Triticale Production and Utilization Manual 2005

Spring and Winter Triticale for Grain, Forage and Value-added

Alberta

Alberta Agriculture, Food and Rural Development

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Contents

List of Tables

List of Figures

SUMMARY

(Adapted from *Triticale*, AAFRD Agdex 118/20-1)

Spring Triticale

Drought tolerance is the primary advantage that spring triticales have over other spring cereal crops. Under dryland conditions, spring triticales are a valuable alternative to feed barley and oats. Spring triticale has a 5 to 19 percent yield advantage over CPS wheat and as much as 30% over CWRS wheat. This advantage is most apparent in areas with longer growing seasons. Spring triticale cultivars need a longer growing season because they mature more slowly than CPS wheat. Triticale is best adapted to the Brown soil zones of Alberta, Saskatchewan and southern Manitoba.

Spring triticale also provides an excellent high yielding alternative to barley and spring oat forage. In particular, a silage yield advantage of around 10 percent over barley and oats under dryland conditions makes triticale an excellent choice for livestock producers. Triticale generally ranks between barley and oats for silage quality.

The desired seeding rate plant population is 310 plants/m^2 (30 plants/ft^2). Triticale does not tiller as much as wheat. Maturity can be delayed and yields can be less when plant population is low. Triticale seeding rate should target higher plant density than CWRS wheat. Calculate your seeding rate using the seed's 1000 kernel weight, germination and seedling mortality for a target plant population. There is a calculator on the Alberta Agriculture website that can help.

Most cultural techniques for growing wheat can be transferred directly to triticale. Consequently, the fertilization, seedbed preparation, seeding depth and seeding methods used for wheat are acceptable for triticale. Spring triticale should be planted during the first two weeks of May. Although only a limited number of pesticides have been tested on spring triticale, pesticides that are suitable for use on both wheat and rye may be considered.

One of the most serious deficiencies of spring triticale is its susceptibility to sprouting in the swath. Spring triticale is more likely to sprout than red-seeded wheat but less likely than white-seeded wheat. Because triticale resists lodging and is hard threshing, it responds well to direct combining in areas where this practice is feasible (i.e. dryland).

Winter Triticale

Winter triticale differs from spring triticale because it requires a cold period (or vernalization) to initiate heading. If winter types are spring-seeded, there is no vernalization and plants will remain vegetative (no heading) and can be used for grazing.

Winter triticale provides a high-yielding early maturing alternative to spring triticale for short-season areas of the prairie provinces. Varieties such as Pika and Bobcat are similar in winter hardiness to the best winter wheats but are less hardy than fall rye. Pika and Bobcat are the only suitable varieties for use in Western Canada at present. Consequently, winter triticale is best adapted for seed production in the Brown soil zone of southern Alberta and in higher snowfall areas such as the Black soil zones of the prairies. In areas where winter triticale is well adapted, yields exceed those of winter wheat by as much as 10 to 20 percent.

Winter triticale can be two to three weeks earlier in maturity than spring triticale in the Black and Grey-wooded soil zones. Winter triticale matures approximately five days later than winter wheat and two weeks later than fall rye under similar growing conditions.

Fall-seeded winter cereals such as triticale and rye provide a valuable source of forage when spring grazed prior to harvest for silage or seed. Spring-seeded winter cereals alone or in mixtures with barley or oats provide an excellent source of pasture from mid-June until late in the fall (see *Winter Cereals for Pasture*, Agdex 133/20-1). Winter triticale and fall rye may also be planted in mixtures with barley or oats to produce a high quality silage crop with late-season grazing.

The test weight and 1000 kernel weight of winter triticale are rather variable compared to those of winter wheat. In general, a winter triticale will have a 1000 kernel weight 20 per cent greater than a CWRS wheat or a winter wheat. Consequently, seeding rates for triticale need to be adjusted to a higher rate.

There is no official test weight (pounds per bushel) for triticale, but it must be 52 lbs/bu (65 kg/hl) to make the grade of Canada No.1. However, the marketplace is demanding 55 lb/bu and higher.

Basic agronomic practices are similar for winter wheat, winter triticale and fall rye. Fertilizer applications should be based on soil tests. Ensure adequate levels of phosphate are applied in the fall and the nitrogen applications are split between fall and spring or if placed all in the fall, nitrogen should be placed outside the seed row.

Because few of the popular pesticides are registered for winter triticale, it may be necessary to use ones that are considered suitable for both wheat and rye.

The best time to seed winter triticale and winter wheat on black soils is between the last week of August and the end of the first week of September. Do not delay seeding winter triticale past mid-September because winter triticale hardens more slowly than winter wheat. Once developed, however, the hardiness of winter triticale equals or exceeds that of winter wheat.

The hardiest winter triticale cultivars are tall and may be subject to lodging if grown under high fertility and moisture conditions. Bobcat is an improvement on lodging susceptibility, but excessive nitrogen can still cause lodging.

Spring grazing for a short period before the end of the first week in June may reduce plant height without reducing seed yield. However, spring grazing may significantly reduce yield if it is poorly managed or timed too late.

Seeding at the earliest recommended date is another way that stand height may be reduced.

When combining triticale, a kernel moisture content of 14.0 percent or less is considered dry.

This manual presents in-depth information on the production and utilization of spring and winter triticale.

Part 1. INTRODUCTION

General information

- Triticale has become an accepted grain and forage crop worldwide, competitive with local grains and forages.
- Canada has leading technology for triticale production and use, but the industry has lagged in adopting this crop.
- New Canadian triticale varieties are equal to or higher yielding than other Canadian crops for grain, forage and biomass production, for feed, food and industrial applications.
- Canadian spring and winter varieties have superior adaptation to stress conditions such as drought, excess moisture, acidic soils, and high fertility situations where other crops are poorly adapted.
- Triticale grain is very suitable as feed for monogastrics and ruminants, especially for swine feed and for silage.
- Novel Canadian cropping systems using triticale provide new levels of sustainable crop planning flexibility, especially for enabling year-long forage supplies using grazing or conserved forage.
- Spring and winter types can be used in combination with other crops to spread the workload of seeding and harvesting more evenly throughout the year.
- Triticale has a special role in integrated cropping systems, providing crop diversity in the rotation, a break in pest, disease and weed cycles, and seasonal flexibility in its production and use pattern (i.e for grain, forage and for inter-cropping etc.).
- Triticale is very yield responsive and well-adapted to high fertility conditions. It is therefore a crop of choice to break a continuous barley rotation and can be used on highly manured lands with excessive nutrient loads. Used in this situation, triticale will remove nutrients from the field, thereby reducing the risk of nutrient leaching into groundwater. At the same time, high yields of triticale silage or grain will be returned to the livestock operation that generated the manure.

Background and history

Triticale is a hybrid between rye and wheat, made by using conventional plant breeding methods. No triticale varieties are genetically modified (GM).

The very first triticales were bred in 1876, and origins can be traced back to Scotland. Work on triticale was initiated in Canada in the 1950's but it was not until 1972 that the first commercial spring variety was released by the University of Manitoba. In the original triticales released in Canada and elsewhere the hope was to combine the hardiness and adaptability of rye to stress conditions with the high food and processing value of wheat. The breeding program in Winnipeg released a number of varieties in the early years (Rosner, Welsh and Carman) selected for grain yield and suitable agronomy. But as elsewhere in the world, these varieties were generally late maturing, very tall and weak-strawed, suffered from shriveled grain characteristics with low test weight, and also had a high frequency of sterile florets, limiting their yield potential in comparison to other cereals.

During this period a winter triticale breeding program was started at OAC Guelph resulting in the development of the early winter varieties OAC Wintri, OAC Trillium and OAC Decade.

High levels of ergot were associated with the high frequency of floret infertility in the early varieties. Also, suitable processing quality for bread was not generally achieved in the early varieties, and still remains a challenge for high value flour markets. Because of these limitations, breeding work was generally diminished at the University of Manitoba, later replaced by breeding and agronomic development programs of Alberta Agriculture, Food and Rural Development (Field Crop Development Centre, Lacombe) and Agriculture and Agri-Food Canada (Swift Current).

By the mid 1980's and into the 1990's genetic solutions to the limiting agronomic and grain features of the early varieties were found internationally, and these have been incorporated into new Canadian varieties now available for production. Current grain yields are competitive with the highest yielding wheat varieties, and may exceed that of barley, and the high quality of the protein has been maintained (expressed as a high percentage of lysine in the protein). New varieties have also been bred with superior forage yield potential that are especially suitable for silage, for early and late spring grazing, for swath grazing, for mixed cropping with other forage species, or for green-feed or haylage. Triticale can be called **'The Crop For All Seasons'.**

There has been a steady increase in triticale acreage on the Prairies from zero hectares grown in the early 1970's, to 17,000 hectares in 1996, 34,000 hectares in 1998 and 110,000 to 120,000 hectares in 2003 (270,000 to 300,000 acres). Production in Alberta accounts for 80 % of the Prairie production as feed, forage and grazing.

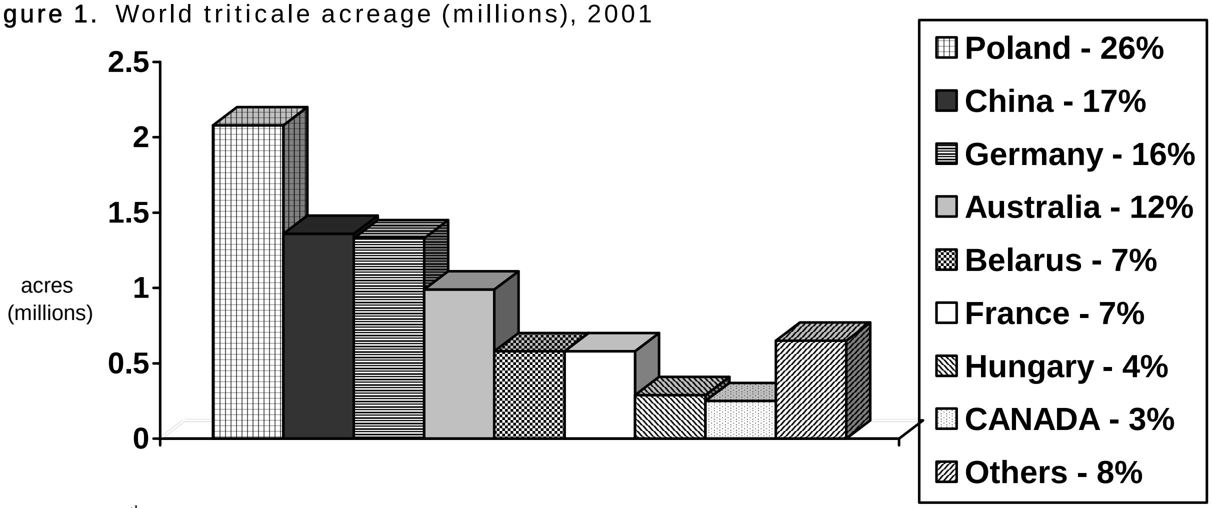
Both spring and winter triticale types are available (including semi-awnless winter varieties) which have provided a new crop option for breaking pest and disease cycles in cereal cropping systems.

Triticale has also demonstrated tolerance to drought and acidic soils, and are grown commercially worldwide (Figure 1).

Continuous breeding improvements in future varieties are expected for grain and forage yield, as well as for those traits which have remained more difficult to improve (earlier maturity, improved test weight, and shorter straw without loss of biomass). The floret sterility problem of the pioneer varieties does not exist in the new varieties, and incidence of ergot is now rare, although this question still remains as a feed marketing issue.

Because triticale has developed faster as a significant commercial crop in countries other than Canada (Figure 1), much of the research and literature about its suitability for feed and for forage is non-Canadian, including most of the feeding trials with animals. As of 2004, the greatest adoption in western Canada appears to be for use as forage, primarily for silage and grazing, with use as a feed grain for swine gaining some recent acceptance. Suitability for poultry and for dairy has been demonstrated in Canada.

Figure 1. World triticale acreage (millions), 2001



(Proceedings, 5th Int. Triticale Symposium, Poland)

Superior agronomics and yield potential in Western Canada

Data from variety registration trials, regional variety tests, and special purpose trials throughout the Prairie Provinces substantiate that triticale varieties have grain yields from 10% to 25% higher than the highest yielding spring wheats (the semi-dwarf Canadian Prairie Spring class).

Triticale is later maturing than wheat by 10 days. The test weight of triticale is still some 6 kg hl^{-1} less than that of wheat, though competitive with other feed grains.

Winter triticale grain yields are equal to or exceed those of winter wheat, although this crop is up to three weeks later maturing than winter wheat.

Silage yields from triticale usually exceed or are at least equal to any other of the cereal crops grown, especially barley. Triticale has stronger straw than barley under highly fertile and moist conditions.

Spring and winter triticale have good disease resistance profiles, and are not susceptible to many of the diseases that attack barley. Therefore, triticale is useful for breaking disease cycles in cereal crop rotations, which results in improved yield. In a crop rotation study, the yield of barley grown on triticale stubble was 14.9 % higher than barley yields from continuous barley on barley (same variety). The yield of barley grown on triticale stubble was 11.7 % higher than yield from continuous barley using rotated barley varieties (Turkington et al., 2005).

Although experimental data is limited, production experience confirms that triticale maintains its yield under conditions of stress, including drought and acid soils, when compared to other cereals. It has also proven highly adaptable to heavily manured soils, as a rotational option in intensive livestock operations. Lateness of maturity for grain is the greatest deficiency of current spring type varieties in short-season areas. Because triticale crop use for different grain and forage uses involves a wide range of planting and harvesting dates, winter triticale is an extra option that can help to stagger seasonal workloads and harvesting operations.

Triticale is now a well established crop internationally, with well over 8 million acres of spring and winter types used for food, feed (monogastrics and ruminants), grazed or stored forage and fodder, silage, green-feed and hay, or as biomass source for ethanol production and other uses.

Novel nutraceutical and other processed grain uses are also being explored. This crop is also adapted to stress conditions that may cause other crops to fail, such as drought, and acid soils, and it has a good disease resistance profile.

Part 2. TRITICALE GRAIN FOR FEED

Triticale grain composition

In order to place a value on triticale grain in feed formulations, it is necessary to compare triticale composition to other feed sources grown under Canadian conditions.

The following tables include data from a limited Canadian database as well as from other sources. Although relative values from non-Canadian sources are likely to be reliable, caution should be used in applying the specific values from such sources. Keep in mind these are averages from samples of non-Canadian varieties grown under non-Canadian conditions. Country or other origin of the data is indicated where appropriate.

In general:

- Canadian triticale has stable compositional quality across environments.
- Total starch levels in triticale are equal to or higher than for wheat.
- Triticale has a high lysine content, expressed as a percentage of protein content, and a high lipid content.
- The protein content of triticale is lower than that found in Canada Western Red Spring (CWRS) wheat, but higher than that in barley, oat, rye and corn.
- Triticale has a desirable mineral content for feed applications.
- Triticale fibre content tends to be higher than that of wheat.
- The vitamin content of triticale is comparable to that of wheat and rye.
- In a single multi-year, multi-site and multi-variety study, Canadian analyses of triticale variability for amino acid content as a percentage of protein content indicated that sample variability was in a range similar to that expected for other grains. The highest variability was found in methionine, cystine and tyrosine (Table 5).

Table 1. Chemical composition of winter and spring triticale varieties, W. Canada, 2001
(Mean %, w/w dry matter basis, except for moisture content)

Winter type:	**Triticale**	**Triticale**	**Wheat**	**Fall rye**
Variety:	**Pika**	**Bobcat**	**AC Tempest**	**Rifle**
Moisture	7.9	7.1	8.5	7.4
Ash	1.95	2.00	2.00	1.39
Protein	13.1	12.9	15.5	14.3
Lipid	1.65	1.78	1.48	1.49
Beta-glucan	0.65	0.64	0.68	2.26
Starch	54.7	55.36	54.86	50.89
Pentosan	4.84	3.78	3.41	4.54

Spring type:	**Triticale**	**Triticale**	**Triticale**	**Triticale**	**Triticale**	**CPS wheat**
Variety:	**94S001008***	**AC Alta**	**AC Certa**	**AC Ultima**	**Pronghorn**	**AC Vista**
Moisture	6.9	7.0	7.7	8.5	7.3	7.3
Ash	1.75	1.96	2.07	1.78	1.83	1.71
Protein	12.3	11.6	12.7	11.6	12.2	13.3
Lipid	2.00	1.71	1.72	1.66	1.65	1.59
Beta-glucan	0.76	0.79	0.54	0.50	0.62	0.81
Starch	57.4	54.0	57.3	59. 4	58.1	56.4
Pentosan	3.52	4.46	4.81	5.44	4.17	4.39
SDF	4.09	3.68	3.61	2.10	3.38	3.33
ISF	12.53	14.53	12.08	12.97	11.18	11.95
TDF	16.63	18.21	15.69	15.07	14.56	15.28

SDF = Soluble dietary fibre; ISF = Insoluble dietary fibre; TDF = Total dietary fibre;
* 94S001008 is an experimental triticale line.
(Salmon, D., Temelli, F. and Spence, S. 2002. Proc. 5th International Triticale Symposium, Poland)

Interpretation: Triticale grain composition for feed compares well with other cereals

Table 2. Grain composition, spring triticale compared to wheat, 2003 Western Canada

Crop: Variety	TCL Certa	TCL Ultima	TCL Pronghorn	TCL T163	CPS wheat Crystal	CPS wheat Vista	SWS wheat Reed	SE
Ash	1.97	1.79	1.84	1.78	1.75	1.66	1.71	0.05
Fat/lipid	1.78	1.64	1.78	1.69	1.80	1.67	1.99	0.04
Moisture	9.3	9.7	9.5	9.9	9.3	9.2	9.5	0.40
Protein	14.7	13.6	13.7	13.1	15.1	15.6	13.7	1.13
Starch	64.7	66.3	65.4	66.5	66.1	66.1	66.4	1.36
IDF	12.06	12.76	11.38	12.47	10.96	11.11	10.59	0.26
SDF	2.71	2.51	2.71	2.51	2.52	2.77	2.74	0.11
TDF	14.77	15.27	14.09	14.99	13.48	13.88	13.33	0.33
Pentosan	8.44	8.71	8.26	8.55	7.68	8.28	8.13	0.86

TCL = Triticale SE = Standard error
SDF = Soluble dietary fiber; ISF = Insoluble dietary fibre; TDF = Total dietary fibre
Means based on two years data and nine locations across the Canadian Prairies.
Values are percentage (w/w) of dry matter basis average of duplicate analyses.
(AARI Report, Temelli, Salmon, and McLeod, 2003)

Interpretation: Triticale grain compares favorably with wheat, except for higher fibre and pentosans

Table 3. Composition of commonly used feed ingredients in swine diets (USA data, 1998)

	DE Mcal/lb	Crude protein %	Lys %	Meth %	Meth + Cys %	Thre %	Trypt %	Ether extract %	Crude fiber %	Ca %	Phosphorus Total %	Phosphorus Available %
Triticale	1505	12.5	0.39	0.20	0.46	0.36	0.14	1.8	12.7	0.05	0.33	0.15
Oats	1256	11.5	0.40	0.22	0.58	0.44	0.14	4.7	27.0	0.07	0.31	0.07
Rye	1484	11.8	0.38	0.17	0.36	0.32	0.12	1.6	12.3	0.06	0.32	na
Wheat SRW	1564	11.5	0.38	0.22	0.49	0.39	0.26	1.9	na	0.04	0.39	0.19
Barley	1383	10.5	0.36	0.17	0.37	0.34	0.13	1.9	18.6	0.06	0.36	0.11
Yellow corn	1600	8.3	0.26	0.17	0.36	0.29	0.06	3.9	9.6	0.03	0.28	0.04

SRW = Soft Red Winter; DE = Digestible energy;
(Values cited from Tri-State Bulletin 869-98, Ohio State University, 1998)

Interpretation: Relative triticale composition data from U.S. and Canadian tables are comparable

Table 4. Composition of triticale, wheat and rye grain (USA data, 1996)

	Triticale	Wheat	Rye
Protein	10.3 – 15.6	9.3 – 16.8	13.0 – 14.3
Starch	57 – 65	61 – 66	54.5
Crude fibre	3.1 – 4.5	2.8 – 3.9	2.6
Free sugars	3.7 – 5.2	2.6 – 3.0	5.0
Ash	1.4 – 2.0	1.3 – 2.0	2.1

% grain weight, dry weight basis
(Cereal Food World, June 1996, American Association of Cereal Chemists)

Interpretation: Triticale composition is comparable to that of other cereals, but with higher fibre

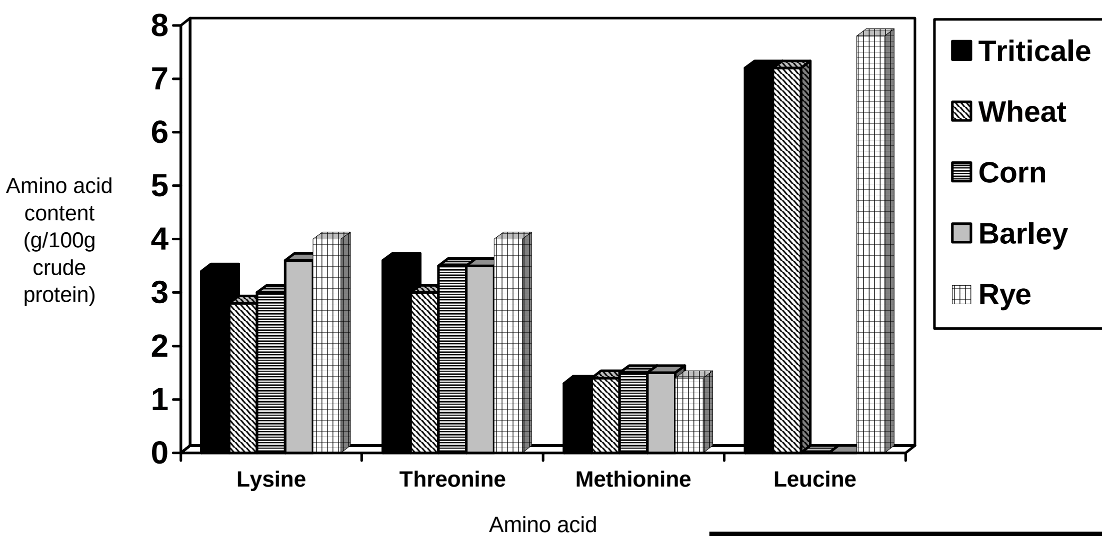
Table 5. Variation in triticale amino acid composition in W. Canada[1]

Amino acid	Mean	Min	Max	Coefficient of variation %
Alanine	3.5	3.0	4.1	6.4
Arginine	4.8	4.2	5.5	5.9
Aspartic acid	5.2	4.2	6.2	8.0
Cystine	2.4	1.9	3.2	11.3
Glutamic acid	24.5	22.1	27.6	5.5
Glycine	4.0	3.5	4.8	6.0
Histidine	2.2	1.9	2.8	6.5
Isoleucine	3.1	2.8	3.5	3.6
Lysine	3.0	2.4	3.6	8.3
Methionine	1.5	1.2	2.0	11.8
Phenylalanine	4.2	3.8	4.7	4.1
Proline	9.3	8.3	10.1	4.6
Serine	4.4	3.8	5.2	5.4
Threonine	2.8	2.4	3.4	6.3
Tryptophan	1.5	1.2	1.8	9.5
Tyrosine	1.8	1.3	2.1	10.6
Valine	4.1	3.6	4.7	4.3

[1] >60 samples from 7 varieties and 5 locations, between 1992 and 1997.
(Adapted from Jaikaran et al, 2001)

Interpretation: Composition data are available, but high levels of sample-to-sample variation occur, requiring the need to test representative feed samples

Figure 2. Amino acid content (g/100g crude protein) of triticale and other grains



(National Research Council, USA, 1989)

Interpretation: Triticale amino acid profile is comparable to that of other cereals

General nutritional information

- Triticale is a suitable, high energy source for all classes of animals, with energy levels comparable to or better than other Canadian cereals.
- Triticale digestibility is comparable or superior to that of other Canadian cereals.
- Triticale starch fermentation is similar to barley and oats, and its enzymatic digestion is higher, which has implications for digestive efficiency beyond the rumen in ruminant animals.
- Net protein utilization of triticale can be superior to that of other cereals (e.g. wheat) which may reflect the high levels of lysine (as % of total protein) found in triticale, and its high protein efficiency.
- In Western Canada and internationally, lysine content of triticale is typically higher than in barley.
- Using triticale as a feed energy source for monogastric animals often means that a reduced amount of protein supplementation is needed in the diet.

