EXTENDING THE GRAZING SEASON WITH MIXTURES OF SPRING-PLANTED SPRING AND WINTER CEREALS

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ABSTRACT
The objective of the study was to extend the grazing season into the fall using crop-combinations of spring-planted spring and winter cereals. Treatments established at Lacombe, Alberta, Canada were spring oat (*Avena sativa L.*) and barley (*Hordeum vulgare L.*) monocrops (SMC), spring-planted winter wheat (*Tritcum aestivum L.*) and winter triticale (*X Triticosecale* Wittmack) monocrops (WMC), spring and winter cereal binary mixtures seeded together in the spring (MX) and the winter cereal seeded after the first clipping of the spring cereal (double crop-DC). Clippings were carried out at 4 to 6 wk intervals after the initial cut (Boot and Late Milk Stage). MX produced more total yield than other systems when cut initially at the Late Milk stage (92% of SMC at initial cut and 65% of WMC for regrowth). MX was superior to DC and SMC for regrowth yield, but not WMC. Treatments containing winter triticale were superior to those containing winter wheat for fall regrowth. Cropping systems like MX have the potential to economically extend the grazing season in the parkland of the Canadian prairies.

KEYWORDS
pasture, cropping systems, double crop, mixture, spring and winter cereals

ACRONYM
DC, double crop; MX, mixture; SMC, spring cereal monocrop, WMC, winter cereal monocrop.

INTRODUCTION
The parkland of the Canadian prairies has a short growing season and inadequate fall pasture. Setting aside cash crop land solely for stockpiled fall pasture is not economical, but if the land is used for conventional production and then pasture it becomes feasible. Spring barley and oats are used for feed grain and conserved whole plant forage in either dried or ensiled form. Traditionally winter cereals (winter wheat, triticale and fall rye) are seeded in late August for use as grain the following year, but may be grazed in the fall (September and October). Winter cereals remain vegetative and will regrow after grazing until they are vernalized during the fall and winter period. If they are planted as early as May, they should remain vegetative throughout summer and fall. The objective of this study was to determine if alternative cropping systems (mixtures and double crops) devised from spring and winter cereal combinations could provide a conventional crop during the growing season (May-August) and then fall pasture (September-October).

MATERIALS AND METHODS
The study was established in 1987 and 1988 on a Black Orthic Chernozem, loam soil at Lacombe, Alberta. Cropping system treatments were SMC of Leduc barley and Cascade oats, WMC of Norstar wheat and Wintri triticale and binary combinations of spring and winter cereals as MX or DC. SMC, WMC and MX and the spring cereal component of DC were planted at the same time in the spring. The winter cereal component of DC was planted immediately after the initial cutting date of DC.

Monocrops were seeded at 200 seeds m^{-2}. The spring and winter cereal components of MX were seeded in alternate rows, each at 100 seeds m^{-2}. DC spring and winter cereal components were seeded, each at 200 seeds m^{-2}, in alternate rows. Total fertilizer applications were 122 kg N, 60 kg P_2O_5 and 60 kg K_2O_5 ha^{-1}, broadcast over all plots. Treatments were cut initially at the Boot or Late Milk stage (stages 45 and 77 after Tottman and Makepeace 1979). In total, the Boot and Early Milk stages were cut (at 4 to 6 wk intervals) 4 and 3 times, respectively. Dry matter yields were compared at initial cut, total regrowth (sum of all regrowth cuts) and fall regrowth (sum of September and October cuts).

Variances were partitioned by analyses of variance in a split plot design with years and initial cutting dates as main plots and cropping system-species combinations as subplots. Except for fall regrowth, cropping system differences were more prevalent than between treatments within cropping systems so comparisons were made at the group level for initial cut yield, total regrowth and total yield.

RESULTS AND DISCUSSION
Boot stage total yield for the cropping systems ranked WMC = MX > SMC = DC; the Late Milk stage ranking was MX > DC = MX = WMC (Table 1). Maximum total yield was attained by MX, DC and SMC when cut at the stage initially; total yield for WMC was unaffected by stage at initial cut.

Initial SMC and DC yields were synonymous, because the winter cereal of DC was not seeded yet. Initial yield ranked as SMC > MX > WMC at the Boot stage, but SMC = MX > WMC at the Late Milk stage (Table 1). MX yielded 78 and 92 % of SMC at Boot and Milk stages, respectively. When planted in early May the spring cereal component of MX compensates for a lower (50%) component seeding rate than SMC by producing larger tillers (Baron et al 1994). In contrast, fall rye, winter wheat and winter triticale plants grown with barley yielded from 15 to 36 % of plants grown in a WMC. After the jointing stage the spring cereal grows above the winter cereal, intercepting most of the incoming light, placing the spring cereal at a competitive advantage (Baron *et al.* 1995).

