2013

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Heifer calving date positively influences calf weaning weights through six parturitions[1]

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ABSTRACT: Longevity and lifetime productivity are important factors influencing profitability for the cow-calf producer. Heifers that conceive earlier in the breeding season will calve earlier in the calving season and have a longer interval to rebreeding. Calves born earlier in the calving season will also be older and heavier at weaning. Longevity data were collected on 2,195 heifers from producers in South Dakota Integrated Resource Management groups. Longevity and weaning weight data were collected on 16,549 individual heifers at the U.S. Meat Animal Research Center (USMARC). Data were limited to heifers that conceived during their first breeding season. Heifers were grouped into 21-d calving periods. Heifers were determined to have left the herd when they were diagnosed not pregnant at the end of the breeding season. Heifers that left the herd for reasons other than reproductive failure were censored from the data. Heifers that calved with their first calf during the first 21-d period of the calving season had increased ($P < 0.01$) longevity compared with heifers that calved in the second 21-d period, or later. Average longevity for South Dakota heifers that calved in the first or later period was 5.1 ± 0.1 and 3.9 ± 0.1 yr, respectively. Average longevity for USMARC heifers that calved in the first, second, or third period was 8.2 ± 0.3, 7.6 ± 0.5, and 7.2 ± 0.1 yr, respectively. Calving period as a heifer influenced ($P < 0.01$) unadjusted weaning BW of the first 6 calves. Estimated postpartum interval to conception as a 2-yr-old cow was greater for females that calved in the first period as heifers but did not differ between heifer calving periods in subsequent calving seasons. In summary, heifers that calved early in the calving season with their first calf had increased longevity and kilograms weaned, compared with heifers that calved later in the calving season.

Key words: fertility, heifer, reproductive longevity

J. Anim. Sci. 2013.91:4486–4491
doi:10.2527/jas2013-6465

[1]Names are necessary to report factually on available data; however, USDA neither guarantees nor warrants the standard of the product, and use of names by USDA implies no approval of the product to the exclusion of others that may also be suitable.

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[3]The authors gratefully acknowledge the assistance of Gordon Hays and the U.S. Meat Animal Research Center cattle crew for care and handling of the cows and collection of data; Lillian Larsen and Darrell Light for management of the database; and Linda Parnell for assistance with manuscript preparation. This research was funded by ARS Current Research Information System number 5438–31000–093–00D, titled "Strategies to Improve Heifer Selection and Heifer Development" (RAC).

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Received March 8, 2013.
Accepted May 29, 2013.

INTRODUCTION

Calving late as a heifer increased the chance of calving late or not calving the next year (Burris and Priode, 1958). Lesmeister et al. (1973) reported a similar trend but indicated that the overall repeatability of a cow staying within their breeding group was low (r = 0.092 to 0.105) and concluded that only moderate improvement could be made by culling cows that calved late in the calving season. This is probably because the length of the postpartum anestrous period decreases as cows calve later in the calving season (Short et al., 1990; Cushman et al., 2007), giving cows that calve late a better opportunity to reinitiate reproductive cycles in time to conceive. Weaning weight was also positively influenced by early calving, because calves had a longer period of growth before the common weaning date (Lesmeister et al., 1973). Funston et al. (2012) reported that heifers born earlier gave birth to lighter calves in their first calving season, but due to the increased age at weaning, these calves had a heavier weaning weight. To our knowledge, no report has ever investigated the influence of calving early as a heifer on calf performance in subsequent years. Therefore, because there was a tendency for cows to remain in calving groups and calving early increased weaning weight, we hypothesized that heifers that calved earlier would remain in the herd longer and would wean heavier calves in their second calving season and beyond.

