PROJECT TITLE: Evaluation of continuous spring wheat cropping – 2010 (4W3162)

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OBJECTIVE: To determine the feasibility of continuous spring wheat cropping of small grains on dryland when the best-known methods of weed control, fertilizer practices, and other management practices are applied in conjunction with tall wheatgrass barriers. In evaluating tall wheatgrass barriers for continuous spring wheat cropping, the following factors will be documented each year:

1. Crop yield
2. Disease problems associated with continuous cropping
3. Insect problems associated with continuous cropping
4. Tillage problems associated with continuous cropping
5. Weed problems associated with continuous cropping

MATERIALS AND METHODS:
The tall wheatgrass barriers eliminated from this study in 1998 were first established in the summer of 1965 as part of another experiment. As originally planned, the experiment contained 2-row grass barriers with a distance of 42 inches between the grass rows. Four of the barrier strips had inside crop dimensions of 30' by 265'. Three other barriers were of 60' by 265' inside dimensions. For check purposes, an exterior area without grass barriers was provided for in the experiment.

During the 1966-71 crop years, the grass barrier system was cropped each year to either spring or winter wheat. Data was collected on the efficiency of the barriers in trapping snow, preventing soil erosion, and affecting temperature relations over the crop. No fertilizer treatments were applied to the site and no program of controlling annual weeds was instituted. By 1971, the fertility status of the soil had declined to a low level and such annual weeds as wild oats, green foxtail, and yellow foxtail infested the land to a moderately serious degree. Beginning in 1971, an attempt to control these weed populations with herbicides was initiated. Safflower was grown in the barrier system in 1972, but thereafter spring wheat was continuously cropped in the barrier system utilizing effective herbicides and fertilizer. The 30 ft. barriers were eliminated in the fall of 1979 to provide two additional 60 ft. barriers for further continuously cropped studies under no-till and till-and plant conditions. The decision to eliminate the 30 ft. barriers was based on our research results indicating the 30 ft. barriers were too narrow to compensate for yield loss due to land removed from crop production. In 1998, the 60 ft. tall wheatgrass barriers were eliminated. The decision to eliminate the 60 ft. barriers was based on previous results indicating the barriers only compensated for yield loss due to land removed from crop production on dry years when the yield was less then 20 bushels per acre and because of volunteer tall wheatgrass problems in the wheat associated with the tall wheatgrass of the barrier strips. Three of the barrier strips removed were tilled and three of the barrier strips were killed with Roundup herbicide without any tillage.

MATERIALS AND METHODS FOR THE 2010 SEASON:
No tillage was performed on the plots in the fall of 2009 and the stubble was allowed to stand over winter to collect snow.

On April 19, 2010, the plots scheduled for tillage were worked twice with a tandem disc, except the

summer fallow plot, which was triple K'd twice just prior to planting. Thirty pounds of N fertilizer per acre was applied as 28-0-0 on April 21, 2010 on the no-till plots, the spring till plots, and summer fallow plot.

On April 23, 2010, the plots were seeded to Vida spring wheat using a Versatile Noble No. 2000 no-till double disc drill with leading coulters and 9-inch row spacing. For both tilled and no-till plots, Vida spring wheat was seeded at the rate of 78 pounds/acre. All the plots were sprayed with Roundup herbicide at the rate of 2.0 pints per acre on April 27, 2010 to control volunteer tall wheatgrass and emerging weeds.
The type of tillage and planting for the various plots were as follows:

OPEN FIELD STUBBLE - CONTINUOUS CROP

Plot A - no-till and no-till planting
Plot B - spring till and seeding
Plot C - no-till and no-till planting
Plot D - no-till and no-till planting
Plot E - spring till and seeding
Plot F - spring till and seeding
(40 ft. barrier for this plot only)
Plot G - no-till and no-till planting
Plot H - spring till and seeding

SUMMER FALLOW - (WHEAT-FALLOW) ROTATION

Plot I - summer fallow
Plot J - spring till and seeding on fallow

On June 16th, the plots were sprayed with Brox M at the rate of 1.5 pints/acre and 1.0 pints/acre of Axial for broadleaf and grassy weed control.

