Economics of backgrounding calves on Italian ryegrass (*Lolium multiflorum*) pastures in the Aspen Parkland

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McCartney, D. H., Lardner, H. A. and Stevenson, F. C. 2008. **Economics of backgrounding calves on Italian ryegrass (*Lolium multiflorum*) pastures in the Aspen Parkland**. Can. J. Anim. Sci. **88**: 19–28. Annual ryegrass or Italian ryegrass (*Lolium multiflorum*) can be used to improve pasture productivity through extension of the grazing season in the Aspen parkland of western Canada. A study conducted at Agriculture and Agri Food Canada Melfort, SK. and Lacombe, AB, showed that weaned calves could successfully graze Italian ryegrass late into the fall as part of the overall backgrounding system. Spring-seeded annual Italian ryegrass produced between 4300 and 6700 kg total dry matter per hectare across all sites and had an average crude protein content of 184 g kg^{-1} and in vitro DM digestibility of 640 g kg^{-1}. Spring calves were early weaned in late August or conventionally weaned in October and backgrounded on Italian ryegrass pasture or a silage-based ration in drylot pens. The cost of growing Italian ryegrass was \$339 ha^{-1} resulting in a grazing cost per day of \$0.31–\$0.68 depending upon the number of grazing days per ha. There were no differences in performance of animals backgrounded on Italian ryegrass pasture compared with those backgrounded in the feedlot. The total cost per head for backgrounding early-weaned calves on Italian ryegrass and finished in a feedlot was \$398 compared with \$429 for early-weaned calves backgrounded and finished in a feedlot, while conventionally weaned calves backgrounded and finished in a feedlot cost \$418. Backgrounding calves on Italian ryegrass pasture reduced the number of days in the feedlot along with the associated cost of yardage and stored feed. Backgrounding calves in a feedlot had a yardage charge of \$0.40 or higher, which added a cost in addition to stored feed costs of the ration. Backgrounding calves on extended season grazing of Italian ryegrass reduced health problems due to elimination of mixing animals in feedlot pens, less need for stored feed including storage and feeding losses and less labour to feed the cattle and haul manure in the spring. Backgrounding calves on high-quality fall pasture was more economical than backgrounding in a feedlot system.

Key words: Background, steer, pasture, economics

McCartney, D. H., Lardner, H. A. et Stevenson, F. C. 2008. **Économique de la semi-finition des veaux dans les pâturages de ray-grass d'Italie (*Lolium multiflorum*) de la forêt-parc à trembles**. Can. J. Anim. Sci. **88**: 19–28. On pourrait se servir du ray-grass annuel ou d'Italie (*Lolium multiflorum*) pour accroître la productivité des pâturages en prolongeant la période de paissance dans la région des forêts-parcs à trembles de l'Ouest du Canada. Une étude effectuée aux stations de recherche d'Agriculture et Agroalimentaire Canada à Melfort (Sask.) et à Lacombe (Alb.) révèle que les veaux sevrés peuvent se nourrir de ray-grass d'Italie à l'automne, dans le cadre d'un régime général de semi-finition. Semé au printemps, le ray-grass annuel a donné entre 4 300 et 6 700 kg de matière sèche par hectare à tous les endroits et une teneur moyenne en protéines brutes de 184 g par kg. La digestibilité *in vitro* de la matière sèche s'établit à 640 g par kg. Les veaux de printemps ont été sevrés hâtivement à la fin d'août ou de la manière traditionnelle, en octobre, puis semi-finis sur pâturage de ray-grass d'Italie ou en parquet, avec une ration d'ensilage. La culture du ray-grass coûte 339 \$ par hectare, ce qui revient à des frais de paissance quotidiens de 0,31 à 0,68 \$, selon le nombre de jours de paissance par hectare. La performance des animaux mis à l'herbe et de ceux gardés en enclos était la même. Le coût global de la semi-finition des veaux sevrés hâtivement avec du ray-grass puis finis à l'enclos s'élève à 398 \$ par sujet, contre 429 \$ pour les veaux sevrés hâtivement puis engraissés et finis en parquet. Les veaux sevrés de la manière usuelle, puis engraissés et finis à l'enclos coûtaient 418 \$ par tête. La semi-finition des veaux au pâturage de ray-grass diminue le nombre de jours passés dans l'enclos et les coûts afférents pour le parcage et l'entreposage des aliments. L'engraissement des veaux en claustration entraîne des frais de parcage d'au moins 0,40 \$ plus le coût du stockage des aliments constituant la ration. La semi-finition des veaux grâce à une plus longue saison de paissance dans les pâturages de ray-grass italien atténue les problèmes de santé parce qu'il n'est plus nécessaire de combiner des animaux dans l'enclos. On gaspille moins d'aliments lors du stockage et de la distribution aux animaux. Enfin, l'alimentation des bêtes et le transport du fumier au printemps exigent moins de main-d'œuvre. La semi-finition des veaux dans un pâturage de haute qualité à l'automne s'avère plus efficace que leur semi-finition en enclos.

