Herd level factors associated with pregnancy success and distribution in beef cow-calf herds

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Abstract

Identifying factors that influence pregnancy success is important in order to optimize beef cow-calf herd management. A logistic regression model was used to evaluate the effect of relevant factors (categories were: herd size, body condition score, breeding season length, and timing of start of breeding season) on the probability of pregnancy status at 2 time-points (day 21 and end of the breeding season). Data were collected by convenience sampling from herds (n = 241) consisting of 8,217 head located in the Midwest and Great Plains regions of the US from 2012 to 2017. Herds with < 50 head had reduced probability of pregnancy (51 and 78%) compared to medium-sized (50 - 99 head) herds (63 and 84%). Cows in thin body condition (score ≤ 4 out of 9) at pregnancy diagnosis had reduced probability of becoming pregnant (44 and 64%) compared to cows in moderate body condition ([score 5 - 6 out of 9] 62 and 86%) and fleshy condition ([score ≥ 7 out of 9] 66 and 91%). Herds with a short (< 63 days) or medium (63 - 84 days) breeding season had increased probability of pregnancy (65 and 58%) for the first 21-day interval compared to herds with a long (> 84 days) breeding season (49%). Herds that started the breeding season in the fall (September 30 - December 31) had higher probability of pregnancy at the end of the breeding season (88%) compared to spring (April 1 - June 30) start dates (82%). Management factors (herd size, body condition score, breeding season length, and timing of start of breeding season) had substantial impacts on the probability of pregnancy.

Keywords: Beef cow, reproductive efficiency, histogram

Introduction

Managing herds to calve in a front-loaded scenario, where 60% or more of the cows become pregnant in the first 21-day interval of the breeding season, can lead to increased pounds of calf weaned per cow exposed for breeding.[1] Front-loaded herds enable a larger percentage of the herd to finish the postpartum anestrus period before the breeding season begins. This creates reproductive momentum, allowing a greater percentage of the herd to be cycling and becoming pregnant early in the breeding season. In turn, this allows for more pounds weaned over a cow's lifetime.[2] Progeny born in the first 21 days of the calving season will weigh more at weaning, and subsequently weigh more at later economically important times of life, heifers will have greater success during breeding, and steers will have more marbling and increased carcass value.[3] Herds that can attain these management goals can have economic success in both short and long terms, due to increased efficiency.

Veterinarians who estimate fetal age by 21-day intervals can use the resulting herd pregnancy distribution to help differentiate between potential causes of reproductive failure due to nutrition, male fertility, female fertility, or pregnancy loss.[1] Objective of this study was to determine if factors such as herd size, breeding season length, body condition of cow at mid pregnancy, or the time of year when breeding season starts, affected the likelihood of pregnancy at the end of the first 21-day interval and at the end of breeding season.

Materials and methods

Herd description

Pregnancy status data were collected from veterinarians and producers throughout the Midwest. Data entry methods included hand-notation on paper, computer spreadsheet, and mobile device application (Pregnancy Analytics App [Beef cattle Institute, Kansas State University, Manhattan, KS]).

Herds were included based on the availability and completeness of datasets. To be included, fetal age estimation had to be collected in a manner that allowed categorizing individual cows into 20- or 21-day intervals.[4,5,6,7] If a herd was presented with fetal age estimated by month or trimester, the entire herd was excluded. The initial dataset included 625 herds with pregnancy diagnosis staged into 20- or 21-day intervals. Only herds with maximum estimated fetal age of 140 days or fewer, and herd size > 10 head were included in the final model (Figure 1). Final dataset included 241 herds representing 8,217 cattle from herds ranging from 11 to 233 animals. A total of 384 herds were removed due to the exclusion criterion. Each dataset included an individual cow identification number, date of pregnancy diagnosis, fetal age estimation, and a total animal count for herd size.