MATERIALS AND METHODS

The U.S. Meat Animal Research Center (**USMARC**) Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Research Herd

Data were recovered from the USMARC database for the spring calving herd for 1980 through 2000. Data were confined to natural service herds and trimmed to remove heifers from the USMARC Twinner herd and all other heifers that produced a twin at any point during their herd life. Retrospective analysis was stopped with heifers that were born in 2000 because that allowed for the possibility of at least 9 calves to be weaned for all heifers at the time of data analysis. Additionally, this allowed the use of historical data without impinging on heifer development studies that began in 2003. The breeding season began approximately June 1. March-born Angus and Angus-crossbred heifers (n = 16,549) were retained at USMARC as replacement heifers and removed from the data set the first time they failed to produce a calf. For each calving period, only heifers that went to breeding and were not culled for health reasons were included in the analysis. For all calves, birth date, birth weight, gender, and dystocia score (Bennett, 2008) were recorded at birth. For those that survived to weaning, a weaning weight was recorded. For cows, estimated postpartum interval from calving to conception was calculated by subtracting the average USMARC gestation length of 281 d from the calving interval.

Production Herds

Data were recovered from producers that are part of the South Dakota Integrated Resource Management groups from 1982 through 2002. Producers that had at least 10 yr of data (9 calves) on their heifers were included in the database and data were confined to all natural service herds. Available data from all producers included pregnancy determination at the end of the breeding season and calving date. Heifers on producer operations (n = 2,195) were retained by producers as replacement heifers and removed from the data set the first time they failed to produce a calf (diagnosed open at the end of the breeding season). For each calving period, only animals that went to breeding and were retained through pregnancy diagnosis for nonpregnant animals, or through the calving season for pregnant animals were included in the analysis. Heifers were grouped into calving during the first 21 d or after, based on calving data of the first calf.

Statistical Analyses

To examine the influence of first calving date on lifetime productivity, heifers that calved at 2 yr of age were grouped based on calving period (first, second, or third 21-d period for USMARC and first 21-d period or later for production herds) in which they produced their first calf. Survival analysis was performed using the LIFETEST Procedure (SAS Inst. Inc., Cary, NC). Pregnancy rates were analyzed using the GLIMMIX Procedure of SAS with a binomial distribution and a logit link to examine the fixed effect of calving period. Birth weights and weaning weights of all calves that survived until weaning were analyzed using the MIXED Procedure of SAS, with calf gender and calving period as fixed effects, and herd and year as random effects. Julian day of calving and dystocia score were analyzed using the MIXED Procedure of SAS, with calf gender and calving period as fixed effects, and herd and year as random effects.

RESULTS

Survival analysis demonstrated that a significantly greater proportion ($P < 0.01$) of the heifers that calved in