Mots clés: Semi-finition, bouvillons, pâturage, économique

Abbreviations: **ADG**, average daily gain; **BW**, body weight; **DM**,dry matter; **IVDMD**, in vitro dry matter digestibility; **ADF**, acid detergent fibre; **NDF**, neutral detergent fibre.

Traditionally, beef calves in western Canada are weaned mid to late October when forage availability in permanent pastures is limited. The calves are either sold to feedlots or retained by the owner and fed a backgrounding ration to gain 1 kg d^{-1} until the animal reaches 350–360 kg, at which time they are fed a high energy grain finishing ration (Vaage et al. 1998; McCartney 2000). During the initial backgrounding period in the confined feedlot, respiratory diseases can cause significant economic loss (Radostits and Blood 1985). This requires daily monitoring of the newly weaned calves upon arrival at the feedlot. In addition, there are feed plus yardage charges of \$0.40 d^{-1} (Highmoor 2004) for the calves in the feedlot. Extending the grazing season, with high-quality annual forages specifically grown for late fall grazing, could reduce these health risks and potentially lower the costs of backgrounding weaned calves.

Annual ryegrass or Italian ryegrass (*Lolium multiflorum* Lam. and *Lolium multiflorum westerwoldicum*) can be used to improve pasture productivity and extend the grazing season (Kunelius 1991; McCartney, 2000; Narashimhalu et al. 2000). However, this crop has never been evaluated under late fall grazing conditions in the Aspen Parkland of western Canada. There are two types of annual ryegrass, Italian and Westerwold. Both types can be used as annual forage crops and are collectively referred to as annual ryegrass (Kunelius 1991). Annual ryegrass is adapted to moist soil zones and will not survive the winter in western Canada. Italian ryegrass is a biennial originating from northern Italy where it is primarily used for winter hay and pasture. It does not normally set seed in western Canada. Westerwold ryegrass is an annual developed from Italian ryegrass plants that set seed in the year of seeding.

In the Great Plains region of the United States, the grazing of winter wheat pastures during the fall and winter months with stocker cattle is a common practice (Horn et al. 2005). Since little Canadian research has been conducted on the performance and economics of backgrounding calves using fall pasture systems, studies were conducted at Melfort, Saskatchewan and Lacombe, AB, to evaluate the economic potential of backgrounding calves with late-season annual ryegrass pasture.

MATERIALS AND METHODS

Grazing experiments were conducted in 1995 and 1996 at the Agriculture and Agri-Food Canada Research Farm, Melfort, Saskatchewan (52°49′N; 104°36 W), a location with an Orthic thick Black Chernozem (Udic Boroll) soil. Mean annual precipitation at Melfort is 439 mm, with 64% occurring from April through September. Experiments also were conducted in 1997 and 1998 at the Agriculture and Agri-Food Canada Lacombe Research Station, Lacombe, Alberta (52°28′N; 113°44′W), a location with an Orthic Black Chernozem Ponoka clay loam (Udic Boroll) soil. Mean annual precipitation at Lacombe is 466 mm, with 77% occurring from April through September.

Pasture Management

Annual ryegrass cv. Maris Ledger was seeded each year slightly deeper (1.0 to 2.5 cm) than traditional forage seed because the seed is slightly larger than other grass forage species. Annual ryegrass was seeded late May at both locations after the potential for vernalization and seed set from late spring frosts had passed. At both Melfort and Lacombe, fields were seeded at a rate of 9 kg ha^{-1} using a 12-m John Deere® no-till drill or a Brillion grass seeder, respectively. Prior to grazing, all paddocks were fertilized with 60 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1}, 40 kg K ha^{-1} and 10 kg S ha^{-1} each spring via coulter disc application according to soil test recommendations.

The Italian ryegrass was very slow to establish and weed management was important during establishment. Consequently, broadleaf weeds were controlled with 2, 4-D Amine (2,4-dichlorophenoxyacetic acid) and MCPA (4-chloro-2-methylphenoxy) acetic acid at 1.5 L ha^{-1}. The Italian ryegrass pastures were managed for grazing from early September to mid November with the total year's growth being utilized at that time. At maturity the Italian ryegrass was extremely leafy with dense foliage and the potential for trampling and wastage during grazing by the animals was quite high. Therefore, at Lacombe, strip grazing was conducted using a portable electric fence, which allowed for increased forage utilization. Available forage was allocated by moving the fence every 2 to 3 d. This method did not appear to limit animal intake. The fence was moved only when the available forage had been grazed to a 2-cm height. Strip grazing was not used at Melfort due to field design, and animals were allocated forage using total available paddock area.

