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EVALUATION OF ENVIRONMENTAL ADAPTABILITY AND BODY CONDITION OF BHAGNARI CATTLE IN PAHARPUR, DERA ISMAIL KHAN: A SIX-MONTH PILOT STUDY

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Abstract

Background: *Field observations of adult cattle under routine management can establish baseline performance and guide studies of environmental adaptability. This six-month pilot study characterized changes in live weight, body condition, physiological measurements, and recorded water intake in adult cattle at Paharpur, Dera Ismail Khan, Pakistan.*

Methods: *A longitudinal observational study was conducted at the Livestock Research and Development Station from May to October 2026. Analyses pooled adults recorded under the Bhagnari and Brahman group labels. Sixteen adults had complete monthly live-weight records. One additional adult contributed monitoring observations through August. Rectal temperature, respiration rate, heart rate, recorded daily water intake, and body condition score (BCS) were summarized descriptively. Within-animal weight change was calculated from May to October and expressed as a mean with a 95% confidence interval (CI).*

Results: *Mean live weight was 448.5 ± 62.7 kg in May, declined to 444.9 ± 65.6 kg in July after a slight increase in June, and reached 476.5 ± 60.1 kg in October. Mean paired weight change was +28.0 kg (95% CI 12.9–43.1 kg). Median BCS remained at 4.0 on the five-point scale throughout follow-up. Fewer adults scored below 4.0 in September and October than in the earlier months. Mean rectal temperature ranged from 38.56 to 38.75 °C across monitoring visits. Mean respiration rate peaked at 20.35 breaths/min in June. Mean heart rate and recorded water intake peaked in July at 67.06 beats/min and 76.82 L/day, respectively, and declined to 54.81 beats/min and 68.50 L/day in October.*

Conclusions: *Mean live weight increased and median body condition was maintained in the adult station cohort. The pooled analysis and lack of concurrent environmental measurements limit inference about breed-specific thermal adaptability. These results provide a baseline for studies that analyze the breed groups separately and pair animal observations with on-site weather measurements.*

INTRODUCTION

Environmental adaptability is essential when evaluating indigenous cattle for sustainable production under changing climatic conditions. Genomic research on Asian zebu cattle identified selection signatures associated with heat tolerance, immunity, metabolism, and fertility, emphasizing the importance of conserving locally adapted genetic resources [1]. However, genetic characteristics alone cannot establish suitability for a particular production environment; physiological responses and maintenance of body reserves also require evaluation.

Bhagnari cattle are an indigenous Pakistani breed associated with Balochistan, characterized by substantial body size and growth potential. Research describing their morphology and productive performance provides a foundation for breed evaluation [2]. Whole-genome resequencing has characterized genetic variation in Bhagnari and other Pakistani indicine breeds, providing resources for investigating adaptation-related traits [3]. Nevertheless, these findings do not establish their performance in Paharpur, Dera Ismail Khan, supporting the need for location-specific observations.

Heat exposure can alter thermoregulation, nutrient intake, and water requirements. An experiment involving Holstein-Friesian crossbred cows demonstrated increased rectal temperature, respiration rate, heart rate, and water intake during short-term heat stress [4]. Similarly, elevated humidity reduced dry matter intake and increased rectal temperature and heart rate in Holstein cows [5]. Although responses may differ between breeds, these findings support evaluating several complementary indicators. Research in beef cattle further identified respiration rate as a useful indicator of heat stress [6]. Experimental evidence also shows that physiological and feeding responses can persist after severe heat exposure, highlighting the value of repeated observations [7].

Body condition scoring provides an additional perspective on nutritional status. Research indicates that body condition score and body weight offer complementary information about tissue reserves and metabolic status [8]. Interpreting both measures alongside feeding and reproductive records can therefore improve assessment of changes over time.

This six-month observational pilot study characterized temporal changes in live weight, body condition, rectal temperature, respiration rate, heart rate, and recorded water intake in adult cattle maintained under routine management in Paharpur, Dera Ismail Khan. The study was designed to establish baseline observations for subsequent evaluation of breed-specific responses to environmental conditions.

