD(.05)	4.0	3.9		
CV %	6.8	6.7		
other Statistics:				
N Source (S)	0.04			
N Timing (T)	0.02			
S x T	0.02			

N rate = 50 lbs N/a

Means with similar lower case letter are not significantly different within a comparison column.

Table 36. Influence of tillage and N application position on spring wheat grain yield at Cresbard SD, in 2008.

N Application Method	N Rate and Source		
	0	50 Urea	50 AMN
Surface Broadcast ^A	40.7	45.7	47.2
Sub-Surface	41.1	50.7	49.8
LSD _(.10)	NS	NS	NS
Pr>F	0.94	0.21	0.22

AMN = ammonium nitrate

^A broadcast applied after planting

^B Applied with drill (7 inch spacings, 2-3 inch depth) before planting.

NS = non-significant

Table 37. Precipitation frequency summary at the spring wheat N timing site near Cresbard SD, in 2008.

N Application Timing	0.25 inch of Precipitation	
	Total	Event
	----- days* -----	
Late Fall	47	134
Winter / Early Spring	27	28
Planting	13	13
5 Leaf Stage	6	11

* days after N application to 0.25 inch total precipitation or a single event

Table 38. Nitrogen rate influence on winter wheat grain yield at Sturgis SD, in 2008.

N Rate ^A	Grain Yield
	----- bu/a -----
0	25.6 b
50	40.3 a
100	44.7 a
150	44.4 a
Statistics:	
Pr>F	0.001
LSD _(.10)	4.5
CV%	8.9

^A ammonium nitrate surface applied at planting.
Soil NO₃-N = 28 lbs/a

Table 39. Influence of N source and N application timing on winter wheat grain yield at Sturgis SD, in 2008.

Time of N Application	N Source		N Source Statistics for N timing	
	Ammonium Nitrate	Urea	Pr>F	CV
	----- bu/a -----			
Sub	38.8	36.7	0.20	4.6
Planting	37.9	39.1	0.59	7.3
Late Fall	35.4	35.3	0.95	11.5
Winter	34.8	37.3	0.19	6.0
Early Spring	40.3	38.7	0.09	2.3
Pr>F	0.18	0.24		
LSD(.05)	NS	NS		
CV %	9.0	6.6		
other Statistics:				
N Source (S)	0.97			
N Timing (T)	0.11			
S x T	0.44			

N rate = 50 lbs N/a

Means with similar lower case letter are not significantly different within a comparison column.

Table 40. Influence of tillage and N application position on winter wheat grain yield at Sturgis SD, in 2008.

N Application Method	N Rate and Source			Pr>F
	50 ESN	50 Urea	50 AMN	
	----- bu/a -----			
Surface Broadcast ^A	38.2	39.1	37.9	0.72
Sub-Surface	38.4	36.7	38.8	0.52
LSD _(.10)	NS	NS	NS	
Pr>F	0.91	0.21	0.73	

AMN = ammonium nitrate

^A broadcast applied after planting

^B Applied with drill (10 inch spacings, 2-3 inch depth) before planting.

NS = non-significant

Table 41. Precipitation frequency summary at the spring wheat N timing site near Sturgis SD, in 2008.

N Application Timing	0.25 inch of Precipitation	
	Total	Event
	----- days* -----	
Planting	17	135
Late Fall	33	50
Winter	14	14
Early Spring	8	8

* days after N application to 0.25 inch total precipitation or a single event

Table 42. Influence of N rate and Foliar N application on spring wheat grain protein near Cresbard SD in 2008.

N rate lbs/a	Foliar ^A		Pr>F ^B	CV %
	No ----- % ^C -----	Yes		
0	12.4 b	13.9 c	yes	4.4
50	12.8 b	13.6 c	no	4.2
100	14.8 a	15.2 b	yes	0.5
150	15.2 a	15.9 ab	yes	1.5
200	15.7 a	16.5 a	yes	1.5
Pr>F ^B	yes	yes		
CV %	6.2	5.2		

Overall Statistics

Foliar (F)	0.001
N Rate (NR)	0.001
F X NR	0.109

^A 30 lbs N/a as 10 gpa UAN (28-0-0) and 10 gpa water applied at Feekes 10.8 (post-pollination)

^B A “no” is where Pr.F is > than 0.10

^C adjusted to 13% grain moisture.

Table 43. Influence of N rate on winter wheat grain protein at Sturgis SD, in 2008.

N rate ^A lbs/a	Grain Protein ^B %
0	11.9 a
50	11.5 ab
100	11.3 b
150	10.7 c
LSD _(.10)	0.5
Pr>F	0.02
CV%	3.5

^A applied as ammonium nitrate at planting

^B adjusted to 13% grain moisture

ROTATIONAL IMPACTS OF BROADLEAF CROPS ON WINTER WHEAT (SCENIC AND WALL, SOUTH DAKOTA)

Objectives:

- 1) To determine the performance and yield of winter wheat planted on five different types of crop stubble.
- 2) To determine response of winter wheat to various rates of nitrogen applied in the spring.

Procedures:

The experiment was conducted at two locations in western South Dakota (Wall and Scenic). The trial was managed using minimum tillage practices. The design of the experiment included growing broadleaf crops (field pea, chickpea, lentil and safflower) and spring wheat in year 1. Blocks of spring wheat (Briggs), dry peas (Grande), Lentils (Morton), Chickpeas (B-90) and Safflower (Finch) were planted on May 2, 2007. All blocks were planted with a 5 foot research JD 750 no-till drill. The spring wheat block at the Scenic location was top dressed with 28-0-0 (50 lb N / acre) on May 1, 2007 with 32 oz / A of Roundup in the mix for weed control. This block was sprayed twice at 8.3 gpA to get the intended fertilizer rate. Blocks of the other four crops were sprayed with Prowl (3 pts/A) + Roundup Original Max (24 oz / A). The spring wheat and safflower were fertilized with 10-34-0 at both locations. The seeding rate for the crops were as follows: spring wheat (Briggs) 90 lbs/a, lentils (Morton) 20 lbs/a + inoculum, field peas (Grande) 140 lbs/a + inoculum, chickpeas (B-90) 70 lbs/a + inoculum, safflower (Finch) 20 lbs/a. At the Scenic site, all five blocks were harvested on August 1, 2007. The block at the Wall site had been planted to camelina, field pea and chickpea variety trials in the spring of 2007. The safflower stubble next to the variety trials was also used for planting winter wheat.

In the fall of 2007 each broadleaf crop block at Wall and Scenic was recropped to winter wheat. Before planting, the Wall site was sprayed with 19 oz Roundup Original Max/A + liquid ammonium sulfate +12 oz LV6 at 10 gpA spray rate on August 29, 2007. The Scenic location was sprayed on September 28, 2007 with 20 oz Roundup Original Max + liquid Ammonium Sulfate (50 ml/gal) at 8 gpA spray rate. Both locations were planted to Expedition Winter Wheat on September 26, 2007. The wheat crop was planted with a JD 750 drill at 1,089,000 seeds per acre with liquid starter fertilizer (10-34-0) added at 6 gallons / acre. Soil moisture samples were taken on each of the blocks that were seeded to winter wheat plots on November 5, 2007. On November 6, 2007; the location at Scenic was sprayed with .9 oz Olympus + Penetrate II + 32-0-0 @ 1 gallon per acre. The 32-0-0 liquid fertilizer was added to improve the coverage and absorption of the Olympus herbicide.

In spring, four fertilizer N rates and a control (with no N fertilizer application) were applied to the winter wheat. The rates were 30, 60, 90 and 120 Lb N/Acre. The source of N was ammonium nitrate (34-0-0). The granular fertilizer was broadcast with a JD 750 drill. Plots, within each crop stubble, were arranged in randomized complete block design with treatments replicated four times. Each fertilizer treatment was broadcast over a 10 foot wide x 60 foot long plot. The Scenic location was sprayed on May 7, 2008 with 27 oz / A Starane NXT + Penetrate II @ 18 ml / gallon + Harmony GT @ .6 oz / acre at a spray rate of 10 gallon per acre. The Wall location was sprayed on May 7, 2008 with 27 oz / A Starane NXT + Penetrate II @ 18 ml / gallon using a 10 gallon per acre spray rate. The harvested plot size was 5 foot wide x 60 foot long for each fertilizer rate in each replication. Performance of winter wheat was evaluated by measuring plant height, number of heads per square foot, number of kernels per head, number of seeds per pound, grain yield, test weight and grain protein.

The planting/harvest dates of the spring wheat and broadleaf crops at Scenic are as follows:

Crop	Planting Date	Harvest Date
Spring Wheat	May 2, 2007	August 1, 2007
Lentil	May 2, 2007	August 1, 2007
Dry Pea	May 2, 2007	August 1, 2007
Chickpea	May 2, 2007	August 1, 2007
Safflower	May 2, 2007	August 1, 2007

The planting/harvest dates of the broadleaf crops at Wall are as follows:

Crop	Planting Date	Harvest Date
Safflower	April 30, 2007	August 20, 2007
Camelina	April 4, 2007	July 18, 2007
Chickpea	April 4, 2007	August 1, 2007
Dry Pea	April 4, 2007	July 18, 2007

Results and Discussion in 2008: Winter wheat stands were good at both locations in the fall of 2007. The Scenic location had downy brome infestation so it was sprayed with Olympus the day after planting. The Wall location was not sprayed and downy brome infestation occurred during winter primarily in the camelina and chickpea blocks that were planted back to wheat.

At Scenic, the highest winter wheat yield was on spring wheat stubble. The Scenic location was very dry (Table 46) and residue cover on the spring wheat ground might have helped conserve soil moisture. The lowest winter wheat yield was on Safflower stubble, due to low soil moisture availability. At Wall, the highest winter wheat yield was on the safflower stubble. Safflower stands were weak in 2007 but weed control was good, thus soil moisture was not limiting for the winter wheat crop. The lowest winter wheat yields were on camelina stubble where soil moisture was most limiting.

Winter wheat grain yield increased with increasing nitrogen fertilizer application at both locations but yields were not different at 60, 90 and 120 lb/ac (Table 47). Grain yield increased by 15 to 20 bushels with the addition of 60 pounds of nitrogen. Nitrogen fertilizer application also increased plant height, number of heads per sq ft., number of kernels per head, and seed protein content. Seed size (seeds / lb) got slightly smaller as nitrogen rates were increased. Test weights decreased as nitrogen levels were increased.

Our intent at both locations was to determine how much soil moisture was present on broadleaf crops stubble for a recrop situation. Soil moisture levels were the highest at the 0-12" depth and got progressively dryer deeper into the soil profile down to 48 inches. Overall, soil moisture was slightly better in November of 2007 at the Wall location as compared to the Scenic location. We had difficulties getting the deep soil samples at Scenic because the soil was so dry.

Table 44. Scenic Nutrient Analysis as of November 5, 2007. These blocks were planted back to Expedition Hard Red Winter Wheat on September 26, 2007.

Cropping Block Sampled	Texture Class	pH	Soluble Salts mmho / cm	O. M. %	NO3-N Lbs / A (0-24")	Phosphorus Lbs / Acre	Potassium Lbs / Acre
S. Wheat	Medium	6.4	0.3	1.2	34	50	778
Lentil	Medium	6.3	0.1	1.2	16	30	742
Dry Pea	Medium	6.5	0.2	0.9	28	22	582
Chickpea	Medium	6.9	0.3	0.6	16	22	564
Safflower	Medium	6.7	0.2	0.6	74	20	480

Table 45. Wall Nutrient Analysis as of November 5, 2007. These blocks were planted back to Expedition Hard Red Winter Wheat on September 26, 2007.

Cropping Block Sampled	Texture Class	pH	Soluble Salts mmho / cm	O. M. %	NO3-N Lbs / A (0-24")	Phosphorus Lbs / Acre	Potassium Lbs / Acre
Safflower	Medium	6.5	0.2	1.7	18	50	1346
Camelina	Medium	6.3	0.2	1.6	34	32	1140
Chickpea	Medium	6.3	0.3	1.6	56	24	868
Dry Pea	Medium	6.5	0.3	1.6	44	44	1212

Table 46. Soil Moisture Percent Values by Previous Crop, sampled on November 5, 2007.

Previous Crop in 2007	Soil Depth in Inches	Soil Moisture % at Scenic	Soil Moisture % at Wall
Spring Wheat at Scenic	0-12"	11.0%	
	12-24	9.4	
	24-36	7.4	
	36-48	6.2	
	Mean		8.5
Lentil at Scenic / Camelina at Wall	0-12	8.9	11.3
	12-24	8.0	10.5
	24-36	6.8	9.2
	36-48	--	7.3
	Mean	7.9	9.5
Dry peas	0-12	9.5	13.1
	12-24	7.8	11.9
	24-36	--	10.0
	36-48	--	8.9
	Mean	8.6	10.9
Chickpea	0-12	9.4	12.5
	12-24	6.9	10.6
	24-36	--	8.5
	36-48	--	8.4
	Mean	8.1	10.0
Safflower	0-12	9.4	13.2
	12-24	6.0	10.9
	24-36	4.8	8.8
	36-48	--	8.2
	Mean	6.7	10.2

(--) indicates that the soil was so dry that the soil probe would go no further down.

Table 47: Mean Effects of N Fertilizer and Previous Crop on Yield of Winter Wheat at Scenic, SD in 2008.

	Height (Inches)	No. of Heads / Sq. Ft.	No. of Kernels / Head	No. of Seeds / Pound	Seed Protein (%)	Test Wt. (Lb/Bu)	Yield (Bu/A)
N03-N Rate (Lbs/A)							
0	25.8	36.3	21.0	14826	9.3	61.0	27.1
30	27.6	40.3	21.9	14984	9.8	58.9	38.9
60	28.5	40.8	21.9	15544	11.2	57.0	44.7
90	28.9	43.7	22.4	15880	11.9	56.4	46.0
120	29.2	46.7	23.0	15892	12.5	56.2	47.0
LSD (0.05)	0.8	5.0	1.6	660	0.5	0.7	2.4
Previous Crop							
Spring Wheat	28.6	42.3	22.3	14459	9.9	60.3	50.3
Lentil	28.6	43.2	22.8	15819	10.7	58.0	39.8
Field Pea	28.5	43.2	22.8	15403	11.8	56.6	41.8
Chickpea	27.3	41.3	21.9	16086	11.4	57.0	36.1
Safflower	27.0	37.7	20.4	15358	11.0	57.6	35.8
LSD (0.05)	0.8	5.0	1.6	660	0.5	0.7	2.4
CV (%)	4.29	19.11	11.77	6.77	6.9	2.01	9.12

Table 48: Mean Effects of N Fertilizer and Previous Crop on Yield of Winter Wheat at Wall, SD in 2008.

	Height (Inches)	No. of Heads / Sq. Ft.	No. of Kernels / Head	No. of Seeds / Pound	Seed Protein (%)	Test Wt. (Lb/Bu)	Yield (Bu/A)
N03-N Rate (Lbs/A)							
0	28.0	34.8	23.0	15328	9.4	59.6	38.1
30	30.1	44.7	24.8	15722	9.7	59.2	48.3
60	31.5	47.6	26.3	16469	10.5	57.5	53.6
90	31.9	49.7	27.0	17862	11.3	56.5	55.6
120	32.2	50.0	26.5	17797	12.0	55.5	53.2
LSD (0.05)	0.9	7.5	2.3	1042	0.3	1.1	2.8
Previous Crop							
Safflower	27.0	51.8	27.0	18036	9.9	56.7	57.6
Camelina	32.0	42.1	23.9	16981	10.6	57.6	42.1
Chickpea	32.6	42.3	24.9	16136	10.8	57.4	48.7
Dry Pea	31.4	45.3	26.4	15390	10.9	59.0	50.6
LSD (0.05)	0.8	6.7	2.1	932	0.3	1.0	2.5
CV (%)	4.75	25.71	14.01	9.76	4.98	3.06	8.75

Table 49: Effect of Previous Crop and N Fertilizer on Performance of Winter Wheat at Scenic in 2008.

Previous crop & N03-N Rate (Lbs/A)	Height (Inches)	No. of Heads / Sq. Ft.	No. of Seeds/ Head	No. of Seeds / Pound	Seed Protein (%)	Test Wt. (Lb/Bu)	Yield (Bu/A)
---Spring Wheat---							
0	26.6	33.0	20.0	14255	8.9	62.9	31.6
30	27.4	36.0	23.0	13933	8.8	61.1	48.1
60	29.4	41.8	22.5	14195	9.8	59.8	54.6
90	29.6	46.8	22.8	14790	10.6	58.9	57.7
120	30.0	53.8	23.0	15124	11.3	58.9	59.7
Mean	28.6	42.2	22.2	14459	9.8	60.3	50.3
---Lentil---							
0	25.4	42.0	21.8	14998	9.2	61.4	22.7
30	28.5	35.5	23.5	15144	9.5	59.3	37.4
60	29.3	47.3	21.8	16451	10.7	57.0	44.9
90	29.7	44.3	22.8	15800	11.7	56.2	47.0
120	30.0	47.0	24.0	16704	12.3	56.2	47.0
Mean	28.5	43.2	22.7	15819	10.6	58.0	39.8
---Dry pea---							
0	27.7	41.5	21.0	15484	9.7	59.1	33.0
30	28.4	44.5	21.5	15616	10.9	57.5	42.1
60	28.7	42.8	23.0	14969	12.2	55.7	43.2
90	29.1	46.8	24.5	15967	12.8	55.7	45.5
120	28.8	40.5	23.8	14980	13.3	55.3	45.5
Mean	28.5	43.2	22.7	15403	11.7	56.6	41.8
---Chickpea---							
0	24.9	35.8	20.8	14625	9.3	60.9	25.0
30	27.5	44.5	22.3	15109	10.0	58.8	35.7
60	27.5	42.0	22.0	16806	11.8	56.0	40.5
90	27.9	43.5	22.3	17707	12.7	54.6	39.6
120	28.4	40.8	22.3	16184	13.3	54.9	39.8
Mean	27.2	41.3	21.9	16086	11.4	57.0	36.1
---Safflower---							
0	24.3	29.0	21.3	14771	9.4	60.9	23.3
30	26.2	41.0	19.3	15117	10.2	57.8	31.5
60	27.7	30.0	20.0	15299	11.6	56.5	40.5
90	28.3	37.3	19.8	15137	11.7	56.8	40.3
120	28.5	51.3	21.8	16467	12.3	55.8	43.3
Mean	27.0	37.7	20.4	15358	11.0	57.5	35.7
Previous Crop x N level							
LSD (0.05)	1.70	11.23	3.66	1477.88	1.07	1.65	5.26
CV (%)	4.29	19.11	11.77	6.77	6.9	2.01	9.12

NS = not significant.