Animal and Grazing Management

All calves at both locations were cared for in accordance with guidelines established by the Canadian Council on Animal Care (1993).

All calves at Melfort and Lacombe were pre-vaccinated prior to weaning for *Clostridial* diseases (Blacklegol® 8 with Spur, Intervet Inc., Millsboro, DE), infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), parainfluenza-3 (PI3), and bovine respiratory syncytial virus (BRSV) (Triangle® 4+ *H. somnus*, Fort Dodge Animal health, Overland Park, KS). All calves were provided water, free-choice mineral and salt. In addition, straw bales were fed in round bale feeders in each paddock free choice. The roughage was provided as a source of additional fibre to help control rate of passage while animals grazed the high-quality ryegrass pasture (Mader and Horn 1986). Live animal weights (weighted over two consecutive days and averaged with no restriction to feed and water) for all treatment groups were assessed at three different time

periods (1) weight and date at early weaning, (2) weight and date when animals were on full feed in the feedlot, and (3) harvest weight and date. After grazing the Italian ryegrass, animals were sorted by sex and allocated to replicate drylot pens for the feedlot finishing phase of the study.

Melfort

Spring-born crossbred (Charolais × Hereford × Angus × Simmental) calves were randomly allocated to one of three replicated backgrounding treatments: System (1) early-weaned calves backgrounded on Italian ryegrass pastures followed by feedlot backgrounding and finishing; System (2) conventionally weaned calves backgrounded on Italian ryegrass pastures followed by feedlot backgrounding and finishing; and System (3) conventionally weaned calves backgrounded and finished in the feedlot.

On 1995 Aug. 28 and Aug. 26, calves were assigned randomly to one of the three backgrounding systems. Early-weaned calves ($n = 57$, 1995 (182 d of age) and $n = 54$, 1996 (181 d of age) were then allocated to one of four replicated paddocks (1.2 ha) of Italian ryegrass (cv. Maris Ledger). The remaining calves and cows ($n = 116$, 1995; and $n = 106$, 1996) grazed on smooth bromegrass/Kentucky bluegrass (*Bromus inermis* Leyss/*Poa pratensis* L.) and crested wheatgrass [*Agropyron cristatum* (L.) Gaertn] pasture until conventionally weaned on 1996 Oct. 10 (225 d of age) and 1996 Oct. 10 (226 d of age). Conventionally weaned calves were randomly allocated to either four replicated ryegrass pastures ($n = 59$, 1995; and $n = 54$, 1996) or directly to four replicated feedlot pens ($n = 57$, 1995; and $n = 52$, 1996). Grazing periods in 1995 were Sep. 06 to Nov. 01 (56 d) and Oct. 10 to Nov. 01 (22 d) for early and conventionally wean calves, respectively. Grazing periods in 1996 were Sep. 03 to Nov. 12 (70 d) and Oct. 10 to Nov. 12 (33 d) for early and conventionally wean calves, respectively.

Calves at Melfort had continual access to the entire paddock area while on pasture. At the end of the fall pasture grazing period all calves were fed a 70% barley silage and 30% rolled barley grain plus supplement (32% CP DM basis). At Melfort only, weight data were used in the analysis, although the steer calves were finished for harvest in a separate study and carcass data were collected. No implants were used. All heifer calves were retained as replacements for the breeding herd and were not included in the finishing part of the study.

Lacombe

Spring-born Calves

Spring-born crossbred (Hereford × Angus and Charolais × Maine Anjou) calves ($n = 106$, 1997 and $n = 110$, 1998) were early or conventionally weaned on 1997 Aug. 29 (153 d of age) or Oct. 21 (206 d of age) or 1998 Aug. 26 (147 d of age) or Oct. 21 (203 d of age). All calves were weighed and divided into replicate groups of three backgrounding treatments: System (1) early-weaned background in feedlot and finished in feedlot; System (2) early-weaned grazed on Italian ryegrass and later backgrounded and then finished in feedlot; and System (3) conventionally weaned, backgrounded and finished in feedlot.

The Italian ryegrass pasture was divided into three replicated paddocks. Forage was strip grazed using a portable electric fence moved two to three times per week after cattle had consumed all available plant material. Cattle grazed Italian ryegrass paddocks down to 2 cm level before being moved to the next paddock. This type of management was done to reduce the amount of residue left in the fields over winter. Steers and heifers grazed together and remained on pasture until all available forage had been consumed or until the snow became too deep to access forage. Animals were then weighed after coming off the pastures (1997 Dec 03, 1998 Dec. 02), sorted by sex, and allocated to four replicated pens for backgrounding and finishing programs. All spring-born calves were implanted once with Ralgro® (Shering-Plough Animal Health) during the finishing phase.

