

Feeding Management During Heat Stress in Ruminants: A Farmer's Guide

**Muteeb ullah Rafiqui¹,
Sourabh Babu²,
Vivek Kumar²,
Jan Mohd Muneeb³**

¹Ph.D. Scholar, Division of Animal Nutrition, ICAR–Indian Veterinary Research Institute (ICAR-IVRI) Izatnagar, Bareilly – 243122, Uttar Pradesh, India.

²Ph.D. Scholar, Division of Pathology, ICAR–Indian Veterinary Research Institute (ICAR-IVRI) Izatnagar, Bareilly– 243122, Uttar Pradesh, India.

³Ph.D. Scholar, Division of Veterinary Biotechnology, ICAR–Indian Veterinary Research Institute (ICAR-IVRI) Izatnagar, Bareilly– 243122, Uttar Pradesh, India.



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*Corresponding Author
Muteeb ullah Rafiqui*

Available online at
www.sunshineagriculture.vitalbiotech.org

Article History

Received: 13.06.2026

Revised: 18.06.2026

Accepted: 23.06.2026

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INTRODUCTION

Heat stress is one of the most significant environmental challenges affecting ruminant livestock production worldwide, particularly in tropical and subtropical regions where high ambient temperatures and humidity prevail for extended periods. Dairy cattle, buffaloes, sheep, and goats experience physiological and metabolic disturbances when environmental conditions exceed their thermo neutral zone, resulting in reduced feed intake, lower milk production, poor growth, compromised reproductive performance, increased susceptibility to diseases, and substantial economic losses for farmers. Heat stress occurs when the animal's ability to dissipate body heat becomes inadequate to counteract the heat generated internally through metabolism and absorbed from the environment. Among the various management interventions available to livestock producers, feeding management is considered one of the most practical and effective approaches to reduce the negative effects of heat stress and sustain productivity during hot weather. Proper nutritional management helps maintain energy balance, support rumen function, improve immune response, reduce metabolic heat production, and enhance the animal's overall ability to cope with elevated temperatures. Understanding the principles of feeding management during heat stress is therefore essential for farmers aiming to maintain the health, welfare, and productivity of their animals during summer months.

Understanding Heat Stress in Ruminants

Ruminants are particularly vulnerable to heat stress because of the considerable amount of metabolic heat produced during ruminal fermentation and nutrient metabolism. When environmental temperatures rise above the animal's comfort zone, physiological mechanisms such as sweating, panting, increased respiration rate, vasodilation, and changes in behavior are activated to maintain normal body temperature

However, prolonged exposure to excessive heat can overwhelm these adaptive mechanisms, resulting in thermal stress. High-producing dairy animals are especially susceptible because milk synthesis itself generates additional metabolic heat. Buffaloes are generally more sensitive to heat stress than cattle due to their dark skin color, sparse sweat glands, and thicker skin, which limit their ability to dissipate heat efficiently. Sheep and goats exhibit comparatively better heat tolerance but still experience declines in productivity under severe heat stress conditions. The severity of heat stress is commonly assessed using the Temperature-Humidity Index (THI), which combines ambient temperature and relative humidity into a single value. As THI increases, animals show signs such as excessive panting, drooling, increased water consumption, reduced feed intake, lethargy, decreased rumination, lower milk yield, and impaired fertility. Understanding these physiological responses is critical for developing effective feeding strategies aimed at minimizing the adverse consequences of heat stress.

Effects of Heat Stress on Feed Intake and Digestion

One of the earliest and most significant responses of ruminants to heat stress is a reduction in voluntary feed intake. Animals instinctively consume less feed in an attempt to minimize the heat generated during digestion and metabolism. Although this adaptation helps reduce internal heat production, it simultaneously decreases nutrient intake, resulting in energy deficits and reduced productivity. Feed intake in dairy cows can decline by 10–30 percent or even more during periods of severe heat stress. Reduced feed consumption leads to lower energy, protein, vitamin, and mineral intake, negatively affecting milk production, growth, reproduction, and immune competence. Heat stress also alters feeding behavior, causing

animals to consume fewer but larger meals during cooler periods of the day. Reduced chewing activity and lower saliva production compromise rumen buffering capacity, increasing the risk of ruminal acidosis. Furthermore, heat-stressed animals often exhibit a preference for concentrate feeds over roughages, which can further disrupt rumen fermentation patterns. These digestive and metabolic alterations contribute significantly to the decline in performance observed during hot weather, emphasizing the need for strategic nutritional interventions.

