The effects of spring versus summer calving on beef cattle reproductive and growth performance in western Canada

Obioha N. Durunna[1], Lynne C. Girardin[2], Shannon L. Scott[3], Clayton Robins[4], Hushton C. Block[5], Alan D. Iwaasa[6], Mohammad Khakbazan[1], and Herbert A. Lardner[7,8]

[1]Agriculture and Agri-Food Canada, Brandon, Manitoba, Canada R7A 5Y3; [2]103-610 Stensrud Road, Saskatoon, Saskatchewan, Canada S7W 0E5; [3]Alberta Livestock and Meat Agency, Edmonton, Alberta, Canada T6X 0B3; [4]Box 83 Rivers, Manitoba, Canada R0K 1X0; [5]Agriculture and Agri-Food Canada, Lacombe Research Centre, 6000 C&E Trail, Lacombe, Alberta, Canada T4L 1W1; [6]Agriculture and Agri-Food Canada, Swift Current, Saskatchewan, Canada S9H 3X2; and [7]Western Beef Development Centre, Humboldt, Saskatchewan, Canada S0K 2A0.
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Durunna, O. N., Girardin, L. C., Scott, S. L., Robins, C., Block, H. C., Iwaasa, A. D., Khakbazan, M. and Lardner, H. A. 2014. **The effects of spring versus summer calving on beef cattle reproductive and growth performance in western Canada**. Can. J. Anim. Sci. **94**: 259–271. The majority of beef producers in western Canada have adopted a spring calving system. Evaluating alternative calving systems such as summer calving may lead to better use of forage resources to optimize cow-calf productivity. In order to evaluate the impact of calving system on cow-calf productivity, 346 Hereford or Angus crossbred cows were used in a 3-yr research study (2007 to 2009) at Brandon, Manitoba; Swift Current, Saskatchewan and Lanigan, Saskatchewan. Cows were bred to calve from February to May (early-calving system, EC) or from May to August (late-calving system, LC). Each system was evaluated for effect on performance and reproductive efficiency. Forage yield, utilization and nutritive value were assessed. Cow body weights (BW), ultrasound measures of backfat and calf BW were evaluated at precalving, breeding and weaning. There was no difference between calving systems for pregnancy rate ($P=0.13$) EC (93.0%) vs. LC (95.8%); calving rate ($P=0.89$) EC (92.0%) vs. LC (91.7%) or proportion of calves born alive ($P=0.85$) EC (99.5%) vs. LC (99.6%). The average length of calving season was not different ($P=0.26$) between the two systems. The EC cows had greater ($P=0.002$) BW losses from calving to breeding but greater ($P=0.001$) BW gain from breeding to weaning than LC cows. Although calves born in LC had greater birth BW ($P=0.003$) than EC calves, calf weaning rate ($P=0.01$) and calf weaning BW ($P<0.0001$) were greater in EC. The higher weaning rate and higher weaning BW with EC has the potential to increase cow-calf productivity and may be more attractive to beef producers in western Canada.

Key words: Cow-calf, calving, spring, summer, reproductive efficiency, growth

Durunna, O. N., Girardin, L. C., Scott, S. L., Robins, C., Block, H. C., Iwaasa, A. D., Khakbazan, M. et Lardner, H. A. 2014. **Les effets du vêlage au printemps comparé au vêlage à l'été sur la performance de croissance et reproductive des bovins de boucherie dans l'ouest du Canada**. Can. J. Anim. Sci. **94**: 259–271. La majorité des producteurs de boeuf dans l'ouest du Canada ont adopté un système de vêlage au printemps. L'évaluation de systèmes alternatifs tels que le vêlage à l'été pourrait entraîner une meilleure utilisation des ressources de fourrage pour optimiser la productivité vache-veau. Pour évaluer l'impact d'un système de vêlage sur la productivité vache-veau, 346 bovins croisés Hereford ou Angus ont été utilisés dans une étude sur 3 ans (2007 à 2009) à Brandon, Manitoba; Swift Current, Saskatchewan et Lanigan, Saskatchewan. Les vaches ont été inséminées pour vêler de février à mai (système de vêlage précoce – EC « early-calving system ») ou de mai à août (système de vêlage tardif – LC – « late-calving system »). Chaque système a été évalué pour son effet sur la performance et l'efficacité reproductive. Le rendement, l'utilisation et la valeur nutritive des fourrages ont été analysés. Le poids corporel (BW – « body weight ») des vaches, les mesures du gras dorsal par échographie et le BW des veaux ont été déterminés avant le vêlage, à l'insémination et au sevrage. Il n'y avait aucune différence entre les systèmes de vêlage par rapport au taux de conception ($P=0,13$) EC (93,0 %) c. LC (95,8 %); taux de vêlage ($P=0,89$) EC (92,0 %) c. LC (91,7 %) ou proportions de naissances vivantes ($P=0,85$) EC (99,5 %) c. LC (99,6 %). La longueur moyenne de la saison de vêlage n'était pas différente ($P=0,26$) entre les deux systèmes. Les vaches dans le système EC montraient de plus grandes ($P=0,002$) pertes de BW du vêlage à l'insémination, mais de plus grands ($P=0,001$) gains de BW de l'insémination au sevrage que les vaches dans le système LC. Bien que les veaux nés dans le système LC montraient un plus grand ($P=0,003$) BW à la naissance que les veaux du système EC, le taux de sevrage des veaux ($P=0,01$) et le BW des veaux au sevrage ($P<0,0001$) étaient plus élevés dans le système EC. Le taux de sevrage plus élevé et le BW au sevrage dans le système EC ont le potentiel d'augmenter la productivité vache-veau et pourrait être plus attirant pour les producteurs de bœuf de l'ouest du Canada.

Mots clés: Vache-veau, vêlage, printemps, été, efficacité reproductive, croissance

[8]*Corresponding author (e-mail: blardner.wbdc@pami.ca).*

Abbreviations: **ADF**, acid detergent fibre; **BCS**, body condition score; **br**, breeding; **BW**, body weight; **CP**, crude protein; **CS**, calving system; **DM**, dry matter; **EC**, early calving; **LC**, late calving; **NDF**, neutral detergent fibre; **OM**, organic matter; **OMD**, organic matter digestibility; **pc**, pre-calving; **TDN**, total digestible nutrients; **wn**, weaning

Identifying management and production strategies associated with better cow nutrition, enhanced cow reproductive efficiency and greater calf growth will improve cow-calf productivity in Canada. The choice of calving season is a management strategy that affects cow-calf production because it dictates the time of weaning and the occurrence of subsequent farming activities such as seeding, especially in mixed farming operations so that calving will not interfere with spring crop-farming activities (Pang et al. 1998; Girardin 2011). As a result of various management, economic and herd health reasons (Mathison 1993), majority of cow-calf producers have adopted early calving (around March and April). Because the majority of these producers in Canada are located in the western Canadian prairies, coinciding available forage during summer with periods of high-energy demand of cows during lactation has the potential for higher cow-calf productivity. Therefore, considering an alternative calving system in the summer may increase cow-calf output via improved utilization of pasture resources.

