# GRASS BARRIERS AND SWATHING FOR SNOW MANAGEMENT

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## INTRODUCTION

Apart from the need to increase our total grain production by 50% by the year 1990, there is a need for the agricultural industry to use water more efficiently (Nicholaichuk 1980). A dramatic spread of salinity is a concern of many farmers in Saskatchewan. The main reason often given for the increase in salinity is the 2-year crop-fallow system that does not efficiently use stored moisture. To improve water use efficiency, and thereby increase production, one option is to extend the cropping system by improved management of our snow resource.

In this presentation, I would like to examine the use of grass barriers and swathing techniques for snow management to increase the available water in dryland crops.

### Grass Barriers

The work on grass barriers was pioneered by research workers in Montana. Barriers of tall wheatgrass planted in single or double rows spaced 9 to 15 m apart have proved very effective for snow management (Black and Siddoway 1976). Based on 8 years of study, they found that (1) soil moisture storage can be increased by 5 cm per year, (2) more water is stored by the barrier system than 21 months of fallow, (3) moisture use efficiency with continuous cropping is in the order of 70 to 80% compared to 30% with conventional wheat-fallow, (4) production efficiency per centimeter of water used was three to four times that of the spring wheat-fallow system, (5) the potential for deep percolation was reduced, thereby reducing the potential of salinity, (6) grain yields were 30 to 59% higher with the continuous cropping system compared to the 2-year wheat-fallow rotation, and (7) winter wheat in barriers outyields winter wheat grown without barriers by 40.6 kg/ha (4 bu/acre).

A similar study was initiated at Swift Current in 1977. Four 10-ha plots were seeded to grass (two plots of Orbit tall wheatgrass and two with Altai wild rye) in single rows, 15 m apart orientated perpendicular to prevailing winds. Three years were required to establish a suitable grass stand of Altai wild rye and tall wheatgrass for trapping snow. The amount and distribution of moisture derived from snow trapped within the grass barriers was determined by snow surveys and direct soil moisture measurements and then compared with the check (nonbarrier plots).

Effect of Grass Species on Moisture Competition. Although the study in Montana demonstrated that tall wheatgrass was suitable for a grass barrier for snow management, it was believed perhaps Altai wild ryegrass could be replaced as a substitute. The tall erect characteristics of the Altai wild rye was considered to be comparable to the tall wheatgrass. However, since initiation of the project, it was observed that the Altai wild ryegrass was a strong competitor for soil moisture. Observations indicated that this species would not be suitable for the original intended purpose.

During 1979-80, a detailed study was conducted to evaluate the moisture competition of the two grass species on soil moisture in trapped snow as a result of snow management. Two factors were considered: effect of the grass species on yield and stored soil moisture.

(a) Effect of Grass Barriers on Stored Soil Water

The Altai species of grass is a strong competitor for stored soil water. Soil water on fallow is depleted to a distance of 3.7 m from the row compared to 1.2 m for Orbit. Using the average water content towards the centre of the strip as a basis for comparison, there is a 35 to 66% reduction in plant-available water in the zone bordering the grass barrier on both fallow and stubble plots (Table 1 and 2). The moisture withdrawal pattern represents the type of rooting system that each of the two grass species have (Fig. 1a and 2a).

Table 1. Effect of grass barrier type on yield and spring soil moisture for winter wheat

| | | Distance from row | Yield reduction % | Moisture |
|---|---|---|---|---|
| Fallow | | | | |
| | Altai | 3.7 | 66 | 66 |
| | Orbit | 1.2 | 1.7 | 4% increase |
| Stubble | | | | |
| | Altai | 2.4 | 40 | 40 |
| | Orbit | - | 40% increase | 9% increase |