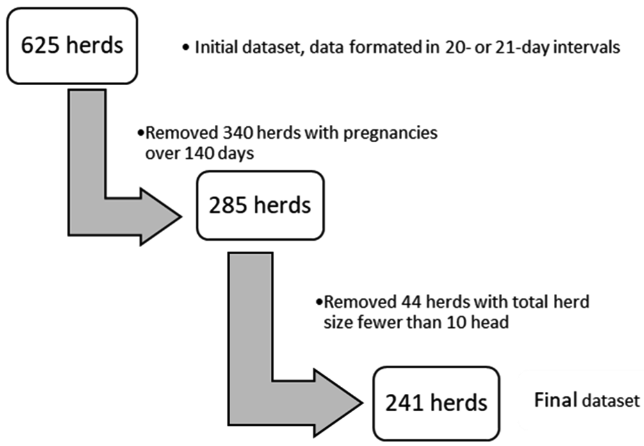

Figure 1. Flow chart depicting the number of herds retained after applying each exclusion criterion.

Pregnancy intervals

Pregnancy examination data collected by transrectal palpation or ultrasonographic evaluation at a single herd examination no more than 140 days after the start of the breeding season were categorized in either 20- or 21-day intervals of fetal age estimates. Herds that categorized fetal age estimate data in 20-day intervals were adjusted by multiplying the percentage identified as becoming pregnant in the first 20 days of the breeding season by 1.05 (5% increase) to equilibrate to a standard percentage becoming pregnant during the first 21 days of the breeding season for all herds. Percent of cows bred were evaluated for 2 endpoints: those cows that were categorized as becoming pregnant in the first 21 days of the breeding season, and those categorized as becoming pregnant by the end of the breeding season, regardless of breeding season length.

Categories based on factors evaluated

Herds were categorized based on number of cows examined for pregnancy diagnosis into 3 categories: small (10 - 49 heads), medium (50 - 99 heads), and large (100 - 233 heads). Breeding season length was calculated across all data sources by the difference between the earliest estimated conception date and the latest estimated conception date. Herds were categorized based on breeding season length into 3 categories: short (< 63 days), medium (63 - 84 days), and long (> 84 days).

Body condition score data collected at the time of pregnancy diagnosis no more than 140 days after the start of the breeding season were based on a 9-point scale, where classification 1 is associated with extremely thin cattle, and classification 9 is associated with extremely obese cattle.[8] The 9-point scale was collapsed into 3 categories for the data set, with the thin category including cows classified as having a score less than or equal to 4, the moderate category including cows classified as having a score of 5 or 6, and cows classified as having a score of 7 or greater being categorized as being fleshy.

The start of each breeding season was determined by finding the earliest estimated conception date in each herd. The start of the breeding season was then categorized into quarters: winter, spring, summer and fall. Winter breeding was January 1 - March 31, spring breeding was April 1 - June 30, summer breeding was July 1 - September 29 and fall breeding was September 30 - December 31.

Statistical analyses

Before analyzing the data, only herds with > 10 head and with individual cattle diagnosed with pregnancies 140 days or fewer were included. The criterion to include only pregnancies 140 days or fewer was established to minimize inaccuracy when staging the pregnancies to 21-day intervals.

All statistical analyses were conducted in RStudio (RStudio, Version 3.3.3, Boston, MA). A logistic regression model was used to evaluate the effect of relevant factors (herd size category, breeding season length category, body condition score category, and timing of breeding season category) on the probability of pregnancy status at 2 time-points (21 days and end of breeding season) for herds with data for all the variable categories (241 herds, 8,217 cattle). Interactions were evaluated using a type III Wald (Chi-square) test.

Results

Pregnancy intervals

On average, 85.3% of each herd was pregnant at the time of pregnancy diagnosis, with 53.6% becoming pregnant by the end of the first 21-day interval (Table and Figure 2). For the first (21-day) interval model, factors that were associated ($p < 0.05$) with the model-adjusted probability of pregnancy included: herd size, cow body condition, and breeding season length. For the model-adjusted probability of pregnancy for the entire breeding season, factors that were associated ($p < 0.05$) included: herd size, body condition, and timing of the start of the breeding season.