Even though it has been a long-standing debate among producers regarding the best time for calving, research trials evaluating time of calving effects on production systems in Canada are limited. Results available from trials in the United States (Adams et al. 2001; Reisenauer et al. 2001; Grings et al. 2005) may not be applicable due to differences in climate and growing conditions. To address this limitation, a multi-year and multi-location trial was conducted to evaluate cow and calf performance under two calving systems. Any strategy having minimal negative impact on the reproductive efficiency of cows as well as on the growth and survival of calves has the potential to increase cow-calf production. Such information would assist cattle producers to adopt the calving management program that best suits their needs. The objective of this study was to evaluate the effects of either an early-calving system (EC) or late-calving system (LC) on western Canada beef cow-calf reproduction and growth performance.

MATERIALS AND METHODS

Study Locations and Weather Information

The 3-yr study was managed from 2007 to 2009 at the Agriculture and Agri-Food Canada, Brandon Research Centre (BRC) in Brandon, MB (lat. 49°52′N, long. 99°59′W), at the Semiarid Prairie Agricultural Research Centre (SPARC) in Swift Current, SK (lat. 50°16′N, long. 107°44′W) and at the Western Beef Development Centre (WBDC) Termuende Research Ranch in Lanigan, SK (lat. 51°51′N, long. 105°02′W). Hereafter, the institution and city are interchangeable and are referred to as location. These different locations were characterized by different soil zones, whereby Swift Current and Lanigan are characterized by Brown and Dark Brown soil zones, respectively, while Brandon is located in a Black soil zone.

Figure 1 shows the monthly averages for total precipitation and maximum and minimum temperature for the three locations. The mean ambient temperature and total precipitation for Brandon were obtained from the Environment Canada weather station (station number: 5010480) located at the Brandon Airport, less than 3 km from the trial location. The weather records for Swift Current were obtained from weather stations 4028040 and 4028060 located at Swift Current, SK. Weather records for Lanigan were obtained from weather stations 4018640 and 4018642 located at Watrous, SK. Supplementary records for this location were obtained from Esk, SK, weather station. Total precipitation in 2007, 2008 and 2009 at Brandon were 453, 537 and 499 mm, respectively. Swift Current's total precipitation for 2007, 2008 and 2009 was 262, 392 and 226 mm, respectively while the total precipitation at Lanigan for 2007, 2008 and 2009 was 294, 298 and 314 mm, respectively.

Animal Management

All animals were cared for according to the guidelines of Canadian Council on Animal Care (1993). The cows used in this 3-yr study were crossbreds of predominantly British (Hereford or Angus) origin. Each year approximately 140 cows at BRC, 60 cows at SPARC, and 100 cows at WBDC were used for the study. The age of the cows at BRC ranged from 2 to 11 yr, while those at SPARC and WBDC were 2 to 15 yr and 2 to 14 yr, respectively. The cows were randomly assigned to one of two calving systems, early calving (EC) or late calving (LC). The cows within each system were randomly assigned to one of two replicates and were allotted to different paddocks such that there were approximately 30, 12 and 25 cows per paddock, respectively, for BRC, SPARC and WBDC. All cows remained in the assigned groups and replicates for the entire duration of the trial.

All cows were bred by natural service to Gelbvieh or Red Angus bulls with an average bull to cow ratio of 1:20 at all locations. The cows were assigned to the different systems prior to the breeding season (63 d). The cows in EC at different locations were bred from May to July, whereas the cows in LC were bred from August to December. All bulls were evaluated for breeding soundness each year prior to the start of the breeding season and were also vaccinated with Express 5 (Boehringer Ingelheim, St. Joseph, MO), Covexin 8 (Schering-Plough, Omaha, NE) and Fusogard (Novartis, Mississauga, ON). The same bulls were used each year, unless they were found to be not sound, in which case they were replaced with a bull of the same breed. Similarly, cows were vaccinated with Covexin 8 (Schering-Plough, Omaha, NE) and Express 5 (Boehringer Ingelheim, St. Joseph, MO) prior to the breeding season. The EC cows at each location were also vaccinated with Scourguard 4KC (Pfizer, New York, NY). Only EC cows were vaccinated with Scourguard because the calving environment in drylot pens had the potential to expose the calves to scour-causing bacteria. At pasture turnout, all cows at

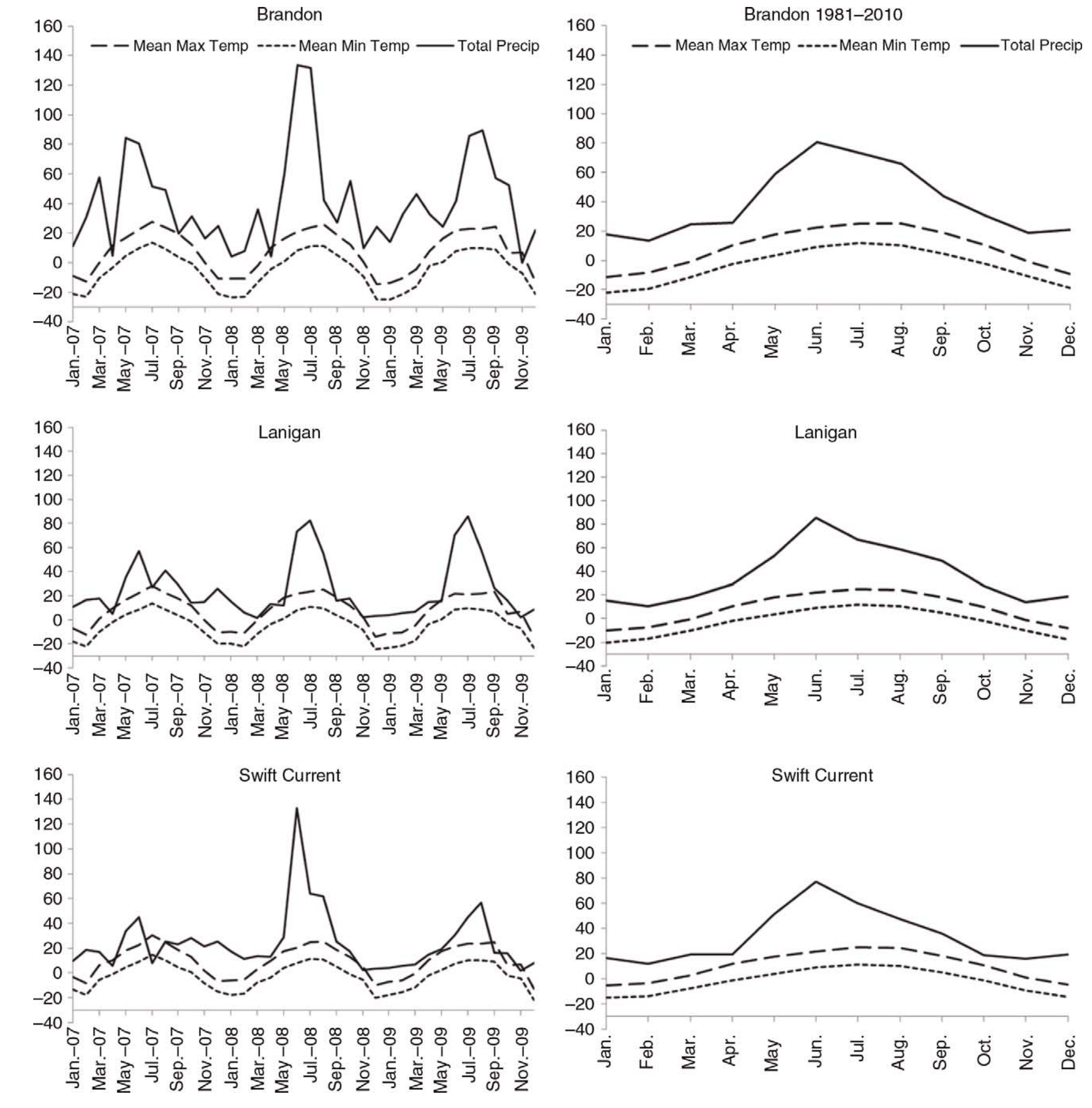

Fig. 1. Average monthly and long-term (1981–2010) trend for precipitation and temperature at the different locations.

