The Numbers Don’t Lie

Rachel Jama Doenges

Mississippi State University

College of Veterinary Medicine

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Advisor: Darcie Sidelinger

History:

In June 2020, examination for pregnancy was performed on 108 Angus and Angus- cross heifers as part of a routine visit. The heifers were examined using transrectal palpation. Of the 108 heifers, 24 were found not to be pregnant.

Prior to this visit, this group of heifers had been seen multiple times for prophylactic care, including vaccination and deworming prior to weaning, at weaning, post-weaning and prior to the breeding season. The heifers were adequately vaccinated for bovine viral diarrhea (BVD) Type 1, bovine viral diarrhea Type 2, infectious bovine rhinotracheitis (IBR), parainfluenza type 3 (PI3), bovine respiratory syncytial viruses (BRSV), common *Clostridial* species, *Campylobacter fetus* and *Leptospirosis interrogans serovars hardjo, canicola, icterohaemorrhagiae, grippotyphosa* and *pomona.* Prior to breeding, a complete breeding soundness examination was not performed.

The heifers were bred via live cover. Bulls were introduced to the group on February 1, 2020 and removed at the beginning of April 2020.

This herd is an open herd. Although, this operation does not purchase cows from outside sources, raising their own replacement heifers; bulls are purchased. The owner only purchases virgin bulls. Also, there are fence lines shared with other properties that allow direct contact with other cattle.

Prior to breeding, the owner had breeding soundness examinations performed on the bulls by another veterinarian. Records were not available. The owner said that all the bulls used passed the breeding soundness examination. He does not believe any other diagnostics were performed.

Diagnostics:

In June 2020, transrectal palpation was performed on all the heifers to determine their pregnancy status and gestational age. Of the 108 heifers examined, 24 were open. The majority

of the pregnant heifers were estimated to be between 60 and 150 days pregnant. Forty-four individuals were 60-90 days pregnant. Thirty-eight individuals were 120 to 150 days pregnant. There were two heifers that were estimated to be 200 days pregnant. These were accidental pregnancies attributed to the neighbor's bull getting into the heifer pasture prior to the breeding season.

In addition, body condition score was evaluated. The average body condition score for the group was 5.6/9. All heifers were given a body condition score of 5/9 or 6/9, except one individual that was given a body condition score of 7/9.

Data Analysis:

The goal mid-gestation pregnancy rate for a cow-calf operation is 95% [1], pregnancy rates lower than 85-90% warrant further investigation.[30] This heifer group had a pregnancy rate of only 78% early in gestation. Once numerous open heifers were discovered, further evaluation of the breeding records was performed.

The gestational ages estimated on transrectal palpation were used to make a conception distribution. The breeding season (February 1- April 4, 2020) was divided into 21-day increments based on the average length of an estrous cycle in cattle. The goal for a cow-calf operation is generally to have 65% of the eligible cattle conceive per 21-day period.[30] If this goal is achieved 65% of the total eligible cows will be bred during the first 21-day period, 23% of the total eligible cows (65% of the remaining open 35%) will be bred during the second 21-day period and 8% of the total eligible cows will be bred during the third 21-day period. In a 65-day breeding season, 4% of cows are expected to be open at the end of the season.[30] In this group of heifers, only 41.5% of heifers conceived in the first 21-day period, none conceived in the second 21-day period and 61.3% of the eligible heifers conceived in the final 21-day period (See chart).