RESULTS AND DISCUSSION:
Precipitation as rain or snow occurred at this site during the October 2009 through September 2010 period as follows:

Month and Year	Inches of Moisture
October 2009	2.14
November 2009	0.02
December 2009	0.82
January 2010	0.78
February 2010	0.35
March 2010	0.29
April 2010	1.13
May 2010	6.44
June 2010	2.94
July 2010	2.54
August 2010	2.27
September 2010	0.71
Total	**20.43**

All of the plots in the study were harvested for yield determinations on August 16, 2010. Grain samples were obtained for test weight and protein analyses.

CONTINUOUS CROPPING RESULTS FROM 2010

	Method of Seeding	Plant Height Inches	Test Weight Lbs/Bu	Grain Protein %	Yield Bu/Acre
1. Continuous Crop					
Plot A	no-till	24.8	60.0	13.6	19.6
Plot B	till	24.8	55.5	16.5	36.8
Plot C	no-till	25.6	59.0	14.5	30.9
Plot D	no-till	24.8	61.5	13.9	34.6
Plot E	till	25.6	55.0	15.7	34.9
Plot F	till	26.0	57.5	13.9	36.8
Plot G	no-till	24.8	60.5	13.6	23.2
Plot H	till	24.4	59.0	13.9	37.0
2. Summer Fallow					
Plot J	till	30.7	54.0	15.6	50.5

On continuous wheat cropping in 2010, tilled and planted plots averaged 36.4 bushels per acre with 15.0 percent protein whereas no-till plots averaged 27.1 bushels per acre with 13.9 percent protein. Open field stubble continuous wheat produced an average yield of 31.9 bushels per acre with 14.5 percent protein, whereas the wheat on summer fallow produced a yield of 50.5 bushels per acre with 15.6 percent protein.

The barriers were eliminated in 1998 and Roundup herbicide has been spring applied each year since 1998 to successfully eliminate volunteer wheatgrass. The principal weed in 2010 was pigeongrass with a few wild oats and broadleaf weeds which were effectively controlled by herbicide application.

Damage by rodents, sawflies, or other pests were not noted in 2010. The principal disease noted was Pyrenophora trichostoma (tan spot) which was most severe in the no-till plots.

Snow Moisture Collection System	Plant Height Inches		Grain Protein Percent		Grain Test Wt. Lbs/Bu		Grain Yield Bu/Acre	
60 Ft. Barriers *	***No-Till***	***Till***	***No-Till***	***Till***	***No-Till***	***Till***	***No-Till***	***Till***
1978	30.9	31.3	13.6	14.3	61.5	60.5	30.0	35.6
1979	21.7	21.5	14.6	16.2	61.0	61.0	15.6	15.3
1980	11.0	10.7	14.7	14.4	56.8	57.8	12.7	9.8
1982	26.0	26.0	13.9	14.6	58.2	58.0	28.1	29.3
1983	25.0	25.8	16.5	16.8	61.2	60.0	20.3	21.5
1984	21.3	21.3	15.8	15.0	59.5	59.8	12.0	11.2
1985	12.3	11.0	16.1	16.9	57.1	56.1	11.1	11.7
1986	27.0	26.7	11.9	12.4	61.7	61.9	9.1**	27.0
1987	21.5	20.3	14.9	15.4	60.5	60.4	22.2	22.7
1988	--	--	--	--	--	--	0.0	0.0
1989	25.0	23.3	15.8	16.0	57.3	56.8	23.5	25.6
1990	19.0	18.7	16.4	17.3	60.0	59.0	12.2	12.2
1991	33.0	33.0	13.0	13.9	61.8	61.7	30.8	29.9
1992	34.8	36.5	12.8	13.1	62.5	62.3	32.4	50.9
1993	32.5	32.4	14.0	14.1	56.5	56.2	19.6	28.4
1994	30.4	34.4	10.5	10.9	61.8	63.0	20.0	32.0
1995	29.6	28.6	12.0	13.2	62.5	62.2	13.7	20.5
1996	20.1	19.4	11.9	12.1	57.2	57.0	18.7	23.5
1997	25.0	24.6	13.4	13.7	53.2	52.8	20.6	31.5
1998	29.9	28.2	10.6	11.2	59.0	58.0	22.7	29.4
Average	**25.0**	**25.2**	**13.8**	**14.2**	**59.4**	**59.2**	**19.3**	**23.4**

