Journal of Animal Science, 2023, **101**, 1–7
https://doi.org/10.1093/jas/skad008
Advance access publication 7 January 2023
Animal Models

Impact of age at first calving on performance traits in Irish beef herds

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Abstract

Reducing age at first calving (**AFC**) has been a challenge in beef herds. There is anecdotal evidence that herd owners choose to calve heifers older because of the perceived consequences of calving heifers at 24 mo of age compared to 36 mo on performance traits in beef herds. The objective of this study was to estimate the association of calving heifers at younger ages on subsequent performance traits, calving interval, longevity, cow weight, dystocia, and progeny weaning weight for parities 1 to 5. Available to the study after data edits were 219,818 calving interval records, 219,818 longevity records, 118,504 cow live-weight records, 230,998 dystocia records, and 230,998 weaning weight records. Linear mixed models were used to quantify performance of each trait in AFC groups for each parity. As parity increased, there was a favorable reduction in calving interval and dystocia ($P < 0.001$), while the likelihood of cows surviving reduced ($P < 0.001$). Both cow live weight and progeny weaning weight increased as parity increased. Age at first calving only had a significant association with dystocia within parity 1 ($P < 0.001$), where older heifers at first calving subsequently had lower risk of calving. Calving interval for parity 1 cows was observed to be longer by 6 d in cows that calved for the first time at 33 to 36 mo compared to cows calved for the first time at 22 to 24 mo ($P < 0.001$). No statistical difference was observed for longevity between cows with an AFC of 22 to 24 mo compared to cows with an AFC of 33 to 36 mo ($P > 0.05$). Cows that calved at a younger age did wean lighter calves for their first three lactations ($P < 0.01$) but had no association with weaning weight for parity 4 and 5 cows ($P > 0.05$). Cows with a lower AFC were lighter for parity 1 to 4 ($P < 0.001$); at parity 5, AFC had no association with cow live weight ($P > 0.05$). The performance of mature cows for calving interval, longevity, calving difficulty, cow live weight, and weaning weight was not impacted by AFC. In conclusion, calving cows for the first time at younger ages do pose risks and associated performance loss but this risk and loss should be minimized by good management.

Lay Summary

Reducing the age at first calving (**AFC**) in beef cows is known to be economically and environmentally beneficial for beef herds. The age of heifers at first calving is influenced by genetics and management. Additionally, beef herd owners choose to delay the breeding of young heifers because of the anecdotal perception that there is a higher risk of calving difficulty and potential negative consequences on lifetime performance of cows that calve at a younger age. This study aimed to estimate the potential risks and consequences of reducing AFC on beef herds which is known to economically beneficial. It was observed that cows that calved at younger ages were more likely to receive assistance at calving at their first calving. This negative consequence could be negated by good management and breeding decisions. In addition, younger calving cows weaned lighter calves for their first three lactations and had lighter cow live weights for their first four lactations. Overall, the impact of AFC was biologically small on key performance traits in beef herds. Results from this study should provide confidence to beef herd owners to calve cows for the first time at 24 mo of age.

Keywords: cattle, dystocia, fertility, longevity, weight

Abbreviations: AFC, age at first calving; CG, contemporary group; PTA, predicted transmitting ability

Introduction

Improving age at first calving (**AFC**) on beef herds improves economic and environmental sustainability of beef herds (Day and Nogueira, 2013; Gerber et al., 2015; Quinton et al., 2018). In a study of 7,655 Blonde d'Aquitaine cows, López-Paredes et al. (2018) documented that there was almost €28 extra profit per slaughtered calf per year for heifers calving between 20 to 27 mo compared to heifers at 40 to 48 mo. Although it is more profitable for beef herds to reduce AFC to 24 mo; beef heifers were on average over 30 mo of age at calving in studies in Ireland (Mchugh et al., 2014; Twomey et al., 2020), United Kingdom (Gates et al., 2013), and Czech Republic (Brzáková et al., 2020). The onset of puberty and fertility of heifers is influenced by both nutrition and genetics, which determine AFC within individual animals (Day and Nogueira, 2013). Genetic improvements have been documented in Irish beef cows for AFC; improved 0.5 genetic standard deviations over 10 yr which equates to 21 d (Twomey et al., 2020). Although there are improvements in genetics and nutrition of beef heifers, the older AFC in beef heifers is also caused by herd owners deciding to calve heifers at older ages due to the perceived consequences of calving heifers at 24 mo (Hickson et al., 2010; Titterington et al., 2015). Herd owners choose to calve heifers older than 24 mo to reduce the risk of calving difficulty and cows underachieving their full potential

Received August 29, 2022 Accepted January 11, 2023.