Table 50: Effect of Previous Crop and N Fertilizer on Performance of Winter Wheat at Wall in 2008.

Previous crop & N03-N Rate (Lbs/A)	Height (Inches)	No. of Heads / Sq. Ft.	No. of Seeds/ Head	No. of Seeds / Pound	Seed Protein (%)	Test Wt. (Lb/Bu)	Yield (Bu/A)
---Safflower---							
0	23.7	44.0	24.0	15305	8.3	57.2	46.7
30	26.2	50.0	27.3	16347	9.1	59.4	58.4
60	27.8	54.8	28.0	17647	9.7	56.9	61.0
90	28.7	50.5	27.0	21373	11.0	55.3	60.5
120	28.6	59.5	28.5	19506	11.5	54.7	61.6
Mean	27.0	51.7	26.9	18035	9.9	56.7	57.6
---Camelina---							
0	30.2	20.5	20.5	15575	9.9	60.1	28.8
30	31.5	42.0	21.5	15913	9.6	59.0	40.4
60	32.5	33.5	25.5	16693	10.6	57.4	47.4
90	33.0	54.5	27.5	16796	11.1	56.7	52.7
120	32.9	60.0	24.5	19927	12.0	54.8	41.3
Mean	32.0	42.1	23.9	16980	10.6	57.6	42.1
---Chickpea---							
0	29.4	40.0	22.8	15223	9.5	60.3	37.8
30	32.1	39.8	25.0	15296	9.9	58.3	47.4
60	33.4	47.3	24.5	16215	10.7	57.1	52.3
90	33.8	41.5	26.0	16860	11.7	56.0	53.3
120	34.5	43.0	26.0	17084	12.4	55.1	52.7
Mean	32.6	42.3	24.8	16135	10.8	57.3	48.7
---Dry Pea---							
0	28.6	34.5	24.8	15208	10.2	60.9	39.0
30	30.8	47.0	25.5	15332	10.2	59.9	47.2
60	32.4	55.0	27.0	15332	10.9	58.5	53.6
90	32.3	52.3	27.5	16419	11.3	58.1	55.9
120	32.8	37.5	27.0	14670	12.1	57.5	57.4
Mean	31.3	45.2	26.3	15392	10.9	58.9	50.6
Previous Crop x N level							
LSD (0.05)	2.09	16.66	5.11	2320	0.75	2.52	6.22
CV (%)	4.75	25.71	14.01	9.76	4.98	3.06	8.75

NS = not significant.

CHICKPEA SEEDING RATE STUDY – (2005-2008)

Objectives: To evaluate the response of two chickpea varieties to various seeding rates.

Procedures: Two chickpea varieties, Dwelly and Sierra, were planted at six seeding rates near Wall in 2007 and 2008. The same study was conducted at two locations, Wall and Hayes in 2005 and 2006. The chickpea variety CDC Yuma was used instead of Sierra in 2005. The experimental design was a randomized complete block with four replications. Treatments were arranged in a factorial design. The plots were planted with a John Deere 750 small plot drill with ten inch row spacing. Granular inoculant (*Mesorhizobium* sp. Ciceri) was added to each seed packet prior to planting. The six seeding rates were 10 seeds m², 20 seeds m², 30 m², 40 seeds m², 50 seeds m², and 60 seeds m². A seeding rate of 10 seeds m² is about equivalent to 1 seed / square foot. Measurements taken included height, biomass at harvest, pod and seed production (taken from 5 random plants / plot), seed grading, seeds / lb, test weight, grain yield, net return and harvest index. *Harvest Index* is a measure of the ratio of grain weight to total plant weight. The plots were harvested with a Wintersteiger Delta research combine. Spartan and glyphosate herbicides were applied at all locations prior to planting to control weeds in 2005, 2006, and 2007.

Planting and Harvest Dates 2005 – 2008.

Location (year)	Planting Date	Harvest Date
Wall (2008)	April 15	September 15
Wall (2007)	April 16	August 1
Wall (2006)	May 3	August 10
Wall (2005)	April 25	August 17
Hayes (2006)	May 3	August 2
Hayes (2005)	April 28	August 22

Discussion and Results: In 2008, the trial was sprayed with Roundup before harvest time to desiccate plants. Moisture was adequate in 2008 but heavy weed pressure limited the yields. Yields increased with increasing seeding rate with the best yield obtained at 30 seeds per m² but with no differences among seeding rates of 20 to 60 seeds m² (Table 51). Harvest index was highest at low seeding rates while pods /plant and seeds per pod decreased with increasing seeding rate. Number of seeds per pound did not change with increasing seeding rate. In 2008, we had problems with herbicide damage (poor agitation of Prowl H20) which led to Kochia and Russian thistle problems in the plot.

In 2007, yield increased with increasing seeding rate with the best yield obtained at 30 seeds per m². The yield at a seeding rate of 30 seeds per m² was statistically the same as the yield at 40 or 50 seeds per square meter. Harvest index was highest at low seeding rates while pods /plant and seeds per pod decreased with increasing seeding rate. Number of seeds per pound increased with increasing seeding rate, indicating smaller seeds at the higher seeding rates.

In 2006, at the Wall and Hayes locations, a seeding rate of 30 seeds per square meter was adequate. At both locations, a seeding rate of 30 seeds per square meter had statistically the same yield as the 40 or 50 seeds per square meter rates. Yields were lowered when the seeding rate was increased to 60 seeds / square meter at Hayes. Net returns in 2006 were the best at 10 seeds m² rate although in most years this low seeding rate would invite much more weed pressure due to the lack of canopy cover. A seeding rate of 30 seeds per square meter is a good seeding rate for chickpeas in most years in the Hayes area.

In 2005, yield increased with increase in seeding rate at both locations with the greatest yield obtained at 40-50 seeds per square meter. The higher seeding rate of sixty seeds per square meter resulted in lower yields than seeding rates of 40 or 50 seeds per square meter. Number

of pods/plant and number of seeds/plant were greater at lower seeding rates, indicating that chickpea plants compensated for lower seeding rates by producing more pods and more seeds. The variety CDC Yuma yielded greater than Dwelly at both locations. The response to seeding rate was the same for both chickpea varieties. The effect of seeding rate on plant height, number of pods per plant, number of seeds per plant, harvest index and grain yield at Wall and Hayes are presented in Tables 51 through 60.

Overall this study showed that increasing seeding rate beyond 30 seeds per square meter is not warranted as there is no statistical advantage on yield and it is cost prohibitive because of expensive seed prices. A seeding rate of less than 30 seeds per square meter (3 seeds/sq.ft.) is not recommended as it would not provide adequate ground cover resulting in heavy weed pressure.

Table 51. Mean Effects of Seeding Rate and Variety on Plants/m², Height, Harvest Index, Pods/Plant, Seeds/Plant, Seeds / lb, Test Wt, and Yield of chickpeas at Wall in 2008.

Seeding Rate (seeds / m ²)	Plants / m ² (Final stand)	Height (Sept 15, 08)	Harvest Index (%)	Pods / Plant	Seeds / Plant	Seeds / Lb	Test Wt. (Lb/Bu)	Yield (Lb/A)
10	8	14	44	21	20	1158	59	412
20	19	15	43	16	16	1133	58	534
30	23	15	42	16	15	1152	58	627
40	36	14	40	12	12	992	58	592
50	40	14	41	10	9	1037	59	575
60	52	14	39	8	7	1000	58	558
LSD (0.05)	6	1	4	4	4	171	1	207
<i>Variety</i>								
Dwelly	29	14	41	14	13	1102	59	521
Sierra	30	14	42	14	13	1056	58	579
LSD (0.05)	3	1	2	2	2	99	1	120
CV (%)	16.7	5.1	8.5	24.5	23.9	13.2	1.3	31.5

Table 52. Mean Effects of Seeding Rate on Seed Size and Net Return at Wall in 2008.

Seeding Rate (seeds / m2)	< 18/64" (%)	> 18/64" (%)	> 20/64" (%)	> 22/64" (%)	Yield (lbs/A)	Value (\$/A)	Seed Cost/A	Net Return* (\$/A)
10	2	5	21	72	412	\$115.39	\$20.80	\$94.59
20	3	3	18	76	534	\$151.53	\$41.60	\$109.93
30	3	4	18	75	627	\$176.57	\$62.40	\$114.17
40	1	2	12	85	592	\$176.01	\$83.20	\$92.81
50	2	3	14	81	575	\$166.94	\$104.00	\$62.94
60	2	4	15	79	558	\$160.33	\$124.80	\$35.53
LSD (.05)	2	3	6	10	207	n/a	n/a	n/a
CV	120.5	79.7	36.2	12.4	31.5	n/a	n/a	n/a

Commodity Value for 2008 <18/64"=no value, >18/64"=\$.10/lb, >20/64"=\$.23/lb, >22/64"=\$.31 ½ lb.
 *Net Return (\$/A)=Value(\$/A) minus seed cost/Acre.

Table 53. Mean Effects of Seeding Rate and Variety on Harvest Index, Pods/Plant, Seeds/Plant, Seeds/Lb, Test Wt., and Grain Yield of Chickpea at Wall in 2007.

Seeding Rate (seeds / m2)	Harvest Index (%)	Pods / Plant	Seeds / Plant	Seeds / Lb	Test Wt. (Lb/Bu)	Yield (Lb/A)
10	33	21.4	22.4	1337	59.6	451
20	32	12.1	11.9	1362	59.2	505
30	29	12.0	11.1	1452	59.0	536
40	25	7.8	7.4	1461	59.5	488
50	23	6.0	5.2	1437	59.2	531
60	22	7.3	6.0	1545	59.1	477
LSD (0.05)	5.7	4.1	4.7	66.1	.61	66
<i>Variety</i>						
Dwelly	27	10.4	10.4	1464	59.2	468
Sierra	28	11.8	11.0	1401	59.3	529
LSD (0.05)	2.4	2.4	2.7	38.1	.35	38
CV (%)	14.6	36.5	43.3	4.5	1.0	13.0

Table 54. Mean Effects of Seeding Rate on Seed Size and Net Return at Wall in 2007.

Seeding Rate (seeds / m2)	< 18/64" (%)	> 18/64" (%)	> 20/64" (%)	> 22/64" (%)	Yield (lbs/A)	Value (\$/A)	Seed Cost/A	Net Return* (\$/A)
10	8	20	43	29	451	\$91.59	\$20.80	\$70.79
20	9	21	45	25	505	\$98.97	\$41.60	\$57.37
30	12	27	43	18	536	\$92.44	\$62.40	\$30.04
40	15	28	42	15	488	\$78.71	\$83.20	\$-4.49
50	14	26	41	19	531	\$90.42	\$104.00	\$-13.58
60	18	30	40	12	477	\$70.68	\$124.80	\$-54.12
LSD (.05)	3.6	3.9	4.5	7.1	94.0	n/a	n/a	n/a
CV	27.6	15.2	10.3	35.7	13.0	n/a	n/a	n/a

Commodity Value for 2007 <18/64"=no value, >18/64"=\$.05/lb, >20/64"=\$.24/lb, >22/64"=\$.31/lb.
 *Net Return (\$/A)=Value(\$/A) minus seed cost/Acre.

Table 55. Mean Effects of Seeding Rate and Variety on Harvest Index, Pods/Plant, Seeds/Plant, Seeds/Lb, Test Wt., and Grain Yield of Chickpea at Wall in 2006.

Seeding Rate (seeds / m2)	Harvest Index (%)	Pods / Plant	Seeds / Plant	Seeds / Lb	Test Wt. (Lb/Bu)	Yield (Lb/A)
10	37	22.8	27.7	1216	60.1	554
20	35	15.3	15.9	1237	59.8	677
30	34	14.1	14.8	1290	60.1	781
40	32	10.7	11.1	1297	60.2	824
50	32	9.8	10.9	1316	60.3	838
60	27	8.1	8.4	1317	60.1	857
LSD (0.05)	8	6.1	8.4	54.3	n/a	87
<i>Variety</i>						
Dwelly	37	14.0	15.8	1328	60.5	903
Sierra	29	12.9	13.8	1230	59.7	608
LSD (0.05)	5	3.5	4.8	31.3	n/a	122.9
CV (%)	25.7	44.9	56.2	4.1	n/a	11.2

Table 56. Mean Effects of Seeding Rate on Seed Size and Net Return at Wall in 2006.

Seeding Rate (seeds / m2)	< 18/64" (%)	> 18/64" (%)	> 20/64" (%)	>22/64" (%)	Yield (lbs/A)	Value (\$/A)	Net Return* (\$/A)
10	2	11	51	36	554	\$97.27	\$76.47
20	2	14	53	31	677	\$113.11	\$71.51
30	2	11	52	35	781	\$136.27	\$73.87
40	2	15	49	34	824	\$139.58	\$56.38
50	4	20	46	30	838	\$131.56	\$27.56
60	2	15	42	41	857	\$151.76	\$26.96

Seed Value <18/64"=no value, >18/64"=\$.05/lb, >20/64"=\$.15/lb, >22/64"=\$.26/lb.

*Net Return (\$/A) = Value (\$/A) minus seed cost / Acre.

Table 57. Mean Effects of Seeding Rate and Variety on Harvest Index, Pods/Plant, Seeds/Plant, Seeds/lb, Test Wt., and Grain Yield of Chickpea at Hayes in 2006.

Seeding Rate (seeds / m2)	Harvest Index (%)	Pods / Plant	Seeds / Plant	Seeds / Lb	Test Wt. (Lbs/Bu)	Yield (Lbs/A)
10	19	13.7	15.0	1396	58.7	308
20	18	11.7	12.5	1415	59.7	374
30	18	11.0	11.9	1407	59.0	459
40	15	9.4	10.3	1516	59.1	417
50	15	9.2	9.4	1428	58.8	440
60	14	8.8	9.3	1593	59.6	384
LSD (0.05)	3	3.8	4.3	133.9	n/a	46
<i>Variety</i>						
Dwelly	17	11.8	12.4	1455	59.2	417
Sierra	16	9.4	10.3	1463	59.2	377
LSD(0.05)	2	2.2	2.5	77.3	n/a	64.8
CV (%)	22.0	35.7	37.3	9.0	n/a	11.3

Table 58. Mean Effects of Seeding Rate on Seed Size and Net Return at Hayes in 2006.

Seeding Rate (per m2)	< 18/64" (%)	> 18/64" (%)	> 20/64" (%)	>22/64" (%)	Yield (lbs/A)	Value (\$/A)	*Net Return (\$/A)
10	2	12	52	34	308	\$53.08	\$32.28
20	3	14	46	37	374	\$64.38	\$22.78
30	5	18	46	31	459	\$72.79	\$10.39
40	8	23	46	23	417	\$58.49	\$-24.71
50	4	20	63	13	440	\$60.85	\$-43.15
60	11	35	32	22	384	\$47.11	\$-77.69

Seed Value <18/64"= no value, >18/64"=\$.05/lb, >20/64"=\$.15/lb, >22/64"=\$.26/lb.

*Net Return (\$/A) = Value (\$/A) minus seed cost / Acre.

Table 59. Mean Effects of Seeding Rate and Variety on Harvest Index, Pods/Plant, Seeds/Plant, Seeds/Lb, Test Wt., and Grain Yield of Chickpea at Wall in 2005.

Seeding Rate (seeds / m2)	Harvest Index (%)	Pods / Plant	Seeds / Plant	Seeds / Lb	Test Wt. (Lbs/Bu)	Yield (Lbs/A)
10	29	28	27	1329	n/a	619
20	33	27	25	1350	50.1	797
30	33	23	20	1381	47.4	876
40	32	19	16	1342	50.4	919
50	32	16	14	1389	49.2	963
60	31	13	12	1409	53.4	910
LSD (0.05)	4	3.9	3.8	58.3	0.5	80
<i>Variety</i>						
Dwelly	31	19.6	19.4	1355	49.1	819
CDC Yuma	33	22.1	19.1	1378	50.1	876
LSD (0.05)	n.s.	2.2	n.s.	n.s.	n.s.	46
CV (%)	12.5	18.3	19.5	4.2	5.7	9.2

Table 60. Mean Effect of Seeding Rate and Variety on Harvest Index, Pods/Plant, Seeds/Plant, Seeds / Lb, Test Wt., and Yield of Chickpea at Hayes in 2005.

Seeding Rate (seeds / m2)	Harvest Index (%)	Pods / Plant	Seeds / Plant	Seeds / Lb	Test Wt. (Lbs/Bu)	Yield (Lbs/A)
10	34	32	31	1256	53.8	518
20	36	26	25	1281	n/a	675
30	39	21	21	1290	55.3	767
40	37	21	20	1254	54.2	1041
50	39	17	16	1251	55.4	1041
60	39	17	16	1280	55.4	954
LSD (0.05)	4	2.0	2.0	50.6	0.8	277
<i>Variety</i>						
Dwelly	36	18.7	18.9	1262	56.5	727
CDC Yuma	39	25.8	24.2	1275	54.2	938
LSD(0.05)	2	3.1	2.9	n.s.	0.5	160
CV (%)	9.6	23.7	23.3	3.9	3.7	32.6

SKIP-ROW SUNFLOWER FOR DROUGHT AVOIDANCE IN DRYLAND CROPPING SYSTEMS - 2007-2008

Background:

Sunflower (*Helianthus annuus*) is a major crop in South Dakota. In 2005, 550,000 acres were planted and production totaled 876.95 million pounds. Currently, most of sunflower production is grown in the central part of the state. Although the crop is well adapted to the eastern part of the state, sunflower production in eastern South Dakota has been replaced by corn and soybean in recent years. The production acres lost to corn and soybean can be replaced by increasing sunflower production in the western part of the state. Sunflower is well adapted to western South Dakota but lack of adequate soil moisture is a major limitation to sunflower yields in the region. The crop frequently runs out of moisture before seed production, lowering yield potential and increasing yield variation from year to year. The skip-row technique which involves leaving some rows unplanted has been reported to improve yields of corn compared to conventional planting. This technique uses wider rows to store soil moisture between the rows by keeping the developing plants from using all the available soil moisture early in the growing season. The skip-row technology has not been evaluated as a drought avoidance strategy for sunflower in South Dakota

Objectives:

The objectives of the study were 1) to determine the impact of planting arrangement (plant one/skip one row, plant two/skip two rows, and conventional planting in 20-inch rows) and plant population on performance of sunflower in a semi-arid environment in western South Dakota and 2) to assess how the skip-row technology would affect weed pressure and weed management in a sunflower crop.

