

## Effects of Climate Change on Goat Husbandry and Breeding in Nigeria: A Review

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### ABSTRACT

*In many regions of the world, climate change is perceived as posing a serious threat to the viability of numerous species, ecosystems, and livestock production systems. Several effects result from the increase in world average temperatures. These outcomes result in various regional and worldwide climatic shifts. Due to the dominance of rural economic structures and sectors focused on developing livestock breeding, the livestock sector in Nigeria is the one that is most significantly impacted by the global climate change. Environmental sustainability depends heavily on the health and welfare of the animals used. Extreme occurrences and seasonal variations harm animal wellbeing, reduce productivity, and impair reproductive efficiency. The goat is an animal that can utilise pasture to its fullest potential throughout the entire year. Climate change will inevitably have significant negative consequences on the natural resources that are the foundation for animal production such as goats in addition to its effects on ecosystems. The availability of pasture and other resources for goats throughout the year is significantly influenced by climatic factors including temperature and precipitation patterns. However, with the attendant effects of climate change goat breeds that are resistant to heat stress can be created by finding genetic markers for heat tolerance to increase productivity.*

**Keywords:** Climate change, Goat, Heat stress, Animal health, Breeding.

### INTRODUCTION

Climate is one of the most significant variables influencing life styles on planet. The existence of living things, the geographic distribution and abundance of plant and animal species, the chemical composition of oceans, seas, and lakes, and the formation of soil are all impacted by the climate, which is created by the interactions of variables like temperature, precipitation, humidity, and wind in a particular region (Jackson, 2018). "Climate change" is defined as a shift in the climate system brought on by natural or human factors. Increases in meteorological occurrences are a result of climate change, which manifests as drought, desertification, imbalances and deviations in precipitation speed and severity, floods, typhoons, storms, tornadoes, hurricanes, etc. The term "climate change" now refers to global warming, which is the recent rise in the average temperature of the Earth's surface. The greenhouse effect of the gases emitted into the atmosphere is what causes the effects of global warming (Köknaolu and Aküna, 2010). When long-wave infrared photons are reflected back into the atmosphere, greenhouse gases, which play a significant role in climatic shifts, adsorb on them and warm the atmosphere. In addition to being produced naturally, human activity also contributes to the production of greenhouse gases (Köknaolu and Aküna, 2010). The globe is currently dealing with climate change as a result of global warming brought on by industrialization, urbanisation, technical and chemical applications used to improve plant and animal output to fulfil the demands of the growing population. It seems inevitable that global warming will result in economic, ecological, and sociological difficulties, even though the events caused by

these threats to the planet are not fully known yet (Demir and Cevger, 2007).

By altering the planet's environment, climate change puts the wellbeing of both current and future generations in danger. Distinct regions of the world may experience climate changes that are different from one another due to global warming. Nigeria is among the nations at risk from the consequences of climate change because of the rise in the extreme values in the eastern Mediterranean. The adverse effects of climate change, including the depletion of water supplies, forest fires, droughts, and desertification, as well as ecological degradation depending on them, would have an impact on Nigeria (Yetisgin and Sen, 2020). The entire amount of greenhouse gas emissions in Nigeria in 2019 were 506.1 million tonnes of CO<sub>2</sub>. 72% of this quantity came from the energy sector, followed by agriculture with 13.4%, industrial processes and product consumption with 11.2%, and garbage with 3.4% (TUIK, 2021). Nigeria's per capita emissions of greenhouse gases grew from 6.07 tonnes of CO<sub>2</sub> in 2015 to 7.30 tonnes of CO<sub>2</sub> in 2020. If no action is taken by 2030, 13.29 tonnes of CO<sub>2</sub> are anticipated. According to estimates, Nigeria will begin to experience the adverse consequences of climate change within the next 10 to 20 years (TUIK, 2021). The fact that a sizable amount of the economies of nations like Nigeria are focused on rural output, such agriculture and livestock production activities, makes it difficult to escape the effects of climate change. Even if there have been advancements in mechanisation, productivity, and animal nutrition, the unpredictability of the environment and the unsteady market structure hinder sustainable production, reduce profitability,

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and encourage rural emigration. As a result, it is getting harder to secure the supply of animal feed due to rising production costs, and product prices are going up. In addition, the importation of livestock and meat is frequently highlighted as a solution to the rising demand. Climate change is anticipated to have a profound impact on global animal production systems and to boost demand for animal products in the years to come (Koyuncu, 2017). This review, therefore intends to shed light on how climate change affects animal breeding, particularly that of goats, and to proffer potential solutions in this area.

