

| RESEARCH ARTICLE

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**CLIMATE CHANGE AND LIVESTOCK PRODUCTION: IMPACTS, ADAPTATION
STRATEGIES, AND SUSTAINABLE MANAGEMENT**

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| ABSTRACT

Climate change is increasingly affecting livestock production systems worldwide through rising temperatures, altered precipitation patterns, extreme weather events, and changing disease dynamics. Livestock contribute significantly to food security, rural livelihoods, and economic development, particularly in developing countries. However, climate-related challenges threaten animal health, productivity, feed availability, and overall sustainability of livestock enterprises.

| KEYWORDS

Climate Change, Livestock Production, Animal Health, Climate Adaptation, Sustainable Livestock Management, Food Security

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Abstract:-

Climate change is increasingly affecting livestock production systems worldwide through rising temperatures, altered precipitation patterns, extreme weather events, and changing disease dynamics. Livestock contribute significantly to food security, rural livelihoods, and economic development, particularly in developing countries. However, climate-related challenges threaten animal health, productivity, feed availability, and overall sustainability of livestock enterprises. This review examines the impacts of climate change on livestock production, including effects on animal physiology, disease prevalence, feed resources, and water availability. Adaptation and mitigation strategies such as climate-smart livestock management, genetic improvement, sustainable feeding systems, and policy interventions are discussed. The review highlights the importance of integrated approaches for enhancing livestock resilience while minimizing environmental impacts and ensuring long-term sustainability.

Introduction:-

Livestock production is a major component of global agriculture, providing meat, milk, eggs, fiber, manure, and draft power. The sector contributes substantially to food security, employment generation, and rural livelihoods. Climate change has emerged as one of the most significant threats to livestock production systems. Increasing temperatures, changing rainfall patterns, droughts, floods, and disease outbreaks are affecting animal productivity and farm profitability across the world. Understanding the relationship between climate change and livestock systems is essential for developing strategies that enhance resilience, reduce vulnerabilities, and support sustainable agricultural development.

Overview of Climate Change:-

Climate change refers to long-term shifts in temperature, precipitation, and weather patterns resulting from natural and human-induced factors.

Major drivers include:-

- Greenhouse gas emissions
- Deforestation
- Industrial activities
- Fossil fuel consumption
- Land-use changes

The primary greenhouse gases include:-

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)

Climate change affects agricultural systems directly and indirectly through environmental and ecological changes.

Importance of Livestock Production:-**Livestock systems contribute significantly to:-**

- Food production
- Rural employment
- Income generation
- Nutritional security
- Agricultural sustainability

Globally, billions of people depend on livestock for their livelihoods and household income.

Effects of Rising Temperatures on Livestock:-**Heat Stress:-**

Heat stress occurs when animals are unable to effectively dissipate excess body heat.

Consequences include:-

- Reduced feed intake
 - Lower growth rates
 - Reduced milk production
 - Decreased reproductive performance
 - Increased mortality
- Dairy cattle, poultry, and pigs are particularly vulnerable to heat stress.

Physiological Changes:-**Elevated temperatures affect:-**

- Respiration rates
- Heart function
- Metabolic activity
- Hormonal balance

These physiological changes negatively impact productivity and animal welfare.

Climate Change and Animal Health:-

Climate change influences disease dynamics in livestock populations.

Emerging Diseases:-**Changes in environmental conditions may facilitate:-**

- Emergence of new pathogens
- Expansion of disease vectors
- Increased disease transmission

Examples include vector-borne diseases transmitted by ticks, mosquitoes, and flies.

Parasite Infestations:-

Warmer temperatures and changing humidity levels can increase parasite survival and reproduction.

This may result in:-

- Increased infection rates
- Reduced productivity
- Higher treatment costs

Impact on Feed Resources:-

Climate change affects both the quantity and quality of livestock feed.

Major impacts include:-

- Reduced forage production
- Nutritional deficiencies
- Pasture degradation
- Increased feed costs

Drought conditions frequently reduce pasture productivity and feed availability.

Water Scarcity and Livestock Production:-

Water is essential for livestock health and productivity.

Climate-induced water shortages may lead to:-

- Reduced animal performance
- Increased disease susceptibility
- Lower milk yields
- Greater production costs

Efficient water management is critical for sustainable livestock systems.

Extreme Weather Events:-

Extreme weather events are becoming more frequent and severe.

These include:-

- Droughts
- Floods
- Heat waves
- Storms

Such events can cause:-

- Livestock mortality
- Infrastructure damage
- Feed shortages
- Economic losses

Economic Implications:-

Climate change imposes substantial economic costs on livestock producers.

These costs include:-

- Veterinary expenses
- Feed procurement costs
- Reduced productivity
- Infrastructure adaptation expenses

Smallholder farmers are particularly vulnerable due to limited financial resources.

Climate-Smart Livestock Management:-

Climate-smart livestock systems seek to enhance productivity while improving resilience and reducing emissions.

Key principles include:-

- Sustainable resource management
- Adaptation planning
- Emission reduction
- Improved efficiency

Climate-smart approaches support long-term sustainability.

Adaptation Strategies:-**Genetic Improvement:-****Breeding climate-resilient livestock can improve tolerance to:-**

- Heat stress
- Diseases
- Environmental variability

Improved Housing Systems:-**Livestock shelters can be designed to:-**

- Enhance ventilation
- Reduce heat stress
- Improve animal comfort

Nutritional Management:-

Balanced feeding programs improve resilience and productivity under changing climatic conditions.

Sustainable Feeding Practices:-**Improved feeding strategies contribute to:-**

- Enhanced productivity
- Reduced methane emissions
- Better animal health

Approaches include:-

- High-quality forage production
- Feed supplementation
- Improved grazing management

Mitigation of Greenhouse Gas Emissions:-

Livestock production contributes to greenhouse gas emissions, particularly methane and nitrous oxide.

Mitigation strategies include:-

- Improved feed efficiency
- Manure management
- Rotational grazing
- Methane reduction technologies

These practices reduce environmental impacts while maintaining productivity.

Role of Technology and Innovation:-

Emerging technologies support climate adaptation and management.

Examples include:-

- Precision livestock farming
- Remote sensing
- Automated monitoring systems
- Artificial intelligence
- Climate forecasting tools

Technology improves decision-making and resource efficiency.

Policy and Institutional Support:-**Governments and organizations can support climate-resilient livestock systems through:-**

- Research funding
- Extension services
- Insurance programs
- Infrastructure development
- Climate adaptation policies

Strong institutional support enhances resilience and sustainability.

Future Prospects:-**Future livestock systems will increasingly emphasize:-**

- Climate resilience
- Sustainable intensification
- Low-emission production systems
- Improved animal welfare
- Precision livestock management

Innovation and policy support will be essential for successful adaptation.

Research Priorities:-**Future research should focus on:-**

- Climate-resilient livestock breeds
- Disease surveillance systems
- Sustainable feed resources
- Water-efficient production systems
- Emission reduction technologies

These areas are critical for long-term sustainability.

Conclusion:-

Climate change presents significant challenges for livestock production systems worldwide. Rising temperatures, changing disease patterns, water scarcity, and extreme weather events threaten animal productivity and food security. However, climate-smart livestock management, genetic improvement, sustainable feeding practices, technological innovation, and supportive policies can enhance resilience and reduce vulnerabilities. A comprehensive and integrated approach will be necessary to ensure sustainable livestock production in an increasingly uncertain climate.

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