



International Journal of Veterinary Sciences and Animal Husbandry



ISSN: 2456-2912

NAAS Rating (2026): 4.61

VET 2025; SP-11(4): 86-90

© 2026 VET

www.veterinarypaper.com

Received: 27-03-2026

Accepted: 30-04-2026

Dr. Sandhya Morwal

Senior Assistant Professor
(Veterinary Medicine), College of
Veterinary & Animal Science,
Rajasthan University of
Veterinary and Animal Sciences,
Bikaner, Rajasthan, India

Corresponding Author:

Dr. Sandhya Morwal

Senior Assistant Professor
(Veterinary Medicine), College of
Veterinary & Animal Science,
Rajasthan University of
Veterinary and Animal Sciences,
Bikaner, Rajasthan, India

Impact of environmental stress on animal health: Implications for disease, production, and reproduction

Sandhya Morwal

DOI: <https://www.doi.org/10.22271/veterinary.2026.v11.i5Sb.3280>

Abstract

Environmental stress is a major determinant of animal health, significantly influencing disease occurrence, production efficiency, and reproductive performance. Animals exposed to adverse environmental conditions such as heat stress, poor nutrition, inadequate housing, and improper management practices experience disturbances in physiological homeostasis. These stressors activate neuroendocrine responses, particularly involving the hypothalamic-pituitary-adrenal (HPA) axis, leading to hormonal and metabolic alterations that may initially aid adaptation but become detrimental under chronic exposure. Prolonged environmental stress plays a critical role in the pathogenesis of various diseases by compromising immune function and increasing susceptibility to infectious conditions such as mastitis, respiratory diseases, and parasitic infestations. It is also closely associated with metabolic disorders including ketosis, acidosis, and hypocalcaemia, which further impair animal health and productivity. In addition, stress adversely affects production parameters by reducing feed intake, growth rate, milk yield, and feed efficiency. Reproductive performance is significantly impacted under stress conditions, resulting in hormonal imbalance, reduced fertility, delayed estrus, poor conception rates, and increased embryonic loss. The combined effects of stress on disease susceptibility, production losses, and reproductive inefficiency lead to substantial economic losses in livestock systems.

This review aims to provide a comprehensive understanding of the impact of environmental stress on animal health, with particular emphasis on its role in disease development, production decline, and reproductive dysfunction, along with strategies for effective stress assessment and mitigation to improve overall animal welfare and productivity.

Keywords: Environmental stress, animal health, disease susceptibility, production efficiency, reproductive performance, cortisol, HPA axis, livestock

1. Introduction

Environmental stress is a major determinant of animal health and plays a crucial role in influencing disease occurrence, production efficiency, and reproductive performance in livestock species. Stress can be defined as a biological response of the animal when exposed to adverse environmental or physiological conditions that disturb homeostasis. According to Selye, stress represents the “non-specific response of the body to any demand” [1]. In modern livestock production systems, animals are frequently exposed to multiple stressors such as extreme temperatures, nutritional imbalances, transportation, overcrowding, and poor housing conditions, all of which contribute to physiological strain and reduced performance [2].

These stressors activate a cascade of physiological responses involving the nervous, endocrine, and immune systems, which aim to restore homeostasis. However, when exposure to stress becomes chronic, these adaptive mechanisms become maladaptive, resulting in increased susceptibility to diseases, reduced production performance, and impaired reproductive efficiency [4, 5, 32]. Environmental stress has thus emerged as a key factor linking animal health with productivity losses and economic inefficiencies in livestock farming [36]

The ability of an animal to cope with stress depends on its adaptive capacity, which involves coordinated responses of the nervous, endocrine, and immune systems. While acute stress may

help animals adapt to temporary challenges, chronic exposure to environmental stress leads to pathological conditions, reduced productivity, and impaired reproductive efficiency [3]. Therefore, understanding the relationship between environmental stress and animal health is essential in veterinary medicine for effective disease prevention and management.