Materials and Methods:

The study was conducted on under dry land conditions in Pennington County near Scenic, South Dakota. In 2007 and 2008. Treatments included three plant arrangements; conventional planting in 20-inch rows (conventional), plant one/skip one row (P1S1), and plant two/skip two rows (P2S2) and two plant populations (12,500 plants/acre and 16,600 plants/acre). Treatments were arranged in factorial combination giving a total of six treatments. The experimental design was a randomized complete block with treatments replicated four times. Plots were planted using a JD 7100 planter with five rows, 20 inches apart. Each plot was 33.3 ft. wide (four passes) and 100 ft long. Seed boxes on the planter were disconnected as necessary to achieve desired row width. A sunflower hybrid, Pannar Seeds 8560 NS/CL/Cruiser was used in the study. The field was sprayed with a recommended rate of Spartan to control weeds before planting. The experiment was planted on June 11 in 2007 and June 12 in 2008. In 2007, the first planting had to be written-off due to severe wildlife damage and the experiment replanted on June 28, 2007. Crop stands were much better in 2008 although Kochia and Russian Thistle weed pressure came later in the growing season. The trial was harvested with a Wintersteiger Delta research combine on November 13, 2007 and October 23, 2008.

Table 61. 2008 Sunflower Skip Row Study, Scenic, South Dakota.

Treatment	Weed Pressure (0-9)* Oct 8, 08	Lodging (%) Oct 8, 08	Plant Height (Inches) Oct 8,08	Final stand (Plants/A) Oct 8, 08	Test Wt (Lb/Bu) Oct 23, 08	Yield (Lb/Ac) Oct 23, 08
Population (plants / A)						
12,500	6.1	0.8	55.7	7209	25.4	754
16,600	5.3	1.0	57.5	10378	25.9	823
LSD (0.05)	ns	ns	ns	1556	0.4	ns
---Row Arrangement (RA)-----						
Conventional	4.8	.3	55.6	8786	25.4	833
P1S1	6.3	.4	56.3	8463	25.8	743
P2S2	6.1	2.0	57.9	9132	25.9	790
LSD (0.05)	1.0	ns	ns	ns	ns	ns
---Pop x RA-----						
12,500- Conventional	5.5	0.0	55.0	6793	25.1	789
12,500-P1S1	6.5	0.8	55.3	6862	25.6	739
12,500-P2S2	6.3	1.5	56.8	7972	25.5	734
16,600 -Conventional	4.0	0.5	56.3	10778	25.7	878
16,600-P1S1	6.0	0.0	57.3	10064	26.0	746
16,600-P2S2	6.0	2.5	59.0	10292	26.2	846
LSD (0.05)	ns	ns	ns	ns	ns	ns
C.V. (%)	17.1	259		20.3	1.7	11.9

* Weed pressure assessed at a scale of 0 to 9; 0 = weed free 9 = completely covered by weeds.

Table 62. Sunflower Skip Row Study - Nutrient Analysis as of June 11, 2007.

Texture Class	pH	Soluble Salts mmho / cm	O. M. %	NO ₃ -N Lbs / A (0-24")	Phosphorus Lbs / Acre	Potassium Lbs / Acre
Medium	5.6	0.3	n/a	130	32	1104

Table 63. 2007 Sunflower Skip Row Study, Scenic, South Dakota.

Treatment	Weed Pressure (1-9)* Nov 9, 07	Plant Height (inches) Nov 9, 07	Test Weight (Lb/Bu) Nov 13, 07	Yield (Lb/Ac) Nov 13, 07
---Population (Pop) (plants/Ac)---				
12,500	3.6	40.6	26.2	598
16,600	1.5	41.1	26.7	517
LSD (0.05)	-	NS	NS	69.5
---Row Arrangement (RA)- -----				
Conventional	2.7	41.0	26.6	557
P1S1	2.5	39.9	26.4	558
P2S2	2.3	41.7	26.4	558
LSD (0.05)	-	NS	NS	NS
---Pop x RA-----				
12,500- Conventional	3.7	40.5	26.1	590
12,500-P1S1	3.7	40.0	26.2	565
12,500-P2S2	2.7	41.5	26.2	639
16,600 -Conventional	1.7	41.5	27.1	523
16,600-P1S1	1.2	39.7	26.6	550
16,600-P2S2	1.7	42.0	26.7	476
C.V. (%)	-	7.1	3.1	14.3

* Weed pressure assessed at a scale of 1 to 9; 1 = weed free 9 = completely covered by weeds.

Results of 2008. Growing season (April to September) precipitation mounted to 14.4 inches. Measurements taken during the growing season included stand assessment, plant height, weed pressure, and yield. 2008 results are given in Table 1 below. Final actual stands were evaluated on October 8, 2008. The final plant stand was only 58% of the original intended stand of 12,500 plants/acre and at 10,378 or 63% of the original stand for the 16,600 population. Soil crusting may have been a factor on reduced final stands. Sunflowers have a strong ability to compensate for stand when developing yield. Weed pressure was greater under skip-row plant arrangement compared to conventional planting. Sunflower plants were slightly tall at higher population of 16,600 plants/ac in all row arrangements. Test weights were not influenced by row arrangement or plant population. Seed yield was greatest under conventional seeding at a higher population of 16,600 plants/ac and lowest at a lower population of 12,500 under the P2S2 row arrangement.

In 2007, plant stands were thin due to cutworm damage. Weed pressure was higher at low plant populations. Test weight and plant height was the same for the two populations. Seed yield was slightly higher when sunflowers were planted at a lower population of 12,500 plants/ac. Overall, row arrangement had little effect on all measured traits. However, there was clearly higher weed pressure under low plant population irrespective of row arrangement. On the other hand, the P2S2 row arrangement showed a slight yield advantage over the other two arrangements at lower population but showed the lowest yield of the three row arrangements at higher plant population. Thin stands may have confounded treatment effects resulting in lack of major differences among treatments.

Clearly there were differences in response to treatments between the two years. The study will be repeated in 2009 to provide data from an additional year before firm conclusions can be drawn.

DRY PEA PLANTING DATE STUDY – OKATON, SD - 2008

Objective: To evaluate the impact of planting date on yield and agronomic characteristics of field pea varieties in west-central South Dakota.

Procedures: Four dry pea varieties (Arvika, Grande, CDC Mozart, Cooper) were planted in a randomized complete block experiment with four replications at 5 planting dates near Okaton, South Dakota in the spring of 2008. Glyphosate (Roundup) was sprayed on as a burn down in the fall of 2007 and Assure II was applied for grassy weed control in the spring of 2008. The seeding rate was at 330,000 seeds/A. The peas were inoculated with a granular pea inoculum at 10 grams/packet (*Rhizobium leguminosarium* biovar *viceae*) prior to planting. A John Deere 750 drill with 10-inch spacing was used to plant the trials at five planting dates on March 4, March 25, April 9, April 22, and May 19, of 2008. Height notes and plant samples (five plants per plot) were taken on July 10, 2008 before harvesting. The peas were harvested for grain on July 23, 2008 with a Delta Wintersteiger combine equipped with vine lifters and a pickup reel. The May 19, 2008 planting date was not harvested due to plant injury caused by herbicide carry over in the soil. Five plants were collected per plot to calculate pods per plant, seeds per pod, and harvest index values. The variety characteristics of the peas are listed in Table 64.

Planting Date Comments:

March 4, 2008: Planting conditions were wet and very muddy. The very top was frozen earlier in the morning but had thawed before we started planting at 10:15am. The drill picked up a lot of straw and mud. All openers worked ok and did not plug, but the closing wheels didn't close the furrow very well. It snowed soon after this planting date.

March 25, 2008: Planting conditions were very good. All furrows closed well and the drill remained clean. The March 4 date was starting to germinate and the furrows had swelled shut to close the rows at this time.

April 9, 2008: Seeding conditions were good. A rain storm was moving in as we planted and it started to rain shortly after we planted the third date. There was plenty of soil moisture but the plots seeded nice and there was very minimal soil sticking to the JD 750 drill.

April 22, 2008: Ideal seeding conditions. Good soil moisture and the drill worked very well.

May 19, 2008: It was too wet to plant any earlier so planting was delayed until May 19th. This date had ideal seeding conditions and the drill worked very well.

Table 64. Dry Pea Variety Characteristics

Variety	Seeds / lb	Leaf Type	Seed Color	Maturity
Arvika (forage type)	3690	Normal	Mottled	Late
Grande	2730	Normal	Yellow	Medium
CDC Mozart	2223	Semi-leafless	Yellow	Early
Cooper	1776	Semi-leafless	Green	Late

Summary:

Planting on March 4th was far from ideal soil conditions as we did not get good furrow closure on that day. Stands from the first planting date were thin and soil temperatures were very cold which delayed germination of the first planting date. The other four dates had good soil conditions for planting and stand establishment. Because of the poor stands the first date had decreased yield, with the following three dates having yields similar to each other. Harvest index (ratio of seed weight to plant biomass), seeds per plant and pods per plant decreased with later planting dates. The March 4th date had much higher pods per plant numbers as these plants were compensating for the weak stand this date had. Height was similar for the first three dates and the fourth date was slightly shorter. In 2008 the best time to plant was the last week of March thru the first half of April. From earlier studies we have done, we have found that planting dry peas later than early May is not recommended in western South Dakota. This is because peas are very sensitive to high temperatures during flowering. If peas are planted later than early May they flower in July when temperatures are typically hot. This study will be repeated in 2009 to provide additional data.

Acknowledgments: Thank you to our cooperator Henry Roghair.

Results:

Table 65. Planting Date vs Plant Height, Peas/Plant, Pods/Plant, Harvest Index, Test Weight and Yield of Dry Peas at Okaton, SD (Jones County) in 2008.

Planting Date	Height (inches)	Seeds / plant	Pods / plant	Harvest Index	Test Wt. (Lb/Bu)	Yield (Bu/A)
March 4, 2008	25	38	8	57	61.5	28.4
March 25, 2008	25	24	6	55	62.5	34.7
April 9, 2008	26	29	6	52	62.1	33.5
April 22, 2008	22	21	5	46	61.0	30.8
Date Mean	24.3	28	6.2	52.3	61.7	31.8
LSD (.05)	2	5	1	3	0.7	3.1
CV	11.5	23.6	25.6	8.9	1.9	13.8

Table 66. Variety vs Plant Height, Peas/Plant, Pods/Plant, Harvest Index, Test Weight and Yield of Dry Peas at Okaton, SD (Jones County) in 2008.

Variety	Height (inches)	Seeds / plant	Pods / plant	Harvest Index	Test Wt. (Lb/Bu)	Yield (Bu/A)
Arvika	35	35	7	48	61.7	28.8
Grande	24	25	6	52	61.2	32.2
CDC Mozart	18	26	6	57	62.8	30.4
Cooper	20	26	6	52	61.4	35.9
Variety Mean	24.3	28	6.2	52.3	61.7	31.8
LSD (.05)	2	5	1	3	0.7	3.1
CV	11.5	23.6	25.6	8.9	1.9	13.8

Table 67. Effect of Planting Date by Variety on Performance of Field Pea at Okaton, SD (Jones County) in 2008.

Planting Date	Variety	Height (inches)	Seeds / plant	Pods / plant	Harvest Index	Test Wt. (Lb/Bu)	Yield (Bu/A)
March 4, 08	Arvika	39	52	10	51	63.2	32.4
	Grande	22	35	8	58	59.3	28.7
	CDC Mozart	19	34	8	61	62.0	21.6
	Cooper	21	33	8	56	61.7	30.9
Mean		25	39	9	57	61.5	28.4
March 25, 08	Arvika	36	30	6	52	62.3	27.7
	Grande	26	22	6	54	62.5	37.2
	CDC Mozart	17	21	5	61	63.8	32.7
	Cooper	20	22	5	53	61.5	41.1
Mean		25	24	6	55	62.8	34.7
April 9, 08	Arvika	36	39	7	48	62.2	28.5
	Grande	26	23	6	52	62.1	34.7
	CDC Mozart	20	27	7	56	62.7	33.7
	Cooper	21	28	5	50	61.5	37.0
Mean		26	29	6	52	62.0	33.5
April 22, 08	Arvika	28	20	4	41	59.4	26.8
	Grande	24	20	5	43	61.0	28.3
	CDC Mozart	17	21	5	52	62.8	33.7
	Cooper	19	23	5	49	60.9	34.4
Mean		22	21	5	46	61.0	30.8
	LSD (0.05)	4	9	2	6	1.4	6.2
	CV (%)	11.5	23.6	25.6	8.9	2.0	13.8

SDSU REDUCED TILLAGE AND NO-TILL CROP ROTATION STUDY WALL, SOUTH DAKOTA

OBJECTIVES

1. To determine crop productivity in varied rotations with different crop intensities.
2. To determine economic returns from various rotation systems with varied levels of crop intensification and diversity.

PROCEDURES

The study with nine different rotations was established in the spring of 1994. The rotations are two to six years in duration and we have completed at least one full cycle in all of the rotation sequences. All phases in each rotation are grown each year. No-till production practices are used to grow all crops except for the winter wheat conventional fallow treatment. Proso millet, field peas, chickpea, hairy vetch, hay millet, spring barley and winter wheat were planted with a JD 750 no-till drill at 10 inch row spacing. The fallow winter wheat is planted with a JD 610 drill at 10 inch row spacing. The safflower, corn and sunflower are planted with a JD 7100 corn planter in 20 inch rows. Nitrogen and phosphorus fertilizer are injected in the fall using strip tillage preparing the zone for planting by the JD 7100 corn planter the following spring.

The experimental design is a randomized complete block with treatments replicated four times. Plots are 25' x 80' in size; the small size allows all the plots to be located on the same soil type and reduces variability due to soil characteristics. The crop yields are measured from each plot and analyzed to compute the average yields for each rotation. Detailed records of all the cultural practices including spraying for insect pests, diseases, and weed control are kept and cost of each practice assessed, and are given on Appendix 1. This allows for yield and economic comparisons to be made each year.

RESULTS AND DISCUSSION

Long Term Trends

Long term results have shown that the inclusion of broadleaf crops such as sunflower, safflower and peas; along with warm season grass crops like corn helps to break weed and disease cycles and can improve wheat yields and profitability. It should be noted that we do not include any farm program payments except loan deficiency payments (LDP) when applicable, in our economic analysis.

The ten year (1999-2008) average yield of winter wheat following millet in a rotation where a broadleaf crop or corn was grown prior to the millet was 41.8 Bu/A. The winter wheat grown in a continuous winter wheat-millet rotation had a ten year average yield of 36.4 Bu/A. This indicates a 5.4 bushels per acre difference due to introducing a broadleaf or warm season crop into the rotation as similar management practices were applied in both rotations over the ten year period. These results indicate the importance of crop diversity in a rotation system. For comparison, the winter wheat-fallow rotation had an average yield of 49.1 Bu/A while fallow wheat in the diversified rotation of 2a yielded 57.3 bushels per acre over the 10 year period. It should also be noted that Rotation 11 (Winter Wheat / Corn / Millet) has no broadleaf crops included and wheat yields are equally as good as those for continuous crop rotations that have broadleaf crops as part of the rotation. The two warm season grass crops (corn and millet) have high demand for soil moisture late in summer while winter wheat has high demand for soil moisture early in spring. This rotation makes full use of all the rainfall received during the growing season. The winter wheat in this rotation seems to benefit from the diverse soil moisture use pattern of the crops. The diversity of crops in this rotation makes for easier weed management.

Introducing safflower, sunflower and pea crops in the winter wheat-millet rotation would be expected to increase demand for soil moisture and thus decrease winter wheat yield compared to the winter wheat-millet rotation. The winter wheat in rotations with safflower, sunflower and pea, however, yielded more than the winter wheat-millet rotation, indicating the increasing problem with root diseases in the undiversified winter wheat-millet rotation (Table 68). The increased income from the

higher yields of winter wheat along with the opportunity to produce a profitable broad-leaf crop like sunflower or safflower can increase the net income of these rotations, particularly in the wetter years.

We continue to use a strip tillage system for corn, sunflowers and safflower. The fertilizer is injected in the fall using a narrow point opener which leaves about a four inch area strip tilled. We have added some reverse mounted closing disks to fill the trench formed by the injector, but still having minimal soil disturbance. In the spring; corn, safflower and sunflowers are planted over the same strips. Since going to this system, crop stands of corn and sunflowers have improved. The residue managers on our planter work better in the strip tilled wheat stubble and it has the added bonus of putting the fertilizer right where the new planted crop will utilize it.

In 2008; Winter wheat yields were good because of good stands in the fall. Decent rains in the fall and snow catch in the winter months helped the young crop along. March was dry at 0.43" and April had 1.13" rainfall for the month. May and June were wet with nearly 5 inches of rainfall in May and 4.41" in June. Corn stands were poor due to cool, wet soil conditions for nearly a month after planting. Wireworm pressure along with poor germination and delayed emergence greatly reduced the corn stands. Soil temperatures at planting time (April 29, 2008) were at 60 degrees for corn and 70 degrees for safflower. Shortly after planting, it started raining and cooled off for the entire month of May. The corn seed had Poncho 250 for wireworm control but this lower rate along with cool, damp conditions (slow growth) after seeding was inadequate to control the wire worms. The corn had a final stand of about 42% of the intended 12,500 kernels / acre that we had planned on. We had a final stand of 5200 plants per acre and this was inadequate. Weed competition was not a serious issue but we were short of plants to produce a good corn crop. Safflower and sunflower stands were excellent this year. The safflower was planted on April 29, 2008 and the sunflowers were planted on June 11, 2008. The hay millet did well due to rainfall of 1.93 inches received in July and .94 inch in August. The proso millet was planted on June 9, 2008. The proso millet plots were sprayed two days after planting to control pigeon grass and broadleaf weeds. A late flush of stinkgrass competed with the proso millet crop all season long.

