Gaurav Kumar *et al*, International Journal of Advances in Agricultural Science and Technology,
Vol.7 Issue.10, October-2020, pg. 11-14 ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Effect of Heat Stress on Productive and Reproductive Health of Animals

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Introduction

Dairy cattle are important part of the livestock sector in India. It is well known that the thermal environment has an integral role in maintaining the health and productivity of cattle. Climate is one of the most important factors in animal adaptation to its surrounding environment and variation in climatic variables such as temperature, humidity, air movement, photoperiod, and solar radiation may impose stress on the productive and reproductive performance traits of animals. According to World Health Organization, World Meteorological Organization and the United Nations Environmental Program, global warming would be a greater frequency and greater duration of exposure to hotter temperatures, especially during the summer months. Because of the climate change effects, summer temperatures have been increasing worldwide and this trend will continue in near future also. Among the livestock, dairy animals are likely to be impacted greatly by the effects of climate change. The IPCC (2007) predicts that by 2100 the increase in global average surface temperature may be between 1.8°C to 4.0°C. India also experiencing increased average temperatures and humidity, and more hot spells recently. Heat stress due to high ambient temperature and humidity elicits harmful effect on growth, production and reproduction of farm animals. Typical hyperthermia sometimes occurs during severe heat in summer and as a result of hard expose to sun throughout the world.

Stress is a reflex reaction revealed by the inability of an animal to cope with its environment, which may lead to many unfavorable consequences, ranging from discomfort to death. Heat stress could be reason of the significant increase of production cost in the dairy

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industry. Heat stress has also been scientifically established to produce negative impact on the growth performance of animals. In animals and humans, some physiological and biochemical adaptations could occur to protect essential cell functions against heat stress.

Effect of Heat Stress on Milk Production and Milk Composition

Different species, breeds and individuals depending upon their physiological states have comfort zones of temperature tolerance. Beyond these limits, the animals require extra energy for thermoregulation. Growth, milk production and reproductive performance in both male and female animals are impaired as a result of the drastic changes in biological functions including disturbances in protein, energy and mineral metabolism, which depress productivity of temperate breeds significantly introduced to a tropical or sub-tropical environment. Heat stress is usually related with a turn down of the productive performances as they concentrate on thermo-regulation mechanisms to avoid hyperthermia. Heat stress is negatively associated with various dairy characters including milk yield and therefore is a considerable financial burden in many milk producing areas of the world. The rise in temperature averages by 1.6, 3.2 and 8.8°C above normal (21 °C) results in the decrease in daily milk yield averages by 4.5, 6.8 and 14%, respectively, and a decline in the daily temperature by 7°C below normal resulted in an increase in the daily milk yield by 6.5% in dairy cattle. Cows exposed to heat stress produces milk with around 49% less lactose and protein than thermo neutral temperature. Thermolysis causes metabolic changes that reduce the feed intake. Therefore, less energy is available for growth and production performances. This is the main reason for reduction in milk yield. High yielding dairy cows and during peak lactation are extremely susceptible to heat stress. Heat load also has a negative association with milk fat and protein composition. Climatic conditions appear to have the marked effect on milk composition during the first trimester of the lactation. Furthermore, the stage of lactation, type of diet, health status, genetic makeup and climatic conditions are the major drivers of variation in milk quality and quantity. However, numerous authors have reported a negative relationship between heat load and milk fat and protein composition. Garner et al. found that these findings suggest that milk fat and protein composition is variable, a portion

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of this variability can be contributed to climatic conditions. The decrease in milk yield in a hot environment is higher in high productive animals especially at the peak of lactation.

Effect of Heat Stress on Reproductive Performance of Animals

Environmental factors such as high temperature, humidity and rainfall lead to decrease in cattle's estrus activity. Female reproduction like sexual behavior and fertility rate are the critical factors that are negatively influenced by environmental stress. It has negative impact on the anterior pituitary, preovulatory follicle, corpus luteum, embryo developments and endometrium resulting in low fertility and loss of fetus. Early embryonic loss in livestock is common due to stress. Prenatal maternal stress results in increased incidence of spontaneous abortion, preterm delivery and low birth weight. Pregnancy rates declined from 61% to 45% as rectal temperature increased 1°C at 12h post insemination. The poor reproductive performance associated with thermal stress may be due to high temperature acting directly on the developing embryo and/or through a maternal endocrine imbalance. Cattle, sheep in heat stress exhibit reduced uterine and umbilical blood flows, resulting reduced fetal oxygen. High temperature shortens the estrus period and reduces the expression of heat, which results in decreased heat detection efficiency. Heat stress damages ovarian follicles and causes a decrease in estradiol synthesis. This decrease in estradiol synthesis could influence expression of estrus, ovulation, and the corpus luteum. Stress results in disturbance of spermatogenesis, decreased sperm fertility parameters and disturbed folliculogenesis. Catechol amines interfere with transport of gametes and decreases blood flow.

Mitigation Strategy

The effects of heat stress on animals cause drastic economic losses to the farmers, but there are few opportunities to recover some of the losses by adapting suitable strategies to mitigate heat stress. There are three major key components to sustain the productivity of animals in hot environment: through physical modifications of environment, nutritional management and genetic development of breeds that are less sensitive to heat stress. Mitigation strategy may vary

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depending on region, resources and species. Strategies that are cost effective and involve indigenous knowledge have the better success rate in adopting those strategies by the farmers.

Conclusion

Heat stress affects directly (mediated by hyperthermia) and indirectly (mediated by reduced nutrient intake and behavior changes) metabolism and physiology of the animals, which ultimately reduce the synthesis of milk and reproductive performance. As knowledge of the negative impacts of heat stress to increase livestock performance, will develop the effective mitigation strategies to support maintenance of productivity during times of high thermal heat loads and preserve appropriate animal welfare standards.