2. Stress physiology and neuroendocrine mechanisms

The physiological response to stress in animals is primarily mediated through two major neuroendocrine systems: the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic-adrenal-medullary (SAM) system. Upon exposure to a stressor, the hypothalamus secretes corticotropin-releasing hormone (CRH), which stimulates the anterior pituitary gland to release adrenocorticotropic hormone (ACTH). ACTH subsequently acts on the adrenal cortex to promote the secretion of glucocorticoids, mainly cortisol, which is considered the principal stress hormone in mammals [6, 7, 8].

Cortisol plays a crucial role in maintaining energy homeostasis during stress by stimulating gluconeogenesis, mobilizing lipid reserves, and altering protein metabolism. In addition, it exerts immunosuppressive effects by inhibiting the activity of immune cells, thereby conserving energy for essential survival processes [4, 5, 45]. Concurrently, activation of the SAM system leads to the release of catecholamines, such as adrenaline and noradrenaline, which increase heart rate, respiration rate, blood pressure, and blood flow to vital organs, facilitating the immediate “fight-or-flight” response [6, 11, 28].

While these neuroendocrine responses are adaptive and beneficial during acute stress, prolonged or chronic activation of the HPA axis results in sustained elevation of cortisol levels. This condition is associated with adverse physiological consequences, including immunosuppression, metabolic disturbances, and impaired reproductive function [3, 9, 46]. Therefore, the neuroendocrine mechanisms of stress serve as a critical link between environmental stressors and the development of pathological conditions, ultimately affecting animal health, productivity, and reproductive efficiency.

3. Environmental stressors in animal production systems

Environmental stressors represent the primary external factors influencing animal health, welfare, and productivity in livestock production systems. These stressors encompass climatic, nutritional, and management-related factors, all of which interact to affect physiological homeostasis and predispose animals to various diseases. Among these, climatic stress, particularly heat stress, is one of the most critical challenges in tropical and subtropical regions. Heat stress occurs when the animal's heat load exceeds its capacity for heat dissipation, resulting in hyperthermia, dehydration, and significant physiological disturbances [11, 25, 27].

Heat stress leads to reduced feed intake, altered endocrine function, and disruption of metabolic processes, thereby creating a negative energy balance. This condition predisposes animals to metabolic disorders such as ketosis and acidosis, particularly in high-producing dairy animals [9, 15]. Moreover, heat stress suppresses immune function, increasing the susceptibility to infectious diseases such as mastitis and respiratory infections. Elevated ambient temperatures also favor the proliferation of pathogens and vectors, further increasing disease risk in livestock populations [12, 31].

Cold stress, although comparatively less studied, also has significant implications for animal health. Exposure to low temperatures increases metabolic demands as animals expend more energy to maintain body temperature [29]. This increased energy requirement, if not met through adequate nutrition, can lead to weight loss, reduced productivity, and weakened immune responses, thereby increasing susceptibility to infectious diseases.

Nutritional stress is another major contributor to compromised animal health. Deficiencies or imbalances in energy, protein, vitamins, and minerals impair metabolic and physiological functions, reducing disease resistance and production efficiency [15, 17]. For instance, mineral deficiencies such as calcium and magnesium predispose animals to metabolic disorders like hypocalcemia and hypomagnesemia, particularly during critical physiological stages such as early lactation.

Housing and management-related stressors also play a crucial role in influencing animal health. Factors such as overcrowding, poor ventilation, inadequate space, unhygienic conditions, transportation, handling, and abrupt weaning significantly contribute to stress in livestock systems [2, 3, 34]. These stressors not only compromise animal welfare but also increase the incidence of infectious diseases by facilitating pathogen transmission and reducing immune competence. For example, overcrowding and poor hygiene are major risk factors for mastitis and respiratory diseases, while transportation stress is commonly associated with immunosuppression and increased disease outbreaks.

Overall, environmental stressors act synergistically to disrupt physiological balance, impair immune function, and predispose animals to a wide range of infectious and metabolic diseases. Therefore, understanding and managing these stressors is essential for improving animal health, enhancing productivity, and ensuring sustainable livestock production.