Table 2. Effect of grass barrier type on yield and spring soil moisture for spring wheat

| | | Distance from row | Yield reduction % | Moisture |
|---|---|---|---|---|
| Fallow | | | | |
| | Altai | 3.7 | 64 | 35 |
| | Orbit | 1.2 | 8 | 5% increase |
| Stubble | | | | |
| | Altai | 3.7 | 51 | 43 |
| | Orbit | 1.2 | 28% increase | 15% increase |

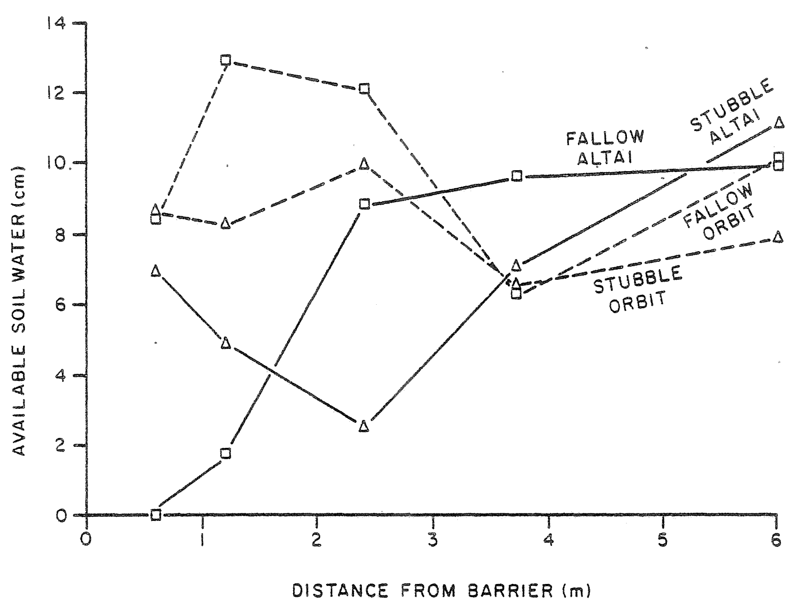


Fig. 1a. Effect of grass barrier on available soil water at varying distances from the row on winter wheat

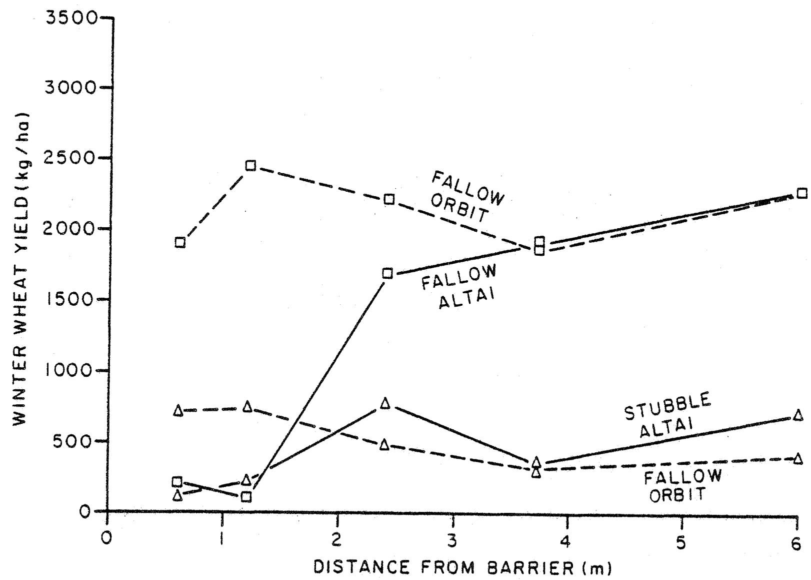


Fig. 1b. Effect of grass barrier on winter wheat yield at varying distances from the row

