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Climate change and its impact on small ruminant production

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ABSTRACT

The small ruminant industry, consisting of sheep and goats, holds global significance, particularly for the livelihoods of rural populations in arid and semi-arid regions. Climate change, marked by rising global temperatures and greenhouse gas (GHG) emissions, poses a significant threat to livestock systems, impacting the health, productivity, and reproduction of small ruminants. Heat stress, driven by increased ambient temperatures, reduces feed intake, growth, milk, meat, and wool production, and impairs reproduction in sheep and goats. Climate change also affects pasture availability, further stressing animals. Adaptation strategies such as behavioral, physiological, and management changes—like rotational grazing, selective breeding, and improved feeding practices—help mitigate these effects. Additionally, efforts to reduce methane emissions through feed additives, improved feed management, and heat-protected sheds contribute to lessening the environmental impact. These adaptation and mitigation strategies are essential to sustaining the small ruminant industry in the face of climate change.

Key Word: Goat, Sheep, Climate, Production

INTRODUCTION

The small ruminant industry is significant globally; 56% of all domestic ruminants are sheep and goats. By 2050, sheep populations worldwide are predicted to rise by 60% (Foresight, 2011). The livelihoods of the rural poor in the dryland agro-ecosystem depend heavily on the production of small ruminants, such as goats and sheep. In the arid and semi-arid regions of India's western region and southern region, the majority of the small ruminant population (>70%). There is a lack

of water, significant weather unpredictability, and low biomass output in these arid and semi-arid regions. In these settings, high grazing intensity and exposure to extreme weather (high ambient temperatures) affect small ruminants' ability for productivity (Shilja *et al*., 2016).

In the present scenario, climate change is the greatest global threat to Sustainability of humans as well as livestock system. As per International Panel of Climate Change (IPCC) average global temperature will increase between 1.8 °C and 4.0 °C in next 90 years. Compared to last 1000 years, rate of climate change is faster in current situation. This climate change affects health and productivity of livestock which leads to deteriorate quality and production of livestock products like meat, milk, wool, skin (Yasha *et al*., 2019).

The generation of greenhouse gas emissions (GHG) is the most important environmental impact as far as livestock farming is concerned. As the emissions from livestock increase, many changes concerning the atmosphere, the land and the oceans are occurring that lead to climate change. Methane is the most important greenhouse gas generated from the animal. In ruminants, methane (CH4) is mainly produced by enteric fermentation and manure storage.

Effect of climate change on small ruminant:

Heat stress impact: - As the greenhouse gases increase, global temperature rises which leads to heat stress in animals. Heat stress affects through decreased reproduction, growth, production, health issues and mortality. Among all ruminant sheep and goat are less susceptible to heat stressed environment but extreme heat stress causes profound effect.

Impact on growth: - Profuse amount of water loss occurs in summer so it should be taken care of in rearing of small ruminants. In hot weather appetites have reduced because of suppressive nerve impulse from peripheral thermal receptor to appetite center which leads to decrease in feed intake. Deceased feed intake has impact on negative energy balance and reduced weight gain. Thus, growth of animals suppressed. This will impact on production of milk, meat, wool in the form of quality or quantity.

Impact on reproduction: - Reproduction plays vital role to maintain flock size but persistent rise in temperature impairs the reproductive ability by decreasing testosterone level. High ambient temperature has a negative impact on female reproductive processes. The estrus cycle is shorter in duration. Heat stress alters the release of numerous reproductive hormones, lowers estrus expression, and impairs oocyte quality and embryonic development. It reduces female fertility, the rate of conception, and the survival of animal embryos (Falah and Al-Ghetaa, 2012).

Impact on production: - Climate change can have a severe impact on sheep and goat farming, as several pressures other than heat stress can counteract it and negatively impact on their productivity (Marai *et al*., 2017). Extreme weather affects the quantity and quality of pastures that are accessible, forcing animals to graze over great distances in search of pastures. Animals may suffer negative consequences from the combined effects of multiple stressors if they are subjected to them simultaneously. Previous study revealed that high temperatures deteriorate the quantity and quality of milk produced by ewes and goats. The state of heat stress in goats and ewes might have a detrimental effect on milk supply. Finocchiaro *et al*., (2005) found that there appears to be a significant variation in the degree of decline in milk production among different sheep breeds. The

amount of fat and casein that milk from a variety of sheep and goat breeds seems to be greatly impacted by exposure to high temperatures. Sheep milk's coagulating qualities are negatively impacted by elevated temperatures. In relation to meat production, the hot season has a detrimental impact on the organoleptic qualities of cattle meat (Marino *et al*., 2016).

Adaptation to climate change impact:

Heat stress: - To adapt heat stress behavioral, physiological, morphological changes play vital role. Many Studies revealed that animals with higher body size having metabolism rate lower compare to smaller body size so capacity of heat release or gain depends on body size. Digestion and metabolism process generate heat inside the body to control that voluntary decrease in feed intake is adopted by animal itself (Attia *et al*., 2016). Coat and skin color also play essential role because dark body color will absorb more light than light body color (Fadare *et al*., 2013).

