REPRO TRACKS

by Cliff Lamb, Texas A&M University

Heat Stress

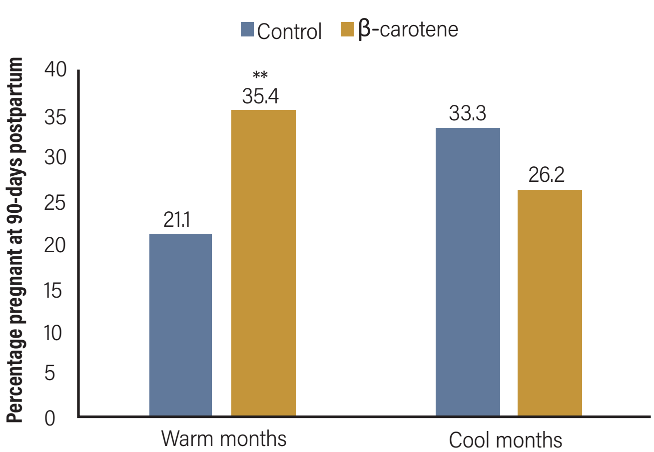
How does heat stress have an effect on fertility?

During my career I have had multiple questions on how heat stress has an effect on reproduction. Obviously, many producers have had experience with reproductive losses that may be attributed to heat stress, but usually this is a retrospective assessment without being sure heat stress was, in fact, the primary reason for reduced fertility.

I have had a chance to look into the literature to determine key issues associated with heat stress on reproduction. Heat stress appears to have two major consequences for the physiology of the cow that reduce her probability of becoming pregnant. Changes in cow behavior — reduced activity and reduced circulating concentrations of reproductive hormones such as estradiol-17β, caused by heat stress — reduce ability to detect estrus. In addition, pregnancy rates during the summer months may be significantly reduced in comparison to animals bred during other months of the year.

Fertility is reduced because heat stress can damage both the oocyte and early embryo. The oocyte can be compromised by heat stress as early as 105 days before it is even ovulated, and as late as around the time of ovulation. The early embryo is also initially sensitive to heat stress, but quickly becomes resistant so that heat stress on Day 1, after cows have been mated, reduced embryonic development, whereas heat stress at Day 3 appears to have no effect.

Figure 1: ***Effect of supplemental feeding of β-carotene in the postpartum period on reproductive function of lactating Holstein cows in Florida. Adapted from Aréchiga et al., 1998.***



Much of this research has focused on dairy cattle in warm climates, but it provides beef producers some insight on where and when to consider mitigation of heat stress to ensure pregnancy rates are not affected.

Conception rates in Holstein cattle decline significantly in the summer months for lactating cows, but not for non-lactating heifers. The lactating cow is very susceptible to heat stress because the increased amounts of heat produced as a result of lactation make it difficult to regulate body temperature during heat stress.

In beef cattle, heat stress, particularly in confinement situations, may have a negative effect on fertility. However, strategies used to reduce the negative effects of heat stress on fertility include utilization of beef breeds resistant to heat stress, or pursuing seasonal breeding patterns to ensure cows are not bred at the warmest time of year.

A strategy used in dairy cows to protect embryos from free radicals associated with heat shock is to administer antioxidants. One of the reasons why heat stress damages the oocyte and embryo may reside in an increase in production of free radical molecules at elevated body temperature. Exposure of maturing oocytes and early cleavage-stage embryos to elevated temperatures increases the production of free radicals. One experiment (Aréchiga et al., 1998) found feeding cows supplemental β-carotene from about Day 15 after calving increased the proportion of cows that were pregnant at 90 days postpartum during the summer, but not during the winter (Figure 1).

Another study demonstrated administration of melatonin during pregnancy in the summer months had reduced the interval to conception and decreased incidence of cows experiencing more than three matings during the following breeding season.

A more practical method for overcoming heat stress is to utilize exogenous hormones for ovulation synchronization for fixed-time artificial insemination (FTAI).

Protocols for FTAI can bypass problems associated with detecting estrus during heat stress, because timing of ovulation is synchronized and insemination can be implemented at a fixed time without the need for estrous detection.

FTAI does not reverse damage to the oocyte or embryo caused by heat stress. Implementation of FTAI programs during heat stress can increase the rate at which cows become pregnant after calving, because it increases the number of eligible cows that are inseminated. This is despite the fact that actual conception rates are not improved.

Embryo transfer (ET) was developed as a tool to increase the number of offspring from genetically superior females. This technology can also be used for improving fertility during heat stress. In fact, it remains the best method available for increasing pregnancy rate in females exposed to heat stress.

Pete Hansen at the University of Florida has demonstrated ET has repeatedly shown to alleviate the reduction in fertility caused by heat stress in dairy cows. Fertility is low during heat stress events (i.e., summer months) largely because of damage to the growing follicle, oocyte and embryo caused by exposure to elevated body temperature.

In ET protocols, the only embryos typically transferred are those that have developed. Thus, the embryo transferred into a heat-stressed recipient has, for one reason or another, escaped the negative effects of heat stress.

In addition, embryos have become resistant to heat stress by the time they reach the stage of development where they are ready to be transferred into a recipient (the morula or blastocyst stage). Thus, it is less likely that maternal hyperthermia will kill an embryo after Day 7 of pregnancy than an embryo in the first day or two of life.

As many producers know, the production of embryos through traditional multiple-ovulation embryo transfer (MOET; superovulation) or through IVF continue to be refined and will become more economically feasible. One potential use for these embryos is to overcome issues with heat stress. AJ

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