Recent cropping changes in this study include: 1) in Rotation 5a, substituting feed barley for spring wheat. 2) in Rotation 6a, growing dry peas for grain rather than spraying them off as a green manure crop, and in 9a, using hairy vetch as a green fallow option rather than using forage peas (the hairy vetch stubble holds better to the soil surface than the field pea stubble), 3) in 2007; Rotation 10 was changed to winter wheat / proso millet / chickpea. This placed the chickpea ahead of the wheat crop. This would give nitrogen credit towards the wheat crop and allow more time between chickpea harvest and wheat planting time). The 2008 growing season in Rotation 10 found weed explosions in the Proso millet. Weeds and Ascochyta Blight disease nearly totally took the chickpea crop. It was decided in the winter of 2008 to readjust this rotation again. The new sequence will be winter wheat / proso millet / dry peas. 4) For Rotation 2a, in 2007 we substituted Golden German hay millet in where proso millet was. Proso millet yields in this rotation have been historically the lowest in the entire trial. The hay millet stands were good in 2007 and 2008. Our six-year rotation has shown us that longer diverse rotations are better than the mostly three-year rotations we started with. The down side is that Rotation 2a requires more types of equipment thus making it more expensive to operate. Another cultural practice change in 2a that we implemented in the spring of 2008 is that we are no longer doing mechanical tillage during the fallow period. We want to determine if mechanical tillage is necessary during the fallow period to maintain better yields in 2a fallow wheat (8.2 bushels wheat yield advantage over a 10 year period as compared to the fallow wheat of Rotation 1).

Table 71 shows the estimated yield goals used for fertilizer recommendations of each crop and rotation since 1999. Thus, all crops have been adequately fertilized with nitrogen since the beginning of the study in 1994. However, our long term results show that attained yields for most crops have been below yield goals (Table 70). For economic reasons, we decided starting in 2006, to adjust yield goals to match long-term average yields for each crop and rotation.

Wall Rotation - Total Precipitation by Month (inches) – September 2007 to August 2008

September 2007	1.19"	January 2008	0.00"	May 2008	4.96"
October 2007	1.92"	February 2008	0.26"	June 2008	4.41"
November 2007	0.16"	March 2008	0.43"	July 2008	3.13"
December 2007	0.03"	April 2008	1.13"	August 2008	0.94"

2008 YIELD RESULTS AND DISCUSSION BY ROTATION

Rotation 1: Winter Wheat / Fallow:

This is the base rotation that all other rotations in the study are compared to. This rotation has had 2 to 3 mechanical tillages each year during the fallow period since we started the rotation study in 1994. We spray in the fall and spring during the cooler months for weed control.

Alice, a hard white winter wheat variety was planted on September 21, 2007 with a JD 610 drill. Liquid starter fertilizer was applied at planting time at six gallons of 10-34-0 per acre. Winter wheat stands were good in the fall due to decent soil moisture conditions. Spring rainfall was adequate with 1.13 inches in April, 4.96 inches in May and 4.41 inches in June. In 2008, winter wheat yields were at 56.2 Bu/A. The 10-year average yield on winter wheat in Rotation 1 is 49.1 Bu/A. This rotation had a net return of \$48.47 / acre in 2008.

Rotation 2: Winter Wheat-a / Sunflower / Hay Millet / Winter Wheat-b / Corn / Chem. Fallow:

This is a very diverse rotation that provides many opportunities for weed control and disease suppression. On the long term, yields from this rotation have been above average even in the dry years. The best winter wheat yields from this entire rotation study have come from winter wheat following fallow (Winter wheat –a) that has consistently out-yielded the fallow wheat in Rotation 1 by an additional 8.2 Bu/Acre over the last ten years. Sunflower yields have averaged 1281 Lb/Acre (Table 70) with extremely low yields in 2002, 2003, and 2007 due to drought stress. Sunflower is deep rooted and tends to dry out the soil profile considerably, thus millet grown after the sunflower crop is very dependant upon spring rains to recharge the top two feet of soil. Proso millet seed yields in this rotation have averaged 909 Lb/Acre over the last 8 years (1999-06). Proso millet yields were lower in this rotation than any other in the trial. It was decided to plant Golden German hay millet and cut it for hay in 2007. Hay millet yields were at 1.57 tons per acre in 2007 and 2.5 tons per acre in 2008. (Table 70). The recrop winter wheat following millet on average, yielded 72% the yield of the fallow wheat in this rotation.

This six-year rotation requires nitrogen applications on every crop so there are no fertilizer savings as is observed in rotations with legumes. The diversity of warm and cool season crops in this six - year rotation spreads the work-load out for the producer. This rotation requires more equipment than most other rotations. The fallow segment was chemical fallowed in 2008. We are currently evaluating whether the mechanical tillage is necessary during the fallow period to maintain the 8.2 bushel per acre advantage over the fallow wheat in Rotation 1. This rotation had a net return of \$49.21 / acre in 2008.

Rotation 3: Winter Wheat / Safflower / Proso Millet:

Winter wheat in this rotation yielded 51.0 Bu/A in 2008 and has averaged 41.2 Bu/A long term. Safflower yields were 1483 Lb/A in 2008 and averaged 891 Lb/A in the ten-year period of 1999-2008. (Table 70). Millet yields were 1224 Lb/A in 2008 with a ten-year average of 1125 Lb/A. The safflower crop is deep-rooted and dries out the ground for the upcoming millet crop. During dry years, a summer fallow could be used to replace the millet crop. In 2008, safflower yields were good and prices were at \$.30 per pound. Wheat yields were good too. Yields of Proso millet have been variable in this rotation depending upon amount of snow catch in the safflower stubble and the amount of rainfall before and during the millet crop.

This rotation provides the diversity of a broadleaf crop along with cool season and warm season grass crops. The two warm season crops are relatively drought tolerant, and the winter wheat makes most of its growth during the cool portion of the summer. This rotation will make full use of all precipitation received. The rotation can be planted with small grain equipment and therefore does not require any additional investment in equipment. This rotation had a net return of \$86.51 / acre in 2008.

Rotation 4: Winter Wheat / Proso Millet:

This rotation alternates between winter wheat and proso (grain) millet. The proso millet crop is a good replacement for summer fallow for a short term basis. Winter wheat yields in this rotation have averaged 36.4 Bu/A over a ten-year period. Millet yields, on the other hand, have averaged 1428 Lb/A over the last ten years. In 2008, the winter wheat yields (36.8 Bu/A) were slightly above the ten-year average while the millet yields (949 Lb/A) were well below average. This rotation is not well diversified and will harbor crown and root rot diseases over time. In some years, large amounts of residue on the soil surface after the winter wheat crop has caused some difficulty in establishing a good stand of millet. On average, winter wheat in this rotation has yielded 74 percent of the fallow winter wheat yields from Rotation 1. This is a rather narrow rotation that does not provide adequate diversity of crops for good weed control. Rotation 4 does not utilize soil moisture very well. This rotation had a net loss in 2008 of \$ - 44.99 per acre.

Rotation 5a: Winter Wheat / Corn / Sunflower / Spring Barley:

This is a very intensive rotation with high moisture demand. Winter wheat yields have averaged 36.0 Bu/A over the ten-year period. Corn yields averaged 42.6 Bu/A over the last ten years though corn failed completely in 2002, 2003, and 2006 due to drought/heat stress. Sunflower yields from this rotation have been the lowest yielding in the study over the ten-year period (1999-2008). Sunflower is harvested late in the fall, and will leave limited stubble to catch snow. Spring wheat did not perform well after sunflower in wet years and did even worse in drier years. Spring barley replaced spring wheat in 2005. Barley is more drought tolerant than spring wheat and matures before spring wheat. Barley yields in 2008 were at 73.7 Bu/A. This rotation had a net return of \$26.84 / acre in 2008.

Rotation 6a: Winter Wheat-a / Winter Wheat-b/ Safflower / Dry Pea:

This rotation was changed in 2005. The original rotation had peas grown as a green-fallow crop. The pea green-fallow in this rotation was intended to lower the demand for fertilizer nitrogen in the rotation. The peas were grown only until early bloom and then killed by a herbicide spray. By bloom, peas have accumulated a good amount of biomass to benefit the following crop and at the same time killing the crop at this stage allowed for potential soil moisture recharge before the winter wheat crop. The problem came at winter wheat planting time when the desiccated pea stubble is cut off by the no-till drill at ground level and then blown away in the wind, leaving the ground bare. Because of this problem, we went to harvesting the peas for grain.

The first winter wheat (WW-a) in Rotation 6a has a ten year average of 42.4 bu / acre. The second winter wheat (WW-b) has a 34.6 bu / acre average over the ten year period (Table 70). Safflower yields averaged 782 lbs/acre for the last 4 years. Safflower and sunflower yields are very comparable in dry years but the sunflower will out yield safflower in wetter years. Growing the field peas for grain is a better option. Peas have proven to be too expensive to grow as a green-fallow crop. The field pea grain yields have an average yield of 1472 Lb/A over the last four years. Planting dry peas eliminates the need to add nitrogen fertilizer during that year and reduces the nitrogen needs of the following wheat crop. Olympus was sprayed on both wheat crops in April of 2008. This was done to suppress downy brome/Japanese Chess. Although Olympus has some winter annual activity, it was necessary to spray for weed control using Starane NXT (27 oz/A) + Penetrate II on both wheat crops in May of 2008. All 4 crops performed well and prices were better this year. No additional Nitrogen was applied to the winter wheat-a crop after the field pea crop. Protein levels of the grain and some reduction in yield of winter wheat-a suggested that more Nitrogen would have been beneficial. Nitrogen was applied on winter wheat-b at 80 lbs N / acre. The safflower received 60 lbs N / 30 lbs P2O5 injected in 20 inch rows in the fall. The safflower is deep rooted and although it was fertilized for a 1200 pound crop; adequate moisture, good weed control and deep rooting pushed the crop to 1650 pounds per acre. The field peas are a legume so they were inoculated at seeding time and no additional nitrogen was applied to them.

This rotation appears to be sustainable with good yields and reduced need to apply nitrogen to the crops. Another advantage includes no need for additional equipment for planting or harvest. This rotation showed the best economic returns of any in the study for 2008 at \$122.77 net return per acre.

Table 68. Hard White Winter Wheat Yields from The Nine Rotation Sequences at Wall in 2008 and Long Term (10 year) data (1999-2008).

Rotation	Crop Sequence	Protein 2008 (%)	Test Wt 2008 (Lb/Bu)	Yield 2008 (Bu/A)	Ave Yield 1999-08 (Bu/A)
1	WW / F	11.9	63.4	56.2	49.1
2a	WW / C / F / WW / Su / HM	11.6	62.0	69.3	57.3
2a	WW / C / F / WW / Su / HM	9.6	61.6	47.6	41.2
3	WW / Sa / PM	9.2	62.3	51.0	41.2
4	WW / PM	8.9	61.1	36.8	36.4
5a	WW / C / Su / S Bar	9.5	60.8	45.9	36.0
6a	WW / WW / Sa / FP	9.9	62.6	43.6	42.4
6a	WW / WW / Sa / FP	10.8	62.2	50.0	34.6
9a	WW / WW / Sa / HV	10.5	62.5	59.2	43.2
9a	WW / WW / Sa / HV	10.0	61.2	48.5	35.2
10	WW / PM / CP	10.5	63.4	29.9	41.2
11	WW / C / PM	9.3	62.5	54.8	43.0
Mean		10.2	62.1	49.4	41.7
LSD (.05)		1.1	1.5	10.4	--
CV		7.7	1.7	14.6	--

WW = winter wheat, F=fallow, C=corn, Su=sunflower, PM=proso millet, HM=hay millet, Sa=safflower, FP=field peas, HV=hairy vetch, CP=chickpea, S Bar=spring barley

Table 69. Net Returns from 2008 Crop at The Wall Rotation

Rotations and Crop Yields:					Dollars Return / A.			
1	Winter Wheat 56.2 bu	/	Fallow		\$ 48.47			
2a	Winter Wheat-A 69.3 bu	/	Sunflower 1690 lbs	/ Hay Millet 2.5 Tons / A	/ Winter Wheat-B 47.6 bu	/ Corn 33.0 bu	/ Fallow	\$ 49.21
3	Winter Wheat 51.0 bu	/	Safflower 1483 lbs	/	Proso Millet 1224 lbs			\$ 86.51
4	Winter Wheat 36.8 bu	/	Proso Millet 949 lbs					\$ -44.99
5a	Winter Wheat 45.9 bu	/	Corn 33.0 bu	/ Sunflower 1494 lbs	/	Spring Barley 73.7 bu		\$ 26.84
6a	Winter Wheat-B 50.0 bu	/	Safflower 1650 lbs	/ Dry Pea 2004 lbs	/	Winter Wheat-A 43.6 bu		\$122.77
9a	Winter Wheat-B 48.5 bu	/	Safflower 1559 lbs	/ Hairy Vetch	/	Winter Wheat-A 59.2 bu		\$ 89.97
10	Winter Wheat 29.9 bu	/	Proso Millet 764 lbs	/	Chickpeas 0 lbs			\$-101.81
11	Winter Wheat 54.8 bu	/	Corn 29.7 bu	/	Proso Millet 1228 lbs			\$ -16.27

Rotation 9: Winter Wheat-a / Winter Wheat-b / Safflower / Hairy Vetch:

The winter wheat grown after the legume-fallow (winter wheat-a) has averaged 43.2 Bu/A over a ten-year period. The second winter wheat crop (winter wheat-b) has averaged 35.2 Bu/A in the same time frame (1999-2008). Safflower in this rotation has the highest yield in the study with a ten-year average of 990 Lb/A. This rotation saw changes in 2005 with the addition of Hairy Vetch to replace pea green fallow. Hairy vetch produces more biomass, is more vegetative and the stubble tends to cling to the ground better than the pea stubble. The better ground cover of the hairy vetch provides better snow catch which will benefit the following winter wheat crop. The hairy vetch is planted into the safflower stalks in late September. The hairy vetch seems to establish very well in the fall and winter hardiness is good. This allows the crop to initiate growth sooner in the spring, and give the ground plenty of cover until the wheat is planted in the fall. Olympus was sprayed on both wheat crops in April of 2008. This was done to suppress downy brome/Japanese Chess. Although Olympus has some winter annual activity, it was necessary to spray for weed control using Starane NXT (27 oz/A) + Penetrate II on both wheat crops in May of 2008. This rotation had a net return of \$89.97 / acre in 2008.

Rotation 10: Winter Wheat / Proso Millet / Chickpea:

This is a well diversified rotation and historically, this rotation has produced some of the best recrop winter wheat yields in the entire study. On the long term, winter wheat in this rotation has averaged 41.2 Bu/A over the last ten years (1999-2008). The eight-year average (2001-2008) yield for the chickpea crop is 639 Lbs/A. Millet yields after the pea crop have been consistently good with a ten-year average of 1293 Lbs/A. Yields in 2008 included: winter wheat – 29.9 bu / acre, proso millet – 764 lbs / acre, and chickpeas – 0 lbs / acre.

This rotation was changed to Winter Wheat / Proso Millet / Chickpea in 2007. This was done to compare the performance of winter wheat after legume crops. Various legume crops are being evaluated in the rotation study. They include: dry peas in Rotation 6a, hairy vetch in Rotation 9a, and chickpeas in Rotation 10.

This is a high risk and potentially high rate of return rotation depending on how the chickpea crop performs. Chickpea is an expensive crop to grow due to the high cost of seed. However, if the crop yields well, the returns are good. It should be noted that three years between chickpea crops is too close because of ascochyta disease concerns. The recommended interval between chickpea crops should be at least four years. We learned about ascochyta first hand in 2008 with a heavy flare up of disease. Having test plots in close proximity made it very easy for the disease to transfer from one plot to the next. That coupled with switching the rotation sequence in 2007 brought on a heavy weed pressure problem that totally destroyed the economics of this rotation. We are planning to replace the chickpeas with dry peas in 2009. The new rotation will be; Rotation 10a: Winter Wheat / Proso Millet / Dry Peas. This rotation had a net loss of \$ - 101.81 per acre in 2008.

Rotation 11: Winter Wheat / Corn / Proso Millet:

This is an intensive but well balanced continuous crop rotation. Inclusion of glyphosate tolerant corn in the rotation allows us to manage weeds much better. The injection of fertilizer in the fall allows us to plant corn into a tilled strip that is 2 to 4 degrees warmer than the non-tilled area between the rows. The winter wheat has averaged 43.0 Bu/A over the last ten years (1999-2008) and yielded 54.8 Bu/A in 2008 (Table 68). Corn plant populations were reduced to 14,200 seeds/acre in 2004 and 2005 in an effort to reduce seed costs and to optimize plant competition for soil moisture. In 2006, 07, and 08, corn population was further reduced to 12,500 seeds/acre. The ten-year average yield for corn is 50.2 Bu/A and this includes 2002 and 2006 that were total crop failures. Proso millet yields have averaged 1159 Lbs/A over the last ten years (1999-08). In 2008; wheat yields were good at 54.8 bushels per acre. Corn yields were poor (29.7 bu/a) due to cool growing conditions at germination time and wireworms. Proso Millet yields were decent at 1228 pounds per acre. This rotation had a net loss of \$ - 16.27 per acre in 2008.

Table 70. Long-Term Yield Trends at The Wall Rotation Study (1999-2008).