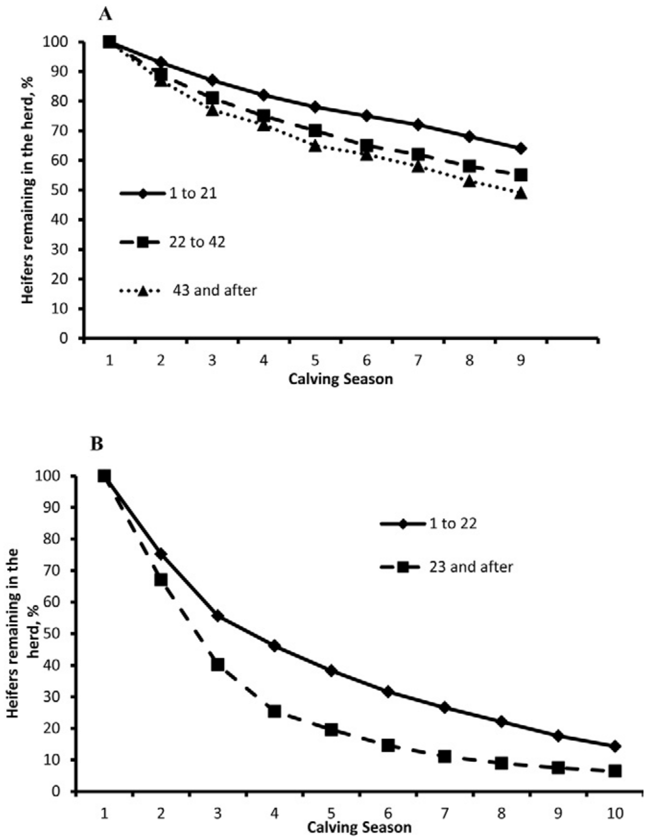

Figure 1. Analysis of the influence of calving period on herd survival from (A) U.S. Meat Animal Research Center (USMARC) and (B) South Dakota Integrated Resource Management groups. (A) Results from Angus and Angus crossbred heifers (n = 16,549) from USMARC. More heifers from the first calving period remained in the herd at 5 yr of age than from the later calving periods ($P < 0.01$); (B) Commercial beef heifers (n = 2,195) on producer operations that were retained by producers as replacement heifers. Heifers that calved during the first 21-d period with their first calf remained in the herd longer than heifers that calved later ($P < 0.01$).

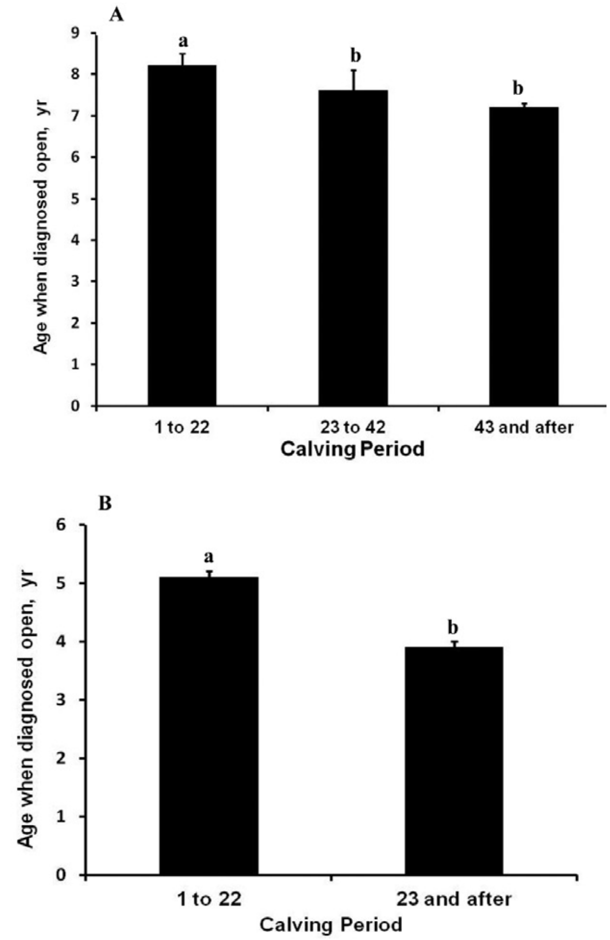

Figure 2. Influence of calving period on average herd life from (A) U.S. Meat Animal Research Center (USMARC) and (B) South Dakota Integrated Resource Management groups. Heifers that calved in the first 21 d of their first calving season had a greater average herd life in both populations ($P < 0.05$). [a,b]Bars with different superscripts are significantly different.

the first 21 d of their first calving season remained in the herd to produce a fifth calf for the USMARC herd (Fig. 1A) and a third calf for the data from South Dakota beef herds (Fig. 1B). This resulted in a greater average herd life for these heifers compared with their contemporary herdmates that calved at a later date ($P < 0.05$; Fig. 2A and 2B).

Heifers that calved during the first 21 d at USMARC were born 2 d earlier than heifers that calved during the second period and 3 d earlier than heifers that calved during the third period ($P < 0.0001$; Table 1). There was no difference in heifer birth weight based on the calving period that they were in during their first calving season; however, heifers that calved in the first period were heaviest when they were weaned ($P < 0.0001$).

By design, heifers that were classified as calving in the first period calved 24 d earlier than those in the second period and 48 d earlier than those in the third period in their first calving season ($P < 0.0001$). For the second through sixth parity, heifers that calved in the first calving period gave birth ~2 to 4 d earlier ($P \leq 0.001$), but there was no difference in the Julian day of calving for the seventh through ninth parity ($P \geq 0.17$). The birth BW of the first calf produced was heavier for those heifers that calved in the third period; however, calf birth BW was heavier for those heifers that calved in the first calving period for the second through seventh parities ($P < 0.0001$). The weaning BW of the first 6 calves born to heifers that calved in the first calving period of their first calving season was greater than those of heifers that calved in the second or third period of their first calving season ($P < 0.05$; Fig. 3).

