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STRATEGIES TO MITIGATE THE HEAT STRESS ON BOVINE REPRODUCTION

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Abstract: Heat stress incurs loss to the livestock farmers by causing negative effects in terms of both production and reproduction. It increases embryonic loss, reduces milk yield, estrous expression, immunity, embryo quality and size, endocrine hormones, sperm quality and quantity. The present article reviews the strategies required to reduce and combat these negative effects of heat stress especially on bovine reproduction.
Keywords: Heat Stress, Reproduction, Management, Anti-oxidants, Genetic Manipulation.

Introduction

Global warming/ climate change are multidimensional implications to livestock, which manifests in the form of heat stress, scarcity of feed and fodder, and changes in epidemiological patterns of vector borne diseases etc., which ultimately leads to reduction in production and reproduction efficiency of livestock. Reproductive functions of livestock are vulnerable to climate changes and both female and males are affected adversely (Kebede, 2016). Developing countries are mostly affects to climate change due to poor resources and lack of knowledge of farmers on climatic changes and their effect on animals and efficiency of veterinary and extension services**.**

MITIGATION STRATEGIES

Some of the mitigation strategies to reduce heat stress on animals and to improve the health status of the animals include alterations of cow's environment, genetic selection of more heat tolerant of heifers, nutritional management, embryo transfer, antioxidant treatment, use of pharmaceuticals and neutraceticals etc., have been recommended to reduce heat stress and improve the reproductive efficiency in heat stressed bovine (Wolfenson *et al.,*2000; De Rensis and Scramuzzi, 2003).

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1. DETECTION OF ESTRUS

Estrus is increasingly difficult to detect due to shorter duration and less intensity. Efficiency of estrus detection can be improved by using a combination of heat detection methods like tail-head-paint can be coupled with visual estrus detection, podometers can also be used. Increasing the time and number of visual observations for estrus can improve the detection rate (Homer *et al.,* 2013). In summer months, heat detection during night and early in the morning hours using an entire male may also improve the efficiency of detection. (Acharya, 1988)

2. PHYSICAL MODIFICATIONS OF THE ENVIRONMENT

A large number of studies have detailed about physical modifications of the environment to ameliorate the heat stress. Different methods include shades, ventilation, combination of wetting and ventilation. The most common approach to ameliorate Heat stress is to alter the cow's environment through provision of house or shade (along with feed and drinking water), evaporative cooling system with water in the form of fog, mist or sprinkling with natural or forced air movement, and possibly cooling ponds (Atrian and Shahryar, 2012). Shading is one of the cheapest ways to modify an animal's environment during hot weather (Das *et al*., 2016). Evaporative cooling with tunnel ventilation or cross ventilation is the most effective cooling systems currently in use (Kadokawa *et al*., 2012).

3. GENETIC MANIPULATION

The mammalian gene pool contains allelic variants of specific genes that control body temperature regulations and cellular responsiveness to hyperthermia. Thus genetic selection, both natural and artificial, can modulate the impact of heat stress on reproductive function (Hansen, 2009). Traits that could possibly be selected include coat color, genes controlling hair length, heat shock resistance in cells. Genetic modification or altering biochemical properties of the embryo before embryo transfer may be possible to improve thermal resistance and increase summer fertility (Hansen, 2009)

4. SELECTION OF MORE HEAT TOLERANT BREEDS

There are distinct breed differences in thermoregulatory ability in cattle (Hansen, 2009). The superior thermoregulatory ability of Zebu cattle has been ascribed to lower metabolic rate, reduced resistance to heat flow from the body core to the periphery and properties of hair coat (Hansen, 2004). During their separate evolution from Bos taurus, zebu cattle (Bos indicus) have acquired genes that confer thermotolerance at the physiological and cellular levels. Cattle from zebu breeds are better able to regulate body temperature in response to heat stress than are cattle from a variety of Bos Taurus breeds of European origin (Hansen, 2004)

5. BREEDING STRATEGIES

Many local breeds already adapted to their harsh climate conditions. Identification and strengthening of local breeds to local climate stress and feed resources and improving the local genetics through cross breeding with heat and disease tolerant breeds are suggested (Hoffman, 2008).