(Titterington et al., 2015). The objective of this study was to determine the association between AFC for dystocia, calving interval, longevity, weaning weight, and mature cow live weight for parity 1 to 5.

Materials and Methods

Ancestry and breed composition (i.e., estimated using pedigree) information, weight records, calving records (i.e., calving dates, calving difficulty scores) as well as predicted transmitting ability (**PTA**) for a range of traits (i.e., carcass weight, calving interval, longevity, maternal weaning weight, direct calving difficulty, and maternal calving difficulty) were available from the national database managed by the Irish Cattle Breeding Federation (www.icbf.com) on individual animals. As part of a national scheme, 27,912 beef herds were enrolled to collect weights on both dam and calf pairings in 2020 and 2021, inclusive (DAFM, 2022). For the present study, data from cows calving from January 2016 to June 2021, inclusive, on these 27,912 beef herds were retained. There were 2,158,542 weight records, 4,433,099 calving records, and 3,953,255 calving difficulty scores available across 1,298,977 number of cows.

Live weight

All live-weight records were collected on beef farms in 2020 and 2021. Live-weight records were divided into weaning weight and cow weight. Weaning weight was defined as animals measured between ≥150 d and ≤ 250 d of age. Cow live weight was defined as a weight recorded for a female between ≥60 d and ≤365 d since the date of calving. There were 539,350 weaning weights and 1,079,279 cow weights retained

Calving difficulty

Irish herd owners subjectively score calving difficulty on a linear scale of 1 to 4 at calving, where 1 represents no calving assistance, 2 represents slight assistance, 3 represents considerable assistance, and 4 represents veterinary assistance as described in Twomey et al. (2020). To ensure there was variability in calving records within herds, data from herd-years where >95% of animals were recorded as having the same calving difficulty score were removed; 2,020,172 calving difficulty records from 868,870 cows were retained. For the purpose of the present study, calving difficulty scores were collapsed into a binary trait, calving dystocia (score 1 and 2 combined vs. 3 and 4 combined).

Fertility traits

Phenotypes for calving interval and longevity were defined similar to those described in detail by Berry and Evans (2014). Calving interval was defined as the number of days between consecutive calving events. Calving interval records <300 or >800 d were not considered further. Cow longevity was defined as binary, whether or not a cow successfully reached the next lactation. A cow was deemed to survive a parity if she had a subsequent calving date within 800 d of her previous calving date. Any cow did not have a subsequent calving date and was recorded as either been slaughtered or died, she was deemed to have not survived that parity.

Classification of AFC

Age at first calving was retained for all cows. Only cows that had their first calf between the age of 22 and 46 mo of age were considered further. Distribution of AFC is in Figure 1. Cows were classified into five groups based on their age at their first calving: 22 to 24 mo, 25 to 27 mo, 30 to 33 mo, 34 to 37 mo, and 37 to 46 mo.

Data edits

For the present study, dams with a parity greater than 5 were not considered further. Animals with an unknown sire or dam were removed. Animals were allocated to a contemporary group (**CG**) for subsequent use in the statistical model. Herd-year-season CGs were generated for each trait separately for the cows and their progeny using an algorithm described in detail by Berry and Evans (2014). For the present study, CGs for calving interval, longevity, calving difficulty traits, and cow weight traits were grouped based on calving date and their herd of calving. The CGs for weaning weight animals were grouped based on date of birth and their birth herd. Only animals within CGs of at least five animals were retained. Number of records remaining for each of the traits is presented in Table 1.