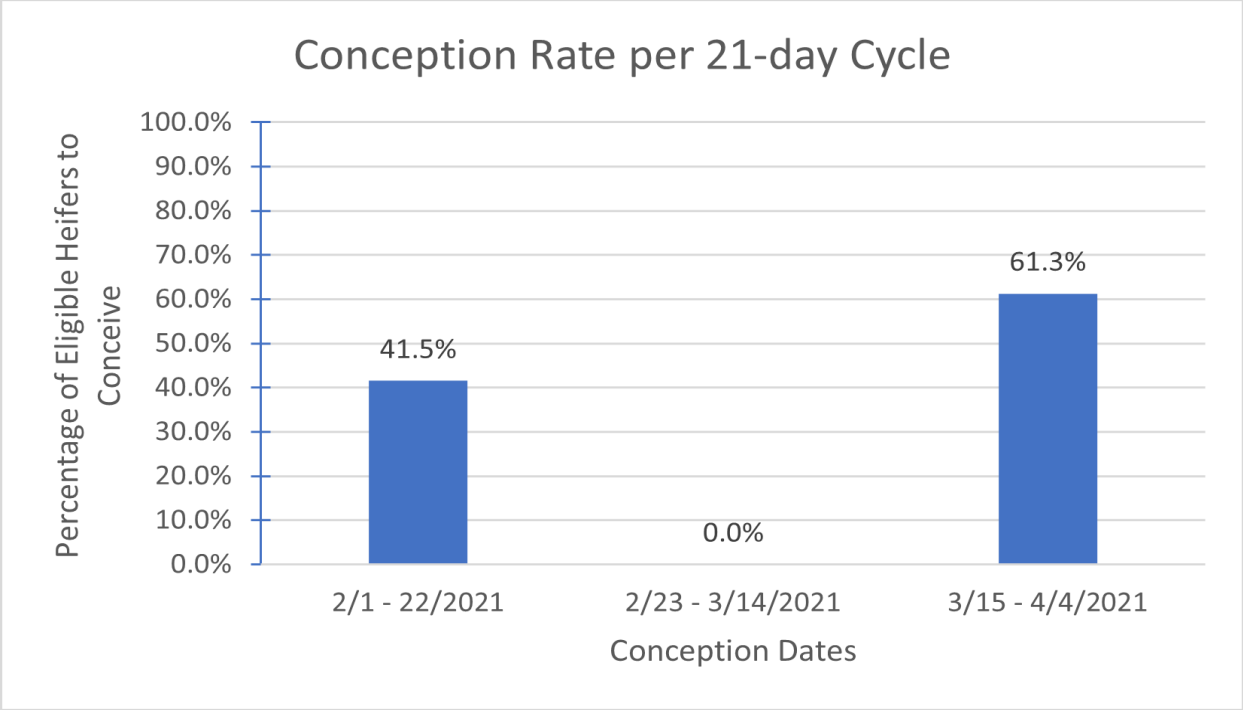

Figure 1: Chart generated from data from this case.

In addition, the pregnancy rate and conception distribution were evaluated for cattle in other age groups. All age groups, except for the 6-year-old cows, had a pregnancy rate of less than the target 95% at their first pregnancy check. The 6-year-olds had a pregnancy rate of 96%. No groups had a normal conception distribution, often the majority of conceptions occurred in this last 21-day period or the last two 21-day periods. Ideally, we would compare these records to that of previous years, but complete records were not available for any years before 2020.

Evaluations and Recommendations:

Causes of pregnancy wastage prior to 150 days gestation include any etiology that prevents ovulation, prevents fertilization, causes early embryonic death (0-42 days of gestation) or causes early fetal loss.[4] A differential diagnosis list was made that encompassed infectious and non-infectious causes for pregnancy wastage at this gestational age. Etiologies that generally cause sporadic abortions were excluded. Also, the differential diagnosis list was limited to etiologies common in the Southeast. Infectious agents included: *Campylobacter fetus* subspecies

venerealis, *Leptospirosis interrogans*, infectious bovine rhinotracheitis/bovine herpes virus type-1, bovine viral diarrhea virus and *Tritrichomonas foetus*. Infectious agents for which the heifers were routinely vaccinated and for which vaccination has good reported efficacy were considered much less likely, so *Campylobacter fetus* subspecies *venerealis, Leptospirosis interrogans*, infectious bovine rhinotracheitis/bovine herpes virus type-1, and bovine viral diarrhea virus were moved down the list. This left *T. foetus* as the main differential for an infectious agent. When the bulls received breeding soundness examinations prior to the breeding season, neither *T. foetus* culture or PCR were performed. The owner had opted not to test because he felt infection was unlikely since he only buys virgin bulls. However, as demonstrated by the accidental breeding of two heifers, his herd is not closed and therefore without testing, *T. foetus* cannot be ruled out.