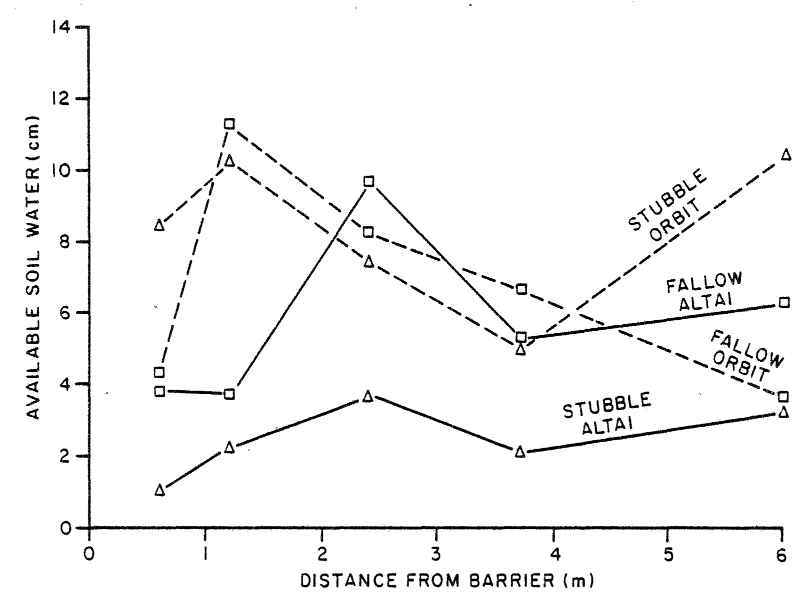


Fig. 2a. Effect of grass barrier on available soil water at varying distances from the row on spring wheat

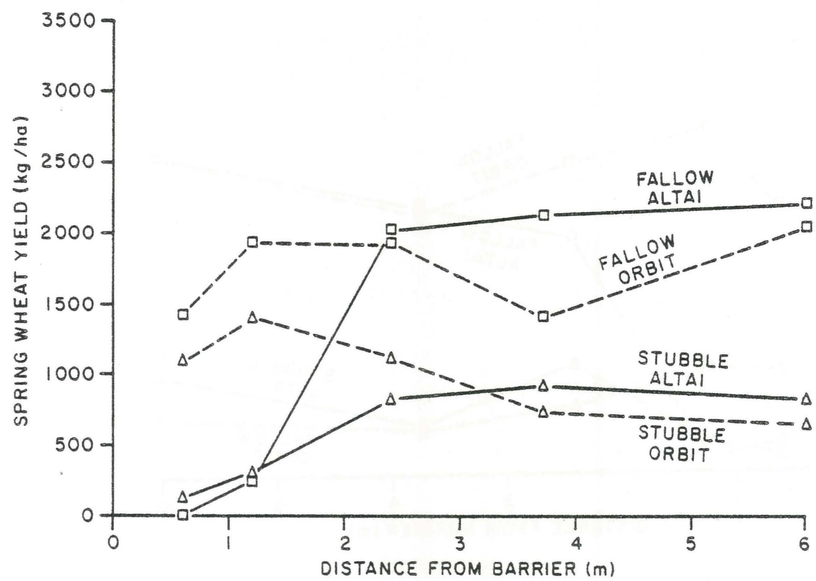


Fig. 2b. Effect of grass barriers on spring wheat yield at varying distances from the row

Noteworthy, on stubble adjacent to Orbit tall wheatgrass, there is an increase of stored soil moisture adjacent to the row on both spring wheat and winter wheat plots. With 1979-80 being a very low precipitation year (5.13 cm), an increase of stored water was derived from snowdrifts that accumulated adjacent to the row.

(b) <u>Effect of Type of Grass Barrier on Yield</u>

As often is the case, yield is synonymous with spring soil moisture. The average yield reduction in a 3.7-m strip bordering the Altai wild ryegrass ranges from 40 to 64% compared to a range of 2 to 8% decrease in a 1.2-m strip adjacent to the Orbit tall wheatgrass (Table 1 and 2). This large yield reduction adjacent to Altai grass strip accounts for an overall yield reduction of both winter and spring wheat yields on plots on which Altai wild ryegrass is used to trap snow.