Rotation & Crop	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Ave Yield (Bu/A) or (Lb/A) (1999-08)
Rotation 1											
Winter Wheat	70.9	58.3	38.6	28.6	77.1	17.7	60.0	31.0	52.2	56.2	49.1 bu
Fallow	0	0	0	0	0	0	0	0	0	0	0
Rotation 2a											
Winter Wheat-a	67.1	66.9	51.1	30.9	72.8	34.3	70.0	49.8	60.4	69.3	57.3 bu
Sunflower	2091	2602	2082	400	584	1093	860	1030	382	1690	1281 lb
Millet	1500	1300	2000	326	0	449	1405	300	Hay millet 1.57T	Hay millet 2.5 T	2.04 Tons (2007-08)
Winter Wheat-b	62.8	46.0	40.2	10.7	46.3	27.1	50.0	38.1	43.7	47.6	41.2 bu
Corn	107.6	65.8	97.5	0	0	70.3	55.0	0	30.0	33.0	45.9 bu
Fallow	0	0	0	0	0	0	0	0	0	0	0
Rotation 3											
Winter Wheat	57.2	45.4	38.1	9.8	47.8	24.2	50.0	40.3	43.3	51.0	41.2 bu
Safflower	976	1391	1575	360	614	957	685	489	375	1483	891 lb
Millet	1500	1266	2000	783	0	867	1906	400	1307	1224	1125 lb
Rotation 4											
Winter Wheat	47.2	32.6	33.7	14.7	57.4	28.9	35.0	37.8	39.2	36.8	36.4 bu
Millet	1500	1370	1800	1182	1500	1888	1848	1000	1241	949	1428 lb
Rotation 5a											
Winter Wheat	36.5	47.6	33.1	3.4	34.9	34.1	49.7	37.0	37.6	45.9	36.0 bu
Corn	100.9	50.2	101.6	0	0	54.9	50.0	0	30.0	33.0	42.6 bu
Sunflower	2010	1958	1443	250	722	455	680	N/A	63	1494	958 lb
S Wheat (1999-04) to Barley (2005-08)	36.3	31.8	28.4	1.6	26.2	0	41.6	15.8	37	73.7	42.0 Bu (4 yrs)
Rotation 6a											
Winter Wheat-a	63.9	60.8	48.0	10.8	35.9	34.5	55.6	25.5	45.6	43.6	42.4 bu
Winter Wheat-b	34.1	48.9	33.0	5.2	35.4	24.7	52.5	26.5	35.5	50.0	34.6 bu
Sunflower (1999-04) to Safflower(05-08)	2210	2468	2011	200	1132	818	651 saff	548 saff	278 saff	1650 saff	782 lb Saff (4 yrs)
Pea Fallow (1999-04) to Field Pea (05-08)	0-pf	0-pf	0-pf	0-pf	0-pf	0-pf	1405 fp	1308 fp	1170 fp	2004 fp	1472 lb
Rotation 9a											
Winter Wheat-a	68.3	57.1	50.0	9.2	44.0	0	64.8	34.4	44.7	59.2	43.2 bu
Winter Wheat-b	29.8	43.0	38.2	4.9	31.7	27.5	56.8	35.2	36.4	48.5	35.2 bu
Safflower	1277	1546	1624	230	1106	617	885	516	539	1559	990 lb
Pea Fallow (1999-04) to H. Vetch (2005-08)	0-pf	0-pf	0-pf	0-pf	0-pf	0-pf	0 - hv	0-hv	0-hv	0-hv	0-hv
Rotation 10											
Winter Wheat	65.1	48.9	40.8	13.1	58.7	22.5	45.0	33.5	45.8	29.9	41.2 bu
Chickpea(1999-06) to millet (2007-08)			1585	95	667	976	292	800			639 Lb (8 yrs)
Millet(1999-06) to Chickpea (2007-08)	1500	1524	2000	622	925	1197	2000	900	1420	764	1092 lb (2 yrs)
									700	0	1293 lbs
											350 lbs (2 yrs)
Rotation 11											
Winter Wheat	54.2	37.8	42.2	13.5	59.4	28.2	53.0	41.7	45.0	54.8	43.0 bu
Corn	99.2	60.2	106.4	0	39.7	76.6	55.0	0	35	29.7	50.2 bu
Millet	1500	1300	2000	829	0	1017	1634	600	1483	1228	1159 lb
Rainfall(Apr-Aug)	13.44 "	8.20 "	12.29 "	5.59 "	5.24 "	9.20 "	10.89"	5.72"	9.08"	14.57"	

N / A = Sunflowers were destroyed by deer when heads were 2" in diameter.

Table 71. Estimated Yield Goals of The Wall Rotation Study (1999-2008).

Crop	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rotation 1											
Winter Wheat	60	60	60	60	60	60	60	55	55	55	55 bu
Fallow	0	0	0	0	0	0	0	0	0	0	0
Rotation 2a											
Winter Wheat-a	60	60	60	60	60	60	60	60	60	60	60 bu
Sunflower	2000	2000	2000	2000	2000	2000	2000	1600	1600	1600	1600 lb
Millet (hay millet '07up)	2000	2000	2000	2000	2000	2000	1500	1200	2	2	2
									tons/a	tons/a	tons/a
Winter Wheat-b	45	45	45	45	45	45	45	45	45	45	45 bu
Corn	80	80	80	80	80	80	80	80	80	80	80 bu
Fallow	0	0	0	0	0	0	0	0	0	0	0
Rotation 3											
Winter Wheat	45	45	45	45	45	45	45	45	45	45	45 bu
Safflower	1500	1500	2000	2000	2000	1500	1200	1200	1200	1200	1200 lb
Millet	2000	2000	2000	2000	2000	2000	1500	1500	1500	1500	1500 lb
Rotation 4											
Winter Wheat	45	45	45	45	45	45	40	35	35	35	35 bu
Millet	2000	2000	2000	2000	2000	2000	2000	1500	1500	1500	1500 lb
Rotation 5a											
Winter Wheat	45	45	45	45	45	45	40	40	40	40	40 bu
Corn	80	80	80	80	80	80	70	80	80	80	80 bu
Sunflower	2000	2000	2000	2000	2000	2000	1500	1300	1300	1300	1300 lb
Spring Barley	n/a	n/a	n/a	n/a	n/a	n/a	50	60	60	60	60 bu
Rotation 6a											
Winter Wheat-a	60	60	60	60	60	60	60	45	45	45	45 bu
Winter Wheat-b	45	45	45	45	45	45	45	45	45	45	45 bu
Safflower	n/a	n/a	n/a	n/a	n/a	n/a	1500	1200	1200	1200	1200 lb
Dry Peas	n/a	n/a	n/a	n/a	n/a	n/a	1800	1800	1800	1800	1800 lb
Rotation 9a											
Winter Wheat-a	60	60	60	60	60	60	60	45	45	45	45 bu
Winter Wheat-b	45	45	45	45	45	45	45	45	45	45	45 bu
Safflower	1500	1500	2000	2000	2000	1500	1500	1200	1200	1200	1200 lb
Hairy Vetch	n/a	n/a	n/a	n/a	n/a	n/a	--	--	--	--	--
Rotation 10											
Winter Wheat	45	45	45	45	45	45	45	45	45	45	45 bu
Chickpea (1999-2006)	n/a	n/a	n/a	1500	1500	1500	1500	1500			
Millet (2007-09)									1500	1500	1500 lb
Millet (1999-2006)	2000	2000	2000	2000	2000	2000	2000	1500			
Chickpea (2007-08)									1500	1500	
Dry pea (2009)											1800 lb
Rotation 11											
Winter Wheat	45	45	45	45	45	45	45	45	45	45	45 bu
Corn	80	80	80	80	80	80	80	80	80	80	80 bu
Millet	2000	2000	2000	2000	2000	2000	1500	1500	1500	1500	1500 lb
Rainfall (Apr-Aug)	13.44 "	8.20 "	12.29 "	5.59 "	5.24 "	9.20 "	10.89"	5.72"	9.08"	14.57"	--

Table 72. Long-Term Economic Trends of The Wall Rotation Study (1999-2008)
(Net Income - \$ per Acre)

Rot	Crop	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Ave Net Return (\$) (1999-2008)
1	W. Wht	\$90.54	\$70.94	\$10.04	\$25.01	\$116.40	\$-30.23	\$46.30	\$21.88	\$236.39	\$215.13	80.24
	Fallow	-59.62	-61.35	-57.03	-72.57	-66.64	-56.29	-73.72	-59.50	-86.26	-118.19	-71.11
	<i>Ave Inc.</i>	15.46	\$4.79	-23.49	-23.78	24.88	-43.26	-13.71	-18.81	75.06	48.47	4.56
2a	W. Wht-a	82.99	95.54	40.94	42.76	107.49	21.04	96.03	102.54	309.85	285.42	118.46
	Sunflower	40.45	84.65	39.43	-109.29	-92.02	3.19	-80.10	-29.44	-113.89	69.54	-18.74
	Millet	-27.28	4.37	-19.28	-57.29	-77.58	-73.57	-22.11	-76.21	-9.97	41.70	-31.72
	W Wht-b	24.74	19.17	9.61	-69.50	39.15	-19.59	21.67	21.64	170.92	82.39	30.02
	Corn	36.30	-25.08	56.84	-160.22	-125.56	-14.84	-51.30	-133.25	-68.70	-88.64	-57.44
	Fallow	-47.40	-52.47	-62.28	-58.69	-52.82	-44.25	-63.08	-49.25	-86.26	-95.10	-61.16
<i>Ave Inc.</i>	18.30	21.03	10.87	-68.70	-33.55	-21.33	-16.48	-27.32	33.65	49.21	-3.43	
3	W. Wht	20.18	14.85	4.42	-72.08	34.93	-34.58	3.41	31.09	157.74	82.57	24.25
	Safflower	-23.86	17.92	51.48	-84.25	-46.52	23.70	-33.35	-57.25	-72.94	238.61	1.35
	Millet	-27.28	11.01	-19.28	-1.81	-77.58	-45.38	7.12	-56.00	-5.90	-61.65	-27.67
	<i>Ave Inc.</i>	-10.32	14.59	12.20	-52.71	-29.72	-18.75	-7.60	-27.38	26.30	86.51	-0.69
4	W Wht	4.41	-9.30	-11.92	-58.02	57.89	-15.32	-41.08	40.01	114.40	20.46	10.15
	Millet	-28.73	9.27	-35.90	49.06	-48.44	0.25	3.96	-30.94	-11.50	-110.45	-20.34
	<i>Ave Inc.</i>	-12.16	-.01	-23.91	-4.48	4.72	-7.53	-18.56	4.53	51.45	-44.99	-5.09
5a	W Wht								41.07	143.54	51.14	78.58
	Corn								-133.25	-68.70	-103.45	-101.80
	Sunflower								-80.50	-150.76	49.36	-60.63
	S. Barley								-77.88	-16.10	110.31	5.44
	<i>Ave Inc.</i>								-62.64	-23.00	26.84	-19.60
6a	W Wht-a								21.44	194.41	83.14	99.66
	W Wht-b								-8.47	93.98	69.06	51.52
	Safflower								-48.60	-93.95	287.37	48.27
	Dry Pea								-20.98	15.15	51.52	15.23
	<i>Ave Inc.</i>								-14.15	52.39	122.77	53.67
9a	W Wht-a								-40.74	99.03	59.55	39.28
	W Wht-b								3.01	96.68	39.25	46.31
	Safflower								-53.29	-37.39	261.11	56.81
	H. Vetch*								00.00*	00.00*	00.00*	00.00*
	<i>Ave Inc.</i>								-22.75	39.58	89.97	35.60
10	WWht(07-08)									174.58	-15.21	79.68
	Mil(07-08)									-19.53	-118.60	-69.06 (2 yrs)
	CP(07-08)									-22.84	-171.63	-97.23 (2 yrs)
	<i>Ave Inc.</i>									44.07	-101.81	-28.87
11	W. Wht	23.06	-1.29	16.24	-61.47	65.64	-15.14	7.31	37.08	179.68	101.19	35.23
	Corn	15.42	-34.38	73.76	-160.22	-62.72	-3.44	-51.30	-133.25	-53.00	-99.96	-50.90
	Millet	-27.85	13.60	-19.28	16.85	-87.98	-35.30	-9.53	-52.99	8.40	-50.06	-24.41
	<i>Ave Inc.</i>	3.54	-7.35	23.57	-68.28	-28.35	-17.96	-17.84	-49.72	45.02	-16.27	-13.36

Note: No Federal Government farm payments are calculated into these values.

(*) Expense of hairy vetch is prorated 80% to W Wht-a and 20% to W Wht-b.

Appendix 1 Detailed Cultural Practices for Each Rotation in 2008

Rotation 1

WINTER WHEAT / SUMMER FALLOW

Cost / A.	2008 Winter Wheat
\$30.33	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 610 drill at 10" rows + 6 gal / A liquid 10-34-0. on September 21, 2007.
18.20	-Top dress 28-0-0 liquid Nitrogen fertilizer on dormant winter wheat at 20 lb N / Acre rate (6.7 gal/Acre). – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
30.78	-Harvest 56.2 bu/A winter wheat – July 29, 2008 Test weight – 63.4 lb / bu (Protein Content – 11.9 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
<hr/>	
\$146.79	Total Cost of Winter Wheat Production

Rotation 1

WINTER WHEAT / SUMMER FALLOW

Cost / A.	2008 Summer Fallow
\$14.81	-Spray w / 19 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate + 12 oz LV6 / acre.10 gpA rate. – August 6, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate. 8 gpA –September 27, 2007.
14.02	-Spray w / 16 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate + 4 oz Banvel 4L. 8 gpA – May 20, 2008.
16.10	-Spray w / 16 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate + 8 oz Banvel 4L. 8 gpA – June 19, 2008.
7.50	-Work w / 24" sweeps. – June 24, 2008.
7.50	-Work w / 12" sweeps. – August 5, 2008.
46.00	-Land Charges 2008
<hr/>	
\$118.19	Cost of Summer Fallow

Rotation 1 SUMMARY 2008

Crop	Income	Expenses	Net Income Per Acre
Winter Wheat	\$361.92	- \$146.79	= \$ 215.13
Fallow	\$ 0.00	- \$118.19	= \$ -118.19
	\$361.92	- \$264.98	= \$ 96.94 / 2 = \$48.47

\$ 48.47 Average Income / acre for Rotation 1 - 2008

Rotation 2a

WINTER WHEAT-A / SUNFLOWER / HAY MILLET / WINTER WHEAT-B / CORN / FALLOW

Cost / A.	2008 Winter Wheat-A
\$ 30.33	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 610 drill at 10" rows + 6 gal / A liquid 10-34-0. on September 21, 2007.
28.10	-Top dress 28-0-0 liquid Nitrogen fertilizer on dormant winter wheat at 35 lb N / Acre rate (11.7 gal/Acre). – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
34.96	-Harvest 69.3 bu/A winter wheat – July 29, 2008 Test weight – 63.4 lb / bu (Protein content – 11.9 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
<hr/>	
\$160.87	Total Cost of Winter Wheat Production

Rotation 2a

WINTER WHEAT-A / SUNFLOWER / HAY MILLET / WINTER WHEAT -B / CORN / FALLOW

Cost / A.	2008 Sunflowers
\$12.26	-Spray w / 16 oz Roundup Original Max + liq Ammonium Sulfate @ 50 ml / gal. 8 gpA spray rate. – September 27, 2007.
71.34	-Inject 28-0-0 + 10-34-0 (80 lb N / 30 lb P2O5) with injector implement set @ 20" row spacing. – October 24, 2007.
17.72	-Spray w / 16 oz Roundup Original Max + liquid ammonium Sulfate @ 50 ml / gal + 4 oz / acre Spartan75 df. 10 gpA spray rate. – May 14, 2008.
27.85	-Plant to Pannar 8560 NS/CL @ 16,600 seeds / acre w / JD 7100 planter. Note: Seed was treated w / Cruiser for wire worm control. – June 11, 2008.
21.63	-Spray with 4 oz / acre Beyond 1L + Penetrate II @ 32 oz / acre + 28-0-0 @ 16 oz / acre rate. 10 gpA spray rate. - July 10, 2008.
37.36	-Harvest 1690 lb / Acre Sunflowers – October 27, 2008. Test weight – 29.0 lb / bushel
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
<hr/>	
\$234.66	Total Cost of Sunflower Production

Rotation 2a

WINTER WHEAT-A / SUNFLOWER / HAY MILLET / WINTER WHEAT-B / CORN / FALLOW

Cost / A.	2008 Hay Millet
\$12.26	-Spray w / 16 oz Roundup Original Max + 50 ml / gal Liquid Ammonium Sulfate. 8gpA spray rate. – May 20, 2008.
30.62	-Planted to Golden German Hay millet w / JD750 drill. w/ starter fertilizer(10-34-0) at 6 gal / Acre. Row spacing was at 10". Seeding rate was at 12 lb/A. – June 9, 2008.
43.92	-Swathe & bale 2.5 Tons / Acre Hay Millet @ 13.5% Moisture – August 28, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
<hr/>	
\$133.30	Total Cost of Hay Millet Production

Hay Millet Quality and Yield - 2008.

NDF %	ADF %	RFV	Crude Protein %	Yield (Tons/A)
65.0	35.0	89	6.8	2.5

Rotation 2a

WINTER WHEAT-A / SUNFLOWER / HAY MILLET / WINTER WHEAT-B / CORN / FALLOW

Cost / A.	2008 Winter Wheat -B
\$32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
64.40	-Top dressed with 28-0-0 @ 90 lb N / acre. – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
28.02	-Harvest 47.6 bu/A winter wheat – July 29, 2008 Test weight – 61.6 lb / bu (Protein content - 9.6 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
<hr/>	
\$192.73	Total Cost of Winter Wheat-B Production

Rotation 2a

WINTER WHEAT-A / SUNFLOWER / HAY MILLET / WINTER WHEAT-B / CORN / FALLOW

Cost / A.	2008 Corn
\$12.26	-Spray w / 16 oz Roundup Original Max + liquid Ammonium Sulfate at 50 ml/gal. 8 gpA spray rate. – September 27, 2007.
71.34	-Injected 28-0-0 + 10-34-0 (80 lbN/acre plus 30 lb P2O5 per acre). 20 inch row spacing. –October 24, 2007.
32.65	-Plant to Econo Brand Dekalb RR/YG 90 day @ 12,500 seeds / acre. Planted w / JD 7100 Corn planter. 20 inch row spacing. - April 29, 2008.
14.02	- Spray w / 16 oz Roundup Ultra Max + Liquid Ammonium Sulfate + 4 oz Banvel 4L. 8 gpA spray rate. – May 20, 2008.
12.26	- Spray w / 16 oz Roundup Ultra Max + Liquid Ammonium Sulfate. 8 gpA spray rate. – June 19, 2008.
23.36	-Harvest 33.0 bushels / acre corn – October 6, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
<hr/>	
\$212.39	-Total Cost of Corn Production

Rotation 2a

WINTER WHEAT-A / SUNFLOWER / HAY MILLET / WINTER WHEAT-B / CORN / FALLOW

Cost / A.	2008 Summer Fallow
\$14.02	-Spray w / 16 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate + 4 oz Banvel 4L. 8 gpA – May 20, 2008.
16.10	-Spray w / 16 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate + 8 oz Banvel 4L. 8 gpA – June 19, 2008.
18.98	-Spray w / 32 oz Roundup Original Max + 50 ml/gal Liquid Ammonium Sulfate. 8 gpA – July 11, 2008.
46.00	-Land Charges 2008
<hr/>	
\$95.10	Cost of Summer Fallow

Rotation 2a SUMMARY 2008

Crop	Income	Expenses	Net Income Per Acre
Winter Wheat-A	\$ 446.29	- \$ 236.95 (\$160.87 + \$76.08)	= \$ 209.34
Sunflower	\$ 304.20	- \$ 253.68 (\$234.66 + \$19.02)	= \$ 50.52
Hay Millet	\$ 175.00	- \$ 133.30	= \$ 41.70
Winter Wheat-B	\$ 275.12	- \$ 192.73	= \$ 82.39
Corn	\$ 123.75	- \$ 212.39	= \$ -88.64
Fallow	\$ 0.00	- \$ 0.00*	= \$ *
	\$1324.36	- \$1029.05	= \$ 295.31 / 6 = \$49.21

*The expense of the fallow (\$95.10) was split 80% to the Winter Wheat-A (\$76.08) and 20% to the Sunflowers (\$19.02).