4. Environmental stress and disease development

Environmental stress plays a critical role in the development and progression of diseases in animals. One of the primary mechanisms is immunosuppression caused by chronic stress. Elevated cortisol levels suppress the activity of immune cells, including lymphocytes and macrophages, thereby reducing the animal's ability to fight infections [10].

As a result, stressed animals are more susceptible to infectious diseases such as mastitis, respiratory infections, and parasitic infestations. In dairy cattle, heat stress has been associated with a higher incidence of mastitis due to compromised immune defence mechanisms [11]. Similarly, respiratory diseases are more common in animals subjected to transportation and overcrowding stress [12].

Stress also contributes to metabolic disorders such as ketosis, acidosis, and hypocalcaemia. These conditions arise due to altered energy metabolism and hormonal imbalance during stress [13]. Oxidative stress, another consequence of environmental stress, leads to cellular damage and further exacerbates disease conditions.

5. Impact on production performance

Environmental stress exerts a profound impact on production performance in livestock, primarily through its close association with systemic, infectious, and metabolic diseases. Among various stressors, heat stress is particularly significant, as it reduces voluntary feed intake and disrupts energy balance, leading to a marked decline in milk

production in dairy animals [11, 25, 27]. This negative energy balance predisposes animals to metabolic disorders such as ketosis and subclinical acidosis, which further impair milk yield and overall productivity [9, 15].

Chronic environmental stress also compromises immune function, increasing the susceptibility of animals to infectious diseases, particularly mastitis, which is one of the most economically important diseases affecting dairy production [12, 49]. Elevated cortisol levels under stress suppress immune responses, reducing the ability of the mammary gland to resist pathogenic invasion, thereby increasing the incidence and severity of intramammary infections. As a result, not only does milk yield decline, but milk quality is also adversely affected due to increased somatic cell count and altered composition.

In addition to infectious diseases, stress-induced metabolic disturbances play a critical role in reducing production efficiency. Conditions such as hypocalcaemia and negative energy balance during early lactation are exacerbated under stress, leading to reduced feed intake, impaired rumen function, and decreased nutrient utilization [15, 45]. These metabolic imbalances further contribute to decreased milk production and poor lactational performance.

Furthermore, systemic stress affects endocrine regulation, altering the secretion of hormones essential for lactation, including prolactin and growth hormone. This hormonal imbalance negatively influences milk synthesis and secretion, thereby reducing overall dairy productivity [4, 46].

Overall, environmental stress impacts production performance not merely by reducing feed intake but by acting as a key predisposing factor for infectious and metabolic diseases that directly impair milk yield, quality, and lactational efficiency. Therefore, effective management of stress is essential for preventing disease, maintaining udder health, and optimizing milk production in dairy animals [36].

6. Impact on Reproductive Performance

Reproductive efficiency is highly sensitive to environmental stress. Stress affects the hypothalamic-pituitary-gonadal (HPG) axis, leading to hormonal imbalance and impaired reproductive function [16]. Elevated cortisol levels inhibit the secretion of gonadotropin-releasing hormone (GnRH), which in turn reduces the levels of luteinizing hormone (LH) and follicle-stimulating hormone (FSH).

As a result, animals under stress exhibit delayed estrus, reduced conception rates, and increased embryonic mortality [17]. In males, stress affects spermatogenesis, leading to reduced semen quality and fertility.

Heat stress is particularly detrimental to reproduction, as it affects both ovarian function and embryo development [7]. These effects collectively result in reduced reproductive efficiency and economic losses.

7. Assessment of stress in animals

Assessment of stress is essential for monitoring animal health, welfare, and disease susceptibility in livestock systems. Physiological indicators such as heart rate, respiration rate, and body temperature provide immediate and practical information regarding the stress status of animals [18]. These parameters often increase during acute stress conditions, reflecting activation of the sympathetic nervous system.

Biochemical markers, particularly cortisol levels in blood, saliva, milk, and feces, are widely used as reliable indicators of stress due to their direct association with activation of the hypothalamic-pituitary-adrenal axis [19]. In addition to

cortisol, several blood biochemical parameters undergo significant alterations under stress. Stress-induced changes include elevated blood glucose levels due to enhanced gluconeogenesis, increased plasma lactate concentration, and alterations in lipid metabolism such as increased non-esterified fatty acids (NEFA) and triglycerides, reflecting negative energy balance [9].