Table. Raw data from 241 herds (8,271 cows)

	Mean	SD	Minimum/Maximum
% Pregnant in first 21 days of breeding season	53.6	18.5	5.2/100
% Pregnant at end of breeding season	85.3	14.8	26.4/100

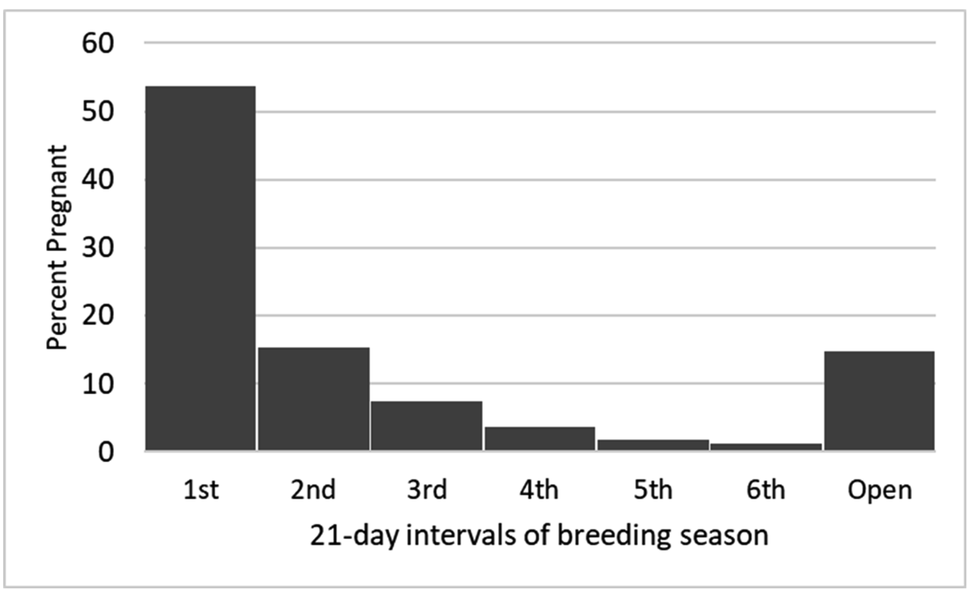

Figure 2. Overall raw average percent pregnant by 21-day interval throughout the breeding season for beef cow-calf herds included in the study (n = 8,217 cows).

Herd size

Herds ranged in size from 10 to 233 cows, with a median of 45. Herd size was associated with the probability of pregnancy diagnosis for the first 21-day interval (Figure 3A, $p = 0.03$, and the end of the breeding season (Figure 3B, $p < 0.01$). For both the first 21-day interval and the overall breeding season, small herds had reduced probability of pregnancy (51 and 78%, respectively) compared to medium (63 and 84%) herds.