### **Over view of animal production and effects of climate change**

The fundamental driver of climate change is an increase in gases known as greenhouse gases, which are produced as a result of industrialization, energy production, population growth, urbanisation, and agriculture. This contact, which is typically unfavourable, leads to a lot of issues (Aydogdu, 2020). Climates on earth are changing as a result of the emission of greenhouse gases, and both the quantity and frequency of extreme weather events are rising. Earth's climate changes as a result of rising greenhouse gas emissions, which are a result of animal production. Climate change has a negative impact on livestock output both directly and indirectly. To put it another way, it is conceivable to discuss a two-way relationship between animal breeding and climate change. Due to greenhouse gases produced by animals, the animal breeding industry has a structure that contributes to climate change and it is also adversely impacted by this changing environment (Dellal, 2008). Animals may experience stress at 1 °C above 30 °C, which could have an impact on their ability to produce. A factor that raises greenhouse gas emissions is the gas emitted as a result of feed consumption and digestion (Koç et al., 2016).

Climate is a major factor in agricultural productivity, and it has recently been changing rapidly. According to scientific data, climate change is having a growing impact on the planet's life. The greatest challenge to achieving sustainable development is climate change, which also poses a serious risk to the survival of humanity. Regarding animal production, it will have far-reaching effects, especially in areas that are crucial to the planet's diet and way of life. While these factors make livestock systems more vulnerable, events like drought can amplify the consequences of new pressures. Climate change will have a negative impact on ecosystems in addition to the natural resources that are the foundation for animal production. The most significant effects on animal productivity are declines in quantity and quality of output, greater susceptibility to pests and diseases, modifications to the reproductive cycle, losses at birth, and a regression in the conversion of feed into product (Koyuncu, 2017). Ecosystems are under serious threat from climate change, and 8% of animal species may go extinct as a result of unusual weather patterns. As a result, the viability of animal breeding is seriously threatened by climate change on a global scale. Environmental parameters include ambient temperature, relative humidity, direct and indirect sun radiation, and wind speed have an impact on the availability of feed and water, feed quality, and disease occurrence. The most efficient production occurs under ideal environmental circumstances. Changes in ambient temperature have a significant impact on livestock productivity and animal welfare among various climatic factors (Joy et al., 2020).

According to studies, livestock exposed to hot and muggy conditions will experience heat stress, infectious diseases, and modifications to a variety of physiological processes that will result in decreased feed consumption, deterioration of health,

decreased reproductive effectiveness, and decreased productivity. Additionally, as animals adjust to temperature changes as part of the climate change process, they will experience behavioural and metabolic changes such as sensitivity (Thorne, 2007). Thus, it is crucial to comprehend the defence mechanisms used by animals in harsh weather, as well as to conduct a thorough analysis of the direct and indirect effects of climate change on livestock output.

### **Effect of climate change on Goat health and reproduction**

Depending on the species, breed, age, and physiological state, livestock has a variety of thermal comfort zones where they can produce optimally (Dangi et al., 2016). The availability of feed and water, feed quality, and disease are all impacted by climatic parameters such as ambient temperature, relative humidity, direct and indirect sun radiation, and wind speed, where production is most effective under ideal environmental conditions (Joy et al., 2020). Animals are directly impacted by the biological, physical, and chemical aspects of their environment, including climate. Extreme temperatures have a negative impact on reproductive physiology, metabolism, and the immune system, as well as production performance (growth, meat, milk, and egg production, among other things) (Koyuncu and Akgün, 2018).

