CLIMATE SMART AGRIBUSINESS FINANCING (CSAF) FORESTRY AND WASTE MANAGEMENT

GLOBAL ISSUES & LOCAL PERSPECTIVES

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate Smart Agribusiness Financing (CSAF) Forestry and Waste Management** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which **Climate Smart Agribusiness Financing (CSAF) Forestry and Waste Management** issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue **Climate Smart Agribusiness Financing (CSAF) Forestry and Waste Management** necessary in policy making process that will stimulate increase in food production and environmental sustainability. **Climate Smart Agribusiness Financing (CSAF) Forestry and Waste Management :** *Global Issues & Local Perspectives* is organized in two parts. Part One deals with The Concept of **Climate Smart Agribusiness Financing (CSAF)**, Part Two is concerned with The Concept of **Forestry and Waste Management**

Eteyen Nyong; August 2026

Chapter Seven

The Impact of Climate Change on Animal Health and Productivity

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INTRODUCTION

Livestock production is a critical component of the global agricultural economy. It provides food in the form of meat, milk, and eggs; raw materials for industries such as leather and wool; and serves as a source of income and employment for millions of people worldwide. In many developing countries, particularly in Africa, livestock are used for cultural purposes, draught power, and as a form of financial security. According to the Food and Agriculture Organization (FAO, 2018), the livestock sector contributes about 40% of the global value of agricultural output and supports the livelihoods of about 1.3 billion people. However, livestock production systems are highly dependent on climatic conditions. Animals need adequate feed, clean water and favorable temperatures for optimal performance. Any disruption in climate patterns therefore has a direct effect on animal health and productivity. Climate change, defined as long-term alteration in average weather conditions, is increasingly disrupting these systems. The Intergovernmental Panel on Climate Change (IPCC) has reported that global surface temperature has risen by approximately 1.1°C since the late 19th century, with increasing frequency of heat waves, droughts, and floods (IPCC, 2021). These changes pose significant risks to animal agriculture. For example, heat stress reduces feed intake and growth rate in livestock, while changes in rainfall patterns affect pasture availability and water resources. Additionally, higher temperatures and altered ecosystems favor the survival and distribution of disease vectors such as ticks, mosquitoes, and flies, thereby increasing the spread of animal diseases. This threatens not only the health and welfare of livestock but also the food security and income of human populations who rely on them. Climate change has emerged as a major challenge to sustainable livestock production globally. Animals are highly sensitive to temperature fluctuations, water scarcity, and disease outbreaks, all of which are exacerbated by climate change. Farmers, particularly in tropical regions like sub-Saharan Africa, are witnessing declining milk yields, reduced growth performance, higher mortality rates, and reproductive challenges in their livestock. This raises concerns about the ability of the livestock sector to meet the growing demand for animal protein in the face of a rapidly increasing global population.

CONCEPT OF CLIMATE CHANGE

Climate change refers to long-term shifts in average weather conditions, particularly those related to temperature, precipitation, and the frequency of extreme events. While the Earth's climate has always experienced natural variations, current climate change is largely anthropogenic—driven by human activities such as deforestation, fossil fuel burning, and industrial emissions of greenhouse gases (GHGs). According to the Intergovernmental Panel on Climate Change (IPCC, 2021), carbon dioxide, methane and nitrous oxide are the major gases responsible for global warming. These greenhouse gases trap heat in the atmosphere, causing the Earth's average temperature to rise. The global surface temperature has already increased by about 1.1°C since pre-industrial times, and projections suggest it could rise by 1.5–2°C before the end of this century if mitigation efforts are not intensified. The consequences include rising sea levels, frequent droughts, floods, hurricanes, and unpredictable rainfall patterns, all of which have implications for agriculture and livestock production.

Climate Change and Agriculture

Agriculture is highly climate-dependent. Crop yields rely on rainfall, temperature, and soil conditions, while livestock depend on the environment for feed, water, and thermal comfort. Climate change therefore threatens food security by reducing both crop and animal production. Thornton et al. (2015) reported that in sub-Saharan Africa and South Asia—regions highly dependent on rain-fed agriculture—climate change could reduce agricultural productivity by up to 25% by 2050. For livestock, the impacts are twofold:

1. **Direct impacts:** changes in temperature and humidity that affect animal physiology and health.
2. **Indirect impacts:** reduced feed and water availability, increased disease prevalence, and reduced biodiversity in grazing lands.