A detailed nutritional database for triticale grain grown under Canadian conditions is not available. Very limited data from other sources are available, and are presented here. Although relative values from non-Canadian sources are likely to be reliable, caution should be used in applying any specific values, which are averages from samples of non-Canadian varieties grown under non-Canadian conditions. Country or other origin of the data is indicated.

Table 6. Wheat, triticale, and rye composition and energy values

	Wheat	Triticale	Rye
Non-starch polysaccharides (NSP)			
Soluble arabinoxylans %	1.8	1.3	3.4
Insoluble arabinoxylans %	6.3	9.5	5.5
Beta-glucans %	0.8	1.7	2.0
Cellulose %	2.0	2.5	1.5
Total NSP			
Soluble %	2.4	1.7	4.6
Insoluble %	9.0	14.6	8.6
Starch %	66 (54-74)	60 (55-63)	50
Protein %	8-22	8-22	na
Metabolizable energy, Poultry (MJ/kg DM)	9.0-14.8	14.0-15.2	14.2
Digestible energy, Pigs (MJ/kg DM)	16.0	16.0	15.5
Metabolizable energy, Ruminants (MJ/kg DM)	13.5	13.3	13.3

Dry matter basis
(S. Australia data, cited from Evans, 1998, SARDI

Interpretation:
High energy level is found in triticale compared to wheat

Anti-nutritional compounds in triticale grain

By the mid 1980s, triticale was suspected to contain a number of potentially anti-nutritional compounds. These compounds are at lower levels in triticale than in rye. The extent that any of these compounds may hinder the feed efficiency of triticale is unknown; quantified, relevant data on this topic are not available. New data is needed on these compounds, for the modern Canadian varieties grown under Canadian conditions.

Compounds that might potentially block the full use of nutrients include:

- Pentosans (produce 'gummy' manure in monogastrics)
- Enzyme inhibitors
- Pectins (binding agents that limit digestibility)
- Alkyl-resorcinols
- Tannins
- Acid-detergent fibers
- Protein-polysaccharide complexes
- Beta-glucans

Some of these may be influential in limiting feed intake, especially in poultry, but little is known about these compounds, and research about them is rare. The levels of these compounds in Canadian triticale varieties in comparison to other Canadian feed grains are not known. International consensus is that these compounds are likely not as high in modern varieties as in the earliest triticale varieties pre-1980, although hard data to confirm this view are unavailable.

Triticale grain for swine and hog feed

According to Canadian and Australian studies, triticale can be included without restriction as a high value, consistent quality cereal grain in least-cost formulations for growing pigs. It may be used in either ground or pelleted form.

Comprehensive nutritional data and feed recommendations for triticale feed use with swine based on Canadian research are still unavailable.

However:

- Triticale digestible energy (DE) levels for swine and protein composition are superior to barley. Triticale DE is equivalent to wheat when used as swine feed, and to corn when fed to young pigs.
- Triticale is often the preferred grain feed for pigs in Australia. Since the development of modern Australian triticale varieties, feed intake problems are no longer being reported there.
- In Australian trials, digestibility in the ileum (a portion of the small intestine) of dry matter, N and amino acids in pigs fed triticale was generally higher than for barley. The exception was the amino acid proline, which was more digestible in barley (van Barneveld, 2002).

The superior protein quality and high yield potential of triticale grain has kept up the international interest in using the crop as a swine feed. Generally, reports show that using triticale as a swine feed has been very successful. Producers have been able to replace other cereals, (e.g. wheat, corn, barley and millet) with triticale without losing productivity or product quality. Triticale is also more cost-effective than its competitors, as its high lysine content means less protein supplements are required. Australia, the United States, Brazil, Poland and Germany have all adopted triticale for commercial swine rations. It is only now starting to occur in Western Canada.

The reference section of this manual lists literature supporting favorable results from feeding triticale to swine. There are only a few Canadian studies reported.

Two Canadian studies (Robertson et al, 1998; Jaikaran et al, 1998) compared 100 percent Pronghorn triticale as the grain source to:

- 100 percent corn.
- 100 percent hulless barley.
- a 50:50 mix of hulless barley and Pronghorn triticale.

The studies compared 25 production, carcass and meat quality characteristics. Triticale performed similarly to the corn (control) diet for 24 characteristics, and similarly to the 50:50 hulless barley and Pronghorn triticale mixture in all cases. The conclusion was that triticale could be successfully substituted for maize or hulless barley in the diets of growing-finishing (25-110 kg) pigs (Tables 7 and 8).

The *Ohio State University Tri-State Swine Nutrition Guide* (1998) recommends that triticale can be used at maximum rates in amounts equal to or greater than barley in the diets of grow-finish, gestating, and lactating swine, and in amounts equal to or greater than for wheat. The guide also suggests that triticale can be used for up to 10 percent of the feed for starter swine feed. This is compared to a zero percent recommendation for wheat, and 15 percent for barley (Table 9).

Table 7. Feeding results with market hogs, comparing Pronghorn spring triticale, corn and hulless barley

	Grain source in the diet			
	Corn	**Hulless barley**	**Triticale**	**Hulless barley/ triticale**
27 – 110 kg feeding period:				
Daily feed intake kg (F)	2.50	2.53	2.50	2.66
Daily gain kg (G)	88.5	91.5	89.9	93.5
Feed efficiency (F/G) kg	2.85	2.87	2.81	2.86
Carcass data:				
Shipping weight kg	109.7 ab	109.1 b	110.7 ab	112.4 a
Shrink %	4.86	5.45	5.22	4.66
Dressing %	79.5 a	78.2 b	78.6 ab	79.0 ab
Backfat mm	19.7 ab	17.5 b	17.9 b	20.7 a
Eye muscle depth mm	47.3 ab	46.9 ab	49.7 a	45.8 b
Estimated lean yield %	59.4 ab	60.2	60.2 a	58.7 b
Carcass cutout lean yield %	55.6 ab	56.6 ab	56.9 a	55.0 b
Grade index	106.5 b	109.2 a	109.6 a	106.4 b

Values with different letters in a row are significantly different (P<0.05). Other values in same row are not.
(Abstracted from Jaikaran et al, 1998)

Interpretation: Triticale is fully substitutable for corn or hulless barley for growing-finishing pigs

Table 8. Meat and carcass quality of market hogs fed Pronghorn spring triticale, corn and hulless barley

Grain source in the diet:	Corn	Hulless barley	Triticale	Hulless barley / triticale mixture
Final live weight and carcass data:				
Shipping (off-test) weight kg	109.7 ab	109.1 a	110.7 ab	112.4 a
Final live weight at abattoir kg	105.1	104.3	104.7	105.5
Warm carcass weight kg	87.8 b	86.2 a	86.8 ab	87.5 ab
Rib eye area (12th rib) cm^2	35.70	36.46	37.90	35.35
Lean in lean cuts g per kg	588.4	603.0	603.3	582.1
Total cut out yield g per kg	556.3	565.6	568.9	550.2
Meat quality of the *longissimus thoracis*:				
pH 45 min	6.27	6.25	6.31	6.31
pH 48 h	5.55	5.53	5.59	5.57
Lightness (L*)	48.6 a	50.6 b	50.8 b	50.1 ab
Chroma (C_{ab}*)	9.3	8.7	8.2	8.6
Hue angle^o (H_{ab})	28.1	29.2	29.9	28.3
Drip loss mg per g	29.1 a	38.7 b	28.3 a	30.7 a
Maximum shear value kg	4.85	4.77	5.00	4.88
Moisture mg per g	747.9 ab	748.4 ab	749.0 b	744.9 a
Intra-muscular fat mg per g	17.9	19.1	18.2	21.1
Total protein mg / g	220.6	218.8	219.6	221.1
Broiled chop overall tenderness	5.39 a	6.18 b	5.55 ab	5.45 a

Values with different letters in a row are significantly different ($P<0.05$)
No significant differences were found for cooking time, cooking loss, initial tenderness, juiciness, flavor acceptability, flavor intensity, amount of connective tissue, or overall palatability
(Robertson et al 1998)

Interpretation: Meat and carcass quality from feeding market hogs triticale is no different from that from feeding corn or hulless barley

Table 9. USA recommended maximum incorporation rates of triticale in swine diets
The USA TriState Swine Nutrition Guide (Ohio State Bulletin 869-98, 1998) suggests maximum incorporation rates of commonly used feed ingredients for swine diets. In these tables, maximum recommended rates vary from 10 to 40 percent.

	Starter	Grow-finish	Gestation	Lactation	Limitations
Triticale	10	40	40	40	Variable quality/ergot
Wheat	0	40	30	40	Expensive
Barley	15	40	40	25	High fiber
Corn	60	80	90	80	Low lysine
Oats	5	20	50	0	High fiber
Rye	0	25	25	10	Variable quality, ergot

(Ohio State University Bulletin 869-98, 1998)

Interpretation: Acceptable incorporation rates are equal to those of wheat and barley for all classes of swine, except slightly less than that for barley in starter rations

An Australian study (Edwards, 1998) concluded that the newest triticale varieties were likely free of the anti-nutritional compounds that had caused problems in earlier varieties. The study found that "the most recent reports of triticale performance in pig and poultry diets confirms triticale to be equal to or better than wheat and maize." This view is obviously popular; triticale is now commonly used for swine rations in the Australian swine industry and elsewhere.

Despite its popularity elsewhere, triticale is now just beginning to be used in Western Canada as a swine feed. Its growth has been limited by a number of factors, including:

- Unfamiliarity with triticale feed properties for swine. Many producers are unsure what the optimal formulations are for various feed combinations.
- Lack of a grain supply.
- Lack of storage bins at feeder sites.
- Lack of a locally validated feed compositional database established using the newest Canadian varieties.
- Uncertainty among producers as to whether or not anti-nutritional characteristics should still be a concern, or whether these will affect feed intake.

Despite not being widely acted on in Canada, the general scientific consensus is that triticale is an excellent feed choice for swine. Its use results in few to no feeding problems, and it is substitutable for other grains. When triticale is substituted, ration costs are lower because less soymeal or other protein meal supplements are needed.

In recent studies, researcher van Barneveld (1998, 2002) concluded that when modern Australian triticale varieties are formulated in diets to supply levels of digestible amino acids and digestible energy equal to that in wheat-based diets, the performance of growing pigs is equal or better than when fed the wheat-based diets. This study also indicated that triticale can be used in swine diets without restriction.

Other Australian results quoted from Cooper (Table 10) conclude that the energy levels in modern Australian varieties are reliable and consistent across locations and varieties, and averaged 13.7 MJ/kg (infrared spectroscopy basis).

Triticale can also be included in diets for young pigs without causing palatability problems.

Table 10. Growth performance of pigs fed balanced diets containing triticale compared with wheat, barley and sorghum

	Gain g/day	**Feed conversion ratio (FCR)**	**Gain g/day EBW basis**	**Feed conversion ratio EBW basis**	**P2 mm**
Triticale	681	2.4	415	4.0	10.1
Wheat	677	2.5	400	4.2	10.3
Barley	662	2.7	377	4.7	9.3
Sorghum	653	2.6	369	4.6	10.2

EBW = Empty body weight
P2 = Backfat depth at the P2 position
(van Barneveld and Cooper, Australia, 2002)

In the United States, Myer (2002) conducted five trials with early-weaned pigs comparing the suitability of triticale to corn for this age group. It was necessary to carry out the study for this age group, as pigs up to five weeks old are not yet fully efficient at digesting energy from cereals.

In these tests:

- The pigs were 3 to 8 weeks old, and from 5 to 25 kg body weight.
- The grain proportion was between 55 to 65 percent of the total diet weight, and was standardized for lysine content.
- The triticale averaged 30 percent more protein and 40 percent more lysine than the corn.
- Triticale fiber content was higher than for corn and fat content was lower. As such, the triticale contained five percent less metabolizable energy than did the corn.
- Averaged over three trials, the daily weight gain for the diets using triticale was five percent higher than for the corn-based diet (Table 11).

The overall conclusion was that "triticale is an effective replacement for corn in diets for growing pigs, including diets for early weaning pigs."

Table 11. Post-weaning growth performance of early-weaned pigs fed triticale or corn/maize

Diet grain source	Average daily gain, kg: Phase I	Phase II	Overall	Average daily feed, kg	3 – 8 week age: Feed/Gain
Trial 1					
Corn	0.27	0.60	0.51	0.78	1.53
Triticale	0.28	0.59	0.59	0.78	1.60
Trial 2					
Corn	0.27	0.59*	0.48	0.79	1.65
Triticale	0.28	0.61	0.50	0.79	1.65
Trial 3					
Corn	0.28	0.61*	0.49*	0.78	1.58
Triticale	0.27	0.64	0.52	0.81	1.57

Paired values in a column do not differ significantly unless * is shown
(Adapted from Myers, 2002, USA)

Interpretation: Gain and feed use efficiency of triticale is equal to or better than for corn

Triticale grain for poultry feed

Triticale is already widely used for feeding poultry around the world, especially in countries with large triticale acreage.

Recent Alberta results from both small-scale experimental trials and in a large-scale production trial by Korver and Zuidhof (Tables 12 and 13) show that triticale has a great potential as a feed for broiler chickens.

These trials suggest that for live performance and production costs, triticale could replace Canada Western Red Spring wheat in the diet at a cost reduction of approximately 5 percent. Triticale is a non-Canadian Wheat Board grain, which could provide additional cost savings.
This cost saving result is very similar to that found by the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico, from an economic study based on international grain prices.

In the commercial scale Alberta trial (Table 13), Korver and Zuidof found that the following were not significantly different when feeding broilers a triticale diet than when feeding a wheat diet:

- Final body weight
- Feed consumption
- Carcass weight at processing
- Flock uniformity
- Percentage of grade-A carcasses
- Percentage of condemned carcasses

Triticale grain use for broilers and laying hens may cause sticky droppings similar to barley or wheat. Adding commercial enzymes to the diet will solve this problem.

Compared to wheat or corn, triticale is generally reported as having superior levels and availability of important amino acids for monogastric animals. However, depending on specific variety comparisons, the protein concentration in newer varieties is often lower than in wheat.

Several studies have looked at protein quality in newer varieties that have a protein concentration in the 10-13 percent range. These include a Saskatchewan study by Salmon (1984), as well as those by Johnson and Eggum (1988), and Myer et al (1996, 2002). All of these have sparked a continuing interest in triticale for broiler diets.

Table 12. Small-scale University of Alberta trial comparing triticale to CWRS wheat for broilers

Feed use and weight gain: Week 1 – 6

	Body weight g Day 0	Body weight g Day 42	Body weight gain (g / chick per day)	Feed intake g / chick / d	Feed conversion efficiency g feed / g gain
CWRS wheat	40.9	2,096*	50.3*	86.6	1.72*
Triticale	41.1	1,972	47.0	88.3	1.88

Carcass quality traits at 412 days:

	Eviscerated carcass	Back half	Thigh	Drum	Front half	Pectoralis minor	Pectoralis major	Wing	Carcass Grade A %
CWRS wheat	65.9	42.8	15.5	15.0	57.2	4.9*	20.7	11.3	75.3
Triticale	65.6	42.3	15.2	15.1	57.7	5.2	21.2	11.3	73.0

Paired values with * are significantly different
All values expressed as % live weight or eviscerated carcass weight, as appropriate
(Korver and Zuidhof, 2003)

Table 13. Commercial-scale University of Alberta trial comparing triticale to CWRS wheat for broilers

For the period day 0 to 42	Body weight g Day 0	Body weight g Day 42	Feed consumption g	FCR	Mortality %	Feed cost [1]	Chick cost [1]	Total cost of production [1]
Wheat	41.0	2,068	4,047	2.063	4.8	0.577*	0.260	0.972*
Triticale	40.7	2,074	4,199	2.165	6.9	0.617	0.266	1.019

[1] $ per kg of live weight; FCR = Feed conversion ratio (g feed / g gain); > 19,000 birds in the trial
Paired values with * are significantly different; Carcass weight, Grade, % condemned, and flock variability did not differ significantly.
(Korver and Zuidhof, 2003)

Interpretation: Slightly higher production costs for triticale, but comparable results as for wheat

Despite the perceived protein superiority of triticale, its use in the poultry diet has often resulted in poorer production compared to wheat or corn. This is because the large plump kernels of newer triticale varieties have a lower ratio of protein to starch in the kernel.

Some studies have shown that negative effects of triticale do not occur when the triticale grain fraction in the diet is limited to as little as 15 percent of the grain portion of the diet. However, other studies with broilers and egg production show no differences in productivity, even when diets consist of 100 percent triticale (Maurice et al, 1989; Karunajeewa and Tham, 1984; Boros, 1999; Leeson and Summer, 1987; Yaqoob and Netke, 1975; McNab and Shannon, 1975; Fayez et al, 1996). Savage et al (1987) reported that increasing the triticale content in the diet actually improved the physical and sensory quality of cooked meat from turkey toms.

In Oregon, USA trials, Nakaue and Boldaji (no date) used the local winter triticale variety 'Celia' in triticale-barley-soybean and triticale-barley-corn-soybean mixtures fed to layers. The results were compared to the control diet of corn-soybean.

No differences were found for:

- Hen-day egg production
- Feed conversion
- Daily egg mass produced
- Interior egg quality
- Shell thickness
- Body weight gain

Egg yolk color from the triticale-fed chickens was lighter than yolks produced by the control group. The feed consumption was lower in the triticale-fed birds than in the control group but egg quality remained the same. Nakaue and Boldaji concluded that the decision to use triticale should depend on its price relative to corn and whether enough supply is available.

In economic studies of broiler and layer rations, Abderrezak-Belaid (1994) showed that "the inclusion of triticale leads to cost savings resulting from the complete replacement of maize and from a considerable reduction of soybean meal in the rations." The study found cost reductions from using triticale ranged from 1.3 to 2.3 percent for broiler rations and from 1.87 to 3.54 percent for layer rations when triticale was priced equal to corn. When triticale was priced at 95 percent of corn, these cost reductions were 4.5 to 7.2 percent for broiler rations, and 6.92 to 8.0 percent for layer rations.

A recent study by Santos et al. (2005, unpublished) found that colonization of the *Salmonella* bacteria in turkeys was discouraged by diets containing high non-starch polysaccharide content from wheat and triticale. Further, addition of enzymes reduced *Salmonella* colonization in turkeys fed triticale or wheat compared to corn.

Triticale grain for ruminants

Triticale grain is a useful energy source for ruminants because it:

- Contains high energy levels.
- Contains starch that is readily digested in the small intestine.

As with other grains fed to ruminants, special care should be taken when feeding triticale grain to avoid digestive disorders arising from acidosis.

