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A Mini Review on Goat Farming amidst the Present Climate Change

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ABSTRACT

Livestock sector is extremely resilient to climate change and are considered to play a significant role in ensuring the food security of the growing human population on the planet. The impact of climate change is visible all over the world and situation in India is more alarming as our rural economy is primarily dependent on crop-livestock production system. As compared to other livestock, goats are considered as the ideal animal due to its draught resilience, high disease resistance and its ability to survive on limited pasture. This review goes through intothe advantages of rearing goats as compared to other livestock, role of goats in climate change mitigation and socio-economic importance of goats. Goats are crucial for poor farmers, especially in lower and middle-income countries in Asia. They provide milk, meat, and other products which can be readily sold and have low labor requirements, making them ideal for families with limited resources. Furthermore, these low income group families consider goat as better resilient animal to manage with stressors like feed and water scarcity, heat stress and to feed on bushes when compared to other animals like cattle and sheep. These advantages makes goat species to effectively counter the adverse effects associated with climate change and also optimize relevant economic returned through sustained production. Therefore goats can be projected to be the future animal with high potential to combat alarming climate change effects and goats can also plays an important role in ensuring food safety to meet the demands of increasing human population in the near future.

HIGHLIGHTS

- Goats exhibit high adaptability to heat stress, water scarcity and poor quality forage.
- Goat farming enhances income diversification and nutritional security for landless farmers.

Keywords: Climate change, Goat Farming, Poor farmers

Animal production is considered as the most widely adopted agricultural practice by marginal and medium farmers particularly in developing countries like India. However the sustainable livestock production has become a challenge for the farmers in the recent climate changing scenario. The increase in greenhouse gases, primarily due to factors such as rapid industrialization, energy production, population growth, increase in urbanization and agriculture, is the main driver of climate change (Stern and Kaufmann, 2014). Climate change is a long-term imbalance in normal weather conditions such as temperature, wind and precipitation in a given region, may be one of the greatest challenges facing by humans and animals during this decade. In India there is an overall decrease in the seasonal mean rainfall. But an increase in extreme rainfall events has occurred over the central India and in many other areas. There are more land regions where the number of heavy precipitation events has increased than where it has decreased. Climate change is one of the challenging issues to our world and thechange in climatic conditions directly and indirectly affects

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livestock population and country economy (Marai *et al*., 2007). Direct effects from air temperature, humidity, wind speed and other climate factors influence animal growth, milk production, reproduction and wool production (Houghton, 2001). The indirect effect of climate change on livestock production is mediated through changes in feed resources, shrinking grazing land and sudden disease outbreaks. Scientific evidence indicates that climate change increasingly impacts life on the planet, posing a significant threat to sustainable development and the future of humankind (Choudhary and Gupta, 2024). Indigenous goat, sheep and cattle are considered more resilient to cope with high heat load, water and energy deficit than the exotic breeds. Among these the goats are projected to be the best animal model to cope up with multiple environmental stressors (Shilja *et al*., 2016). The goat population has tremendously increased over the years in Asia and this is mainly because of the various advantages of goat population for coping with environmental adversities in tropical countries. Thus in this review an integrated approach will be presented showing the superiority of goats as compared to other livestock species which may substantiate their superior resilience ability to survive under harsh climatic condition.

Physiological adaptability to climate stress

Livestock rearing in most of the world have shifted towards small ruminants mainly because of management advantages when compared to large ruminants. Goats are considered tobe homoeothermic animals, which are capable of actively regulating their body temperature to maintain thermal balance (Ferreira *et al*., 2021). This ability of goat is crucial for animals exposed to fluctuating environmental variables, particularly in regions affected by climate change. Goats are efficient in selecting plants and their parts higher in protein and energy compared to those selected by other livestock, but still able to survive on high fibre diet. Goats also conserve moisture in their gut, minimize water loss, and still produce kids and a relatively good amount of milk, meat and manure even when inhabiting arid areas (Pragna *et al*., 2018). Goats exhibit a remarkable capacity for heat dissipation, facilitated by their enlarged ears, extensive vascular network and thin skin, which increase surface area for efficient heat loss. This adaptation is particularly evident in some goat breeds inhabiting arid and semi-arid regions, where high ambient temperatures and low relative humidity prevails. Goats possess several morphological traits which are crucial for managing heat stress and optimizing efficiency in extreme climatic conditions. Their narrower muzzles and split upper lips enhance their ability to selectively forage, which can be critical in environments with scarce resources. Goats also help to control invasive plant species, prevent the overgrowth of shrubs, maintain open landscapes, and contribute to the diversity of plant species. During drought or water scarcity, goats decreases voluntary dry matter intake in an effort to maintain equilibrium with the available body water. These behavioral adaptations makes goat more tolerant to high environmental temperatures and low humidity.

