COMPARISON OF A SPRING WHEAT-MECHANICAL FALLOW ROTATION WITH A WINTER WHEAT-CHEMICAL FALLOW ROTATION IN SOUTHWESTERN SASKATCHEWAN

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ABSTRACT

A Canuck spring wheat-mechanical tillage fallow rotation (SWMF) was compared to a Norstar winter wheat-chemical fallow rotation (WWCF) between 1981 and 1985 at Swift Current. Over the 5 year period, production costs were somewhat greater for SWMF but grain yields, gross returns, and net returns were not significantly different between rotations. Yearly variation in grain yields and net returns were less for WWCF. In the wetter years of 1981, 1982, and 1983, SWMF had significantly larger grain yields, gross returns, production costs, and net returns. In the drier years of 1984 and 1985, production costs were similar but WWCF had significantly larger grain yields, gross returns, and net returns. Total herbicide costs for both rotations were essentially equal. Available soil water in the spring of the crop year was equal for the two rotations which suggested WWCF had less non-productive loss of water.

Introduction

A spring wheat-fallow rotation incorporating conventional tillage management (SWMF) has predominated in southwestern Saskatchewan for many years. With the introduction of the more winter hardy winter wheat variety, Norstar, in the 1970's, many producers became interested in winter wheat as an alternative to spring wheat. One important reason for this was the reported 25% yield advantage of winter wheat over spring wheat (Fowler and Gusta 1981). At Swift Current, Austenson and Anderson (1969) noted that a zero-till seeded winter wheat-chemical fallow rotation (WWCF) outyielded SWMF by 45%. They also noted that either preseeding tillage on chemical fallow or seeding on mechanically tilled fallow reduced winter wheat yields and greatly increased the risk of winterkill. The present recommendation for winter wheat production on fallow calls for zero-till seeding into chemical fallow (Fowler 1986). In addition to the possible yield advantage over SWMF, WWCF is also attractive because the soil is well protected from erosion with residue and/or crop.

WWCF is a potential rotation for southwestern Saskatchewan, but it entails considerably different management practices than the traditional SWMF. Unfortunately, producers have little information on the economic ramifications of switching from SWMF to WWCF. This paper reports on a five year study of an agronomic and economic comparison of WWCF to SWMF at Swift Current.

Materials and Methods

The study was established at the Agriculture Canada Research Station at Swift Current on a Swinton silt loam (Ayres et al. 1985), an Orthic

Brown Chernozem (Canada Soil Survey Committee. Subcommittee on Soil Classification 1978). To have both phases of the rotations present every year, each of the two replicates was divided into four 60 x 180 m plots. Two plots were randomly assigned to each wheat-fallow rotation with the rotation cycling on its assigned plot.

Spring wheat (cv 'Canuck') was seeded in early May with a hoe press drill following seedbed preparation which consisted of one operation with a heavy duty cultivator and attached rodweeder. Winter wheat (cv 'Norstar') was seeded in early September with a prototype offset double disc drill (Dyck and Tessier 1986) directly into the chemical fallow. Seeding rates were 67 kg/ha for both spring and winter wheat.

Both SWMF and WWCF were managed using generally recommended practices for Saskatchewan. Both winter wheat and spring wheat received fertilizer P as mono-ammonium phosphate (11-48-0) placed with the seed at a rate of 45 kg/ha of fertilizer product. Fertilizer N was applied at recommended rates based on fall soil tests. In three years, fertilizer N was broadcast in early May as ammonium nitrate (34-0-0) on both winter and spring wheat. The 5-year average application rate was 10 kg N/ha and 5 kg N/ha for spring and winter wheat, respectively (the actual rate was never less than 17 kg N/ha on any plot).

All plots were sprayed with 2,4-D in late fall or early spring to control winter annual weeds. During the crop year, the winter wheat required no additional herbicides. Weed control on the chemical fallow was accomplished with several spray application of glyphosphate/dicamba/2,4-D mix at recommended rates as required. During the crop year, broadleaf weeds were controlled in the spring wheat with bromoxynil or a bromoxynil/MCPA mix, while grassy weeds were controlled with diclofop methyl. Several operations with a heavy duty cultivator and/or rodweeder were performed as required to control weeds in the mechanical tillage fallow areas.

All wheat plots were windrowed with a self-propelled swather leaving 15 to 30 cm tall stubble. Yield measurements were made by threshing several 30 m swath segments per cropped plot with a conventional combine.

Soil water was determined gravimetrically to a depth of 120 cm using a 5 cm diameter soil core taken in mid to late October and in April or early May. Three soil cores were taken in each plot at each sampling. Spring soil samples were taken in the same general vicinity of fall soil samples. Available soil water was estimated assuming the 40 bar water content was the limit of water availability.

