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Popular Article

Effect of Climate on Fertility in Small Ruminants

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One of the most important factors affecting life styles on earth is climate. The climate, which is formed by the effects of factors such as temperature, precipitation, humidity and wind in a particular region, affects the existence of living things, the geographical distribution an abundance of plant and animal species, the chemical structure of oceans, seas and lakes and the formation of soil (Jackson, 2018). The change that occurs in the climate system as a result of natural factors or human activities is defined as "climate change" (IPCC, 2007). Climate changes; drought, desertification, imbalances and deviations in the speed and intensity of precipitation, floods, typhoons, storms, tornadoes, hurricanes etc. manifests itself with increases in metrological events. Climate change has emerged in the form of global warming, which is defined as the increase in the average temperature on the Erath's surface in recent years. The effects of global warming can be seen as a result of the greenhouse effect of the gases released into the atmosphere (Bozoglu *et al*., 2003; Koknaroglu and Akunal, 2010). Greenhouse gases having an important place in climatic changes adsorb on long-wave infrared rays reflected back to the atmosphere and cause the atmosphere to warm. Greenhouse gases arise not only naturally but also as a result of various activities of people (Koknaroglu and Akunal, 2010). Today, the world is facing with climate change due to global warming caused by technological and chemical applications used to increase plant and animal production in meeting the needs of the increasing population as well as industrialization and urbanization (Koknaroglu and Akunal, 2010). Although the events occurred due to these problems threatening the world are not fully understood yet, it seems inevitable that global warming will cause economic, ecological and sociological problems (Demir and Cevger, 2007). Climate change threatens the welfare of present and future generations by changing the ecosystem of

the planet. Climate changes caused or to be caused by global warming may be vary in different ways by different parts of the world (Tufekci and Tozlu, 2021).

The impacts of extreme heat on animal health, reproduction and productivity jeopardize the economic viability of livestock farming. The variation in climatic conditions leads to significant disruptions in milk production and meat quality, exacerbating economic pressure on farmers (Anass *et al*., 2024). Livestock has a range of thermal comfort zone where they can produce optimally and this varies according to the species, breed, age and physiological state (Nardone *et al*., 2010; Dangi *et al*., 2016). Climatic factors such as ambient temperature, relative humidity, direct and indirect solar radiation and wind speed affect the availability of feed and water, feed quality and pathogenesis where production is most efficient under optimum environmental conditions (Joy *et al*., 2020). Tufekci and Tozlu (2021) mentioned that, the climate change impacts on agriculture and livestock are being witnessed all over the world, but in the developing countries like India, its effect is much more drastic as a large section of the population depends on agriculture for livelihood. In Indian subcontinent, heat stress is the most important climatic stress which adversely affects the livestock and sometimes even threatens the survival of the animals. Small ruminants are critical to the development of sustainable and environmentally sound production systems. Among the climatic components that may impose stress on the productive and reproductive performance traits of sheep and goats are ambient temperature, humidity, air movement, photoperiod, solar radiation, wind speed etc. of which the ambient temperature is the most important variable. Heat stress affects performance and productivity of small ruminants in all phases of production. Climate affects small ruminant's production in four ways.

1. The impact of changes in small ruminant's pasture availability
2. Impacts on pastures and forage crop production and quality
3. Changes in the distribution of diseases and pests
4. The direct effects of weather and extreme events on health, growth and reproduction

Further, changes in temperature and precipitation regimes may result in spread of disease and parasites in new regions or produce high incidence of diseases and mortality with concomitant decrease in small ruminant's productivity. Animal possesses its own adaptive mechanism to counter the environmental extremes under the changing climatic conditions. The principle adaptive mechanism of small ruminants is: physiological, neuro-endocrinological, biochemical, cellular and molecular mechanisms. Several mitigation strategies are presently being targeted to improve small ruminant's production under the changing climate scenario. Generally, three basic management schemes for reducing the effect of thermal stress have been suggested:

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1. Physical modification of the environment
2. Genetic modifications to improve thermo tolerance
3. Improved nutritional management schemes

Impact of climate change on reproduction: Increased body temperature in rams during heat stress causes testicular degeneration, a decrease in the percentage of normal and fertile spermatozoa, low ejaculate volume, high semen pH, decreased sperm motility and decreased sperm quality (Hamilton *et al*., 2016, Rahman *et al*., 2016). Temperature increases the risk of infection in the mammary glands of lactating animals (Koyuncu and Akgul, 2018), and caused a decrease in birth weight and viability of the offspring born in January, February and July, August of pregnant goats. It has been reported that mortality rates in the first month after birth increase in cold and warm months (Luo *et al.*, 2020).