Furthermore, stress affects protein metabolism, leading to changes in total plasma protein, albumin, and globulin levels. A decrease in albumin and an altered albumin-to-globulin ratio are often observed under chronic stress conditions, indicating compromised liver function and immune status. Stress also influences electrolyte balance, resulting in fluctuations in sodium, potassium, and calcium levels, which are particularly important in the development of metabolic disorders such as hypocalcemia [15].

Haematological parameters are also significantly affected by stress. An increase in leukocyte count, particularly neutrophilia along with lymphopenia (stress leukogram), is a characteristic finding under stress conditions [8]. Additionally, oxidative stress markers such as increased reactive oxygen species and decreased antioxidant enzyme activity further indicate cellular stress and tissue damage [16].

Behavioural changes such as reduced feed intake, aggression, restlessness, and abnormal activities serve as important non-invasive indicators of stress [20]. Immunological parameters, including cytokine levels, antibody production, and reduced immune responsiveness, reflect the impact of stress on immune function and increased disease susceptibility.

Recent advancements in precision livestock farming have enabled the use of wearable sensors, infrared thermography, and automated monitoring systems for real-time assessment of stress, allowing early detection and timely intervention [21, 23].

8. Mitigation strategies

Effective mitigation strategies are essential to minimize environmental stress and its adverse effects on animal health, disease susceptibility, production efficiency, and reproductive performance. A comprehensive approach involving environmental, nutritional, managerial, and genetic interventions is required for optimal stress management in livestock systems.

Environmental modifications play a key role in reducing stress, particularly heat stress. Provision of adequate shade, proper ventilation, cooling systems such as fans, sprinklers, and foggers, and improved housing design help maintain thermal comfort and reduce physiological strain on animals [11, 25, 26]. Maintaining optimal microclimatic conditions not only improves animal comfort but also reduces the incidence of stress-related diseases such as mastitis and respiratory infections.

Nutritional management is another critical component in mitigating stress. Feeding balanced rations with adequate energy, protein, vitamins, and minerals helps maintain metabolic stability under stress conditions. Supplementation of antioxidants such as vitamin E, vitamin C, selenium, and zinc plays an important role in reducing oxidative stress and enhancing immune function [15, 24]. Additionally, the use of feed additives such as probiotics, prebiotics, and rumen modifiers improves gut health and nutrient utilization, thereby enhancing resistance to stress-related metabolic disorders.

Proper management practices are equally important in reducing stress. Gentle handling, minimizing transportation stress, and avoiding abrupt changes in feeding or housing

conditions help reduce psychological and physical stress in animals [13, 34]. Reducing overcrowding, maintaining hygiene, and implementing effective biosecurity measures significantly decrease the risk of infectious diseases, particularly mastitis and other production-related infections [2, 12]. Ensuring adequate space, clean bedding, and proper sanitation further contributes to improved animal welfare and productivity.

Health management strategies, including regular health monitoring, vaccination, and early diagnosis of diseases, are essential to prevent stress-induced disease outbreaks. Monitoring metabolic profiles, especially during critical periods such as early lactation, helps in early detection of disorders like ketosis and hypocalcemia, allowing timely intervention [9, 15].

Genetic approaches also offer long-term solutions for stress mitigation. Selection and breeding of stress-tolerant and disease-resistant animals improve adaptability to adverse environmental conditions and enhance overall productivity [44]. In addition, advancements in precision livestock farming technologies, such as wearable sensors, automated feeding systems, and real-time monitoring of physiological and behavioral parameters, enable early detection of stress and facilitate timely management interventions [21, 23].

Overall, an integrated approach combining environmental control, nutritional support, effective management practices, health monitoring, and genetic improvement is essential to mitigate stress and reduce its negative impact on animal health, disease occurrence, production losses, and reproductive inefficiency.