Triticale, and starch and protein digestion in ruminants

Ruminant animals such as cattle and sheep have a limited ability to digest energy sources including starch in the small intestine, even though energy digestion in the small intestine is much more efficient than in the rumen.

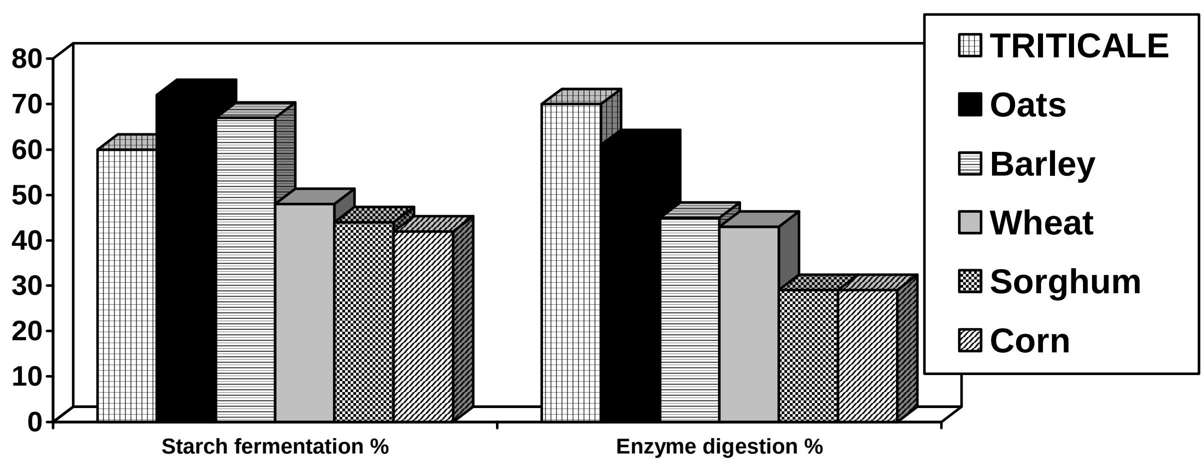
Fermentation in the rumen is an important first part of the digestion of cereals such as triticale, but when it is incomplete, unfermented starch moves through to the other parts of the digestive system.

Thus starch utilization from any cereal grain source depends on:

- Whole digestive tract digestibility
- The extent of starch digestion in the rumen and small intestine, and
- The amount of lactic acid produced in the rumen and hind gut (van Barneveld, 2002).

Recent Australian research (Figure 3) demonstrated that triticale has similar capacity for starch fermentation as barley and oats, but has a higher enzyme digestion capacity. Further research is needed to demonstrate that this translates into higher energy availability for ruminant animals, but energy levels from other feeding experiments give favorable energy values for triticale thus far.

Figure 3. Enzyme digestion and starch fermentation of cereals in ruminants (Australia, 1999)



(Bird et al, 1999, Animal Nutrition in Australia)

Interpretation: High enzyme digestion and starch fermentation values cause Australian sources to suggest that triticale may have a special advantage as feed for ruminants

Triticale grain for dairy cattle

Concentrates used in modern dairy cattle rations require feed sources with high energy value. Triticale is a suitable component for such feeds and helps produce high milk yield, quality and protein. Research data on triticale grain use in concentrates for dairy cattle is very sparse. However, this use of the grain is now conventional in Australia when price and supply are competitive with other high energy grains.

In a Canadian study in New Brunswick, McQueen and Fillmore (1991) fed lactating Holstein dairy cows three different grain rations:

- 100 percent barley
- 57 percent barley plus 43 percent triticale
- 86 percent triticale plus 14 percent barley

Alfalfa silage (15 percent crude protein and 62.2 percent dry matter digestibility) was fed *ad libidum*.

The grain ration was fed at 1 kg per day per 2.75 kg of milk produced. The trial ran for 11 weeks and found (Table 14) that:

- Grain rations containing triticale were well consumed by the cows. Milk yields and quality were similar to that from the barley ration.
- Cows fed triticale gained less weight, indicating that more of the productive energy was expressed in milk production.

Research data on triticale grain use in concentrates for dairy cattle is very sparse, but this use of the grain is now conventional in Australia when price and supply is competitive with other high energy grains.

Table 14. Effects of triticale and barley rations on Holstein cow milk production and quality

	100% barley	57% barley + 43% triticale	86% triticale + 14% barley		SEM
Dry matter intake, kg per day					
Concentrate mix	8.2	8.8	8.3		0.88
Alfalfa silage	13.3	12.2	12.2		1.24
Total	21.5	21.0	20.5		1.91
Yield, kg per day					
Actual yield	23.6	25.6	24.0		2.75
4 % fat-corrected milk	23.6	26.6	24.7		2.52
Fat	0.94	1.09	1.01	Sig	0.102
Protein	0.79	0.83	0.80		0.084
Lactose	1.12	1.27	1.18	Sig	0.128
Composition, %					
Fat	4.13	4.25	4.27		0.276
Protein	3.38	3.24	3.35		0.163
Lactose	4.79	4.97	4.89		0.134
Body weight, kg					
Initial	603	573	581		1.6
Gain, per day	0.61	0.31	0.19	Sig	0.124
Energy (MJ per day) in					
Milk produced	73.74	82.85	77.42	Sig	1.830
Body weight gain	12.61	6.31	3.85	Sig	0.617
Production	86.35	89.16	81.27		2.036
Maintenance	56.05	53.60	53.95		0.543
Total	142.40	142.76	135.22		2.317

Sig = Mean values in the same row differ significantly, otherwise they do not
SEM = Standard error of the mean
(McQueen and Fillmore, 1999)

Interpretation: Milk quantity and quality were similar for cows fed triticale or barley, but cows fed triticale did not gain as much weight as those fed barley

Triticale grain for feedlot beef

In countries where a regular triticale supply chain exists, triticale grain is commonly used as a high energy, low-cost grain source for feeding cattle. Although Canadian data is lacking, international results show triticale grain can be fully substituted for other feed grains in feed concentrates without loss of feed intake, overall digestibility or feedlot performance.

Large feedlot operators in Western Canada have used triticale grain for cattle feed, often in combination with triticale silage and other grain or legume silage. According to limited Canadian survey results, these operators have opted for triticale grain because of its low cost and high-energy value.

Research data on this use of triticale grain in Canada are lacking, reflecting the absence of a developed supply chain for grain for use in the feed industry. Limited data are available from the United States and Australia.

Caution has to be used when high levels of triticale and other grains are fed to beef cattle as the primary energy source. Using buffering additives or improving grain processing can help to avoid acidosis and digestive upsets. Coarse cracking of the grain by grinding or rolling can also reduce feeding problems.

When the above precautions are taken, cereals such as triticale can constitute the bulk of feedlot beef rations when supplemented with:

- Roughage (from hay or silage).
- Vitamins and minerals.
- Protein sources added to meet requirements.

In the United States, Hill and Utley (1989) conducted two trials on finishing steers, comparing feedlot corn rations, feedlot corn/triticale rations and feedlot triticale rations. Evaluations of steer performance and carcass quality traits indicated few differences amongst the treatment effects (Table 15). They concluded that "new triticale varieties produce grain that can be substituted for conventional grains in finishing steer diets."

In the United States, Lofgren (University of California) conducted a trial to compare different diets each with 68 percent grain content using Brahman x British cattle of initial weight of around 733 lbs.

Diets compared included:

- 100 percent barley.
- 100 percent triticale.
- 50/50 barley/triticale mixture.

The remaining ration comprised:

- 5 percent alfalfa hay.
- 5 percent Sudan hay.
- 10 percent beet pulp.
- 0.5 percent urea.
- 3 percent fat.
- 7 percent molasses.
- 1 percent limestone.
- 0.5 percent trace mineralized salt.
- 1,000 IU vitamin A per lb of ration.

For all but two traits measured, the performance of the triticale was considered equivalent to that of barley. The two exceptions were that the:

- Quality grade was superior for the 100 percent triticale ration.
- 100 percent triticale ration-fed cattle had a lower carcass yield.

Table 15. Performance and carcass traits of steers fed corn and triticale diets in US feedlots

Trial 1

Dietary treatment:	Corn	Corn/triticale mix	Triticale
Number of steers	5	5	5
Steer performance			
Initial weight, kg	372.2	372.2	371.9
Final weight, kg	476.0	480.4	479.1
84 day ADG, kg	1.24	1.29	1.28
Average daily feed, kg	10.9	10.5	10.2
Feed / Gain	8.8	8.1	8.0
Carcass traits			
Carcass weight, kg	284.0	277.4	273.8
Dressing %	59.7	57.7	57.2
Quality grade[a]	10.4	10.8	11.4

Interpretation: 'New triticale varieties produce grain that can be substituted for conventional grains in finishing steer diets'.

Trial 2

Dietary treatment:	Corn	Corn/triticale mix	Triticale
Number of steers	10	9	10
Feedlot performance			
Initial weight, kg	387.8	385.7	388.3
Final weight, kg	516.6	512.5	504.1
84 day ADG, kg	1.53	1.51	1.38
Average daily feed, kg	11.1	11.1	10.7
Feed / Gain	7.3	7.4	7.8
Carcass traits			
Carcass weight, kg	303.2	300.6	296.0
Dressing %	58.7	58.6	58.7
Rib fat, cm	0.8	1.0	0.8
Ribeye area, cm^2	78.4	83.1	86.9
Internal fat, %	1.9	1.8	2.0
Marbling score	5.1[b]	4.3	4.3
Quality grade[a]	11.7[b]	11.1	10.5

ADG = Average daily gain
[a] Quality grades: 10 = US Good; 11 = US Good+ ; 12 = US Choice
[b] Significant differences were found for Marbling score and Quality grade, but were attributed to genetic differences in the animal groupings, rather than to a feed effect.
(Hill and Utley, 1989)

Triticale grain for sheep feed

No Canadian reports were found that describe the use or effectiveness of triticale as a feed grain for sheep. In theory, the high energy level of triticale should make it a suitable component in concentrates for feedlot applications.

Reports from South Africa confirm previous feeding results from that country indicating triticale may be fed to feedlot lambs successfully in enriched whole grain mixtures. However, the feed conversion ratio was lower than for maize in one study. In another study, some variability was found in the average daily gain and feed conversion ratio among different triticale varieties.

In a South African study, finishing lambs over 25kg were fed a 2:1 mixture of triticale:oat at 10.6 percent of the total diet. In addition to this, the lambs were given five different protein supplements for comparison. The study found that there were no differences found for the different diets. The explanation given for this result was that the protein quality of the triticale:oat ration fulfilled the non-degradable protein (NDP) requirement of lambs over 25kg.

Thus, the protein profile of triticale grain may contribute favorably to its use for sheep.

Triticale grain for horse feed

Rolled or flaked processed triticale can be used as the sole cereal grain in diets for horses. Due to its high starch digestibility, triticale may even be superior to other grains for horse diets.

When using triticale as a horse feed:

- Mix triticale grain in equal volume with chaff to slow the rate of carbohydrate intake. This helps avoid over-energetic behavior, diarrhea and other problems.
- Process triticale grain to improve its intake rate.
- Scale the amount of cereal grain content in each meal to the animal body weight to help avoid other problems.

For horse feed, the preferred cereal grains are those that have starch that is more digestible in the small intestine. Excess starch and sugars that are not digested in the small intestine of the horse flow into the large intestine, where a build-up of excess D-lactic acid can occur. This, in turn, starts physical and metabolic changes in the horse resulting in "hyper" or over-energetic behavior, diarrhea, laminitis and founder (Kohnke et al, 1999).

Triticale appears to have the high starch digestibility in the small intestine of horses that suit its use as a horse feed (Rowe et al, 2001). As when feeding other cereals to horses, triticale should be given as a rolled product and not as a finely ground feed.

Australian sources agree that processed triticale grain can be used as a substitute for more commonly used cereal grains in horse diets. They provide the following recommendations for triticale grain fed to horses:

- Limit the cereal grain to not more than 500g per 100kg body weight per meal, or not more than 4g of starch per kg body weight per meal.
- Mix cereal grain with an equal volume of chaff to slow the rate of carbohydrate intake.
- Soak, coarse crush, steam flake, or pellet the grain to improve intake.

Part 3. TRITICALE GRAIN – OTHER USES

Triticale grain for food use

Although data with the most recent Canadian varieties are lacking, triticale is considered a very suitable grain for human diets, due to its high energy and lysine levels. Although triticale is often a minor component in multi-grain breads, the overall human food market for triticale in Canada remains very small.

For bread (leavened) products, triticale lacks the gluten strength found in wheat, but its flour can be incorporated in leavened products in mixtures with wheat, where it gives a nutty flavor to products. For this purpose, processing quality is similar to and competes with Canada Prairie Spring Wheat, with medium protein level and gluten strength. Breads made from 100 percent triticale flour have texture more like rye than wheat. Breakfast cereals have also been made from it.

Triticale flour yield is less than wheat, and as a softer grain it must be milled differently. When triticale is used in multi-grain breads, production must ensure high-grade standards, including the absence of ergot bodies.

Baking trials completed by Kevin Swallow at Alberta Agriculture's Leduc Food Processing Centre found a large difference in performance and food quality between triticale varieties:

- Tests showed that 60 percent Bobcat (winter type) flour made good quality bread, both when made by hand and in the bread machine, while 60 percent Pronghorn (spring type) flour did not.
- Neither Bobcat nor Pronghorn flours made good pasta or noodles.
- Excellent tortillas and chapattis were made from 100 percent Bobcat flour.

Overall, the study found that the triticale flour yields were less than Canadian Red Spring Wheat. The study also reported that the mill did not have to be set differently when using triticale.

Internationally, triticale has found great success in a very large number of ethnic cereal-based foods. Some of these markets where these foods are sold cite triticale's flavour as one of its advantages. A long list of Indian foods contain triticale, where it is used in a 1:1 mix with wheat. These include: chapatti, jamoor, kesaribath, porridge, makmal poori, samosas, uppittu, halwa, shankarpoli, paratha, idli, matthi, mattar, pinni, jalebi, tortillas, comncha, Ethiopian injera and many other products.

Triticale grain for value-added processing and nutraceuticals

Investigations are underway to see if triticale's functional properties are different from other grains for food or non-food derivatives and uses. These properties include:

- Viscosity
- Foaming
- Emulsion stabilization
- Water binding
- Anti-oxidant
- Extrusion

Research is also ongoing to determine whether fractionation of triticale grain can identify potential value-added components. These could include: special proteins, lipids or starches, food emulsifying agents, β-glucan, pentosans, fiber (soluble and insoluble) and tocols.

Triticale may also see use in the fight against certain diseases. Its levels of dietary fiber and lignans may be high enough for use in high fiber food products as part of a dietary approach to control cancer, coronary heart disease or maturity onset (Type II) diabetes.

Triticale grain use for industrial purposes

In the long term, demand for ethanol-based fuel will likely continue to increase in North America. Canadian spring and winter triticale varieties are suitable for use in the conversion process, offering high crop yield potential and potentially low price when compared to wheat.

Triticale has been processed in some ethanol plants in Western Canada. However, the value of the co-products produced is not as high as when Canada Prairie Spring Wheat is used as the feedstock.

Most auto manufacturers are moving to engine design that can accept as much as 85 percent ethanol in the fuel (the E85 standard). Once this standard is accepted in the United States, Canada will have to move to the same standard. This could create a significant domestic demand. Most of today's ethanol fuel is exported to the United States.

The economics of ethanol production is best when grain prices are low and oil prices are high.

Any grain for industrial energy use (for example, conversion to ethanol) requires:

- Grain yield and price competitiveness with other grains.
- Plump kernels with a low percentage thins.
- High starch content and conversion rates to ethanol.
- A market for co-products.
- Regularized grain supply chain.
- Sufficient tax or other incentive for the ethanol to be competitive with gasoline in the fuel market.

Of these, the first five criteria are readily met by triticale at this time.

Comparative trials of different crops with different triticale varieties demonstrate that the biological value of triticale varieties is comparable to the most suitable wheat varieties for ethanol processing (McLeod et al 1997). Grain yields are also similar or better than for other cereals.

Canadian triticale varieties have generally lower fiber content than wheat, and comparable starch, fermentable sugars, pentosans, potential ethanol yields and lower protein content (McLeod et al., 1997).

From compositional studies using the same samples, Sosulski and Tarasoff (1997) (Table 16) concluded that the relative crop ranking for potential ethanol production in an ethanol plant was, from best to worst:

- Hard red winter wheat.
- Canada Prairie Spring (CPS) and Soft White Spring (SWS) wheat.
- Durum wheat, spring triticale and winter triticale and hulless barley.
- CWRS wheat and fall rye.

In some processing plants, poor gluten properties in triticale have led to "stickiness" in the extraction processes. While Canadian triticale breeders think this should not be a problem in modern varieties, the subject has not been researched at the plant-scale level.

Table 16. Grain properties and potential ethanol yields of W. Canadian grain crops

Crop	Cultivar	Starch %	Fermentable sugars %	Pentosans %	EY (S + FS) L / tonne	EY (P) L / tonne
HRW wheat	Norstar	67.2 (3.2)	1.3 (0.3)	na	392 (10)	na
HRW wheat	Kestrel	66.0 (1.6)	0.5 (0.2)	na	386 (10)	na
CPS wheat	Genesis	64.3 (1.8)	1.0 (0.3)	10.2 (1.3)	377 (10)	49 (8)
SWS wheat	AC Reed	65.1 (2.0)	0.9 (0.3)	8.6 (0.9)	382 (13)	40 (6)
SWS wheat	AC Taber	64.5 (2.3)	1.1 (0.2)	9.0 (1.0)	379 (14)	41 (6)
Durum wheat	Plenty	63.7 (2.1)	0.8 (0.3)	na	373 (12)	na
S. triticale	Pronghorn	64.9 (2.1)	1.2 (0.2)	8.9 (1.0)	382 (16)	41 (4)
S. triticale	Banjo	64.5 (1.9)	0.6 (0.2)	9.8 (1.2)	377 (12)	47 (5)
S. triticale	AC Certa	64.3 (2.3)	0.7 (0.3)	9.2 (0.7)	376 (17)	43 (3)
S. triticale	Wapiti	64.3 (2.1)	0.7 (0.2)	10.4 (1.4)	376 (12)	47 (6)
S. triticale	AC Copia	63.5 (2.2)	0.7 (0.1)	10.7 (1.4)	371 (14)	49 (6)
S. triticale	AC Alta	63.3 (2.4)	1.0 (0.4)	12.1 (1.9)	365 (15)	55 (8)
S. triticale	T114	62.3 (2.0)	0.8 (0.1)	11.0 (1.0)	365 (13)	51 (6)
Winter triticale	Pika	65.0 (2.0)	0.7 (0.3)	na	377 (16)	na
Winter triticale	Wintri	62.8 (2.4)	0.4 (0.2)	na	366 (13)	na
CWRS wheat	Katepwa	62.1 (1.8)	0.9 (0.2)	na	364 (12)	na
Fall rye	Prima	65.0 (1.2)	0.6 (0.3)	na	366 (7)	na
Fall rye	Musketeer	61.0 (1.0)	1.0 (0.4)	na	355 (8)	na

S = Starch; FS = Fermentable sugars; P = Pentosans; EY = Potential ethanol yields
Mean and (SD); Data averaged over 7 locations and 3 years
(Sosulski and Tarasoff, 1997)

Interpretation: Crop ranking for potential ethanol production in an ethanol plant was – hard red winter wheat > CPS and SWS wheat > durum wheat, spring triticale, winter triticale and hulless barley > CWRS wheat and fall rye.

Part 4. TRITICALE FOR FORAGE

Triticale forage productivity and use

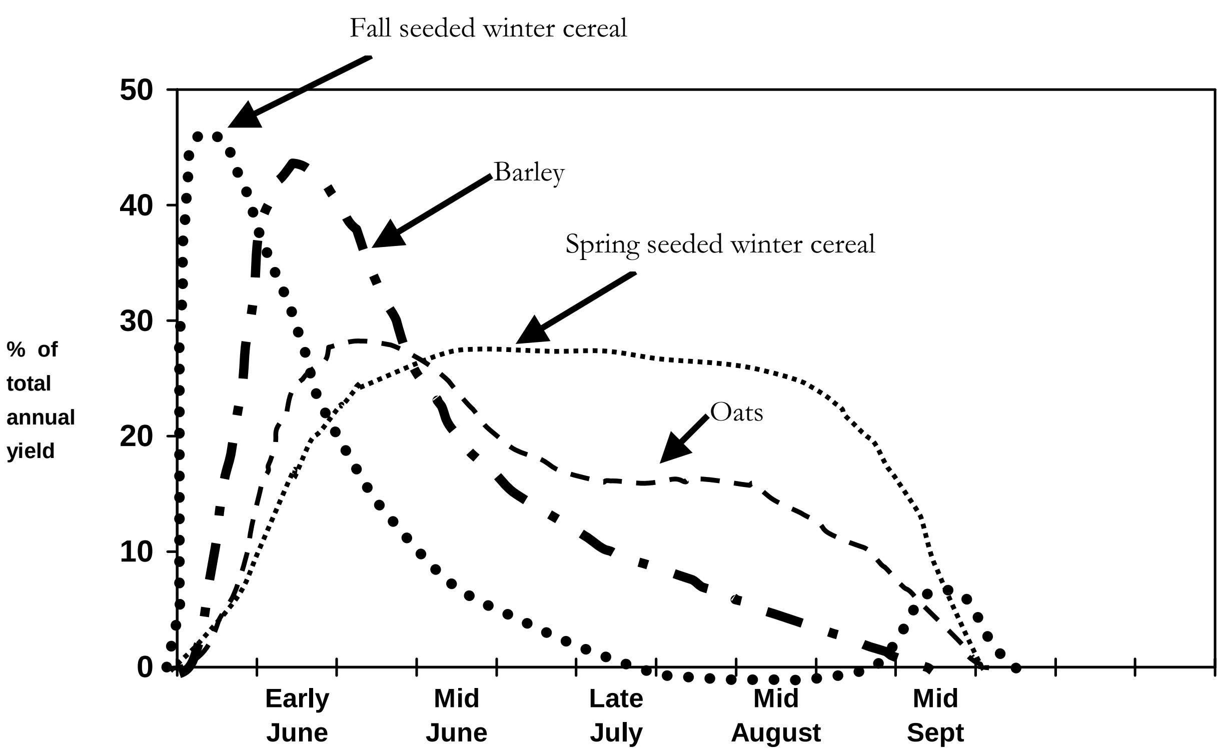
Annual cereals can provide an excellent source of supplementary forage, offering an extended grazing season and diversity in crop rotations (Figure 4). Due to its superior silage yield potential, triticale has proven to be very competitive with other cereals for yield and quality.