The economic analysis used a partial budgeting approach to examine the costs and returns. In this analysis, only those costs that differed between treatments were considered. Fixed machine costs, operating and repair costs for machinery, and labor requirements were estimated from Saskatchewan Agriculture (1988a). Labor was valued $9/h and other inputs were valued at 1988 cost levels (Saskatchewan Agriculture 1988b). Grain was valued at $165/t and $148/t for spring and winter wheat, respectively. No allowance was made for any erosion protection benefits of WWCF.

Prior to experiment initiation in fall of 1979, the land had been cropped in SWMF for many years. Data for 1980 was not included in the analysis because the winter wheat was seeded on mechanical tillage fallow. In 1981, data from one replicate was treated as missing as both winter wheat and spring wheat crops were on land which had been mechanically fallowed in both 1979 and 1980. Winter wheat seeded in fall 1980 was on chemical fallow of 1979 spring wheat stubble. In early spring 1982, winter wheat on one replicate showed considerable winterkill damage and was tilled and reseeded to spring wheat. Yield data from this plot was treated as a missing observation.

Annual data was subjected to statistical analyses using the general linear model analysis of variance procedure for randomized block designs (SAS Institute Inc. 1985). When data was grouped over years, the analysis was run as a split plot design (Steel and Torrie 1980).

Results and Discussion

As expected, the absence of tillage resulted in lower fixed and variable machine costs for WWCF than SWMF (Table 1). Because of large herbicide costs, the chemical fallow was approximately 50% more expensive than the mechanical fallow. However, the chemical fallow herbicide costs of WWCF were roughly matched by the greater in-crop herbicides required for SWMF. Consequently, total herbicide costs for the two rotations did not differ greatly. Over all years, total production costs for WWCF averaged $12/ha less than SWMF (Table 2).

Table 1. Annual production costs for SWMF and WWCF

		------------Year------------					
Cost	Rotation	1981	1982	1983	1984	1985	Mean
Fallow							
Fixed Machinery	SWMF	22	25	25	11	16	20
	WWCF	7	7	7	8	8	7
Mach. Oper. + Labor	SWMF	26	30	30	12	16	23
	WWCF	5	5	5	5	5	5
Herbicides	SWMF	3	3	3	3	3	3
	WWCF	60	60	60	67	55	60
Crop							
Fixed Machinery	SWMF	45	45	48	36	42	43
	WWCF	45	46	45	34	41	42
Mach. Oper. + Labor	SWMF	39	39	42	32	39	38
	WWCF	39	40	39	31	38	38
Seed + Fertilizer	SWMF	26	26	34	38	30	31
	WWCF	25	29	26	29	29	27
Herbicides	SWMF	53	53	53	48	48	51
	WWCF	3	3	3	3	3	3

Overall (1981-1985), winter and spring wheat yields were similar (P < 0.10, Table 2). This result contradicts the general yield advantage reported for winter wheat over spring wheat in Saskatchewan (Fowler and Gusta 1981). Gross and net returns were not significantly different for the two rotations. WWCF grain yields showed much less yearly variation than SWMF. This greater yield stability of WWCF translated into greater stability of gross and net returns. From the viewpoint of net returns, both rotations are equally feasible for southwest Saskatchewan.

When grouped into wet and dry years, the rotations performed differently. In the wet years of 1981, 1982, and 1983, SWMF had significantly larger grain yields, gross returns, production costs, and net returns than SWMF. The higher production costs of SWMF in wet years was partly due to the greater tillage requirements necessary to maintain adequate weed control on summerfallow areas (Table 1).

In the dry years of 1984 and 1985, the total production costs for the rotations were equal, but WWCF had significantly larger grain yields, gross returns, and net returns. The ability of WWCF to outyield SWMF in drought years was also noted by Austenson and Anderson (1969).

Table 2. April-May-June-July (AMJJ) precipitation (mm), grain yields (kg/ha), gross returns ($/ha), total production costs ($/ha), and net returns ($/ha) for SWMF and WWCF++

Item	Rot.	1981	1982	Year 1983	1984	1985	All years 1981-1985	Wet years 1981-1983	Dry years 1984-1985
AMJJ precip.		211	254	209	111	87	174	225	99
Grain	SWMF	2134	3033	2635*	1445+	1235*	2093	2601*	1340*
Yield	WWCF	2356	2265	2520	2352	1760	2236	2380	2056
Gross	SWMF	176	250	217+	119+	102+	173	214*	111*
Return	WWCF	174	168	187	174	130	165	176	152
Prod.	SWMF	107	110	116	90	97+	104+	111*	94
Cost	WWCF	92	95	92	89	89	92	93	89
Net	SWMF	69	140	101	29*	5*	69	103+	17*
Return	WWCF	82	75	94	85	41	75	84	63

++ All economic results are expressed on a total rotation basis.
\+ Significantly different P<0.10.
* Significantly different P<0.05.

