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Climate Variability and Its Impact on Productivity and Health in Indigenous Cattles of Surajgarh, Chirawa and Pilani Block of Jhunjhunu District, Rajasthan

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Abstract: *Climate variability has emerged as a significant challenge affecting livestock production systems across arid and semi-arid regions of India. Rajasthan particularly the Jhunjhunu district experiences high temperatures, erratic rainfall and frequent droughts that directly influence cattle productivity and health. This investigates the effects of climate variability on indigenous cattle in Jhunjhunu district. These examines key climatic variables as temperature fluctuations, rainfall variability and heat stress and their impact on milk yield, reproductive efficiency, feed intake, disease prevalence and overall animal health. Indigenous cattle breeds are known for their adaptability to harsh climatic conditions; however, extreme climatic variability can still influence their physiological performance and productivity. The findings highlight that increased heat stress, water scarcity and reduced fodder availability are the primary constraints affecting livestock production. These also discusses adaptation strategies adopted by farmers including improved shelter, fodder management and the conservation of indigenous breeds. This contributes to understanding the relationship between climate change and livestock systems in semi-arid regions.*

Keywords: Climate variability, Indigenous cattle, Heat stress, Productivity and Animal health

I. INTRODUCTION

Climate variability and climate change have become major concerns for agriculture and livestock sectors worldwide. Livestock production systems are particularly sensitive to climatic conditions because animals depend on environmental factors such as temperature, humidity, water availability and fodder resources for survival and productivity. In arid and semi-arid regions as Rajasthan fluctuations in temperature and rainfall patterns have significant implications for livestock health and productivity.

India possesses one of the largest livestock populations in the world and indigenous cattle breeds play a vital role in rural livelihoods and the dairy economy. However, climate variability is increasingly affecting animal production systems by altering feed availability, increasing heat stress and enhancing the spread of diseases. Rising temperatures and unpredictable rainfall patterns disrupt animal physiology and reduce feed intake which ultimately leads to a decline in milk production and reproductive performance. Heat stress is considered one of the most important climatic factors influencing cattle productivity. When ambient temperature exceeds the animal's thermoneutral zone, cattle experience physiological stress, leading to reduced feed intake, metabolic disturbances and decreased milk yield.

Indigenous cattle breeds, particularly those found in hot arid regions of India possess certain adaptive characteristics as heat tolerance, disease resistance & ability to survive under limited feed resources. These adaptive traits enable them to withstand harsh climatic conditions better than exotic or crossbred cattle. Jhunjhunu district in Rajasthan is characterized by semi-arid climatic conditions with extreme temperature variations, frequent droughts and limited

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fodder resources. The blocks of Surajgarh, Chirawa and Pilani have a significant population of indigenous cattle that contribute to local dairy production and rural livelihoods. Climate variability poses several challenges for livestock management in this region.

II. LITERATURE REVIEWS

Several literature reviews are discussed below.

Baumgard L. H. et.al. (2025) examines domestic ruminants physiologically adapt to heat stress through metabolic and hormonal adjustments. Authors explain that high environmental temperatures disturb feed intake, energy metabolism and endocrine balance. Animals respond by altering insulin activity, glucose utilization and lipid metabolism to maintain homeostasis. Hormonal changes involving cortisol, prolactin, and thyroid hormones also regulate thermoregulation and productivity. Study emphasizes that understanding these biological mechanisms is important for improving livestock management, breeding heat-tolerant animals and minimizing productivity losses under increasing climatic temperatures.

Rojas-Downing M. et.al. (2024) examines the impacts of climate change on livestock production and discusses possible adaptation and mitigation strategies. The authors highlight that rising temperatures, irregular rainfall and extreme weather events negatively affect animal health, productivity and feed resources. Heat stress reduces growth, milk yield and reproductive efficiency while climate variability may increase the spread of livestock diseases. This also outlines adaptation strategies as improved housing, better feed management and breeding of heat-tolerant animals. Mitigation approaches like efficient manure management and reduced greenhouse gas emissions are emphasized for sustainable livestock production.