Management of grazing: - During summer, availability of grasses is less so for sheep and goat production, rotational grazing can be a helpful grazing management technique (Sharma and Sahoo, 2017). By maintaining forage at an earlier growth stage, rotational grazing allows for better quality digestibility, increased productivity. Good quality silage, feed pellets, and feed blocks can be made from the unconventional feed sources. In summer if there is a shortage of feed, these can be used to feed.

Physiological mechanism: - Numerous physiological adaption mechanisms found in animals aid in lowering heat load. Animals may experience a rise in body temperature to the point that their health becomes unstable when the physiological system is unable to reduce the effects of heat load. Since body temperature is the end result of all activities in the body that include heat gain and loss, it is a useful indicator of an animal's ability to deal with heat. The primary indicators of the physiological adaptation mechanism in small ruminants are changes in heart rate (HR), respiration rate (RR), and rectal temperature (RT) (Sejjan *et al.,* 2017).

Mitigation Strategies:

Methane mitigation:

Greenhouse gases (mostly methane) produced by ruminant needs to be mitigated. For those various strategies required: Change in feed or feeding management; Adding feed additives that modify Rumen; Selection of animal breed and rearing system (Marino *et al*., 2016).

Change in feed or feeding management: - Regarding feeding management, reducing CH_4 emissions is typically linked to any actions that improve animal performance and feed efficiency. Feeding techniques that restrict ruminal fermentation and raise voluntary feed intake mitigate CH_4 emission. The type of fodder used can also have an impact on the amount of CH_4 produced in the rumen.

Adding feed additives that modify Rumen: - Lipids are useful as feed additives because they effectively stop protozoa and methanogens from growing. vegetable oils, coconut oil, reduce rumen methanogenesis (Dohme *et al*., 2000). Although ionophores antibiotics like monensin are uncommon in commercial small ruminant production, they have impact on CH4 mitigation.

Selection of animal breed and rearing system: - when individual animal emission of methane can be measured or accurately predicted, genetics could be used to mitigate emissions per kg product through direct selection (Lambe *et al*., 2014). Various animal chooses various plant during grazing, the rate at which rumen digests, and the interactions between hosts and microbes can be predict. This makes it possible to use genetic selection to choose animals that emit less intestinal CH_4 on a daily or DMI basis.

Heat stress mitigation:

Heat protected shed: This type of shed provides comfortable microclimate to the animals during summer. In this chamber, floor is at lower level than the outside. It helps to maintain temperature. Along with that the roof is made up of tharmocol enclosed with PV sheet, also provide fans and foggers if required. It is, necessary to make the shed sufficiently high and make sure there are openings for ventilation in the roof or walls (Dawood, 2017).

Managemental practices: Modifications to the ration composition, such as increased energy density, the use of feed additives, feeding schedule adjustments (such as feeding at cool hours or intervals), grazing time, and dietary fiber adjustments (such as using high-quality fiber forage) can all significantly help to lessen the harmful effects of heat stress. Therefore, feeding animals frequently and during the cooler parts of the day encourages them to continue eating their regular diet and helps to reduce heat stress. Offering enough fresh, cold drinking water is one of the best ways to lessen heat stress (Silanikove, 2000). It is crucial that animals always have access to enough clean, cool, fresh water because sheep and goats have higher water needs when living in high temperatures.

Breed Selection: Compared to exotic cattle breeds, native tropical breeds are typically less productive (Renaudeau *et al*., 2007). The utilization of native breeds, however, would probably be most effective in raising production levels in extremely difficult conditions (hot climate). By crossing commercial breeds with exotic species, we can take advantage of a particular breed's resistance to heat and increase performance levels through crossbreeding. Either selection under stress or the introduction of "heat adaptation" genes from a local breed into a commercial breed can improve an animal's ability to mitigate climate change impact.

CONCLUSION

Climate change has an impact on the small ruminant production system, and it also contributes to global warming. The growth of the sheep and goat industry is hampered by greenhouse gas emissions. Accurate assessments of greenhouse gas emissions are essential for organizing efficient mitigation strategies in various regions and animal husbandry systems. However, since small ruminants are not the only cause of climate change, the negative effects of global warming brought on by other sources may also have an adverse effect on small ruminant performance, which would contradict the effectiveness of mitigation strategies that have been put in place and are expected to have a significant impact on animal behavior. Thus, in order to achieve sustainable small-ruminant production, attention must be paid to both adaptation and mitigation. The former will aim to lower the amount of greenhouse gas emissions that contribute to global warming, while the latter will lessen the impact of climate change on the wellbeing and productivity

of small-ruminant farmers. Predicting how climate change will affect the health of small ruminants and creating measures for adaptation to it may be made easier with the use of new technology.

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