An advantage of growing winter triticale is its extension of early spring and late fall grazing.

In these applications, forage triticale has much to offer in helping diversify Western Canadian cropping systems (Briggs, 2001; *The Growth Potential of Triticale in Western Canada*).

For detailed information on triticale forage production, refer to the AgDex '*Triticale Forage Manual*' (2005, in press).

Figure 4. Seasonal distribution of pasture yields of annuals



(adapted from A. Aasen, Western Forage/Beef Group, Lacombe)

Triticale silage

Some quick facts about triticale silage production and quality:

Spring triticale for silage

- Spring triticale for silage is competitive with other silage options in Western Canada and in other countries, both for quality and for yield. Under stress, including drought and high temperatures, excess moisture, acid soils or excess of soil nutrients, triticale will maintain its yield potential and straw strength compared to barley or oats. Barley or oats may have less drought tolerance and weaker straw than triticale.
- Best management practices for growing and harvesting spring triticale silage are different than for barley silage. The two crops develop very differently and have very different straw characteristics, with triticale stems being more lodging resistant.
- When harvested after heading, spring triticale generally ranks between oats and barley for quality. As with other cereals, earlier silage harvest (optimum soft dough) improves quality and protein content but at the price of potential yield.
- Depending on conditions, spring triticale intercropped with peas may yield as well as triticale does by itself. However, the pea content in the silage usually results in a significant increase in the protein content as compared to that found when triticale is grown alone.

Winter triticale for silage

- Fall-planted winter cereals such as triticale and rye provide a valuable source of forage when spring grazed prior to being harvested for silage or seed. Rotating winter cereals with barley silage crops offers breaks for disease and pest control.
- When winter triticale is grown in a spring seeded inter-crop with spring oats or barley, the silage yield may sometimes decrease. However, if the crop is left for late summer and fall re-growth, the silage plus pasture yield usually exceeds the yield of either mixture component grown separately. It also provides fall grazing.
- If using oat inter-cropped with spring-seeded winter triticale, the expected forage yield performance is mixture = oat > winter mono-crop. This is especially true when seeding early.

Spring and winter triticale silage quality

- In Alberta, overall protein expectation for protein content in annual silage crops is described as: oats (9 percent) < barley, spring rye and triticale (10 percent) < sunflower (12 percent) < field peas (18 percent) < fababean (20 percent +).
- Canadian feedlots occasionally report reduced intake and/or gain from triticale silage as compared to barley. These probably relate either to change of feed, or to samples being harvested at non-optimal stages, or to samples being inadequately chopped or packed. Further research is needed on this topic.
- Compared to other silage, reduced intake is often reported as an issue in feeding triticale. This does not always translate into reduced animal productivity or quality. Improved triticale silage management and processing (a short chop length) can reduce this problem. Varieties with rough awns should be avoided for green-feed or haylage, or should be cut earlier before awns become hard and thick. The winter triticale 'Bobcat' is the first semi-awnless variety specifically bred to reduce this problem.

Reduced awn triticale

The reduced-awn characteristic of the winter triticale Bobcat is a very desirable trait. The lack of awns may reduce mouth irritation and sores if the crop is harvested after the optimum maturity date for good quality silage.

A study on barley by Karren et al (1994) advised against using rough-awned semi-dwarf barley in cattle silage because it can cause mouth lesions if silage is harvested at mature stages or moisture content is too low. The semi-awnless variety Bobcat was released to address any potential problems with awns. Harvesting silage at the recommended stage will eliminate this problem.

Reduced awns will be a feature found in future triticale varieties bred for forage use. It is anticipated that more reduced awn spring triticale varieties will be registered in 2005.

Triticale silage yield

In Alberta trials, triticale silage productivity is usually rated as being better than barley. Extension information from Manitoba does not support this superior rating.

In silage yield comparisons between 20 registered barley and triticale varieties and experimental lines grown at Lacombe, Alberta between 1998-2000, researchers found that:

- The dry silage yield of triticale averaged 14,324 kg/ha (minimum 12,812 kg/ha; maximum 16,137 kg/ha.
  This converts to 12,758 lbs/ac (min. 11,411 lbs/ac to max. 14,373 lbs/ac).
- The barley silage yield averaged 13,346 kg/ha (minimum 10,903 kg/ha; maximum 14,675 kg/ha).
  This converts to 11,887 lbs/ac (min. 9,711 lbs/ac to max. 13,070 lbs/ac.

Table 17. Silage composition of farm samples, Alberta data, 1984 -1994

	Triticale	Barley hulless	Barley 6-row	Barley 2-row	Alfalfa
Moisture %	66.9 (7.7, 14)	61.2	63.7 (7.4, 882)	62.2 (6.4, 62)	60.0 (9.6, 309)
Protein %	11.0 (2.1, 14)	12.8	11.0 (2.7, 867)	11.3 (2.5, 62)	16.7 (3.2, 308)
Calcium %	0.36 (0.13, 14)	0.30	0.49 (0.22, 863)	0.42 (0.19, 62)	1.64 (0.54, 304)
Phosphorus %	0.26 (0.07, 14)	0.28	0.26 (0.07, 863)	0.25 (0.06, 62)	0.23 (0.07, 305)
Acid detergent fibre %	34.5 (4.9, 14)	26.1	32.0 (6.2, 863)	31.0 (4.3, 61)	36.0 (5.9, 304)
Selenium mg/kg	0.14 (0.04, 5)	-	0.14 (0.12, 210)	0.08 (0.04, 5)	0.23 (0.25, 91)
Sulphur %	0.20 (0.02, 4)	-	0.24 (0.10, 65)	0.23 (0, 1)	0.30 (0.09, 26)
Neutral detergent fibre %	-	-	53.6 (4.9, 9)	-	34.8 (13.1, 10)
Lignin %	-	-	0.0 (0.0, 0)	-	0 (0, 10)
Iron mg/kg	287 (243, 6)	-	300 (596, 136)	134 (48, 4)	355 (450, 48)
Copper mg/kg	5.5 (3.5, 6)	-	4.9 (2.0, 155)	3.6 (1.7, 4)	6.7 (5.7, 73)
Manganese mg/kg	39 (10, 6)	-	38 (20, 156)	29 (12, 4)	39 (15, 69)
Zinc mg/kg	24 (10. 6)	-	31 (12, 159)	31 (6, 4)	27 (12, 70)
Magnesium %	0.15 (0.02, 6)	-	0.21 (0.06, 155)	0.18 (0.04, 4)	0.33 (0.09, 67)
Potassium %	2.31 (1.13, 6)	-	1.61 (0.44, 151)	1.39 (0.24, 4)	2.15 (0.88, 62)
Sodium mg/kg	31 (35, 6)	-	978 (1257, 121)	1562 (1096, 4)	344 (814, 46)
Molybdenum mg/kg	3.2 (3.0, 4)	-	1.9 (1.6, 77)	0.6 (0.8, 2)	2.3 (1.8, 30)
Cobalt mg/kg	6.7 (3.5, 4)	-	1.8 (2.8, 61)	0.4 (0, 2)	1.5 (1.9, 20)

Average analysis of silages
AAFRD web sources, 1984-1994
Silages had >60% contribution from the crop listed.
Mean, (standard deviation and number of samples)

Interpretation: Variability exists between crops, samples and varieties, but triticale silage quality is comparable to that of other cereals used for silage, perhaps with lower protein content

Triticale silage quality composition

Alberta trials have shown equal or better productivity when beef and dairy herds are fed triticale silage compared to other silages. In some studies, productivity was equal to or better than other silages despite lower intake of triticale silage compared to other forage silages such as barley and alfalfa.

Triticale is particularly well adapted for high forage yield production on heavily manured fields, where it is also an efficient remover of excess soil nutrients. Harvesting protocols and timing must be adjusted to accommodate the differences between triticale and barley in these situations. In high productivity systems where lodging is a problem, triticale should be compared to semi-dwarf barley, which also has special adaptation to high fertility conditions.

Using book values to determine nutritive value of cereal silage should only be used for comparison, as nutritional values are best determined by feed testing. This is because of:

- Quality variation affected by harvest date (in green-feed and for silage).
- Variable mixture compositions, when results from different crop mixtures are reported.

Due to variation in harvest dates, crop type and environmental conditions, nutritional value can only be determined by appropriate sampling and feed analysis. Typical compositional values for Alberta-grown silages are indicated in Table 17.

In silage, an acid detergent fibre (ADF percentage) level exceeding 39 percent would be rated as fair or poor. In multiple farm trials by Alberta Agriculture, Food and Rural Development in 1999-2002, no value for triticale ever exceeded 37 percent. This confirms the high energy potential of triticale as a forage source (Table 18, Figure 10).

In a Canadian study, Zobell et al (1992) compared barley and triticale silage fed to 120 steers as 25 percent of the ration, combining it in the diet with either barley or high-moisture barley.

No differences in weight, daily gain, dry matter intake or feed efficiency were found between the two diets. They concluded that "triticale silage can be fed to replace barley silage at moderate levels in growing steer rations containing barley grain."

Table 18. Silage yield and quality at Lacombe, Alberta, 1993-1995

	Pika winter triticale	Wapiti spring triticale	Prima fall rye	Tukwa semi-dwarf barley	Virden standard barley	Cascade spring oat
Harvest date	July 28	Aug 20	July 14	Aug 2	Aug 6	Aug 13
Yield t/ha	14.3	14.4	14.0	11.1	11.5	13.1
Dry matter %	41.3	37.0	40.0	32.0	34.0	31.0
Crude protein %	9.0	9.7	8.2	11.0	9.5	9.0
IVDOM %	61.0	66	63	68	60	62
NDF	57	48	53	49	59	55
ADF	33	29	30	27	34	34

IVDOM = In vitro digestible organic matter; NDF, ADF = Neutral or acid detergent fibre
Mean values averaged over three years.
(Baron et al 2000)

Interpretation: Triticale produced excellent silage yields and quality in the same range or sometimes better than other cereal forages

Silage mixtures and harvest stages

In Alberta, forage-clipping studies by Juskiw et al (2000) estimated potential silage productivity at different harvest dates. The researchers tested Wapiti spring triticale in mixtures at various seeding rates with Noble barley and AC Mustang oat.

They found that:

- Forage yields of the mixtures were generally in the middle of the yields of the components, or not different from one or the other component.
- The date for optimum harvest was generally in the middle of the dates of the components, or not different from one or the other component.
- Forage quality of the mixtures was also generally intermediate, with higher sample quality from higher amounts of leafy tissue in the sample, and with an earlier harvest.
- Higher seeding rates tended to increase forage yields. Seeding rates are dependant on soil type and moisture conditions. For example, for black and grey wooded soils with adequate moisture, 25 to 28 plants per square foot or 250 to 280 per square metre is optimum.

The Ontario Ministry of Agriculture, Food and Rural Organizations (OMAFRA) website describes similar findings for Ontario conditions. The site also says that harvesting at the soft dough stage results in the highest energy production per acre.

Triticale:pea silage mix

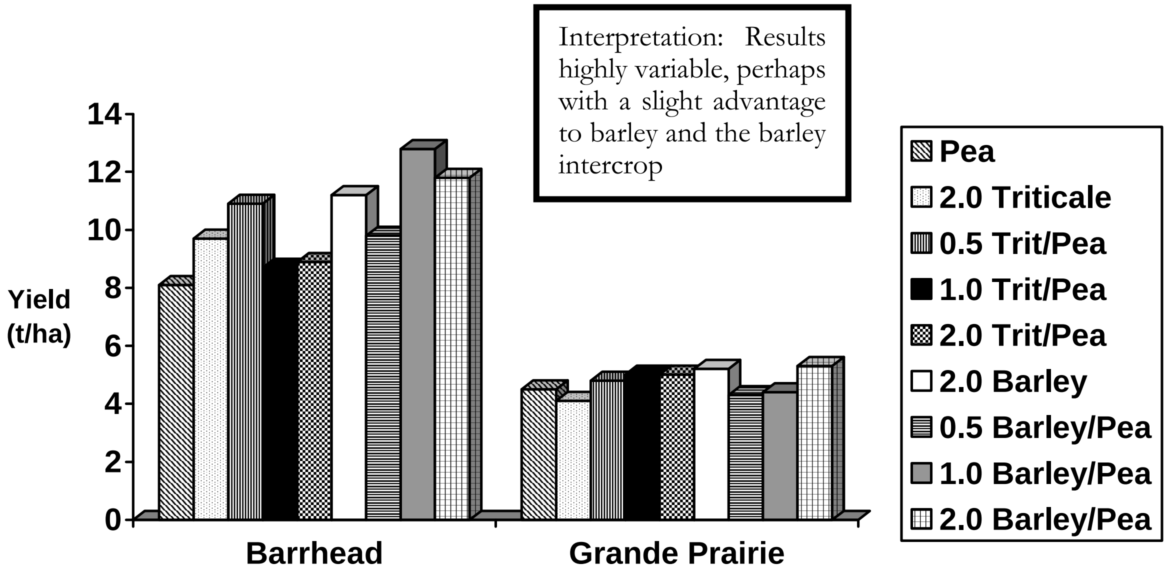
Spring triticale can be grown as an admixture with peas to raise the protein content. However, trials at Lacombe from 1981-1983 (Berkenkamp and Meeres, 1992) found that in comparison to pea mixtures with other spring cereals, the yield potential (t/ha) by crop was ranked as:

- Oat (12.0 t/ha)
- Wheat (8.8 t/ha)
- Barley (8.2 t/ha)
- Triticale (6.6 t/ha)

In these studies, the mixtures were seeded at 90 kg peas plus 20 kg per hectare cereal. None of the mixtures exceeded the yield of mono-cropped oats.

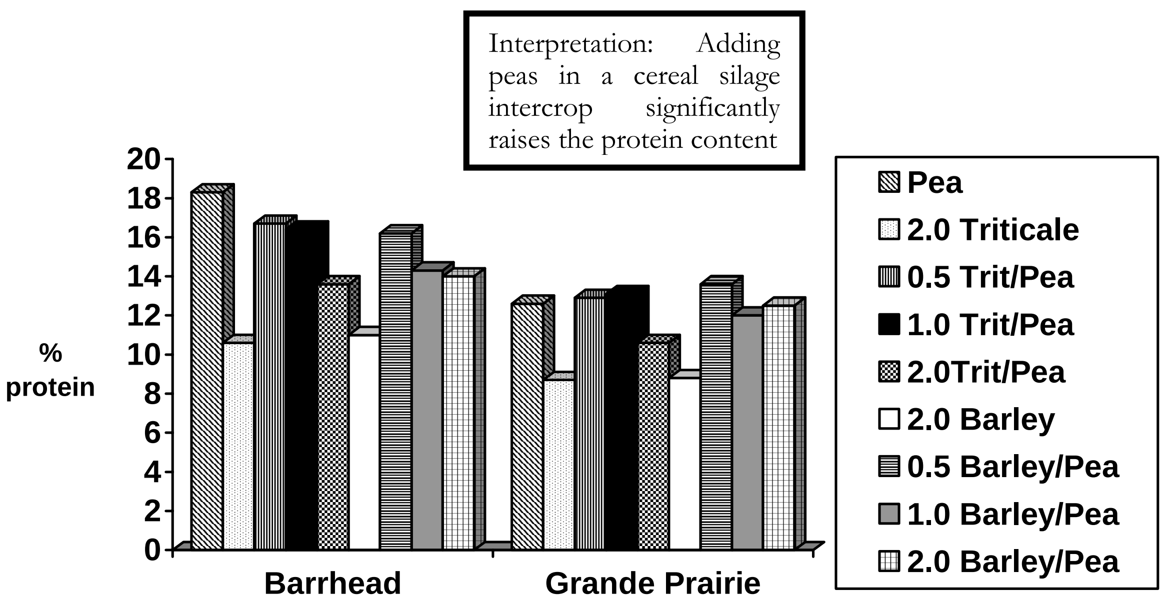
Studies by Blade and Lopetinsky (2002) at four locations found variable yield performance for barley and triticale in mixtures with peas. Yields depended on location and site yield potential (Figure 5). Although results were variable at different locations, including peas in the mixture usually increased the protein content in the harvested silage; this sometimes came at the expense of silage-yield-per-unit-area (Figure 6).

Figure 5. Cereal/pea silage biomass yield (ton/ha) at two sites in Alberta, with high (Barrhead) and low (Grande Prairie) yield potential



2 year means from 2 of 4 sites reported, using Performance 4010 pea variety; Peas seeded at 7 plants/sq.ft. in all treatments; Cereal seeding rates are listed in bu/acre
(Blade and Lopetinsky 2002)

Figure 6. Cereal/pea silage protein % at two sites in Alberta, with high (Barrhead) and low (Grande Prairie) yield potential



2 year means from 2 of 4 sites reported, using Performance 4010 pea variety. Peas seeded at 7 plants/sq.ft. in all treatments; Cereal seeding rates are listed in bu/acre
(Blade and Lopetinsky, 2002)

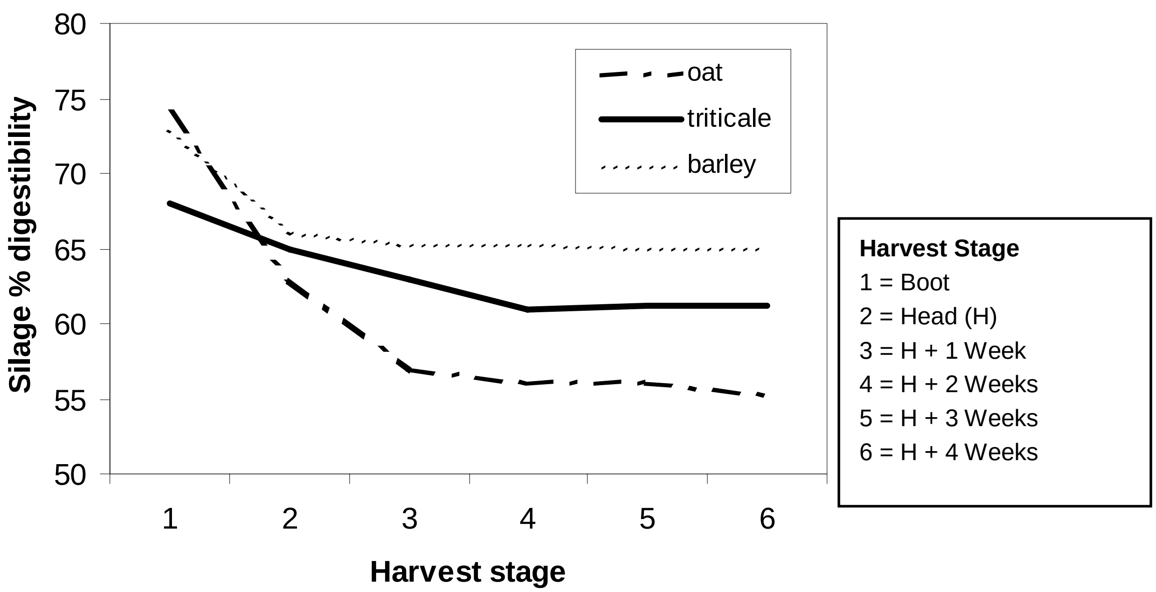
Silage harvest stage for dairy cattle

In recent Canadian work, Kennelly and Khorasani (2000) compared barley, oat, triticale and an inter-cropped triticale/barley silage, and monitored the effect of harvest date on silage quality. They recommended that the optimum time for harvest was at the soft dough stage in order to best balance potential quality and yield.

Data from Baron (Figure 7) clearly show that triticale silage quality is midway between barley and oat for all likely silage harvest dates.

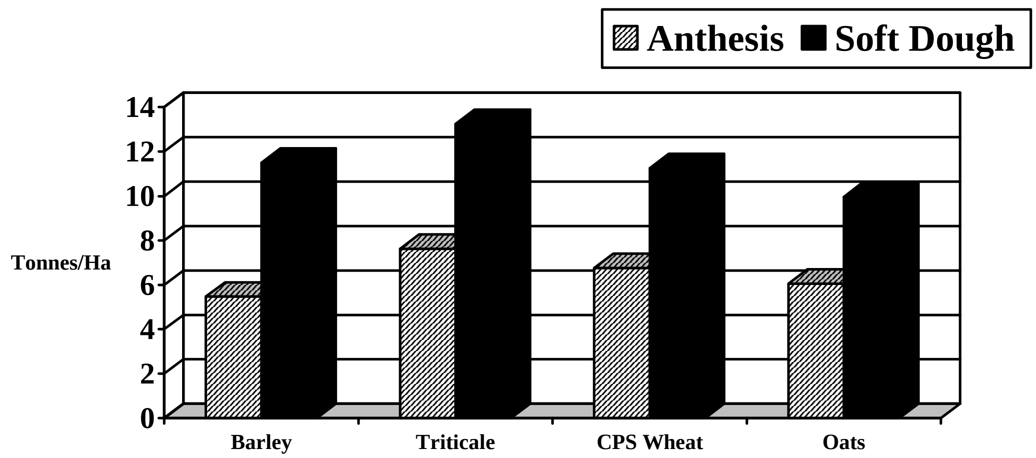
Figures 8 to 10 show comparisons of silage yield, protein, NDF and ADF of various cereal silages cut at anthesis (flowering) and at soft dough stages of growth.