Fall-born Calves

Fall-born cross-bred (Hereford × Angus and Charolais × Maine Anjou) calves were allocated to one of three backgrounding treatments in the spring of 1997 ($n = 97$) and 1998 ($n = 118$). Calves were either early or conventionally weaned and allocated to one of three treatments which included: System (1) backgrounded and finished in the feedlot; System (2) backgrounded on perennial pasture until September followed by finishing in a feedlot; and System (3) backgrounded on perennial pasture until September then fall grazed on Italian ryegrass followed by finishing in a feedlot.

Calves in 1997 and 1998 were early weaned on 1997 Apr. 16 (214 d of age) and 1998 Mar. 31 (189 d of age), and conventionally weaned on 1997 Apr. 23 (221 d of age) and 1998 May 12 (231 d of age). Calves either grazed perennial pasture or were placed on a backgrounding ration in four replicated feedlot pens in early June of each year. System 1 animals were placed on a backgrounding ration (80% silage; 20% grain) to gain 0.75 to 1.0 kg d^{-1}. Systems 2 and 3 calves grazed together on perennial forage from early June to early September in 1997 and 1998, respectively. On 1997 Sep. 09 and 1998 Sep. 10, the calves from System 2 were placed on backgrounding diets following grazing of perennial pasture. Heifers and steers were fed together in four replicated feedlot groups until the start of the finishing period. Finally, the extended grazing calves, System 3, were allocated to three replicated fields of Italian ryegrass for late fall grazing until 1997 Nov. 24 and 1998 Nov. 17. Fall calves at Lacombe were not implanted.

Economic Analysis

The total costs of pasture and feed plus yardage and the number of days in the feedlot were also determined to evaluate the total economic costs associated with each treatment group in both the spring and fall calving groups. Costs were calculated for each of the systems on an enterprise cost basis using information from Alberta and Saskatchewan Agriculture custom rate guides (AAF 2006; SAF 2006a,b) and other publications (McCartney 2000; Baron et al. 2003, 2004; Highmoor 2004; McCartney et al. 2004) (Tables 1–3). Barley silage was priced at \$0.09 kg^{-1} (DM) and grain and protein supplement at \$0.17 kg^{-1} (DM). These prices are based on actual costs and from monthly feed prices using Canfax Research Services Calgary, AB. The actual cost of growing Italian ryegrass was \$337.84 ha^{-1} (Table 1) and the cost of growing perennial pasture was calculated at \$252.64 ha^{-1} (Table 2). The cost per day of grazing was then calculated on the actual number of grazing days per hectare divided by the total cost (Table 4).

Revenues for harvest weights were calculated based on specific monthly 5-yr averages for finished cattle in Saskatchewan for those months when cattle were harvested (SAF 2000). These historical feeder cattle prices were used as an example of prices during the time of the research, as these prices were not affected by the BSE (bovine spongiform encephalopathy) crisis in 2003 and related market issues. The total cost for each system consisted of the number of days on perennial or Italian rye grass pastures charged at the actual cost per day plus the total cost of all grain and supplements fed plus the daily yardage charges of \$0.40 (Table 3).

Statistical Analysis

The analysis was conducted separately for each unique portion of the data: (1) Melfort data; (2) Lacombe spring calving data; (3) Lacombe fall calving data. Each data analysis was conducted with the MIXED procedure of SAS (Littel et al. 1996). The effects of year and the applied treatments (backgrounding, calf sex, and weaning) were considered to be fixed effects. Exploratory analysis revealed variance heterogeneity among the years for a number of the response variables. The analysis was set up to model this heterogeneity among years where necessary. Model fit criteria (corrected Akaike's information criterion) were used to decide the worthiness of modeling unique residual variance estimates for different years relative to a pooled residual variance estimate across years.

Treatment effects were declared significant at $P < 0.05$. Means were presented with a LSD as a measure of precision and a complementary tool with contrasts to ascertain significantly different means.

Table 1. Cost[z] per ha Italian ryegrass

Establishment costs	\$ ha^{-1}
Cultivation	\$37.05
Seeding and spraying	\$14.82
Seed 5.45 kg @ \$3.19	\$42.98
Fertilizer (60-30-40-10)	\$109.00
Fence repair	\$3.71
Depreciation on fence	\$4.94
Land costs	\$86.45
Taxes	\$9.88
Water	\$6.18
Pasture management	\$22.83
Total cost per ha	\$337.84

[z]Based on actual costs and Baron et al. (2003, 2004).

Table 2. Costs[z] per ha for perennial pasture

Establishment costs	\$ ha^{-1}
Cultivation, seeding amortized over 10 yr	\$9.48
Fertilizer (60-30-40-10)	\$109.00
Fence repair	\$3.71
Depreciation on fence	\$4.94
Land costs	\$86.45
Taxes	\$9.88
Water	\$6.18
Pasture management	\$22.83
Total cost per ha	\$252.64
Cost per animal grazing day	\$0.55

[z]Based on actual costs and Baron et al. (2003, 2004).