Materials and Methods

Study Design and Location

A six-month longitudinal observational pilot study was conducted at the Livestock Research and Development Station, Paharpur, Dera Ismail Khan, from 1 May to 31 October 2026, under the project "Research studies on the adaptation of Bhag Nari (Cattle Breed) in D. I. Khan region and exploration of its beef potential." Physiological responses, body condition, live weight, feeding, water consumption, and health were monitored under routine farm conditions. No experimental heat challenge or randomized treatment allocation was undertaken.

Study Animals and Management

The adult studypopulation comprised 16 individually ear-tagged cattle. Sample size was determined by the available herd without a formal power calculation. Each animal constituted the independent sampling unit.

Ear-tag numbers linked physiological measurements with body-weight, reproductive, feeding, and health records. Information on age, sex, parity, source, arrival date, and reproductive status was maintained in farm registers.
Animals were maintained under the station's routine husbandry practices. Recorded ration components included green fodder, maize silage, wheat straw, and concentrate mixture (commercial wanda).

Data Collection and Physiological Measurements
Repeated observations were extracted from the physiological, adult-weight, calf-weight, reproductive-status, and health worksheets. Actual recording dates were retained and measurement intervals were identical. Physiological variables comprised rectal temperature, respiration rate, and heart rate, recorded in degrees Fahrenheit, breaths per minute, and beats per minute, respectively.

Body Condition and Live Weight
Body condition was recorded using a five-point scale, including half-point increments. Scores were interpreted alongside feeding and reproductive records to distinguish changes in body reserves from weight changes associated with pregnancy or parturition.
Adult live weight was recorded in kilograms using digital weight scale. Within-animal weight change was calculated as the difference between the first and last valid measurements within the study period. Percentage weight change was calculated relative to baseline weight.
Available calf records included identification, dam identification, sex, birth date, birth weight, and subsequent dated weights. Calf observations were analyzed separately from the 16-adult cohort, with follow-up determined by birth date and available measurements. Average daily gain was calculated as:

$$\mathrm{ADG} = \frac{W_2 - W_1}{t_2 - t_1}$$

where W_1 and W_2 represent consecutive weights in kilograms, and $t_2 - t_1$ represents the elapsed interval in days. Third-month weights were classified as weaning weights.

Feeding and water records
Recorded feed quantities and daily water-consumption values were linked to individual animals and observation dates. The recording method was calculated ration allocations. Feed quantities were described as dry matter.

Reproductive and health records
Pregnancy status, insemination dates, and parturition dates were extracted from farm records and linked to individual observations. Pregnancy of the animals were diagnosed using portable ultrasound machine. The combined ticks/worms field was summarized as a recorded parasite observation.

Data Management and Statistical Analysis
Data were organized with one record per animal per observation date. Ear-tag identifiers, dates, units, and categorical entries were standardized. Duplicate records, implausible values, missing observations, and inconsistencies between worksheets were checked against source registers. Statistical analyses were performed using SPSS 26.0 (IBM USA). Continuous variables were summarized by observation occasion using sample size, mean and standard deviation, or median and interquartile range. Body condition scores were summarized using medians, interquartile ranges, and score distributions. Individual trajectories and changes from baseline were described within-animal variation.
Where data completeness and model convergence permit, continuous outcomes were evaluated using a linear mixed-effects model with observation occasion as a categorical fixed effect and animal identity as a random intercept:

$$Y_{it} = \beta_0 + \beta_t + b_i + \varepsilon_{it}$$

where Y_{it} is the outcome for animal i at occasion t, β_0 is the intercept, β_t is the observation-occasion effect, b_i is the animal-specific random intercept, and ε_{it} is the residual error.

Ethical considerations
The study was approved by the Government of Khyber Pakhtunkhwa vide ADP No: 816/240231.