Figure 7. Silage digestibility of cereals at different harvest stages



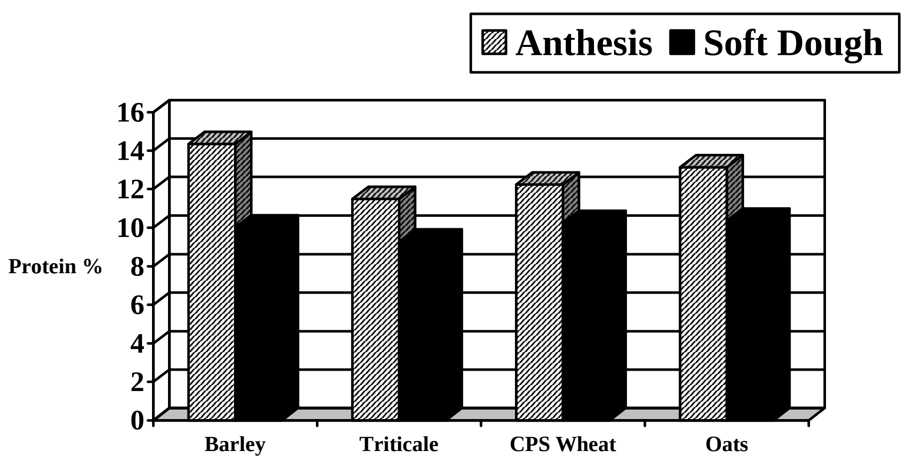
From AgDex 118/20-1
(Baron, AAFC, Lacombe)

Figure 8. Comparison of silage yields at anthesis and soft dough stages of growth for barley, triticale, CPS wheat, and oats at Lacombe, 1996 crop year.



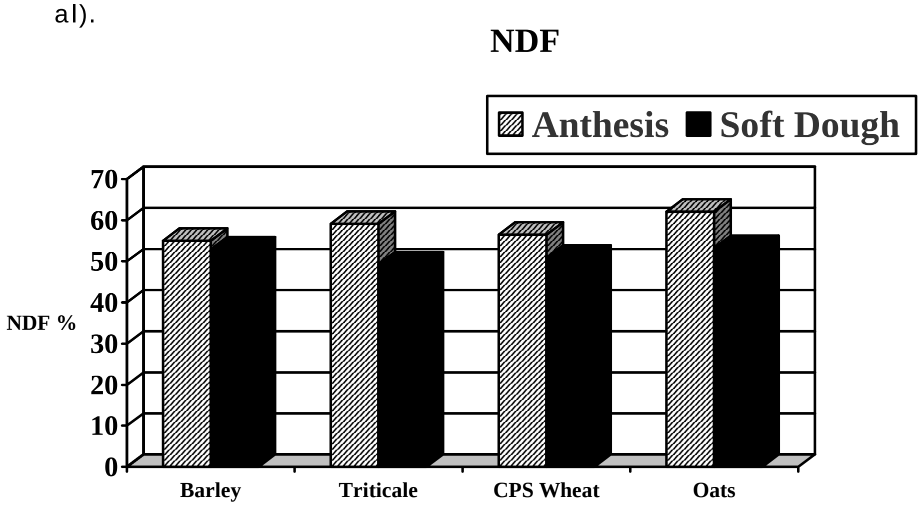
(Baron et al.)

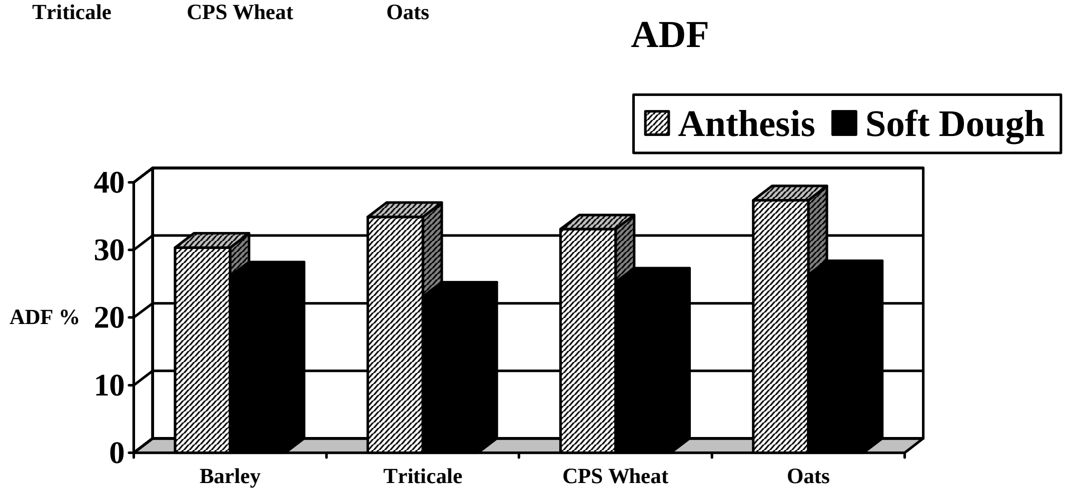
Figure 9. Comparison of protein in silage cut at anthesis and soft dough stages of growth for barley, triticale, CPS wheat, and oats at Lacombe, 1996 crop year.



(Baron et al.)

Figure 10. Comparison of NDF and ADF of silage cut at anthesis and soft dough stage of growth for barley, triticale, CPS wheat, and oats at Lacombe, 1996 crop year (Baron et al).





Best management practices for ensiling triticale forage

- Use different crops and varieties to spread the timing for optimum harvest of silage in different fields.
- Use the varieties that have the highest grain yield. Grain yield and forage yield are highly related.
- Whether using horizontal silos, towers or plastic tunnel bags, harvesting should be completed before the standing crop reaches 60-65 percent moisture content. The soft dough stage is a good harvest target.
- Earlier harvesting improves silage protein but lowers potential harvestable yield and energy.
- Avoid harvesting after the mid-dough stage, as the higher fibre content negatively affects energy content.
- If you need high protein silage, harvest earlier than the mid-dough stage.
- Triticale stems are tougher than barley and may need more processing to get optimum feed acceptance. Slow down harvesting speed to compensate for chop length.
- Cut, chop triticale silage so that plant cells are damaged. Chopping reduces silage losses. The smaller the pieces, the easier it to is to exclude air when packing. Livestock also find smaller pieces more edible (.75 to 1.25 inches or 1.9 to 3.2 cm).
- Fill silos rapidly. Pack and seal them quickly to avoid exposure to air, and to promote bacterial action and lactic acid fermentation.
- Use silage additives when necessary to improve silage quality and utilization.

The following section includes tables and figures showing comparative silage quality and productivity from Canadian research trials. Interpretations from the data are also presented in abbreviated form.

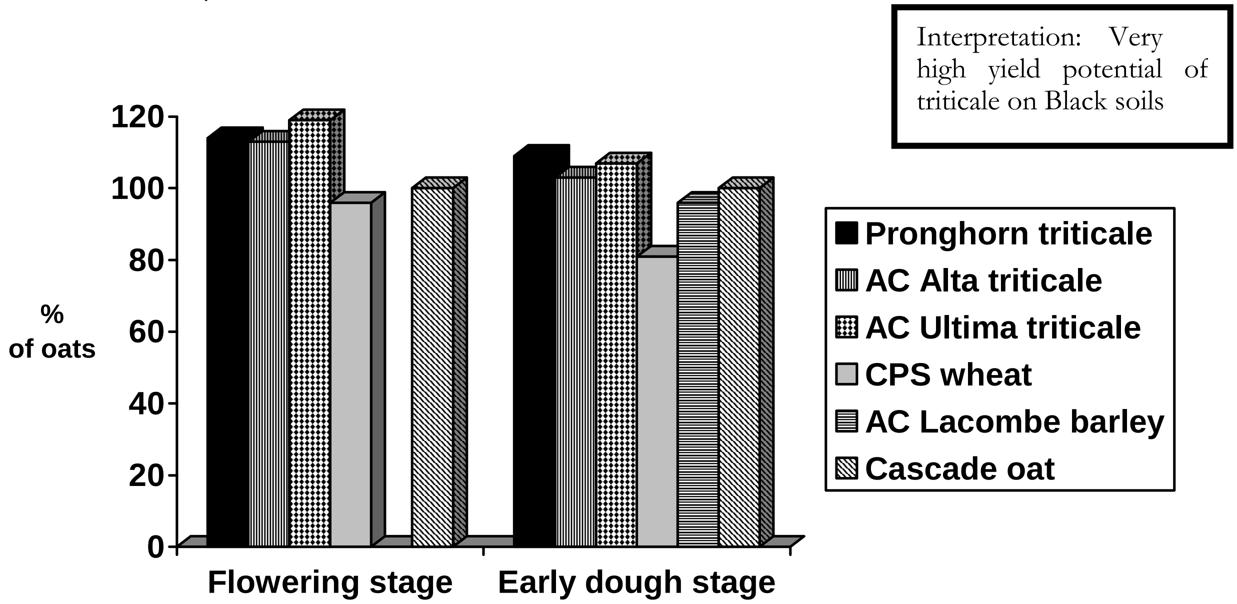
Table 19. Cereal silage performance on manured land, W. Canada 1998 -1999

	Silage yield Metric Tonnes/acre	Protein %	Protein yield kg / ha	ADF %
1998 results:				
AC Certa triticale	6.3 c	11.4 b	709 b	29.3 c
AC Alta triticale	7.6 b	12.4 a	913 a	29.3 c
Pronghorn triticale	7.5 bc	11.6 b	851 ab	29.3 c
Triticale / barley mixture	8.5 ab	10.6 c	885 a	31.2 b
Taber CPS wheat	7.5 b	12.3 a	910 a	27.8 d
AC Lacombe barley	9.2 a	10.0 c	938 a	32.6 a
1999 results:				
Barley silage (1 cut)	7.1			
Triticale silage (1 cut)	8.1			
Winter triticale (1st cut)	8.2			
Winter triticale (2nd cut)	2.8			

1998 results – In a column, treatments with the same letter do not differ significantly

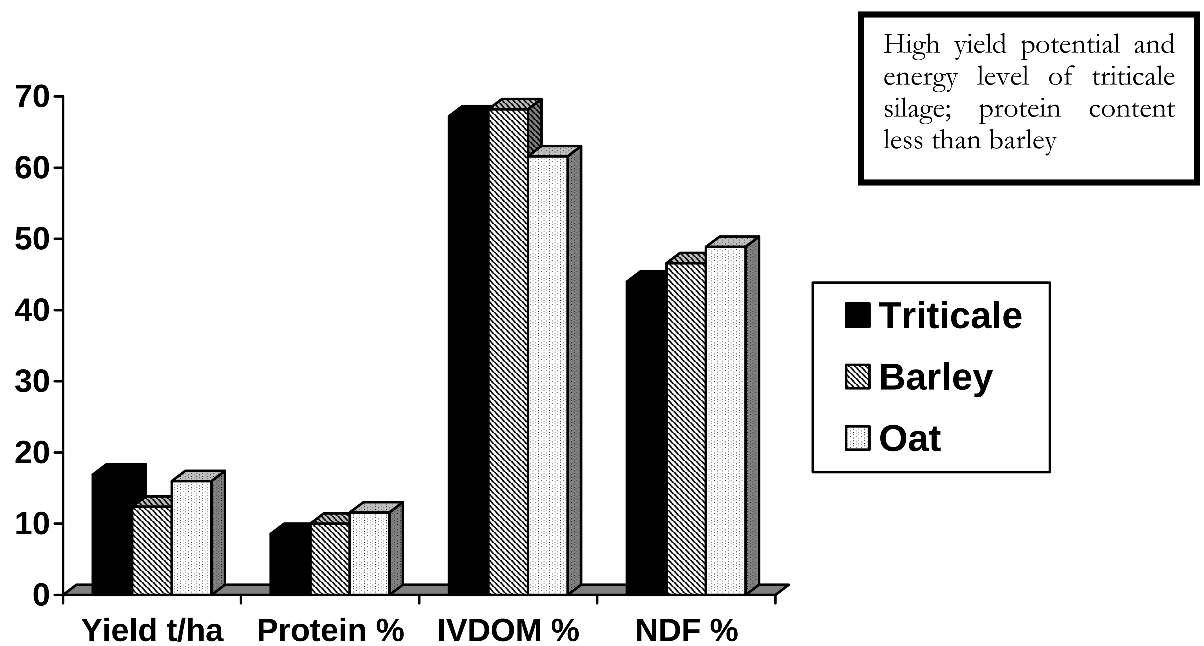
(Data from Highland Feeders Ltd., 1999 On-farm demonstration)

Figure 11. Cereal silage yields at two harvest stages, as a percentage of oats (Lacombe trials, 1995-2000)



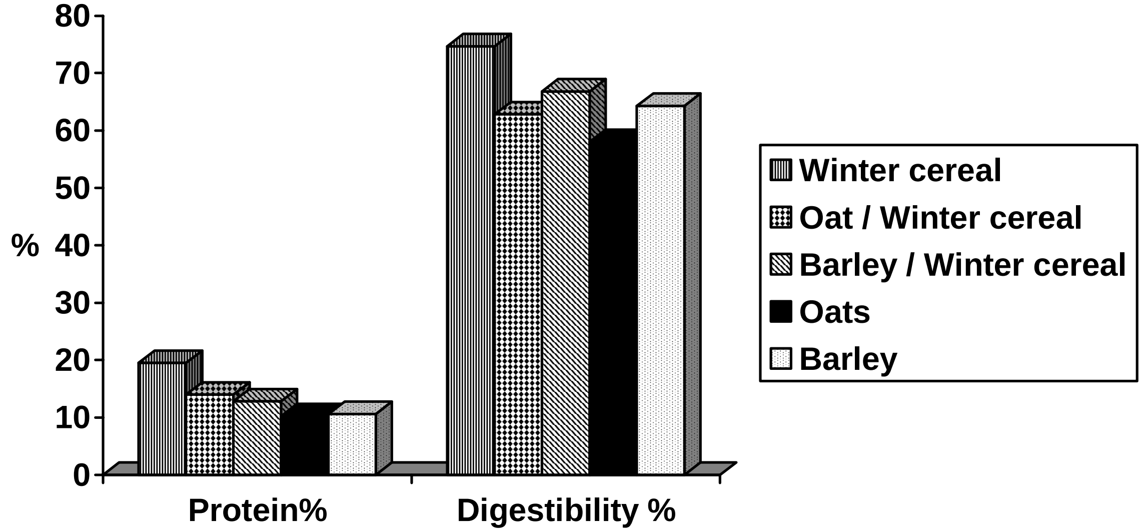
(AAFRD, 2000)

Figure 12. Yield potential and forage quality of spring cereals, early dough stage



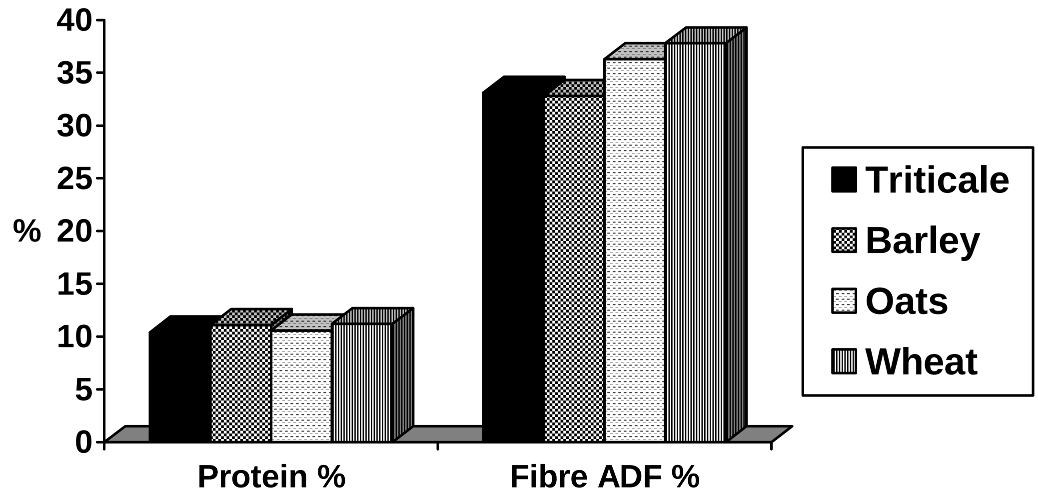
IVDOM % = In vitro digestible organic matter
NDF = Neutral detergent fiber
(Salmon et al, 1996)

Figure 13. Silage quality of inter-cropped winter triticale and other cereals



(Baron et al, AAFC Lacombe Research Station, cited in Aasen, 2004)

Figure 14. Cereal forage protein and ADF fibre content, % dry matter



Nutrient analyses - mean of Provincial samples of Alberta grown silage
(Alberta extension data: 2001)

Table 20. Triticale silage performance as feed for milk cows, Lacombe, Alberta, 2000

	Spring Triticale	Barley semi-dwarf	Barley standard	Winter triticale barley mix (Low yield)	Winter triticale barley mix (High yield)
Yield t / ha	14.6	11.2	11.7	9.4	11.7
Crude protein %	9.7	11.0	9.5	14.0	14.0
IVDOM %	66.5	67.0	60.0	68.0	68.0
NDF %	48.2	50.0	58.8	50.0	50.0
Milk yield kg / t	606	480	214	615	615
Costs $ / ha					
Production	205	193	193	198	198
Harvest	220	170	178	153	178
Total	425	363	371	351	376
Milk value over costs					
$ / ha	2553	1934	1737	1623	2059
$ / t	175	173	149	173	176

IVDOM = In vivo digestible organic matter NDF = Neutral detergent fibre
Silage yield, milk productivity and economic returns for milk production.
From >3 years of data in trials at Lacombe
(Baron and Dick, 2000)

Table 21. Silage productivity comparisons for milk production

	Silage component in the diet				
	Alfalfa	Barley	Oat	Triticale	SEM
Dry matter intake					
kg/day	19.6 a	18.6 a	16.7 b	17.2 b	0.42
% of body wt.	3.29 a	3.12 a	2.83 b	2.90 b	0.06
Milk, kg/d					
Yield	31.6	31.5	30.1	30.2	0.51
4% FCM	29.1	27.7	27.3	26.6	0.78
Fat	1.10	1.01	1.01	0.97	0.05
Protein	0.95	0.96	0.90	0.94	0.02
Lactose	1.47	1.50	1.42	1.43	0.03
Milk composition, %					
Fat	3.50	3.23	3.45	3.21	0.14
Protein	3.01 b	3.07 b	3.04 b	3.14 a	0.03
Lactose	4.67 b	4.80 a	4.76 ab	4.75 ab	0.03
Milk energy, Mcal/d	21.4	20.9	20.4	20.0	0.44
Gross efficiency, kg of milk/kg of DMI	1.61 c	1.69 bc	1.80 a	1.76 ab	0.03
Body wt., kg	596	596	590	591	4.9
Body wt. changes, g/d	-264	74	473	464	301

Means in the same row with different letters differ significantly (P<0.05)
SEM = Standard error
W. Canadian study
(Khorasani et al, 1996, J. Dairy Sci. 79: 862-872)

Interpretation: Milk yield from the triticale silage diet was slightly less than from alfalfa and barley, but milk productivity and quality were very similar

Triticale grazing productivity and quality

Some quick facts about triticale grazing productivity and quality:

- Spring-planted winter cereals alone or in mixtures with barley or oats (inter-cropping) provide an excellent source of pasture from mid-June until late in the fall (see *Winter Cereals for Pasture*, Agdex 133/20-1).
- Triticale grown for forage in cereal mixtures tends to offer the most positive traits related to survival and re-growth in a mixture, but will not always be the highest yielding annual forage solution.
- "Inter-cropping is the best alternative where annual forage is needed for fall season pasture, and extended ground cover is required to combat soil erosion for a longer portion of the year." (Baron et al, 1993)

Triticale, either in spring or winter form, offers an excellent potential for extending the spring and fall grazing seasons.

The use of winter cereals such as winter triticale can provide farmers with a valuable alternative to perennial forages and can be used to extend the traditional grazing season into the early spring and late fall.

Fall seeded winter triticale

Fall rye, winter wheat, and winter triticale can provide some fall grazing and provide earlier spring grazing the next spring (early to late May) compared to perennials.

If the winter crop is intended for seed or silage production, grazing should be discontinued once crop elongation begins.

In general, the order of regrowth of green material in the spring follows (first to last):

- Fall rye
- Winter triticale
- Winter wheat

In Florida, Bertrand and Dunavin (1974) showed that triticale alone, or in mixture with ryegrass and crimson clover, were equal to rye as grazing forage for growing beef calves.

In studies with winter triticale in Missouri, Miller et al (1993) studied the effects of simulated grazing (clipping) on subsequent grain yield when used in a double-crop situation, and compared these to when winter wheat was used alone.