Surprisingly, the increase in stored soil water adjacent to the Orbit tall wheatgrass results in an increase in yield (Fig. 1b and 2b). This observation further verifies that Orbit tall wheatgrass is not a strong competitor for soil water and is well-suited as a grass barrier for snow management.

(c) Effect of Barrier Type on Snow Entrapment and Soil Water Gain and Subsequent Yield

Barrier type appears to affect the overall snow entrapment and subsequent soil water gain even on a low precipitation year as experienced in 1979-80. On the plot where Orbit tall wheatgrass barriers were used to trap snow, 53% of the overwinter precipitation was trapped as snow within the barrier strip (Table 3). Altai barriers only trapped 37% compared to 30% for stubble check (Table 4). No snow was accumulated on fallow during the winter of 1979-80.

Table 3. Effect of grass barrier type on overwinter soil water gain and subsequent yields during 1979-80

| Continuous Crop | | Altai | Orbit | Control |
|---|---|---|---|---|
| Winter wheat | | | | |
| | Soil water (cm) | 4.5 | 6.0 | 3.4 |
| | Yield (kg/ha) | 352 | 535 | 257 |
| Spring wheat | | | | |
| | Soil water (cm) | 7.9 | 4.8 | 4.8 |
| | Yield (kg/ha) | 550 | 803 | 822 |

Table 4. Effect of grass barrier type on snow entrapment

| Treatment | % Snow Trapped |
|---|---|
| Altai barriers | 37.2 |
| Orbit barriers | 53.4 |
| Stubble check | 30.6 |
| Fallow | 0 |

Soil water gain pattern closely resembled that of snow entrapment. For winter wheat, 6 cm of water was stored on the Orbit trap strip compared to 4.5 for the Altai and 3.4 for conventional stubble (Table 3). On spring wheat, observations of soil water gain differed. More water was stored on the Altai plots than on Orbit. However, the yields did not correspond with accumulated soil water because of the strong competitive nature of the Altai barriers and their subsequent effect on yield adjacent to the rows.

(d) Effect of Barriers on Microclimate

Evaporation and wind speed were two factors considered in assessing the effect that barriers may have on the microclimate. A standard anemometer and an ogo-pogo evaporimeter, installed at a height of 0.75 m in early spring, were monitored throughout the growing season.

The cumulative evaporation and wind reduction over the season was 25 and 17%, respectively. (Table 5). Wind speed reductions were similar to those reported by Black and Siddoway (1976). The reduction of evaporation and wind speed helps to offset the competition of the barriers for stored moisture. It is believed the main benefit may be derived during the early stages of growth when soil water near the surface is limited.

Table 5. Effect of grass barriers on evaporation and wind

| | Within Barriers | Check | % Reduction |
|---|---|---|---|
| Evaporation (mm) | 730 | 970 | 25 |
| Wind (km) | 12660 | 10540 | 17 |

Trap Strips for Snow Management

The University of Saskatchewan Agricultural Engineering Department conducted, under contract (Stepphun 1980), a study on snow trapping performance of the tall stubble strip left by the prototype deflector and swathing attachments during the winter of 1979-80 on the University farm near Saskatoon and on a farm near Eston. On the University of Saskatchewan Kernan farm, a field of spring wheat was swathed with a 19-foot International Harvester 175 self-propelled windrower into six 3.2-ha test blocks. Blocks were randomly selected for swathing with clipper, deflector or no attachment; swathing without an attachment resulted in a conventional cut which served as a test control.

Each block was windrowed in a north-south direction and included a 7.6-m wide conventionally cut headline. Height of the deflector strips ranged from 13 to 29 cm for conventional stubble to 80 cm maximum. Deflector strips were placed on 5.8 m centres. The side-mounted clipper formed trap strips averaging 61.7 cm tall, 45 cm wide and spaced 6.25 m apart. The intervening crop was cut at conventional height near 118 cm.