* Data in 1981 were omitted as different varieties were planted in no-till and till and plant plots.
In 1988, continuous cropped wheat plots were a complete crop failure. **In 1998, the barriers were eliminated.**
** Deep seed placement contributed to the lower yield of the no-till plots in 1986.

Snow Moisture Collection System	Plant Height Inches		Grain Protein Percent		Grain Test Wt. Lbs/Bu		Grain Yield Bu/Acre	
Open Field Stubble	***No-Till***	***Till***	***No-Till***	***Till***	***No-Till***	***Till***	***No-Till***	***Till***
1978	30.0	31.4	13.2	14.7	61.5	60.5	31.1	44.0
1979	21.6	22.9	14.5	16.1	61.0	59.5	19.5	19.7
1980	8.0	8.0	16.2	17.1	58.0	57.5	3.9	3.9
1982	26.0	26.0	14.3	15.5	57.5	57.5	24.9	27.6
1983	26.0	27.0	16.0	17.7	61.0	60.0	23.7	24.9
1984	22.0	20.0	16.7	16.0	58.2	58.5	10.8	9.2
1985	11.0	11.0	15.6	16.6	57.0	55.7	11.2	10.6
1986	25.0	26.0	12.1	12.7	61.3	61.2	18.6**	30.8
1987	22.0	19.0	16.6	16.7	60.5	59.0	27.3	24.6
1988	--	--	--	--	--	--	0.0	0.0
1989	22.0	20.0	17.1	17.8	56.5	56.0	20.0	20.6
1990	20.0	17.0	16.3	16.6	59.0	59.0	10.9	9.6
1991	33.0	33.0	14.0	14.7	61.5	61.5	34.7	31.9
1992	36.5	36.5	12.9	13.2	62.5	62.0	38.0	53.5
1993	33.9	33.1	14.2	14.6	57.0	57.0	28.2	22.9
1994	32.3	35.4	10.3	11.9	62.5	63.0	35.0	38.5
1995	29.1	26.8	11.3	13.6	62.5	62.5	17.9	22.7
1996	20.9	18.5	11.7	11.6	55.5	56.0	24.4	29.7
1997	24.0	23.9	13.2	13.9	55.0	54.0	26.0	33.4
1998	29.1	29.5	10.8	11.9	58.5	58.5	26.2	30.1
1999	27.8	27.9	10.3	10.8	60.8	61.0	25.7	35.4
2000	--	--	13.3	13.3	63.5	63.4	28.6	32.4
2001	24.5	26.2	12.8	13.1	61.3	61.4	34.7	39.8
2002	22.8	21.8	12.5	13.1	59.8	59.6	24.8	26.2
2003	28.9	28.6	13.8	15.6	61.3	60.4	35.1	37.6
2004	27.2	25.6	14.3	14.4	61.4	60.4	28.9	33.2
2005	30.3	27.8	15.8	14.9	56.4	58.0	50.5	51.8
2006	25.9	25.9	14.3	13.4	55.1	55.6	26.6	29.2
2007	28.5	29.3	14.0	13.4	59.4	59.5	41.1	45.2
2008	14.8	12.8	15.4	16.2	58.5	58.0	9.4	7.3
2009	23.9	23.2	13.7	14.1	61.1	60.9	36.5	39.1
2010	25.0	25.2	13.4	15.0	60.3	56.8	27.1	36.4
Average	**25.1**	**24.6**	**13.9**	**14.5**	**59.5**	**59.2**	**25.0**	**28.2**

* Data in 1981 were omitted as different varieties were planted in no-till and till and plant plots.
In 1988, continuous cropped wheat plots were a complete crop failure.