The first postpartum interval from calving to estimated date of conception was significantly longer for heifers that calved in the first period as compared with those that calved in the second or third period ($P < 0.0001$); however, this difference disappeared by the second postpartum interval ($P \geq 0.26$) and there was no difference in postpartum interval from the second to eighth postpartum interval. There was no difference in average dystocia scores among heifer calving groups for any calving season ($P \geq 0.12$).

Table 1. Influence of calving period on cow performance traits through the first 9 calves from heifers at the U.S. Meat Animal Research Center (USMARC)

	Calving period[1]			
	1	2	3	*P*
Heifers, no.	11,061	4,372	1,116	
Birth date, day of year	93.2 ± 1.8[a]	95.2 ± 1.8[b]	96.9 ± 1.8[c]	<0.0001
Heifer birth BW, kg	38.6 ± 0.4	38.8 ± 0.4	38.5 ± 0.4	0.06
Heifer weaning BW, kg	203.4 ± 3.8[a]	199.3 ± 3.9[b]	195.9 ± 3.9[c]	<0.0001
First calf birth date, day of year	70.5 ± 1.6[a]	93.3 ± 1.6[b]	116.1 ± 1.6[c]	<0.0001
First calf birth BW, kg	38.0 ± 0.8[a]	38.8 ± 0.8[a]	39.0 ± 0.8[b]	<0.0001
First dystocia score[2]	2.90 ± 0.29	2.92 ± 0.29	2.87 ± 0.29	<0.69
First postpartum interval,[3] d	113.4 ± 3.2[a]	92.1 ± 3.2[b]	70.5 ± 3.2[c]	<0.0001
Second pregnancy rate, %	92.6 ± 0.3[a]	87.6 ± 0.5[b]	83.9 ± 1.2[c]	<0.0001
Second calf birth date, day of year	98.0 ± 3.2[a]	99.7 ± 3.2[b]	101.0 ± 3.2[c]	<0.0001
Second calf birth BW, kg	38.8 ± 0.9[a]	38.8 ± 0.9[a]	37.7 ± 0.9[b]	<0.0001
Second dystocia score	1.27 ± 0.14	1.28 ± 0.14	1.24 ± 0.14	0.36
Second postpartum interval, d	82.8 ± 2.6	82.5 ± 2.6	83.9 ± 2.7	0.26
Third pregnancy rate, %	92.7 ± 0.3[a]	90.4 ± 0.5[b]	88.4 ± 1.1[c]	<0.0001
Third calf birth date, day of year	97.6 ± 2.6[a]	99.3 ± 2.6[b]	101.5 ± 2.7[c]	<0.0001
Third calf birth BW, kg	39.6 ± 0.8[a]	39.3 ± 0.8[b]	38.9 ± 0.8[b]	0.002
Third dystocia score	1.12 ± 0.08	1.12 ± 0.07	1.11 ± 0.08	0.72
Third postpartum interval, d	85.3 ± 3.3	85.3 ± 3.3	85.8 ± 3.4	0.84
Fourth pregnancy rate, %	93.7 ± 0.3[a]	91.5 ± 0.5[b]	91.4 ± 1.0[b]	<0.0001
Fourth calf birth date, day of year	98.5 ± 3.0[a]	99.8 ± 3.0[b]	102.4 ± 3.0[c]	<0.0001
Fourth calf birth BW, kg	41.0 ± 1.0[a]	40.9 ± 1.0[a]	40.3 ± 1.0[b]	0.05
Fourth dystocia score	1.12 ± 0.08	1.09 ± 0.08	1.09 ± 0.08	0.12
Fourth postpartum interval, d	81.1 ± 2.9	81.4 ± 2.9	81.6 ± 3.0	0.84