Results

Adult live weight

Live-weight records were available for the same 16 adult cattle from May through October 2026. Mean live weight was 448.5 ± 62.7 kg in May, declined to 444.9 ± 65.6 kg in July after a slight increase in June, and rose each month thereafter to 476.5 ± 60.1 kg in October (Table 1). The mean within-animal change from May to October was +28.0 kg (SD 28.3 kg, 95% CI 12.9 to 43.1 kg). Individual weight trajectories varied, with several animals showing a mid-study decline before regaining weight (Figure 1).

Physiological measurements and recorded water intake

Mean rectal temperature varied little across monitoring occasions, ranging from 38.59 to 38.75 °C. Mean respiration rate reached 20.35 ± 0.79 breaths/min in June and declined to 18.94 ± 1.06 breaths/min in October (Table 2). Mean heart rate and recorded daily water intake were highest in July, at 67.06 ± 5.29 beats/min and 76.82 ± 10.42 L/day, respectively. By October, these values had declined to 54.81 ± 4.31 beats/min and 68.50 ± 5.73 L/day. The monthly trajectories show that respiration rate, heart rate, and recorded water intake were higher in June and July than in October, while mean rectal temperature changed by less than 0.2 °C (Figure 2).

Body condition and follow-up

Median body condition score was 4.00 throughout the study. The lower quartile rose from 3.50 in May–August to 3.88 in September and October, while the upper quartile remained at 4.00 (Table 2). A score of 4.0 was the most frequent category throughout follow-up, and the proportion of adults with scores below 4.0 was lower in September and October than in the earlier months (Figure 3). One additional adult contributed monitoring records through August and had no live-weight records. Its death was recorded in September.

Table 1: Live weight of adult cattle in Paharpur

Weighing date	Adults, n	Live weight, mean ± SD (kg)	Range (kg)
May 2026	16	448.5 ± 62.7	330–575
June 2026	16	452.9 ± 60.9	336–577
July 2026	16	444.9 ± 65.6	343–585
August 2026	16	455.9 ± 64.8	355–605
September 2026	16	469.7 ± 64.4	380–619
October 2026	16	476.5 ± 60.1	395–621

The same 16 adults were weighed on each date. Mean within-animal change from May to October was +28.0 kg (SD 28.3 kg, 95% CI 12.9 to 43.1 kg).

Table 2: Physiological measurements, recorded water intake, and body condition of adult cattle

Recording date	Adults, n	Rectal temperature (°C)	Respiration (breaths/min)	Heart rate (beats/min)	Recorded water (L/day)	BCS, median [Q1–Q3]
May 2026	16	38.63 ± 0.18	19.06 ± 1.09	62.53 ± 5.03	71.35 ± 7.73	4.00 [3.50–4.00]
June 2026	16	38.75 ± 0.22	20.35 ± 0.79	66.76 ± 5.36	74.94 ± 10.00	4.00 [3.50–4.00]
July 2026	16	38.69 ± 0.21	20.24 ± 0.90	67.06 ± 5.29	76.82 ± 10.42	4.00 [3.50–4.00]

August 2026	16	38.63 ± 0.23	19.41 ± 1.06	59.76 ± 5.77	68.47 ± 6.55	4.00 [3.50–4.00]
September 2026	16	38.60 ± 0.19	19.12 ± 1.20	57.38 ± 4.69	68.50 ± 5.72	4.00 [3.88–4.00]
October 2026	16	38.59 ± 0.31	18.94 ± 1.06	54.81 ± 4.31	68.50 ± 5.73	4.00 [3.88–4.00]

Values are mean ± SD except for body condition score (BCS), which is summarized by the median and quartiles. One adult had monitoring records through August, no weight records, and a recorded death on 22 September.

