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EFFECT OF HEAT STRESS ON GENETIC AND PHYSICAL HEALTH OF BREEDING CATTLE

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ABSTRACT

Heat stress presents a significant challenge to the genetic and physical health of breeding cattle. It affects physiological functions, reproductive efficiency, and genetic adaptation, leading to substantial economic losses. Implementing effective mitigation strategies, including environmental management, nutritional adjustments, and genetic selection, is essential to enhance cattle resilience against heat stress. Future research should focus on genetic markers associated with heat tolerance to improve breeding programs and sustain cattle production in changing climatic conditions.

Key words: Heat stress, Physical health, Genetic, Breeding

I. INTRODUCTION

Heat stress is a critical environmental factor affecting the productivity and health of breeding cattle worldwide. Climate change has led to rising global temperatures, exacerbating the impact of heat stress on livestock. Heat stress negatively influences genetic expression, reproductive efficiency, and overall physical health, ultimately reducing productivity and profitability in the cattle industry. This review explores the physiological and genetic consequences of heat stress on breeding cattle and discusses potential mitigation strategies.

II. PHYSIOLOGICAL EFFECTS OF HEAT STRESS

Heat stress leads to a series of physiological alterations in cattle, including increased body temperature, elevated respiration rate, and excessive sweating (Hansen, 2019). These changes disrupt homeostasis, leading to oxidative stress and metabolic imbalances. Prolonged exposure to high temperatures can cause dehydration, reduced feed intake, and impaired nutrient absorption, which significantly impact growth and reproductive performance (West, 2003).

III. IMPACT ON REPRODUCTIVE HEALTH

Reproductive efficiency is crucial for breeding cattle, and heat stress severely impairs fertility in both male and female animals. In females, heat stress disrupts estrous cycles, reduces oocyte quality, and leads to early embryonic mortality (Roth, 2020). In males, high temperatures negatively affect sperm production, motility, and morphology, reducing overall fertility rates (Das et al., 2016). The cumulative effect of heat stress on reproduction results in decreased calving rates and economic losses for cattle producers.

IV. GENETIC CONSEQUENCES OF HEAT STRESS

Heat stress also influences gene expression related to thermoregulation and adaptation. Specific genes, such as HSP70 and HSP90, play essential roles in heat shock responses, helping cattle cope with thermal stress (Collier et al., 2008). However, prolonged heat

exposure can lead to genetic mutations, altering cattle's ability to adapt to heat stress over generations (Bernabucci et al., 2010).

V. STRATEGIES FOR MITIGATING HEAT STRESS

To minimize the adverse effects of heat stress, several management strategies can be implemented:

Environmental Modifications

Providing shade, ventilation, and cooling systems (e.g., sprinklers, fans) can help regulate body temperature (Armstrong, 1994).

Nutritional Interventions

Adjusting diets to include antioxidants, electrolytes, and high-energy feed can mitigate metabolic imbalances (Kadzere et al., 2002).

Genetic Selection

Breeding programs focusing on heat-tolerant traits, such as coat color, skin properties, and heat shock protein expression, can improve resilience (Hoffmann, 2010).

Behavioral Adaptations

Modifying grazing patterns to avoid peak heat hours and ensuring access to adequate water sources can reduce heat stress impacts (Vitali et al., 2009).

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