Animals' ability especially Goats to adapt to changing climatic circumstances may be negatively impacted by indirect consequences of climate change, such as feed and water scarcity, food-borne illnesses, host resistance to infectious agents, and the expansion of vector-borne diseases. Changes in wind patterns can cause some infections and disease carriers to spread across a larger region, whereas high temperatures stimulate the growth of parasites or pathogens. Climate change may alter how diseases spread, but some serious illnesses can also strike herds that have never had a sickness before (Petrovica et al., 2015). According to numerous studies, hot and humid environments will cause temperature stress in livestock as well as infectious diseases, changes in many physiological functions, and a decline in feed consumption while animals attempt to adapt to temperature changes through behavioural and metabolic changes like increased sensitivity to disease. According to reports, the respiration rate, body surface temperature, and rectal temperature all rise as the temperature rises (Aleena et al., 2018). There are some goat breeds that can thrive in warm climates and produce at respectable rates. The advantages of these species include their tiny body sizes, minimal water and feed requirements, high feed conversion rates, and ability to transform substandard feeds into superior output. An effective technique to lessen the effects of climate change on goat production is to find tolerant breeds for greater flexibility under extreme climatic situations (high temperature, feed deficit, and water scarcity) (Joy et al., 2020).

Goats that are milking are less productive in hot environments, and their energy needs go up in part because of their increased respiratory rates. A reduction in milk production and quality can result from both heat stress and the development of lactation (Smith et al., 2013). In addition, heat stress may harm sheep's udder health and milk quality by increasing bacterial colonisation there (Sevi and Caroprese, 2012). In goats, heat stress also has an impact on meat production and meat quality. Several studies have linked darker meat and a higher pH to this effect (Archana et al., 2018). Goats under heat stress develop testicular degeneration, a decline in the proportion of healthy and fertile spermatozoa, poor ejaculate volume, high semen pH, decreased sperm motility, and lower sperm quality as a result of elevated body temperatures (Hamilton et al., 2016). Increased temperatures decrease the birth weight and viability of the offspring of pregnant goats born in January, February,

July and August, as well as increase the risk of infection in the mammary glands of breastfeeding animals (Koyuncu and Akgün, 2018). According to reports, both cold and warm months saw a rise in the first month after birth death rates (Luo et al., 2020). Heat stress affects dairy-oriented breeds more than meat-producing animals (Bernabucci et al., 2010). In studies done on Saanen and Hair goats, the levels of the thyroid hormones T3 (triiodothyronine) and T4 (thyroxine) fell as the temperature and humidity index values rose. In order to maintain body temperature in this circumstance, energy production is decreased and carbohydrate metabolism is slowed (Koluman et al., 2013). Markers of metabolic response to heat stress in animals include heptaglobin and Non-Esterified Fatty Acids (NEFA) (Aleena et al., 2016).

### Effects of climate change on Goat breeding

Animal production is a sub-sector of Nigeria's agricultural industry that mostly employs family labour, has high added value, and makes a substantial contribution to the population's access to appropriate and balanced nutrition. In the region where it has been practised for many years, goat rearing among other animal breeding generates a significant economic value (Gürer and Ulutaş, 2021). Animals like goats can utilise pasture to its full potential at all times of the year. In addition to its effects on ecosystems, climate change will unavoidably result in significant issues with the natural resources supporting animal production. The availability of animals for year-round grazing and other resources is greatly influenced by climatological factors such as temperature and rainfall patterns. The number of grazing areas determines how dependent some regions of Nigeria are on animal breeding (Gökkür and Uysal, 2020).