The livestock sector also contributes to climate change. Ruminants such as cattle, sheep, and goats produce methane during rumen fermentation, while manure releases both methane and nitrous oxide. Thus, livestock production is both a victim and a contributor to climate change.

Climate Change and Animal Physiology

Animal physiology is highly sensitive to environmental changes. When animals are exposed to heat stress, their body temperature rises above the comfort zone, leading to physiological adjustments aimed at maintaining homeostasis. Such adjustments include increased respiration rate, sweating, panting, and reduced feed intake. However, prolonged exposure to heat stress can overwhelm these mechanisms, resulting in decreased productivity and higher mortality. For instance, dairy cows produce less milk under high temperatures because heat stress reduces feed intake and nutrient absorption. Poultry exposed to high temperatures lay fewer eggs and may experience poor shell quality. Heat stress also leads to hormonal imbalances that reduce reproductive efficiency in livestock (Nardone et al., 2010).

Climate Change and Animal Health

The health of livestock is influenced by several climate-related factors:

a. **Heat Stress:**
Heat stress occurs when environmental temperature exceeds the animal's ability to dissipate heat. This condition causes dehydration, reduced immunity, and in severe cases, death. Animals under heat stress are more susceptible to diseases due to weakened immune responses.

b. **Disease Prevalence**:
Warmer temperatures and altered rainfall patterns create favorable conditions for parasites, bacteria, and viruses. For example, the distribution of ticks, tsetse flies, and mosquitoes has expanded due to climate change, leading to increased prevalence of vector-borne diseases such as trypanosomiasis, bluetongue, Rift Valley fever, and tick-borne fevers.

c. **Nutritional Stress:**
Climate change reduces pasture quality and quantity due to droughts and erratic rainfall. In regions where crop residues are used as feed, lower crop yields also reduce feed availability. Malnutrition weakens animals and makes them more prone to infections.

d. **Water Scarcity:**
Drought conditions limit water availability for livestock, causing dehydration, reduced feed intake, and poor metabolic functioning. Scarcity of clean water further predisposes animals to waterborne diseases.

Climate Change and Animal Productivity

Climate change directly reduces animal productivity in several ways:

a. **Growth Performance:**

High ambient temperatures reduce appetite and feed intake, leading to slower weight gain and poor body condition in cattle, sheep, goats, and pigs.

b. **Milk Production:**

Dairy animals are highly sensitive to heat stress. Studies have shown that milk yield decreases significantly during hot seasons. Furthermore, milk composition (fat and protein content) is negatively affected by heat stress.

c. **Reproduction**

Heat stress interferes with hormonal balance, reducing fertility in both male and female animals. Conception rates decline, embryonic mortality increases, and calving intervals become longer. In poultry, fertility and hatchability of eggs also decline under high temperatures.

d. **Egg and Meat Production:**

In poultry, egg-laying capacity decreases under thermal stress, while eggshell quality becomes poor. Broilers show reduced feed efficiency, slower growth, and lighter carcass weight. Similarly, beef cattle under heat stress produce lower-quality meat with reduced marbling and tenderness (Olaniyi, et al., 2018).

Socio-economic Implications of Climate Change on Livestock Production

The impacts of climate change on animal health and productivity extend to rural communities and national economies. In developing countries where livestock is a major source of income, reduced productivity leads to financial losses, food insecurity, and poverty (Gill et al., 2010). Farmers spend more on feed, veterinary care, and water supply, thereby increasing production costs. In severe cases, loss of animals due to drought or disease outbreaks devastates household income and food supply. At the national level, reduced livestock productivity affects meat and milk supply chains, raising food prices and threatening nutritional security. In Nigeria, for example, rising temperatures and desertification in the northern region have intensified conflicts between farmers and herders over limited grazing resources. This highlights how climate change can also exacerbate socio-political tensions (Rojas-Downing et al., 2017).

