INNOVATIVE CROPPING SYSTEMS FOR SASKATCHEWAN

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ABSTRACT

This paper provides a brief overview of some of the components of the Innovative Acres Program being carried out in Saskatchewan. Initial emphasis of the program has been snow management as a means of extending rotations through increased soil moisture storage. Chemical summerfallow, winter wheat and annual grain legumes have become important components of the rotations being studied in the drier portions of the province, the Brown and Dark Brown soil zones. In the moister areas, Black and Gray soil zones, emphasis has been placed on achieving maximum yields through optimum use of fertilizers, herbicides and pesticides. Soil building crops such as alfalfa, clovers and annual grain legumes are seen as increasing components of crop rotations in these areas.

OBJECTIVES

The Innovative Acres Program was initiated in the autumn of 1981 with the objective of maximizing productivity and maintaining soil quality through water efficient farming practices.

METHODS

Cropping systems using innovative management techniques have been established at 39 locations throughout the province. These systems are cooperatively developed with participating farmers and regional agricultural committees. In each case the innovative cropping system, established on a 20-ha parcel is compared to an adjacent 20-ha parcel utilizing the regular farming system in the district. The comparisons made between the innovative and regular parcels have been based on a detailed soil survey and the establishment of transects along which twelve benchmark sampling sites are positioned. These sites represent upper, mid and lower topographic positions in the landscape. Neutron moisture casings are installed to a depth of 130 cm at each of the benchmark sites to measure soil water storage and crop use. Soil samples for fertility analysis and subsequent nutrient recommendations in addition to samples for yield are taken along the transect in the area adjacent to the moisture measurement sites. The Innovative treatments include: investigations of the effects of fall stubble management on the retention of snow water, the use of legumes for underseeding or as a partial summerfallow, chemical summerfallow when necessary, and the use of optimum fertilizer applications. Replicate plots were established at a number of the sites to provide more information on fertilizer management, nitrogen fixation by grain legumes, variable rate fertilizer application and crop residue management. At each of the locations individual farmers also included field strip demonstrations on management practices of local interest.

RESULTS AND DISCUSSION

Stubble Management

The manipulation of snow cover by fall stubble management offers the greatest potential for increasing plant available water on the Canadian prairies. Under good management each extra cm of water available to the growing wheat crop increases grain yield by about 100 kg ha^{-1}. Currently only about one-third of the fall and winter precipitation is stored as plant-available water; the remainder is lost as blown snow, runoff and drainage.

The Innovative Acres Program has monitored four fall management practices; 1) standing stubble, 2) standing stubble with snow strips, 3) fall cultivated stubble and 4) fallow. The snow catch strips were created by a swather attachment which leaves strips of taller stubble but harvests the heads. The data presented in Table 1 summarizes the results of 3 years of study of 100 fields.

Table 1. Differences in overwinter soil water storage between different fall stubble management systems.

Management System	Extra soil water gained (cm)			
	Upper Slope	Mid Slope	Lower Slope	Field Average
Standing stubble over fallow	2.5	3.6	6.3	3.4
Standing stubble over fall cultivated stubble	2.1	2.1	0.5	1.7
Stubble and trap strips over standing stubble	1.0	0.6	1.9	0.9

The studies indicate that leaving stubble standing in fall, in conjunction with herbicide treatment to control winter annuals, increases plant available water by approximately 2 cm. An additional 1 cm of snow water recharge can be attained by leaving snow catch strips in standing stubble.

Measured yield gains on fields showed that on the average an additional 280 kg ha^{-1} of wheat grain was produced where stubble was left standing. The major yield gains occurred on the mid-slope positions which represent the largest area of the field. The data presented in Table 2 shows the comparison of wheat yields for paired stubble and fall cultivated stubble with similar fertilizer treatments.

The results of the study indicate that fall stubble management has the potential to increase grain yields in the drier regions of the province. Differential height swathing or straight combining provides for good snow catch, and if used in conjunction with winter wheat and a flexible cropping system, can result in increased production in the Brown and Dark Brown soil zones. More research is required in the wetter areas of the province and on the problems associated with snowmelt infiltration.

Chemical Summerfallow

Chemical fallow has been a small but growing component of the Innovative Acres Program. It is particularly adaptable to the Brown and Dark Brown soil zones where it may compete favorably to conventional tillage fallow in terms of cost. If done properly, chemical fallow has been found to increase soil moisture storage in addition to providing cover and thus reducing erosion (Table 3).

Table 2. Measured yield gains by slope position for standing stubble vs. fall cultivated stubble (1983 and 1984, average of 6 sites).