RESULTS AND DISCUSSION

Grazing Management of Annual Ryegrass

At both Melfort and Lacombe, the Italian ryegrass was very slow to establish, but with adequate moisture the total one-cut yield was between 4300 and 6700 DM kg ha^{-1} over all years and sites. The leaves remained green and growth continued into the late fall period. Because ryegrass normally grows in warmer climates, the plants remained vegetative until the first killing frost each year. Forage quality in November was 137 g kg^{-1} crude protein and in vitro organic matter

Table 3. Yardage costs[z] for weaned calf (272 kg) based on cow yardage charges

	Costs[y]
Fuel	\$13.22
Machinery repairs	12.07
Building repairs	4.34
Utilities	16.05
Custom work	11.38
Paid labour	11.63
Unpaid labour	41.59
Taxes/licenses/water	4.13
Depreciation	15.78
Lease payments	2.63
Total yardage costs	132.81
\$ per wintering day/cow	0.78
\$ per wintering day/calf	0.40[y]

[z]Source: Highmoor (2004).
[y]Calculated based on ½ the yardage costs for mature cow.

Table 4. Economics of grazing Italian ryegrass pastures

	Grazing days	Average grazing days per ha^{-1}	Cost per day[z]
Lacombe			
1996 fall born calves	76	701	0.48
1997 spring born calves	76	655	0.51
1997 fall born calves	69	1033	0.33
1998 spring born calves	84	1098	0.31
Melfort			
1995 early wean	56	494	0.68
Late wean	22	635	0.53
1996 early wean	70	500	0.68
Late wean	33	528	0.64

[z]Cost per day for weaned calf (272 kg) based on \$337.84 ha^{-1}.

digestibility was 627 g kg^{-1} (Table 5). Riemer and Gaudiel (1984) at Brooks, AB, on irrigated sites found that Maris Ledger Italian ryegrass was the highest yielding of six cultivars evaluated over a 4-yr period (12 220 kg ha^{-1}) under a grazing/multiple cut system. In late October the Maris Ledger had a crude protein content of 146 g kg^{-1} and an acid detergent fibre of 314 g kg^{-1}. Kunelius and Narasimhalu (1983) in Charlottetown, PEI, found yields of 9760 DM kg ha^{-1} under a two-cut rainfed system. Crude protein was 153 g kg^{-1} and in vitro DM digestibility was 750 g kg^{-1}.

Based on the high quality of the Italian ryegrass we assumed a high rate of passage; however, there was no evidence this had a negative impact on performance. However, researchers in Oklahoma have shown no detrimental effects on the animal's performance when grazing lush pasture such as Italian ryegrass (Mader and Horn 1986). Straw was fed ad libitum as an additional source of fibre but intake was minimal over all years and was not included in the pasture cost.

Calves successfully grazed the annual ryegrass during early snowfalls in November and December at both Melfort and Lacombe. Calves remained on the Italian ryegrass pasture for an additional 3 wk in snow depths ranging from 5 to 15 cm depending on the year. Grazing through the snow or trampling available forage was not a problem for the grazing animal provided strip grazing was managed using electric fence.

Table 5. Nutritive value of Maris Ledger Italian Ryegrass over 2 yr (g kg^{-1} DM)

Month	Crude protein	IVDMD[z]	ADF[y]	NDF[x]
Melfort				
September	242.0	626.0	260.0	438.4
October	199.0	669.0	285.0	456.0
November	137.0	627.0	345.0	527.0
Lacombe				
September	185.0		244.0	440.0
October	154.0		219.0	410.0
November	187.0		249.0	472.0

[z]IVDMD = in vitro dry matter digestibility.
[y]ADF = acid detergent fibre.
[x]NDF = neutral detergent fibre.

Performance of Calves

The purpose of these trials was to evaluate the performance and economics of different grazing and feeding systems for backgrounding and finishing beef cattle. A summary of the statistical analysis and animal performance can be found in Tables 6, 7 and 8. No differences ($P > 0.05$) were observed in live animal weights between treatment groups of spring-born calves at Melfort and Lacombe when animals came off pasture and onto full feed in the feedlot (Tables 6 and 7).