Importance of Water During Heat Stress

Water is the most important nutrient for animals experiencing heat stress and often determines their ability to survive and remain productive under challenging environmental conditions. As temperatures rise, water requirements increase substantially because animals lose greater amounts of water through sweating, panting, urination, and evaporative cooling processes. A lactating dairy cow may consume between 60 and 120 liters of water per day during hot weather, while buffaloes, sheep, and goats also exhibit significantly increased water consumption. Providing unrestricted access to clean, cool, and fresh drinking water is therefore essential. Water troughs should be conveniently located, adequately sized, regularly cleaned, and protected from direct sunlight whenever possible. Cool water can help lower body temperature and improve feed intake, while inadequate water availability rapidly leads to dehydration, reduced milk production, poor thermoregulation, and increased susceptibility to heat-related disorders. Farmers should pay particular attention to water quality because contaminated water can discourage consumption and predispose animals to digestive and infectious diseases. Ensuring abundant water availability throughout the day remains one of the simplest and most effective methods for mitigating heat stress.

Feeding Time and Feeding Frequency

The timing of feed delivery plays a critical role in maximizing feed intake during hot weather. Since animals tend to eat more readily when environmental temperatures are lower, feeding should be concentrated during the cooler hours of the day, particularly in the early morning and late evening. Providing approximately 60–70 percent of the daily ration during evening hours encourages greater feed consumption because animals can eat comfortably during the cooler nighttime period. Night feeding has been associated with improved dry matter intake, enhanced nutrient utilization, and better productivity under heat stress conditions. In addition to adjusting feeding times, increasing feeding frequency can also be beneficial. Offering smaller amounts of fresh feed multiple times per day improves palatability and encourages consistent intake while reducing feed spoilage. Farmers should avoid presenting large meals during the hottest part of the day because digestion generates additional metabolic heat that may worsen thermal stress. Freshly mixed rations should be protected from excessive heating, fermentation, and deterioration to maintain feed quality and encourage consumption.

Improving Dietary Energy Density

Because feed intake declines during heat stress, increasing dietary energy density becomes essential for maintaining adequate nutrient supply. Animals must obtain sufficient energy from smaller quantities of feed, making the formulation of nutrient-dense diets particularly important. High-quality concentrates and highly digestible feed ingredients can help compensate for reduced dry matter intake. Supplemental fats are especially useful because they provide approximately 2.25 times more energy than carbohydrates while generating relatively little metabolic heat during digestion and metabolism. The inclusion of protected fats or bypass fats in dairy cattle rations can significantly improve energy intake without

increasing ruminal fermentation heat production. These supplements support milk yield, body condition, and reproductive performance during periods of elevated temperature. However, excessive concentrate feeding should be avoided because it increases the risk of ruminal acidosis and digestive disturbances. The goal is to achieve a balanced ration that provides adequate energy while maintaining optimal rumen function and animal health.

Protein Management During Heat Stress

Protein nutrition requires careful consideration during hot weather because the digestion and metabolism of protein generate substantial amounts of heat. Feeding excessive quantities of crude protein may increase metabolic heat production and place additional stress on animals already struggling to regulate body temperature. Rather than simply increasing dietary protein levels, farmers should focus on improving protein quality and utilization efficiency. High-quality protein sources and rumen undegradable protein supplements can provide essential amino acids more efficiently while reducing nitrogen losses and unnecessary heat generation. Bypass protein sources are particularly valuable because they deliver amino acids directly to the small intestine, supporting milk production, growth, and reproduction without excessive ruminal degradation. Balanced protein nutrition helps maintain productivity and immune function while minimizing the metabolic burden associated with excess nitrogen excretion. Proper protein management therefore contributes significantly to the overall effectiveness of heat stress mitigation programs.