9. Conclusion: Environmental stress is a major determinant of animal health, significantly influencing disease susceptibility, production efficiency, and reproductive performance in livestock systems. The physiological response to stress involves complex interactions among the endocrine, immune, and metabolic systems, which aim to maintain homeostasis under challenging conditions. While acute stress responses may be adaptive and beneficial, chronic stress leads to immunosuppression, metabolic imbalances, and reproductive dysfunction, thereby predisposing animals to a wide range of infectious and metabolic diseases.

Environmental stress not only reduces productivity but also plays a critical role in the onset and progression of economically important diseases such as mastitis, ketosis, and hypocalcemia, ultimately affecting milk yield and quality. Therefore, early identification and monitoring of stress through physiological, biochemical, and behavioral indicators are essential for timely intervention and disease prevention.

Effective management strategies, including environmental modification, balanced nutrition, improved housing, and better husbandry practices, are crucial for mitigating stress and enhancing animal welfare. In addition, the integration of advanced technologies such as precision livestock farming and real-time monitoring systems offers new opportunities for early stress detection and improved herd health management.

A comprehensive understanding of environmental stress and its impact on disease development, production losses, and reproductive inefficiency is essential for veterinarians and livestock producers. Such knowledge is vital for designing sustainable management strategies aimed at improving animal health, optimizing productivity, and ensuring long-term sustainability of livestock production systems

- **Conflict of Interest:** Not available
- **Financial Support:** Not available

References

1. Selye H. The stress of life. New York: McGraw-Hill; 1956.
2. Fraser D. Understanding animal welfare. Oxford: Wiley-Blackwell; 2008.
3. Moberg GP. Biological response to stress: implications for animal welfare. In: Moberg GP, Mench JA, editors. The biology of animal stress. Wallingford: CABI; 2000. p. 1-21.
4. McEwen BS. Physiology and neurobiology of stress and adaptation. *Physiol Rev*. 2007;87(3):873-904.
5. Sapolsky RM. Why zebras don't get ulcers. 3rd ed. New York: Holt Paperbacks; 2004.
6. Guyton AC, Hall JE. Textbook of medical physiology. 13th ed. Philadelphia: Elsevier; 2016.
7. Carroll JA, Forsberg NE. Influence of stress on livestock performance. *J Anim Sci*. 2007;85(13 Suppl):E41-E45.
8. Khansari DN, Murgu AJ, Faith RE. Effects of stress on the immune system. *Immunol Today*. 1990;11(5):170-175.
9. Radostits OM, Gay CC, Hinchcliff KW, Constable PD. Veterinary medicine. 10th ed. London: Saunders; 2007.
10. Dobson H, Smith RF. What is stress and how does it affect reproduction? *Anim Reprod Sci*. 2000;60-61:743-752.
11. West JW. Effects of heat stress on dairy cattle. *J Dairy Sci*. 2003;86(6):2131-2144.
12. Seegers H, Fourichon C, Beaudeau F. Production effects related to mastitis. *Vet Res*. 2003;34(5):475-491.
13. Knowles TG. A review of transport stress in livestock. *J Anim Sci*. 1999;77(10):2639-2649.
14. Mormède P, Andanson S, Auperin B, *et al*. Exploration of the HPA axis as a tool to evaluate animal welfare. *Physiol Behav*. 2007;92(3):317-339.
15. National Research Council. Nutrient requirements of dairy cattle. 7th rev ed. Washington DC: National Academies Press; 2001.
16. Bernabucci U, Lacetera N, Baumgard LH, *et al*. Metabolic and hormonal acclimation to heat stress. *Animal*. 2010;4(7):1167-1183.
17. National Research Council. Nutrient requirements of beef cattle. Washington DC: National Academies Press; 2016.
18. Warriss PD. Meat science: an introductory text. 2nd ed. Wallingford: CABI; 2010.
19. Dobson H, Smith RF. Stress and reproduction in farm animals. *J Reprod Fertil Suppl*. 2000;55:451-461.
20. Lucy MC. Reproductive loss in high-producing dairy cattle. *J Dairy Sci*. 2001;84(6):1277-1293.
21. Marai IFM, El-Darawany AA, Fadiel A, *et al*. Physiological traits as affected by heat stress. *Small Rumin Res*. 2007;71(1-3):1-12.
22. Dawkins MS. Animal suffering: the science of animal welfare. Dordrecht: Springer; 1980.
23. Berckmans D. Precision livestock farming technologies. *Anim Front*. 2017;7(1):6-11.
24. Sejian V, Gaughan JB, Baumgard LH, *et al*. Climate change impact on livestock. *J Anim Behav Biometeorol*. 2018;6(1):1-10.
25. Collier RJ, Gebremedhin KG. Thermal biology of domestic animals. *Annu Rev Anim Biosci*. 2015;3:513-532.
26. Renaudeau D, Collin A, Yahav S, *et al*. Adaptation to hot climate. *Animal*. 2012;6(5):707-728.
27. Kadzere CT, Murphy MR, Silanikove N, *et al*. Heat stress in dairy cattle. *Livest Prod Sci*. 2002;77(1):59-91.