Data analysis

The association between AFC with each of the traits of interest was quantified using linear mixed models in ASReml 4.2 (Gilmour et al., 2021). The model fitted for each trait was:

$$Y = AFC * Parity + Het + Rec + Sex + PTA_{CI} + CG_{calve} + e$$

$$X = AFC * Parity + Het + Rec + parity + DSC + PTA_{lw} + CG_{calve} + e$$

$$W = AFC * Parity + Het + Rec + Het\_calf + Rec\_calf + Sex + Age + PTA_{cwt} + PTA_{mwt} + CG_{birth} + e$$

$$Logit\{P(Z = 1|X)\} = AFC * Parity + Het + Rec + Sex + PTA_{sur} + CG_{calve} + e$$

$$Logit\{P(V = 1|X)\} = AFC * Parity + Het + Rec + Het\_calf + Rec\_calf + Sex + Age + PTA_{mcd} + PTA_{dcd} + CG_{calve} + e$$

where Y is the dependent variable for calving interval; X is the dependent variable for cow weight; W is the dependent

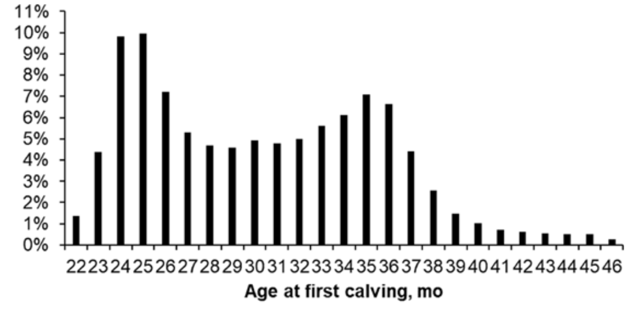

Figure 1. Distribution of age at first calving of beef cows.

Table 1. Number of dams, records, and contemporary groups (CGs) as well as mean and standard deviation for each trait

Trait	Number of dams	Number of records	Number of CG	Mean	Standard deviation
Weaning weight (kg)	161,366	213,280	24,924	280	55
Cow live weight (kg)	98,471	118,504	8,280	641	92
Calving interval (d)	159,516	219,818	14,455	380	61
Calving difficulty (1/0)	166,780	230,998	14,592	0.04	0.19
Longevity (1/0)	194,308	274,986	17,319	0.87	0.34

variable for weaning weight; $Logit\{P(Z=1|X)\}$ is the logit of the odds of a positive outcome for longevity; $Logit\{P(V=1|X)\}$ is the logit of the odds of a dystocia; *AFC* is the fixed effect for AFC class (i.e., 22 to 24 mo, 25 to 27 mo, 28 to 30 mo, 31 to 33 mo, 34 to 37 mo, 38 to 46 mo); *Het* is the fixed effect of a general heterosis coefficient of the dam (i.e., 0.00, 0.01 to 0.10, 0.11 to 0.20,…, 0.91 to 0.99, 1.00); *Rec* is the fixed effect of a general recombination loss coefficient of the cow (i.e., 0.000, 0.001 to 0.050, 0.051 to 0.100,…, 0.451 to 0.499, 0.500, >0.500); *sex* is the gender of the calf; PTA_{CI} is the fixed effect of a PTA of the dam for calving interval; CG_{calve} is the fixed effect for herd-year-season of calving; *DSC* is the fixed effect of days since calving in months; PTA_{lw} is the fixed effect of the PTA of the dam for cow live weight; *Het_calf* is the fixed effect of a general heterosis coefficient of the calf (i.e., 0.00, 0.01 to 0.10, 0.11 to 0.20,…, 0.91 to 0.99, 1.00); *Rec_calf* is the fixed effect of a general recombination loss coefficient of the calf (i.e., 0.000, 0.001 to 0.050, 0.051 to 0.100,…, 0.451 to 0.499, 0.500, >0.500); PTA_{cwt} is the fixed effect of the PTA of carcass weight of the calf; PTA_{mwt} is the fixed effect of the PTA for maternal weaning weight of the dam; CG_{birth} is the fixed effect for herd-year-season of birth for the calf; PTA_{sur} is the fixed effect of the PTA of the dam for longevity; PTA_{mcd} is the fixed effect of the PTA of the dam for maternal calving difficulty; PTA_{dcd} is the fixed effect of the PTA of the calf for direct calving difficulty; *e* is the random residual effect, where $e \sim N(0, I\sigma^2 e)$ with $\sigma^2 e$ is the residual variance.