Non-infectious causes include etiologies that prevent cycling, including poor nutrition, stress (to include heat stress) and presence of peripubertal heifers that are not consistently cycling. Also, bull fertility must be considered. During the visit on June 17, 2020, there were no obvious signs of a nutritional issue. That said, this does not necessarily indicate that prior to breeding the heifers were in good condition. However, based on these body condition scores and historical visits to the farm, nutritional issues were considered less likely in this group. Stress was also considered less likely. The owner had not made recent changes in the herd. Weaning had occurred well in advance of breeding season (June 2019). Also, the Spring weather made heat stress less likely. It is possible that the heifers were in a peripubertal state during the breeding season. Since no breeding soundness examinations were performed prior to breeding, there was no opportunity to identify heifers that were not yet cycling and intervene.

The conception distribution seen is supportive of a fertility issue that occurred during or affected the second 21-day cycle. It is less likely that an infectious agent would selectively affect

a single 21-day period, especially a contagious agent that would propagate through the herd. An exception to this would be an infectious agent that causes transient infertility, such as *T. foetus*.[19] This conception distribution can also be attributed to any cause of transient infertility of the bull. A common cause is traumatic injury preventing breeding. Traumatic injury can even cause marked decreases in conception rates in a multiple bull system if the dominant bull is affected.[30] In our case, injury was not noted by the owner to any bull and is therefore lower on the differential diagnosis list. As far as infertility in cows, it would be rare for any etiology to make all cows in a group stop cycling completely at the same time.[30] However, this pattern could reflect heifers of different stages of sexual maturity where there are some that have reached puberty at the beginning of the breeding season and the remaining heifers start cycling during the season. Again, the two differential diagnoses that are most likely are *T. foetus* infection or having sexually immature heifers at the start of the breeding season.

Finally, the abnormal pregnancy rates and conception distributions seen across numerous age groups are indicative of an ongoing issue. This makes an issue with heifer development more likely.

After evaluating the breeding records, the following recommendations were made to the owner: test all bulls for *T. foetus*, perform breeding soundness examinations including reproductive tract scoring on all replacement heifers prior to breeding season, record all calving dates in order to develop a calving distribution that will help with management of cattle going into the next breeding season and record body condition scores on cattle prior to breeding to identify if there is a nutritional component to the fertility issues.

Discussion:

Heifer Management and It's Long-term Effects

Heifer development and management of the first breeding season sets the stage for their reproductive careers. Heifers that enter their first breeding season when they are still peripubertal will not be bred until later in the season when they start cycling. Heifers bred later in the season will calve later. These individuals will then have less time between calving and the subsequent breeding season and will likely still be in postpartum anestrus at the beginning of the next breeding season. This is especially true in heifers, because heifers generally have a longer postpartum anestrus (80-100 days)[7] than mature cattle (50-60 days)[8]. For this reason, it is recommended to start the heifer breeding season 2-3 weeks prior to the breeding season for the mature cows.[30] These heifers are consistently bred late in the season and calve late. Once this pattern is developed, it is almost impossible to correct. Appropriate management of heifers sets them up for lifelong success. Important factors of management are genetics, nutrition, heifer selection and intervention when issues are found.

In order to produce quality replacement heifers, planning must start when the heifers are conceived. Despite much research into genetic links to female fertility traits, this area is still cryptic and heritability is low.[25] However, there are genetic traits that have high heritability, such as carcass quality and growth rate, that are helpful when producing replacement heifers.[20] There is also a proposed link between scrotal circumference of the sire as a yearling and the age of puberty of the heifer. However, this correlation has not been consistently demonstrated across breeds. More recent research on *Bos taurus* has failed to demonstrate a clear relationship between sire yearling scrotal circumference and female reproductive traits, including age of puberty, pregnancy rates and calving rates in first breeding season.[18] However, positive correlation has been shown in Brahman[31] and Nelore cattle.[10] Genetic links to reproductive traits

will continue to be explored. The availability of artificial insemination makes it easier for even small producers to introduce new and more advantageous genetic lines into their herds.

