

IMPACT OF ENVIRONMENTAL STRESS ON DAIRY PRODUCTION

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ABSTRACT

Sustainability in livestock production system is mostly affected by climate change. Climate change affects various factors associated with production, reproduction, health and adaptability of the animals. Dairy sector is more susceptible to climate change. The temperature humidity index (THI) is the widely used as index to measurement of thermal stress in animals. Environmental stress has adverse effects on health status of dairy animals and decreases the milk production and reproductive performance of dairy cows resulting in huge economic losses. Global climate change is expected to alter temperature, humidity, rainfall, atmospheric carbon dioxide. The dairy sector is a more susceptible to climate change and global warming where it is mostly affected by the temperature and humidity such as temperature humidity index (THI). Combined effect of high ambient temperature and high humidity results adverse effect on reproductive performance of farm animals. The management strategies viz., microclimatic modification, nutritional management, feeding strategies and artificial insemination protocol are to be strictly followed to ameliorate the adverse effects of heat stress in dairy animals.

Keywords: Heat Stress, Dairy Production, Temperature Humidity Index

INTRODUCTION

Livestock sector plays a vital role for livelihood food security in India. The animal husbandry and agriculture are the major resource of income for the farmers and directly affects the economic conditions of farmers. Climate change is one of the major threats for the sustainability of livestock production systems in tropical countries. Sere et al. (2008) reported that heat stress has adverse effects on the productive, reproductive and health performances of dairy animals. According to inter governmental panel on climate change (IPCC, 2007), there is an increase in body surface temperature, rectal temperature (RT), respiration rate (RR) and pulse rate (PR) and decrease in feed intake, production and reproductive efficiency in hot climatic conditions. Increase in temperature of earth per decade by 0.2°C, global average surface temperature would be increased to 1.4-5.8°C by 2100. The major environmental factors affects livestock production system include temperature, relative humidity (RH), solar radiation, precipitation and wind speed (WS). Strategies to ameliorate negative impact of heat stress on production and reproduction in dairy animals include improved housing and management intervention to reduce climatic impacts on livestock. Various cooling system such as use of fogger and sprinkler with or without fan, feeding management, diet manipulation and change in reproductive protocol, will also improve dairy farm profitability. Cooling system is the most effective way to increase both milk production and reproduction in dairy animals during the summer season.

ENVIRONMENTAL FACTOR AND ANIMAL STRESS

Many environmental factors directly or indirectly affects on production performance of animals. Change in climatic condition directly affects the production and reproduction level of animal about 58.3% and 63.3%, respectively. High environmental temperature leads to changes in the animal's body physiology such as rise body temperature ($>102.5^{\circ}\text{F}$), respiration rates ($> 70\text{-}80/\text{minute}$) and blood flow.

TEMPERATURE HUMIDITY INDEX (THI) TO ASSESSMENT OF HEAT STRESS LEVEL

Temperature-humidity index (THI) is the universal and most precise indicator of stress assessment as temperature and humidity. Hot climatic conditions lead to decline production and nutrient intake of animal. Heat generated by metabolizing nutrient contributed to body temperature maintenance in a cold environment. However, in a hot climate, heat needs to be dissipated to maintain body temperature and normal physiological functions. THI is account for combine effects of environment temperature and relative humidity and animal response. THI can be calculated by formula (Mc Dowell, 1972),

$$\text{THI} = 0.72 (\text{C db} + \text{C wb}) + 40.6$$

Where, C db = dry bulb temperature ($^{\circ}\text{C}$), C wb = Wet bulb temperature ($^{\circ}\text{C}$). RH: Relative humidity (RH %) /100.

If THI, 72 there absence of heat stress, 73 to 78= mild heat stress, 79 to 88= moderate heat stress, 89-98 = severe heat stress and <72 = danger for animal. When the environmental temperature rises from the upper critical limit, the detrimental effects of heat stress on animals in terms of reduction in production of milk, changes in composition of milk and reduced reproductive performances are observed in cattle and buffaloes.

Table1: Classification of stress level based on THI values (Armstrong, 1994).

THI	Stress Level	Symptom in Livestock
< 72	None	Optimum productive and reproductive Performance
73-78	Mild	Increases respiration rate and rectal temperature, animals seek for shade
79- 88	Moderate	Decrease dry matter intake and water intake in buffalo is significantly increase. Body temperature is increased and reproductive performances are severely affected in cattle and buffalo
89- 98	Severe	The reproductive performances in animals are significantly decreased. Excessive panting and restlessness are observed
>98	Danger	Heat stress is extreme and animals may die

EFFECT OF HEAT STRESS ON ANIMAL REPRODUCTION

Climate change has a great impact on the reproductive activity of cattle and buffaloes. High temperature combined with high level of relative humidity has detrimental effect on reproduction of cattle in summer season. Heat stress had negative effect on reproductive traits of cattle and buffaloes which can be quantified through formulating temperature humidity index (THI). Conception rates of lactating dairy animals have been declined with increased THI more than 72-73 in cattle (Schuller et al., 2014) and 75 in buffalo (Dash, 2013).

EFFECTS OF HEAT STRESS ON HEALTH OF DAIRY ANIMALS

Heat stress has direct and indirect effects on health performance of animal leading to changes in physiology, metabolism, hormonal and immune system. Increase in environmental temperature has a direct negative effect on voluntary feed intake and efficiency of feed utilization (Baile and Forbes, 1974). Lactating cows start to decline the feed intake at air temperature of $25-26^{\circ}\text{C}$ and reduces more rapidly above 30°C in temperate climatic conditions and at 40°C it may decline by 40% in cattle, 8-10% in buffalo heifer and 22-35% in goat.

STRATEGIES TO AMELIORATE HEAT STRESS

To reduce the heat stress is the multidisciplinary approach. It should include modification of micro environment; nutritional management and genetic improvement are key components for sustainable livestock production under hot environment conditions.

MODIFICATION OF MICRO ENVIRONMENT

Modification of micro environment to improve heat dissipation mechanism to alleviate heat stress is one of the most important measures to be considered in hot environment. The most common approach to ameliorate heat

stress is to modify environment near to cow way through provision of shade, evaporative cooling system by use of fogger, mister or sprinkler with fan or without fan. Improve reproductive performance of cows using effective cooling systems that combine evaporative cooling with tunnel ventilation or cross ventilation.

NUTRITIONAL MANAGEMENT

Reduced dry matter intake with greater availability of key nutrients. During hot climate, dietary fat content in feed is to be increased to enhanced milk production efficiency and yield. Supplementation of niacin supportive to reducing of heat stress in cattle and supplementation with antioxidants during the heat stress period is an additional to improve fertility in buffaloes.

GENETIC MODIFICATION

The identification of heat tolerant animals within high producing breeds and they can be select genetically for crossbreeding programme to improve genetic variation and cooling capability.

CONCLUSION

Heat stress is a major economic issue in the dairy industry. It affects the production reproduction and health of animal through physiological changes. Environmental stress has adverse effects on health status of dairy animals and decreases the milk production and reproductive performance of dairy cows resulting in huge economic losses. The most common method to reduce heat stress in dairy cows by provision of shades, sprinklers, ventilation and evaporative cooling will be suitable for adapting to climates changes. Environmental modifications and nutritional management are key elements to alleviate the impact of heat stress on animal's performance during the hot climate. Wallowing and sprinkling are the most effective methods to reduce heat stress in case of buffalo during summer season. Strategies to reduce negative impact of heat stress of animals using cooling system, ration manipulation, change in reproductive protocol, antioxidant, use of buffers, yeast and hormones will improve the economic status of dairy farmers.

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