Results

Weaning weight

For weaning weight, the linear regression coefficient of carcass weight PTA and maternal weaning weight PTA was 1.7 and 2.5, respectively ($P < 0.001$). Weaning weight of progeny increased as dam parity increased from parity 1 to 4 ($P < 0.01$), although the difference between parities reduced as AFC increased (Figure 2). For dams with an AFC between 22 and 24 mo, parity 2, 3, 4, and 5 cows produced progeny 10, 19, 23, and 24 kg heavier at weaning compared to parity 1 cows. Age at first calving was significantly associated with weaning weight up to parity 3 ($P < 0.01$); weaning weight was greater from cow with an older AFC (Figure 2). There was no statistical significant difference between cows with an AFC of 22 to 24 mo and 25 to 28 mo or between cows with an AFC of 33 to 36 mo and 37 to 47 mo within each of the parities ($P > 0.05$). Cows with an AFC of 34 to 36 mo weaned calves 12, 6, and 3 kg heavier than cows with an AFC of 22 to 24 mo, for parity 1, 2, and 3 cows, respectively.

Cow live weight

The PTA for cow live weight had a linear regression coefficient of 2.0 kg with cow live weight ($P < 0.001$). There were statistical significant differences between dam weights between each of the parities for all AFC categories ($P < 0.01$); live weight increased in older parity cows (Figure 3). Cows with an AFC of 22 to 24 mo, parities 2, 3, 4, and 5 cows were 55, 102, 129, and 145 kg heavier than parity 1 cows, respectively. Age at first calving had a statistical significant association on dam weight for parities 1, 2, 3, and 4 ($P < 0.01$; Figure 3); AFC had no statistical significant association on the dam weight for parity 5 cows ($P > 0.05$). The difference between 22 to 24 mo AFC and 33 to 36 mo AFC was 60 kg, 42 kg, 19 kg, and 7 kg for parity 1, 2, 3, and 4 cows, respectively.

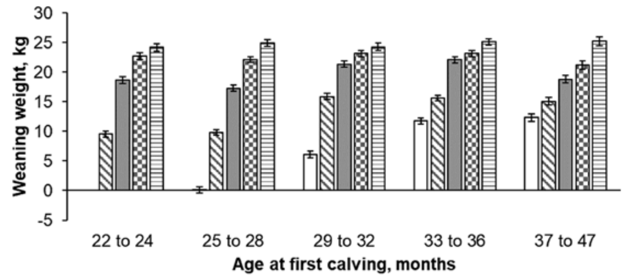

Figure 2. Associations between the interaction for age at first calving (AFC) and parity of the dam with progeny weaning weight (and 1 SE at each side); parities include first (no fill), second (diagonal gray striped), third (solid gray fill), fourth (checker gray and white), and fifth (horizontal gray striped). First parity cows with an AFC of 22 to 24 are the referent animal (not shown).

Calving interval

The linear association between calving interval and the PTA for calving interval was 2.2 d. The calving interval for parity 1 cows was significantly longer than parity 2, 3, 4, and 5, irrespective of AFC ($P < 0.001$). For cows with an AFC of 22 to 24 mo, calving interval was 6 d longer for parity 1 cows compared to parity 2 cows and parity 1 cows were 8 d longer than parity 3, 4, and 5 (Figure 4). There was a statistically significant difference between AFC for calving interval for parity 1 cows ($P < 0.001$); cows with an AFC of 29 to 32 mo and 33 to 36 mo had a calving interval of 5 to 7 d longer than cows with an AFC of 22 to 24, 25 to 28, and 37 to 47 mo. Parity 5 cows with an AFC of 22 to 24 had a 5-d shorter calving interval than parity 5 cows with an AFC of 37 to 47 mo ($P < 0.05$).

Longevity

The increase in longevity PTA by 1 unit improves odds of cows reaching the next parity by 1.47 (95% CI: 1.44 to 1.50) odds. The likelihood of a cow reaching the next lactation

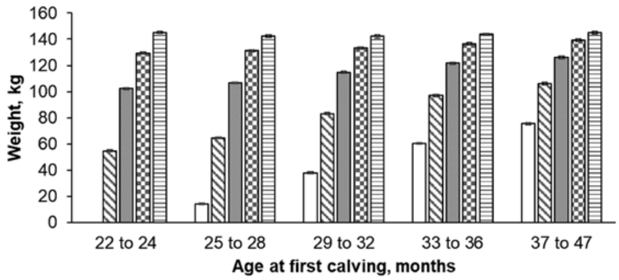

Figure 3. Associations between the interaction for age at first calving (AFC) and parity of the dam with dam live weight (and 1 SE at each side); parities include first (no fill), second (diagonal gray striped), third (solid gray fill), fourth (checker gray and white), and fifth (horizontal gray striped). First parity cows with an AFC of 22 to 24 are the referent animal (not shown).