Nutritional status and weight are the factors that most strongly correlate with the onset of puberty and both can be controlled. Nutritional considerations begin prior to birth with the nutritional management of the replacement heifer's dam. The negative effects of having a poorly conditioned dam during that last trimester of pregnancy when the majority of fetal growth occurs has been well documented. In a study performed by University of Nebraska, heifers whose dams were given protein supplementation during the final trimester weighed more at weaning, reached puberty at a younger age and had higher pregnancy rates in their first breeding season.[14] However, it is becoming more evident that nutritional status in early gestation when organ development occurs is also very important for the general and reproductive success of offspring. For example, it has been demonstrated that heifers whose dams had nutritional restriction during the second trimester had smaller ovaries and smaller amounts of luteal tissue at 14-15 months of age.[17] These heifers had similar birth weights, weaning weights and average daily gains when compared to heifers whose dams did not have nutritional restriction. This was a limited study and the importance of fetal programming on reproductive success needs to be explored further. However, it is clear that nutrition of the dam throughout pregnancy does have long lasting effects on the development of their offspring.

Weight has a stronger correlation with initiation of puberty in heifers than age. Heifers reach puberty when they are 55-60% of their adult weight.[12] Many producers aim to have heifers at approximately 65% before the first breeding season.[11] Heifers that are at 55% of their adult body weight at the beginning of the breeding season have similar pregnancy rates for the first breeding season as heifers that were 60% of their mature body weight at the beginning of the

breeding season. However, heifers that were at a higher percentage of their adult body weight were more likely to conceive early in the breeding season.[20] To reach these goals, nutrition needs to be monitored closely from birth to puberty. Generally, producers set a target average daily weight gain and feed accordingly for consistent weight gain throughout development. However, studies have shown that when the weight gain occurs, whether consistently throughout development or in spurts, has less effect on reproductive success in the first breeding season than the heifer's weight at the start of the breeding season.[20] Peripubertal heifers have been induced to cycle by a sudden increase in the plane of nutrition fed.[15]

Appropriate selection of replacement heifers is critical to the success of a cow-calf operation. Time and resources wasted on poor heifers can be incredibly costly. One of the simplest criteria for selection is age. Heifers that were born early in the calving season will be older and more likely to be cycling at the start of their first breeding season.[20]

Prior to breeding, breeding soundness exams should be preformed to evaluate sexual maturity and eliminate poor candidates from the group. Reproductive tract scoring is reliable in determining if heifers are cycling or will likely be cycling by the start of breeding season. The reproductive tract is given a score from 1 to 5 based on tract tone and presence of ovarian structures indicative of normal cycling. Scores of 1 and 2 are indicative of heifers that are not cycling. A score of 3 indicates that the heifer is not currently cycling, but puberty is eminent. Scores of 4 and 5 indicate that the heifer is cycling and is about to ovulate (4) or already has (5). Any heifer with a reproductive tract score of 1 should be culled at this time. Initiation of puberty in cattle is multifactorial and can be influenced by management. This is important, because if a heifer is not cycling 4-6 weeks prior to breeding season, management strategies can be altered to help induce puberty.

During the breeding soundness exam, pelvic area should also be measured. This is done using a Rice Pelvimeter. The height is measured from the midpoint of the pubic symphysis to the mid sacrum. The width is measure between the shafts of the ilia at the widest point perpendicular to the vertical measurement. These values are multiplied to determine the pelvic area. The pelvic area does not correlate to conception rates. However, there is a correlation between pelvic areas of less than 140 cm^2 and increased incidence of dystocia.[9] These heifers should be culled. Also, it is important to avoid selecting for excessively large pelvic areas (> 180 cm^2), because these heifers tend to have larger calves and this too can lead to calving difficulties.[23] When pelvic area is evaluated, pelvic canal shape should also be evaluated.