Bhatta R. & Naqvi S. (2023) focuses on practical strategies to mitigate heat stress in livestock under changing climatic conditions. Authors discuss various approaches including improved housing design, shade provision, cooling systems as sprinklers and fans and better water availability. Nutritional strategies as electrolyte supplementation, balanced feeding and antioxidants are also emphasized to maintain animal health. This highlights genetic selection and breeding of heat-tolerant breeds as a long-term solution that integrated management practices can significantly reduce thermal stress and sustain livestock productivity.

Thornton P. K. & Herrero M. (2022) reviews the potential impacts of climate change on global livestock production systems that rising temperatures, changing rainfall patterns and increased frequency of extreme weather events significantly affect animal health, feed availability and productivity. Heat stress reduces growth rate, milk production and reproductive efficiency in livestock. The study also highlights indirect effects as reduced pasture quality, water scarcity and increased disease prevalence. Authors emphasize the need for climate-resilient livestock management practices, improved breeding strategies and sustainable resource management to ensure food security and livestock sustainability.

Collier R. J., Dahl G. E. & VanBaale M. J. (2021) reviews major scientific advances in understanding how environmental factors influence dairy cattle productivity and physiology. Authors discuss about temperature, humidity and seasonal variations affect milk yield, reproductive efficiency & metabolic processes. Heat stress is identified as a key environmental challenge that alters hormonal balance, reduces feed intake and affects immune responses. Paper also examines modern technologies as cooling systems, improved housing design and nutritional interventions that help mitigate environmental stress and improve the welfare and productivity of dairy cattle.

Bharti P., Saikia J. & Ranjeet (2016) discusses the effects of heat stress on the health, productivity and reproductive performance of dairy animals. High ambient temperature and humidity reduce feed intake, milk production, fertility and immune function. Authors highlight physiological responses as increased respiration rate, body temperature and changes in blood biochemical parameters. Prolonged exposure to heat stress may lead to metabolic disorders and economic losses for dairy farmers. Paper stresses the importance of proper housing, ventilation, cooling systems and nutritional management to reduce the adverse effects of heat stress in dairy herds.

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III. METHODOLOGY

Present study was conducted in three blocks of Surajgarh, Chirawa and Pilani located in the Jhunjhunu District of Rajasthan, India. These regions experience semi-arid climatic conditions characterized by high summer temperatures, low rainfall and significant seasonal variability.

Study Area and Sample Selection

A total of 150 indigenous cattle were selected from different villages of the three blocks. The cattle mainly belonged to indigenous breeds as Rathi cattle, Tharparkar cattle and local desi cattle. The sample was divided equally among the three blocks:

Surajgarh – 50 cattle
Chirawa – 50 cattle
Pilani – 50 cattle

Farmers were selected using a random sampling technique and data were collected through structured questionnaires, field observations and veterinary records.

Data Collection

Data were collected for a period of 12 months to cover seasonal variations (summer, monsoon and winter). The following parameters were studied:

Climatic Variables
Average temperature (°C)
Relative humidity (%)
Rainfall (mm)
Productivity Parameters
Average daily milk yield (litres/day)
Body condition score
Calving interval
Health Indicators
Incidence of heat stress
Occurrence of diseases (mastitis, tick infestation, dehydration)
Feed intake levels

Meteorological data were obtained from the nearest agricultural weather stations while livestock health data were recorded with the help of local veterinary practitioners.

IV. RESULT & DISCUSSION

The results revealed that climate variability significantly affected both the productivity and health of indigenous cattle in the study area.