Disease Resistance in Goats

Among all the domestic ruminants, goats are well known for their disease resistance and can survive better even in adverse climatic conditions. Goats have higher number of lymphocytes and neutrophils in circulation which shows a well-developed immune system in the species (Daramola and Adeloye, 2009). Gastrointestinal parasitic infection is a very common problem in all small ruminants. Goats are reported to have less gastro intestinal infections as comparedto other ruminants. The susceptibility to parasitic infection seems to be related with genetic factors and may vary among different breeds and species. Teshome and Derso (2015) studied the prevalence of major skin diseases in ruminants in Ethiopia and reported that the prevalence of ecto-parasite infestations was higher in sheep (13.58%) and cattle (7.95%) and lower in goats (2.24%). Goats also possess vast genetic diversity. Indigenous breeds in Africa, Asia and the middle-east are particularly well-adapted to harsh environment.

Ecological adaptability

Goats thrive well in diverse ecosystems-from mountainous terrains to arid and semi-arid plains. Their browsing behavior minimizes competition with grazers and enables restoration of degraded lands. Goats help to control bush encroachment and invasive plant species. They require less feed and water per unit of meat and milk produced which results into a smaller environmental footprint. Goats also emit less greenhouse gas as compared to cattle, buffalo and sheep. Goats have high feed conversion efficiency and

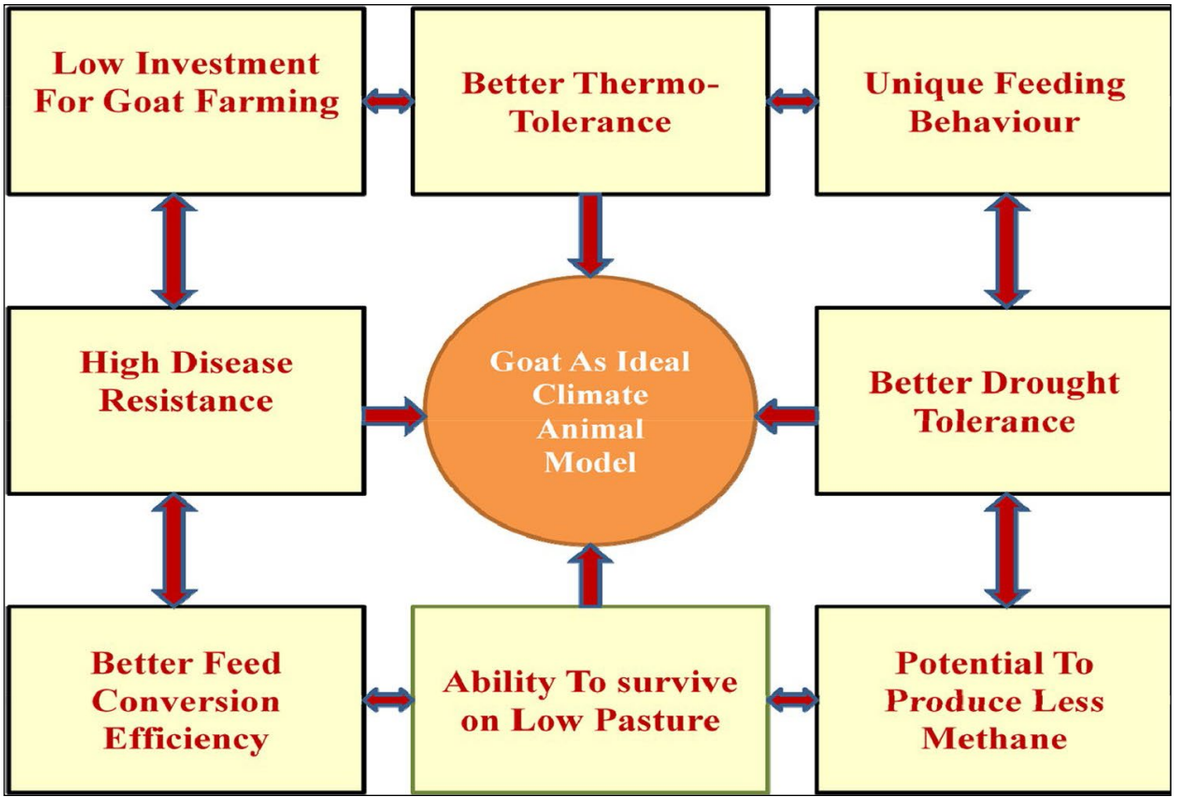

Fig. 1

therefore produce less enteric methane emission per unit of feed ingested. Genetic selection of goats with high feed conversion efficiency will produce less CH_4. Furthermore, genetic selection for reduced CH_4 production can help farmers indirectly increase profits byincreasing feed without adding carbon credits (Animut *et al*., 2008).