**Deep seed placement contributed to the lower yield of the no-till plots in 1986.

A 37-year summary of data obtained from the continuous spring wheat and wheat-fallow systems are reported below.

Snow Moisture Collection System	Plant Height Inches	Grain Protein Percent	Grain Test Weight Lbs/Bushel	Grain Yield Bushel/Acre
Open Field Stubble				
1974	20.0	15.2	60.0	26.0
1975	25.0	16.1	59.5	30.4
1976	28.0	--	62.5	40.3
1977	15.3	16.4	60.3	4.2
1978	30.7	14.0	61.0	37.6
1979	22.3	15.3	60.3	19.6
1980	10.8	16.7	57.8	3.9
1981	--	14.9	58.0	19.8
1982	26.0	14.9	57.5	27.6
1983	26.5	16.9	60.5	24.3
1984	21.0	16.4	58.4	10.0
1985	11.0	16.4	56.4	10.9
1986	25.5	12.4	61.3	24.7
1987	20.5	16.7	59.8	26.0
1988	--	--	--	0.0
1989	21.0	17.5	56.3	20.3
1990	18.0	16.5	59.0	10.3
1991	33.0	14.4	61.5	33.3
1992	36.5	13.1	62.3	45.6
1993	33.5	14.4	57.0	25.6
1994	33.9	10.8	62.8	36.8
1995	28.0	12.4	62.5	20.3
1996	19.7	11.7	55.8	27.1
1997	24.0	13.6	54.5	29.7
1998	29.3	11.4	58.5	28.2
1999	27.9	10.6	60.9	30.5
2000	--	13.2	63.4	30.5
2001	25.3	12.9	61.3	37.2
2002	22.3	12.8	59.7	22.5
2003	28.8	14.7	60.8	36.3
2004	26.4	14.3	60.9	31.0
2005	29.0	15.4	57.2	50.0
2006	25.9	13.9	55.4	27.9
2007	28.9	13.7	59.4	43.1
2008	13.8	15.8	58.3	8.4
2009	23.6	13.9	61.0	37.8
2010	25.1	14.5	58.5	31.7
Average	**24.3**	**14.4**	**59.4**	**26.3**

Snow Moisture Collection System	Plant Height Inches	Grain Protein Percent	Grain Test Weight Lbs/Bushel	Grain Yield Bushel/Acre
Summer Fallow				
1974	21.0	16.9	58.5	45.4
1975	28.0	16.4	59.0	35.3
1976	32.0	--	61.0	62.5
1977	19.5	16.2	59.5	18.5
1978	32.5	14.5	60.5	54.7
1979	23.4	16.7	61.0	24.9
1980	12.0	15.6	59.0	23.0
1981	--	17.1	59.5	23.4
1982	26.0	15.6	57.0	32.9
1983	28.0	16.6	60.0	26.0
1984	21.0	17.3	58.1	22.9
1985	18.0	16.9	56.2	12.0
1986	28.0	13.2	60.9	38.9
1987	23.0	15.0	59.5	36.0
1988	13.0	18.4	57.5	3.7
1989	23.0	16.3	57.5	27.0
1990	23.0	16.5	58.3	21.9
1991	32.0	14.8	61.5	38.4
1992	37.5	13.8	62.0	67.4
1993	32.5	12.8	57.0	40.4
1994	38.4	12.2	62.5	49.9
1995	30.7	14.1	62.0	27.4
1996	21.3	12.4	56.0	39.6
1997	26.1	14.4	53.5	38.6
1998	30.7	14.2	56.5	41.2
1999	33.1	12.6	59.0	53.8
2000	--	15.0	63.0	47.0
2001	28.7	14.6	61.5	48.1
2002	23.2	15.0	58.0	30.5
2003	30.3	15.4	59.5	45.6
2004	33.5	15.0	59.5	52.0
2005	30.3	12.8	59.5	59.1
2006	26.8	15.0	53.0	37.1
2007	32.7	13.1	59.0	51.2
2008	20.9	16.6	58.5	20.9
2009	26.4	13.8	61.0	31.6
2010	30.7	15.6	54.0	50.5
Average	**26.8**	**15.1**	**58.9**	**37.3**