Winter wheat was a very strong competitor with summer annual broadleaf and grassy weeds. Although the winter wheat was never as clean of weeds as the well-sprayed spring wheat, the level of weed infestation in the winter wheat was always less than the economic threshold justifying spraying with post-emergence herbicides. Downy brome (Bromus tectorum L.) was not present in this study but is becoming a serious problem in reduced-tillage winter wheat production in southwestern Saskatchewan (Paquette et al. 1988). Where present, this hard-to-control weed would reduce the yields and net returns of WWCF.

There was no difference between rotations in soil nitrates to 60 cm in either the first fall or second fall after wheat harvest (Table 3). The nitrates for the second fall after harvest would be affected by N taken up by the winter wheat seedlings and by the 5 kg N/ha added with P fertilization of the winter wheat.

Table 3. Soil nitrates to 60 cm at fall soil sampling

Sampling	Rotation	Period 1979-1981	1980-1982	1981-1983	1982-1984	1983-1985	Mean
1st fall after wheat harvest	SWMF	17	10	13	13	18	14
	WWCF	17	21	24	16	18	19
2nd fall after wheat harvest	SWMF	63	65	48	39	53	53
	WWCF	38	62	43	69	63	58

WWCF had more soil water at the first fall after wheat harvest than SWMF (Table 4). This was probably due to the earlier maturation of the winter wheat giving a longer period to conserve precipitation before fall sampling. WWCF also had slightly more water in the first spring after harvest -- probably a carry-over of extra water present the previous fall. Despite the consumptive use of water by the winter wheat seedlings from seeding until fall soil sampling, there was no difference in soil water in the second fall after harvest. This suggests the fallow phase of WWCF may have had better water conservation from harvest to the second October than the fallow phase of SWMF. Elsewhere in the Northern Great Plains, marginally better water conservation from the wheat harvest to the second fall has been measured for chemical fallow compared to mechanical fallow (Lindwall and Anderson 1981, Tanaka and Aase 1987). There was no difference between rotations in soil water at sampling in the spring of the crop year. The remaining standing stubble of the zero-till seeded chemical fallow trapped sufficient snow water to replenish soil water used by winter wheat seedlings from fall soil sampling to spring soil sampling. Overall, the results suggest WWCF had less non-productive water loss than SWMF from wheat harvest to the spring of the crop year.

Table 4. Available soil water to 120 cm

		Period					
Sampling	Rotation	1979-1981	1980-1982	1981-1983	1982-1984	1983-1985	Mean
1st fall after wheat harvest	SWMF	-9	20	-3	34	-13	7^+
	WWCF	-18	41	10	46	-9	24
1st spring after wheat harvest	SWMF	35	49	37	95	43	54^+
	WWCF	46	66	49	108	53	60
2nd fall after wheat harvest	SWMF	88	114	134^*	142	91	117
	WWCF	83	104	149	133	66	113
2nd spring after wheat harvest	SWMF	102	106	180	145^+	97	129
	WWCF	104	115	159	141	124	130

$^+$ Significantly different P<0.10.
* Significantly different P<0.05.

When a winter wheat stand appears unsatisfactory in the early spring because of winterkill damage and/or the presence of hard-to-control weeds (e.g. downy brome), it is a common practice to work under the winter wheat and reseed the land to spring wheat. The equal soil water in the spring of the crop year for WWCF and SWMF indicates reseeding can be done without fear that the winter wheat seedlings have dried out the soil and thereby reduced the spring wheat yield potential. In this study, the winter wheat which was reseeded to spring wheat in 1982 yielded 2912 kg/ha -- similar to the 3033 kg/ha that spring wheat yielded on mechanical fallow.

Although not considered in this study, erosion control would be an important benefit of WWCF on land where wind erosion with SWMF is a common occurrence.

Conclusions

The 5-year average production costs were somewhat greater for SWMF but grain yields, gross returns, and net returns were not significantly different between rotations. Yearly variation in grain yields and net returns were less for WWCF. In the wetter years of 1981, 1982, and 1983, SWMF had significantly larger grain yields, gross returns, production costs, and net returns. In the drier years of 1984 and 1985, production costs were similar but WWCF had significantly larger grain yields, gross returns, and net returns. Total herbicide costs for both rotations were essentially equal. Nitrogen conservation over fallow were not different for the two rotations. The results suggested WWCF had less non-productive loss of water from wheat harvest to the spring of the crop year.

On the medium textured soil used in this study, WWCF was an economically viable alternative to SWMF. However, downy brome, which was not present in this study, could substantially reduce the profitability of WWCF. Winter wheat in WWCF did not dry out the soil between seeding and early spring indicating reseeding a unsatisfactory winter wheat stand with spring wheat is a practical option.

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