WBDC were vaccinated with Anthrax spore vaccine (Colorado Serum Company, Denver, CO) as a precautionary measure due to possible outbreaks of anthrax in that municipality resulting from high rainfall in those years. In the fall, all cows received vitamin A and D (Dominion Veterinary Laboratories Inc., Winnipeg, MB) at 1 mL per 100 kg body weight (BW).

Calf management at birth involved administering injections of vitamins A and D (Dominion Veterinary Laboratories Inc., Winnipeg, MB) at 1 mL per 50 kg BW, while vitamin E and selenium were administered via injections of Dystosel (Pfizer, Kirkland, QC) at 2 mL per 45 kg of BW. Calves with horns were dehorned using dehorning paste (Dominion Veterinary Laboratories Inc., Winnipeg, MB) and while all male calves were castrated using castration rings (Kane Veterinary Supplies, Edmonton, AB). At 60 d of age, and again at weaning, the calves were vaccinated with Somnu Star pH (Novartis, Mississauga, ON), Covexin 8 (Intervet/Schering-Plough, Omaha, NE), and Express 5 (Boehringer Ingelheim, St. Joseph, MO). The calves at Lanigan were also vaccinated with Anthrax spore vaccine (Colorado Serum Company, Denver, CO) at 60 d of age as a precautionary measure.

Ten weeks after bull removal, a veterinarian conducted pregnancy checks on the cows via rectal palpation. Cows were culled if they were not pregnant for the second consecutive year or if they lost their calf for the second consecutive year. Cows were also culled if udders were physically damaged or not structurally sound or if the cow was lame and unresponsive to treatment. Replacement heifers were chosen at weaning within each location before being randomly assigned to a calving group. The replacement heifers were selected based on birth to weaning performance and on their dams' performances. Based on the beef industry standard, a replacement rate or culling rate of 10% was used for both groups at all locations every year.

Feeding Management and Calving Systems

A separate feeding management procedure was employed for the different calving systems such that allocated feed met the nutritional requirements [National Research Council (NRC) 2000] at each physiological stage in each system. Cow diets were supplemented with hay and trace mineral salt depending on the availability of forage, weather conditions and physiological status. The trace mineral salt (FeedRite, Winnipeg, MB) contained Ca (9%, as fed), P (10%, as fed), Na (10%, as fed), I (100 mg kg^{-1}, as fed), Cu (2500 mg kg^{-1}, as fed), Mn (6000 mg kg^{-1}, as fed), and F (1000 mg kg^{-1}, as fed). The trace mineral salt also contained Zn (7500 mg kg^{-1}, as fed), Fe (4750 mg kg^{-1}, as fed), vitamin A (1 000 000 IU kg^{-1}, as fed), vitamin D_3 (140 000 IU kg^{-1}, as fed) and vitamin E (2500 IU kg^{-1}, as fed).

Early Calving System

The EC cows calved in drylot pens, which were holding pens during the pre-calving and calving phases. Table 1 shows the range of the calving dates for the different locations. During this period, all cows were fed mixed hay grown at each research location except Lanigan, where all hay was purchased from local producers. The cow-calf pairs were later turned out for pasture grazing when sufficient pasture was available to support both cows and calves. The summer grazing period on mixed cool season species pastures (see following section for composition) occurred from May to September. Cattle movements within these pastures were based on forage availability and management needs. Following summer pasture, the cows were transferred to swath-graze annual crops for approximately 30 d (with varying start and end dates depending on year), except at Swift Current, where cows grazed standing annual crops. For the locations that managed swath-grazing, the annual crops (oat or barley) seeded in June were swathed at the soft dough stage in early September.

Bale grazing commenced after the cows finished grazing the swaths or standing crops; however, calves were weaned prior to the start of bale grazing. During bale grazing, the cows were supplemented with either rolled barley grain (1 to 3 kg cow^{-1} d^{-1}) or range pellets (2 to 3 kg cow^{-1} d^{-1}) depending on environmental conditions and pregnancy status. The cows in EC at BRC did not bale graze in 2007 due to the lack of a separate winter grazing site and were instead managed in drylot. The calves in this system were weaned between September and October at an average age of 193 d.

Late Calving System

The LC cows were managed to calve on summer pasture. The calving dates for this group at different locations are shown in Table 1. Following calving, the pasture management and movement of animals in LC were similar to the routines of EC. Briefly, following summer pasturing, cow-calf pairs were moved to swath-graze annual crops for approximately 30 d. After swath grazing, the cows were moved to winter management sites for bale grazing (using similar management strategies as EC) until spring pastures were available for the following calving season. Unlike EC, LC only made use of drylot temporarily, when bale-grazing sites were not ready. The LC calves were weaned between December and January at an average age of 194 d.

Forage Composition, Biomass and Nutrient Quality Evaluations

The perennial pastures at Swift Current were either monocultures of crested wheatgrass (*Agropyron cristatum*) or Russian wild ryegrass (*Psathyrostachys juncea*), while the pastures at Lanigan were either 100% Russian wild ryegrass or 75% crested wheatgrass and 25% smooth bromegrass (*Bromus inermus*). The perennial pastures at the Brandon location were approximately 16% alfalfa (*Medicago sativa* L.), and 84% meadow bromegrass (*Bromus riparius* Rehm.).

Grazing commenced when sufficient pasture was available and cattle were moved based on forage availability. Grazing was targeted to a pasture utilization level of about 40 to 50%. Ten 0.25-m^2 quadrat clippings were collected from all pastures at random prior to grazing in order to estimate forage biomass and nutrient quality. Ten random clippings were also taken at the end of grazing to estimate residue yield. The initial (entry clippings) and end (exit clippings) yields of pastures were extrapolated to ha^{-1} using dried clipped samples from the 0.25-m^2 quadrats. The estimated forage intake or disappearance was calculated as the difference between the average entry and exit yields within each pasture.

