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Impact of Heat Stress on Dairy Animals and Its Mitigation Strategies

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Heat stress poses a significant challenge to livestock production in India and is projected to exacerbate in the future due to prevailing trends of global warming. The temperature between 15°C to 25°C is considered as optimal range for dairy animal homeostasis, but exceeding this range, particularly in tropical and subtropical regions including India, results in the disruption of the overall performance of cattle. Heat stress has a major impact on milk production per tropical livestock unit and is predicted to be reduced by 25% by the end of this century. Summer season-induced stress adversely affects the reproductive efficiency of dairy animals which is influenced by many factors including day length, ambient temperature, relative humidity, and availability of nutrition.

Impact of Heat stress on dairy animal production

Extreme heat events have the potential to cause suboptimal animal performance and welfare, leading to economic losses and diminished food security.

- Heat stress primarily reduces feed intake, consequently leading to negative energy balance and associated decline in productivity by 35-50%.
- Heat stress in livestock is linked to elevated maintenance costs, attributed to increased energy expenditure for heat-mitigating processes such as panting and sweating.
- Heat stress experienced during the prenatal period exerts lifelong effects on postnatal growth rates, leading to decreased birth weight and alterations in behavior, post-absorptive metabolism, and body composition.
- Heat stress induces the shunting of blood from vital organs towards peripheral circulation, creating a hypoxic condition that is linked to the development of oxidative stress, thereby impairing vital organ functions.
- Heat stress suppresses the innate immune function by decreasing the vital immune responses of the body and increasing the risk of production diseases such as mastitis and metritis in dairy animals.
- Heat stress impairs the development of follicular growth resulting in an increased prevalence of ovulation failure.
- Heat stress is additionally linked to decreased expression of estrus, notably affecting the duration of estrus and the farmer's ability to detect it.
- Heat stress also impairs the establishment of pregnancy primarily the early embryonic development, even leading to an increased incidence of embryonic death.

Mitigation strategies to ameliorate the impact of heat stress

Heat stress mitigation strategies may vary by species, region, and resources. The major key components to ameliorate the impact of heat stress on dairy animals include:

Environmental alteration through physical means

Effective environmental management of livestock is essential to optimize production and mitigate the adverse effects of climate change on animal production systems. It comprises of provision of shading systems and evaporative cooling techniques. Shading systems are attributed to reducing the radiant heat load by 30% from incoming direct solar irradiation. These could be either natural through trees or artificial by well-isolated roof systems by painting white color on the upper part of the shade system or use of reflective roof with white galvanized or aluminum roof. Additionally, the installation of

cooling systems including fogging and misting systems, wet pads, or forced ventilation through the use of spray or fan can be beneficial in cooling the surrounding environment.

Nutritional strategies for heat stress

Optimizing livestock production in changing climatic conditions relies heavily on ensuring appropriate and balanced nutrition. The animal must be supplemented with a 10-25% extra maintenance ration including feeding of high-quality forage, concentrates, and fat to meet the energy requirements. Supplementation of fat has beneficial effects on the rate of synthesis of various hormones necessary for follicular growth and maintenance of pregnancy. Dietary supplementation of feed additives along with vitamins (Vitamin A, C, E) and trace minerals (Sodium, Potassium, and Selenium) help reduce oxidative stress and improve energy utilization by the animal. Additionally, the inclusion of ascorbic acid helps improve immunity, thus assisting in ameliorating the negative impact of heat stress.

Selection of heat-tolerant breeds

The breeding of dairy animals for high milk yield has narrowed their thermoregulatory range, exposing them to greater susceptibility to the adverse effects of heat stress. Therefore, identifying heat-tolerant animals within high-producing breeds proves advantageous for sustaining both productivity and survivability amidst heat stress. Cattle possessing shorter, thicker hair and lighter coat colors exhibit greater adaptation to hot climates compared to their counterparts with longer hair with darker coats.

Hormonal regimens and Assisted reproductive technologies

The potential strategy to mitigate the adverse effects of heat stress is to administer gonadotropin-releasing hormone (GnRH) at the onset of estrus, aiming to stimulate the release of a typical LH surge, hence improving the conception rate. Moreover, the application of exogenous progesterone enhances the plasma progesterone levels to compensate for its decrease in chronic heat stress conditions. Timed artificial insemination and ovulation synchronization protocols should be implemented to ensure conception and enhance the overall pregnancy rate during summer anestrus conditions, compensating for the reduced estrus detection rate.

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