Once peripubertal heifers are discovered on a breeding soundness exam, there are ways to intervene. As previously stated, a marked increase in nutritional plane can induce puberty. Another strategy is the use of progestins. Progestins decrease the negative feedback of estradiol-17β which allows an increase in luteinizing hormone (LH) secretion.[2] LH secretion leads to enhanced follicle development.[16] Progestins are used orally and via intravaginal implants to induce regular cycling in peripubertal heifers.[16]

Heifers that calve within the first 21-days of their first seasons remain in the herd longer and are more productive; producing more pounds of weaned calves throughout their life.[20] Conversely, if a cow starts their breeding career by being bred late in the season, this pattern tends to continue throughout their life. There are many factors that affect age of puberty in heifers. Long term management strategies are the most consistent way to ensure that replacement heifers are prepared for their first breeding season. However, performing reproductive tract scoring prior to the breeding season can help you identify peripubertal heifers[24] and allows for implementation of short-term strategies to initiate puberty in these heifers.

Tritrichomonas foetus

T. foetus is a flagellated protozoan.[29] It is the cause of major reproductive losses and therefore economic losses in the cattle industry. *T. foetus* can be difficult to detect and manage, because bulls are usually asymptomatic carriers, and the clinical signs can be insidious in females.[29]

T. foetus is an obligate parasite of the genital tract of cattle. It is primarily transmitted via coitus. However, *T. foetus* can survive in semen and be transmitted via artificial insemination.[19] Screening of semen for artificial insemination is commonly performed,[5] so *T. foetus* is most common in herds that are bred by natural service.[21] Iatrogenic spread is also possible via poorly sanitized obstetric instruments.[22]

Bulls are usually asymptomatic for infection and serve as chronic carriers.[19, 21, 26, 29] Occasionally, a mild, transient balanoposthitis may be noted.[29] Studies have shown a higher prevalence of *T. foetus* in older bulls.[22] Historically, *T. foetus* was thought to be more prevalent in older bulls, because they were believed to have deeper crypts and folds in the penile and preputial epithelium[6] that made a better environment for *T. foetus* which is microaerophilic.[29] However, a histologic study comparing the epithelium of bulls of varying ages showed that the penial and preputial epithelium is not statistically different in young and old bulls.[27]

In cows, *T. foetus* elicits an inflammatory response, causing vaginitis, cervicitis and endometritis. When the infections progress to cause endometritis, early embryonic death and abortion occur.[3] Pregnancy wastage secondary to *T. foetus* most commonly occurs in the first trimester. However, abortion can occur later in gestation.[5] Pyometra might be seen secondary to retained fetus and fetal membranes.[5] After pregnancy wastage, infected cows undergo a transient period of infertility while the immune system clears the infection. The infection is generally

cleared in 5 to 20 weeks.[22] After the infection is cleared, the cows can become pregnant again. There are also cows that will become chronically infected and deliver seemingly healthy calves.[22] Due to the nature of the pathogen, the producer may only notice lower conception rates or longer calving seasons.

Diagnosis is largely based on culture with subsequent microscopic identification of the organism or PCR testing. A combination of PCR and culture increases sensitivity. *T. foetus* can be cultured using Diamond's media or commercially available InPouchs. Preputial scrapings are collected from bulls to test for *T. foetus*.[29] Uterine fluid, fresh fetal fluid or fetal abomasal content, or vaginal scrapings can be used to test females at the time of pregnancy wastage.[5, 29]

Conclusions:

Weaned calves are the primary source of income for cow-calf operations.[13] The cost of low calving rates can be crippling. The producer not only loses the potential income from the sale of a calf, but also the expenses of maintaining the cow. Furthermore, if the cow is culled as an open heifer, the producer has lost their investment in raising and developing that heifer. Through a simple record review, as was done with this case, and evaluation of the herd reproductive profile; you can quickly identify issues and make targeted recommendations for the client. In this case, the analysis was performed using paper records and an Excel spreadsheet, no expensive equipment was necessary to identify potential issues and recommended next steps. This is a service that can easily be provided in general practice and can be of great value to your clients.

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