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Climate Change And Novel Approaches To Enhance Livestock Resilience Against Heat Stress

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Abstract:

Climate is the average weather over a lengthy period of time, usually thirty years. Precisely speaking, it represents the average and fluctuations of meteorological factors across periods varying from months to millions of years. One of the main causes of climate change is anthropogenic activity. Climate change is a significant risk factor affecting livestock performance in India Livestock is crucial to the global economy, and the effects of climate change extend beyond crop production to impact livestock as well. This includes decreased milk yields and quality, lower meat production, and reduced fertility. As a result, food security based on livestock is threatened in many regions around the world. Heat stress directly affect global livestock production by undermining health, welfare, and productivity, while also indirectly impacting it by diminishing the quality and availability of animal feed. To mitigate the economic losses caused by heat stress, several key strategies are being employed.

Keywords: Climate change, environmental modifications, advanced strategies, novel technologies

Introduction:

Climate change, on the other hand, poses a threat to livestock production due to its effects on biodiversity, animal illnesses, animal reproduction, water availability, feed crop and forage quality, and milk production. Heat-stress management strategies may vary among species, region and resources. Seasonal variations and climatic extremes will affect the health of livestock because of its negative impact on the quantity and quality of herbages which also will lower productivity and reproduction efficiency (Sejian, 2013). A significant global danger to the sustainability of livestock systems is climate change. Thus, reducing the negative effects of extreme climates and adapting to them are important in reducing the impact of climate change on livestock. In many regions there is an uncertainty that livestock performance will be impacted by climate change, and most prediction models indicate that these effects will be

deleterious. In few years, there may be abrupt shifts in climate or more subtly over decades. Climate change is commonly linked to a rise in the Earth's overall temperature. Although animals can adapt to hot climates, the mechanisms they employ for survival may have negative effects on their overall performance. A 1-3 °C rise in local mean temperature is expected to result in a small increase in agricultural yield at mid to high latitudes. Frosts, heat waves, or periods of intense rain can also negate the benefits of the temperature rise in these places. However, in lower latitudes, a smaller temperature increases of 1-2 °C can make crop and cereal output worse (Thornton *et al.*,2007).

Novel Technologies For Heat Stress Amelioration in Livestock Species:

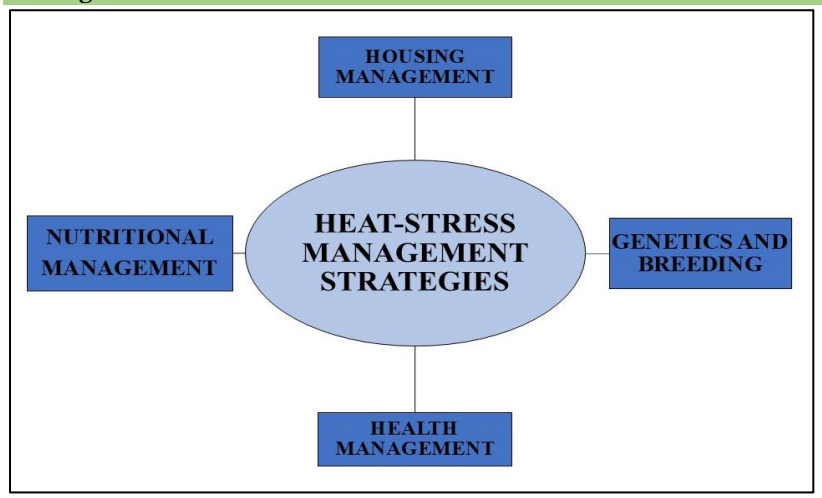
It can be broadly divided into four categories: Housing management, Nutritional interventions, Genetics and breeding, and Health management.

- Housing management strategies include design of animal shelters, animal shade, cooling systems, and forced ventilation.
- Nutritional improvements include seasonal feeding, fiber feeding, fat and concentrate feeding, vitamin and mineral supplementation and providing cold drinking water.
- Genetic and breeding approaches include the study of animal genetic diversity, gene selection for thermotolerance through genomic and proteomic approaches, embryo transfer, and the development of stress-tolerant breeds.
- Health management strategies include monitoring and controlling disease outbreaks, epidemiological surveillance measures, rapid investigation of outbreaks, use of geographic information systems to map disease outbreaks, and climate-related disease outbreaks.

All of these strategies can help sustain livestock production in changing climate (Sejian *et al*., 2018).

