

Impact of Temperament and Stress on Reproductive Efficiency

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Introduction

Cow-calf operations are the foundation of the beef industry, determining the number of calves available for harvest. The success of these operations depends on the ability of beef females to maintain estrous cyclicity and produce one calf per cow annually. Reproductive success in cattle hinges on a combination of factors that work synergistically to optimize fertility and overall herd performance. Key contributors include proper nutrition, which ensures cows receive the necessary vitamins and minerals for healthy reproductive function; effective management practices, including regular health monitoring and timely veterinary care; and a stress-free environment, which minimizes disruptions to hormonal balance and estrous cycles. It is well documented that stressful conditions adversely impact cattle health, growth, and overall well-being. Many factors such as routine handling, transportation, and environmental conditions may result in a stress response, which is defined simply as the inability of an animal to cope with its environment (Dobson and Smith, 2000). Induction of the stress response triggers the activation of the hypothalamic-pituitary-adrenal axis and sympathetic nervous system, resulting in physiological changes aimed to reestablish homeostasis (Minton, 1994). Cortisol, often referred to as the "stress hormone," is produced by the adrenal glands and helps the body cope with stress by mobilizing energy reserves, modulating immune responses, and affecting various metabolic processes. While acute increases in cortisol can be adaptive and beneficial for handling immediate stressors, chronic or excessive cortisol elevation can have detrimental effects, including impaired immune function, reduced growth rates, and compromised reproductive performance (Carroll and Forsberg, 2007). Understanding and managing stressors effectively is essential to prevent prolonged cortisol elevation and its negative impacts on animal health and productivity.

Stressful Stimuli and Reproduction

As indicated previously, stress can affect a wide range of biological processes within the body, including reproductive function. More specifically, stressors interfere with mechanisms involved with regulation of the precise timing of events within the follicular phase, thereby decreasing fertility (Dobson and Smith, 2000). Acute and chronic stressors disrupt the physiological processes necessary for ovulation and normal reproductive function. In cattle subjected to multiple administrations of adrenocorticotropic hormone, to mimic chronic stress, estradiol secretion was reduced and ovulation was delayed or failed to occur altogether (Noble et al., 2000). Estradiol plays a critical role in regulating the estrous cycle, stimulating follicular development, and preparing the reproductive tract for potential embryo implantation. Low levels of estradiol can lead to irregular or suppressed estrous cycles, reduced ovulation rates, and diminished fertility (Smith and Dobson, 2002). Consequently, cows undergoing stressful situations and with decreased estradiol levels may experience lower conception rates and extended calving intervals.

A variety of stressors can contribute to suboptimal fertility in beef production, and therefore reduce reproductive efficiency. Temperament, a measure of reactivity of cattle to humans and new environments, has been shown to impact cattle growth, health, and reproduction (Cooke, 2014). For example, when exposed to human handling, cattle with excitable temperament exhibit agitation or aggression, which is largely attributed to their fear and inability to maintain homeostasis in that situation and thus considered a stress response. Cattle with excitable temperament have greater circulating cortisol concentrations compared to those with calmer temperament during routine handling procedures (Figure 1), which may impact normal physiological processes required for proper reproductive function. Therefore, temperament of beef females should be considered to optimize beef production efficiency.

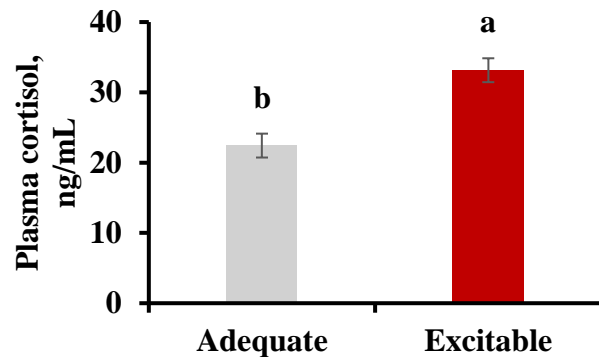


Figure 1. Plasma cortisol concentrations according to temperament score in beef heifers. Means with different superscripts differ significantly ($P \leq 0.05$). Adapted from Harvey et al. (2024).

Assessing Temperament in Beef Cattle

Assessing beef cattle temperament is crucial for optimizing herd management and ensuring both animal welfare and operational efficiency. By evaluating temperament traits such as responsiveness to handling, flight zone behavior, and reaction to novel stimuli, producers can identify cattle that are more amenable to handling and less prone to stress (Cooke, 2014). This assessment helps in selecting animals that are likely to adapt better to various management practices, ultimately leading to improved productivity and safety for both the cattle and the handlers. Understanding and managing cattle temperament also contributes to better overall herd health, reduced risk of injury, and enhanced quality of the final product.

