

Turning Shelters into Shields: Housing Management for Enhancing Bovine Resilience under Climate Change

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INTRODUCTION

The livestock sector contributes significantly to agricultural GDP and rural livelihoods in developing countries. In tropical and subtropical climates, dairy animals are exposed to extreme environmental fluctuations such as heat waves, cold spells, and erratic rainfall patterns. These climatic stressors adversely affect animal physiology, production efficiency, and reproductive performance. Housing management serves as the primary interface between animals and their environment and plays a crucial role in mitigating climatic stress.

2. Climatic Stress and Thermal Load in Bovines

Thermal stress occurs when environmental conditions exceed the animal's thermoregulatory capacity. The **Temperature Humidity Index (THI)** is widely used to assess thermal stress levels.

- **THI > 72:** Moderate heat stress
- **THI > 78:** Severe heat stress

2.1 Heat Stress

Heat stress leads to increased respiration rate, excessive salivation, reduced feed intake, altered rumen function, and impaired metabolic efficiency. Buffaloes are particularly susceptible due to their dark skin, thick hide, high body mass, and limited sweat glands.

2.2 Cold Stress

Cold stress, though less emphasized in tropical regions, significantly affects calves and young stock during winter, especially under damp and poorly ventilated housing conditions.

3. Impact of Climate Stress on Production and Reproduction

3.1 Production Performance

Thermal stress diverts energy from productive functions to thermoregulation, resulting in:

- Decreased milk yield and altered milk composition (reduced fat and SNF)
- Reduced growth rates in calves and heifers
- Increased incidence of metabolic disorders, mastitis, and lameness

3.2 Reproductive Performance

Reproductive efficiency is highly sensitive to environmental stress:

- Disruption of hormonal balance.
- Silent estrus, reduced conception rates, and increased embryonic mortality
- Extended calving intervals and increased services per conception

4. Housing Systems as a Mitigation Strategy

Housing systems vary in their ability to provide climatic protection and animal comfort.

Housing System	Characteristics and Suitability
Open Housing	Economical but offers minimal protection from climatic extremes
Loose Housing	Semi-covered system with open paddocks; widely practiced in India
Climate-Resilient Housing	High roofs, ridge ventilation, reflective roofing, foggers, and sprinklers; effective in hot-humid climates
Tunnel Ventilation Housing	Enclosed system with fans and cooling pads; suitable for high-yielding dairy herds
Deep Litter System	Organic bedding providing insulation; ideal for cold climates and young stock

5. Economic and Biological Benefits of Improved Housing

5.1 Production Benefits

- Loose housing systems can increase milk yield by 8–12%
- Climate-resilient housing may improve productivity by 20–25% during heat stress periods
- Tunnel ventilation systems have reported up to 30% higher milk yield in high-producing cows

5.2 Reproductive and Health Benefits

- Estrus detection efficiency improves significantly under better housing conditions
- Conception rates in buffaloes may increase from ~35% to >55%
- Reduced incidence of heat stress-related disorders, respiratory diseases, and hoof problems

5.3 Physiological Indicators of Comfort

Well-housed animals exhibit:

- Normal rectal temperature
- Reduced respiration and pulse rates
- Increased lying time, rumination activity, and positive social behaviors

6. Climate-Responsive Housing Design Practices

Key low-cost and advanced interventions include:

- **Orientation:** East–West alignment to minimize solar radiation
- **Roof Design:** High, insulated, and reflective roofing materials
- **Ventilation:** Ridge and sidewall ventilation for heat and gas removal
- **Active Cooling:** Use of fans, foggers, and sprinklers
- **Drainage and Hygiene:** Proper slope and drainage to prevent water logging and hoof diseases
- **Winter Protection:** Deep bedding and windbreaks for calves and young stock

CONCLUSION

Climate change poses a serious challenge to sustainable dairy production. Housing management represents a critical adaptation strategy for mitigating environmental stress and enhancing bovine productivity, reproductive efficiency, and welfare. Future dairy housing designs should integrate climate-smart architecture, cost-effective materials, and region-specific management practices. A well-designed housing system not only improves animal performance but also strengthens the resilience and profitability of dairy farming under changing climatic conditions