CLIMATE CHANGE PATHWAYS AFFECTING ANIMAL HEALTH

Climate change affects livestock health through several interlinked pathways. These pathways can be categorized into direct effects, such as heat stress and water scarcity, and indirect effects, such as disease spread, feed shortages, and environmental degradation. Understanding these pathways is important for developing effective adaptation and mitigation strategies in animal agriculture.

Direct Effects of Climate Change on Animal Health:

Heat Stress

Heat stress is one of the most significant direct impacts of climate change on animals. When temperatures exceed the animal's thermoneutral zone, physiological mechanisms such as panting, sweating, and increased respiration are activated to dissipate heat. However, prolonged exposure to high ambient temperatures overwhelms these coping mechanisms, resulting in dehydration, reduced immunity, lower productivity, and increased mortality. For example, studies in dairy cows show that exposure to temperatures above 25–27°C reduces feed intake by up to 30%, leading to a corresponding decline in milk yield. Poultry also experience significant losses, with egg-laying hens producing fewer and poorer-quality eggs during heat waves.

Water Scarcity

Climate change alters rainfall distribution, leading to frequent droughts and water shortages. Water scarcity affects animals by reducing feed intake and nutrient absorption, causing dehydration, weight loss, and metabolic stress, and increasing susceptibility to waterborne diseases. In arid and semi-arid regions, scarcity of water often forces farmers and pastoralists to migrate with their herds, exposing animals to additional stress and disease risks.

Extreme Weather Events

Frequent floods, storms, and droughts also directly threaten animal health. Floods may lead to drowning, displacement, and contamination of water sources, while droughts reduce pasture growth and increase the risk of starvation. Such events create harsh conditions that undermine animal welfare and increase mortality rates.

Indirect Effects of Climate Change on Animal Health:

Spread of Diseases and Parasites

Changes in temperature and humidity influence the distribution and life cycle of disease vectors such as ticks, flies, and mosquitoes. Warmer climates and wetter environments extend the geographical range of these vectors into previously unaffected areas. For instance, ticks are now being reported in higher altitudes where they were previously absent. Mosquitoes thrive in warmer conditions, increasing the risk of Rift Valley fever, West Nile virus, and malaria in animals. Tsetse flies, responsible for African trypanosomiasis, are spreading beyond traditional endemic zones.

Nutritional Stress and Malnutrition

Erratic rainfall patterns reduce pasture growth, crop yields, and feed availability. During prolonged droughts, animals are forced to graze on poor-quality pastures with low protein and energy content. This results in malnutrition, stunted growth, and increased vulnerability to diseases. Furthermore, rising atmospheric carbon dioxide levels reduce the nutrient content of forage crops, leading to lower protein concentrations in animal diets.

Mycotoxin Contamination of Feed

Higher temperatures and increased humidity create favorable conditions for fungal growth in feed crops such as maize and groundnuts. These fungi produce toxic substances known as mycotoxins (e.g., aflatoxin, fumonisin), which are harmful to animal health. Ingesting contaminated feed can cause liver damage, reproductive failure, immunosuppression, and even death in severe cases.

Habitat Loss and Migration Pressure

Desertification, flooding, and shrinking water resources force farmers and herders to migrate in search of grazing land and water. This often leads to overcrowding of animals in limited areas, increasing the spread of contagious diseases and parasites. It also escalates competition between herders and farmers, sometimes resulting in conflicts that further endanger animal health and survival.

Case Studies

- Case Study 1: Heat Stress in Dairy Cattle in India. A study found that heat stress caused milk production in crossbred dairy cows to decline by up to 40% during peak summer (Choudhary and Sirohi, 2022). The reduction was attributed to decreased feed intake and altered metabolism. Similar trends have been observed in Nigeria, where indigenous breeds such as White Fulani cattle show resilience but still experience reduced productivity during prolonged hot seasons (Thornton et al., 2009).

