PROJECT TITLE: Evaluation of Continuous Cropping with Tall Wheatgrass Barriers

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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 in grass barrier systems
3. Insect problems associated with continuous cropping in grass barrier systems
4. Tillage problems associated with continuous cropping
5. Rodent problems, if any, associated with tall wheatgrass barriers
6. Weed problems associated with continuous cropping between tall wheatgrass barriers

MATERIALS AND METHODS:

The tall wheatgrass barriers being evaluated 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, this 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 has been 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.

MATERIALS AND METHODS FOR THE 1995 SEASON:

No tillage was performed on the plots in the fall of 1994 and the stubble was allowed to stand over winter to collect snow. All the plots were sprayed with Roundup herbicide at the rate of 1 quart per acre on April 5, 1995 to control volunteer tall wheatgrass and other emerging weeds. All the continuous crop plots received an application of 30 lbs of actual nitrogen in the form of liquid nitrogen on April 26, 1995 whereas the summer fallow plot received an application of 200 lbs/a of 18-46-0 granular fertilizer.

On May 5th, the plots scheduled for tillage were worked twice with a tandem disc, except the summer fallow plot which was triple K'd twice. Also on May 5th, the no-till plots were seeded to Ernest spring wheat at a rate of 78 pounds/acre using a Versatile Noble No. 2000 no-till double disc drill with leading coulters and 9-inch row spacing. 70 pounds/acre of 18-46-0 was applied through the drill.

The tilled plots were also seeded on May 5th using the Versatile Noble No. 2000 double disc drill with 9-inch row spacing. Ernest spring wheat was seeded at the rate of 78 pounds/acre and 70 pounds/acre of 18-46-0 was applied through the drill.

The type of tillage and planting for the various plots were as follows:

<u>60 Ft. Barriers - Continuous Crop</u>

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)

<u>Open Field Stubble - Continuous Crop</u>

Plot G - no-till and no-till planting
Plot H - spring till and seeding

<u>Summer Fallow - (wheat-fallow) Rotation</u>

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

On June 9th, 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 pigeon grass and broadleaf weed control.

RESULTS AND DISCUSSION:

Precipitation as rain or snow occurred at this site during the October 1994 through September 1995 period as follows:

Month and Year	Inches of Moisture
October 1994	1.56
November 1994	0.22
December 1994	0.52
January 1995	1.00
February 1995	1.25
March 1995	0.97
April 1995	0.96
May 1995	3.24
June 1995	0.90
July 1995	3.34
August 1995	2.54
September 1995	0.48
Total	**16.98**

All of the plots in the study were harvested on August 21, 1995. Grain samples were obtained for test weight and protein analyses.

	Method of Seeding	Plant Height Inches	Test Weight Lbs/Bu	Grain Protein %	Yield Bu/Acre	Adj. Yield Bu/Acre *
1. 60 ft. Barriers						
Plot A	no-till	30.3	62.5	11.8	12.0	11.4
Plot B	till	28.3	62.0	13.8	23.3	22.2
Plot C	no-till	30.7	62.5	12.2	16.3	15.5
Plot D	no-till	27.9	62.5	11.9	15.0	14.3
Plot E	till	29.1	62.5	13.5	18.0	17.1
Plot F	till	28.3	62.0	12.4	23.3	22.2
2. Open Field						
Plot G	no-till	29.1	62.5	11.3	17.9	17.9
Plot H	till	26.8	62.5	13.6	22.7	22.7
3. Summer						
Plot J	till	30.7	62.0	14.1	27.4	27.4

* Adjusted yield in bushels/acre when the land removed from wheat production by the presence of the barriers is included in the plot size for yield determinations. The land removed was based on the current recommendation to utilize single row barriers 3 ft. in width. Adjusted yield factor = .952.

On continuous wheat cropping, tilled and planted plots averaged 21.8 bushels per acre with 13.3 percent protein whereas no-till plots averaged 15.3 bushels per acre with 11.8 percent protein. The 60 ft. barrier continuous wheat produced an average adjusted wheat yield of 17.1 bushels per acre with 12.6 percent protein. Open field stubble continuous wheat produced an average yield of 20.3 bushels per acre with 12.4 percent protein, whereas the wheat on summer fallow produced a yield of 27.4 bushels per acre with 14.1 percent protein.