The estimates of forage yield from swath grazing annual crops were determined from 10 random 0.25-m^2 quadrat clippings. These samples were collected when the crops reached the soft dough stage, just prior to swathing. It was estimated that 0.3 m of the swath contained about 1.4 kg of dry matter (DM). Hence, this estimate was used to calculate the amount accessible to the animals based on feed quality and the estimated

Table 1. Calving dates and number of cows that calved within different calving intervals at the study locations[z]

	Early-calving system									Late-calving system								
	2007			2008			2009			2007			2008			2009		
BRC	Feb. 28–Apr. 10			Feb. 29–May 05			Mar. 04–May 19			May 16–Jul. 23			May 18–Jul. 16			May 11–Jul. 14		
WBDC	Mar. 29–Apr. 14			Mar. 01–May 12			Feb. 26–May 16			May 25–Jul. 26			May 26–Jul. 30			May 19–Aug. 03		
SPARC	Feb. 28–Mar. 27			Feb. 27–Apr. 26			Mar. 01–Apr. 21			May 14–Jul. 12			May 20–Jul. 31			May 22–Jul. 15		
Calving day (d)	≤21	22–42	>42	≤21	22–42	>42	≤21	22–42	>42	≤21	22–42	>42	≤21	22–42	>42	≤21	22–42	>42
BRC	31	28	0	37	18	6	43	17	6	40	19	1	37	16	8	24	36	5
WBDC	51	0	0	25	23	8	13	28	12	24	16	7	40	7	3	18	16	6
SPARC	21	6	1	19	6	4	21	4	4	14	9	2	17	12	1	17	12	1

[z]BRC, Brandon Research Centre, Brandon, MB; WBDC, Western Beef development Centre, Lanigan, SK; SPARC, Semiarid Prairie Agricultural Centre, Swift Current, SK.

DM intake for beef cows (NRC 2000). Cow-calf pairs were allotted to swaths sufficient for 2–3 d grazing period based on the number of cows per group. Available forage was limited to a 2–3 d period in order to avoid high feed wastage, poor feed utilization and low performance associated with higher swath allocations (McCartney et al. 2004).

Following swath grazing, round hay bales (mixed grass–legume forages) were used for bale grazing on winter grazing sites that were either perennial forages or annually cropped fields. Bale grazing started earlier in some years due to depleted perennial forages or poor forage production for swath grazing. The weight of a random sample ($n = 10$) of bales was used to determine available forage, while the quality of bales was determined by collecting representative core samples from 10 random bales. While bale grazing, the animals received an energy or protein supplement depending on weather conditions and amount of snow cover. The cows were also moved every 4 d to reduce feed wastage.

Prior to laboratory analysis, forage samples from all sites and additional bale core samples were dried at 50°C for 48–72 h to determine DM and ground through a 1-mm screen with a Wiley mill (Model no. 4; Arthur H. Thomas Co., Philadelphia, PA). Ash content was determined by combustion of 1 g of sample in porcelain crucibles at 600°C for 2 h (Association of Official Analytical Chemists 2005). Forage samples were also analyzed for organic matter (OM) and organic matter digestibility (OMD) using modified procedures of Troelsen and Hanel (1966). Other analyses included crude protein (CP) (Jefferson et al. 2004), total calcium (Ca) (Steckel and Flannery 1965) and total phosphorus (P) (Varley 1966; Milbury et al. 1970). Acid detergent fibre (ADF) and amylase-treated neutral detergent fibre (NDF) were determined using the ANKOM200 fibre analyzer (ANKOM Technology, Fairport, NY) according to the manufacturer's protocols. Total digestible nutrients (TDN) were calculated based on ADF content (Adams 1995) using the Pennsylvania State equation.

$$TDN = 4.898 + \{89.796*[1.0876 - (0.0127*ADF)]\}$$

Animal Measurements

Cow BW, body condition score (BCS) and ultrasound measures of body fat composition from all cows were determined three times during the production cycle, at pre-calving (pc), breeding (br) and at weaning (wn). Body condition scoring was done by assessing fat cover on the short ribs of the left side of the cow using a 5 point scale (1 = thin, 5 = fat). Calf BW was taken three times during the production cycle, within 24 h after birth, at approximately 60 d of age or start of breeding season and at weaning.

Technicians at each location were cross-trained for the BCS technique and ultrasound analysis with the same technician at each location performing these duties for the duration of the study. Ultrasonography was used to assess subcutaneous rib fat thickness (rib) between the 12th and 13th rib and rump fat thickness (rump) on the rump near the tail-head of the left side of the cow using an Aloka SSD-500V ultrasound machine (Hitachi Aloka Medical Ltd., Wallingford, CT) with a 3.5 MHz Aloka UST-5044 probe.

The measurements collected at all sites over 3 yr were BW (BW_{pc}, BW_{br}, BW_{wn}), BCS (BCS_{pc}, BCS_{br}, BCS_{wn}), rib fat thickness (rib_{pc}, rib_{br}, rib_{wn}) and rump fat thickness ($rump_{pc}$, $rump_{br}$, $rump_{wn}$). Other variables were calculated as differences between any two successive measurements (b-p = br-pc; w-b = wn-br); hence, body weights ($BW_{b\text{-}p}$, $BW_{w\text{-}b}$), BCS ($BCS_{b\text{-}p}$, $BCS_{w\text{-}b}$) or rib fat thickness ($rib_{b\text{-}p}$, $rib_{w\text{-}b}$) and rump fat thickness ($rump_{b\text{-}p}$, $rump_{w\text{-}b}$) were calculated.

Measurements of cow reproductive performance included pregnancy rate, calving percentage, calving span, calves born alive and weaning percentage. Pregnancy rate was calculated as the proportion of cows exposed to bulls that were confirmed pregnant by a veterinarian by palpation. Calving percentage was estimated as the proportion of exposed cows that actually calved. The calving span or length of calving was calculated as the difference between the last and first calving day of live birth within each system in each year. Calves born alive was estimated as the proportion of calves alive at birth. Weaning percentage was the proportion of calves born that were weaned. In situations where a cow had a stillbirth, it was assumed that the cow was reproductively sound but was unable to wean.

Statistical Analysis

The analyses utilized a randomized complete block design with the experimental location (BRC, SPARC, WBDC) treated as a blocking factor, where each treatment (EC, LC) was replicated ($n = 2$) within each block and the year effect (2007, 2008, 2009) was included as a random factor. The average forage yield and forage utilization from pastures within each location were analyzed using Proc Mixed in SAS software (SAS 9.3, SAS Institute, Inc. Cary, NC), and included the calving systems (CS), locations (L) and interaction between CS and L (CS × L) as fixed effects, while year was considered a random effect.

In addition, cow reproductive performances were analyzed using the GLIMMIX procedure of SAS software. Cow and calf BW and body composition data were analyzed using the MIXED procedure of SAS software. The models also included the CS, L and CS × L as fixed effects, while year was also included as a random effect. The days between successive measurements and the dams' ages were used as linear covariates for the changes (gains/losses) in BW, BCS, rib-fat thickness and rump-fat thickness. Differences between treatment effects were estimated and tested using the PDIFF option of SAS with a Tukey–Kramer adjustment and statistical difference was declared at $P < 0.05$.