The productivity of pastures will inevitably decline due to climate change. The rise in CO<sub>2</sub> levels and temperature have a substantial impact on the quantity and quality of feed (Chapman et al., 2012). Environmental stressors like drought, extreme heat or cold, ozone layer depletion, high carbon dioxide levels, soil water, and salinity can reduce the amount of pasture and feed supplies that are available. Although perennial plants have a little yield, they can thrive on arid soils with little irrigation or rainfall and a high salt content. Heat stress can decrease the amount of crop collected, alter the crop's nutritional value, and worsen the species' composition (Chauhan and Ghosh, 2014). While this lowers the amount of nutrients that are accessible to animals, it also reduces the amount of milk and meat that small herd owners can produce, which has an impact on food safety and profitability (Koyuncu and Nageye, 2020). Through thermal stress, which specifically alters the quality and quantity of meadows and raises the prevalence of pests and illnesses, climate change has a variety of effects on grazing. Each of these factors could jeopardise animal welfare and productivity (Stocker et al., 2013). Animal production is impacted by climate change in a variety of direct and indirect ways. The headings below list the primary consequences on animal breeding.

### Climate change and its effects on biochemical parameters in Goats

In general, rising global temperatures are linked to climate change. In extreme situations, exposure of animals to harsh weather (such as intense heat waves, floods, and drought) can result in animal deaths in addition to output losses (Gaughan and Cawsell-Smith, 2015). Animals may adapt to hotter climates, but the survival mechanisms they use can have a negative impact on how well they produce. Between 10 and 30 degrees Celsius, livestock thrives. Every 1°C increase

in ambient temperature above 30°C is said to result in an average 3-5% decrease in the feed consumption of cattle, sheep, goats, and poultry (Koyuncu, 2017).

Changes in nutrition will result from heat stress' physiological impacts on the goat's digestive system. It will alter metabolic processes (acid-base balance and cortisol release) and reduce rumen fermentation and rumen volatile fatty acid synthesis (Pragna et al., 2018). (Wojtas et al., 2013). Additionally, NEFA (non-esterified fatty acids), T3 and T4 hormone levels in the blood will change (Sejian et al., 2019). As a result, there can be a rise in the Streptococcus bacteria and a fall in the Fibrobacter bacteria. Due to genetic variations, goats' reactions to heat stress varied (Pragna et al., 2018).

### Pasture and Grazing

The carrying capacity of feed-based cultivated regions and the buffering capacity of agricultural systems will both decline as a result of the desertification process brought on by global warming (Koyuncu & Akgün, 2018). For plants to produce, light, temperature, and rainfall are crucial elements, and they must all be present at a level that meets their needs. A sustained increase or drop in temperature or rainfall can have a negative impact on plant life, leading to a considerable loss in productivity or even total destruction. Rainfall provides natural pasture areas with water, a very necessary element for crucial activities. A reduction in the overall amount of rainfall or anomalies in seasonal distribution are very important factors for grazing area production, especially in arid and semi-arid locations. As with all plant production, climate change, where changes in the atmosphere have an accelerating influence, affects pasture productivity. Abnormal climatic circumstances happening with overuse accelerate this change negatively and lead it to be irreversibly disposed (Herbel and Pieper, 1991).

### Effects of climate change on Goat welfare

Due to the dominance of rural economic structures and sectors focused on developing livestock breeding, the livestock sector in Nigeria is the one that is most significantly impacted by the global climate change. Animal breeding is indirectly impacted by its inter-sectoral interactions with agriculture in terms of fodder plant production, but the agricultural sector has a structure that is directly affected by the climate, particularly in terms of plant output (Sarözkan and Küçükoflaz, 2020). Extreme occurrences and seasonal changes impair animal wellbeing and reduce productivity and reproductive efficiency (Sejian et al., 2015). In terms of goat wellbeing, stress might result in behavioural changes (a decrease in feeding and ruminating, an increase in lying, standing, and self-grooming activities) (ErgulEkiz et al., 2020). Additionally, it led to an increase in respiratory rate, water intake, and frequency of water consumption (Bernabucci et al., 2010). (Aleena et al., 2018). Depending on the perceived threat posed by the temperature, heat stress triggers different behavioural responses. Heat stress is a phenomenon that impairs animal wellbeing, reduces animal production productivity, worsens health issues, and results in financial losses (Sucu et al., 2015). The productivity of the animals will increase if the barn conditions are improved in response to the changing climatic conditions (Ünal et al., 2018). This will prevent the loss of progeny.