Slope position	Wheat Yield ($kg\ ha^{-1}$) Stubble	Wheat Yield ($kg\ ha^{-1}$) Cultivated Stubble	Yield Increase ($kg\ ha^{-1}$)	W.U.E. ($kg\ cm^{-1}$)
Upper	1915	1735	175	194
Middle	2390	1990	400	270
Lower	2290	2150	140	100

Table 3. Soil moisture comparisons for chemical and regular summerfallow.

	Soil water gain (cm)	
	Chemical fallow	Regular fallow
Harvest - Spring (9)	5.3	5.0
Spring - August (9)	-1.0	-0.3
August - Spring* (5)	3.8	3.6
Total Gain (5)	8.0	7.1

*Four of the fields were seeded to winter wheat

The levels of NO_3^--N in chemical fallow fields are generally lower than in tilled fallow systems and extra fertilizer nitrogen inputs are often required to maximize yield. The data presented in Table 4 summarizes measured changes in NO_3^--N levels.

Table 4. Comparison of NO_3^--N levels for chemical and regular fallow systems.

	Changes in NO_3^--N ($kg\ ha^{-1}$)	
	Chemical fallow	Regular fallow
Spring '83-Fall '83 (5)	+73	+101
Fall '83-Spring '84 (4)	-55	-62
Spring '83-Spring '84 (4)	+18	+39

Partial Legume Fallow

Annual grain legumes are currently being grown in partial fallow systems as an alternative to either chemical or conventional summerfallow. Crops such as lentils are planted in the spring, and if moisture conditions are favorable for growth the crop can be maintained for its seed yield, desiccated to provide coverage for direct seeding of winter wheat, or worked in the next spring to provide green manure for the spring seeded crop. This system not only provides erosion control but offers the potential for a possible cash crop in addition to the benefits associated with biological nitrogen fixation.

N_2 Fixation by Annual Grain Legumes

The objective of this research is to quantify N_2 fixation and the yield of grain legumes as affected by rhizobial inoculation, cultivar and soil-climatic zone. Two cultivars of lentils, field peas and fababeans have been used in these studies. Inoculation was found to increase yields at nearly all sites with average yield increases of 24% for lentils, 35% for peas and 59% for fababeans. Estimations of N_2 fixation by ^{15}N isotopic dilution indicate that greater than 50% of the nitrogen in the grain legumes is due to fixation (Table 5).

Table 5. Estimation of N_2 fixation by grain legumes (Foam Lake 1984).

	^{15}N isotopic dilution		By difference
	% N derived† from fixation	N fixed (kg/ha)	N_2 fixed (kg/ha)
	Lentils		
Eston	54.6	44.1	20.7
Laird	31.7	27.3	6.1
	Peas		
Tara	59.9	78.3	72.0
Trapper	58.8	70.8	61.7
	Fababeans		
Aladin	52.3	20.3	0
Outlook	58.9	16.2	0

† $1 - \dfrac{\%\ ^{15}N \text{ excess fixing plant}}{\%\ ^{15}N \text{ excess non-fixing plant}}$

SOIL FERTILITY RESEARCH BEING CONDUCTED BY THE SASKATCHEWAN INSTITUTE OF PEDOLOGY

1. Sulphur and its relationship to carbon, nitrogen and phosphorus in a climotoposequence of Saskatchewan soils (J.R. Bettany, J.W.B. Stewart).

2. Natural sulphur isotope abundance variations applied to the study of the soil S cycle (J.R. Bettany).

3. Nature and forms of sulphur in boreal forest soils (J.R. Bettany, D.W. Anderson).

4. The soil S cycle (J.R. Bettany, J.W.B. Stewart).

5. Nitrogen-sulphur interactions in soils (J.W.B. Stewart, J.R. Bettany).

6. Micronutrients in Saskatchewan soils (J.W.B. Stewart, J.J. Germida).

7. Nitrogen fertilizer management for winter wheat (E.H. Halstead, D.B. Wilkinson, E. de Jong).

8. N_2 fixation in annual grain legumes (D.A. Rennie, E.H. Halstead, E. de Jong).

9. The effect of potassium chloride on the root rot of cereals (E.H. Halstead).

10. Investigations of the efficiency of large broadcast applications of fertilizer phosphate over an eight-year period (J.W.B. Stewart, J.L. Henry).

11. The agricultural use of potash (J.L. Henry).

12. The reserves and labile pool of potassium in agricultural soils (L.M. Kozak, P.M. Huang).

For additional information on these projects, please refer to the Saskatchewan Institute of Pedology's Twentieth Annual Report (1984-85) or contact the scientists involved.