RESULTS

Forage Yield and Nutrient Quality

There was a location effect ($P = 0.001$) on forage yield from the pre-graze clippings, but CS ($P = 0.54$) and CS × L ($P = 0.26$) were not significant (Table 2). The initial forage yield at BRC was greater ($P < 0.03$) than the initial yield at SPARC or WBDC but there was no difference ($P = 0.97$) between the initial yields at SPARC and WBDC. The CS ($P = 0.48$) and CS × L ($P = 0.33$) had no effect on forage disappearance, but there were differences ($P < 0.01$) among locations where BRC had greater ($P < 0.03$) forage disappearance than SPARC or WBDC. There was CS × L effect ($P = 0.01$) on residue yield. There was no difference ($P > 0.99$) in residue yield between EC and LC at SPARC (1069, 1048 kg ha^{-1}) and WBDC (1241, 1179 kg ha^{-1}), respectively. The residue yield at BRC was greater ($P = 0.01$) for LC (2388 kg ha^{-1}) than EC by approximately 793 kg ha^{-1}.

There was no CS effect ($P > 0.11$) on nutrient quality evaluated except CP ($P = 0.01$), where EC (13.0% CP) received feeds with higher CP than LC (11.5%; Table 3). The CP content of most feed sources was above 9% while the average energy content differed with location, ranging from 58 to 77% TDN. Acid detergent fibre ranged from 23 to 39%, while NDF values ranged from 45 to 63%. There was no difference in nutrient quality between the hay and pasture samples for OM ($P = 0.20$), OMD ($P = 0.43$), CP ($P = 0.98$), P ($P = 0.38$), Ca ($P = 0.21$) or NDF ($P = 0.23$). Compared with hay, pasture forage had greater average TDN ($P = 0.001$) with hay samples having greater ADF content ($P = 0.001$).

Cow Reproductive Performance, Calving Distribution and Weaning Rate

The year effect variances were close to zero for pregnancy rate, calving rate and weaning rate, while the year effect accounted for about 31% of the variation in the length of calving season (Table 4). There was no difference ($P = 0.13$) in pregnancy rate between EC (93%) and LC cows (96%). There was also no CS × L interaction ($P = 0.79$) on pregnancy rate, but there was location effect ($P = 0.04$), where cows at BRC had a lower pregnancy rate (91%) compared with SPARC (96%) or WBDC (95%) locations. The calving rate was affected by location ($P = 0.03$) but not by CS or CS × L ($P > 0.80$). There was no effect ($P > 0.37$) of CS, L or CS × L on the proportion of calves born alive, given that cows at SPARC gave birth to live calves, while proportions for EC and LC were slightly different at BRC (98%, 99.5%) and WBDC (100%, 99.3%), respectively.

The calving distribution was approximately 60% ($n = 261$) for EC and 57% ($n = 233$) for LC cows that calved between the first and 21st d of calving season. About 30% (EC) and 34% (LC) calved between d 22 and 42 while approximately 9% within each group (EC = 41 cows, LC = 35 cows) calved after d 42 of the calving season. Even though mean length of calving season for

Table 2. Forage yield at the different study locations (DM basis)[z]

Year		Calving system (CS)		Location (L)			P values		
		Early	Late	BRC	WBDC	SPARC	CS	L	CS × L
2007									
	Initial forage yield (kg ha^{-1})	3459.7	5368.5	8589.2	2555.8	2344.0			
	Forage residues (kg ha^{-1})	1657.2	1664.2	2188.6	1526.5	1095.9			
	Forage utilization (kg ha^{-1})	1807.3	3704.3	6400.6	1034.2	1247.2			
2008									
	Initial forage yield (kg ha^{-1})	2547.6	4445.8	7292.7	2141.7	1988.6			
	Forage residues (kg ha^{-1})	1265.5	1737.8	2242.7	1258.5	1171.2			
	Forage utilization (kg ha^{-1})	1505.7	2705.8	5456.5	880.7	816.6			
2009									
	Initial forage yield (kg ha^{-1})	1441.2	1627.4	1355.3	1541.1	1662.4			
	Forage residues (kg ha^{-1})	727.8	842.0	834.9	813.2	703.2			
	Forage utilization (kg ha^{-1})	671.0	796.0	386.5	728.0	974.5			
Overall[y]									
	Initial forage yield (kg ha^{-1})	3467 ± 976.5	3779 ± 979.9	6547 ± 1314.5*a*	1990 ± 973.3*b*	2332 ± 1435.1*b*	0.54	< 0.01	0.26
	Forage residues (kg ha^{-1})	1302 ± 223.0	1538 ± 224.8	1991 ± 269.6	1210 ± 220.5*b*	1059 ± 283.3	0.05	< 0.01	0.01
	Forage utilization (kg ha^{-1})	2177 ± 741.4	2531 ± 747.2	5044 ± 1076.4*a*	791 ± 731.5*b*	1226 ± 1173.3*b*	0.48	< 0.01	0.33

[z]BRC, Brandon Research Centre, Brandon, MB; WBDC, Western Beef development Centre, Lanigan, SK; SPARC, Semiarid Prairie Agricultural Centre, Swift Current, SK.
[y]From least squares means.
a, *b* Different letters within row are significantly different at $P < 0.05$.

EC and LC cows were 58 and 64 d, respectively, CS, L or the CS × L had no ($P > 0.26$) effect on the duration of the calving season. The weaning rate of EC cows (99%) was greater ($P = 0.01$) than LC cows (95%). Neither L nor CS × L affected ($P > 0.33$) weaning rate.

Cow Body Performance

Cow BW and body composition were evaluated with 424 EC cow-calf pairs and 398 LC cow-calf pairs. For these traits, year accounted for 0 to 13% of the phenotypic variation. Initial BW of cows in the two calving systems did not differ ($P = 0.12$). Even though CS × L ($P = 0.84$) was not significant, there was location effect ($P < 0.0001$) where BW of cows at the WBDC averaged 80 and 72 kg less than cows at SPARC and BRC, respectively. There was CS effect ($P = 0.002$) on cow BW change at breeding with no effect of L and CS × L ($P > 0.11$). The change in BW from pre-calving to breeding indicated that the

Table 3. Average nutrient quality of forages by calving system and location[z]

Calving system	Location	Forage	OM[y] (%)	OMD[y] (%)	CP[y] (%)	P[y] (%)	Ca[y] (%)	ADF[y] (%)	NDF[y] (%)	TDN[y] (%)
Early	BRC	Swath	91.6	59.9	12.5	0.3	0.4	33.2	54.1	64.7
		Hay	70.9	53.8	11.0	0.3	0.4	36.0	56.2	61.5
		Pasture	89.7	62.7	16.7	0.4	0.5	31.3	53.2	66.9
	WBDC	Swath	78.7	–[x]	13.3	0.3	0.3	34.5	52.5	63.2
		Hay	84.2	–	12.3	0.2	0.9	37.0	55.1	60.3
		Pasture	92.3	49.9	10.6	0.2	0.6	33.8	60.1	64.0
	SPARC	Swath	91.4	66.0	14.1	0.2	0.4	22.7	45.4	76.7
		Hay	91.8	53.7	11.5	0.2	0.6	38.9	63.2	58.2
		Pasture	90.3	53.4	9.6	0.1	0.5	31.4	56.4	66.7
Late	BRC	Swath	89.0	61.1	11.8	0.3	0.4	36.3	54.3	61.2
		Hay	91.5	52.1	11.5	0.2	0.6	37.1	56.1	60.3
		Pasture	90.0	49.8	9.2	0.2	0.7	39.0	60.1	58.1
	WBDC	Swath	78.7	–	13.3	0.3	0.3	34.5	52.5	63.2
		Hay	84.4	–	11.4	0.2	0.8	37.5	56.9	59.8
		Pasture	92.4	49.9	10.4	0.2	0.5	33.4	59.8	64.4
	SPARC	Swath	90.5	60.8	12.4	0.2	0.5	25.1	47.0	73.9
		Hay	91.2	55.5	12.5	0.2	0.6	37.4	62.3	59.9
		Pasture	91.2	51.3	7.6	0.1	0.4	31.8	58.8	66.3