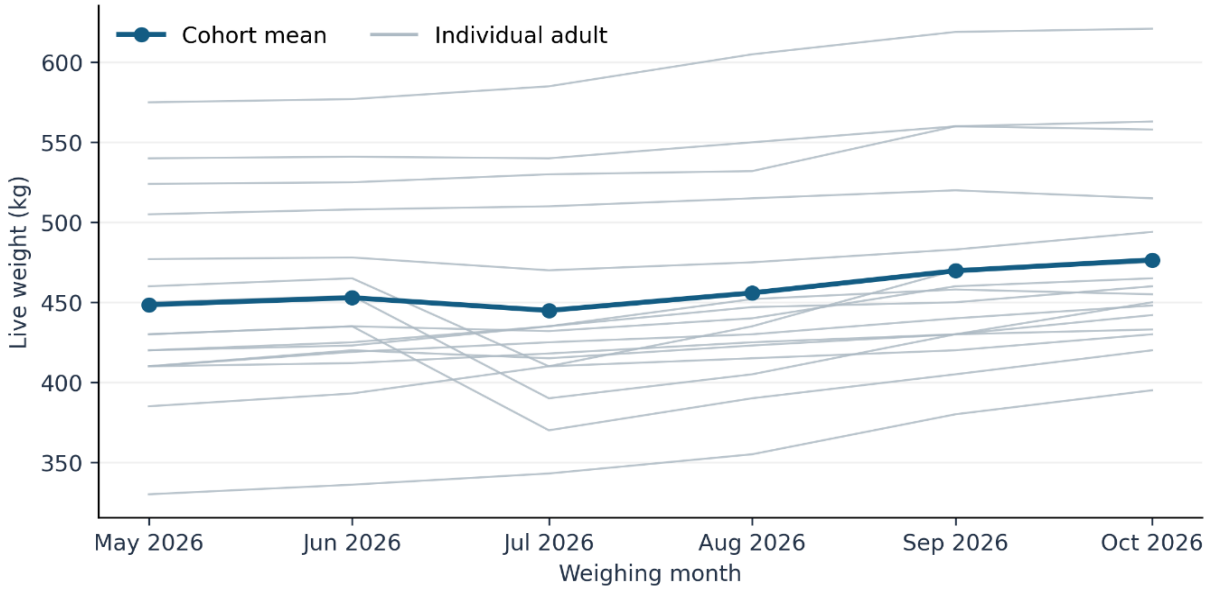


Figure 1: Individual and mean adult live weight

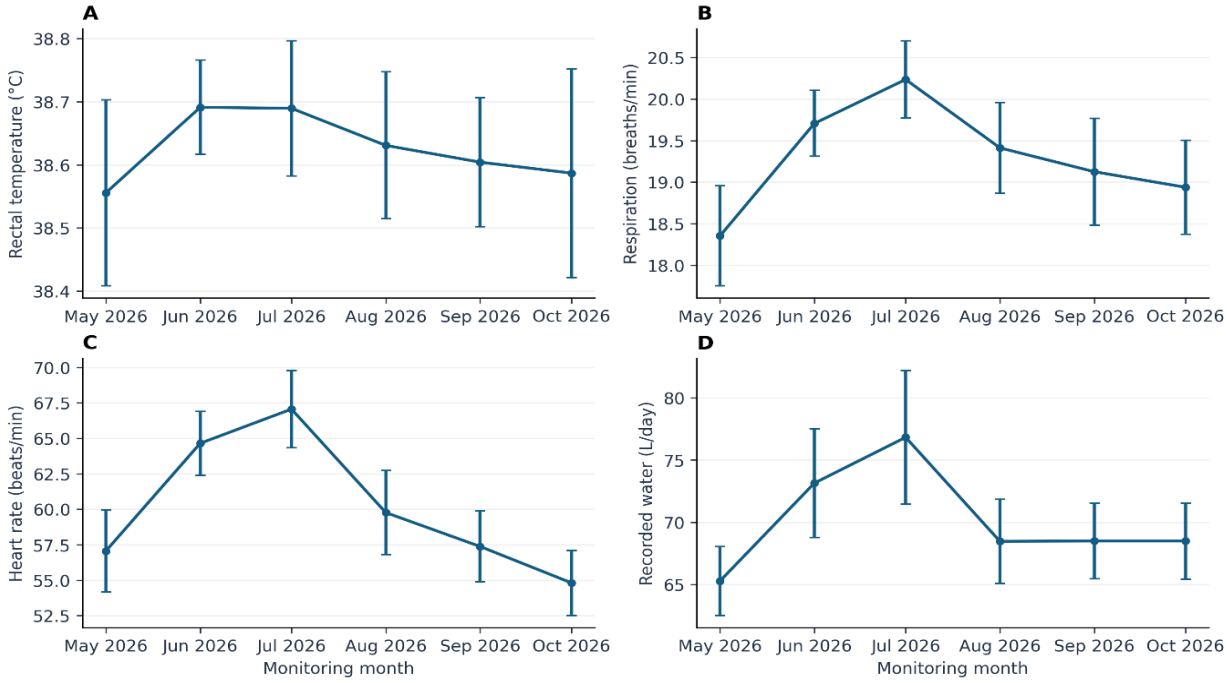


Figure 2: Monthly physiological measurements and recorded water intake

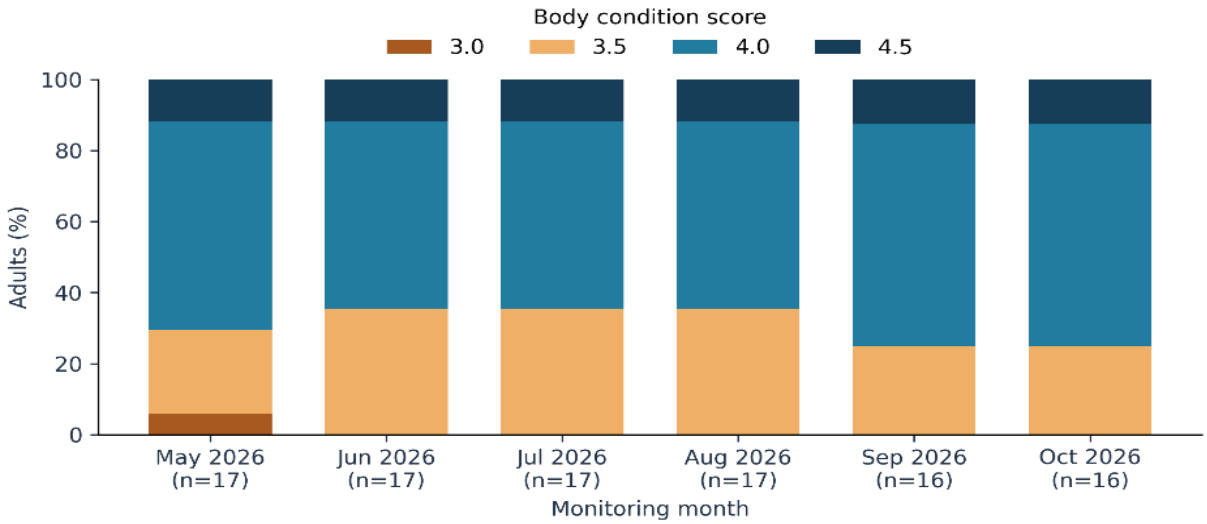


Figure 3: Monthly distribution of adult body condition scores

Discussion

Adult cattle monitored at the Paharpur station showed a net increase in live weight and maintained a median body condition score (BCS) of 4.0 from May to October 2026. Respiration rate, heart rate, and recorded water intake were higher in June or July than in October, while mean rectal temperature varied by less than 0.2 °C (Tables 1 and 2, Figures 1–3). The physiological and live-weight measurements capture different aspects of performance. The former describe the animals' responses at individual visits, whereas changes in live weight and BCS reflect processes operating over a longer period.

The higher respiration rates recorded in June and July, alongside relatively stable mean rectal temperature, are consistent with increased respiratory heat dissipation. Brown-Brandl et al. [9] found that respiration rate responded to environmental conditions and shade availability in feedlot cattle. In controlled exposures to prolonged heat and humidity, Beatty et al. [10] also documented differences in the magnitude and time course of physiological responses between Brahman and Angus-cross cattle. The Paharpur measurements were collected at discrete visits, so their monthly means may obscure short periods of elevated respiration or rectal temperature. Moreover, wind speed and solar radiation can modify the relationship between temperature, humidity, and cattle heat load [11,12]. Without concurrent environmental measurements, the observed physiological variation cannot be attributed specifically to heat exposure or used to establish thermal acclimatization.