In essence, heat stress has an impact on a variety of breeding traits and reproduction in goats, and prompt intervention is necessary to increase animal welfare and output.

### Climate change and the advantages of Goat husbandry and breeding

Goats will emerge as a species that will benefit animal production in the future because of their strong capacity to digest a variety of plant species and feed resources that may be impacted by climate change. The goat is a ruminant mammal that has a particularly high level of disease resistance and heat stress tolerance. Goat breeding will become more significant, particularly to meet the demands of the dairy industry. Due to their low body mass, ruminant status as a result of their big salivary glands, wide mucosal surface area that can absorb roughage, and anatomical and physiological traits that boost foregut volume. They have lower metabolic requirements than other ruminant species and can survive in arid environments (Silanikove and Koluman, 2015).

Goats are bred in dry regions of the world more than 50% of the time. This demonstrates that goats have an advantage over other species when it comes to heat stress adaptability (Monteiro et al., 2018). Goats produce less greenhouse gas than other kinds of ruminants when it comes to producing goats (Koluman and Silanikove, 2018). Similarly, it has been claimed that using the genetic marker HSP 70 (Heat Shock Protein 70) to assess a domestic goat breed's capacity for heat tolerance is safe and this can promote their reproductive potentials (Aleena et al., 2018).

## CONCLUSION

Global warming is anticipated to have a greater impact on pasture-based livestock systems than on industrial livestock systems. Due to the direct impact of solar radiation brought on by global warming, high temperatures, a lack of precipitation, and drought on pastures and plants. Primarily in poorer nations, where pasture-based livestock is the predominant approach, it is estimated that animal productivity will decline by 25% as a result of global warming. Malnutrition prevalence increased from 8.4% to 9.9% in 2020, after being essentially stable from 2014 to 2019. In terms of population, it is predicted that between 720 and 811 million people will be hungry in the world in 2020, accounting for the additional statistical uncertainty (FAO, 2021). But in the next years, as the population grows and per capita consumption rises, there will also be a rise in the need for animal products (Nardone, 2002; Delgado, 2003). As a result, pastures' ability to support grazing should be considered. Technological advancements can boost the adoption of heat-resistant plant varieties and the utilisation of agricultural wastes for animal nutrition. Additionally, it is possible to promote the growth of forage crops that will collect carbon dioxide, methane, and nitric oxide emissions, which have a major impact on pasture greenhouse gas emissions (Durmuş and Koluman, 2019). The interactions between the elements involved in this process play a significant role in preventing the potential consequences of climate change on animal breeding systems. Sustainable approaches for animal production can considerably help to mitigate the consequences of climate change. In order to secure both humane and sustainable global food production, it is required to adopt specific and regional policies. Native breeds outperform culture breeds bred for industrial use in strength and durability. Consequently, our indigenous breeds will be advantageous in addressing the issues brought on by climate change (Koyuncu, 2017).

As a result, both humans and livestock and goat husbandry may be directly or indirectly threatened by climate change. In arid and semi-arid areas, goat populations make up around half of the total. Due to their environment and physiological makeup, goats are better able to adapt to stress events than other species. According to studies, goats are better at adapting to extreme climatic circumstances and can be utilised to improve genetic traits, particularly those related to heat tolerance. Breeds that

are resistant to heat stress can be created by finding genetic markers for heat tolerance. Region-specific research is required because it is recognised that the impacts of climate change will differ in different geographic areas. Along with breeding studies on our native breeds, further research on genetic markers should be conducted in this direction. Existing barns should be reorganised and updated with air conditioning equipment to reduce the negative impacts of temperature variations. Local breeds adapted to breeding programmes that will be proposed by research taking into account their environmental and genetic characteristics can be an alternative to reduce the potential effects of climate change on maintaining the production of goats.

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