Fiber Management and Rumen Health

Although reducing heat production is a primary objective during hot weather, adequate dietary fiber remains essential for maintaining rumen health and normal digestive function. Fiber stimulates chewing activity and saliva production, which help buffer rumen pH and

support microbial fermentation. However, highly fibrous and poorly digestible roughages produce more fermentation heat and can reduce voluntary feed intake. Therefore, farmers should emphasize high-quality forages with moderate fiber content and good digestibility. Young green fodders, properly fermented silages, and high-quality hays are preferable to mature, lignified, or poorly preserved roughages. Appropriate forage processing, including chopping to suitable particle lengths, can improve intake while preserving the physical effectiveness required for rumen function. The use of dietary buffers such as sodium bicarbonate may help stabilize rumen pH and reduce the risk of acidosis, particularly when concentrate levels are increased to enhance energy density. Maintaining optimal rumen health is critical for sustaining nutrient utilization and productivity during heat stress.

Mineral and Electrolyte Supplementation

Heat stress increases the loss of electrolytes and minerals through sweating, urination, and increased respiratory activity. Consequently, the dietary requirements for sodium, potassium, chloride, and other essential minerals often increase during hot weather. Electrolytes play vital roles in maintaining fluid balance, nerve transmission, muscle function, acid-base regulation, and cellular metabolism. Potassium is particularly important because significant quantities are lost through sweat, especially in dairy cattle. Supplementation with potassium-rich mineral mixtures or feeds can help prevent deficiencies and support thermoregulation. Sodium and chloride supplementation through common salt is equally important and should be provided either through free-choice salt blocks or balanced mineral mixtures. Adequate levels of calcium, phosphorus, magnesium, zinc, copper, selenium, and manganese are also necessary to support immune function, reproductive performance, and overall health. Well-formulated mineral supplements specifically designed for summer feeding can significantly improve animal resilience to heat stress.

Vitamins and Antioxidant Nutrition

Heat stress is associated with increased oxidative stress due to the excessive production of reactive oxygen species within body tissues. Oxidative stress damages cellular structures, impairs immune function, and contributes to reduced productivity. Antioxidant vitamins and minerals play important roles in protecting animals against these harmful effects. Vitamin E and selenium are among the most effective antioxidants for supporting immune function and reducing oxidative damage. Vitamin C supplementation may also be beneficial because endogenous synthesis may become insufficient during severe stress conditions. Adequate levels of vitamins A, D, and B-complex vitamins contribute to improved health, metabolic function, and disease resistance. Supplementation of antioxidant nutrients during summer months can help animals maintain physiological stability, reduce stress-related disorders, and sustain productive performance under adverse environmental conditions.