Recorded water intake was highest in July, when mean heart rate also peaked (Table 2, Figure 2). Arias and Mader [13] found that environmental conditions explained part of the variation in daily water intake in feedlot cattle. In the present cohort, variation in ration moisture, feeding level, and reproductive stage could also have affected drinking water intake. These factors are particularly relevant because green fodder and maize silage contribute water through the ration. The July peak therefore describes a change in recorded drinking water intake under the prevailing management conditions. Its contribution to total water intake cannot be estimated from the available records.

Mean live weight declined from June to July and then increased through October (Table 1, Figure 1). The mean paired increase of 28.0 kg was equivalent to 6.2% of the cohort's mean baseline weight, with substantial variation among animals (SD 28.3 kg). Live weight includes variation in gastrointestinal fill, hydration, and pregnancy-associated mass. Parturition and changes in the ration could therefore have contributed to some of the individual weight fluctuations. The feed records represent calculated allocations, which provide limited evidence about individual dry matter intake. Consequently, the measured weight increase cannot be partitioned into changes in tissue mass and other components of live weight.

The distribution of BCS showed fewer adults scoring below 4.0 in September and October, even though the median remained at 4.0 (Table 2, Figure 3). Reporting the distribution is informative in a small cohort scored in half-point increments, where changes among several animals may leave the median unchanged. Lean et al. [14] found that live weight and BCS had different relationships with parity in Holstein cows, illustrating the importance of considering reproductive history when interpreting these measures together. In the Paharpur cohort, the stable median and the lower frequency of scores below 4.0 late in follow-up indicate that body condition was generally maintained among adults observed at those visits. Since one animal ceased contributing monitoring records after August, the monthly distributions reflect both individual score changes and a change in cohort composition.

The study provides a field baseline for adult cattle maintained at the Paharpur station. The small, single-station cohort limits generalizability, and the pooled summaries include adults listed under both the Pure Bhagnari and Brahman group labels. The observed weight and condition patterns therefore characterize the station cohort. Estimating breed-specific environmental responses would require verified group membership, group-specific analysis, and standardized physiological measurements paired with environmental observations at each visit.

Limitations

This six-month observational pilot study involved a small adult cohort at a single research station, limiting the generalizability of the findings. The analysis pooled cattle listed under the Pure Bhagnari and Brahman group labels, which precluded estimation of breed-specific responses. Live-weight analysis included 16 adults with paired records. One additional adult contributed physiological and body condition observations through August and died in September, so the monitoring cohort changed during follow-up.

Physiological measurements were obtained at discrete visits without concurrent records of ambient temperature, humidity, solar radiation, or wind speed. Brief episodes of thermal strain may therefore have been missed, and the observed physiological changes cannot be attributed specifically to heat exposure. Recorded feed quantities represented calculated ration allocations, limiting assessment of individual dry matter intake. Variation in reproductive stage, hydration, and gastrointestinal fill may also have influenced live weight independently of changes in body tissue reserves.

Conclusion

From May to October 2026, the 16 adult cattle with paired weight records at the Paharpur station gained an average of 28.0 kg (95% CI 12.9–43.1 kg), while the median body condition score remained at 4.0 throughout follow-up. Mean respiration rate, heart rate, and recorded water intake were higher in June or July than in October, while mean rectal temperature varied by less than 0.2 °C across visits. These findings provide a six-month baseline for adult cattle under routine station management. Because the analysis pooled the Bhagnari and Brahman groups and lacked concurrent environmental measurements, breed-specific thermal adaptability remains to be evaluated. Future studies should analyze the groups separately and pair animal measurements with on-site weather observations.

Declarations

Ethics approval and consent to participate

The Government of Khyber Pakhtunkhwa approved the project under Annual Development Programme (ADP) No. 816/240231.

Consent for publication

Not applicable.

