PROJECT TITLE: Evaluation of Continuous Cropping with Tall Wheatgrass Barriers

PROJECT LEADER: Jerald W. Bergman, Superintendent, Eastern Agricultural Research Center, Sidney, Motnana

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 cropping dimensions of 30' x 265'. Three other barriers were of 60' x 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 1989 SEASON: No tillage was performed on the plots in the fall of 1988 and the stubble was allowd to stand over winter to collect snow. All of the plots were sprayed with Roundup herbicide on April 27th at the rate of 1 quart/acre to control volunteer tall wheatgrass and other emerging weeds. Soil tests showed adequate nitrogen and phosphorus, so no fertilizer was applied in 1989.

On May 1st, the plots scheduled for tillage were worked twice with a tool bar and harrow, except the summer fallow plot which was triple K'd twice. Immediately after, the tilled plots were seeded to Amidon spring wheat at a rate of 78 lbs. per acre. A 7-inch single disk John Deere press drill was used to seed the tilled plots.

The no-till plots were also seeded on May 1st using a Versatile Noble No. 2000 no-till double disc drill with leading coulters and 9-inch row spacing. Amidon spring wheat was seeded at the rate of 78 lbs. per acre.

The type of tillage and planting and soil moisture depth at planting time for the various plots in 1989 were as follows: The depth of moisture was determined by use of a Paul Brown soil moisture probe.

60 Ft. Barriers - Continuous Crop	Soil Moisture Depth in Inches (May 1st)
Plot A - no-till and no-till planting	28
Plot B - spring till and conventional seeding	24
Plot C - no-till and no-till planting	24
Plot D - no-till and no-till planting	24
Plot E - spring till and conventional seeding	22
Plot F - spring till and conventional seeding (40 ft. barrier for this plot only)	24
Open Field Stubble - Continuous Crop	
Plot G - no-till and no-till planting	22
Plot H - spring till and conventional seeding	20
Summer Fallow - (wheat-fallow) rotation	
Plot I - spring till and conventional seeding on fallow	24
Plot J - summer fallow	

On May 6th, all the plots were sprayed with 1 quart/acre of Roundup herbicide to control emerging volunteer wheatgrass. On May 27th, all the plots were sprayed with 1.5 pints/acre of Buctril herbicide for broadleaf weed control and 3 pints/acre of Hoelon for pigeongrass control.

RESULTS AND DISCUSSION: Precipitation as rain or snow occurred at this site during the September 1988 through August 1989 period as follows:

Month and Year		Inches of Moisture
September 1988		1.74
October		0.13
November		0.38
December		0.75
January 1989		0.56
February		0.43
March		0.43
April		2.65
May		1.98
June		0.97
July		0.90
August		1.32
	Total	12.24

All of the plots in the study were harvested on August 15, 1989. Grain samples were obtained for test weight and protein analyses.

	Method of Seeding	Soil Moisture Depth Ins. 1/	Plant Hgt. Ins.	Test Wt. Lbs/ Bu.	Grain Protein Percent	Yield Bu/ Acre	Adj. Yield Bu/A. 2/
1. 60 Ft. Barriers							
Plot A	no-till	28	27	57.5	15.4	29.9	28.5
Plot B	till	24	25	57.0	15.3	28.9	27.5
Plot C	no-till	24	24	57.0	16.0	22.2	21.1
Plot D	no-till	24	24	57.5	15.9	22.0	21.0
Plot E	till	22	22	57.0	15.8	25.3	24.1
Plot F	till	24	23	56.5	16.9	26.6	25.3
2. Open Field Stubble							
Plot G	no-till	22	22	56.5	17.1	20.0	20.0
Plot H	till	20	20	56.0	17.8	20.6	20.6
3. Summer Fallow							
Plot I		24	23	57.5	16.3	27.0	27.0

1/ Soil moisture readings made on May 1st

2/ Adjusted yield in bushels per 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.

On continuous wheat cropping, tilled and planted plots averaged 25.4 bushels per acre whereas no-till plots averaged 23.5 bushels per acre. The 60 ft. barrier continuous wheat produced an average adjusted wheat yield of 24.6 bushels per acre. Open field stubble continuous wheat produced an average yield of 20.3 bushels per acre, whereas the wheat on summer fallow produced a yield of 27.0 bushels per acre. The yields reflect the depth of soil moisture at planting time.

The principal fungal diseases noted in this study were Pyrenophora trichostoma (tan spot) and Septoria. The incidence of disease was light in all the continuous wheat plots as well as the wheat on fallow plots.

Despite herbicide use, a few kochia and Russian thistle plants were evident in all the plots but only at a very low infestation level. Damage by rodents, sawflies, grasshoppers, or any other pests were not observed in 1989.

A 16-year summary of the data obtained from the barrier system from 1974-1989 is reported below:

Snow Moisture Collection System	Plant Height Inches	Grain Protein Percent	Grain Test Wt. Lbs/Bu.	Grain Yield Bu/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
Average	22.3	15.2	59.6	19.1 1/

1/ Adjusted yield to compensate for land removed for 3 ft. barier width is 18.2 bushels per acre.

Snow Moisture Collection System	Plant Height Inches	Grain Protein Percent	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
Average	21.7	15.7	59.3	20.4
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
Average	24.0	16.0	59.2	30.4

During the last 16-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 on fallow and 0.1 lbs. per bushel higher on continuous cropping in open field stubble than on fallow. Conversely, grain protein content has averaged 0.8% higher on summer fallow than on continuous cropping within the barrier system and 0.3% higher grain protein on summer fallow than open field continuous cropping. Adjusted average yields for continuous crop spring wheat in the 60 ft. barriers is 18.2 compared to 20.4 bushels per acre for open field continuous cropped spring wheat and 30.4 bushels per acre for summer fallow.

In this long term study, the continuous wheat cropping yields in the barrier system have yielded 18.2 bushels per acre compared to a yield of 20.4 bushels per acre in the continuous wheat cropping in open field stubble. 0.9 bushels 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 with nearby wheat plants also causes some yield reduction. 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, and 1989) 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, and 1987). 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, and 1978).

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[1/]								
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	19.1[2/]	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
Average	20.2	19.8	13.4	13.8	54.1	53.9	17.7	19.1

1/ 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.

2/ 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[1/]								
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[2/]	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
Average	21.4	21.1	15.2	16.1	59.3	58.5	17.4	19.6

1/ 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.

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

In 1977, no-till treatments were added to this long term continuous cropping system for comparison with conventional till and plant plots. The no-till plots have produced yields similar to conventional till and plant plots except in 1978 when the no-till plots had a larger population of wild oats than conventional till and plant plots and in 1986 when the no-till plots were seeded with a Versatile Noble No. 2000 no-till drill and deep seed placement contributed to the lower yields in the no-till plots. Plant height and test weight have been slightly higher in no-till plots but protein has been slightly higher in till and plant plots.

The incidence of the disease Pyrenophora trichostoma (tan spot), has been greater 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 is also effective in controlling annual weeds that have emerged in the no-till plots.

In 1989, no-till plots produced an average yield of 23.5 bushels per acre, whereas tilled and planted plots produced an average of 25.6 bushels per acre. Plant height and test weights were slightly higher in no-till plots when compared to till and plant plots.

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.

The availability of a remote weather station funded by the Montana Wheat and Barley Committee will permit us to monitor many important weather parameters in this study during the 1990 season. It is interesting to note that continuous spring wheat cropping has produced about 5 bushels per acre per year more than the spring wheat-fallow rotation.