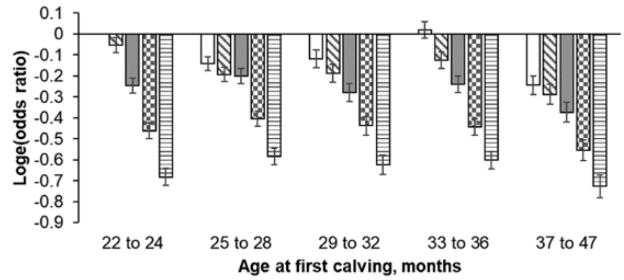

Figure 5. Associations between the interaction for age at first calving (AFC) and parity of the dam with the $\log_e$ of the odds ratio of dam's longevity (and 1 SE at each side); parities include first (no fill), second (diagonal gray striped), third (solid gray fill), fourth (checker gray and white), and fifth (horizontal gray striped). First parity cows with an AFC of 22 to 24 are the referent animal (not shown).

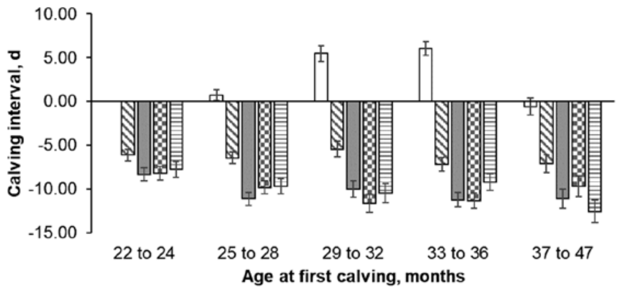

Figure 4. Associations between the interaction for age at first calving (AFC) and parity of the dam with calving interval (and 1 SE at each side); parities include first (no fill), second (diagonal gray striped), third (solid gray fill), fourth (checker gray and white), and fifth (horizontal gray striped). First parity cows with an AFC of 22 to 24 are the referent animal (not shown).

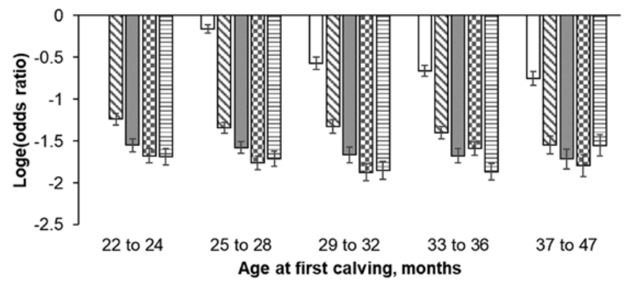

Figure 6. Associations between the interaction for age at first calving (AFC) and parity of the dam with the $\log_e$ of the odds ratio of dystocia (and 1 SE at each side); parities include first (no fill), second (diagonal gray striped), third (solid gray fill), fourth (checker gray and white), and fifth (horizontal gray striped). First parity cows with an AFC of 22 to 24 are the referent animal (not shown).

reduced in older parity cows, irrespective of AFC ($P < 0.001$; Figure 5). For cows with an AFC of 22 to 24 mo, the odds of a cow reaching the next lactation for parities 3, 4, and 5 ranged from 0.51 to 0.78 (95% CI: 0.47 to 0.84) times odds of a parity 1 cow. Cows with an older AFC tended to be less likely to reach lactation 2, although no difference was observed between cows with an AFC of 22 to 24 and 33 to 36 mo (Figure 5). Cows with an AFC of 25 to 47 mo ranged from 0.78 to 1.02 (95% CI: 0.72 to 1.09) times the odds of cows with an AFC of 22 to 24 mo.