Total regrowth ranked WMC > MX > DC = SMC at Boot stage, while WMC > MX > DC > SMC at the Early Milk stage (Table 1). WMC had twice the total regrowth when cut initially at the Boot compared to Late Milk stage, but total yield was unaffected. MX produced 117% more regrowth when cut initially at the Boot vs. Early Milk stage. The longer the initial cutting date is delayed after the Boot stage the more winter cereal regrowth is depressed. No light reached the level of the winter cereal in the canopy after the heading stage in barley-MX (Baron *et al.* 1995). Immediately after the initial cut at the Boot stage a significant proportion of the regrowth for SMC, MX and DC consists of spring cereal tillers. Some of the spring cereal tillers were spared because their growing points were below cutting height (5 cm). This does not happen after the Late Milk stage. The MX produces more regrowth than SMC when cut at the Early Milk stage because the winter cereal component of MX regrows. However, MX regrowth yielded 65% of WMC (Table 1), because tillers of the winter cereal in MX do not attain the density of those in WMC (Baron *et al*. 1994). The regrowth of spring cereal tillers in DC after the Boot stage probably suppressed growth of the newly planted winter cereal plants, because total regrowth never rivaled the WMC or MX. Also, planting the winter cereal as late as the Early Milk stage in DC, resulted in plants that were too small to produce as much forage as the larger, but sparser tillers of the MX.

Differences between winter wheat and triticale in any system were not apparent, except for fall regrowth. Generally, triticale outyielded wheat in the DC and MX (Table 2). Winter triticale and fall rye regrow more rapidly than wheat after cutting in mixture treatments (Baron et al 1995). Winter triticale and fall rye are more well adapted for growth in the MX, because of a combination of higher photosynthetic rate under shade (rye) and lower dark respiration rates (both rye and triticale) than wheat (Baron *et al.* 1996).

CONCLUSION

A mixture of spring-planted spring and winter cereals can extend the grazing season into September and October and provide a conserved forage crop during the normal growing season. MX was superior to DC for fall pasture and total yield. WMC had higher regrowth yields than MX, but MX had the highest total yield of all systems.

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Table 1
Yields of initial cut, total regrowth and total dry matter yield for cropping systems averaged over years

	Initial Cut Yield		Total Regrowth Yield		Total Yield	
	Boot	Late Milk	Boot	Late Milk	Boot	Late Milk
	t ha^{-1}					
SMCz	2.41[c]	7.55[a]	3.11[c]	0.46[f]	5.52[c]	8.01[b]
WMC	0.93[e]	4.33[b]	6.56[a]	3.15[c]	7.49[b]	7.48[b]
DC	——	——	3.76[c]	0.83[e]	6.25[c]	8.19[b]
MX	1.87[d]	6.95[a]	5.61[b]	2.07[d]	7.71[b]	9.16[a]

[a-f] Means followed by the same letters are similar (P < 0.05) within parameters among stages based on standard error of a difference between groups.
[Z] SMC is mean of spring barley and oat monocrops; WMC is mean of winter wheat and triticale monocrops; DC is mean of double crop combinations of spring and winter cereals planted sequentially; MX is mean of mixtures of spring and winter cereals planted together.

Table 2
Fall regrowth yields for species combinations grown as double crops and mixtures averaged over years

	Double crop		Mixture	
	Boot	Late Milk	Boot	Late Milk
	t ha-1			
Oat - Wheat	0.23[b]	0.19[b]	0.68[g]	1.42[de]
Oat - Triticale	0.41[a]	0.50[a]	1.19[ef]	2.04[b]
Barley - Wheat	0.18[b]	0.28[b]	0.56[g]	1.65[cd]
Barley - Triticale	0.40[a]	0.31[ab]	1.02[f]	2.38[a]
Oat vs. Barleyz	ns	ns	ns	ns
Wheat vs. Triticale	**	*	**	**

[a-f] Means followed by the same letter are similar (P < 0.05) within cropping systems according to standard error of a difference between groups.

[z] Nonorthoganol comparisons between crop combinations containing oats and barley or wheat vs. triticale.
ns, *,** are not significant P < 0.05, P < 0.01, respectively for nonorthoganol comparisons.