SUMMARY: During the past 37-year period of this continuous cropped spring wheat study, grain test weights have averaged 0.5 lbs per bushel higher under continuous cropping. Conversely, grain protein content of wheat on fallow has averaged 0.7% higher than wheat on open field continuous cropping. Average yields for continuous crop spring wheat is 26.3 bushels per acre for open field continuous cropped spring wheat and 37.3 bushels per acre for summer fallow.

In this long-term study the continuous wheat cropping yields in the barrier system yielded 3.0 bushels per acre less than continuous wheat cropping in open field stubble. One bushel per acre of the yield difference is due to the land removed from wheat production by the presence of the barriers as this land area is included in the plot size for yield determination. The competitive effect of the tall wheatgrass in the barriers nearby wheat plants also causes some yield reduction. However, tall wheatgrass barriers do provide some benefits such as reduced wind erosion and favorable climatic effects within the barriers, which should be considered for soil and water conservation of the land. These factors become more critical in years of below normal rainfall and on soils with lower soil moisture carrying capacity.
The results of this long term study have shown that the barrier system continuous cropping wheat generally out yields open field stubble continuous cropping wheat when yields are less than 20 bushels per acre but that open field stubble continuous cropping wheat generally had a yield advantage over the barrier system when wheat yields exceed this level. Open field stubble continuous cropping wheat had a very definite yield advantage over the barrier system continuous cropped wheat when yields exceed 30 bushels per acre.

In 1977, no-till treatments were added to this long-term continuous cropping system for comparison with conventional till plant plots. The no-till plots have produced yield similar to conventional till and plant plots except for in 1978, 1986, 1992 – 2007, 2009 and 2010. In 1978 the no-till plots had a larger population of wild oats than conventional till and plant plots. In 1986 when the no-till plots were seeded with a no-till versatile Noble No. 2000 drill deep seed placement contributed to the lower yields in the no-till plots. In 1992 – 2004, the lower no-till yields were attributed in part to volunteer wheatgrass in the no-till plots and a higher incidence of disease in the no-till plots. Since 2004, the lower no-till yields have been attributed principally to a higher incidence of disease. Test weights have been slightly higher in no-till plots whereas protein has averaged 0.6% lower in no-till plots than tilled plots despite the no-till plots' lower yield of 3.2 bushels per acre.

The incidence of the disease *Pyrenophora trichostoma* (tan spot) and *Septoria* has been highest in the no-till plots. Conversely, the incidence of annual weeds such as wild oats, green foxtail, and yellow foxtail has been usually greater in the till and plant plots with the exception of 1978, 1997, 1998, 1999 and 2000 when wild oats occurred in the no-till plots. Volunteer tall wheatgrass was an annual problem in all the barrier plots each spring, necessitating an annual application of Roundup herbicide to destroy the volunteer wheatgrass prior to seeding. This treatment has also been effective in controlling annual weeds that have emerged in the no-till plots prior to seeding time. Over the thirty-seven year period, continuous spring wheat cropping has produced 7.6 bushels per acre per year more than the spring wheat-fallow rotation.

FUNDING SUMMARY: Expenditure information to be provided by OSP. No other grants support this project.

MWBC FY2012 GRANT SUBMISSION PLANS: It is planned to submit this project for funding consideration in the next fiscal year.

The long-term influences of no-till, conventional till, and continuous cropping on wheat growth, vigor, yield, quality and other crop performance characteristics is a continuing objective. Continuation of this long-term study could include detailed soils analyses to determine the long-term influence of no-till, conventional till, and continuous cropping on soil health. It may also prove beneficial to assay the soils of the continuous cropping wheat plots for potential biocontrol agents for wheat diseases and / or other wheat pests and test the use of foliar-applied fungicides and fungicide seed treatments to help control fungal diseases.