

PROJECT TITLE: Evaluation of Continuous Spring Wheat Cropping

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OBJECTIVES: 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 in this study 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 1999 SEASON:

No tillage was performed on the plots in the fall of 1998 and the stubble was allowed to stand over winter to collect snow. All the plots were sprayed with Roundup herbicide at the rate of 2 quarts per acre on April 13, 1999 to control volunteer tall wheatgrass and emerging weeds.

On April 22nd, the plots scheduled for tillage were worked twice with a tandem disc, except the summer fallow plot which was triple K'd twice. On April 22nd, the no-till plots were seeded to McNeal spring wheat using a Versatile Noble No. 2000 no-till double disc drill with leading coulters and 9-inch row spacing.

The tilled plots were also seeded on April 22nd using the Versatile Noble No. 2000 double disc drill with 9-inch row spacing. For tilled and no-till plots, McNeal spring wheat was seeded at the rate of 78 pounds/acre and 80 pounds of 18-46-0 was applied through the drill.

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 May 25th, the plots were sprayed with 2.5 pints Hoelon/acre, 1.5 pints Buctril/acre, and 0.125 pints/acre MCPA ester plus 1.75 pints/acre oil crop concentrate for pigeongrass and broadleaf weed control. On June 7th, the plots were sprayed with 2.5 pints Hoelon and 1.75 pints of crop oil concentrate per acre for pigeongrass and wild oat control.

RESULTS AND DISCUSSION:

Precipitation as rain or snow occurred at this site during the October 1998 through September 1999 period as follows:

<u>Month and Year</u>	<u>Inches of Moisture</u>
October 1998	3.91
November 1998	1.33
December 1998	0.57
January 1999	0.93
February 1999	0.28
March 1999	0.06
April 1999	0.41
May 1999	2.50
June 1999	3.72
July 1999	2.31
August 1999	0.60
September 1999	<u>1.04</u>
Total	17.66

All of the plots in the study were harvested on August 12, 1999. Grain samples were obtained for test weight and protein analyses.

	<u>Method of Seeding</u>	<u>Plant Height Inches</u>	<u>Test Weight Lbs/Bu</u>	<u>Grain Protein %</u>	<u>Yield Bu/Acre</u>
1. Continuous Crop					
Plot A	no-till	26.2	60.5	11.2	27.3
Plot B	till	28.9	60.5	10.6	33.6
Plot C	no-till	28.5	61.0	10.4	30.5
Plot D	no-till	28.0	61.0	9.6	23.0
Plot E	till	28.9	61.5	10.6	35.0
Plot F	till	27.0	60.5	10.7	43.6
Plot G	no-till	28.5	60.5	10.1	21.8
Plot H	till	26.8	61.5	11.3	29.4
2. Summer Fallow					
Plot I	till	33.1	59.0	12.6	53.8

On continuous wheat cropping, tilled and planted plots averaged 35.4 bushels per acre with 10.8 percent protein whereas no-till plots averaged 25.7 bushels per acre with 10.3 percent protein. Open field stubble continuous wheat produced an average yield of 30.5 bushels per acre with 10.6 percent protein, whereas the wheat on summer fallow produced a yield of 53.8 bushels per acre with 12.6 percent protein.

The lower yields on no-till plots are attributed to wild oats and volunteer wheatgrass infestations of the barrier tall wheatgrass and its spread into the no-till plots in 1998. The applications of one quart of Roundup in the springs of 1993, 1994 and 1995 about two weeks prior to seeding unfortunately failed to control the volunteer. Two quarts per acre of Roundup spring applied in 1996, 1997 and 1998 for volunteer wheatgrass control provided only fair-good control. The barriers were eliminated in 1998. The incidence of *Pyrenophora trichostoma* (tan spot) and *Septoria* was also most pronounced in the continuous wheat no-till plots; moderate in the continuous wheat tilled plots with a light to moderate level in the wheat on fallow plot. A moderate wild oat infestation in several plots (A, C and D) and pigeongrass in all plots has necessitated the use of Hoelon to control these grassy weeds. Hoelon applied on May 25th and June 7th provided fair to good control of the grassy weeds.

Damage by rodents, sawflies, or other pests were not noted in 1999.

A 25-year summary of data obtained from the barrier system from 1974-1998 is reported below:

Snow Moisture Collection System	Plant Height Inches	Grain Protein Percent	Grain Test Weight Lbs/Bushel	Grain Yield Bushel/Acre
<i>60 ft Barriers</i>				
1974	20.7	15.6	60.0	18.1
1975	26.3	16.2	58.8	26.4
1976	30.0	--	62.0	32.9
1977	16.4	15.7	60.3	4.9
1978	30.7	13.8	61.3	31.4
1979	21.7	15.0	61.0	15.4
1980	10.8	14.6	57.3	11.2
1981	--	16.0	58.2	18.7
1982	26.0	14.3	58.1	28.7
1983	25.4	16.6	60.6	20.9
1984	21.3	15.4	59.7	11.6
1985	11.7	16.5	56.6	11.9
1986	26.8	12.1	61.8	24.2
1987	20.8	15.2	60.5	23.7
1988	--	--	--	0.0
1989	24.2	15.9	57.1	25.8
1990	18.8	16.9	59.5	12.9
1991	33.0	13.5	61.8	30.3
1992	35.7	13.0	62.4	42.5
1993	32.5	14.1	56.3	24.0
1994	32.4	10.7	62.4	26.8
1995	29.1	12.6	62.3	18.0
1996	19.8	12.0	57.1	21.7
1997	24.7	13.6	53.0	24.7
1998	29.1	10.9	58.5	26.1
Average	24.7	14.4	59.4	21.3 *

* Adjusted average yield to compensate for land removed for 3 ft. barrier width is 20.3 bushels/acre. The 60 ft. barriers were eliminated in 1998.

A 26-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
<i>Open Field Stubble</i>				
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
Average	24.1	14.5	59.4	23.6
<i>Summer Fallow</i>				
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
Average	26.1	15.2	59.0	34.8

During the past 26-year period of this continuous cropped spring wheat study, grain test weights have averaged 0.4 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 23.6 bushels per acre for open field continuous cropped spring wheat and 34.8 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 also shown that the barrier system continuous cropping wheat generally outyields open field stubble continuous cropping wheat when yields are less than 20 bushels per acre (1977, 1980, 1984, 1985, 1989 and 1990) but that open field stubble continuous cropping wheat generally had a yield advantage over the barrier system when wheat yields exceed this level (1974, 1975, 1976, 1978, 1983, 1987, 1993, 1994, 1995, 1996, 1997, and 1998). 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 (1975, 1976, 1978, 1991, and 1992).

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, 1993, 1994, 1995, 1996, 1997, 1998 and 1999. 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, 1993, 1994, 1995, 1996, 1997 and 1998, the lower no-till yields were attributed in part to a larger population of volunteer wheatgrass in the no-till plots despite the application of Roundup herbicide in early spring of each year. A higher rate of Roundup herbicide and/or a fall application of Roundup herbicide provides improved control of the volunteer tall wheatgrass. Also in 1993, poor seed to soil contact in the no-till plots resulted in delayed emergence and reduced yields and in 1997 wild oats were a problem. Test weights have been slightly higher in no-till plots whereas protein has averaged 0.3% lower in no-till plots than tilled plots despite the no-till plots' lower yield.

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 and 1999 when wild oats occurred in the no-till plots. Volunteer tall wheatgrass has been an annual problem in all the barrier plots each spring, necessitating an application of Roundup herbicide to destroy the volunteer wheatgrass prior to seeding. This treatment has been effective in controlling annual weeds that have emerged in the no-till plots prior to seeding time. Over the twenty-six year period, continuous spring wheat cropping has produced 6.2 bushels per acre per year more than the spring wheat-fallow rotation.

Snow Moisture Collection System 60 Ft. Barriers *	Plant Height Inches		Grain Protein Percent		Grain Test Wt. Lbs/Bu		Grain Yield Bu/Acre	
	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 Open Field Stubble	Plant Height Inches		Grain Protein Percent		Grain Test Wt. Lbs/Bu		Grain Yield Bu/Acre	
	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
Average	25.0	24.6	13.9	14.7	59.3	59.0	21.8	24.9

* 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.

The grass barriers were sprayed with Roundup in 1998 following harvest. In 1999, the land that had previously been in grass barriers was planted, with half of the barrier land tilled and the other half of the barrier land planted without tillage. Spring wheat was continuously cropped with spring tillage or no tillage, or grown in a crop/fallow rotation, as done in previous years. Wheat samples were collected from each treatment and compared.

Spring wheat grown on grass barrier land was taller, had greater protein content, lower test weight, and greater yield than continuously cropped wheat. Differences in tillage treatments were not detected in wheat that was continuously cropped in height, protein, and test weight but continuously cropped spring wheat with spring tillage had greater yield than continuously cropped spring wheat no tillage. Differences in tillage treatments were detected in wheat grown on grass barrier land. Wheat following grass that had been tilled had significantly greater yield and protein content, and significantly lower test weight than wheat following grass that had not been tilled.

Description	Tillage	Height in	Grain Protein %	Test Weight lb/bu	Yield bu/acre
Continuously cropped since 1974	No-till	28a	9.4a	63.1a	32.2a
Continuously cropped since 1974	Spring-till	28a	9.7a	63.4a	41.7 b
Grass until 1998	No-till	33 b	11.6 b	61.8 b	55.7 c
Grass until 1998	Spring till	33 b	13.5 c	60.9 c	69.0 d
Crop/fallow	Black fallow	33 b	12.6 c	62.1 b	54.5 c

Data analyzed using t-tests

FUTURE PLANS:

Future plans of this long-term study will include investigating the influences of the grass barriers on wheat production within the area previously occupied by the barriers. 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 long-term objective that will continue. 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.