In this comparison, winter triticale performed as well as the winter wheat. However, it was also apparent that:

- To keep grain yield potential, grazing should not be allowed beyond the first node stage.
- If the main goal is yield, then the amount of grazing would have to be adjusted to allow the grain to recover sufficiently during the post-grazing portion of the growing season.

Spring seeded winter triticale

When seeded in the spring, winter cereals (such as winter triticale) remain vegetative throughout the spring, summer and fall. There is no heading because seedlings do not receive the cold treatment, or vernalization, that would normally occur in the fall. Vernalization is required in order for heads to form the following summer (see box below).

Two options are commonly considered:

- Growing a mono-crop of winter cereal for grazing.
- Using a mixture of winter cereal and spring oat or barley.

The second option has a rapidly growing spring cereal, which allows for high grazing yield in the spring and early summer. It also allows the opportunity of using the blend for silage and subsequent grazing in the fall.

Seeding rates may be influenced by the intended end use. For example, if a blend or mixture of spring and winter cereals is intended for silage production and then fall grazing, seeding rates of 75% of the normal rates for each component in the mixture may be recommended. (Refer to the production section of this manual)

Mixing spring-planted winter triticale with tall varieties of oats or barley has been shown to be an effective source for spring and summer grazing as well as for silage. The barley and oat:

- Are very vigorous in the early growth stages.
- Dominate the canopy in the early stages of growth.
- Provide excellent forage quality.

> Vernalization is a physiological change in the seedling, usually received in the fall when seedling temperatures that are below 5-7°C and low light intensity serve as triggers for the plants to develop heads the following year.

After the earlier season grazing or silage harvest, the winter triticale becomes more dominant in the mixture. It has the potential to provide vigorous re-growth and high quality forage in late summer and fall. This is at the same time as the re-growth potential for spring cereals and perennials decreases.

Aasen (2004) reported that adding a one-half bushel of oats or barley to a winter cereal for spring seeding increased spring growth in a mixture, and also made the graze available 10 days earlier than either component by itself. When managed in this manner, spring and fall grazing potential improves as compared to other grazing options.

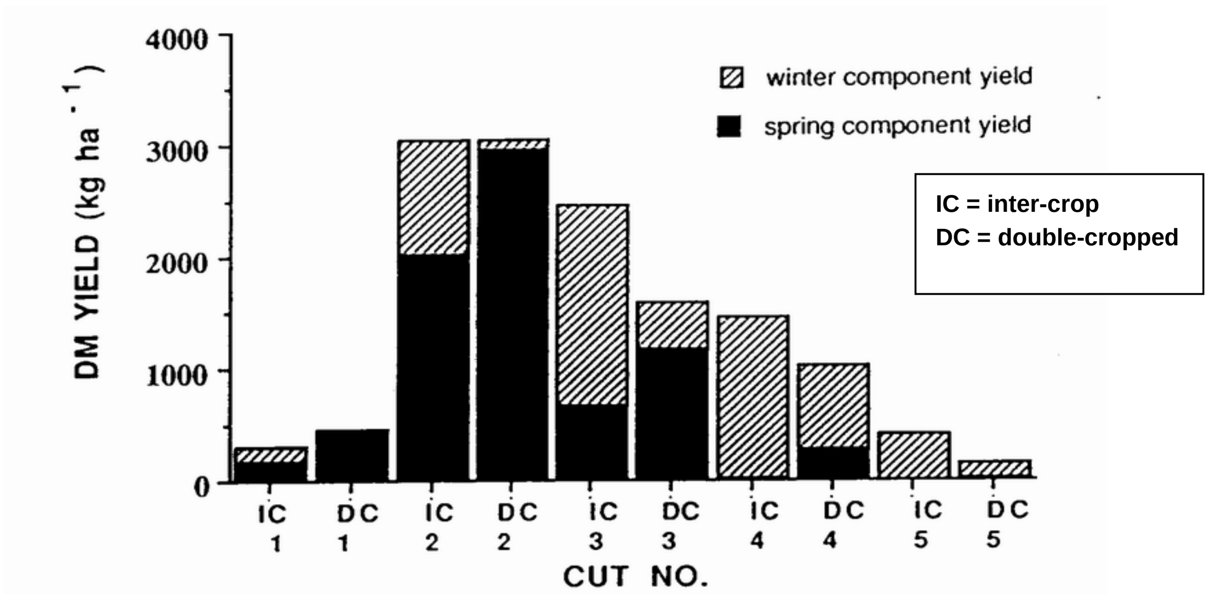
These effects are well illustrated by the results of a study at Lacombe from spring seeding a blend of winter and spring cereals. Researchers found that the spring forage yield came mainly from the spring cereal, and was taken over by the re-growth of the winter component later in the season (Figure 15).

General grazing recommendations

The following should be done to avoid problems when grazing cereals, especially when the growth is very lush:

- Avoid acidosis by providing a straw supply or access to grass stands in adjacent pastures to supplement the low fibre content in the graze.
- Avoid high applications of nitrogen sources as high nitrate levels can cause problems on spring cereals. Frosts and drought usually increase nitrate levels. Know the lab quality of the forage feed being used. Sample and submit for feed analysis.
- Use mineral supplementation to avoid potential for grass tetany.
- Supplement grazing livestock with straw or hay to add fibre, reducing runny manure problems.

Figure 15. Seasonal forage yield contribution from spring and winter components in inter-crop (IC) and double crop (DC) management systems



Note: cutting dates ranged from mid-June to mid-October or late October on average.
(Baron et al 1993)

Interpretation: The major yield contribution comes from the spring component in early season, and from the winter component in the late part of the season

Stocking rates

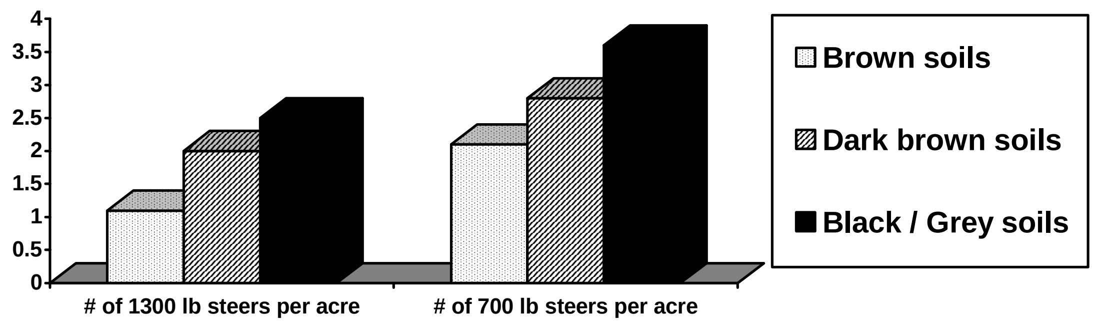
Suitable stocking rates can only be determined from experience, and depend on the circumstances of each graze crop. Saskatchewan Agriculture (Figure 16) recommends maximum stocking rates per acre of 1.1 to 2.5 for 1300 lb cows, and 2.1 to 3.6 for 700 lb steers on annual pasture, depending on the soil type and its productivity.

Table 24 is an example of simulated stocking rates based on research conducted in Alberta.

Palatability is not often a problem, and is better for winter triticale and winter wheat than for fall rye.

Figure 16. Typical maximum stocking rates for annual pastures in Saskatchewan (a guideline)

Interpretation: Soil type and animal size influence maximum stocking rate for grazing



Based on the website (sourced February 8, 2004)
http://www.agr.gov.sk.ca/docs/crops/forage_pasture/forage_management_production/annualsforforage.asp

Table 22. An example of grazing productivity in Alberta using triticale

	Triticale/barley Steers	**Perennial grass Heifers**
Rainfall (mm)	264	274
Grazing initiation date	July 1	May 29
Grazing completion date	Oct. 23	Sept. 9
Grazing days	115	103
Stocking rate (animals / ha)	0.38	0.38
Daily gain (kg / day)	0.94	0.74
Total gain (kg / ha)	23.6	19.3

Interpretation: Not a head-to-head comparison, but gains on triticale/barley pasture were at least equal or higher than those on a perennial grass

Performance of a spring seeded binary combination of winter triticale and spring barley compared to perennial grass as a pasture in central Alberta
(Salmon et al 1996)

Triticale use for green-feed and hay

There is little research on triticale being used for green-feed hay. However, the optimum time for harvesting cereals as dry hay is the same as silage stages of cutting, late milk to soft dough stages.

Triticale green-feed and hay can be managed similarly to other green- feed and hay sources. Dried-out, late harvested samples can cause palatability issues for animals and create mouth ulceration. These problems can be limited by using the semi-awnless winter variety Bobcat. Varieties with rough awns should be avoided for green-feed or hay or cut earlier before awns become hard and thick.

Triticale straw can be used in animal systems but, along with wheat straw, in not considered to have as high a feeding quality as barley or oat straw. This is likely because of the higher fibre content and lower energy content and protein.

Table 23. Hay and green-feed composition of farm samples, Alberta data, 1984 -1994

	Triticale	Wheat	Timothy
Moisture %	11.0 (3.7, 29)	13.6 (4.9, 221)	13.3 (4.1, 440)
Protein %	10.3 (3.5, 29)	9.8 (4.6, 182)	8.2 (3.3, 4330)
Calcium %	0.31 (0.20, 29)	0.29 (0.18, 181)	0.54 (0.30, 429)
Phosphorus %	0.18 (0.10, 29)	0.18 (0.08, 182)	0.15 (0.07, 4340)
Acid detergent fibre %	34.1 (2.8, 29)	31.2 (13.0, 204)	37.3 (6.0, 429)
Selenium mg/kg	-	0.51 (0.37, 23)	0.10 (0.14, 141)
Sulphur %	-	0.27 (0.11, 16)	0.14 (0.07, 77)
Neutral detergent fibre %	-	-	66.3 (5.6, 22)
Lignin %	-	-	4.4 (3.1, 22)
Iron mg/kg	56 (0, 1)	242 (338, 19)	173 (391, 83)
Copper mg/kg	4.6 (0, 1)	4.1 (2.1, 20)	5.6 (7.4, 125)
Manganese mg/kg	17 (0, 1)	56 (24, 19)	68 (82, 119)
Zinc mg/kg	26 (0, 1)	25 (10, 20)	26 (16, 125)
Magnesium %	0.09 (0, 1)	0.17 (0.07, 19)	0.14 (0.05, 117)
Potassium %	0.88 (0, 1)	1.33 (0.59, 19)	1.25 (0.37, 116)
Sodium mg/kg	-	395 (791, 18)	42 (54, 79)
Molybdenum mg/kg	-	1.7 (1.3, 9)	2.0 (2.0, 65)
Cobalt mg/kg	-	2.0 (2.1, 6)	0.7 (0.9, 35)

Average analysis of forages, AAFRD web sources, 1984-1994
The forage had >60% contribution from the crop listed.
Table shows mean, (standard deviation and number of samples)

Interpretation: Triticale forage quality is in the same range as other forage crops, with differences in mineral composition. Considerable variation is found between individual forage samples

Triticale use for swath grazing

Swath grazing is the swathing of late seeded cereals in mid-September at the soft dough to dough stage. The swath is left in the field for cattle grazing through the winter. The swathing is done late in the season in order to maximize quality for cattle grazing through the winter. Cattle can usually eat the swath even if the swath is under snow.

Swath grazing:

- Eliminates the cost and time of baling or silaging.
- Eliminates the cost of cleaning corrals and hauling manure from feedlots.
- Extends the field grazing season.

Successful swath grazers spend a lot of time managing their animals to ensure efficient grazing as well as good animal condition and health. Most users are grazing dry, mature, beef cows in reasonable body condition.

Most information about swath grazing is from producer experience and surveys. Best management practices for swath grazing are summarized below. Productivity data specifically describing swath grazing of triticale were not found in the literature. For general information on swath grazing refer to Ropin' the Web (www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex4245?opendocument).

Managing the crop

- Stagger seeding dates in different fields, so swathed crops are all at the soft to mid-dough stage at the desired swathing date. Late May to June seeded winter triticale works well in this application.
- Use winter triticale plus oat or barley as a mixture to improve the swath forage quality; raise seeding rates up to 25 percent more than for a grain crop.
- Use normal fertilizer rates. If soil N load is very high, and the crop is subjected to major stress during growth (frost, drought, cool weather), be aware of problems that sometimes develop from having high nitrate levels in the forage. If in doubt, send samples to a feed test laboratory.
- Delayed seeding for swath grazing allows for pre-seeding herbicide use. Check herbicides for restrictions on subsequent feed use.
- A crop previously planned for grain can be cut for swath grazing after a heavy frost.
- During the grazing period, animal manure can return high amounts of nutrients to the grazed field. Soil testing is recommended to determine fertilizer requirements for subsequent crops.
- Ensure that any swath residuals are fully grazed off, baled off, or spread in the field. This avoids residual damage to subsequently seeded crops from the swath strips.

Managing the animals

- Test swath quality before feeding to determine necessary levels of supplemental feed, and to estimate the likely duration of the graze period using the swaths in the field. Typical analyses should include fibre content, projected energy levels, protein level, calcium, phosphorus and nitrates.
- If swath grazing calves, young cows, thin cows or cows with calves, supplemental feed and minerals may be necessary, especially during periods of cold and snow.
- Choose fields for swath grazing that are sheltered from the wind, and close to buildings and a water source.
- Choose fields where wildlife grazing will be minimized, as wildlife will trample swaths and reduce the amount of available feed.
- Monitor swath use and ease of access. Blade away snow drifts if the drifts deeply bury the swaths or if snow becomes hard-packed.
- Animals can efficiently graze snow-covered swaths late into the winter with proper management (for example, the use of electric fencing).

Triticale – a crop for all seasons

How Triticale Fits into Sustainable Cropping Rotations

Producers recognize the many different ways in which spring and winter triticale can be incorporated into rotations to extend seasonal access to forage, and to spread field operations throughout the year. As such, forage has become the predominant triticale application in Western Canada.

Winter triticale can be used for dual purposes over more than a calendar year. However, if grazed or harvested for forage and then left for grain production, grain yields are generally reduced. Spring triticale can be grown as a mixture with other cereals or with legumes in a forage or grain mixture harvest. It will improve the standability of weak-strawed species in a mixture. Spring or winter triticale can also be used as a short-term cover crop and/or for green manure, or in combination with chemical fallow.

Salmon et al (1993) warn that, "Over-wintering of spring planted winter wheat or winter triticale is not a suitable means for seed production, compared with conventional fall planting or re-seeding to spring cereals." Some producers have found that with good management practices, they have had some success in producing silage in the second year. However, this practice is not recommended as it increases the probability of winterkill and lowers yield potential.

Spring and winter triticale are both suitable for grain and forage use, with the latter being grazed or conserved. Western Canadian producers have developed numerous ways to use this crop to advantage in different rotations. A number of these options are illustrated in Figures 17 and 18.

For producers requiring a continuous supply of silage for feedlots, winter and spring triticale can be planted in different fields to provide a continuum of harvesting dates for silage, when scheduled with fields of barley and oat silage. Winter triticale can be harvested for silage from mid to late July, barley from late July to early August, oats from early to mid August, and spring triticale from mid to late August. In addition, use of spring triticale for swath grazing through the winter can reduce the fall workload for storing silage in cow-calf operations.

Thus triticale for forage can well be described as '**The Crop for All Seasons**'.

Because of the high demand for barley silage and feed grain, many western Canadian rotations tend to have too high a frequency of barley cropping. This causes increased problems from barley leaf diseases. Triticale for silage or grain provides an excellent disease break from barley and oats, since triticale is not susceptible to many of the same diseases as oat or barley.

Figure 17. Seasonal windows for spring triticale for different forage applications: Some examples
These charts show comparative time lines for different forage applications with spring triticale.

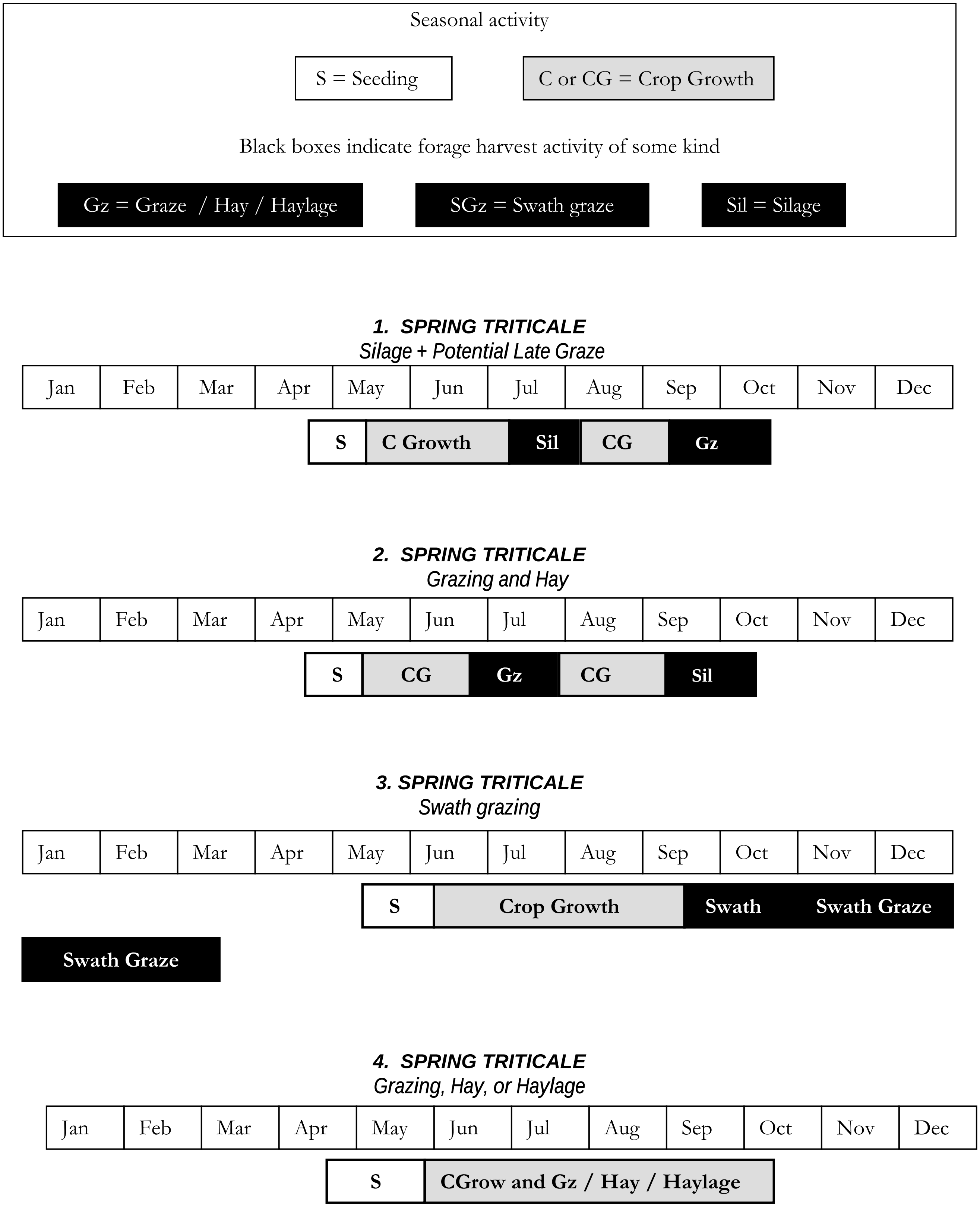
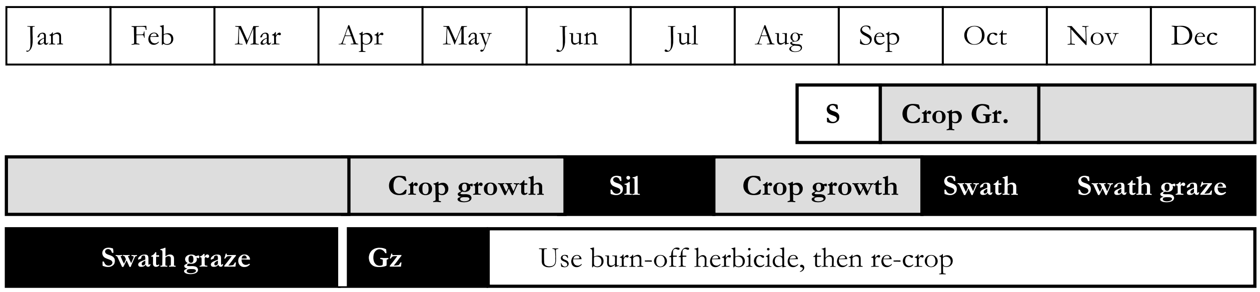


Figure 18. Seasonal windows for winter triticale for different applications: Some examples

Best management practice dates for different activities will vary considerably from north to south in Alberta. These charts show comparative time lines for different forage applications with winter triticale.