6. NUTRITIONAL MANAGEMENT

Select and feed fresh, palatable and high quality forages as far as possible and feed ingredients that have a high digestibility in the animal to lower the heat production by nutrient utilisation within the animal (Chase, 2013). Stressed animals require readily fermentable carbohydrates. Feed ingredients should have buffering capacity or some buffers like sodium bicarbonate, magnesium oxide and sodium sesquicarbonate to maintain a normal rumen environment by lowering the incidence of acidosis effectively in the rumen which is common incidence during hot weather (Chase 2013).

7. EMBRYO TRANSFER

Many investigations have indicated the use of embryo transfer to bypass embryonic mortality during the first 7 days of development when embryos are much more susceptible to heat stress. The technique can significantly improve pregnancy rates during the summer months. Recent developments in improving embryo resistance to heat stress through the use of both genotype manipulation and addition of survival factors such as insulin-like growth factor-1 which protects cells from a variety of stresses may further improve pregnancy rates with embryo transfer (Drost *et al.,*1999).

8. HARMONAL MANIPUATION AND TIMED AI

Fixed-time AI (FTAI) along with hormonal manipulation can be employed when there are problems in detecting the estrus in heat stressed animal. A hormonal manipulation (Ov-Synch i.e, GnRH-PGF_2 –GnRH/ Co-Synch/ Heat-Synch etc) protocols eliminate the need for estrus detection. Insemination is performed at a predetermined time following the last GnRH injection. The timed AI shortened the interval to first service and increased pregnancy rates in heat stressed cows when compared to insemination at observed estrus (de la Sota *et al.,* 1998).

9. GnRH INJECTION AT ESTRUS

Injection of GnRH at estrus may be another possible way to improve fertility in the summer. Studies have shown to improve the conception rate from 18% to 29% when lactating cows were injected with GnRH at detected estrus during summer. Lactating dairy cows injected with GnRH at the first signs of standing heat during the summer and autumn months reported to increase conception rates (56%) compared to untreated (41%) controls (Kaim *et al.,* 2003).

10. ANTI-OXIDANTS, VITAMINS AND MINERALS

Administration of exogenous antioxidant nutrient supplementation especially vit-C, A and E and trace minerals like zinc, manganese, copper, selenium, chromium etc. can be used to attenuate the negative effects of environment stress (Kumar *et al.,* 2011). Evidence suggests that embryonic survival can be improved by antioxidant administration (Wolfenson *et al.,* 2000).

There is an evidence to indicate that one of the causes for embryonic death in heat stressed animals is production of ROS by embryos developing at elevated body temperatures (Hansen, 2009). However, body has antioxidants in the form of enzymatic (superoxide dismutase [SOD], glutathione (GSH) peroxidase and catalase), non-enzymatic (albumin, L-cysteine, homocysteine, melatonin and protein sulfhydryl groups), and non-enzymatic low molecular weight antioxidants (ascorbic acid, GSH, uric acid, α-tocopherol, β-carotene, pyruvate and retinol), which increases as a results of Heat stress to provide protection against negative effects of ROS (Das *et al*., 2016). The beneficial effects of antioxidants feeding on reproductive function during heat stress are also reported in lactating cows.

11. PHARMACEUTICALS AND NUTRACEUTICALS TREATMENT

Pharmacological treatments can also be developed to reduce the degree of hyperthermia experienced by the cows exposed to heat stress. Many feed additives, which can partially alleviate heat stress through increased heat dissipation and thus lowering internal body temperature. Use of fungal cultures in the feed decreased body temperatures and respiration rates in hot, but not cool weather.

Recently, encapsulated niacin when fed to the lactating cows increase sweating rates and lower the core body temperatures compared to the thermal neutral controls. The use of encapsulations techniques to bypass the rumen, feed additives to improve heat loss, and (or) manipulating cellular biochemical composition may improve reproductive function during the summer months (Bilby *et al.,* 2008).

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