[z]BRC, Brandon Research Centre, Brandon, MB; WBDC, Western Beef development Centre, Lanigan, SK; SPARC, Semiarid Prairie Agricultural Centre, Swift Current, SK.
[y]OM, organic matter; OMD, organic matter digestibility; CP, crude protein; P, phosphorus; Ca, calcium; ADF, acid detergent fibre; NDF, neutral detergent fibre; TDN, total digestible nutrients.
[x]–, missing data.

Table 4. Reproductive efficiency in the early vs late calving systems[z]

		Variables (*n*)				
Year/location	Calving system	Pregnancy rate (%)	Calving rate (%)	Calves born alive (%)	Weaning rate (%)	Calving season length (d)
2007	Early	92.2 (154)	89.6 (154)	100 (138)	98.6 (138)	28.8
	Late	97.2 (145)	88.0 (150)	99.2 (132)	94.7 (132)	50.3
2008	Early	92.0 (163)	89.0 (164)	100 (146)	100 (146)	57.8
	Late	94.7 (151)	91.7 (156)	100 (143)	95.1 (143)	53.5
2009	Early	89.2 (157)	93.7 (158)	98.0 (148)	96.6 (148)	61.2
	Late	93.7 (142)	93.1 (145)	98.5 (136)	94.1 (136)	54.8
BRC	Early	86.9 (214)	86.9 (214)	98.4 (186)	97.3 (187)	53.5
	Late	93.8 (209)	88.6 (210)	98.9 (187)	95.2 (187)	52.5
WBDC	Early	94.0 (168)	94.7 (169)	100 (160)	99.4 (160)	46.5
	Late	96.4 (139)	93.4 (151)	99.3 (141)	93.6 (141)	57
SPARC	Early	95.7 (92)	92.5 (93)	100 (86)	98.8 (85)	42.8
	Late	96.7 (90)	92.2 (90)	100 (83)	95.2 (83)	49.2
Overall[y]	Early	93.0	92.0	99.5	98.7	58.3
	Late	95.8	91.7	99.6	94.7	63.6
BRC		90.9*a*	87.8*a*	99.0	96.4	63.7
WBDC		95.4*b*	94.2*b*	99.7	98.0	62.4
SPARC		96.2*b*	92.5*ab*	100	97.6	56.7

[z]BRC, Brandon Research Centre, Brandon, MB; WBDC, Western Beef Development Centre, Lanigan, SK; SPARC, Semiarid Prairie Agricultural Centre, Swift Current, SK; n = total number of animals within each system and year.
[y]From least square means.
a, *b* Different letters within column are significantly different at $P < 0.05$.

average BW loss in EC cows (56 kg) was greater than that of LC cows (27 kg). At weaning, L and CS × L had no effect ($P > 0.12$), but there was a CS effect ($P = 0.001$) on average BW change from breeding to weaning, where LC cows lost approximately 15 kg while EC cows gained 17 kg.

There was a CS × L ($P = 0.006$) effect on the BCS of cows prior to calving. There was no difference ($P > 0.30$) between calving systems for the average cow BCS_{pc} at BRC and WBDC, while EC cows had improved ($P = 0.0006$) BCS_{pc} as compared with LC cows at SPARC. There was CS × L effect ($P = 0.006$) on the change in BCS measured at breeding. At SPARC and WBDC, LC cows had greater $BCS_{b\text{-}p}$ ($P < 0.05$) than EC cows. There was also an interaction ($P = 0.005$) where EC cows at WBDC had greater ($P = 0.02$) average $BCS_{w\text{-}b}$ than LC cows at the same location.

There was a CS × L effect on ultrasound measures of rib ($P = 0.0006$) and rump ($P = 0.004$) fat thickness at pre-calving. Average rib_{pc} was similar ($P > 0.99$) for cows in the two CS at BRC but was different ($P = 0.02$) for cows at WBDC, while the difference at SPARC indicated a trend ($P = 0.06$) that was higher for the LC system. The average $rump_{pc}$ between the two calving systems at WBDC was different ($P = 0.03$). There was a CS × L effect ($P = 0.0003$) on $rib_{b\text{-}p}$ where the average $rib_{b\text{-}p}$ was greater in LC cows at SPARC ($P = 0.001$) and WBDC ($P = 0.04$). There was a trend for L effect ($P = 0.05$) on $rib_{w\text{-}b}$. There was CS × L ($P = 0.001$) for $rump_{w\text{-}b}$, where LC cows at SPARC had greater ($P = 0.008$) gains.

Calf Performances

Calving system and L had an effect ($P < 0.003$) on the birth BW of calves. Calves born to LC cows had greater birth BW than those from EC cows (Table 5). Calves at BRC had greater ($P < 0.0001$) birth BW than those at SPARC or WBDC. Even though location did not have an effect ($P = 0.16$) on the calf $BW_{w\text{-}b}$, the CS and CS × L were significant ($P < 0.04$). However, there were differences between the two systems at SPARC where EC calves weighed 60 kg more ($P = 0.0008$) $BW_{w\text{-}b}$, than LC calves. Calving system and L had an effect ($P < 0.0006$) on the weaning BW of calves. At weaning, EC and LC calves at BRC were 194 and 212 d old, respectively. The average weaning ages for EC and LC calves at SPARC were 197 and 173d, respectively, while the weaning ages at WDBC were 189 and 199 d, respectively, for EC and LC. The EC calves had greater weaning BW than LC calves by 28 kg. The calves at BRC had greater ($P < 0.05$) weaning BW than calves at SPARC and WBDC.

DISCUSSION

Forage Yield and Nutrient Quality

There were no differences between the two calving systems for the entry or pre-graze pasture yield and animal pasture intake. However, a significant interaction for residue yield showed a wide margin between the two systems at the BRC location. The size of this difference may have contributed to the observed CS effect on residue yield. The reasons behind the disparity at this location were not clear because we observed that the residue yields at the other locations were numerically higher within EC. The abundant total precipitation at BRC may have contributed to the high entry yield, which may have resulted in weathering of unconsumed swathed annuals, thereby increasing residue as it was unpalatable.