\$ 49.21 Average Income / acre for Rotation 2a – 2008

Rotation 3

WINTER WHEAT / SAFFLOWER / MILLET

Cost / A.

2008 Winter Wheat

\$12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
64.40	-Top dressed with 28-0-0 @ 90 lb N / acre. – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
29.12	-Harvest 51.0 bu/A winter wheat – July 29, 2008 Test weight – 62.3 lb / bu (Protein content – 9.2 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008

\$206.09 Total Cost of Winter Wheat Production

Rotation 3

WINTER WHEAT / SAFFLOWER / MILLET

Cost / A.

2008 Safflower

\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
58.14	-Injected 28-0-0 plus +10-34-0 (60 lb N/acre + 30 lb P2O5 / acre) - October 24, 2007.
26.26	-Spray w / 16 oz Roundup Original Max + liquid ammonium sulfate @ 18 ml / gal + 3 ½ pints Prowl H2O. 8 gpA spray rate. – April 18, 2008.
21.70	-Plant to Finch w / JD 7100 planter @ 210,000 seeds/acre rate. (20 lbs/acre). – April 29, 2008.
24.64	-Harvest 1482 lb / Acre Safflowers – September 10, 2008. Test weight – 44.8 lb / bushel
.50	-Soil Sampling / acre
46.00	-Land Charges 2008

\$205.99 Total Cost of Safflower Production

Rotation 3
WINTER WHEAT / SAFFLOWER / MILLET

Cost / A.	2008 Millet
\$11.39	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon. 8 gpA spray rate. –September 27, 2007.
14.02	-Sprayed w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate + 4 oz/A Banvel 4L . 8 gpA spray rate. – May 20, 2008.
30.32	-Planted to Sunup Proso millet w / JD750 drill. w/ starter fertilizer(10-34-0) at 6 gal / Acre. Row spacing was at 10". Seeding rate was at 18 lb/A. – June 9, 2008.
20.60	-Harvest 1224 lb / acre Test weight- 55.3 lbs/bushel – September 9, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$135.09	Total Cost of Millet Production

Rotation 3 SUMMARY 2008

Crop	Income	Expenses	Net Income Per Acre
Winter Wheat	\$288.66	- \$206.09	= \$ 82.57
Safflower	\$444.60	- \$205.99	= \$ 238.61
Millet	\$ 73.44	- \$135.09	= \$ - 61.65
	\$806.70	- \$547.17	= \$ 259.53 / 3 = \$ 86.51

\$ 86.51 Average Income / acre for Rotation 3 – 2008

Rotation 4
WINTER WHEAT / MILLET

Cost / A.	2008 Winter Wheat
\$13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
44.60	-Top dressed with 28-0-0 @ 60 lb N / acre (20 gpA). – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
24.56	-Harvest 36.8 bu/A winter wheat – July 29, 2008 Test weight – 61.1 lb / bu (Protein content - 8.9 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$183.41	Total Cost of Winter Wheat Production

Rotation 4
WINTER WHEAT / MILLET

Cost / A.	2008 Millet
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon. 8 gpA spray rate. –September 27, 2007.
18.20	-Top dressed with 28-0-0 @ 20 lb N / acre (6.7 gpA). – March 11, 2008.
14.02	-Sprayed w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate + 4 oz/A Banvel 4L . 8 gpA spray rate. – May 20, 2008.
30.32	-Planted to Sunup Proso millet w / JD750 drill. w/ starter fertilizer(10-34-0) at 6 gal / Acre. Row spacing was at 10". Seeding rate was at 18 lb/A. – June 9, 2008.
12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon. 8 gpA spray rate. –June 11, 2008.
19.02	-Harvest 949 lb / acre Test weight- 56.2 lbs/bushel – September 9, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$167.39	Total Cost of Millet Production

Rotation 4 SUMMARY 2008

Crop	Income	-	Expenses	=	Net Income Per Acre
Winter Wheat	\$203.87	-	\$183.41	=	\$ 20.46
Millet	\$ 56.94	-	\$167.39	=	\$ - 110.45
	\$260.81	-	\$350.80	=	\$ - 89.99 / 2 = \$ - 44.99

\$ - 44.99 Average Income / acre for Rotation 4 – 2008

Rotation 5a
WINTER WHEAT / CORN / SUNFLOWER / SPRING BARLEY

Cost / A.	2008 Winter Wheat
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
44.60	-Top dressed with 28-0-0 @ 60 lb N / acre (20 gpA). – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
26.88	-Harvest 44.0 bu/A winter wheat – July 29, 2008 Test weight – 60.8 lb / bu (Protein content - 9.5 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$200.54	Total Cost of Winter Wheat Production

Rotation 5a
WINTER WHEAT / CORN / SUNFLOWER / SPRING BARLEY

Cost/A.	2008 Corn
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 29, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + liquid Ammonium Sulfate at 50 ml/gal. 8 gpA spray rate. – September 27, 2007.
71.34	-Injected 28-0-0 + 10-34-0 (80 lb N/acre plus 30 lb P2O5 per acre). 20 inch row spacing. –October 24, 2007.
32.65	-Plant to Econo Brand Dekalb RR/YG 90 day @ 12,500 seeds / acre. Planted w / JD 7100 Corn planter. 20 inch row spacing. - April 29, 2008.
14.02	- Spray w / 16 oz Roundup Ultra Max + Liquid Ammonium Sulfate + 4 oz Banvel 4L. 8 gpA spray rate. – May 20, 2008.
12.26	- Spray w / 16 oz Roundup Ultra Max + Liquid Ammonium Sulfate. 8 gpA spray rate. – June 19, 2008.
23.36	-Harvest 33.0 bushels / acre corn – October 6, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$227.20	Total Cost of Corn Production

Rotation 5a
WINTER WHEAT / CORN / SUNFLOWER / SPRING BARLEY

Cost / A.	2008 Sunflower
\$71.34	-Inject 28-0-0 + 10-34-0 (80 lb N / 30 lb P2O5) with injector implement set @ 20" row spacing. – October 24, 2007.
17.72	-Spray w / 16 oz Roundup Original Max + liquid ammonium Sulfate @ 50 ml / gal + 4 oz / acre Spartan75 df. 10 gpA spray rate. – May 14, 2008.
27.85	-Plant to Pannar 8560 NS/CL @ 16,600 seeds / acre w / JD 7100 planter. Note: Seed was treated w / Cruiser for wire worm control. – June 11, 2008.
21.63	-Spray with 4 oz / acre Beyond 1L + Penetrate II @ 32 oz / acre + 28-0-0 @ 16 oz / acre rate. 10 gpA spray rate. - July 10, 2008.
34.52	-Harvest 1494 lb / Acre Sunflowers – October 27, 2008. Test weight – 28.6 lb / bushel
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$219.56	Total Cost of Sunflower Production

Rotation 5a
WINTER WHEAT / CORN / SUNFLOWER / SPRING BARLEY

Cost / A.	2008 Spring Barley
\$44.60	-Top dressed with 28-0-0 @ 60 lb N / acre (20 gpA). – March 11, 2008.
30.17	-Plant to Eslick Barley @ 69.7 lb or 1,219,680 seeds (1.45 bushels) / acre rate. Seeded w / JD 750 drill. Starter fertilizer 10-34-0 was applied at 6 gallons per acre rate. – March 25, 2008.
12.26	-Spray w / 16 oz Roundup Original Max + liquid Ammonium Sulfate at 50 ml/gal. 8 gpA spray rate. – April 2, 2008.
20.98	-Spray barley with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
29.98	-Harvest 73.7 bu/A Barley – July 29, 2008 Test weight –51.8 lb / bu (Protein content - 11.4 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$184.49	Total Cost of Spring Barley Production

Rotation 5a SUMMARY 2008

Crop	Income	Expenses	Net Income Per Acre
Winter Wheat	\$251.68	- \$200.54	= \$ 51.14
Corn	\$123.75	- \$227.20	= \$ -103.45
Sunflower	\$268.92	- \$219.56	= \$ 49.36
Spring Barley	\$294.80	- \$184.49	= \$ 110.31
	\$939.15	- \$831.79	= \$ 107.36 / 4 = \$26.84

\$ 26.84 Average Income / acre for Rotation 5a - 2008

Rotation 6a

WINTER WHEAT-B / SAFFLOWER / FIELD PEA / WINTER WHEAT-A

Cost / A.	2008 Winter Wheat – B
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
64.40	-Top dressed with 28-0-0 @ 90 lb N / acre (30 gpA). – March 11, 2008.
15.68	-Spray wheat with Olympus @ .9 oz / acre rate Plus Penetrate II @ 18 ml / gallon. 10 gpA spray rate. – April 18, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
28.80	-Harvest 50.0 bu/A winter wheat – July 29, 2008 Test weight – 62.2 lb / bu (Protein content - 10.8 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$237.94	Total Cost of Winter Wheat –B Production

Rotation 6a

WINTER WHEAT-B / SAFFLOWER / FIELD PEA / WINTER WHEAT-A

Cost / A.	2008 Safflower
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
58.14	-Injected 28-0-0 plus +10-34-0 (60 lb N/acre + 30 lb P2O5 / acre) - October 24, 2007.
26.26	-Spray w / 16 oz Roundup Original Max + liquid ammonium sulfate @ 50 ml / gal + 3 ½ pints Prowl H2O. 8 gpA spray rate. – April 18, 2008.
21.70	-Plant to Finch w / JD 7100 planter @ 210,000 seeds/acre rate. (20 lbs/acre). – April 29, 2008.
25.98	-Harvest 1649 lb / Acre Safflowers – September 10, 2008. Test weight – 44.6 lb / bushel
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$207.33	Total Cost of Safflower Production

Rotation 6a

WINTER WHEAT-B / SAFFLOWER / FIELD PEA / WINTER WHEAT-A

Cost / A.	2008 Field Pea
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 29, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 27, 2007.
34.61	-Plant to Grande peas @ 300,000 seeds per acre (138.2 lbs/A) (2170 seeds/lb)+ 8 lb / acre granular innoculum w / JD 750 drill. No starter fertilizer added. – March 25, 2008.
17.72	-Spray w / 16 oz / acre Roundup Original Max + 50 ml / gal liquid Ammonium Sulfate + Spartan @ 4 ounces per acre. 10 gpA spray rate. – April 2, 2008.
23.48	-Harvest 2004 lb or 33.4 bushels / Acre Grande peas – July 29, 2008. Test weight – 65.0 lb / bushel
46.00	-Land Charges 2008
\$148.88	Total Cost of Field Pea Production

Rotation 6a

WINTER WHEAT-B / SAFFLOWER / FIELD PEA / WINTER WHEAT-A

Cost / A.	2008 Winter Wheat – A
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
15.68	-Spray wheat with Olympus @ .9 oz / acre rate Plus Penetrate II @ 18 ml / gallon. 10 gpA spray rate. – April 18, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
26.74	-Harvest 43.6 bu/A winter wheat – July 29, 2008 Test weight – 62.6 lb / bu (Protein content - 9.9 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
\$171.48	Total Cost of Winter Wheat-A Production

Rotation 6a SUMMARY 2008

Crop	Income	Expenses	Net Income Per Acre
Winter Wheat - B	\$ 307.00	- \$ 237.94	= \$ 69.06
Safflower	\$ 494.70	- \$ 207.33	= \$ 287.37
Field pea	\$ 200.40	- \$ 148.88	= \$ 51.52
Winter Wheat - A	\$ 254.62	- \$ 171.48	= \$ 83.14
	\$ 1256.72	- \$ 765.63	= \$ 491.09 / 4 = \$122.77

\$ 122.77 Average Income / acre for Rotation 6a - 2008

Rotation 7

The plots from rotation #7 (WW-Corn-Fallow) were combined with rotation #2 (WW-Sunflower-Millet) to make a longer six year rotation (2a) in 1999.

Rotation 8

The plots from rotation #8 were added to rotations 5, 6 and 9 to make longer 4 year rotations in 1998.

Rotation 9a

WINTER WHEAT-B / SAFFLOWER / Hairy Vetch / WINTER WHEAT-A

Cost / A. 2008 Winter Wheat –B

\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
44.60	-Top dressed with 28-0-0 @ 60 lb N / acre (20 gpA). – March 11, 2008.
15.68	-Spray wheat with Olympus @ .9 oz / acre rate Plus Penetrate II @ 18 ml / gallon. 10 gpA spray rate. – April 18, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
28.32	-Harvest 48.5 bu/A winter wheat – July 29, 2008 Test weight – 61.2 lb / bu (Protein content - 10.0 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$217.66	Total Cost of Winter Wheat–B

Rotation 9a

WINTER WHEAT-B / SAFFLOWER / Hairy Vetch / WINTER WHEAT-A

Cost / A. 2008 Safflower

\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
58.14	-Injected 28-0-0 plus +10-34-0 (60 lb N/acre + 30 lb P2O5 / acre) - October 24, 2007.
26.26	-Spray w / 16 oz Roundup Original Max + liquid ammonium sulfate @ 18 ml / gal + 3 ½ pints Prowl H2O. 8 gpA spray rate. – April 18, 2008.
21.70	-Plant to Finch w / JD 7100 planter @ 210,000 seeds/acre rate. (20 lbs/acre). – April 29, 2008.
25.24	-Harvest 1559 lb / Acre Safflowers – September 10, 2008. Test weight – 44.6 lb / bushel
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$206.59	Total Cost of Safflower Production

Rotation 9a

WINTER WHEAT-B / SAFFLOWER / Hairy Vetch / WINTER WHEAT-A

Cost / A.	2008 Hairy Vetch
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 29, 2007.
42.70	-Plant to Hairy Vetch @ (20 lb/A) + 5 lb / acre granular pea/lentil inoculum w / JD 750 drill. – September 25, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 27, 2007.
14.33	-Spray with Assure II @ 8 oz / acre + 9.5 ml / gallon Penetrate II. 10 gpA spray rate. – May 20, 2008
16.10	-Spray to terminate hairy vetch w / 16 oz Roundup Original Max + 50 ml / gal liquid ammonium sulfate + 8 oz / A Banvel 4L. 8 gpA spray rate. – June 19, 2008.
<u>46.00</u>	-Land Charges 2008
\$146.20	Total Cost of Hairy Vetch Production

Rotation 9a

WINTER WHEAT-B / SAFFLOWER / HAIRY VETCH / WINTER WHEAT-A

Cost / A.	2008 Winter Wheat-A
\$13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
18.20	-Top dressed with 28-0-0 @ 20 lb N / acre (6.7 gpA). – March 11, 2008.
15.68	-Spray wheat with Olympus @ .9 oz / acre rate Plus Penetrate II @ 18 ml / gallon. 10 gpA spray rate. – April 18, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
31.74	-Harvest 59.2 bu/A winter wheat – July 29, 2008 Test weight – 62.5 lb / bu (Protein content –10.5 %)
.50	-Soil Sampling / acre
<u>46.00</u>	-Land Charges 2008
\$179.87	Total Cost of Winter Wheat-A Production

Rotation 9a SUMMARY 2008

Crop	Income	Expenses	Net Income Per Acre
Winter Wheat-B	\$ 286.15	- \$246.90 (\$217.66 + \$29.24)	= \$ 39.25
Safflower	\$ 467.70	- \$206.59	= \$ 261.11
Hairy Vetch	\$ 0.00	- \$ 0.00	= \$ 0.00*
Winter Wheat-A	\$ 356.38	- \$296.83 (\$179.87 + \$116.96)	= \$ 59.55
	<u>\$1110.23</u>	<u>- \$750.32</u>	<u>= \$ 359.91 / 4 = \$ 89.97</u>

*The expense of the hairy vetch (\$146.20) was split 80% (\$116.96) to the Winter Wheat-A and 20% (\$29.24) to the Winter Wheat-B.