Methods for assessing temperament in cattle involve a combination of observational and measurable techniques to gauge an animal's behavior and stress response or fear. The temperament score most used in research settings is calculated from the average between chute score and exit score (Cooke, 2014). The chute score assesses how calmly or agitatedly an animal behaves when confined in a squeeze chute, typically involving observations of its movement, vocalizations, and general demeanor. Chute score is assessed on the following scale: 1 = calm with no movement, 2 = restless movements, 3 = frequent movement with vocalization, 4 = constant movement, vocalization, shaking of the chute, and 5 = violent and continuous struggling. Exit velocity, on the other hand, measures the speed at which cattle exit the chute using infrared sensors over a predetermined distance, providing a quantitative assessment of their reaction to the handling process. Exit velocity is then converted to a 1-5 scale, where 1 are the slowest animals and 5 are the fastest. Exit velocity and chute score are then averaged, providing an individual temperament score between 1 to 5, whereas animals with a temperament score of ≤ 3 are considered adequate and those with temperament score > 3 are considered excitable (Brandão and Cooke, 2021). This assessment offers a robust evaluation of an animal's temperament, allowing for the identification

of cattle that may require special management strategies to ensure both safety and efficiency in handling practices.

Temperament and Reproduction

Cattle with excitable temperament have impaired reproductive performance, significantly influencing the efficiency and outcomes of breeding programs. Additionally, cattle with excitable temperament have decreased feed intake and altered feeding behavior compared to calm cohorts (Nkrumah et al., 2007; Llonch et al., 2018), which may create energy deficits that subsequently impact reproductive performance.

Replacement heifer development is a critical component of beef production, serving as the foundation for sustaining herd productivity and ensuring long-term genetic progress. Properly developing replacement heifers involves optimizing their nutrition, health, and management to ensure they reach puberty in a timely manner. Research demonstrates that heifers with adequate temperament had accelerated puberty attainment and greater body weight gain compared to excitable cohorts (Cooke et al., 2019). Replacement heifer development must include careful consideration of temperament, as it influences heifer performance, longevity, and integration into the breeding herd.

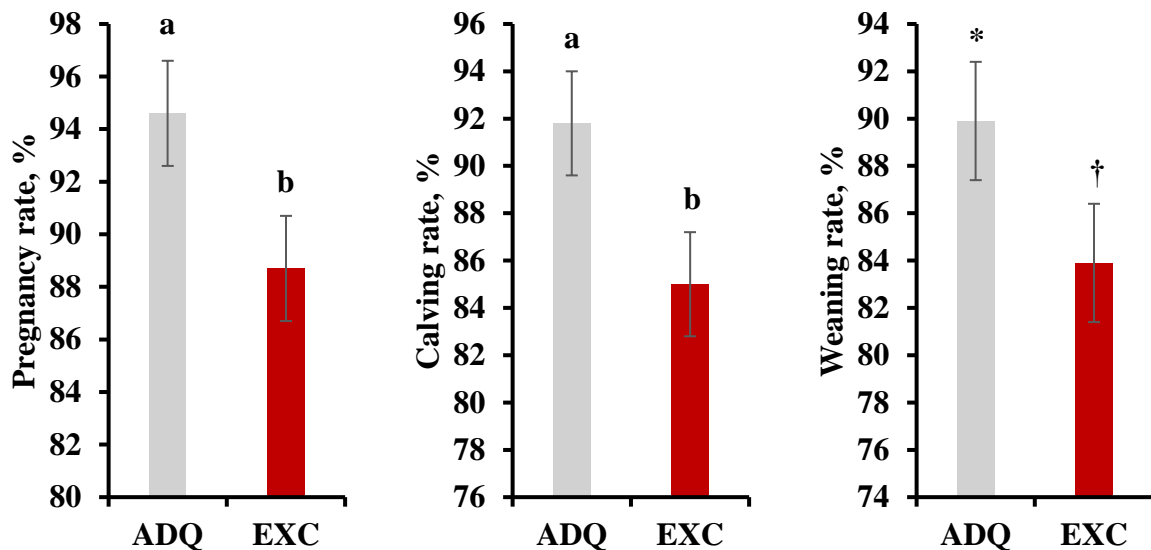


Figure 2. Effect of temperament in beef cows on pregnancy rate, calving rate, and weaning rate. Different superscripts indicate statistical difference ($P \leq 0.05$), and different symbols indicate a tendency ($P < 0.10$). Adapted from Cooke et al. (2009a).