- Case Study 2: Rift Valley Fever in East Africa. Climate variability, particularly heavy rainfall and flooding, has been linked to outbreaks of Rift Valley fever in East Africa. This disease, transmitted by mosquitoes, affects cattle, sheep and goats, causing abortions, high mortality in young animals, and economic losses for farmers. Outbreaks are often preceded by unusual rainfall patterns, highlighting the connection between climate change and vector-borne diseases (Anyamba et al., 2001).

- Case Study 3: Tick Expansion in Southern Africa Research indicates that rising temperatures have allowed ticks to colonize areas in southern Africa previously unsuitable for their survival. This has led to an increased incidence of tick-borne diseases such as East Coast fever and babesiosis, causing significant economic losses in the cattle industry (Rust and Rust, 2013).

ADAPTATION AND MITIGATION STRATEGIES

The impacts of climate change on animal health and productivity are profound and far-reaching. However, these challenges are not insurmountable. Farmers, researchers, and policymakers are increasingly exploring adaptation and mitigation strategies to minimize the negative effects of climate change on livestock. While adaptation focuses on helping animals and production systems adjust to new climatic conditions, mitigation aims to reduce greenhouse gas emissions and slow down the pace of climate change.

Adaptation Strategies:

Improved Housing and Environmental Management

Proper housing is essential for reducing the impact of heat stress on livestock. Strategies include providing shade structures (trees, sheds, or artificial roofs) to protect animals from direct sunlight; using ventilation systems (fans, cooling pads, sprinklers) in intensive systems; and constructing climate-resilient shelters with insulation to reduce exposure to extreme heat or cold. For example, in poultry farming, tunnel ventilation combined with misting systems has been shown to significantly reduce mortality during hot weather (Niang, et al., 2014).

Breed Selection and Genetic Improvement

Some breeds of livestock are more tolerant to heat, diseases, and water scarcity than others. Indigenous breeds in Africa, such as the N'dama cattle and Red Sokoto goats, have natural resilience to harsh climates and parasites. Farmers can adopt such breeds or crossbreed them with exotic breeds to combine productivity with resilience. Advances in biotechnology also provide opportunities for genetic selection of animals with traits such as heat tolerance, disease resistance, and efficient feed utilization (Soumya et al., 2022).

Nutritional Management

Proper feeding strategies can reduce the effects of climate stress on livestock. Measures include supplementation with high-quality feed, minerals, and vitamins during droughts; use of silage and hay to store feed for dry seasons; incorporation of drought-resistant forage crops (e.g., sorghum, millet, Napier grass); and strategic use of feed additives and probiotics to improve digestion and immunity. Ensuring adequate water supply is also critical. Farmers can adopt water harvesting, storage, and distribution systems to provide animals with continuous access to clean water.

Health Management and Disease Control

Effective veterinary care reduces the vulnerability of livestock to climate-induced diseases. Recommended practices include regular vaccination programs against major livestock diseases; vector control measures, such as acaricides for ticks and insecticide-treated nets for mosquitoes; surveillance systems to detect emerging diseases linked to climate change; and prompt treatment of sick animals to reduce mortality and prevent spread of infections.

Farmer Education and Indigenous Knowledge

Raising awareness among farmers about climate change and its impacts helps them adopt better practices. Extension services, farmer field schools, and community-based organizations can play a major role in training farmers on adaptive strategies. Indigenous knowledge, such as seasonal migration of herds, selective breeding, and the use of herbal remedies, has also enabled pastoral communities to cope with harsh climates for centuries. Incorporating this knowledge into modern practices strengthens adaptation capacity (Thornton, et al., 2009).

Mitigation Strategies:

Reducing Greenhouse Gas Emissions from Livestock

Livestock contribute significantly to methane and nitrous oxide emissions. Mitigation measures include improving feed quality to enhance digestion and reduce methane emissions from ruminants; use of feed additives, such as fats, tannins, and probiotics, to suppress methane production in the rumen; and manure management through biogas production, composting, and controlled storage to reduce methane and nitrous oxide release (Herrero, et al., 2016; Zervas and Tsiplakou, 2012).