Socio-Economic Relevance

Goats hold significant socio-economic importance, particularly in developing countries, by providing income, food security, and serving as a source of livelihood for many, especially small and landless farmers. In many developing countries like India, goats are often called as "poor man's cow" due to their low input requirements, high fecundity, and easy marketability. Goat farming is getting more and more attractive as a result of the rising demand for animal products. There is a need to create a scientificway of goat keeping without having a negativeinfluence on the environment because goatfarming is often the only means of life for manywomen in remote areas (Hossain *et al*., 2015). Goat farming provides a continuous income stream for many families through the sale of milk, meat, and other products like skins. Goat farming is a pathway to economic empowerment for many, with the potential to lift families out of poverty, particularly through the sale of a larger number of animals.

Drought Tolerance in Goats

Goats have evolved various adaptive strategies which helps them to escape from undesirable effects of drought. During the period of water scarcity the voluntary intake of dry matter was found to decrease in order to maintain equilibrium with the available body water (Alamer., 2009). Goats have the ability to desiccate their feces and can concentrate their urine in order to reduce the water loss through feces and urine in case of drought conditions. Forage resources are in trend of depletion both in terms of quality and quantity due to negative impacts of climate

Table 1: Global production, emission and emission intensity for small ruminants

Species	Production (million tonnes)		Absolute emissions[1] (million tonnes CO_2 –eq)		Average emission intensity (kg CO_2-eq/kg product)	
	Milk[2]	Meat[2]	Milk	Meat	Milk[2]	Meat[2]
Goat	12.0	4.8	62.4	112.5	5.2	23.5
Sheep	8.0	7.8	67.4	186.9	8.4	24.0

[1]Absolute emission include emission from production and post farmgate emissions.

[2]Functional unit for meat and meat defined as fat and protein corrected milk and carcass weight.

change. There is no specific feed requirement for goats which is beneficial for them to meet their nutritional requirement with the available forage, instead goats can utilize those forages too which other ruminants rejects to consume.

Apart from the physiological advantages, goats are equipped with several anatomical features to cope with water scarcity. The rumen, salivary glands and kidney have significant roles in their osmo-regulatory mechanisms. The fermentation vat, rumen, acts as a water storage tank during dehydration periods. Goats also conserve moisture in their gut, minimize water loss and still produce kids and a relatively good output of milk, meat and manure even in drought conditions (Silanikove, 2000). Thus, goats when exposed to water stress can able to maintain a normal water balance in body tissues to ensure a body water level compatible with life.

Less methane production potential

The process of emission of gases from livestock is complicated and is still under study. The main livestock that cause greenhouse gas emission are cattle, buffalo, sheep, goat and yak and is through the process of enteric fermentation. The end product of this enteric fermentation is volatile fatty acids which are the primary source of energy in ruminants. This process leads to liberation of four fermentation gases like Carbon Dioxide (CO_2), Hydrogen (H_2), Nitrous Oxide (NO_2) and Methane (CH_4). Among these gases, methane is the main gas which particularly contributes to global warming by trapping much more heat in the earth's atmosphere than carbon dioxide. Because of this, there is very much focus on methane impact on climate changes caused by livestock including goats. Research have shown that different livestock have different methane production potential but it is believed that goats emits less methane (CH_4) than all other domestic ruminants per unit body weight because goats have high feed conversion efficiency, they emit less methane per unit of feed consumed (Koluman Darcan, 2023).

The emission of methane from goats varies according to roughage and concentrates in their diet. The amount of methane emitted by goats largely depends upon what they can eat and in what season. The ratios of protein and fibre in plants providing roughage will alter considerably by season, plant maturity and local precipitation in different sites grazed and browsed by goats. It has been found that feeding of a high concentrate to low roughage diet produces less enteric CH_4 vis-à-vis low concentrate to high roughage diet.

CONCLUSION

Goat stands out to be a species which can be reared more effectively even during the adverse climatic conditions. Their adaptability, low environmental impact and socio-economic benefits make them an ideal species for addressing the challenges of food security and sustainable development in the changing climatic scenario.

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