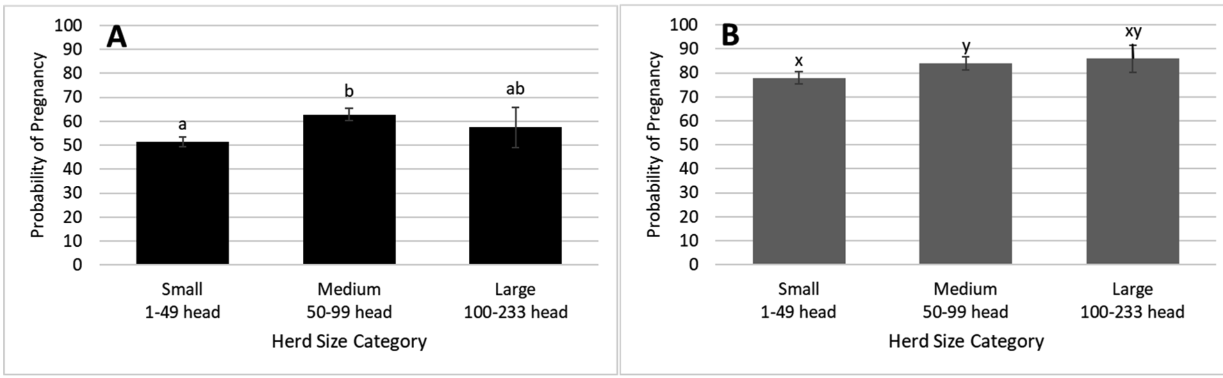

Figure 3. Model-adjusted probability of pregnancy +/- 2 SEM for the first 21-day interval (Figure 3A: left chart – black columns) and overall breeding season (Figure 3B: right chart – grey columns) by herd size (n=241 herds). Bars without a common superscript have different model-adjusted probabilities ($p < 0.05$).

Body condition score

Majority (87.5%) of cows in the data set were described as having moderate body condition, whereas 4.6% were classified as thin, and 7.8% were classified as fleshy. Body condition had substantial effects on first 21-day model ($p < 0.01$) and overall breeding season ($p < 0.01$). Thin cows had reduced probability of pregnancy (44%) as compared to moderate (62%) and fleshy (66%) cows for the first 21-day outcome. For the end of breeding season, thin cows had the lowest probability of pregnancy (64%), whereas fleshy cows had the highest probability of pregnancy (91%).

Breeding season length

Over half the herds (65.2%) had a breeding season that was classified as short (< 63 days). Breeding season length was associated ($p < 0.01$) with the probability of pregnancy in the first 21-day interval, with short-season length herds having an increased probability of pregnancy (65%) compared to long-season herds (49%; Figure 4). There was no association ($p = 0.14$) between breeding season length and probability of pregnancy diagnosis at the end of the breeding season.

Start of breeding season

The start of the breeding season was associated with the probability of pregnancy at the end of breeding season ($p < 0.01$), but was not associated with the first 21-day interval ($p = 0.26$). Herds starting the breeding season in spring had reduced probability of pregnancy (82%) compared to herds starting the breeding season in the fall (88%). Herds starting the breeding season in the winter and summer had numerically (but not statistically) reduced probabilities of pregnancy (81 and 78%, respectively) as compared to spring and fall.

Discussion

Although this dataset is not representative of the entire cow-calf industry, it does describe a relevant sub-set of US beef herds. Similar to industry averages, the majority of the herds in this dataset

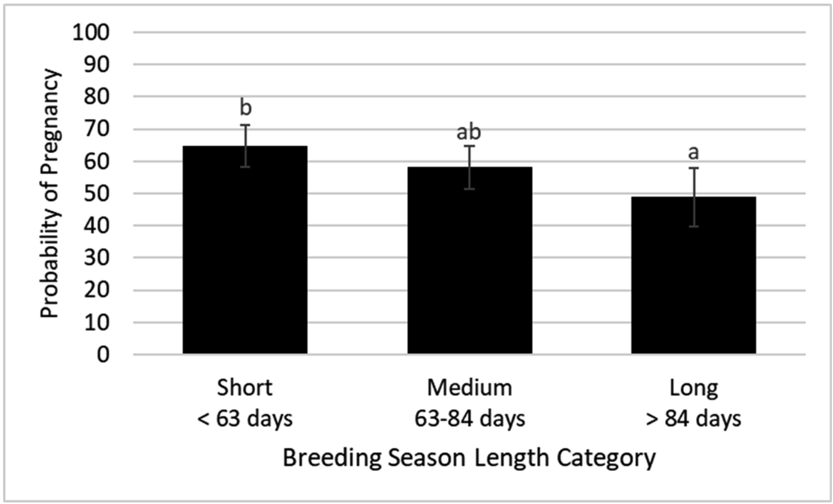

Figure 4. Model-adjusted probability of pregnancy +/- 2 SEM for the first 21-day interval by breeding season length (n = 241 herds). Bars without a common superscript have different model-adjusted probabilities ($p < 0.05$).

were < 50 head, with herds categorized as "small" herds (10 - 49 head) accounting for 80% of the population. Cattle producers rely on cow herd productivity in order to be economically sustainable. Herd size can affect profitability and efficiency, as larger herds tend to have decreased overhead costs and feed costs per head.[9] In this dataset, smaller herds had reduced probability of pregnancy during the first 21 days of breeding and for the entire breeding season compared to medium-sized herds; perhaps this was a result of the larger comparative importance of off-farm income and subsequent reduced time and management directed to the cow herds' productivity in smaller compared to larger herds.