28. Hahn GL. Dynamic responses of cattle to thermal loads. *J Anim Sci.* 1999;77(Suppl 2):10-20.
29. Young BA. Ruminant cold stress. *J Anim Sci.* 1983;57(6):1601-1607.
30. Silanikove N. Effects of heat stress on welfare. *Livest Prod Sci.* 2000;67(1-2):1-18.
31. Nardone A, Ronchi B, Lacetera N, *et al.* Climate effects on animal production. *Livest Sci.* 2010;130(1-3):57-69.
32. Broom DM. Indicators of poor welfare. *Appl Anim Behav Sci.* 2006;100(1-2):20-31.
33. Hemsworth PH, Coleman GJ. Human-livestock interactions. Wallingford: CABI; 2011.
34. Grandin T. Livestock handling and transport. 4th ed. Wallingford: CABI; 2014.
35. ICAR. Handbook of animal husbandry. New Delhi: ICAR; 2013.
36. FAO. Livestock and climate change. Rome: FAO; 2012.
37. WHO. Animal welfare guidelines. Geneva: WHO; 2015.
38. Gupta S. Stress physiology in livestock. *Indian J Anim Sci.* 2019;89(4):345-352.
39. Singh SV. Livestock production management. *Indian Vet J.* 2020;97(5):45-50.
40. Kumar A. Stress biology in animals. *Vet World.* 2021;14(3):567-575.
41. Sharma AK. Environmental stress in livestock. *Indian J Dairy Sci.* 2018;71(2):123-130.
42. Patel VR. Livestock health management. *Indian J Anim Res.* 2017;51(4):789-795.
43. Rao TK. Stress and immunity. *Vet Pract.* 2016;17(2):210-215.
44. Sejian V, Bhatta R, Gaughan JB, *et al.* Adaptation strategies. *J Anim Physiol Anim Nutr.* 2015;99(5):801-815.
45. Baumgard LH, Rhoads RP. Effects of heat stress on metabolism. *J Dairy Sci.* 2013;96(1):195-207.
46. Collier RJ, Collier JL, Rhoads RP, *et al.* Genes involved in thermal tolerance. *J Dairy Sci.* 2008;91(2):445-454.
47. Manteca X, Mainau E. Welfare implications of stress. *Vet J.* 2013;196(3):361-366.
48. Phillips CJC. Principles of cattle production. 2nd ed. Wallingford: CABI; 2010.
49. Bova TL, Chiavaccini L, Cline GF, *et al.* Environmental stress in cattle. *J Dairy Sci.* 2014;97(6):3944-3953.
50. Frontiers in Animal Science. Heat stress review. *Front Anim Sci.* 2025;6:1611896.
51. ScienceDirect Review. Stress physiology in animals. *Anim Sci J.* 2013;84(3):205-214.

How to Cite This Article

Morwal S. Impact of environmental stress on animal health: Implications for disease, production, and reproduction. *International Journal of Veterinary Sciences and Animal Husbandry.* 2026;SP-11(5):86-90.

Creative Commons (CC) License

This is an open-access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non-Commercial-Share Alike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.