Maximum snow cover was measured for depth and density in February and March 1980. The number of observations per test block ranged from 64 to 199 for depth and 9 to 22 for density taken randomly with a gravimetric M.S.C. (7 cm diameter) core sampler. Mean values for each variable were used to compute the average snow-water equivalent for each block. Average snow cover values are recorded in Table 6 and indicate a close relationship between stubble height and snow accumulation. The tall trap strips generally retain from 1.5 to 2.5 more snow mass than in the low stubble.

Table 6. Average snow depth, density, water equivalent and soil water enrichment for snow trap blocks Winter 1979-80

| Location | | Snow Depth (cm) | Density ($g/cm^3$) | Water Equivalent (cm) | Soil Water Gain (cm) |
|---|---|---|---|---|---|
| Saskatoon | | | | | |
| North University Kernan Farm | Control | 18 | .23 | 4.2 | 5.2 |
| | Clipper | 46 | .26 | 12.2 | 8.6 |
| | Deflector | 43 | .27 | 11.4 | 13.4 |
| South University Kernan Farm | Control | 18 | .24 | 4.4 | 5.8 |
| | Clipper | 43 | .28 | 11.8 | 9.1 |
| | Deflector | 36 | .24 | 8.4 | 6.5 |
| Eston | | | | | |
| Wise-Bayne Farm | Control | 17 | .24 | 4.2 | 5.8 |
| | Deflector | 23 | .27 | 6.1 | 6.0 |

Gravimetric soil cores were obtained from each block during late September and October of 1979 and again in late April and early May of 1980. Samples from four depth layers up to 80 cm were weighed before and after oven drying at 100°C and used to compute soil water masses and bulk densities. Table 6 records the average overwinter soil water enrichments in 5 to 90 cm profile test blocks. At Saskatoon, extra soil water recharge associated with the snow trap strips amounted to roughly 150% of the recharge in conventional stubble. At a test site 5 miles north of Eston, soil water data did not indicate any advantage from the trap strips. At Eston, it is believed that large areal variability caused by limited snow cover was not adequately sampled, i.e., extra water in the strips was insufficient to spread uniformly to a significant detectable amount. More than likely, any extra snow-melt water absorbed by the soil moved downward past the sampling zone or was evaporated at a greater rate on the surface.

As one would expect, snow is necessary to realize the benefit from snow management. Consequently, the results are more dramatic from the Saskatoon tests compared to those at Eston.

While on the topic of trap strips, it should be noted that another new method practiced by Del Erickson at Portreeve, Saskatchewan (Personal

Communication 1980), is one which involves leaving a 40 cm strip of unswathed grain about every 12 m. The amount of unharvested crop is estimated to be 3% of the total acreage or equivalent to 67 kg/ha (1 bu/acre).

Dr. Harold Stepphun, formerly of the University of Saskatchewan, found that a field with intermittent strips of grain had trapped an average of 9 cm of snow above conventional stubble trappage (Froehlich 1980). By comparing soil water measurements between autumn and spring levels, there was an average additional gain of 5 cm over the conventionally swathed field.

Stepphun concluded that even under conservative yield estimates recharge from snow trapping accounted for an extra yield of 423 kg/ha and the ratio of investment reached 600% (Froehlich 1980).

Mr. Del Erickson (Personal Communication) has practiced leaving a 40 cm strip of unswathed grain for several years and has found economic benefits to be appreciable.

## SUMMARY

Altai wild ryegrass was found to be unsuitable for grass barriers. The extensive root system has an affect on a large area adjacent to the barrier in which stored soil water is withdrawn. Subsequent yields are drastically reduced. Furthermore, the snow trapping capability of tall wheatgrass is superior to wild ryegrass.

Trap strips for snow management appear to be promising. Preliminary results indicate that up to 50 cm of additional water can be trapped by strips of tall standing stubble. Trap strips have the advantage of being low-cost and noncompetitive.

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