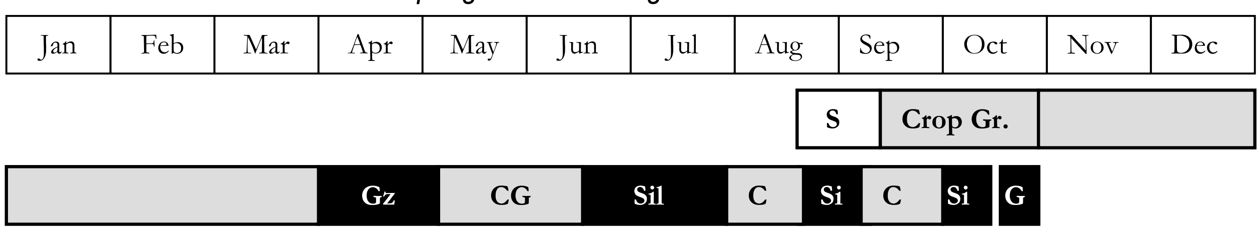
1. WINTER TRITICALE – Fall seeded

One Silage Cut + Swath Graze + Potential Spring Graze



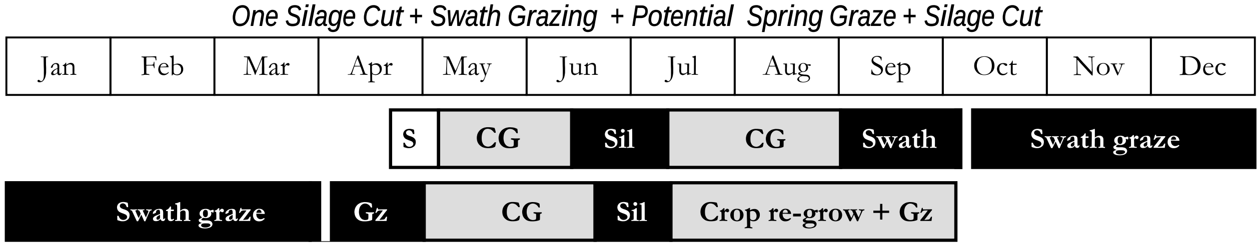
2. WINTER TRITICALE – Fall seeded

Potential Spring Graze + 3 Silage Cuts + Potential Fall Graze



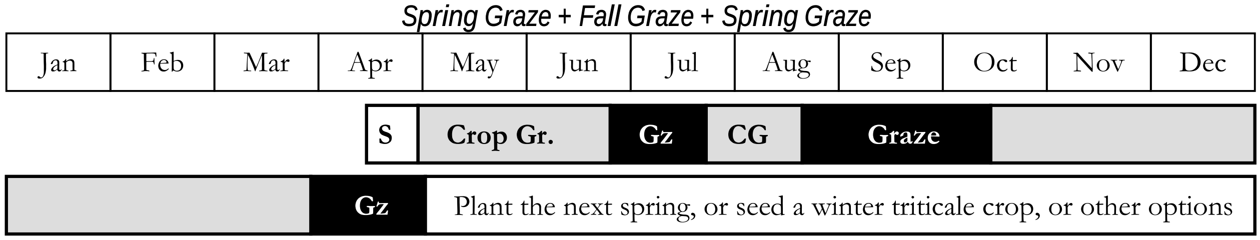
3. WINTER TRITICALE – Spring seeded (Pure stand or with cereal or legume)

One Silage Cut + Swath Grazing + Potential Spring Graze + Silage Cut



4. WINTER TRITICALE – Spring seeded with oats or barley

Spring Graze + Fall Graze + Spring Graze



Part 5. TRITICALE PRODUCTION

Varieties

A diversity of spring triticale varieties with high grain and forage yield potential are available to producers. The number of adapted winter varieties is fewer than for the spring types. These varieties also allow a greater diversity of crop rotational options for improved protection from disease and insect damage. As well, the potential biomass production capability for these varieties exceeds that of most other cereal crop options under Western Canadian conditions.

Registered triticale varieties have an excellent disease resistance profile. Although they are more resistant than some other cereals, the late maturity of the spring varieties limits suitability for grain production in some areas.

Winter triticale varieties are as winter hardy as the best winter wheat varieties but less than fall rye.

Registered triticale varieties are well suited for grain and silage operations. These operations include:

- Forage mono-cropping.
- Inter-cropping and double cropping.
- Other special forage applications.

All spring and winter varieties are rated as good to very good for resistance to stem rust (except Pronghorn, which is rated as poor in Manitoba), leaf rust, and bunt. They are all rated as resistant to loose smut.

Triticale in general has superior drought resistance compared to barley, wheat and oat.

Spring triticale varieties

Table 24. Aggregate table derived from 2004 Provincial Variety Descriptions

	Yields, adjusted to % of Pronghorn in each Provincial region / area:											
	Alberta Regional Zones						Manitoba	Saskatchewan Areas				
Spring varieties	**Irr**	**1**	**2**	**3**	**4**	**5+6**	**Long-term**	**Irr**	**1**	**2**	**3**	**4**
Pronghorn	100	100	100	100	100	100	100	100	100	100	100	x
AC Alta	106	103	100	84	101	101	105	102	107	102	96	x
AC Certa	95	99	93	91	92	92	104	93	102	98	98	x
AC Copia	105	100	94	96	84	94	95	92	101	97	93	x
AC Ultima	107	103	95	109	105	97	107	na	108	102	100	x
Banjo	na	na	na	na	na	na	103	na	na	na	na	x

na = Insufficient data to describe
x Indicates not recommended in SK Area 4 due to late maturity

Spring varieties	**Days to maturity MB**	**Height inches MB**	**Test weight lb/bu AB**	**Test weight lb/bu SK**	**1000 Kernel weight g AB**	**Root rot SK**	**Fusarium head blight C**
Pronghorn	96	40	55	55	43	F	F
AC Alta	99	35	54	54	49	F	P
AC Certa	97	40	59	59	43	G	P
AC Copia	95	39	57	58	46	F	P
AC Ultima	96	38	56	56	45	F	P
Banjo	100	42	na	na	na	na	P

na = Insufficient data to describe
Disease resistance shown as P = Poor, F = Fair, G = Good, C = Consensus from Coop trials and special tests
Data are from different Provinces, indicated as AB, MB, SK

Other agronomic traits:

- All spring and winter varieties are rated as good for shattering and lodging resistance.
- In most regions, spring triticale varieties are typically as late as or later maturing than AC Crystal CPS wheat.
- Compared to other cereal species, triticale varieties have only a fair tolerance to pre-harvest sprouting.
- AC Ultima is a variety bred for improved sprouting resistance. It has a high Hagberg Falling Number, which is associated with a lower proneness to sprout.

Winter triticale varieties

Winter triticale is a high yielding, early maturing alternative to spring triticale for short-season areas of the prairies. Pika and Bobcat are the only two winter varieties currently registered for Western Canada, and typically mature about three weeks earlier than spring varieties. Their winter hardiness is rated as equal to that of the best winter wheat varieties, but not as high as fall rye.

Bobcat is awnletted, with shorter and stronger straw than Pika. It is also easier to thresh than Pika. Bobcat is best suited to areas of higher snowfall, higher summer rainfall, or irrigation.

Winter triticale is best adapted for seed production in the Brown soil zone of Southern Alberta, and in high snowfall areas such as the Black soil zones of the prairies. In areas of good adaptation, winter triticale yields may exceed those of winter wheat by as much as 10 to 20 percent (Table 25).

Table 25. Comparisons of winter triticale, fall rye and winter wheat (1995-2000)

	Winter survival %		Relative grain yield %		Julian Calendar day of maturity		1000 kernel weight, g		Test weight lbs/bu	
Soil Zone :	**Black**	**Brown**	**Black**	**Brown**	**Black**	**Brown**	**Black**	**Brown**	**Black**	**Brown**
Bobcat winter triticale	66	85	118	119	236	223	36	35	53	51
Pika winter triticale	91	88	104	137	233	221	35	42	54	56
Musketeer fall rye	90	91	100	105	229	214	34	34	58	58
CDC Osprey winter wheat	84	80	100	100	223	219	32	32	63	62

Julian Calendar 223 is August 10, 236 is August 23.
(Source AAFRD, Ropin' the Web)

Interpretation: Winter triticale is very competitive agronomically with other winter cereals

Top 10 Reasons to Grow Winter Triticale

The top ten reasons to grow winter triticale in Western Canada are the same as for winter wheat (taken from the website www.usask./agriculture/plantsci/winter_cereals)

1. Good fit with conservation farming systems.
2. Uses water more efficiently than do spring-seeded crops.
3. Avoids wheat midge damage because of early heading. This reduces insecticide use.
4. Good weed competitor, so wild oat herbicide may not be required
5. Not spraying for wild oat control reduces risk for developing herbicide resistance.
6. Reduced risk of fusarium head blight due to early development and maturity.
7. Avoids seeding problems in late, wet springs, and offers earlier, less risky harvest dates.
8. Reduced tillage and pesticide use means lower energy requirements.
9. Less disturbance of wildlife, especially waterfowl and upland game birds.
10. High yields and lower input costs offer a high probability of increased returns per acre.

Seeding triticale

Most cultural practices needed for growing triticale can be taken directly from wheat. These include:

- Managing for seedbed preparation
- Seeding rate
- Seeding depth
- Seeding date
- Seeding methods

Triticale seeding rates

- Plant more weight of triticale seed per unit area than when planting wheat. This is because triticale has larger seeds than does wheat.
- Adjust seeding rates to achieve targeted plant densities for specific triticale uses and conditions.
- Keep in mind that optimum seeding rates vary depending on what the triticale will be used for.

If seeded on its own (mono-crop) for forage, the minimum seeding rate for triticale should be at least the same as the seeding rate used for grain production, or somewhat higher (up to 25 percent), to ensure adequate stand establishment.

When planting mixtures with triticale (inter-cropping), the seeding rate for the mixture is adjusted upwards from the normal rate. However, the seeding rate for each component of the mixture is lowered. Research at the Field Crop Development Centre in Lacombe indicated that 75 percent of the normal recommended rate for each of the components is optimum. For example, if the normal seeding rates for triticale and barley is 2 bu/ac, for a triticale and silage barley mixture the rates should be adjusted to 1.5 bu/ac of triticale and 1.5 bu/ac of silage barley, for a total seeding rate of 3.0 bu/ac. The same recommendation applies to spring/winter cereal mixtures seeded in spring for grazing.

Some quick facts about seeding triticale:

- Choose and manage seeding rates to achieve target plant stand densities in the field.
- Triticale has the largest seed size of all common small-grained cereal crops. Ensure that your seed rate compensates for this.
- Optimum seeding rates depend on the use that is planned for the crop and on local conditions. Check provincial recommendations for general guidelines.
- Rates are usually adjusted upwards when seeding forage mixtures or inter-cropped triticale.
- For mono-crop triticale forage production, recommended seeding rates are usually 25% higher than seeding rates for grain production.
- In two-component forage-crop blends using triticale, one guideline suggests each component consist of 75 percent of the normal seeding rate for the individual components alone.

For best management practices, triticale should be seeded to achieve a desired target plant stand frequency in the field. For this, the 1000 kernel weight (g) of the seed source must be known. Note that triticale has a much larger 1000 kernel weight than do other cereals.

Plant populations recommended in Table 27 and Table 28 are based on research results obtained over several years.

Within limits, higher seeding rates in triticale lead to:

- Higher crop yields.
- Better weed competition.
- Earlier maturity.
- Fewer tillers per plant.
- Shorter plant height.

Seeding rates should generally be adjusted upwards for:

- Large seed size.
- Low seed germination rate.
- Deep seeding (not a recommended practice).
- High moisture and yield potential conditions.
- Heavy textured soils.
- Rough seedbeds.
- Heavy weed pressure conditions (especially in organic production).

Lower seeding rates may be suitable for dry conditions. Triticale does not tiller as freely as wheat, and has greater difficulty in compensating for low stand establishment. Use your own experience to adjust plant density targets to your local conditions.

Lodging

Triticale can lodge because of:

- Height.
- Lush growth under conditions of high moisture and fertility.
- High seeding rates.

Earlier seeding appears to reduce this tendency towards lodging.

Table 26. Seeding rate formula

Use the following formulas to calculate the seeding rate in pounds per acre (or kg/ha). The seedling survival rate value used assumes that 10 percent of seeds planted do not produce plants in the field.

$$\text{Rate (lbs/acre)} = \text{Desired population/ft}^2 \times 1000 \text{ kernel wt (g)} \div \text{Seedling survival rate } (0.90) \div 10$$

$$\text{Rate (kg/ha)} = \text{Desired population/m}^2 \times 1000 \text{ kernel wt (g)} \div \text{Seedling survival rate } (0.90) \div 100$$

Interactive seeding rate calculators for triticale are available on the Alberta Agriculture website at http://www1.agric.gov.ab.ca

Table 27. Recommended seed rates for triticale used for grain

Triticale for grain[1]	Desired plant population Per sq.m.	Per sq. ft. (Range)	Range in 1000 kernel weight (g)	Range in # seeds/lb
Spring triticale	310	30 (25-35)	43-49	9,500 – 10,800
Winter triticale	250	24 (18-30)	43-49	9,500 – 10,800

([1]Adapted from AAFRD AgDex 81)

Table 28. Typical seeding rates[1] for triticale used for forage

	lb/acre	Av. bu/acre
Triticale for greenfeed	80 - 100	1.5 - 2.0
Triticale/pea mixture for greenfeed	¾ normal rate + pea at ¾ normal rate	1.2 (+ 1.5 – 2.3 bu/acre of peas)
Winter triticale, fall and spring seeded, dry regions	80	1.5
Winter triticale, fall and spring seeded, moist regions	110	2.0
Triticale/cereal inter-crop for summer or fall pasture, silage, or fall grazing	100 - 110	1.5 - 2.0
With oat, add oat at	20 - 25	1.2 - 1.75
With barley, add barley at	30	0.5
Spring triticale for swath grazing	100 – 120	1.5 - 2.0
Winter triticale + spring cereal, swath grazing	15 - 20	0.25 - 0.5
With oat, add oat at	70	2.0
With barley, add barley at	100	2.0

[1] Recommended seeding rates, as target plant densities are unavailable, so use lbs/acre
Recommendations may differ from zone to zone

- AAFC recommends 1 bu/acre each of triticale and peas if grown together in a mixture
- AAFC recommends using winter triticale seeded at 1.25 bu/acre plus 1/3 to 1/2 bu/acre of spring cereals, intercropped

(Table adapted from AAFC, AAFRD, BCMAFF, MAFRI, and SAFFR websites, 2004)

Seeding date

For seeding spring triticale, plant as early as possible to reduce risk when harvesting grain and to maximize forage yields. Because spring triticale is a late maturing crop, seeding for grain production should be completed by the second week of May in all parts of the western prairies and British Columbia. If conditions allow, seed as early as May 15 for maximum yield.

Optimum seeding dates for winter triticale for grain are the same as those for winter wheat. At least three or four weeks of growth are needed to develop seedling hardiness in winter triticale. This allows winter triticale to develop at least 3 to 4 leaves and adequate crown establishment.

The range of suitable dates for seeding winter triticale is from the second week of August (the earliest date recommended for more northerly and higher altitude sites) to no later than the second week of September (for southern prairie locations).

Variation in soil temperature for germination is the main environmental factor influencing the optimum planting dates for winter triticale. Late seeding usually results in lower winter hardiness, since winter triticale does not harden as fast as winter wheat and fall rye. Seeding too early allows too much seedling growth and increases the risk of winterkill.

Winterkill can be minimized using the same optimal management procedures as for winter wheat (for more detail refer to *Winter Wheat in the Parkland Area of Alberta*, Agdex 112/11-1). This involves direct seeding into tall standing stubble to trap snow, and to prevent the seedling crown structures from being exposed to critical low killing temperatures. Avoid late, deep seeding as it results in poor establishment of the winter triticale crop.

Consult the section of this manual on triticale forage use for optimum seeding dates for special forage applications. Seeding dates for special purposes, including forage use or swath grazing, should be adjusted according to general guidelines shown in Figures 17 and 18, and adjusted for local conditions and management objectives.

Seeding depth

Shallow seeding is recommended for winter triticale to ensure rapid emergence and optimal winter hardening.

Triticale should be seeded between 0.5 to 1.5 inches deep (optimum 1 inch) and never deeper than 2 inches. Shallow seeding allows for:

- More rapid emergence.
- Early vigor.
- Improved competition with weeds.

Due to its large seed size, triticale is able to emerge from deep seeding. However, this usually results in decreased emergence and less plant vigour. Just as with winter wheat, shallow planting of winter triticale is recommended to ensure a rapid emergence and a hardening of the crown to improve winter survival.

Seed quality and seed standards

Use pedigreed seed as it has many superior properties as compared to bin-run seed:

- Guaranteed genetic purity.
- Certified low levels of other crop types and weeds.
- Potentially lower levels of seed-source disease and pest infection.
- Tested for germination.
- Better seed size uniformity.
- More even germination.
- Generally better yield potential.

If using bin-run seed, ensure that seed is cleaned to pedigreed seed standards, and that germination percentage is never less than 75 percent. Use accredited seed laboratories to check seed quality. Samples with germination percentage as low as 75 percent may also be reduced in vigor.

Fertilizer requirements of triticale

In general:

- Recommended fertilizer rates for forage use are generally similar to those for producing grain.
- Base your fertilizer requirements on results from soil tests, and fertilize according to pre-planned yield targets for the particular field.
- Adjust yield targets and fertilizer applications according to previous crop, soil type, and expected seasonal moisture levels.
- On fields that have received high levels of manure application (to which triticale is well adapted especially for silage production), monitor soil nutrient levels for over-accumulation of P and K in the soil.
- Banding with N is recommended.
- Placing some of the N with the seed can be an effective procedure under optimal conditions. However, maximum recommended rates must be reduced under drought conditions.
- Ammonium nitrate (34-0-0) with the seed is safer than 46-0-0 (Table 32).
- Double shoot, side banding, mid-row banding air drills and/or air seeders with spreader boots all reduce the risk of seed or seedling burn from fertilizer placement with the seed. Air seeders with spreader boots increase the Seed Bed Utilization (SBU). For example 9" sweeps with 3" spreader boot is 33% SBU (Table 32).
- Double shoot systems, new mid-row air drills, or side banding units have seed and fertilizer separation to reduce risk of seed or seedling burn.

Production goals can be set by reviewing the specific suggestions that are included with the soil test results. General guidelines for fertilizer application on the prairie provinces can be used when soil test results are unavailable (Tables 29 to 32).

When growing winter triticale, N-P-K-S should normally be banded at recommended rates.

If you are broadcasting additional nitrogen in spring, 34-0-0 is preferred as losses can occur with 46-0-0 when there is low moisture and temperatures higher than 10 degrees Celsius.

Table 29. General fertilizer recommendations (lb/acre) for wheat, for Alberta
(These recommendations can safely be used for spring and winter triticale)

		Nitrogen		Phosphate (P_2O_5)	
	Soil zone	**Fallow**	**Stubble**	**Fallow**	**Stubble**
Spring wheat	Brown	5-20	20-50	10-20	0-15
	Dark brown	5-20	25-60	15-35	0-25
	Thin black	5-25	35-65	15-35	10-35
	Black + Grey wooded	5-35	30-80	15-40	15-40
Winter wheat	Brown	20-30	25-55	10-25	10-25
	Dark brown	25-35	30-65	20-40	15-30
	Thin black	25-45	40-80	25-45	20-40
	Black + Grey wooded	nr	nr	nr	nr

nr = No recommendation reported *(AAFRD website, 2004)*

Table 30. General fertilizer recommendations (lb/acre) for all crops, for Saskatchewan

	Nitrogen				
Soil zone	**Stubble**	**Summerfallow**	**Phosphorus**	**Potash**	**Sulphur**
Dark brown	25-60	0-15	20-35	-	-
Black	45-65	15-55	20-35	-	-
Dark grey	50-90	20-60	20-35	0-35	0-20
Grey	50-95	20-60	20-35	0-35	10-20

(SAFFR website, 2004)

Table 31. General fertilizer recommendations for triticale for Manitoba

Nitrogen (N)	0-20 lb/acre following fallow or legume breaking
	20-40 lb/acre following grass and grass-legume breaking
	40-60 lb/acre following stubble
Phosphate (P_2O_5)	30-40 lb/acre (shortage shows as purpling/browning on leaf tips)
Potassium (K_2O)	On sandy textured or organic soils, 15-30 lb/acre
Sulphur (S)	When required, 15 lb/acre

(MAFRI website, 2004)

Table 32. Maximum rates of nitrogen (as urea 46-0-0) that can be safely placed in the seed row with cereal grains

	Width of spread in the row											
	1 inch			2 inch			3 inch			4 inch		
	Disc or knife			Spoon or hoe			Sweep			Sweep		
Row spacing (in)	6	9	12	6	9	12	6	9	12	6	9	12
Seed Bed Utilization (%)	17	11	8	33	22	17	50	33	25	67	44	33
	Maximum recommended N with seed (lb/acre):											
Light soil (sandy loam)	20	15	10	30	25	20	40	30	20	50	40	30
Medium soil (loam to clay loam)	30	25	20	40	35	30	50	40	35	60	50	40
Heavy soil (clay to heavy clay)	40	35	40	50	40	35	60	50	40	70	60	50

- If ammonium nitrate (34-0-0) is used, and seedbed moisture is good to excellent, 50% higher rates can be used.
- 'Safe' rates listed are for good to excellent seedbed moisture conditions, with packing and residue cover to reduce seedbed moisture loss.
- The research for these rates was done with wheat, barley and oats, but results would also apply to triticale.

(Source AAFRD website 2004)

Grain harvest and storage

Harvesting and storage management for triticale is generally similar to that for wheat. However, spring triticale for grain is a late-maturing crop, and is also more susceptible to sprouting conditions at harvest than HRS wheat.

In dryland conditions, straight cutting of triticale is recommended where conditions allow. This is because straight cutting for grain can help reduce losses from pre-harvest sprouting, which triticale is much more susceptible to than is wheat.

Combining at 14 percent grain moisture is considered dry for triticale. This moisture content will not cause storage problems.

Moisture content lower than 13.5 percent is very desirable, as most moulds and insects tend to be inactive below this moisture level. Risk is also reduced when storage temperatures are lowered below:

- 8°C for insects.
- 3°C for moulds.
- –8°C for mites.