Sustainable Pasture and Land Management

Unsustainable grazing contributes to desertification and greenhouse gas emissions. Mitigation measures include practicing rotational grazing to prevent overgrazing; planting drought-resistant forage species that capture carbon and improve soil fertility; and promoting agroforestry systems where trees provide shade for animals while also sequestering carbon (Yusuf and Adesiji, 2017).

Renewable Energy Adoption in Livestock Systems

Farmers can reduce reliance on fossil fuels by adopting renewable energy technologies, such as solar-powered water pumps for irrigation and livestock watering; biogas digesters that convert animal manure into clean cooking and lighting fuel; and wind energy for small-scale farm operations. These measures reduce greenhouse gas emissions while providing cost-effective energy solutions for farmers (World Bank, 2020).

Policy and Institutional Support

Governments and international organizations play a crucial role in promoting climate-smart livestock production. Policies should focus on subsidies for farmers adopting sustainable practices; strengthening veterinary infrastructure and disease surveillance; funding research on climate-resilient breeds and feeding systems; and supporting insurance schemes to protect farmers against climate-related losses (World Bank, 2020).

Integrated Approaches: Climate-Smart Livestock Systems

The most effective way forward is to adopt climate-smart livestock systems that combine adaptation, mitigation, and sustainable productivity. Such systems increase resilience of animals and farming communities to climate shocks, reduce emissions from livestock production, and improve food security and farmer livelihoods. For instance, integrating improved feeding systems, disease control, renewable energy, and resilient breeds ensures that livestock production remains sustainable even under adverse climate conditions (Thornton and Herrero, 2015).

CONCLUSION AND RECOMMENDATIONS

Conclusion

Climate change is one of the greatest threats to sustainable livestock production in the 21st century. It compromises animal health by increasing the risks of heat stress, disease outbreaks, malnutrition, and water scarcity. Productivity in terms of milk, meat, and eggs is declining, thereby threatening global food security. Developing countries, particularly in sub-Saharan Africa, are the most vulnerable due to their heavy dependence on livestock for income, nutrition, and cultural practices. Despite these challenges, opportunities exist to safeguard livestock production. By adopting climate-smart practices that combine adaptation and mitigation strategies, farmers can reduce the vulnerability of their herds, improve productivity, and secure their livelihoods. However, success requires the collective efforts of farmers, researchers, policymakers, and international organizations working together to address the multi-dimensional impacts of climate change on animal agriculture.

Recommendations

Based on the discussions and findings of this chapter, the following recommendations are made:

Farmers must adopt improved housing and ventilation systems to protect animals from heat stress. They must utilize climate-resilient breeds and crossbreeding strategies to improve tolerance to harsh environments. Improve feeding practices by cultivating drought-resistant forage crops and storing feed as hay or silage for dry seasons must be incorporated. They must ensure that constant access to clean water through water harvesting, storage and distribution systems are provided. They must make sure that their animals are vaccinated as and when due and also participate in disease control programs to minimize the impact of climate-induced diseases.

Researchers and Academics must **c**onduct more studies on the interactions between climate variables and livestock production, develop and promote climate-resilient livestock breeds using biotechnology and genetic selection. They must explore cost-effective renewable energy solutions for smallholder farmers and also disseminate research findings to farmers through extension services and farmer field schools.

Government and Policy Makers must develop and implement climate-smart agricultural policies that support livestock farmers. They must provide subsidies, credit facilities, and insurance schemes to help farmers cope with climate-related losses. They must invest in veterinary infrastructure, disease surveillance, and early warning systems for climate-induced disease outbreaks. They must also encourage reforestation, pasture management, and land restoration programs to combat desertification.

International Organizations and Development Partners must **s**upport climate adaptation projects in developing countries through funding and technical assistance. They must strengthen collaborations between countries to manage trans-boundary animal diseases. They must also promote global awareness campaigns on the importance of sustainable livestock systems in addressing food security and climate change.

This chapter highlights not only the biological and physiological consequences but also the socio-economic implications. Furthermore, it provides practical insights into adaptation and mitigation strategies, thereby serving as a useful resource for students, researchers, policymakers and livestock farmers.

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