Table 1: Average Climatic Conditions in the Study Area

Block	Avg. Summer Temp (°C)	Avg. Winter Temp (°C)	Annual Rainfall (mm)	Relative Humidity (%)
Surajgarh	44.2	8.5	420	36
Chirawa	43.8	9.2	410	38
Pilani	45.1	7.8	395	34

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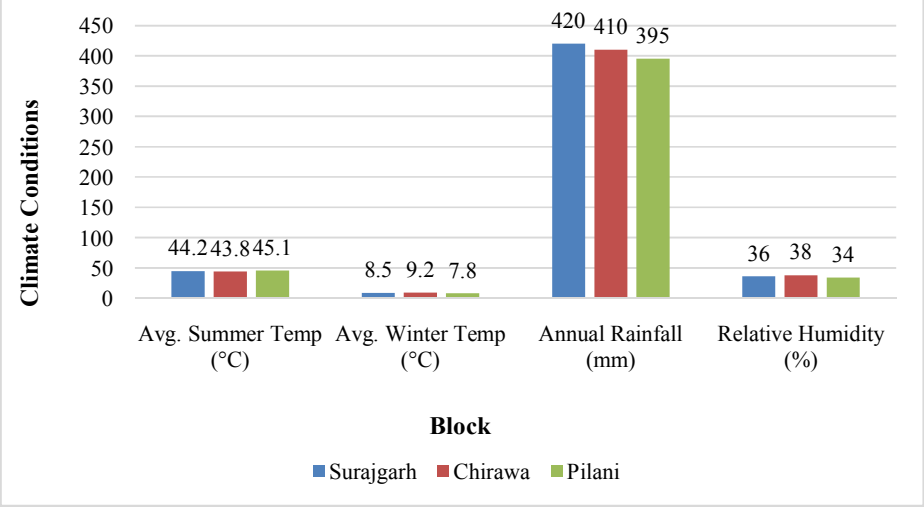
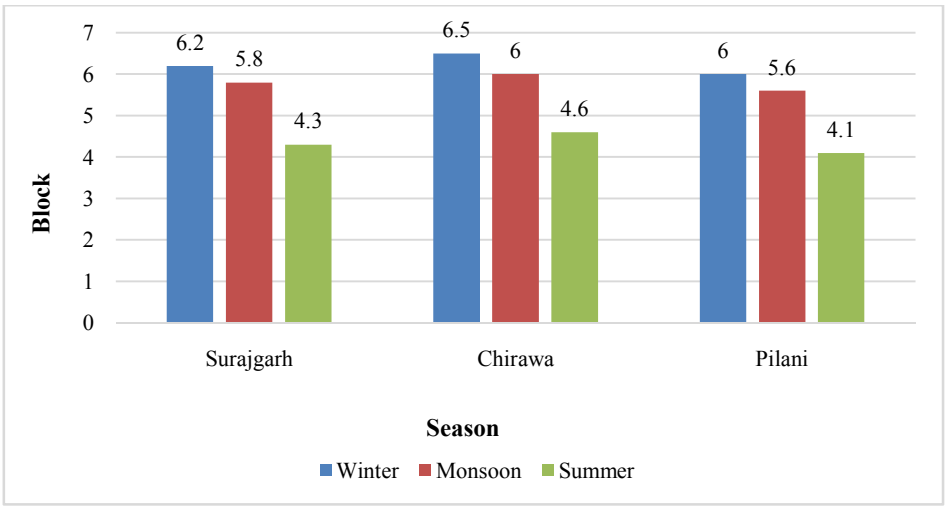


Figure 1: Average Climatic Conditions in the Study Area

Climatic data indicate significant seasonal variation across Surajgarh, Chirawa and Pilani in Jhunjhunu District, Rajasthan. Pilani recorded the highest average summer temperature (45.1°C) and lowest winter temperature (7.8°C) indicating more extreme climatic conditions. Surajgarh received comparatively higher annual rainfall (420 mm) while Pilani experienced the lowest rainfall and humidity levels. Such climatic variability influences fodder availability, water resources and livestock comfort, increasing the risk of heat stress and reducing productivity of indigenous cattle in the region. Low humidity and irregular rainfall patterns were common across all blocks.