Feed Additives for Heat Stress Management

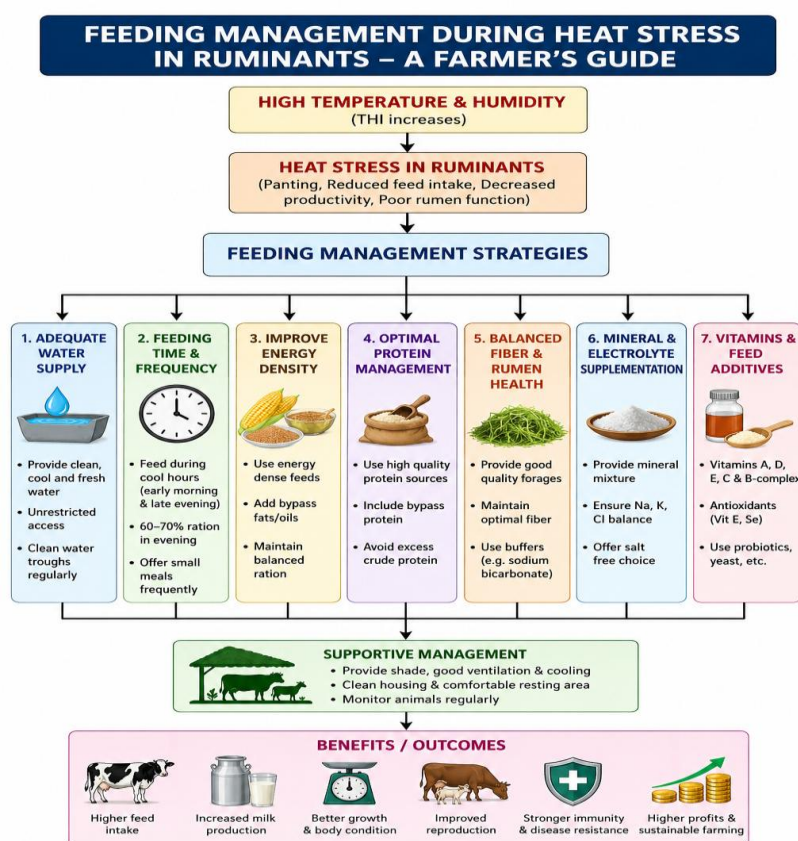
Several feed additives have demonstrated beneficial effects in heat-stressed ruminants. Probiotics and yeast cultures help stabilize rumen fermentation, improve fiber digestion, and enhance feed efficiency. These additives support microbial activity and may contribute to improved nutrient utilization during periods of reduced feed intake. Dietary buffers such as sodium bicarbonate help maintain rumen pH and reduce the risk of acidosis associated with altered feeding behavior and increased concentrate consumption. Certain plant extracts, organic acids, and nutritional supplements have also shown promise in improving stress tolerance and animal performance. While feed additives cannot completely eliminate the effects of heat stress, they can serve as valuable components of a comprehensive nutritional management program.

Feeding Strategies for Different Ruminant Species

The feeding requirements of different ruminant species vary according to their physiological characteristics and production objectives. Dairy cattle benefit from nutrient-dense rations containing high-quality forages, protected fats, bypass proteins, buffers, and balanced mineral supplementation. Buffaloes require special attention because of their greater sensitivity to heat stress and tendency to reduce feed intake dramatically during hot weather. Providing succulent green fodder, adequate water, and feeding during cooler hours is particularly important for buffalo management. Sheep and goats generally tolerate heat better than cattle and buffaloes, but they still benefit from high-quality forage, strategic supplementation, and continuous access to clean water. Lactating and rapidly growing animals within all species require additional nutritional support to maintain productivity during periods of thermal stress.

Practical Recommendations for Farmers

Successful feeding management during heat stress involves a combination of nutritional and managerial practices designed to minimize heat load and maximize nutrient utilization. Farmers should ensure continuous access to clean water, feed animals during cooler hours, provide highly digestible and nutrient-dense diets, maintain adequate fiber intake, supplement essential minerals and vitamins, utilize appropriate feed additives, and monitor animals closely for signs of heat stress. Feed storage facilities should protect feed from spoilage, heating, and moisture damage. Regular assessment of body condition, milk production, feed intake, and animal behavior can help identify problems early and facilitate timely corrective measures. Integrating proper feeding management with other heat mitigation strategies such as shade provision, ventilation, cooling systems, and good housing design offers the greatest potential for maintaining animal health and productivity during hot weather.



CONCLUSION

Heat stress represents a major challenge to ruminant production systems, particularly in regions characterized by prolonged periods of high temperature and humidity. Reduced feed intake, altered rumen function, nutrient deficiencies, and physiological stress collectively contribute to significant declines in productivity and profitability. However, carefully planned feeding management can substantially reduce these negative effects and help animals maintain health and performance

during summer months. Adequate water supply, strategic feeding schedules, nutrient-dense diets, balanced protein and fiber nutrition, electrolyte supplementation, antioxidant support, and the use of beneficial feed additives collectively form the foundation of effective heat stress management. By adopting these scientifically sound feeding practices, farmers can improve animal welfare, enhance production efficiency, reduce economic losses, and ensure sustainable livestock farming under increasingly challenging climatic conditions