Fifth pregnancy rate, %	94.4 ± 0.3[a]	91.7 ± 0.6[b]	88.8 ± 1.3[c]	<0.0001
Fifth calf birth date, day of year	94.8 ± 2.8[a]	96.5 ± 2.8[b]	99.5 ± 2.8[c]	<0.0001
Fifth calf birth BW, kg	43.7 ± 1.0[a]	43.7 ± 1.0[a]	42.9 ± 1.0[b]	0.01
Fifth dystocia score	1.04 ± 0.06	1.04 ± 0.06	1.02 ± 0.07	0.46
Fifth postpartum interval, d	81.9 ± 3.0	81.7 ± 3.1	81.8 ± 3.2	0.93
Sixth pregnancy rate, %	94.3 ± 0.3[a]	92.0 ± 0.6[b]	92.8 ± 1.2[ab]	0.002
Sixth calf birth date, day of year	95.2 ± 2.8[a]	96.6 ± 2.8[b]	97.9 ± 2.9[b]	0.001
Sixth calf birth BW, kg	41.9 ± 0.9[a]	41.5 ± 0.9[b]	40.8 ± 0.9[c]	0.002
Sixth dystocia score	1.08 ± 0.07	1.09 ± 0.07	1.06 ± 0.07	0.52
Sixth postpartum interval, d	83.9 ± 3.3[a]	82.8 ± 3.4[a]	79.9 ± 3.5[c]	0.009
Seventh pregnancy rate, %	93.7 ± 0.4	93.1 ± 0.7	93.3 ± 1.3	0.69
Seventh calf birth date, day of year	96.2 ± 3.0	96.9 ± 3.0	95.1 ± 3.1	0.17
Seventh calf birth BW, kg	39.8 ± 1.1[a]	39.2 ± 1.1[b]	38.7 ± 1.1[b]	0.002
Seventh dystocia score	1.17 ± 0.09	1.12 ± 0.09	1.19 ± 0.09	0.06
Seventh postpartum interval, d	83.1 ± 3.5	83.7 ± 3.6	85.4 ± 3.8	0.38
Eighth pregnancy rate, %	92.3 ± 0.5[a]	92.2 ± 0.9[a]	86.8 ± 2.0[b]	0.006
Eighth calf birth date, day of year	97.7 ± 3.1	98.6 ± 3.1	98.3 ± 3.3	0.40
Eighth calf birth BW, kg	41.1 ± 1.0	40.9 ± 1.0	40.5 ± 1.1	0.32
Eighth dystocia score	1.15 ± 0.07	1.13 ± 0.07	1.15 ± 0.07	0.72
Eighth postpartum interval, d	87.5 ± 2.9	88.5 ± 3.0	87.7 ± 3.6	0.71
Ninth pregnancy rate, %	92.6 ± 0.6	90.4 ± 1.1	91.0 ± 2.1	0.17
Ninth calf birth date, day of year	100.7 ± 2.3	102.6 ± 2.7	101.6 ± 3.0	0.10
Ninth calf birth BW, kg	41.5 ± 0.8	41.3 ± 0.8	41.3 ± 0.9	0.72
Ninth dystocia score	1.07 ± 0.06	1.05 ± 0.06	1.06 ± 0.07	0.69

[a–c]Within a row means with different superscripts are different ($P < 0.05$).

[1]1 = heifers that gave birth on d 1 to 21 of their first calving season, 2 = heifers that gave birth on d 23 to 42 of their first calving season, 3 = heifers that gave birth on or after d 43 of their first calving season at USMARC.

[2]Scoring system 1 to 8: 1 = no assistance; 2 = little difficulty, assistance given by hand; 3 = little difficulty, mechanical pull; 4 = slight difficulty, mechanical pull; 5 = moderate mechanical pull; 6 = hard mechanical pull; 7 = Caesarian section; 8 = abnormal presentation (Bennett, 2008).

[3]Estimated postpartum interval from calving to conception based on consecutive calving dates and assuming a 281-d gestation length.