The lower yields on no-till plots and lower yields within the 60 ft. barriers are attributed to volunteer wheatgrass infestations as a result of high seed production of the barrier tall wheatgrass in 1993 and 1994 and its spread into the no-till plots. 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. A higher rate of Roundup will be applied in 1996 for volunteer wheatgrass control. The incidence of *Pyrenophora trichostoma* (tan spot) and *Septoria* was 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 few wild oat plants in several barrier plots (A, B and C) and some pigeongrass in all plots necessitated the use of Hoelon to control these grassy weeds.

Damage by rodents, sawflies, grasshoppers, or other pests was not a factor in 1995 although some grasshoppers were evident late in the season.

A 22-year summary of the data obtained from the barrier system from 1974-1995 is reported below:

Snow Moisture Collection System	Plant Height Inches	Grain Protein Percent	Grain Test Weight Lbs/Bushel	Grain Yield Bushel/Acre
60 ft Barriers				
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
Average	**24.7**	**14.7**	**59.9**	**20.9 ***

* Adjusted average yield to compensate for land removed for 3 ft. barrier width is 19.9 bushels/acre.

Snow Moisture Collection System	Plant Height Inches	Grain Protein %	Grain Test Wt Lbs/Bu	Grain Yield Bu/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
Average	**23.8**	**15.1**	**59.7**	**22.6**
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
Average	**25.8**	**15.6**	**59.5**	**33.3**

During the past 22 year period of this continuous cropped spring wheat study, grain test weights have averaged 0.4 lbs. per bushel higher under continuous cropping within the barrier systems than test weights of wheat on fallow and 0.2 lbs. per bushel higher than wheat on continuous cropping in open field stubble. Conversely, grain protein content of wheat on fallow has averaged 0.9 % higher than wheat on continuous cropping within the barrier system and 0.4% higher than wheat on open field continuous cropping. Adjusted average yields for continuous crop spring wheat in the 60 ft. barriers is 19.9 bushels per acre compared to 22.6 bushels per acre for open field continuous cropped spring wheat and 33.3 bushels per acre for summer fallow.

In this long term study the continuous wheat cropping yields in the barrier system have yielded 2.7 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 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 has a yield advantage over the barrier system when wheat yields exceed this level (1974, 1975, 1976, 1978, 1983, 1987, 1993, 1994 and 1995). Open field stubble continuous cropping wheat has 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 and 1995. 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 and 1995, the lower no-till yields may be 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 may provide improved control of the volunteer tall wheatgrass. Also in 1993, poor seed to soil content in the no-till plots resulted in delayed emergence and reduced yields. 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' slightly 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 greater in the till and plant 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 especially effective in controlling annual weeds that have emerged in the no-till plots prior to seeding time. Over the twenty-two year period, continuous spring wheat cropping has produced 6.0 bushels per acre per year more than the spring wheat-fallow rotation.

Snow Moisture Collection System	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
60 Ft. Barriers *								
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
Average	**25.0**	**25.3**	**14.2**	**14.7**	**60.0**	**59.8**	**19.0**	**22.6**

* 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.

Snow Moisture Collection System	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
Open Field Stubble*								
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
Average	**24.9**	**24.6**	**14.5**	**15.3**	**59.8**	**59.4**	**20.9**	**23.2**

* 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.

FUTURE PLANS:

One of the long term objectives of this study is to develop the most successful methods of continuous cropping with spring wheat regardless of economic factors. Economic factors and demand may change rapidly and drastically. If the need for the continuous cropping of wheat arises, we need to be ready with the proper technology to permit farmers to shift to continuous crop production successfully. This may require a special means of moisture conservation such as tall wheatgrass barriers as well as new fertilizer practices, crop varieties, weed control methods, reduced tillage, and new types of farm equipment. Another objective of this study is to determine the long term influences of no-till, conventional till, and continuous cropping on spring wheat growth, vigor, yield, quality, and other crop performance characteristics. Continuation of this long term study could include detailed soils analyses to determine the long term influences of no-till, conventional till, and continuous cropping on soil organic matter, soil nutrients, etc., by a soil scientist.