Melfort Spring Calves

At Melfort, when the calves came off of the Italian ryegrass pastures and entered the feedlot, the early-weaned ryegrass group weighed 255 kg, the conventionally weaned ryegrass group weighed 264 kg and the conventionally weaned feedlot group weighed 266 kilograms (Table 8). The early and conventionally weaned ryegrass calves were in the feedlot for less than half the time compared with the conventionally weaned feedlot group (23 and 50 d). Following this, all calves were equally distributed to various backgrounding and

Table 6. Analysis of effects and contrasts for Melfort[z]

Effect/ Contrast[y]	Weaning wt[x]	Final Weight	Total costs	Net revenue
		(P value)		
Background (B)	0.418	0.385	**<0.001**	**<0.015**
Year (Y)	**<0.001**	**<0.001**	**0.029**	**<0.001**
Y × B	0.920	0.900	**<0.001**	0.771
1995	0.674	0.415	**<0.001**	0.197
1996	0.591	0.710	**<0.001**	**0.069**

[z]Data were only available for 1 of the 2 yr for a number of the response variables, not available at all, or could not be analyzed (e.g., "Days in feedlot"). The analysis of net revenue at Melfort used a separate residual for each site.
[y]A contrast testing the treatment effect for each year.
[x]All animals were weighed at the time of early weaning.

Table 7. Analysis of effects and contrasts for Lacombe

Analysis/Effect/Contrast[z]	Weaning wt[x]	On feed wt	Days in feedlot	Final Weight	Total costs	Net revenue	Carcass cutability	Fat class	Marbling	Rib eye area
Lacombe – Spring										
Background (B)	0.927	**0.010**	**<0.001**	**0.007**	**<0.001**	**0.004**	**0.063**	**0.032**	0.422	**0.066**
Calf sex (C)	**0.078**	**<0.001**	0.297	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.001**	**0.002**
C × B	0.795	0.625	0.872	0.905	0.849	0.931	0.295	0.956	0.490	0.403
Year (Y)	0.860	0.462	**<0.001**	**0.004**	**<0.001**	0.297	0.129	0.411	**0.001**	**<0.001**
Y × B	0.940	**<0.001**	0.117	0.245	0.383	0.536	0.912	0.689	0.830	0.283
1997[z]	0.997	**<0.001**	**<0.001**	**0.061**	**<0.001**	**0.011**	0.159	0.244	0.850	**0.061**
1998	0.873	**<0.001**	**<0.001**	**0.023**	**0.004**	0.158	0.330	0.107	0.435	0.250
Y × C	0.996	0.868	0.268	0.245	**0.060**	0.803	0.798	0.280	0.844	**0.020**
Y × B × C	0.935	0.898	0.292	0.609	**0.011**	0.998	0.941	0.822	0.590	**0.071**
Lacombe – Fall										
Background (B)	0.179	**<0.001**	**<0.001**	**0.003**	**<0.001**	0.254	0.192	0.148	**0.093**	0.129
Calf sex (C)	**0.077**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.001**	0.137	0.330	0.156	0.132
C × B	0.685	0.368	**0.001**	0.324	<0.001	0.862	0.500	0.793	0.193	0.937
Weaning time (W)	0.680	0.463	**0.042**	0.476	**0.045**	0.924	0.647	0.540	0.332	0.517
B × W	0.600	0.945	0.157	0.498	0.196	0.794	0.169	0.213	0.443	0.174
C × W	0.474	0.938	0.876	0.281	0.928	0.219	0.604	0.517	0.990	0.786
B × C × W	0.810	0.550	0.663	0.128	0.678	0.155	0.725	0.435	0.746	0.529
Y	**<0.001**	**0.035**	**<0.001**	0.302	**<0.001**	0.108	**<0.001**	**<0.001**	**<0.001**	0.411
Y × B	0.944	**0.017**	**0.004**	0.379	**<0.001**	0.187	0.829	0.603	0.480	0.175
1996	0.628	0.199	**0.000**	0.258	**0.000**	**0.052**	0.326	0.686	0.565	0.148
1997	0.178	**<0.001**	**<0.001**	**0.008**	**<0.001**	0.987	0.492	0.172	0.135	0.199
Y × C	0.921	0.496	0.545	0.701	**0.062**	0.856	0.477	0.218	**0.079**	0.786
Y × B × C	0.740	0.808	**<0.001**	0.316	**<0.001**	0.385	0.633	0.734	0.159	0.118
Y × W	0.953	0.473	0.442	0.687	0.476	0.619	0.594	0.547	0.390	0.861
Y × B × W	0.131	0.550	0.687	0.448	0.642	0.572	0.651	0.729	0.466	0.505
Y × C × W	0.518	0.614	0.883	0.641	0.857	0.630	0.350	0.164	**0.067**	0.776
Y × B × C × W	0.468	0.513	0.173	0.104	0.172	0.167	**0.008**	**0.014**	0.120	**0.081**