Factors such as body condition at various times during the annual production cycle influence both the length of the postpartum anestrus interval[10,11] and fertility,[12] and should be managed accordingly. Cows with lower BCS at calving have longer postpartum anestrus when compared to cows with a higher BCS.[10] The current dataset indicates that cows classified as having thin body condition at pregnancy diagnosis were less likely to have become pregnant in the first 21-day interval, and by the end of the preceding breeding season. The reduction in pregnancies for thin cows could be attributed to the previously mentioned prolonged anestrus period, or as an indication of health constraints during the breeding season or early gestation that negatively impact both body condition and fertility.[10,11,12] However, little research has been conducted to investigate the effect of body condition at pregnancy diagnosis on fertility during the preceding breeding season.

Management techniques can be implemented in order to change the reproductive momentum of beef herds. Cow-calf production is limited by the 365 days in a year and a 283-day pregnancy, requiring that cows conceive within 82 days after calving to maintain a 365-day calving interval or fewer. A herd's breeding season length can have important impacts on subsequent and future calf crops. Over 50% of operations in the US (34.1% of the US cow herd) do not have a defined breeding season.[13] Of the operations that had defined breeding seasons, nearly 70% calved in a 3-month period.[13] According to the USDA NAHMS survey, the length of the breeding season for herds identifying as having a single defined breeding season averaged 110 days, which is nearly twice as long as the median breeding season length (60 days) of this dataset.[13] Based on this dataset, herds with a short breeding season length tended to have increased probability of pregnancy at 21 days compared to herds with long breeding seasons. Herds with reduced time allotment to become pregnant, may have indirectly selected for cows that are capable of completing the postpartum anestrous period prior to the start of breeding or early in the breeding season. An extended breeding season results in an extended calving season that will result in an increased proportion of cows having few days available after calving to complete postpartum anestrus prior to the start of the subsequent breeding season.[1] In this dataset, there was no difference between season length and probability of becoming pregnant by the end of the breeding season, most likely due to the increased mating opportunities in the long breeding season herds. The shorter season length herds had already attained 65% pregnant by the first 21-day interval, thus fewer cows were available for breeding in the remaining 21-day periods of the breeding season.

Considering environmental constraints, particularly periods of peak and nadir forage availability, the date to start the breeding season can impact the reproductive success of beef cow herds. Improved reproductive success is associated with improved postpartum plane of nutrition, and subsequent short postpartum anestrous interval. Results from this study indicate that cows exposed to bulls starting in the spring season had reduced probability of pregnancy as compared to fall breeding seasons. However, both spring and fall breeding season herds had numerically increased probability of pregnancy as compared to winter and summer breeding season herds. The impact of day length at the start of the breeding season or the change in day length post-calving and/or available forage quantity and quality at various times of the year may influence the length of postpartum anestrus and fertility of beef cows.[14] Herds that start their breeding season in the winter or summer may have reduced probability of pregnancy due to environmental challenges (e.g. extreme temperatures, poor forage availability) or other environmental factors. These results provided additional considerations when determining the optimum breeding season start date.

Conclusion

Within this dataset, management factors such as breeding season length, timing of the start of the breeding season, herd size, and body condition score at pregnancy diagnosis impacted pregnancy success. Because of the positive association between a short breeding season and a large proportion of the herd becoming pregnant in the first 21 days of the breeding season, managing a beef cow-calf herd's breeding season length may be useful to improve subsequent calving distributions, thereby impacting the potential calf weight weaned. Optimizing herd nutrition and resulting body condition score is crucial for reproduction success. In the future, more research needs to be conducted to evaluate the economics of these management choices.

Conflict of interest

None to declare.

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