Heat stress and its management in dairy animals

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Sustainability in livestock production system is largely affected by the climate change. An imbalance between the metabolic heat production inside animal body and its dissipation to the surroundings results in heat stress under high air temperature and humid climates. Stress is a reflex reaction of animals in harsh environments and causes unfavorable consequences ranges from discomfort to death of the animal. Climate change is one of the major threats for survival of various species, ecosystems and the sustainability of livestock production systems across the world, especially in tropical and temperate countries. It was also indicated that mainly developing countries tend to be more vulnerable to extreme climatic events as they largely depends on climate sensitive sectors like agriculture and forestry.

The thermoneutral zone (TNZ) of dairy animals ranges from 16°C to 25°C, within which they maintained a physiological body temperature of 38.4-39.1°C. However, air temperatures above 20-25°C in temperate climate and 25-37°C in a tropical climate like in India, it enhance heat gain beyond that lost from the body and induces HS. As a results body surface temperature, respiration rate (RR), heart rate and rectal temperature (RT) increases which in turn affects feed intake, production and reproductive efficiency of animals. Further, the sensitivity of dairy cattle to HS increases with increase in milk production, which might be due increase in metabolic heat output with increase production levels in dairy animals.

Reduced milk productivity of cows is considered as the most negative effect of heat stress as its economic results are usually visible after a few days. However, reproductive disorders may be a bigger problem for breeders. Similar like milk yield, the fertility is also depended of heat stress; however, its disorders are more difficult to detect and reveal after a longer period of time. Heat stress makes it difficult to detect oestrus in cows, negatively influences fertility and reduces reproductive capacity by reducing the efficacy of insemination. It also contributes to the increase of cases of calving difficulty, postpartum paralysis, increasing the number of stillbirths and the inflammation of the uterine mucus membrane.A negative energy balance can also promote ovarian cyst formation, disrupt germinal vesicle development, lead to disturbances in steroid concentration, potentially causing embryonic mortality, and reduce sperm production in stud bulls.Indicators of heat stress can be directly measured on the animals (behavioural, physiological, productive and reproductive indicators) and those environmental parameters that can be considered as risk factors. Indicators based only on the environmental parameters can be used to set thresholds, i.e. limits beyond which the risk that animals undergo thermal stress increases. But animals do not necessarily negatively react to the exceeding of these limits. The behavioural response elicited by heat stress can vary based on the breed, age, parity, physiological state, individual characteristics etc.

Effect on immune system: Heat stress occurs when an animal is unable to maintain equilibrium between heat accumulation and heat dissipation. During periods of heat stress the hypothalamic-pituitary-adrenal (HPA) and the sympathetic-adrenal–medullary (SAM) axis are activated for maintaining homeostasis in response to

stressful stimuli. The production of cortisol during periods of acute stress acts as a stimulus for the immune system, however during chronic stress cortisol secretion has been associated with immune suppression. Consequently, the suppression of the immune system results in the animal becoming more susceptible to disease and immune challenges.

Effect on Reproductive performance: Heat stress has adverse effects on the reproductive performances of dairy cattle and buffaloes. The main natural physical environmental factors affecting livestock system includes air temperature, relative humidity (RH), solar radiation, atmospheric pressure and wind speed. All these environmental factors are pooled to produce heat stress on animals, which is defined as any combination of environmental variables producing conditions that are higher than the temperature range of the animal's thermoneutral zone (TNZ). Heat stress has an adverse effect on reproduction traits of dairy cattle and buffaloes. A negative correlation exists between reproduction traits of cattle and buffaloes with THI and animals experience the adverse effects of heat stress when the THI crosses a threshold level. The conception rate in lactating dairy cows declines with THI more than 72-73 in cattle and 75 in buffalo. The significant ($p \leq 0.05$) decline in the first service pregnancy rate of dairy cattle was observed at THI level above 72 [14 and heat stress was one of the major factors for a significant reduction in a pregnancy rate of crossbred cows in India. The buffaloes are also susceptible to heat stress with respect to decline in fertility above THI level 75 in a subtropical climate. This review was aimed to determine the influence of heat stress in relation with THI on reproductive performances of cattle and buffaloes.

Management Strategies

Several management strategies can be employed to mitigate the effects of heat stress in farm animals. These include:

1. Providing Shade and Ventilation: Ensuring adequate shade and ventilation can help reduce heat load on animals. This can be achieved through the provision of shade structures, trees, or ventilation systems.
2. Cooling Systems: Implementing cooling systems, such as sprinklers or fans, can help lower body temperature and reduce heat stress.
3. Heat Tolerant Breeds: Selecting heat-tolerant breeds or strains can help reduce the impact of heat stress.
4. Nutritional Interventions: Providing nutritional supplements, such as electrolytes or antioxidants, can help mitigate the effects of heat stress.
5. Monitoring and Early Detection: Regularly monitoring temperature and humidity levels, as well as animal behavior and physiology, can help identify heat stress risk and enable early intervention.

In addition to these management strategies, several practical applications can be employed to reduce heat stress in farm animals. These include:

1. Adjusting Feeding and Watering Schedules: Adjusting feeding and watering schedules to avoid heat stress peaks can help reduce animal discomfort.
2. Providing Access to Cool Water: Ensuring access to cool water can help animals regulate their body temperature.
3. Using Cooling Technologies: Using cooling technologies, such as cooling pads or cooling vests, can help reduce body temperature and heat stress.

Further research is needed to develop and refine management strategies for heat stress in farm animals. This includes:

1. Developing Heat Stress Indices: Developing heat stress indices that can be used to predict and monitor heat stress risk.
2. Investigating Novel Cooling Technologies: Investigating novel cooling technologies, such as evaporative cooling systems or misting systems.

3. Examining the Impact of Heat Stress on Animal Welfare: Examining the impact of heat stress on animal welfare and developing strategies to mitigate this impact

Conclusion: Heat stress is a significant issue affecting farm animals worldwide. By employing effective management strategies, such as providing shade and ventilation, using cooling systems, and selecting heat-tolerant breeds, farmers and animal caregivers can help reduce the impact of heat stress on farm animals. Further research is needed to develop and refine these strategies and to investigate novel approaches to mitigating heat stress in farm animals.

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