REPRO TRACKS

by Cliff Lamb, Texas A&M University

Level Playing Field

The effects of the male contribution to embryonic loss.

Recently scientists have started to understand the effect of the male is on fertility, especially embryonic loss. I recently had a chance to discuss advances with a graduate student. He summarized his thoughts, some of which are included in this article.

Pregnancy loss is considered one of the main causes of reproductive inefficiency in the beef cattle industry, estimated to cost more than $1 billion (U.S. dollars) every year.

Embryonic mortality occurring either early (before 28 days of gestation) or late (after day 30) is usually associated with maternal driven factors such as nutritional deficiency, handling stress, genetic alterations, reproductive diseases/infections and inadequate hormonal levels. However, recent studies conducted by Pohler's lab at Texas A&M University reported bulls also have a significant contribution to pregnancy losses during the embryonic development.

To investigate sire contribution to pregnancy loss at different periods of embryonic development, a study (Table 1) was conducted where Angus cows and heifers were artificially inseminated (AIed) with eight different Angus sires. Pregnancy rates and embryonic mortality at different periods of gestation were compared between those bulls.

Pregnancy diagnosis was performed at days 24, 31 and 60 post-AI, and sires were classified based on pregnancy loss during these periods. According to this study, even when bulls are selected for AI (or natural service) and pass all standard semen evaluation, there is still considerable variance in pregnancy rate and pregnancy loss, with some bulls having high pregnancy rates records but a greater incidence of embryonic mortality. Therefore, using sire fertility records based on a single pregnancy check may result in an inaccurate assessment for bull selection in order to improve reproductive performance.

After sperm deposition in the female reproductive tract by either natural service or AI, the sperm will have to undergo a process of capacitation and hyperactivation until it reaches the oviduct, where it will be ready to fertilize the oocyte (egg). Fertilization rates in beef cattle range from 60-100% with averages typically less than 90%. The failures in this process of fertilization seem to be influenced by the competence and quality of the oocyte and the concentrations of estradiol produced by the cow rather than semen inefficiency when high-quality semen is used. However, after fertilization, many changes must occur to the embryo and uterine environment in order to establish a viable pregnancy.

Some studies have indicated the

Table 1: ***Sire classification based on pregnancy loss during different periods of embryonic and fetal development in Angus cows inseminated to one of eight Angus sires (adapted from Franco et al., 2021).***

Sire	Early embryonic mortality (EEM, %)	EEM classification	Late embryonic mortality (LEM, %)	LEM classification
1	3.7	Low EEM	5.1	Low LEM
2	20.0	High EEM	3.4	Low LEM
3	11.1	High EEM	9.9	High LEM
4	11.7	High EEM	2.5	Low LEM
5	10.5	High EEM	3.3	Low LEM
6	5.7	Low EEM	12.6	High LEM
7	2.8	Low EEM	2.3	Low LEM
8	3.0	Low EEM	11.0	High LEM

For the first interval of pregnancy loss (between days 24 and 31 of gestation) sires were classified as either high or low early embryonic mortality (EEM), while for the second interval (between days 31 and 60 of gestation) sires were classified as either high or low late embryonic/early fetal mortality (LEM)

majority of embryonic mortality occurs between days 14 to 18 of gestation (period of maternal recognition of pregnancy). Yet advancements of more precise early pregnancy markers indicate a considerable amount of pregnancy loss (approximately 16%) occurs between days 20 and 30 of gestation (during embryo implantation and placenta formation) and can be highly influenced by the genetics of the bull.

Both the male and female genetic material are necessary for proper embryonic development to term, however, as paternal genome plays a different role in conceptus formation.

With the intention to investigate how the male influences pregnancy losses in beef cattle, Pohler's group generated parthenogenic embryos (embryos produced in the laboratory containing maternal genome only) and transferred these embryos into recipient cows. In this study, they observed that only 12 out of 36 (33.3%) parthenogenetic embryos were able to survive between day 26 and 40 of gestation. However, no embryonic heartbeat was ever detected and the size of the pregnant uterus, as well as amount of fluid, appeared to be smaller than in a normal pregnancy on the same developmental day.

When they collected conceptus tissue from pregnant recipient cows and compared parthenogenetic and normal embryos, they observed parthenogenetic embryos resulted in smaller embryo size, with a free-floating embryo in the uterus and no site of implantation and/or embryo attachment. The results from this study indicated the lack of male genetics impaired proper embryonic attachment to the uterus and placenta development.

Embryonic mortality in cattle remains a significant economic burden for the beef cattle industry. The mechanism that regulates embryonic development and pregnancy success is complex and involves both the male and female genetics. In addition, the development of markers to identify sires with high or low probability of pregnancy loss may improve sire fertility and increase beef reproductive efficiency. AJ

Editor's note: Cliff Lamb is the animal science department head and a professor at Texas A&M University in College Station, Texas.