Table 5. Bodyweight and body composition under different calving systems and locations[z]

	Calving systems (CS)		Locations (L)			Calving systems × locations						P values		
						BRC		WBDC		SPARC				
Variables	Early	Late	BRC	WBDC	SPARC	ECS	LCS	ECS	LCS	ECS	LCS	CS	L	CS × L
Cow body weight (kg)														
Precalving	701 ± 8.5	710 ± 8.6	727 ± 8.8*a*	655 ± 9.2*b*	735 ± 9.5*a*	724	731	648	662	732	738	0.12	< 0.01	0.84
PC to BR[y]	−55.7 ± 6.37*a*	−26.9 ± 6.31*b*	−43.1 ± 8.11	−29.1 ± 7.97	−51.6 ± 8.25	−50.1	−36.1	−48.4	−9.7	−68.5	−34.8	< 0.01	0.12	0.46
BR to WN[y]	16.5 ± 8.08*a*	−14.7 ± 8.10*b*	−12.0 ± 9.16	10.0 ± 9.37	4.6 ± 9.21	−1.4	−22.6	38.1	−18.1	12.7	−3.5	< 0.01	0.12	0.12
Cow body condition (1 − 5 point scale)														
Precalving	3.4 ± 0.05*a*	3.2 ± 0.05*b*	3.4 ± 0.05*a*	2.6 ± 0.05*b*	3.8 ± 0.06*c*	3.4*a*	3.4*a*	2.7*b*	2.6*b*	4.0*c*	3.6*d*	< 0.01	< 0.01	< 0.01
PC to BR[y]	−0.27 ± 0.10*a*	0.10 ± 0.10*b*	−0.05 ± 0.10*ab*	0.02 ± 0.10*b*	−0.23 ± 0.11*a*	−0.09*abc*	−0.02*abc*	−0.15*b*	0.19*ac*	−0.58*d*	0.12*abc*	< 0.01	0.02	< 0.01
BR to WN[y]	−0.09 ± 0.05	−0.23 ± 0.05	−0.16 ± 0.07	−0.14 ± 0.07	−0.18 ± 0.07	−0.06*ab*	−0.26*ab*	0.09*a*	−0.37*b*	−0.29*ab*	−0.07*ab*	0.07	0.93	< 0.01
Cow rib fat (mm)														
Precalving	6.7 ± 0.32	6.8 ± 0.34	4.3 ± 0.40*a*	4.7 ± 0.39*a*	11.4 ± 0.46*b*	4.2*ac*	4.5*ac*	6.0*ab*	3.3*c*	10.0*d*	12.8*d*	0.83	< 0.01	< 0.01
PC to BR[y]	−0.7 ± 0.42*a*	2.9 ± 0.38*b*	−0.8 ± 0.44*a*	−0.3 ± 0.46*a*	4.5 ± 0.58*b*	−0.8*ab*	−0.8*ab*	−2.0*a*	1.4*b*	0.7*ab*	8.3*c*	< 0.01	< 0.01	< 0.01
BR to WN[y]	−0.9 ± 1.25	−2.1 ± 0.85	−0.2 ± 1.17	−0.5 ± 1.26	−3.8 ± 1.18	−0.1	−0.2	0.7	−1.6	−3.3	−4.3	0.43	0.05	0.78
Cow rump fat (mm)														
Precalving	10.3 ± 1.57	9.9 ± 1.65	7.4 ± 1.70*a*	6.0 ± 1.59*a*	17.0 ± 1.73*b*	6.7*ab*	8.1*ab*	8.6*a*	3.4*b*	15.7*c*	18.3*c*	0.63	< 0.01	< 0.01
PC to BR[y]	−2.5 ± 2.03	−1.3 ± 1.94	−2.1 ± 2.05	−0.3 ± 2.04	−3.3 ± 2.26	−2.5	−1.8	−2.2	1.7	−2.8	−3.8	0.47	0.27	0.68
BR to WN[y]	−1.6 ± 0.59	−1.0 ± 0.48	0.1 ± 0.65*a*	−1.4 ± 0.68*ab*	−2.5 ± 0.68*b*	1.0*a*	−0.7*a*	−0.5*ab*	−2.4*ac*	−5.3*c*	0.2*ad*	0.43	0.03	< 0.01
Calf body weight (kg)														
Birth weight	41.5 ± 0.54*a*	43.4 ± 0.55*b*	45.3 ± 0.60*a*	41.3 ± 0.64*b*	40.8 ± 0.68*b*	43.8	46.7	40.2	42.4	40.4	41.1	< 0.01	< 0.01	0.32
Birth weight to BR[y]	76.0 ± 6.66	69.0 ± 6.66	69.10 ± 7.36	79.1 ± 7.37	69.3 ± 7.38	69.9	68.3	89.5	68.6	68.6	70.1	0.27	0.35	0.30
BR to WN[y]	150 ± 9.0*a*	120 ± 9.3*b*	147 ± 10.2	125 ± 10.4	134 ± 9.7	159*ab*	136*abc*	129*abc*	120*ac*	164*b*	104*c*	< 0.01	0.16	0.03
Weaning weight	265 ± 3.4*a*	237 ± 3.4*b*	264 ± 4.0*a*	239 ± 4.1*b*	250 ± 4.3*b*	276	251	253	226	265	235	< 0.01	< 0.01	0.91

[z]BRC, Brandon Research Centre, Brandon, MB; WBDC, Western Beef development Centre, Lanigan, SK; SPARC, Semiarid Prairie Agricultural Centre, Swift Current, SK.
[y]Indicates differences between time points; PC, precalving; BR, breeding; WN, weaning.
a − *d* Within rows, different letters are significant at $P < 0.05$.

The nutrient qualities (especially CP and TDN) of annual cereal swaths across the different sites were comparable with the values of barley used for swath grazing in Alberta (McCartney et al. 2004), while the ADF and NDF values for annuals at SPARC were lower than those reported by Kelln et al. (2011). The average CP content of hay fed to the cows in this study was lower than the 14.0% reported by Legesse et al. (2012) for grass–alfalfa hay. Even though the NDF values for hay were similar in both studies, the values of ADF and Ca reported by Legesse et al. (2012) were also greater than the values in the current study. Nevertheless, the forage nutrient qualities for the different calving systems at the different locations were adequate for body requirements of the cows in the current study based on the NRC (2000) nutrient requirements for beef cattle.

The higher TDN values from pastures compared with hay implies that higher energy levels of pastures would support the extra nutrient requirements of lactating cows. Different studies have demonstrated the importance of providing adequate energy levels to beef cows to keep them in good condition pre- and post-partum (Houghton et al. 1990; DeRouen et al. 1994). Available forages in the pastures during the last trimester for EC cows are usually low in protein and energy (Geisert et al. 2008), but the higher energy content of pastures will be more advantageous to LC cows during lactation than to EC cows. Cows in EC continued on hay diet until May (about 2 mo post-calving) before turn-out to pasture grazing, while LC cows had access to the pastures before calving. This agrees with previous studies that calving on pasture during the summer provides an opportunity to match the cow's nutrient requirements with the available forage nutrient supply (Adams et al. 1994, 1996). In addition, because the first 3 mo post-calving is the period of highest energy demand (NRC 2000), this implies that LC cows may more easily meet their energy needs during early lactation than EC cows.