The heat stress was shown to affect both the male and female reproductive functions in livestock in several ways, viz. fertilization rate, estrous activity, embryonic survival, sperm motility and abnormalities and mortality in spermatozoa (Marai *et al.*, 2007, Narayan *et al.,* 2018). According to (Sawyer, 1979), most of the reproductive processes are influenced by environmental stressors, either by directly affecting the functions of reproductive organs or blocking the cellular functions of the hypo-thalamic-pituitary-gonadal axis. Working with Australian Merino ewe (Narayan *et al.,* 2018), reported heat stress to result in reduction in embryo production during artificial insemination or embryo transfer., which was attributed to the disruption of the physiological and cellular features of the reproductive function of the animals and early embryo development. The ewes exposed to a hot condition during the first 3 days after artificial insemination shown to affect the oocyte and or embryo quality (Sawyer, 1979). The susceptibility of pregnant and lactating ruminants to heat stress is found to be much higher than those of non-pregnant and non-lactating ones (Alliston and Ulberg, 1961). Dobson *et al*., 2012, reported heat stress affecting the reproductive performance n sheep through impaired reproduction. Naqvi *et al.* (2004) observed thermal stress to harm the embryo quality during the pre-ovulatory period in Bharat Merino sheep. Exposure of Ossimi ram to severe heat stress during host summer and at THI of over 84, reported increasing the rectal and scrotal skin temperature, abnormalities in sperm and semen and further reduction of conception rate and lambing (Darawany, 1999). Studies with ewes of different breeds viz. Ossimi, Rahmani and Ossimi Suffolk have shown to have negative relationships between conception rate and ambient temperature and daylight length (Darawany, 1999, Naga *et al.,* 1987, Marai *et al*., 2004). Further, exposed to high ambient temperature, the reproductive functions of the females are found to be adversely affected, with a reduction in the length of the estrous cycle and effect on ovulation (Marai *et al.,* 2008). Chemineau, (1993) reported

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an increase in early embryonic mortality and a decrease in fecundity in ewes subjected to heat stress. Studying crossbred ewes of Targhee x Suffolk under heat stress conditions for a short and long duration of 25 days and 53 days respectively, Brown *et al*., (1977) observed a smaller size of lambs at birth for both duration of treatments.

Summary

Some sheep and goat breeds have been found to adapt to warm environments providing acceptable productivity rates. The positive characteristics of these species are related to their relatively small body size, low water and feed requirements, good feed conversion rate and the capacity to convert poor quality feed into quality products. Therefore, identifying tolerant breeds for higher adaptability in extreme environmental conditions (high temperature, feed shortage, water scarcity) is an applicable strategy to reduce the impact of climate change on sheep and goat production (Silanikove and KolumanDarcan, 2015; Joy *et al*., 2020).

The understanding of the negative impact of heat stress on the productivity and well-being of sheep and goats is of paramount importance today to take up appropriate alleviation strategies. It is therefore, necessary that the livestock keepers are given adequate exposure for improved understanding of the impact of such elevated ambient temperature which is likely to be intensified further in the coming years with the increasing impact of climate change. In this endeavor, there is a need to intensify the linkage between the associated researchers, extension workers and the livestock keepers to improve knowledge and skills of the later for ensuring all necessary measures of good management practices and for taking appropriate strategic and operational management decisions to improve production systems in such heat stress condition. It would be also necessary to continue the research efforts on the subject to improve our understanding of such climate extreme situations for providing necessary guidance to the stakeholders associated with the farming of these small ruminants for harnessing maximum production and ensuring the well-being of the animals (Biswal *et al.*, 2021).Region specific investigations should be undertaken with regard to the adaptation of small ruminants in the local stressed climates. The adapted local breeds can be better alternatives as an appropriate bio-resource to sustain small ruminant production under changing climatic conditions (Alena *et al*., 2020).

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