\$ 89.97 Average Income / acre for Rotation 9a - 2008

Rotation 10
WINTER WHEAT / MILLET / CHICKPEA

Cost / A.	2008 Winter Wheat
\$ 14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 21, 2007.
13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
28.10	-Top dressed with 28-0-0 @ 35 lb N / acre (11.7 gpA). – March 11, 2008.
15.68	-Spray wheat with Olympus @ .9 oz / acre rate Plus Penetrate II @ 18 ml / gallon. 10 gpA spray rate. – April 18, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
22.36	-Harvest 29.9 bu/A winter wheat – July 29, 2008 Test weight – 63.4 lb / bu (Protein content –10.5 %)
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$195.20	Total Cost of Winter Wheat Production

Rotation 10
WINTER WHEAT / MILLET / CHICKPEA

Cost / A.	2008 Millet
\$14.81	-Spray w / 19 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon + 12 oz LV6 / acre. 10 gpA spray rate. – August 6, 2007.
12.26	-Spray w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate @ 50 ml / gallon. 8 gpA spray rate. –September 27, 2007.
28.10	-Top dressed with 28-0-0 @ 35 lb N / acre (11.7 gpA). – March 11, 2008.
14.02	-Sprayed w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate + 4 oz/A Banvel 4L . 8 gpA spray rate. – May 20, 2008.
30.32	-Planted to Sunup Proso millet w / JD750 drill. w/ starter fertilizer(10-34-0) at 6 gal / Acre. Row spacing was at 10". Seeding rate was at 18 lb/A. – June 9, 2008.
18.43	-Harvest 764 lb / acre Test weight- 55.1 lbs/bushel – September 9, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
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\$164.44	Total Cost of Proso Millet Production

Rotation 10
WINTER WHEAT / MILLET / CHICKPEA

2008 Chickpeas	
\$13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8gpA spray rate. – September 14, 2007.
17.72	-Spray w / 16 oz Roundup Original Max + liquid ammonium Sulfate @ 50 ml / gal + 4 oz / acre Spartan75 df. 10 gpA spray rate. – April 2, 2008.
79.09	-Plant to Sierra Chickpeas @ 130,000 seeds per acre (120 lb/A) (1080 seeds / lb) + 3 lb / acre granular inoculums w / JD 750 drill. No starter fertilizer added. – April 15, 2008.
14.88	-Spray w / 16 oz Poast + 24 oz crop oil concentrate / acre. 10 gpA spray rate. – June 23, 2008.
0.00	-Harvest 0 lb or 0.0 bushels / Acre Sierra chickpeas - September 9, 2008. (Heavy ascochyta pressure)
46.00	-Land Charges 2008
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\$171.63	Total Cost of Chickpea Production

Rotation 10 SUMMARY 2008

Crop	Income	-	Expenses	=	Net Income Per Acre
Winter Wheat	\$179.99	-	\$195.20	=	\$ - 15.21
Millet	\$ 45.84	-	\$164.44	=	\$ - 118.60
Chickpea	\$ 0.00	-	\$171.63	=	\$ - 171.63
	\$225.83	-	\$531.27	=	\$ - 305.44 / 3 = \$ - 101.81

\$ - 101.81 Average Income / acre for Rotation 10 - 2008

Rotation 11

WINTER WHEAT / CORN / MILLET

Cost / A.	2008 Winter Wheat
\$13.94	-Spray w / 20 oz Roundup Original Max + Liquid Ammonium Sulfate. 8 gpA spray rate. –September 14, 2007.
32.83	-Plant to Alice @ 73.0 lbs or 950,000 seeds/acre. Planted w / JD 750 drill at 10" rows + 6 gal / A liquid 10-34-0. - September 25, 2007.
64.40	-Top dressed with 28-0-0 @ 90 lb N / acre (30 gpA). – March 11, 2008.
20.98	-Spray wheat with 27 oz / acre Starane NXT + Penetrate II @ 6 oz / acre. 10 gpA spray rate. – May 7, 2008.
30.32	-Harvest 54.8 bu/A winter wheat – July 29, 2008 Test weight – 62.5 lb / bu (Protein content – 9.3 %)
.50	-Soil Sampling / acre
<u>46.00</u>	-Land Charges 2008
\$208.97	Total Cost of Winter Wheat Production

Rotation 11

WINTER WHEAT / CORN / MILLET

Cost / A.	2008 Corn
\$12.26	-Spray w / 16 oz Roundup Original Max + liquid Ammonium Sulfate at 50 ml/gal. 8 gpA spray rate. – September 27, 2007.
71.34	-Injected 28-0-0 + 10-34-0 (80 lb N / acre plus 30 lb P2O5 per acre). 20 inch row spacing. –October 24, 2007.
32.65	-Plant to Econo Brand Dekalb RR/YG 90 day @ 12,500 seeds / acre. Planted w / JD 7100 Corn planter. 20 inch row spacing. - April 29, 2008.
14.02	- Spray w / 16 oz Roundup Ultra Max + Liquid Ammonium Sulfate + 4 oz Banvel 4L. 8 gpA spray rate. – May 20, 2008.
12.26	- Spray w / 16 oz Roundup Ultra Max + Liquid Ammonium Sulfate. 8 gpA spray rate. – June 19, 2008.
22.30	-Harvest 29.7 bushels / acre corn – October 6, 2008.
.50	-Soil Sampling / acre
<u>46.00</u>	-Land Charges 2008
\$211.33	Total Cost of Corn Production

Rotation 11
WINTER WHEAT / CORN / MILLET

Cost / A.	2008 Millet
\$14.02	-Sprayed w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate + 4 oz/A Banvel 4L . 8 gpA spray rate. – May 20, 2008.
30.32	-Planted to Sunup Proso millet w / JD750 drill. w/ starter fertilizer(10-34-0) at 6 gal / Acre. Row spacing was at 10". Seeding rate was at 18 lb/A. – June 9, 2008.
12.26	-Sprayed w / 16 oz Roundup Original Max + Liquid Ammonium Sulfate . 8 gpA spray rate. – June 11, 2008.
20.64	-Harvest 1228 lb / acre Test weight - 55.1 lbs/bushel – September 9, 2008.
.50	-Soil Sampling / acre
46.00	-Land Charges 2008
 \$123.74	 Total Cost of Proso Millet Production

Rotation 11 SUMMARY 2008

Crop	Income	-	Expenses	=	Net Income Per Acre
Winter Wheat	\$310.16	-	\$208.97	=	\$101.19
Corn	\$111.37	-	\$211.33	=	\$- 99.96
Millet	\$ 73.68	-	\$123.74	=	\$- 50.06
	\$495.21	-	\$544.04	=	\$ - 48.83 / 3 = \$ - 16.27

\$ - 16.27 Average Income / acre for Rotation 11 - 2008

COST OF INPUTS – 2008

SEED

Alice Winter Wheat.....	\$ 7.00 / Bu
Eslick Barley.....	\$ 3.00 / Bu
Grande Field Peas.....	\$ 9.00 / Bu
Sierra Kabuli Chickpea.....	\$52.00 / 100 lbs
<i>(Note: the seed is treated w/ LSP / Apron / Maxim)</i>	
Finch Safflower.....	\$23.00 / 50 lbs
Dekalb Econo Brand RR/YG Corn (80,000 kernels).....	\$129.00 / bag
Pannar 8560 NS / CL + Cruiser Sunflower – Size 3 (200,000 seeds).....	\$185.00 / bag
Golden German Hay Millet.....	\$.40 / lb
Sunup Millet.....	\$.25 / lb
Hairy Vetch.....	\$1.50 / lb

HERBICIDES

(From Warne Chemical, Rapid City, SD – Dec, 2007)

Assure II.....	\$142.22 / gal
Beyond 1L.....	\$541 / gal
Bronate (Brox M).....	\$39.58 / gal
Roundup Original Max.....	\$53.60 / gal
Atrazine 90df.....	\$ 2.33 / lb
Harmony GT.....	\$12.90 / oz
Harmony Extra (Affinity TM).....	\$15.20 / oz
Ally.....	\$24.21 / oz
Treflan 10% granules.....	\$ 0.83 / lb
2,4D Ester LV6.....	\$21.32 / gal
Clarity (dicamba).....	\$62.50 / gal
Poast.....	\$69.30 / gal
Spartan 75df.....	\$41.32 / lb (\$2.58 / oz)
Spartan 4F.....	\$386 / gal
Starane.....	\$111.36 / gal
Starane NXT.....	\$72.45/gal
Maverick.....	\$14.80 / oz
Olympus WG.....	\$10.94 / oz
Olympus Flex.....	\$ 3.65 / oz
Aim.....	\$171.42 / quart (\$5.35 / oz)
Cleanwave.....	\$46.20 / gallon
Crop Oil.....	\$ 6.60 / gal
Penetrate II.....	\$18.50 / gal
Ammonium Sulfate.....	\$ 6.06 / gal
Prowl H2O.....	\$32.24 / gal

INSECTICIDES

Lorsban 4E.....	\$37.88 / gallon
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FUNGICIDES

Tilt.....	\$340.00 / gallon
Headline.....	\$292.90 / gallon

FERTILIZER

(Warne Chemical, Rapid City, SD – Sept 2007)

10-34-0.....	\$380.00 / Ton (\$2.22 / gallon)
<i>(Johnson's Ranchers Supply, Wall, SD – March 11, 2008)</i>	
28-0-0.....	\$370.00 / Ton (\$1.97 / gallon) (\$.66/lb N)

SEED TREATMENTS

Granular Inoculum for chickpeas.....	\$55.95 / 40 lb bag
Vitavax/Thiram/RTU.....	\$33.41 / gal
Raxil MDW.....	\$87.80 / gal
Seed treatment fee.....	\$ 0.25 / acre
Field Pea/Vetch inoculum (peat base).....	\$ 0.60 / bu

EQUIPMENT CHARGES

No-till Planting.....	\$12.50 / acre
Conventional Planting.....	\$10.00 / acre
Mechanical Tillage.....	\$ 7.50 / acre
Swathing hay.....	\$10.59 / acre
Baling hay.....	\$10.00 / 1500 lb bale

APPLICATION RATES

Herbicide.....	\$ 5.00 / acre
Top dress Fertilizing.....	\$ 5.00 / acre
Injection Fertilizing.....	\$ 8.00 / acre

HARVEST RATES

Base.....	\$16.00 / acre
Over 20 bu/acre.....	\$ 0.16 / bu
Trucking.....	\$ 0.16 / bu

Soil Sampling & Analysis.....	\$.50 / acre
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LAND CHARGES

\$600 / A x .07=\$42.00 + \$4 land tax=\$46.00/Acre

GRAIN SALE VALUES

(Grain Prices for 2008 crop from Dakota Mill & Grain, Rapid City, SD - December 15, 2008)

Winter Wheat.....	See chart on next page.
Sierra Chickpeas.....	crop failure
Sunflower (oil-type).....	\$ 18.00 / cwt.
Corn #2 yellow.....	\$ 3.75 / bu
Safflower.....	\$ 30.00 / cwt
Proso Millet.....	\$ 6.00 / cwt
Barley.....	\$ 4.00 / bu
Field peas.....	\$ 6.00 / bu *
<i>(*price quote from Howe Seeds, Dec 18, 2008)</i>	

HAY SALE VALUES

Golden German millet hay.....	\$70.00 / ton
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Winter Wheat Value Per Bushel with Protein Adjustment.
(Prices from Dakota Mill and Grain, Rapid City as of December 15, 2008)
(Average sale value for fall of 2008)

Protein Content	Winter Wheat \$ / bu
8.8%	\$5.54
9.0	\$5.60
9.2	\$5.66
9.4	\$5.72
9.6	\$5.78
9.8	\$5.84
10.0	\$5.90
10.2	\$5.96
10.4	\$6.02
10.6	\$6.08
10.8	\$6.14
11.0	\$6.20
11.2	\$6.26
11.4	\$6.32
11.6	\$6.38
11.8	\$6.44
12.0%	\$6.50
12.2	\$6.52
12.4	\$6.54
12.6	\$6.56
12.8	\$6.58
13.0	\$6.60
13.2	\$6.62
13.4	\$6.64
13.6	\$6.66
13.8	\$6.68
14.0	\$6.70
14.2	\$6.72
14.4	\$6.74
14.6	\$6.76
14.8	\$6.78
15.0	\$6.80
15.2	\$6.82
15.4	\$6.84
15.6	\$6.86
15.8	\$6.88
16.0	\$6.90
16.2	\$6.92

Precipitation for September 2003 through August 2008

Wall Rotation Rainfall Data - 2003-04 (inches)

<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>
September 03..	1.22"	January 04...	0.08"	May.....	3.62"
October.....	0.43"	February.....	0.02"	June.....	2.05"
November.....	0.09"	March.....	0.30"	July.....	2.35"
December.....	0.03"	April.....	0.19"	August.....	0.99"

(Accumulative total precipitation from Sept.1, 2003 to Aug. 31, 2004 is 10.79 ")

(Accumulative total precipitation from Apr.1 to Aug. 31, 2004 is 9.20 ")

Wall Rotation Rainfall Data - 2004-05 (inches)

<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>
September 04..	3.48"	January 05...	0.03"	May.....	4.75"
October.....	0.76"	February.....	0.00"	June.....	1.95"
November.....	0.08"	March.....	0.50"	July.....	1.82"
December.....	0.07"	April.....	1.35"	August.....	1.02"

(Accumulative total precipitation from Sept.1, 2004 to Aug. 31, 2005 is 15.81 ")

(Accumulative total precipitation from Apr.1 to Aug. 31, 2005 is 10.89 ")

Wall Rotation Rainfall Data - 2005-06 (inches)

<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>
September 05..	0.39"	January 06...	0.17"	May.....	1.21"
October.....	0.63"	February.....	Missing	June.....	1.08"
November.....	0.24"	March.....	Missing	July.....	0.89"
December.....	0.28"	April.....	1.36"	August.....	1.18"

(Accumulative total precipitation from Sept.1, 2005 to Aug. 31, 2006 is 7.43" + missing data in Feb and Mar.)

(Accumulative total precipitation from Apr.1 to Aug. 31, 2006 is 5.72")

Wall Rotation Rainfall Data - 2006-07 (inches)

<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>
September 06..	2.59"	January 07...	0.02"	May.....	1.81"
October.....	0.31"	February.....	0.29"	June.....	3.23"
November.....	0.29"	March.....	1.51"	July.....	1.56"
December.....	0.02"	April.....	0.56"	August.....	1.92"

(Accumulative total precipitation from Sept.1, 2006 to Aug. 31, 2007 is 14.11")

(Accumulative total precipitation from Apr.1 to Aug. 31, 2007 is 9.08")

Wall Rotation Rainfall Data – 2007-08 (inches)

<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>	<u>Month</u>	<u>Total Precip.</u>
September 07..	1.19 "	January 08...	0.00"	May.....	4.96"
October.....	1.92"	February.....	0.26"	June.....	4.41"
November.....	0.16"	March.....	0.43 "	July.....	3.13"
December.....	0.03"	April.....	1.13"	August.....	0.94"

(Accumulative total precipitation from Sept.1, 2007 to Aug. 31, 2008 is 18.56")

(Accumulative total precipitation from Apr.1 to Aug. 31, 2008 is 14.57")

1971-2000 (30 year average) Total Precipitation from September 1 – August 31 is 17.24"

1971-2000 (30 year average) Total Precipitation from April 1 – August 31 is 11.53"

Wall Rotation Study Soil Analysis - As of December 10, 2008 for the 2009 Season.

Plot No. - Rotation	2009 Crop and estimated yield goal	Soil Texture	Soil pH	Soluble Salts	Organic Matter %	NO3-N lb / acre 0-6" 0- 24"		P ppm	K ppm	Add N lb/A	Add P205 lb/A	Add K2O lb/A	2008 Yield (Bushels, tons, Lbs / acre)
						top	total						
101-1	Fallow	Medium	7.1	0.5	1.3	29	47	14	401	--	--	--	56.2 bu HRW
102-1	HRW-55bu	Medium	6.6	0.4	1.5	54	95	8	436	40	30	0	Fallow
117-2a	HRW-45bu	Medium	6.4	0.3	1.4	9	19	19	511	95	0	0	2.5 T/a Millet Hay
118-2a	Corn-80bu	Medium	6.4	0.3	1.4	15	30	15	494	65	5	0	47.6 bu HRW-b
119-2a	Fallow	Medium	6.8	0.3	1.3	10	22	27	494	--	--	--	33.0 bu Corn
103-2a	HRW-60bu	Medium	6.5	0.4	1.3	34	90	14	399	60	10	0	Fallow
104-2a	Sunf 1600 lb	Medium	6.6	0.3	1.6	13	26	10	397	30	10	0	69.3 bu HRW-a
105-2a	Mil- 2 tons/a	Medium	6.2	0.3	1.5	8	18	24	390	35	0	0	1690 lb Sunflower
106-3	HRW-45bu	Medium	6.4	0.3	1.4	9	22	15	365	90	5	0	1224 lb Millet
107-3	Saff-1200 lb	Medium	6.5	0.3	1.3	18	34	14	434	25	5	0	51.0 bu HRW
108-3	Mil-1500 lb	Medium	6.4	0.3	1.2	10	23	16	451	30	0	0	1483 lb Safflower
109-4	Mil-1500 lb	Medium	6.4	0.3	1.7	18	32	23	460	20	0	0	36.8 bu HRW
110-4	HRW-35bu	Medium	6.6	0.3	1.5	7	19	14	372	70	5	0	949 lb Millet
111-5a	HRW-40bu	Medium	6.3	0.3	1.5	12	23	21	491	75	0	0	73.7 bu Barley
122-5a	Corn-80bu	Medium	6.0	0.2	1.7	15	24	23	504	70	0	0	45.9 bu HRW
112-5a	Sunf 1300 lb	Medium	6.8	0.4	1.4	11	33	19	397	30	0	0	33.0 bu Corn
113-5a	Barley 60bu	Medium	6.6	0.3	1.5	10	24	16	474	80	0	0	1494 lb Sunflower
114-6a	HRW-b 45bu	Medium	6.6	0.3	1.5	15	30	12	436	80	10	0	43.6 bu HRW-a
115-6a	Saff-1200 lb	Medium	6.6	0.3	1.4	14	26	8	402	35	15	0	50.0 bu HRW-b
121-6a	Dry Pea-1800 lb	Medium	6.4	0.3	1.6	7	13	13	516	0	5	0	1650 lb Safflower
116-6a	HRW-a 45bu	Medium	6.0	0.4	1.5	46	69	24	440	45	0	0	2004 lb dry pea
123-9a	HRW-b 45bu	Medium	6.3	0.3	1.6	25	42	13	459	70	10	0	59.2 bu HRW-a
124-9a	Saff-1200 lb	Medium	6.8	0.3	1.4	14	28	7	410	30	20	0	48.5 bu HRW-b
125-9a	Hairy Vetch	Medium	6.7	0.3	1.5	6	21	10	514	0	0	0	1559 lb Safflower
120-9a	HRW-a 50bu	Medium	6.3	0.4	1.6	49	73	11	436	50	15	0	HVetch g. manure
126-10	HRW-45bu	Medium	6.4	0.3	1.7	12	28	18	425	85	0	0	0 lb Chickpeas
127-10	Mil-1500 lb	Medium	6.6	0.4	1.5	21	41	12	464	10	5	0	29.9 bu HRW
128-10	Dry Pea-1800 lb	Medium	6.7	0.3	1.5	6	14	16	432	0	0	0	764 lb Millet
129-11	HRW-45bu	Medium	6.1	0.2	1.4	8	23	24	410	90	0	0	1228 lb Millet
130-11	Corn-80bu	Medium	6.2	0.3	2.0	21	38	11	428	60	15	0	54.8 bu HRW
131-11	Mil-1500 lb	Medium	6.2	0.3	1.3	11	28	24	433	25	0	0	29.7 bu Corn

Note: to convert P & K values to lb/A take ppm value x 2.
Example: 500 ppm is equal to 1000 lb/Acre

