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# Linking Ecology and Physiology in Plant and Livestock Systems

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## Abstract

Plants and livestock exist within complex ecological systems where their physiological processes are closely linked to environmental conditions. Understanding these interactions is essential for sustainable agriculture, food security, and environmental management. This paper examines the relationship between ecological factors and physiological mechanisms in plants and livestock, focusing on key processes such as photosynthesis, respiration, transpiration, metabolism, and reproduction. Using a literature-based review approach, this study synthesizes current scientific knowledge on plant and animal ecophysiology, highlighting how biotic and abiotic factors such as temperature, water availability, soil quality, and species interactions affect biological performance. The analysis shows that environmental stressors significantly influence productivity, survival, and adaptation in both plants and livestock. The findings emphasize the importance of integrating ecological and physiological perspectives to improve agricultural resilience under climate change. The paper concludes that better understanding of ecophysiological mechanisms can support more sustainable farming systems, optimize resource use, and enhance productivity while reducing environmental degradation.

**Keywords:** Ecophysiology, Plants, Livestock, Environment, Sustainable Agriculture

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## 1. Introduction

Plants and livestock are fundamental components of agricultural ecosystems and play a crucial role in global food production. However, their growth, development, and productivity are strongly influenced by environmental conditions. Ecological and physiological processes are deeply interconnected, as organisms continuously interact with both biotic factors (such as other species, pathogens, and competition) and abiotic factors (including temperature, water, light, and soil nutrients).

In plants, physiological processes such as photosynthesis, respiration, and transpiration determine how efficiently they convert sunlight, water, and nutrients into biomass. These processes are highly sensitive to environmental changes. For example, water stress can reduce photosynthetic activity, while extreme temperatures may disrupt metabolic functions. Similarly, livestock physiology including metabolism, thermoregulation, and reproduction is closely tied to environmental conditions. Heat stress, for instance, can reduce feed intake, growth rate, and

reproductive performance in animals [1].

Traditional agricultural research often studies plant physiology and animal physiology separately. However, recent ecological approaches emphasize that both plants and livestock should be viewed as part of integrated agroecosystems. Changes in plant productivity directly affect livestock nutrition, while livestock management influences soil fertility, vegetation dynamics, and ecosystem health.

This paper argues that linking ecology and physiology provides a more comprehensive framework for understanding agricultural sustainability. By examining how environmental factors shape biological processes in plants and livestock, this study contributes to the development of climate-resilient and resource-efficient farming systems [2].

## 2. Materials and Methods

This study employs a qualitative literature review approach based on peer-reviewed scientific articles, textbooks, and reports related to plant and animal ecophysiology. Sources were collected from databases such as Google Scholar, Scopus, and Web of Science using keywords including “plant ecophysiology,” “livestock physiology,” “environmental stress,” and “sustainable agriculture.”

The selected literature was analyzed thematically to identify key patterns in how environmental factors influence physiological processes in plants and livestock. No primary experimental data were collected; therefore, ethical approval was not required.

## 3. Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

### 3.1 Ecological Influences on Plant Physiology

The analysis indicates that plant physiological performance is highly dependent on environmental conditions. Photosynthesis is strongly affected by light intensity, temperature, and water availability. Under drought conditions, plants reduce transpiration by closing stomata, which also limits carbon dioxide uptake and reduces photosynthetic efficiency.

Soil nutrient availability also plays a critical role in plant metabolism. Deficiencies in nitrogen, phosphorus, or potassium can significantly limit growth and productivity. Additionally, interactions with microorganisms, such as mycorrhizal fungi and nitrogen-fixing bacteria, can enhance plant nutrient uptake and resilience to stress [3].

### 3.2 Ecological Influences on Livestock Physiology

Findings show that livestock physiological performance is closely linked to environmental stressors. Heat stress significantly affects animal metabolism, reducing feed intake, altering hormonal regulation, and impairing reproductive function. Dairy cattle, for instance, experience decreased milk production under high temperatures due to increased energy expenditure for thermoregulation.

Water availability and pasture quality are also crucial determinants of livestock health and productivity. Poor-quality forage leads to malnutrition, while contaminated water increases disease risk. Livestock employ adaptive strategies such as seeking shade, reducing activity during peak heat, and increasing water consumption to cope with environmental challenges [4].



### 3.3 Integrated Plant–Livestock Ecophysiology

The results highlight a strong interdependence between plant and livestock systems. Healthy vegetation provides essential nutrients for livestock, while livestock grazing influences plant community structure and soil fertility. Sustainable agricultural management requires balancing these interactions to maintain ecosystem stability and long-term productivity.

Integrated systems such as agroforestry and mixed crop-livestock farming demonstrate how plants and animals can coexist in mutually beneficial relationships, enhancing biodiversity and resilience [5].

## 4. Discussion

The findings of this study clearly demonstrate that ecological conditions play a fundamental role in shaping physiological processes in both plants and livestock, and that these processes are deeply interconnected within agricultural ecosystems. Climate variability, water scarcity, soil degradation, and biodiversity loss emerge as major environmental stressors that threaten the stability and productivity of modern farming systems. However, rather than viewing these challenges solely as constraints, this study highlights the potential for adaptive responses and management strategies that can enhance resilience if ecological and physiological principles are properly integrated into agricultural planning [6].