Table 8. Summary of animal performance and costs

Analysis/Effect/ Level	Weaning weight (kg)	On feed weight (kg)	Days in feedlot (days)	Final wt. (kg)	Total Cost	Net Revenue[y] ($ animal^{-1})	Cutability (%)	Fat class (no.)	Marbling (no.)	Rib area (cm)
Melfort – spring										
Background										
Feedlot	234	266	50	591	54	x589	56.1	6.78	441	89.4
Early-ryegrass	229	255	23	576	63	x560	57.4	6.77	481	83.9
Late-ryegrass	227	264	23	580	56	x589	57.5	6.27	437	88.8
LSD0.05	11	16	[z]	22	0.5	22	1.3	1.08	50	4.7
Lacombe – spring										
Background										
Early-feedlot	206	354	294	537	429	531	55.1	5.39	472	77.3
Late-feedlot	206	369	245	560	418	575	56.9	4.55	457	81.5
Early-ryegrass	204	353	219	549	398	576	57.1	4.24	458	80.0
$LSD_{0.05}$	10	13	7	15	11	30	1.7	0.82	23	3.7
Calf sex										
Heifer	201	347	251	521	406	519	54.7	5.66	479	77.2
Steer	209	371	254	576	424	603	58.1	3.79	445	82.1
$LSD_{0.05}$	9	10	6	12	9	24	1.4	0.67	19	3.0
Lacombe – fall										
Background										
Feedlot	244	466	265	547	417	582	60.3	2.83	478	91.1
Pasture/Feedlot	237	436	197	552	410	603	59.5	2.98	497	87.4
Pasture/Ryegrass	229	404	134	519	331	619	60.4	2.44	469	86.4
$LSD_{0.05}$	16	21	7	21	12	42	1.1	0.59	28	4.5
Calf sex										
Heifer	231	417	193	515	373	571	59.7	2.87	490	86.9
Steer	243	454	205	563	399	631	60.4	2.63	473	89.7
$LSD_{0.05}$	13	17	6	17	10	35	0.9	0.48	23	3.7
Weaning time										
Early	235	432	202	542	391	602	60.2	2.67	476	88.9
Late	238	439	196	536	381	600	60.0	2.82	487	87.7
$LSD_{0.05}$	10	14	5	15	8	30	0.8	0.42	20	3.1

[z]There is minimal variability and a measure of precision was not possible because time on days in feedlot is not measured.
[y]Net revenue is based on market price at time when cattle went on full feed (SAF 2000).

finishing ration trials. Harvest weights were collected but feed amounts and costs were not part of this study. At harvest, early-weaned ryegrass calves weighed 576 kg, conventionally weaned calves on ryegrass then feedlot weighed 580 kg, and conventionally weaned feedlot calves weighed 591 kg.

Lacombe Spring Calves

At Lacombe, when the calves came off the Italian ryegrass pastures and entered the feedlot, System 1 early-weaned feedlot group weighed 354 kg, System 2 early-weaned ryegrass group weighed 353 kg, and System 3, conventionally weaned feedlot group weighed 369 kg or 5% greater ($P < 0.05$) than System 1 or 2 (Tables 7 and 8). At harvest, animal weights were similar for all treatments, with the spring-born early-weaned feedlot group weighing 537 kg, the early-weaned ryegrass group weighing 549 kg, and the conventionally weaned feedlot group weighing 560 kg.

Differences ($P < 0.05$) were observed between treatments in the number of days animals were in the feedlot on stored feed ration. The early-weaned ryegrass group were in the feedlot for 219 d or 34% less time (75 d) than the early-weaned feedlot group (Table 8). The conventionally weaned feedlot group had 16% fewer days in the feedlot (39 d) compared with the early-weaned feedlot system.

Lacombe Fall Calves

At the end of the grazing phase of the backgrounding trial all fall-born cattle were put on feed in the feedlot. Fall calves in System 1, backgrounded and finished in the feedlot weighed 30 kg heavier than System 2 calves, which were backgrounded on perennial pasture until September then finishing in the feedlot (Tables 7 and 8). System 3 calves backgrounded on perennial pasture until September then fall grazed on Italian ryegrass followed by feedlot finishing, weighed 13% less than System 1 animals ($P < 0.05$). At harvest, final animal weights ($P < 0.05$) for System 1, 2 and 3 were 547, 552, and 519 kg, respectively. The advantage between the systems is the reduced number of days ($P < 0.05$) the cattle were in the feedlot for all systems, which can be a significant cost savings for the producer. System 1 cattle were in the feedlot 265 d, System 2, 197 d and System 3 for 134 d (Table 8).

There is very limited information on grazing Italian ryegrass in Canada. Narasimhalu (1994) in Charlottetown, PEI, found that annual ryegrass could extend the grazing season for Holstein steer calves by 78 d from early October until early December at a gain of 0.9 kg d^{-1}. Johnston (2001) at New Liskeard, ON, grazed calves for 28 d starting Sep. 20 on the regrowth from annual ryegrass and oat silage intercrop and found calf gains of 0.68 kg h d^{-1} with 157 kg gain per hectare. Quinton (1996, personal communication) at Kamloops Research Station, Kamloops, BC, found that ryegrass regrowth from irrigated intercropping with barley silage provided 64 to 78 d of fall grazing for early-weaned (Sep. 1) calves followed by feeding in a feedlot. By March of the following year the total gain for the early-weaned calves backgrounded on the ryegrass was similar to traditional weaned calves (Nov. 01) fed in a feedlot.