Calving difficulty

The increase in the direct calving difficulty PTA by 1 unit increases the odds of a cow having dystocia by 1.46 (95% CI: 0.45 to 1.48) odds. Increasing the maternal calving difficulty PTA by 1 unit increased the odds of a cow having dystocia by 1.32 (95% CI: 1.31 to 1.34) odds. The odds of a recorded calving difficulty were significantly lower for parity 2, 3, 4, and 5 cows compared to parity 1 cows ($P < 0.001$); there was no statistical significant difference for calving difficulty between parities 3, 4, and 5 ($P > 0.05$; Figure 6). For cows with an AFC of 22 to 24 mo, the odds of a recorded calving difficulty for parities 2, 3, 4, and 5 ranged from 0.18 to 0.29 (95% CI: 0.15 to 0.33) times odds of a parity 1 cow. AFC had a statistical significant association with calving difficulty for only parity 1 cows ($P < 0.001$). The odds of parity 1 cows with an AFC of 29 to 47 mo were 0.47 to 0.56 (95% CI: 0.40 to 0.65) times the odds of parity 1 cows with an AFC of 22 to 24 mo.

Discussion

Although there is large economic and environmental benefit of reducing AFC in beef herds, due to lower feed costs and increased lifetime productivity (Day and Nogueira, 2013; López-Paredes et al., 2018), beef heifers are still relatively old at first calving in some countries (Gates et al., 2013; Brzáková et al., 2020; Twomey et al., 2020). The older AFC in beef heifers is likely caused by herd owners deciding to calve heifers at older ages due to the perceived consequences of younger AFC. This study was to analyze the actual consequence of AFC on subsequent performance of beef cattle.

Factors determining AFC on farms

To achieve a target AFC of 22 to 24 mo of age, early nutrition and genetics influence the age beef heifers reach puberty (Heslin et al., 2020). Day and Nogueira (2013) identified that nutritional management postweaning in beef herds is vital to achieve early puberty to attain 60% to 65% of the body weight at breeding. In addition to management, AFC is low to moderate heritability in beef cows ranging from 10% to 27% (Heise et al., 2018; Brzáková et al., 2020; Shin et al., 2021). Although improvements in management on beef herds (Martinez Cillero et al., 2018; Chavas et al., 2022) and genetic merit of AFC in beef heifers (de Rezende et al., 2020; Twomey et al., 2020) have been observed, the AFC of beef cows is still higher than 24 mo in some beef herds.

The selection of a heifer to be inseminated is multifactorial. In a survey of French dairy farms, the decision to inseminate heifers was determined firstly by the weight of the heifer and secondly was when heifers reached specific age (Le Cozler et al., 2012). In a survey by Hickson et al. (2010), New Zealand beef farmers calving at 3 yr were concerned about subsequent performance of heifers if calved at 2 yr of age. Furthermore, anecdotal evidence suggests that farmers are concerned that heifers are not mature enough at 15 mo to be inseminated and may impede heifer growth, causing dystocia, thus making it more difficult to get the resulting primiparous cows pregnant again (Titterington et al., 2015).

Minimizing dystocia

The perceived increase in risk of calving is a reason why many farmers choose to calve heifers at older ages. The present study did observe a lower probability of dystocia with an increasing AFC for parity 1; it did not have any associated consequences on dystocia in subsequent lactations. Contrary, in dairy cows, higher dystocia and calving assistance were more likely when AFC was >24 mo (Berry et al., 2009; Atashi et al., 2021). Conflicting phenotypic associations in literature between AFC and calving difficulty are likely caused by the antagonistic relationship between maternal and direct calving difficulty. Genetic correlations between AFC and direct calving difficulty were reported to be positive 0.27 to 0.30 in beef and dairy cows (López-Paredes et al., 2018; Stefani et al., 2021), although a negative relationship was observed between maternal calving difficulty and AFC (−0.39) in beef cows (López-Paredes et al., 2018). This suggests that heifers genetically predisposed to younger AFC are genetically predisposed to produce smaller and more easily born calves but are more likely to have calving difficulties associated due to maternal effects (i.e., smaller body size, narrow pelvic area). In addition, heifers with an older AFC are likely to have a greater levels of fat deposition and greater body conditions scores which are associated to dystocia (Bahrami-Yekdangi et al., 2022). Younger AFC will cause higher cost on beef herds due to the increased calving assistance required (Phocas et al., 1998; Amer et al., 2001), due to the increased labor and veterinary costs, as well as the impact on subsequent lactations and higher risk of mortality (Ring et al., 2018). Nevertheless, achieving heifers calving at 22 to 24 mo will still improve lifetime productivity of beef animals (López-Paredes et al., 2018). The risk of calving difficulties in heifers calving at 22 to 24 mo can be minimized by ensuring heifers reach target growth rates with good nutritional management (Day and Nogueira, 2013) and also use sires known to be easy calving as well as selecting heifers with a good maternal calving difficulty, in conjunction with selecting for AFC; maternal breeding objectives aim to improve both AFC and maternal calving difficulty simultaneously (Roughsedge et al., 2005; Twomey et al., 2020). It is also worth noting that heifers were more likely to have a calving difficulty at their first calving irrespective of their AFC. Thus, delaying AFC does not remove risk of calving difficulty; it will only minimize the risk.