Kernels with moisture content up to 20 percent can be harvested and, if properly dried, will not lose quality. If drying triticale grain, maximum desirable temperatures are:

- 40°C for seed.
- 65°C for commercial grain.

If swathing the crop, ensure that the grain moisture is 35 percent or lower. It is recommended that winter triticale be straight combined, as it matures three weeks earlier than spring triticale and several classes of wheat. Combine settings should be set similar to those for wheat, with care taken to slow the cylinder speed to minimize grain cracking and splitting.

Triticale grain grade standards

Kernel size and test (bushel) weight

- Triticale test weight is comparable to other cereals, except some wheat classes and hulless barley.
- Registered varieties have test weights that readily allow them to meet the minimum requirement of the top grade of No. 1 Canada Triticale (65 kg/hl = 52 lb/bu; Source CGC Official Grain Grading Guide, August 1, 2003) (Table 34).
- Triticale has a very large kernel size which should always be taken into account when determining seeding rates, and for which processing adjustments may also be needed for grain use in value-added technologies.

Modern triticale varieties have very high kernel weights, and test (bushel) weights that are comparable or superior to many other cereal grains. The range of differences between varieties for test weight is of similar order for all the cereal crops listed in Table 33 except for milling wheat and malting barley, where uniformity of test weight in different varieties is a more stringent registration requirement.

A wide range of seed size is found between varieties in all cereals, including triticale (Table 33). It is particularly important to properly adjust seeding rates for triticale to meet adequate target plant densities in the field due to:

- Wide range of differences in varieties
- Variability between seed lots
- Large average kernel seed size

Adjustments are often needed to milling and processing equipment for optimal performance when working with larger seeded grains.

Plant Breeder's Rights

Avoid becoming involved in unauthorized sales of varieties that have Plant Breeders Rights (PBR). Fines are substantial for illegal use. Many varieties of grain are managed under Plant Breeder's Rights legislation. This legislation allows the owner of the variety to prevent the unauthorized sale or use of a protected variety's seed. Fines for unauthorized use are substantial, and active programs are underway to identify all PBR-related unauthorized seed use in Western Canada. Contact your seed distributor for clarification of your rights and obligations when growing a PBR variety.

Table 33. Test weight and 1000 kernel weight of triticale and other cereal grains

		Test Weight (lbs/bushel)[1]		1000 Kernel Weight (g)		
Cereal crop		Min – Max	CGC Min.[2]	Min – Max	Average	Variety
TRITICALE	Spring triticale	54 – 59	52.0	43 – 49	43	Pronghorn
	Winter triticale	54 – 59	52.0	43 – 49	43	Pika
OAT	Milling or feed oat	38 – 42	44.8	35 – 43	41	Derby
	Hulless oat	41 – 50	-	30 – 38	-	-
WINTER	Fall rye	56 – 58	52.6	30 – 33	30	Dakota
	Winter wheat	62 – 65	62.4	30 – 38	34	CDC Claire
WHEAT	CWRS wheat	58 – 64	60.0	33 – 42	37	AC Barrie
	CWHWS wheat	58 – 59	60.0	34 – 35	35	Snowbird
	CPS wheat (all)	61 – 62	61.6	39 – 43	42	AC Crystal
	CWES wheat	60 – 62	60.0	39 – 46	43	Glenlea
BARLEY	General purpose barley	48 – 53	50.4	39 – 49	48	CDC Dolly
	Semi-dwarf barley	47 – 53	50.4	35 – 48	48	CDC Bold
	Hulless barley	57 – 62	60.0	32 – 41	38	CDC McGwire
	2-row malting barley	51 – 53	50.4	43 – 47	45	AC Metcalfe
	6-row malting barley	47 – 51	50.4	36 – 42	40	Robust

[1] lb/bu x 1.25 = kg/hl; Data source: Alberta, Manitoba and Saskatchewan Provincial annual variety description pamphlets
[2] CGC Min. - Canadian Grain Commission minimum test weight (lb/bu) required for the top deliverable grade

Table 34. Triticale Canada Grade Standards

	Triticale, Canada No. 1 Canada	No. 2 Canada	No. 3 Canada
Minimum test weight, kg/hl (lb/bu)	65.0 (52.0)	62.0 (49.6)	-
Foreign material:			
Cereal grains other than wheat %	1.0	2.0	3.0
Ergot %	4K	8K	0.1
Excreta %	0.01	0.01	0.03
Matter other than cereal grains %	0.5	1.0	2.0
Sclerotinia %	4K	8K	0.1
Stones %	0.033	0.033	0.066
Total foreign material %	2.5	4.0	7.0
Grain damage:			
Broken %	4.0	7.0	50.0
Fireburnt %	Nil	Nil	Nil
Fusarium %	0.25	0.5	1.0
Heated %	0.1	0.75	5.0
Smudge and blackpoint %	10.0	15.0	-
Sprouted %	0.5	2.0	10.0

K = Number of kernel-sized pieces in 500g
(Official Grain Grading Guide, August 1, 2003, Canadian Grain Commission)

Table 35. Triticale seed grade standards for Canada

	Maximum number of weeds in 1 kg of seed				Maximum	
	Noxious weeds			Total	ergot	Minimum
		Primary +	Total	other	bodies	percent
Seed grade name	Primary	secondary	weeds	crops	per kg	germination
Canada Foundation No. 1	0	0.0	2	1	2	75
Canada foundation No. 2	0	0.2	4	2	10	65
Canada Registered No. 1	0	0.0	3	2	2	75
Canada Registered No. 2	0	0.2	6	4	10	65
Canada Certified No. 1	0	0.2	3	4	4	75
Canada Certified No. 2	0	1.0	6	10	15	65
Common No. 1	0	2.0	10	25	4	75
Common No. 2	2	4.0	20	50	15	65

- True loose smut tests are also required on all samples of pedigreed seed, to determine need for seed treatment
- Tolerance frequency for genetic off-types in certified seed production is 5 / 10,000 plants *(CSGA Circular 6-94)*

(Source: Canada Seeds Act, Schedule I, Table II, March 2004)

Interpretation: Using pedigreed seed avoids planting high frequencies of weed seeds, and provides crop purity

Part 6. CROP PROTECTION

Diseases of triticale

Triticale usually has a very low incidence of disease problems compared to other cereals. It is not susceptible to barley scald, making it an excellent alternative for grain or forage/silage use in continuous barley rotations.

Triticale has an excellent resistance level to rusts and to powdery mildew, but shares many other minor diseases in common with other cereal crops. Crop rotations that include triticale should be lengthened so that cereal crops that are at risk from the same diseases are never grown back-to-back (Table 36). Using proper crop rotation, disease-free seed, and seed treatments will solve most disease problems before they occur.

The only registered seed treatment approved for use on triticale is:

- Vita flo 280 for damping off, seed decay and seedling blight.

Management practices that result in rapid crop establishment, proper crop nutrition and early vigorous growth also produce crops with a better ability to tolerate disease infestation. In the case of ergot infection in cereals, there is considerable evidence linking high levels of ergot infection with sub-optimal levels of copper availability in the soil. Soil tests for micronutrients are required to check soil copper levels when this deficiency is suspected.

Due to triticale's excellent leaf and head disease tolerance, the use of fungicides for control of infection has not proven necessary in Western Canadian triticale production.

Fusarium head blight or FHB (*Fusarium graminearum*) is the most serious disease threat to triticale, especially in the eastern prairies. Growers need to practice a high level of seed and crop rotational management to minimize infection risk. Special post-crop measures are required in any field where this disease occurs to minimize further disease spread to other crops. In Alberta, all triticale seed must be tested for *Fusarium graminearum* before cleaning at municipal plants and seeding.

When best management practices are applied, similar to those recommended for rye, the risk of ergot infection in triticale should be no more than for wheat:

- Use ergot-free seed, planted in ergot free fields in an extended rotation that gives yearly separation between ergot-susceptible crops.
- Mow grassy headlands to avoid infection from grasses spreading into the edges of triticale production fields.
- Ensure soil copper levels are adequate. High ergot levels are a good indication of low copper.

There are other diseases that occur rarely or at an insignificant level in Western Canadian triticale. These include:

- Bacterial blight
- Barley yellow dwarf virus
- Cochliobolus and browning root rots
- Cephalosporium stripe
- Sharp eyespot
- Spot blotch (and blackpoint)
- Take-all
- Tanspot
- Wheat streak mosaic virus

For details about specific diseases of triticale, see ***Diseases of Field Crops in Canada***, Editors K.L. Bailey, B.D. Gossen, R.K. Gugel, and R.A.A. Morrall, Univ. of Saskatchewan Extension Press 2004.

Fusarium head blight

Fusarium head blight (FHB) is the most destructive disease of wheat and barley in the eastern prairies. It affects a number of crops including triticale (Table 36).

The causal fungus is *Fusarium graminearum*. It has the capacity to survive for many years in the soil of previously infected fields. It is very serious problem in Manitoba and Saskatchewan, but as of 2004, had not moved significantly into Alberta.

With the exception of Pronghorn and some of the new varieties, which are rated as intermediate or fair for resistance, current spring triticale varieties have poor tolerance to *Fusarium graminearum*.

Winter triticales, like winter wheat, also have poor tolerance. However, like winter wheat, winter triticales may escape serious FHB infection because they flower and mature earlier in the season than do spring cereals. Under intense disease pressure, such as in Manitoba, winter triticales may escape heavy late-season infection from the disease. When doing so they offer a lower-risk management alternative for feed or forage production.

A provincial plan has been enacted in Alberta to reduce the risk of the disease spreading into the province. Under this plan, the following statutory preventative measures apply to all cereal seed crops, including triticale.

These measures also represent best management practice for areas that already have the disease:

- In Alberta all cereal seed must be tested and certified free of *Fusarium graminearum* before cleaning and planting.
- All non-Alberta seed must be treated with a fungicide seed treatment registered for *Fusarium graminearum.*
- If *Fusarium graminearum* is found in an Alberta production field, that crop will be immediately ensiled, harvested or destroyed, and the crop residue deeply buried. Cereal production, including corn and grasses, is then disallowed in that field for a minimum of three years.
- Infected feed brought into Alberta, or found in Alberta, shall be managed using best management practices in order to prevent the escape of inoculum during transportation and feeding.

While *Fusarium graminearum* can significantly reduce a crop's yield potential, there is an even more serious effect. The fungus produces a mycotoxin, deoxynivalenol (DON), that can reduce crop value and create feed and food safety risks. This toxin reduces feed intake and can cause serious illness in animals and humans. Growing plants and kernels may not show visual symptoms of FHB but can still have high DON levels in the grain.

Research on DON levels in triticale is underway, but very little is yet known about the relationship between symptoms of FHB and DON levels in triticale. Little is also known about whether or not DON levels differ among diseased triticale varieties.

Table 36. Cereal crop host range for major diseases that can attack triticale

	Triticale	Wheat	Barley	Oat	Rye	Corn	Cultivated grasses	Wild grasses
Fusarium head blight	x	xx	xx	xx	xx	xx	x	x
Ergot	x	x	x	-	xx	-	x	x
Leaf spot complex	x	xx	x	x	x	-	-	-
Common root rot	x	xx	xx	x	x	-	x	x
Leaf rust	x	xx	x	-	x	-	-	-
Stem rust	x	x	xx	-	x	-	-	-

Diseases listed in order of relative risk for triticale.
x = Some risk   xx = Severe risk
(Source http://www.infogrow.ca/content/disease/general/hostRangeWCan.shtml)

Interpretation: Other crops in the rotation can affect the disease risk for triticale, because some diseases have a wide host range

Ergot

While ergot rarely reduces the yield potential of any cereal crop, it can reduce the value of triticale for food and feed grain. This is due to the highly toxic nature of alkaloids found in the ergot bodies in the harvested crop. These alkaloids are extremely poisonous to humans and to livestock. This potential danger has resulted in an extremely low grade tolerance of 0.1 % for ergot in triticale and other cereal grades. Marginally deficient micronutrient levels of copper will increase ergot levels.

Ergot can infect (in order of risk from most to least):

- Rye
- Triticale
- Wheat
- Barley

Ergot infects grasses, which provide a source of infection from headlands into infected fields.

- If ergot is only found in the triticale crop perimeter, infection from grassy headlands is the most likely inoculum source.
- If ergot bodies are found in heads of the crop scattered evenly throughout the field, the likely source of the infection is seed contaminated with black, grain-sized, over-wintering bodies called sclerotia.

When an ergot-infected field is harvested, some sclerotia will be found in the harvested seed sample. Other sclerotia will return to the soil with the chaff and straw where they can over-winter for usually not more than one year.

In spring, the sclerotia germinate and produce tiny mushroom-like structures. These structures in turn produce spores that can infect open florets of susceptible cereals. Infected florets have their seed replaced by a sclerotium. Honeydew liquid may also be formed which splashes between heads and further spreads the disease.

High levels of ergot are found when cereal flowers open under stress (e.g. drought stress) and when conditions are cool and moist, as this extends the time under which infection can occur.

Ergot control measures

Florets in new triticale varieties are less frequently sterile than florets in earlier varieties. Also, the florets tend to remain closed, unlike the open floret structures of rye. As such, the risk of spores getting into the florets is much lower than in rye, and more like the risk found in wheat. However, as florets can open under stress, good management is still the best approaching to controlling the disease.

Best management practices to prevent ergot occurring in triticale are the same as those for rye:

- Use cleaned triticale seed (preferably pedigreed) that is completely free from ergot to avoid introducing this disease to the field. There are no cereal varieties with a true resistance to ergot, nor are there any pesticide controls available.
- Do not grow triticale in fields following crops that you know to have had an ergot infestation. Mix up the crop types in your crop rotation to avoid cereal following cereal. Also avoid planting triticale after brome or in fields with quack grass, as both of these grasses are extremely susceptible to ergot.
- Keep grass headlands mowed up to heading time, so that ergot cannot complete its annual life cycle on the wild grasses that grow there. This will reduce the potential for field-edge infections in the next year. If ergot bodies survive in the headlands, they can be a source of infection for adjacent triticale plants in the field.
- If ergot bodies are seen in the crop on the field edges, but not elsewhere in the field, cut the edges of the field separately and store that harvested grain apart from the rest of the grain from that field. Delaying crop harvest will allow many ergot bodies to fall to the ground, reducing their frequency in the harvested crop.
- Ensure soil copper levels are adequate. High ergot levels are a good indication of low copper.

Several other techniques also help to control ergot. These include crop rotation, and deep cultivation or deep seeding (1-2 inches deep) to deeply bury the sclerotia. Commercial seed cleaning can also reduce ergot levels. However, if infection levels are high around field margins, separate binning may still be required.

Insects and pests of triticale

Risks from insect damage in triticale are similar to those for wheat. Triticale is vulnerable to grasshoppers, aphids, armyworms, orange blossom wheat midge and cutworms.

Management practices for these insects are the same as for other cereals. These practices should be applied only when continual field scouting indicates that the problem has reached an economic threshold for control.

Consult provincial recommendation guides (*'Crop Protection'* AgDex 606-1) for the best management practices for controlling insect infestations, and for information about approved insecticides.

Weed management in triticale

The ability of various cereals to compete with weeds is usually in the following order for winter cereals, ranked from best to worst:

- Fall rye
- Winter triticale
- Winter wheat

For spring cereals the order from most competitive to least is:

- Oat
- Barley and triticale (equal)
- CWRS Wheat
- CPS Wheat

The actual competitiveness of different cereals depends on growing conditions, management practices, weed load and relative growth stage of the weed and crop. As such, the actual order of resistance may differ.

Triticale's competition to weeds is provided by its leafiness and tallness, which impact light and moisture competition. Even so, there is still a wide range of weeds that can be a problem for triticale. These weed types vary between spring and winter triticale, and also vary by soil zone.

Best management practices for weed control

Best management practices for weed control in spring triticale are similar to those for spring wheat, and for winter triticale are similar to those for winter wheat.

These include:

- Seed at higher rates and ensure proper fertility, which can help control weeds in spring and winter triticale.
- Plan ahead. Chemical weed control options in triticale are limited. Select relatively clean fields to seed triticale.
- In the case of perennial weed problems such as Canada thistle and quack grass, apply pre-harvest glyphosate the previous fall or use as a pre-seed burn-off in direct seeded situations. Use in-crop herbicides to control or suppress broadleaf weeds.
- Use certified seed as this ensures that only triticale, and not weeds, is seeded. Certified seed is also more vigorous than bin-run seed.
- Seed early, as earlier sown spring triticale usually results in more competitive stand establishment, and provides a jump-start on the weeds.
- Seed shallow at between 0.5 to 1.5 inches (optimum 1.0 inch). Shallow seeding generally results in uniform seedling emergence that quickly covers the ground and competes with emerging weeds.
- Use good sanitary practices. Clean machinery and seeding equipment before seeding.

Only a few registered herbicides are available for triticale. It would be useful if a wider range of minor-use registrations could be approved, for use in single and double cropping situations for both grain and forage. This would include burn-off applications for perennial weed control in reduced tillage situations.

Weed competitiveness of triticale

No differences have yet been reported for the weed competitiveness between triticale varieties. However, a general rule of thumb in cereals is that taller, leafier varieties are more competitive due to the ability to close the canopy quickly.

Being somewhat weed competitive, triticale is sometimes used in a 'green' approach in crop rotations to reduce weed seed banks. When seeded early and under good conditions, triticale will compete with many weed species. Although it is not as effective as rye, winter triticale is very competitive with wild oats.

Triticale's potential as a herbicide substitute is of particular interest to organic growers, who could use this crop for partial control of weeds in their rotations. Use of triticale in this way has not been promoted in any of the extension literature available in Western Canada. This is because while triticale's 'competitiveness' is known, there is not a large database about its effectiveness for weed control when used in this manner.

Australia's Lemerle and Cooper (1996) found that triticale was a better weed competitor than wheat against the grass weed annual ryegrass. Triticale's potential to suppress weed growth in organic crop production is currently being tested (Spaner, 2004) at the University of Alberta.

Weed management strategy in spring triticale should follow the same principles as used for spring wheat. Strategies for winter triticale should follow winter wheat principles.

When grain is delivered and graded, weed seeds that cannot be cleaned out are considered foreign matter. Grain containing more then two percent foreign matter are downgraded.

'Foreign matter' could include:
- Cow cockle
- Ragweed
- Tartary buckwheat
- Vetch
- Wild oats
- Non-cereal domestic grains

Problem weeds and limited availability of registered herbicides for triticale

Although there are many herbicides that could control the most common weeds that occur in spring and winter triticale (Table 37), very few herbicides are registered in Canada for use in this crop. There is clearly a need for more herbicides to be registered for minor use in triticale.

Registered products for control of wild oats and some broadleaf weeds in triticale include:
- Achieve
- Hoe Grass II
- Pardner

Check the Alberta AgDex 606-1 '*Crop Protection*' each year for registration changes.

The use of pre-seeding and post-seeding glyphosate (Roundup), which must be applied before the crop emerges, are options to reduce weed competition when direct seeding. Pre-harvest glyphosate can also be used in the crop year prior to seeding spring triticale.

Currently, Alberta Agriculture researchers (Hall and Topinka) have submitted two years of research supporting the following herbicides for minor-use application:
- Horizon, Everest and Sundance for wild oats.
- Refine extra, 2 4-D and MCPA for broadleaf weeds.

Note these herbicides are not recommended and listing these products does not imply endorsement for use.

Table 37. Commonly occurring weeds in triticale on the Canadian Prairies

Summer Annuals		**Winter Annuals**	**Perennials**
Annual smartweed	Persian darnel	Downy brome	Canada thistle
Annual sow-thistle	Prostrate pigweed	Stinkweed	Field horsetail
Cleavers	Redroot pigweed	Flixweed	Foxtail barley
Barnyard grass	Russian pigweed	Narrow leaved Hawk's-beard	Quackgrass
Bluebur	Russian thistle	Shepherd's purse	Perennial sow thistle
Shepherd's Purse	Cleavers		Toadflax
Common chickweed	Spiny sow-thistle		Dandelion
Common groundsel	Stork's-bill		Field bindweed
Corn spurry	Tartary buckwheat		
Cow cockle	Volunteer canola		
Green foxtail	Volunteer mustard		
Hemp Nettle	Wild mustard		
Kochia	Wild oats		
Lamb's quarters	Wild buckwheat		
Night flowering catchfly			

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Triticale Manual Questionnaire

Please fill out this questionnaire to assist us in monitoring crop development and use of triticale. It will also provide us with a contact address to send future updates and technical information. ***Thank you for your cooperation.***

Name____Company____________________

Address_____________________________City_____________Postal code____________

E-mail address____

Telephone number____

Occupation____

How many years have you been growing or working with triticale?____________

Are you growing _ spring _ winter _ both

What markets or uses are you growing it for (please check)

- _ grain for human consumption
- _ grains for feed
- _ silage
- _ green feed
- _ swath grazing
- _ grazing
- _ combination of silage and fall or spring grazing

If you are feeding to livestock, which type ______________, age ranges____________

Average number of acres ____

Production per acre____

Soil type____

Dryland acres ______________ Irrigation acres _________________________

Management practices: _grown from or common seed _pedigreed seed

Variety - Spring _Pronghorn _AC Alta _AC Certa _AC Copia _AC Ultima

- Winter _ Bobcat _Companion _Fridge _Pika _Wapiti _Carman _Other - please list______________________

Seeding rates: _________________________dates:________________________

Fertility practices _spring _fall _seed placed _banded types__________
rates:____

Weed control products: _____________________rates:__________________________

General comments ____

Please send copy to Bill Chapman, AAFRD, Box 4560 Barrhead, Alberta T7N 1A4
Thank-you.