One of the most significant implications of this research is that sustainable agricultural development cannot be achieved by focusing exclusively on either plant or livestock systems in isolation. Traditional agricultural models often treat crop production and animal husbandry as separate domains, leading to fragmented management practices. However, the results of this study reinforce the idea that plants and livestock are interdependent components of a single ecological system. For instance, changes in plant productivity due to drought or nutrient depletion directly affect livestock nutrition, growth, and health. Conversely, livestock grazing patterns influence vegetation dynamics, soil structure, and nutrient cycling, which in turn affect plant physiological performance. This reciprocal relationship suggests that integrated management approaches are essential for maintaining ecosystem balance and agricultural sustainability.

The study also underscores the importance of climate-smart and ecologically based farming practices in mitigating environmental stress and enhancing system resilience. Practices such as rotational grazing, cover cropping, agroforestry, and mixed crop–livestock systems can improve soil fertility, enhance water retention, and promote biodiversity. Rotational grazing, for example, allows vegetation to recover between grazing periods, reducing overgrazing and soil erosion while maintaining pasture quality for livestock. Similarly, agroforestry systems where trees, crops, and livestock coexist can moderate microclimates, reduce heat stress in animals, and improve nutrient availability for plants through organic matter accumulation [7].

From a physiological perspective, these management strategies can help optimize key processes such as photosynthesis in plants and thermoregulation in livestock. By improving soil moisture and nutrient availability, farmers can enhance plant growth and productivity even under variable climatic conditions. Likewise, providing shade, adequate water, and high-quality forage can reduce heat stress in livestock, improving feed efficiency, reproduction, and overall health. This demonstrates that ecological management and physiological well-being are mutually reinforcing rather than contradictory objectives [8].

However, implementing integrated ecophysiological approaches also presents practical



challenges. Many farmers lack access to adequate technical knowledge, financial resources, and institutional support to adopt sustainable practices. In addition, existing agricultural policies in many countries still prioritize short-term productivity over long-term environmental sustainability. This creates a gap between scientific understanding and real-world application. Therefore, stronger collaboration among researchers, policymakers, extension services, and farming communities is needed to translate ecophysiological knowledge into practical, scalable solutions.

Furthermore, this study highlights the need for more empirical research that quantitatively examines ecophysiological responses under different environmental scenarios. While this review synthesizes existing literature, future experimental studies should investigate how specific climate variables such as temperature extremes, drought intensity, and soil salinity affect plant–livestock interactions at physiological and ecosystem levels. Long-term field experiments and modeling approaches could provide deeper insights into adaptive strategies for climate resilience.

## 5. Conclusion

Linking ecology and physiology in plant and livestock systems is not only conceptually important but also practically essential for achieving sustainable agricultural development in an era of rapid environmental change. This study has demonstrated that the productivity, resilience, and long-term viability of agricultural systems depend on a deep understanding of how ecological conditions shape physiological processes in both plants and animals, and how these processes interact within integrated agroecosystems. Rather than viewing crops and livestock as separate production units, this research emphasizes the need to recognize them as interdependent components of a dynamic ecological system that must be managed holistically.

The findings of this study highlight that environmental stressors such as climate variability, drought, heat stress, soil degradation, and biodiversity loss pose significant threats to both plant and livestock performance. These stressors disrupt key physiological processes, including photosynthesis in plants and thermoregulation, metabolism, and reproduction in animals, ultimately reducing agricultural productivity and threatening food security. However, the study also shows that plants and livestock possess adaptive mechanisms that can be supported and enhanced through appropriate ecological management strategies.

Therefore, sustainable agricultural systems must be designed based on an integrated ecophysiological framework that aligns environmental stewardship with biological productivity. Practices such as agroforestry, rotational grazing, mixed crop–livestock systems, cover cropping, and conservation agriculture offer promising pathways to strengthen ecosystem resilience while maintaining or even improving productivity. These approaches enhance soil fertility, water retention, biodiversity, and microclimatic regulation, which in turn support healthier physiological functioning in both plants and livestock.

At the policy level, this study underscores the need for governments and agricultural institutions to shift from conventional productivity-driven models toward climate-smart and ecologically informed farming systems. Agricultural policies should incentivize sustainable land management, support smallholder farmers in adopting integrated practices, and invest in research, extension services, and capacity building that bridge the gap between scientific knowledge and on-the-ground implementation. Without such institutional support, the adoption of ecophysiological principles in farming will remain limited and uneven.

From a research perspective, this study contributes to the growing body of literature that advocates for interdisciplinary approaches in agricultural science. Future research should move beyond descriptive studies and focus on long-term empirical experiments that quantitatively measure ecophysiological interactions under real-world climatic conditions. Integrating field



experiments with ecological modeling and remote sensing technologies could provide more precise predictions of how plant–livestock systems will respond to future climate scenarios.

In practical terms, farmers and agricultural practitioners should be encouraged to adopt integrated management strategies that balance production goals with environmental sustainability. This includes optimizing grazing intensity, diversifying cropping systems, conserving water resources, and protecting soil health. By doing so, agricultural systems can become more resilient to climate shocks while continuing to support rural livelihoods and food security.

Ultimately, this study concludes that the future of sustainable agriculture lies in the successful integration of ecological and physiological knowledge in plant and livestock systems. By recognizing the interconnectedness of living organisms and their environment, and by translating this understanding into practical management strategies, it is possible to build agricultural systems that are productive, resilient, and environmentally responsible. Such systems will be essential for meeting global food demands while safeguarding natural ecosystems for future generations.

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