2008 Wall Rotation Yields, Expense/Acre, Break-Even Costs & Break-Even Yields

Net return/A	Rotation & Crop	(A) Yield/Acre	(B) Expense of Crop/Acre	(C) Cost of Production	(D) Yield to Break-Even
1 (\$48.47)	W Wheat Fallow at \$118.19 / acre.	56.2 bu	\$146.79 + \$118.19	\$ 4.71/bu	41.1 bu
2a (\$49.21)	W Wheat-A Sunflower Hay Millet W Wheat-B Corn Fallow at \$95.10 / acre.	69.3 bu 1690 lb 2.5 Tons 47.6 bu 33.0 bu	\$160.87+ \$76.08 \$234.66+ \$19.02 \$133.30 \$192.73 \$212.39 (\$76.08+\$19.02)*	\$ 3.42 / bu \$.15 / lb \$53.32 / ton \$ 4.05 / bu \$ 6.44 / bu	36.8 bu 1409 lb 1.90 tons 33.3 bu 56.6 bu
3 (\$86.51)	W Wheat Safflower Millet	51.0 bu 1483 lb 1224 lb	\$206.09 \$205.99 \$135.09	\$ 4.04 / bu \$.14 / lb \$.11 / lb	36.4 bu 686 lb 2251 lb
4 (\$-44.99)	W Wheat Millet	36.8 bu 949 lb	\$183.41 \$167.39	\$ 4.98 / bu \$.18 / lb	33.1 bu 2789 lb
5a (\$26.84)	W Wheat Corn Sunflower Barley	45.9 bu 33.0 bu 1494 lb 73.7 bu	\$200.54 \$227.20 \$219.56 \$184.49	\$ 4.37 / bu \$ 6.88 / bu \$.15 / lb \$ 2.50 / bu	36.6 bu 60.6 bu 1219 lb 46.1 bu
6a (\$122.77)	W Wheat-B Safflower Field Pea W Wheat-A	50.0 bu 1650 lb 33.4 bu 43.6 bu	\$237.94 \$207.33 \$148.88 \$171.48	\$4.76 / bu \$.13 / lb \$4.46 / bu \$3.93 / bu	38.8 bu 691 lb 24.8 bu 29.4 bu
9a (\$89.97)	W Wheat-B Safflower Hairy Vetch (green fallow) W Wheat-A	48.5 bu 1559 lb \$146.20 / acre. (\$116.96+\$29.24)* 59.2 bu	\$217.66 + \$29.24 \$206.59 \$ 5.01 / bu	\$ 5.09 / bu \$.13 / lb	41.8 bu 688 lb 49.3 bu
10 (\$ -101.81)	W Wheat Millet Chickpea	29.9 bu 764 lb 0 lb	\$195.20 \$164.44 \$171.63	\$ 6.53 / bu \$.22 / lb crop failure	32.4 bu 2741 lb crop failure
11 (\$ -16.27)	W Wheat Corn Millet	54.8 bu 29.7 bu 1228 lb	\$208.97 \$211.33 \$123.74	\$ 3.81 / bu \$ 7.11 / bu \$.10 / lb	36.9 bu 56.3 bu 2062 lb

$$C = B / A$$

$$D = B / E$$

Grain Sale Values for determining Yield to Break-Even Point (E)

Winter Wheat.....	See Chart Below	Corn.....	\$ 3.75 / bu
Hay Millet.....	\$ 70 / ton	Proso Millet.....	\$.06 / lb
Sunflower.....	\$.18 / lb	Safflower.....	\$.30 / lb
Barley.....	\$ 4.00 / bu	Field Pea.....	\$ 6.00 / bu

Winter Wheat Chart (values adjusted for protein content) (E)

Rot 1 - \$6.44 / bu	Rot 3 - \$5.66 / bu	Rot 6a-a - \$5.84 / bu	Rot 9a-b - \$5.90 / bu
Rot 2a-a - \$6.44 / bu	Rot 4 - \$5.54 / bu	Rot 6a-b - \$6.14 / bu	Rot 10a - \$6.02 / bu
Rot 2a-b - \$5.78 / bu	Rot 5a - \$5.48 / bu	Rot 9a-a - \$6.02 / bu	Rot 11 - \$5.66 / bu

*The fallow expense is separated at 80% for the first crop year and 20% to the second crop year.

WALL ROTATION STUDY WEED RATINGS

- Objectives:**
- 1) To determine weed species and weed intensity in each rotation.
 - 2) To evaluate the effects of crop rotations on weed control.

Procedures: All 124 plots of the Wall Rotation Study were evaluated (visually rated) for weed species presence and weed density on April 15, July 15, and October 15, 2008. A rating of zero (**0**) means that the plot was completely weed free. A rating of five (**5**) indicates that the plot was totally covered with weeds. The **Weed Rating Score** is derived from adding up the weed scores in the four plots of one rotation with the same cropping treatment and dividing by 4. The **Rotation Weed Mean** is derived from adding up weed scores for each crop in the rotation and dividing by the number of cropping treatments in each rotation. The lower the **Weed Rating** score and **Rotation Weed Mean**, the lower the incidence of weeds.

Discussion: Overall, the most weed free rotation in 2008 was Rot 9a (Wheat/Wheat/Safflower/Hairy Vetch). This is partly due to the fact that both wheat-a and wheat-b of Rotation 9a were sprayed w / Olympus in the spring of 2008. Both wheats in Rot 6a and Rot 10 wheat were also sprayed with Olympus in April of 2008. The intent of using Olympus is to control downy brome and Japanese Chess but it also has activity on some winter annual broadleaf weeds. Olympus is working well now but it should be cautioned that continued use of Olympus will in time, allow resistant strains of weeds to develop. Starane NXT was applied to every winter wheat and barley plot of the rotation study in May of 2008 for control of all Kochia types. Starane NXT also has some other broadleaf weed activity (wild buckwheat, lambsquarters, annual sunflower and russian thistle). There is a green fallow period in Rotation 9a (hairy vetch) that helps to smother out weeds. The hairy vetch is planted in the fall and although it doesn't produce ground cover quickly in the early spring, it does have a very dense growth by the time it is sprayed off with herbicide in June. The canopy of sprayed off hairy vetch eliminates weed pressure during that time period.

The rotation in 2008 with the most overall weed pressure was Rotation 10a (Wheat/Millet/Chickpea). This occurred because we changed the sequence of this rotation, placing the chickpea before winter wheat. The chickpea planted on chickpea which is not recommended at all but was necessary to rearrange the sequence, exploded with weeds. Ascochyta Blight was also a major problem in the chickpeas in 2008. This rotation will be changed in 2009 to (Winter Wheat / proso millet / dry pea).

Rotation 5a was nearly as weedy overall in 2008 as Rotation 10a. See Table 73. This was due to 2008 being a wetter year starting in May that got more weed seed started.

Rotation 4 has historically been a weedy rotation especially in April and July. Olympus was sprayed in the fall of 2006 and 2007 for winter-annual grassy weed control (downy brome, Japanese Chess) in the winter wheat crop. In April of 2008, Rotation 4 (Winter wheat/Proso millet) was the cleanest rotation at the study. The cleanest rotation as of July 15, 2008 was Rotation 1 (Wheat/Fallow). The cleanest rotation as of October 15, 2008 was again Rotation 4 (Winter Wheat / Proso Millet). Rotation 4 is much cleaner in the spring of 2008, indicating that the Olympus is performing very well. Rotation 4 has about 11 months of fallow period between harvest of the wheat crop to planting of the millet crop. This non-crop period has in the past, proven to be problematic. Proso Millet in Rotation 4 requires more sprayings per summer than the other millet plots in this study. Crown rot disease and weed problems are an ongoing problem in rotation 4 and soil moisture is not being properly utilized.

Table 74 is a combined average of April, July, and October weed pressure over a 5 year period (2004-2008). It indicates that Rotation 9a is the over-all cleanest rotation with a rating of 1.4. There are six rotations that are in the middle with ratings of 2.2 to 2.8. Rotations 10a and 4 are definitely the weediest in the trial at 3.6 and 3.8 respectively.

Table 75 shows what weeds are present at the 3 rating dates of April 15, July 15, and October 15 in 2008. Weeds are listed from highest count to least in each of the crops or fallow listed.

Table 76 lists the weeds at the Wall Rotation, their life span, origin and characteristics. Approximately half of these weeds are of major economic importance and are directly competing with the crops at some point for valuable moisture, nutrients and sunlight. The **bolded weeds** are the most prevalent at the study, followed by the non-bolded weeds that are present but not in high numbers.

Weed pressure in the rotations will vary from year to year depending upon soil and air temperature, rainfall, canopy cover, mechanical tillage, and types of herbicides used and timing of planting. Ultimately, it is important to get a thorough weed cleansing at least one time during the crop season and/or during the fallow periods. Every crop in this rotation has a fallow period of at least a few months where there is no crop growing. It is critical to get good weed control during these opportunity windows of the fallow periods. Spraying pre-plant of the crops and also in the late fall are excellent times to keep weed populations in check. It is important to be versatile on herbicide options so resistant species of weeds do not develop.

Table 73. Wall Rotation Weed Rating Scores and Rankings - 2008.

Rotation	Rank as of 4-15-08	Apr 15, 2008 rating	Rank as of 7-15-08	July 15, 2008 rating	Rank as of 10-15-08	Oct 15, 2008 rating	Overall Rank Apr,Jul,Oct 2008	Total Weed Pressure (Apr 15, July 15, Oct 15) 2008
1	5 th	0.3	1 st	0.1	6 th	1.0	2 nd	0.4
2a	3 rd	0.2	3 rd	0.8	8 th	1.3	6 th	0.8
3	8 th	1.0	5 th	0.9	2 nd	0.4	5 th	0.7
4	1 st	0.0	6 th	1.8	1 st	0.3	4 th	0.7
5a	6 th	0.3	6 th	1.8	9 th	2.4	8 th	1.5
6a	2 nd	0.2	4 th	0.9	3 rd	0.5	3 rd	0.5
9a	4 th	0.2	2 nd	0.3	3 rd	0.5	1 st	0.3
10	9 th	1.6	9 th	2.9	7 th	1.0	9 th	1.8
11	7 th	0.7	6 th	1.8	3 rd	0.5	7 th	1.0
Total		4.5		11.3		7.9		7.7

Table 74. Wall Rotation Weed Rating Scores and Rankings - (2004 - 2008).

Rotation	Average for April 15 th , (2004,05,06,07,08)	Average for July 15 th , (2004,05,06,07,08)	Average for October 15 th , (2004,05,06,07,08)	Total Weed Pressure 4-15,7-15,10-15 for (2004,05,06,07,08)	Overall Ranking
1	0.6	1.1	0.9	2.6	5 th
2a	0.8	0.8	0.7	2.4	4 th
3	1.0	0.9	0.4	2.3	3 rd
4	1.5	1.6	0.6	3.8	9 th
5a	0.8	0.8	1.0	2.7	6 th
6a	0.6	1.1	0.5	2.2	2 nd
9a	0.4	0.6	0.3	1.4	1 st
10	1.2	1.7	0.6	3.6	8 th
11	0.9	1.0	0.8	2.8	7 th
Total	7.8	9.6	5.8	2.6 (Mean)	

Table 75. Wall Rotation Weed Ratings, 2008.

Rotation Number & crop	April 15, 2008		July 15, 2008		October 15, 2008	
	Weed Rating	Weeds Present	Weed Rating	Weeds Present	Weed Rating	Weeds Present
Rotation 1						
Fallow	0.500	Pc, db, s	0.000	none	0.000	none
W. Wheat	0.125	Db	0.375	Db, fxt, pl	2.000	vw
<i>Rot Mean</i>	0.312		0.187		1.000	
Rotation 2a						
Sunflower	0.250	Pc, db, sp	0.000	none	3.500	Vw
Forge Millet	T	Traces of sp, pc, db,dan	3.500	Sg, tg, pl, sp, ko	0.000	none
W. Wheat-b	0.000	none	0.125	Pl, ps, db	0.000	none
Corn	T	Traces of db	1.375	Pw, wg	2.000	Vw
Fallow	1.000	Pc, sp, db	T	Traces of tg	2.750	Sg
W. Wheat-a	0.125	Db	T	Traces of pl, byg, db	0.000	none
<i>Rot Mean</i>	0.229		0.833		1.375	
Rotation 3						
Safflower	2.500	Db, pc	1.000	Jc, f mar, sal, sun, rt, pl, tg	1.250	Vw
Proso Millet	0.500	Pc, db	1.500	Rt,sg,fmar,lis,wg,tg,ko,pw,wg	0.000	none
W. Wheat	T	Traces of pc	0.375	Sg, pl, db	0.000	none
<i>Rot Mean</i>	1.000		0.958		0.416	
Rotation 4						
Proso Millet	0.125	Db, pc, s, sp	2.250	Sg,sun,ps	0.625	Vw, tg
W. Wheat	T	Traces of pc	1.500	Sg, pl, tg, db, jc, sal	0.125	dan
<i>Rot Mean</i>	0.062		1.875		0.375	
Rotation 5a						
Sunflower	0.750	Db, pc, sp	0.000	none	3.750	Sg, fxt
S. Barley	T	Traces of sprayed sp	0.125	Sg, tg, db	3.000	Sg
W. Wheat	0.250	Pc, db	0.500	Pl, ps, jc	0.000	none
Corn	0.250	Db, pc	1.250	Pw, sg, pig, wg	3.000	Vw
<i>Rot Mean</i>	0.312		1.875		2.437	
Rotation 6a						
Field Pea	0.250	Sprayed db	0.125	Sal, pl, db	0.000	none
W. Wheat-a	0.375	db	0.625	Db, sg, pl	0.500	Dry peas
W. Wheat-b	T	Traces of db, pc	1.750	Tg, pl	0.000	none
Safflower	0.250	Pc, db	1.250	Tg, sal, pl	1.750	Vw, tg
<i>Rot Mean</i>	0.218		0.937		0.562	
Rotation 9a						
Hairy Vetch	0.250	Pc, db	0.000	none	0.000	none
W. Wheat-a	0.375	Db, pc, sp	0.250	Tg, db	0.000	none
W. Wheat-b	T	Traces of db	0.000	Db, pl, sal	0.000	none
Safflower	0.375	Db, pc, tm, vw	1.125	Db, pl, hv, tg, sal, ko ,mt	2.250	vw
<i>Rot Mean</i>	0.250		0.343		0.562	
Rotation 10						
Proso Millet	2.500	Db, pc	3.500	Sg, wg, ps	2.250	Vw, db
Chickpea	T	Traces of db	1.375	Ps, tg, sp, f mar, pl, mt	0.625	Mt, sal
W. Wheat	2.500	db	4.000	Db	0.250	Dan
<i>Rot Mean</i>	1.666		2.958		1.041	
Rotation 11						
Corn	1.250	db	1.500	Wg, pw	1.500	Vw
Proso Millet	1.000	Sp, pc, s, db	4.000	Sg, pw, ko, pl	0.000	none
W. Wheat	0.125	pc	0.125	Pl, sg	0.000	none
<i>Rot Mean</i>	0.791		1.875		0.500	

Note: Weeds listed above are listed from most to least prevalent.

Note: T = traces of weeds.

Legend: db-downy brome, jc - Japanese chess, vw-volunteer wheat, ko-kochia (ALS & non - ALS strains), pl-prickly lettuce, dan - dandelion, bl-blue lettuce, fxt - green or yellow foxtail, s-sedge, rt - Russian thistle, sg - stinkgrass, lq - lambs quarters, byg - barnyard grass, pig - red root pigweed, saf - volunteer safflower, vol millet - volunteer millet, an sun - annual sunflower, pw - poverty weed, f mar - fetid marigold, ps - prostrate spurge, tg - tumble grass, lls - lance-leaf sage, pc - pennycress, wg - witchgrass, pl - prickly lettuce, tm - tansy mustard, sal-salsify.

Table 76. Weeds at the Wall Rotation Study and their Characteristics - 2008.

Common Name	Growth Form	Life Span	Origin	Season or flowering dates	Reproduction
Downy Brome	Grass	Winter Annual	Europe	Cool	Seeds
Japanese Chess	Grass	Winter Annual	Europe	Cool	Seeds
Pennycress	Forb	Annual / Winter Annual	Europe	April-June	Seeds
Prickly Lettuce	Forb	Annual	Europe	July-Sept	Seeds
Tumble grass	Grass	Perennial	Native	Warm	Seeds
Stinkgrass	Grass	Annual	Europe	Warm	Seeds
Volunteer Wheat	Grass	Winter Annual		Cool	Seeds
Shepherds-purse	Forb	Annual / Winter Annual	Europe	March-November	Seeds
Western Salsify	Forb	Biennial / sl per.	Eurasia	May-July	Seeds
Witchgrass	Grass	Annual	Native	Warm	Seeds
Prostrate Spurge	Forb	Annual	Native	June-October	Seeds
ALS Kochia	Forb	Annual	Eurasia	July-October	Seeds
Non-ALS Kochia	Forb	Annual	Eurasia	July-October	Seeds
Russian Thistle	Forb	Annual	Europe	Aug-October	Seeds
Green Foxtail	Grass	Annual	Eurasia	Warm	Seeds
Yellow Foxtail	Grass	Annual	Europe	Warm	Seeds
Dandelion	Forb	Perennial	Eurasia	Apr-October	Seeds
Mare's Tail	Forb	Annual	Native	June-Sept	Seeds
Fetid Marigold	Forb	Annual	Native	July-Sept	Seeds
Sedge	Sedge	Perennial	Eurasia	July-Sept	Seed, rootstocks, tubers
Blue Lettuce	Forb	Perennial	Native	June-Sept	Rhizomes / seed
Tansy Mustard	Forb	Annual	Native	March-Aug	Seeds
Lance-leaf Sage	Forb	Annual	Native	June-October	Seeds
Common Purslane	Forb	Annual	Eurasia	May-Nov	Seed/stem fragments
Wild Buckwheat	Forb	Annual	Europe	June-Sept	Seeds
Barnyard Grass	Grass	Annual	Europe	Warm	Seeds
Common Sunflower	Forb	Annual	Native	July-Sept	Seeds
Curlycup gumweed	Forb	Biennial / sl per.	Native	July-October	Seeds
Black Nightshade	Forb	Annual	Native	May-October	Seeds
Lambsquarters	Forb	Annual	Europe	June-Sept	Seeds
Redroot Pigweed	Forb	Annual	Native	July-October	Seeds
Sand bur	Grass	Annual / sl per.	Native	Warm	Seeds
Buffalo bur	Forb	Annual	Native	May-October	Seeds
Field Bindweed	Forb	Perennial	Eurasia	June-Sept	Rhizomes / seed
Canada Thistle	Forb	Perennial	Eurasia/N. Africa	June-August	Rhizomes / seed

Note: The **bolded weeds** above are listed from the most to least prevalent in the Wall Rotation Study in the 2008 growing season.

ALS Kochia = Acetolactate Synthase (ALS) resistant Kochia has a less sulfonyleurea-sensitive ALS enzyme.

Legend: sl per. = short lived perennial.

Information in the above table is from "Weeds of Nebraska and the Great Plains" Published by Nebraska Department of Agriculture.