Table 2: Average Milk Production of Indigenous Cattle (Litres/Day)

Season	Surajgarh	Chirawa	Pilani
Winter	6.2	6.5	6.0
Monsoon	5.8	6.0	5.6
Summer	4.3	4.6	4.1



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The data show clear seasonal variation in milk production of indigenous cattle in Surajgarh, Chirawa and Pilani of Jhunjhunu District, Rajasthan. Milk yield was highest during winter with Chirawa recording the maximum production (6.5 litres/day). Production declined slightly during the monsoon season and dropped significantly in summer, with Pilani showing the lowest yield (4.1 litres/day). The reduction in summer productivity may be attributed to high temperatures, heat stress & reduced feed intake which adversely affect the physiological performance and milk-producing capacity of indigenous cattle. The results indicate that milk production declined significantly during summer due to heat stress and reduced feed intake. Cattle in Chirawa showed slightly better productivity possibly due to better fodder availability and management practices.

Table 3: Major Health Problems Observed (% of Animals Affected)

Health Issue	Surajgarh (%)	Chirawa (%)	Pilani (%)
Heat Stress	38	34	42
Mastitis	16	14	18
Tick Infestation	22	19	24
Dehydration	28	24	31

Results indicate that several health problems affect indigenous cattle in Surajgarh, Chirawa and Pilani of Jhunjhunu District, Rajasthan. Heat stress was the most common issue, particularly in Pilani (42%), due to higher summer temperatures. Dehydration also showed a relatively high occurrence, indicating insufficient water availability during hot periods. Tick infestation and mastitis were observed at moderate levels. These health problems reduce animal productivity and highlight the need for improved shelter, hygiene and proper veterinary care for sustainable livestock management. Data show that heat stress and dehydration were the most common health issues especially during peak summer months. Pilani block reported the highest incidence due to extreme temperature conditions.

Findings suggest that climate variability has a direct impact on the physiological performance and health status of indigenous cattle in the study region. High temperatures during summer months lead to reduced feed intake, increased water requirements, and higher respiration rates in animals. These factors collectively contribute to a decline in milk production and reproductive efficiency. The results also indicate that indigenous cattle breeds exhibit relatively better resilience to heat stress compared to exotic breeds prolonged exposure to extreme climatic conditions still affects their productivity. The incidence of diseases such as mastitis and tick infestation increases due to changes in environmental conditions and management practices. Irregular rainfall patterns influence the availability of green fodder which indirectly affects animal nutrition and milk yield. Farmers in the study area reported that during severe summer periods, cattle productivity declines by nearly 25–30% highlighting the economic impact of climatic stress on rural livestock farmers.

V. CONCLUSION

The climatic data show that Pilani experiences relatively higher summer temperatures and lower rainfall compared to the other blocks creating harsher environmental conditions for livestock. These climatic factors directly influence milk productivity as the results indicate that milk yield is highest during winter and declines significantly during summer due to heat stress and reduced feed intake. Health assessment reveals that heat stress, dehydration, tick infestation and mastitis are common problems affecting cattle with higher incidence in areas experiencing more extreme climatic conditions. Although indigenous cattle breeds possess some natural adaptability to semi-arid environments prolonged exposure to high temperatures negatively affects their performance. Therefore, improved management practices as adequate shade, proper hydration, balanced nutrition and regular veterinary care are essential to maintain cattle health and sustain livestock productivity in the region.

These concludes that climate variability significantly influences the productivity and health of indigenous cattle in Surajgarh, Chirawa and Pilani blocks of Jhunjhunu district. Rising temperatures, low rainfall, and seasonal climatic fluctuations lead to reduced milk production, increased heat stress and higher incidence of livestock diseases. Although indigenous breeds demonstrate some adaptability to harsh climatic conditions, extreme heat and limited fodder

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availability still negatively affect their performance. Therefore, appropriate adaptation measures as improved shelter management, adequate water supply, heat stress mitigation strategies and better nutritional practices are essential to maintain livestock productivity. This highlights the need for climate-resilient livestock management practices and awareness among farmers to reduce the adverse effects of climate variability on indigenous cattle in semi-arid regions of Rajasthan.

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