DISCUSSION

According to a review by Patterson et al. (1992), heifers need to calve by 24 mo of age to achieve maximum lifetime productivity and heifers that lose a pregnancy or conceive late in the breeding season are likely to not have enough time to rebreed during a defined breeding season. Furthermore, any cow that misses a single calving is not likely to recover the lost revenue of that missed calf (Mathews and Short, 2001) and a heifer should wean 3 to 5 calves to pay for her development costs (Clark et al., 2005). Longevity of a beef female is very important to the sustainability and profitability of any beef operation. The present study furthers previous research, demonstrating that heifers that calve early tend to remain in those calving groups throughout their life and wean a heavier calf in their first calving season (Burris and Priode, 1958; Lesmeister et al., 1973), by demonstrating greater herd survival for those heifers that calve early and an increase in calf weaning weights through the first 6 parturitions for those heifers. In total, heifers in the earliest calving group had an increase in weaning weight that amounted to the production of an extra calf during their lifetime. This represents a large financial advantage for the cow-calf producer and demonstrates why it is important for cow-calf producers to ensure that their replacement heifers conceive as early as possible.

These data indicate that producers who can afford to breed extra heifers should do so, providing themselves the opportunity to pick as replacements heifers that conceived earliest by estimating fetal age at pregnancy diagnosis (Lamb et al., 2003). Heifers that conceived later as 2-yr-old cows could be sold to other producers with a later breeding season. However, the question remains whether moving those heifers to a different contemporary group would improve their subsequent performance. This seems most likely, given their first postpartum interval to breeding would be increased. However, if these heifers are actually reproductively insufficient, then they might not perform any better in the new management group. Although the idea of selling heifers that conceived later as yearlings is not novel, to our knowledge there has been no controlled study to examine how these heifers perform relative to their new management groups. Such a study would aid in dissecting the mechanisms associated with decreased herd life of heifers that calve late as 2-yr-old cows.

A second, but similar, strategy would be to focus on the youngest heifers before they go to breeding. Funston et al. (2012) reported that these heifers were at greater risk to conceive later in their first breeding season or fail to be pregnant at pregnancy diagnosis. Perhaps, these are the heifers to target for ovulation induction protocols at the start of their first breeding season to attempt to induce them to conceive earlier. However, this is another place where the long-term ramifications are unclear, because no one has

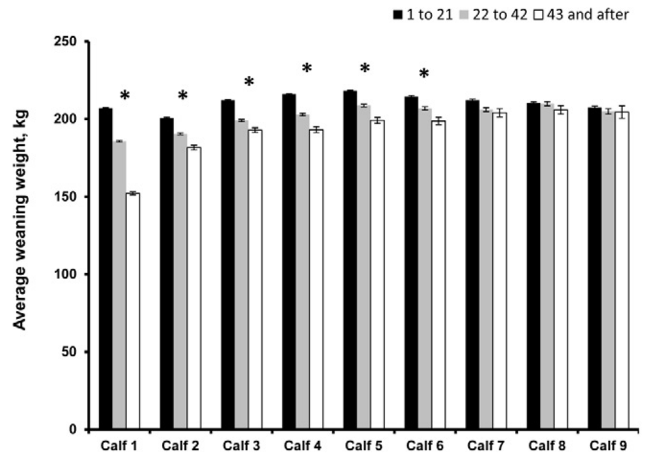

Figure 3. Calf weaning weights based on heifer calving period for the U.S. Meat Animal Research Center (USMARC) cows. Heifers that calved in the first 21 d of their first calving season weaned a heavier calf in each of their first 6 calving seasons (*$P < 0.05$).

ever examined how these heifers perform in subsequent calving seasons if they conceive early to an ovulation induction protocol during their first breeding season. Most likely, those that respond positively to an ovulation induction protocol would be the younger heifers that would have conceived and stayed in the herd anyway. If this is true, then the use of an ovulation induction protocol still helps to identify the most reproductively sound young heifers and these protocols would aid producers who need to use their younger replacement heifers to maintain or increase herd size.