Availability of data and materials

The data can be obtained from the corresponding author upon formal request.

Competing interests
None.

Funding
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Authors' contributions
Arsalan Khan (AK), Shakir Khan (SK), and Imtiaz Khan (IK) conceptualized the study, conducted the investigation, and collected the data. AK wrote the original draft. SK analyzed the data and revised the manuscript.

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Not Applicable.

REFERENCES

Mavunga TK, Sölkner J, Mészáros G, Pichler R, Ramasamy S, Manomohan V, et al. Genomic diversity and selection signatures in Asian zebu cattle: insights into adaptation and genetic erosion. Sci Rep. 2025;15:33346. doi:10.1038/s41598-025-14744-z.

Ali I, Tariq MM, Waheed A, Yousafzai FA, Bokhari FA, Rafeeq M, et al. Exclusive characteristics of the Bhag Nari cattle among the other indigenous cattle breeds of Pakistan. Pak J Zool. 2018;50(5):1979–82. doi:10.17582/journal.pjz/2018.50.5.sc5.

Iqbal N, Liu X, Yang T, Huang Z, Hanif Q, Asif M, et al. Genomic variants identified from whole-genome resequencing of indicine cattle breeds from Pakistan. PLoS One. 2019;14(4):e0215065. doi:10.1371/journal.pone.0215065.

Habiba MU, Hoque SAM, Uddin M, Esha KAJ, Seema SZ, Al-Noman KM, et al. Effect of short duration heat stress on the physiological and production parameters of Holstein-Friesian crossbred dairy cows in Bangladesh. Climate. 2025;13(1):18.

Jo J, Lee H. Impact of relative humidity on heat stress responses in early-lactation Holstein cows. Animals (Basel). 2025;15(11):1503. doi:10.3390/ani15111503.

Eigenberg RA, Brown-Brandl TM, Nienaber JA, Hahn GL. Dynamic response indicators of heat stress in shaded and non-shaded feedlot cattle, part 2: predictive relationships. Biosyst Eng. 2005;91(1):111–8.

Wijffels G, Lees AM, Sullivan ML, Sammes SL, Li Y, Gaughan JB. Allostasis as a consequence of high heat load in grain-fed feedlot cattle. Transl Anim Sci. 2024;8:txae133. doi:10.1093/tas/txae133.

Roche JR, Lee JM, Macdonald KA, Berry DP. Relationships among body condition score, body weight, and milk production variables in pasture-based dairy cows. J Dairy Sci. 2007;90(8):3802–15. doi:10.3168/jds.2006-740.

Brown-Brandl TM, Eigenberg RA, Nienaber JA, Hahn GL. Dynamic response indicators of heat stress in shaded and non-shaded feedlot cattle, part 1: analyses of indicators. Biosyst Eng. 2005;90(4):451–62. doi:10.1016/j.biosystemseng.2004.12.006.

Beatty DT, Barnes A, Taylor E, Pethick D, McCarthy M, Maloney SK. Physiological responses of Bos taurus and Bos indicus cattle to prolonged, continuous heat and humidity. J Anim Sci. 2006;84(4):972–85. doi:10.2527/2006.844972x.

Mader TL, Davis MS, Brown-Brandl T. Environmental factors influencing heat stress in feedlot cattle. J Anim Sci. 2006;84(3):712–9. doi:10.2527/2006.843712x.

Gaughan JB, Mader TL, Holt SM, Lisle A. A new heat load index for feedlot cattle. J Anim Sci. 2008;86(1):226–34. doi:10.2527/jas.2007-0305.

Arias RA, Mader TL. Environmental factors affecting daily water intake on cattle finished in feedlots. J Anim Sci. 2011;89(1):245–51. doi:10.2527/jas.2010-3014.

Lean IJ, Sheedy DB, LeBlanc SJ, Duffield T, Santos JEP, Golder HM. Holstein dairy cows lose body condition score and gain body weight with increasing parity in both pasture-based and total mixed ration herds. JDS Commun. 2022;3(6):431–5. doi:10.3168/jdsc.2022-0246.