Economics

Pasture establishment, feed and yardage costs are presented in Tables 2 and 3. The cost per day of grazing Italian ryegrass ranged between $0.31 and $0.68 and was based on the cost ha^{-1} divided by the actual number of grazing days per hectare. There are very few economic data published on the true cost of grazing cattle on annual or perennial pasture in western Canada. Highmoor (2005) concluded that overhead costs incurred per animal unit month of grazing on perennial pasture in Saskatchewan ranged from $11.29 to $13.00 and were more expensive than traditionally expected. Perrilat et al. (2004) suggested that feeding systems, which include grazing, were economically competitive with traditional feedlot feeding systems and grain farming. Baron (2004) at Lacombe, AB, concluded that annual pastures had advantages, but were risky in that they had very high costs associated with establishment and production. In addition, there is limited information in western Canada on the actual cost of growing and feeding barley silage on a cow-calf operation. Most of the available information is based on a custom rate feeding charge at a commercial feedlot. Traditional silage prices are based on the current feed grain prices multiplied by a factor. Thus, there is a tremendous need for future research to accurately develop these costs across a range of growing conditions in western Canada.

At Melfort, cost from early weaning to the time when the cattle were on the backgrounding ration in the feedlot was $63 for early weaning on ryegrass, $56 for conventionally weaned calves on ryegrass followed by feedlot and $54 for conventionally weaned calves on perennial pasture followed by feedlot ($P < 0.05$) (Tables 7 and 8). The cost for grazing the ryegrass at Melfort was 16% higher than at Lacombe, and this was due to several factors. At Melfort, there was significant wastage of the available forage by the animal as grazing was not controlled with electric fence at this site. In addition, early snow also resulted in inaccessibility of the ryegrass forage by the animal and this resulted in a higher overall cost per day of grazing.

When calves at Melfort started on the full backgrounding ration in the feedlot after finishing the ryegrass grazing, their net return at that time was similar to the net return at Lacombe at harvest (Table 8). This means that the profit in the system occurred through a saving related to the labour cost associated with drylot feeding.

At Lacombe, the total costs per animal from early weaning to harvest, based on calculated costs and the actual number of days on pasture for spring calves early-weaned feedlot group was $429.00, the early-weaned

ryegrass group was $398.00 and the conventionally weaned feedlot group was $418.00 per animal ($P < 0.05$) (Tables 7 and 8). This suggests that early weaning calves and backgrounding them on pasture allows for an 8% savings in costs compared with placing them directly into a feedlot. Net revenues at harvest for the Lacombe calves were similar for all treatments.

Total system costs for fall calves from early weaning until harvest for each system were System 1 = $417, System 2 = $410, and System 3 = $331. Steer weights were greater ($P < 0.05$) than heifer weights and steers were in the feedlot longer, 205 d compared with 193 d, respectively. Total system costs were $399 for steers and $373 for heifers.

At both Melfort and Lacombe, a higher stocking rate would have resulted in greater grazing days per hectare, which would have lowered the daily costs for grazing the Italian ryegrass. However, increasing the stocking rate was not possible due to the limited number of calves on the study. Grazing in the snow also lowered grazing utilization, which resulted in lower grazing days per hectare. Even with these grazing management issues, the total cost of early-weaned calves grazing ryegrass pasture was significantly lower ($P < 0.05$) than the other two treatments. In addition, the Melfort calves on the extended grazing ryegrass treatments did not require treatment for bovine respiratory disease while 10 calves on the conventionally weaned background treatment in the feedlot required treatment (Harland R. 1996, personal communication). These costs were in addition to the cost analysis presented in Table 8.

There were no differences ($P > 0.05$) in carcass cutability, fat class, marbling and rib eye area between any of the backgrounding systems in all trials. There were significant differences due to sex of animal, which would be expected.

CONCLUSION

In future research and in this study, cattle numbers could have been increased to achieve higher utilization of the ryegrass with reduced wastage and thus lower the actual cost per day. In addition, the energy content of the backgrounding ration could be increased to improve the daily rate of gain during the backgrounding period and thus reduce the number of days in the feedlot. Backgrounding calves on extended season grazing of Italian ryegrass reduced health problems by elimination of animals mixing in feedlot pens, less need for stored feed including storage and feeding losses, and less labour to feed the cattle and haul manure in the spring. Backgrounding calves on high-quality fall pasture is shown to be more economical than backgrounding in a feedlot pen system.

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