Additionally, heightened agitation in temperamental cows may affect overall health, potentially resulting in higher rates of pregnancy loss and calf mortality, and decreased calf weaning weight. Research demonstrates that probability of pregnancy in crossbred cows exposed to natural service and artificial insemination was decreased linearly as temperament score increased (Cooke et al., 2009a). These results were corroborated in research conducted with *B. indicus* (Cooke et al., 2017), and *B. taurus* beef cows (Cooke et al., 2012), in which cows with excitable temperament had reduced pregnancy rates compared to cows with calmer temperament. Temperament also

influences the success of reproductive biotechnology, such as embryo transfer. Animals with a calm and manageable temperament are less likely to experience stress during handling and transfer procedures, leading to higher success rate and better outcomes (Fernandez-Novo et al., 2020). More specifically, pregnancy rate in embryo transfer recipient beef cows was improved in those with calm vs. excitable temperament (Kasimanickam et al., 2019). Collectively, calmer beef females have greater pregnancy, calving, and weaning rates compared to temperamental cows (Figure 2), contributing to the productivity and sustainability of the operation.

Reducing Stressful Stimuli and Improving Temperament of Beef Cattle

To optimize reproductive performance in beef cattle, it is essential to employ strategies that effectively reduce stress and improve temperament. One approach is simply culling aggressive animals to improve overall herd temperament. By removing individuals that exhibit aggressive or disruptive behavior, producers can foster an environment that not only enhances the wellbeing and productivity of the herd, but also reduces the risk of injury and stress among animals and handlers. With favorable temperament and docility correlated with many economically relevant traits, selection pressure on those animals who exhibit extreme aggression or agitation is warranted. However, there may be a point of diminishing returns, given that some degree of maternal aggression is needed to protect offspring in environments where predators are present. In fact, beef cows that were classified as aggressive at the time of calving had reduced calf morbidity and mortality (Sandelin et al., 2005), demonstrating the need to balance herd temperament with the practical realities of predator management.

Implementing selection changes in a beef herd to improve traits such as temperament is a gradual process that spans years. Hence, additional strategies are needed to reduce stress and improve temperament of beef cattle herds. For example, gradual and consistent exposure to handling practices helps reduce stress and build trust between the animals and handlers. Implementing low-stress handling techniques, fosters a more cooperative and manageable herd. This acclimation process not only improves the ease of routine management tasks but also contributes to better overall health, reduced injury risk, and increased productivity. Investing time and effort into proper acclimation pays long-term dividends in the form of a more harmonious and well-adjusted herd. Supporting this rationale, Cooke et al. (2009b) reported that acclimating Brahman crossbred heifers to handling improved temperament and accelerated puberty attainment compared to unacclimated cohorts.

As mentioned, temperament influences the success of reproductive technologies, such as multiple ovulation embryo transfer programs. Previous research demonstrated that administration of a non-steroid anti-inflammatory drug (NSAID) to recipient cows at the time of embryo transfer improved pregnancy rate in temperamental but not calm cows (Kasimanickam et al., 2018). These results could be attributed to the fact that the NSAID inhibits physiological processes contributing to early embryonic loss and reduced embryo viability, and reduces the effects of heightened stress in excitable cows (Kasimanickam et al., 2018). Another strategy to mitigate the effects of excitable temperament on reproductive success may be application of a bovine appeasing substance, which mimics the components of the natural pheromone produced by the mammary gland of beef females (Pageat and Gaultier, 2003). Utilization of this substance has been demonstrated to improve performance and reduce stress related responses (Cappelozza and Cooke, 2022), and may be an

effective tool to improve temperament and reproductive performance in cattle. Further research is warranted investigating the impact of incorporation of an appeasing substance into a comprehensive herd management program.

Conclusion

Reducing stress and improving temperament in beef cattle are critical factors in enhancing overall reproductive performance and productivity. By implementing strategies such as proper handling techniques, providing a well-structured and comfortable environment, and ensuring adequate nutrition, producers can create conditions that minimize stress and foster a more favorable temperament. This, in turn, leads to improved reproductive efficiency, healthier animals, and increased profitability. Prioritizing animal welfare not only benefits the cattle themselves but also contributes to the long-term success and sustainability of beef production operations.

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