It is clear from these data that cows are not staying completely within their calving periods. If they were, the difference in Julian calving day among the groups would be >2 to 3 d for the second through sixth calf. The estimated postpartum interval from calving to conception was greater in the first postpartum period for those heifers that calved in the first period, but this is a combination of experimental design and management, because heifers were grouped by calving date and heifers were bred to calve earlier than mature cows, artificially extending the first postpartum interval to breeding of heifers that calved in the earliest group.

As cows, their estimated postpartum interval did not differ due to heifer calving group and averaged ~81 to 83 d. In beef cattle, prolonged postpartum intervals can decrease the proportion of cows that are cycling at the start of the breeding season and thereby decrease pregnancy rates and pounds of calf weaned per cow exposed during a breeding season. Postpartum interval length is influenced by several factors, including suckling, nutrition, age, dystocia, genetic variation, stress, and disease (Short et al., 1990; Yavas and Walton, 2000). Postpartum interval to first behavioral estrus decreases as cows calve later in the calving season and varies with breed (Short et al., 1990; Cushman et al., 2007), but averages ~62 d (Cushman et al., 2007). Therefore, the majority of these cows had the opportunity to ovulate at least 1 time before conception, whether they had a short estrous cycle or an estrous cycle of normal length at first ovulation.

Although some influence of postpartum interval on fertility cannot be ignored because some heifers that calved very late might not have had the opportunity to initiate estrous cycles before the end of the next breeding season, it does seem likely that other factors contributed to the decreased fertility observed in heifers that calved late in the present study. Warnick and Hansen (2010) reported that cows that failed to conceive in 1 or 2 previous seasons did not differ in ovulation rate when compared with cows that had never failed to conceive, but they had greater early embryonic loss. Similarly, Cushman et al. (2013) reported that cows that left the production herd early were older by ~40 d at first calving than contemporary fertile herdmates that had always produced a calf. There was no increase in anovulation in the low fertility group in this study either. Thus, there is a good possibility that other factors besides postpartum return to estrus contributed to decreased fertility in late-calving heifers. If this is true, then moving late-bred heifers to a different management group will not improve their performance in subsequent years.

Selection at first pregnancy diagnosis has advantages over selection on the basis of age of the heifer (Funston et al., 2012). The first advantage is that the majority of replacement heifers would produce at least 1 calf, given a 2% pregnancy loss between pregnancy diagnosis and calving. Although this is not enough to recoup her development costs, it is better than a replacement heifer that does not produce a calf, a risk that still exists if heifers are chosen on age or BW alone. Although there appears to be inherent fertility based on calving early in the first calving season, not all of this is captured simply by selecting the oldest heifers as replacements, as suggested by Funston et al. (2012). Minick Bormann and Wilson (2010) reported that age at first calving had a greater heritability than calving day (0.28 vs. 0.07), but that it was not a good indicator of inherent fertility. In general, heifers that are young at first calving are born to heifers (or cows) that were older at first calving. This is reflected in the decreased difference in Julian day of calving after the first calving season. In the present study, the advantage in Julian day of calving decreased to only ~2 to 3 d in the second calving season. When Funston et al. (2012) grouped heifers based on their own birth period, the advantage for Julian day of calving for the calves born in the first calving period was only 5 to 7 d. Thus, it appears that more than an advanced age at first calving is contributing to the improved fertility associated with calving early as a heifer and selecting a replacement heifer based on the date she becomes pregnant is better than selecting her based on age.

Implications

According to the 2007 to 2008 National Animal Health Monitoring System survey, the greatest percentage of cows culled from the herd were for pregnancy status (33.0%). Furthermore, 15.6% of animals culled were <5 yr of age. Females culled from a herd before producing 3 to 5 calves decrease profitability and sustainability of the operation. By breeding more replacement heifers than required, cow-calf producers can choose those that conceived earliest at pregnancy diagnosis. By doing this, they should be able to increase the proportion of heifers that wean enough calves to pay for their development costs. In addition, the increased weaning weights during the first 6 seasons will increase the profit margin for the operation.

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