Pregnancy Rate and Calving Rate

Previous studies (Bagley et al. 1987; Pang et al. 1998) observed pregnancy rates similar to the present study. The current study found slightly greater pregnancy rates than Stonehouse et al. (2003), who reported pregnancy rates of 85 and 88%, respectively, for winter and summer calving groups, which implies that the calving season did not influence conception. However, the numerically higher conception rate for summer-calving cows was similar to our observations in the current study. The slightly higher conception rate in the current study compared with the report of Pang et al. (1998) for similar calving systems in Alberta may be attributed to the longer breeding season employed in this study (63 d vs. 42 d). A 63-d breeding season will avail cows with more estrus cycles than a 42-d breeding season, thereby increasing the chances of conception. Deutsher et al. (1991) reported that a shorter breeding season was associated with lower pregnancy rate and higher culling rates.

The calving rates did not match the pregnancy rates, presumably because some cows aborted. This difference could have been larger because some cows calved despite being designated as open cows during pregnancy check. Some cows initially designated as pregnant did not calve (presumably aborted) but the foetuses were not recoverable for post-mortem examination. The calving rates reported in this study were greater than those of Pang et al. (1998), who reported 82 and 83% in EC and LC systems, respectively. Griffin et al. (2010) did not observe any difference in the calving rates of spring- and summer-calving cows. The nuances between the two systems for calving rates, as supported by Pang et al. (1998) and Griffin et al. (2010), may suggest that both systems provided an effective support for foetal development despite varying environmental conditions.

Length of Calving Season and Weaning Rate

The results show that the two systems did not differ in the length of calving season. The length of calving season is important to producers, although some producers may manage the length of the calving season by imposing shorter breeding seasons. Pang et al. (1998) reported a calving span of 53 and 47 d for EC and LC groups, respectively. The lengths of the calving season they reported for both calving groups were shorter than that of the current study, presumably because of the shorter breeding season employed in their study. The calving distribution for EC cows at Lanigan was such that majority calved early in the first year and calved late in subsequent years. The reason behind the skewed distribution is unclear but may be related to animal allocation in that year.

The higher weaning rate of EC cows may reflect lower calf mortality in this system as compared with the LC system. Calf survival to weaning is important to cow-calf producers because a higher percentage of weaned calves commands more income from sales or provides greater options for replacements or both. The results from the current study were contrary to the findings of Bagley et al. (1987), who indicated greater losses in spring-born calves than in those born in the fall. Stonehouse et al. (2003) compared winter (February–April) and summer (June–August) calving in Ontario, Canada, but did not observe any difference between the two systems for calf survival rate and calf weaning rate. In addition, Pang et al. (1998) did not observe any difference between spring and summer calving systems for the weaning rate in Alberta.

Disparate results on calf survival under different production systems may be due to several factors related to genetic and non-genetic factors, especially weather and management (Azzam et al. 1993). The EC has limitations postpartum that may restrict optimum cow-calf performance. Subzero temperatures are common in the prairies, especially in the early spring, which increases the risk of neonatal calf losses from severe frostbite or hypothermia. Furthermore, the wet condition of the calves when born exacerbates the risk of freezing from wind-chill. On the other hand, spring-born calves, being more mature by the fall season, are more likely to survive heavy storms that occur during this period than summer-born calves. Because there were no differences between the two calving systems for most reproductive measures in the current study, EC may be more appealing to producers due to higher weaning rate, but either system could be compromised if extreme weather events occur at the wrong time.

Cow Performance

The BW and body composition have important effects on cow reproductive efficiency and reflect the adequacy of the cow's energy reserves necessary for optimum reproductive performance (Houghton et al. 1990). Our observations on the BW of cows were not consistent with Griffin et al. (2010), who reported greater average BW in spring-calving cows than in the summer-calving cows at pre-calving, pre-breeding and weaning. Their study used the actual BW, while the current study considered the gains or losses in BW between measured time points.

Even though there were no differences between the two groups at pre-calving, the change in BW of cows at breeding agreed with the observations of Griffin et al. (2010) who indicated better performance in summer-calving cows. Also in agreement with the current study, Deutscher et al. (1991) reported greater cow BW loss in early-calving cows (March) than in late-calving cows (April) prior to breeding. Weight loss during the first 3 mo of lactation occurs as a result of negative energy balance in the cows because the energy lost in milk is greater than energy obtained from feed. Because the current study did not measure milk production or energy content of milk, the lower BW loss in LC cows could potentially be due to differences in milk production or pre-partum/post-partum nutrition from the grass pastures or both. The lower BW loss and superior body condition for LC cows was probably due to higher energy diet from grass-pastures compared with the hay fed to EC cows.

Pang et al. (1998) observed slightly greater cow weights at weaning in the EC group, which supported the reports of Deutscher et al. (1991) and Bellido et al. (1981). The periods of weaning in this study were marked by different seasons and different diets, likely influencing their BW. Calves from EC cows were weaned between September and October, while those in LC were weaned between December and January. This implies that the EC group were weighed on pasture or when they had been transferred to graze swathed annuals while LC cows were weighed while receiving hay in the drylot.

The existence of significant interactions for some of the traits (BCS_{pc}, $BCS_{b\text{-}p}$, $BCS_{w\text{-}b}$, rib_{pc}, $rib_{b\text{-}p}$, $rump_{pc}$ and $rump_{w\text{-}b}$) may preclude important information from the current study and would require further studies given that the observed differences were not consistent across all locations. Griffin et al. (2010) did not observe any difference in BCS at weaning between spring-calving and summer-calving cows. From a production standpoint, it is important for the cows to be in better condition at breeding than at weaning because of positive concomitant effects on conception. A system that facilitates greater body recovery and subsequent reproductive efficiency at breeding may be more appealing to producers and confers an advantage to LC cows over EC cows.

Calf Performance

Evaluating the birth and weaning weights of calves would substantiate the level of production efficiency within each system. Our results show that LC supported greater birth BW while EC produced calves with greater weaning BW. In contrast to the results from this study, Griffin et al. (2010) observed no difference between the birth weights of calves born in the spring and summer, while Stonehouse et al. (2003) reported greater birth weight for calves born in the winter than calves born in the summer. Furthermore, our results agreed with Lardy et al. (1998) and Sprott et al. (2001) that EC resulted in heavier calves at fall-weaning. Griffin et al. (2010) reported greater ADG for spring calves from birth to weaning, while Deutscher et al. (1991) did not observe any difference in the weaning weights of calves within EC vs. LC. Although the sale weight of calves at weaning contributes to producer earnings, LC had lower total costs at all locations, while EC had greater total revenue and net revenues (Tanis Sirski, personal communication). This implies that EC would be more preferable to producers wishing to maximize their farmgate earnings; however, a comprehensive economic analysis is needed to confirm this recommendation.

CONCLUSION

This study compared the reproductive and growth performance of cows that were bred to calve in the spring (EC) or summer (LC). There was no difference between the two systems for pregnancy rate, calving rate and proportion of calves born alive. In addition, the average length of calving season between the two systems was not different. The calves in LC had greater birth BW while their dams lost less average BW at breeding; however, the calves in EC had higher weaning rate and higher weaning BW. In addition, the cows in EC had greater BW when the calves were weaned. The capacity for EC to wean more calves at heavier BW than LC suggests the potential of EC to increase cow-calf productivity.

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