Impact on subsequent animal performance

Although AFC is economically important to cow-calf beef systems (López-Paredes et al., 2018; Taylor et al., 2018), there is a potential concern that there are negative implications on other economically important traits in subsequent parities. Calving interval and weaning weight are two key animal performance traits driving profitable beef production systems (López-Paredes et al., 2018; Taylor et al., 2018). Calving interval is longer in parity 1 cows compared to parity 2, 3, 4, and 5 which was also observed in dairy cows (Evans et al., 2006; Eastham et al., 2018; Atashi et al., 2021). Cows experiencing their first calving are not physically or physiologically mature, so are in a different metabolic state than multiparous cows (Ferreira et al., 2021). Longer calving interval may also be due to herd owners calving heifers earlier in breeding season to mature herd, which is a management practice to give parity 1 cows time to heal. Diskin and Kenny (2014) discussed that not reaching suitable target weights at breeding is associated to poor subsequent fertility. Thus, herd owners may be tempted to delay insemination in young heifers to reduce risk of the poor fertility in parity 1 cows; nevertheless, calving heifers older did not help in the poor fertility performance of parity 1 cows. In matter of fact, older AFC tended to result in longer calving interval in parity 1 cows in the present study which is likely linked to herd owners keeping older calving heifers to subsequent calving season. The weak association between AFC and calving interval in the present study was supported by genetic association studies, which reported a genetic correlations close to zero between AFC and other fertility traits (Gutiérrez et al., 2002; Heise et al., 2018; Brzáková et al., 2020).

There was an association between AFC and weaning weight in parity 1 and 2 cows; cows with a younger AFC weaned lighter calves. This is similar to what was reported in dairy cows; Dobos et al. (2004) reported a significant improvement in dairy cows milk, fat, and protein production in lactation 1 and 2 for cows with an older AFC. Atashi et al. (2021) and Eastham et al. (2018) also reported that cows with an older AFC had a higher milk production in their first lactation. Therefore, the age of the cow seems to be strongly linked to milk produced and subsequently the weaning weight in beef cows. Although a lighter calf will be produced in cows first parity for young AFC cows, cows with an AFC of 24 mo will have produced an extra calf at the same age compared to cows calving with an AFC of 36 mo.

Mature live weight

Live weight of parity 5 cows was not associated with AFC, although there was a strong association between AFC and live weight of cow's parity 1 to 4. In Nellore cattle there was weak negative genetic (−0.19) and phenotypic (−0.16) correlation between AFC and mature live weight (Regatieri et al., 2012), although Schmidt et al. (2018) reported no relationship between mature cow weight and AFC supporting results in the present study. Reducing the AFC in cows will reduce the weight of cows during their productive years, thus reducing total energy required for maintenance of cows over their lifetime (Sessim et al., 2020). As well as this, it will only slightly negatively impact cull cow value in beef herds, and will have no effect on cull cow value in herds with good longevity rates.

Conclusion

There is an increased likelihood of dystocia in parity 1 beef cows that calved at 24 mo of age compared to cows that calved for the first time at an older age, but AFC does not have an association with calving difficulty in subsequent parities. Management decisions can reduce the risk of calving difficulty in parity 1 cows. The lower weaning weight observed for younger AFC cows for parity 1 and 2 is biologically small and this is negated by the extra calf produced in her lifetime as there was a similar survival rate for cows calving at 22 to 24 mo and 33 to 36 mo. Cows that calved at younger AFC were lighter from parity 1 to 4, which is beneficial as lighter cows have a lower maintenance cost. Although the impact was biologically small, younger AFC had a favorable association in early parities for calving interval.

Acknowledgments

Funding from the Irish Department of Agriculture, Food and the Marine research grants GREENBREED and MULTIREPRO research grants GREENBREED and MULTIREPRO is greatly appreciated.

Conflict of Interest Statement

The authors declare no real or perceived conflicts of interest.

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