Housing Management:

There are wide range of technological and environmental modifications available to mitigate the effects of hot climates. However, if nutrition, disease control, or breeding practices are not adequate and animal performance is being limited, then environmental modifications to reduce heat stress in farm animals are not ideal (Renaudeau *et al*., 2011). By reducing the amount of solar radiation surrounding the animal, these environmental modifications minimize the heat stress. For outdoor animals, one of the easiest and most economical ways to reduce heat from solar radiation is to provide either artificial or natural shading. Trees are highly effective natural shading materials that provides cooling to the animals when the moisture from the leaves evaporates. Artificial shades have been successfully used in the livestock sector in heat-stressed animals that are present either in confinement or in intensive situations. Although shade effectively protects cattle from solar radiation, it does not alter the air temperature to maximize the cows' sensible heat-loss pathways. Different types of roofing materials are available, from metal to synthetic materials for shade structures. However, the most effective in terms of reducing heat



loads are reflective roofs, such as white galvanized roofs and aluminium. Various cooling systems were also been evaluated. Evaporative cooling systems use energy from the air to evaporate water, which evaporates into warmer air that lowers air temperature and increases relative humidity. This system requires a fan, an evaporative cooling pad, and a pump to circulate water to the pad. Other evaporative cooling methods include misting, fogging and sprinkling systems.

Nutritional Management:

In hot climate there are several nutritional management areas that need to be taken into account. Most animals have different feeding habits in the summer, and they usually eat more in the evening when the weather is cooler (Atrian and Shahryar, 2012). Moreover, feeding more often will improve feed utilization efficiency in the rumen and reduce daily variations in ruminal metabolites. The feeding schedule could be changed to improve the animal's capacity to withstand the metabolic and climatic heat load in summer (Nesamvuni et al., 2012). Feeding of fresh, palatable and high-quality forages (Increases the digestibility and reduces the heat production by nutrient utilization), Buffers (Lowers the incidence of Ruminal acidosis), Fat or grain sources (Enhance energy density of ration), Addition of yeast or yeast culture (Maintains pH of rumen), Feeding of dietary rumen bypass fat (Combat negative energy balance Exogenous supplementation), Anti-oxidants like Vitamins C, A and E and trace elements such as zinc, copper, manganese, selenium, chromium (Attenuate the negative effects of environmental stress and acts as Immunomodulator) (Kumar *et al*., 2011) , Electrolyte supplementation (Relief from dehydration and evaporative heat loss and respiratory alkalosis) (Digicomo *et al*.. 2015), Pharmacological and Nutraceutical Treatment such as addition of fungal cultures in the feed which decreases body temperatures and respiration rates in high temperature regions.

Genetic And Breeding Approaches:

Modern literature reveals a preventive rationale aimed at improving cattle tolerance to heat and heat stress through genomic selection of advantageous genotypes. Genotyping and breeding animals that are naturally more tolerant of high temperatures, combined with appropriate Heat Stress detection and remediation strategies, can minimize negative effects on cattle health, welfare, and production. Finding the appropriate genotypes to select is the first stage in breeding cattle for Heat Tolerance and can genetically prevent the detrimental effects on Heat stress. Improving Anatomical Resistance to Heat Stress stimuli,

General Association of Single Nucleotide Polymorphisms (SNPs), Enhancing HSR Protein Activity, Increasing Protein Stability and Function these are the four interpretations identified in existing literature for identifying the advantageous genotypes (Scerri *et al*., 2023). Introduction of various cell growth factors like caspase inhibitor and insulin like growth factor-1 (IGF-1) which protects cells from a variety of stresses, improve rates of pregnancy with embryo transfer, Protect heat-induced cellular damage and developmental competence of embryos.

Health Management:

Climate change can greatly influence the incidence, prevalence, and distribution of livestock diseases (Anbupriyan *et al.,* 2024). Disease surveillance measures facilitate faster intervention in the event of an unexpected disease outbreaks in the livestock caused by climate change and to reduce the current and projected health risks due to heat stress. If data is provided in a timely and sufficient manner, monitoring will improve and adaptability will increase (Nitish *et al*., 2021). Ameliorating strategies can help to overcome environmental stress. These important strategies are being implemented to overcome the economic losses caused by heat stress.

Conclusion:

Heat stress is a significant climatic factor that negatively impacts agricultural and livestock production globally. These strategies aim to alleviate environmental stress. Additionally, there should be a greater focus on adopting modern technologies in India to help prevent heat stress. Heat stress related to climate change has been identified as a key factor negatively impacting animal production. Although animals have various adaptive mechanisms that help them survive in extreme environmental conditions, these adaptations often limit their productivity. Significant progress in environmental management, including enhanced housing and cooling systems as well as modified feeding strategies, genetic and breeding approaches can help mitigate the impact of thermal stress on performance. The effectiveness of these solutions varies based on several factors related to the animals, such as species, physiological stage, breed, and the specific livestock production system. Recent developments in heat stress amelioration designed to reduce heat stress provide encouraging options for enhancing livestock resilience in the face of climate change challenges.

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