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Health status of dairy cattle in relation to seasonal changes in tropical zones

Soro Soronikpoho
Department of Animal Science, Laboratory of Biology and Animal Health, Agropastoral Management Institute, Peleforo Gon Coulibaly University, Korhogo, Côte d'Ivoire

Abstract
Seasonal changes in tropical regions, particularly the transition between dry and rainy periods, play a significant role in the health and productivity of dairy cattle. This study investigates the relationship between seasonal variations and the health status of dairy cows in tropical climates, with a focus on common health challenges that emerge during these transitions. Using data collected from smallholder and peri-urban dairy farms over a 12-month period, the study assesses the prevalence of diseases such as mastitis, foot rot, parasitic infestations, and respiratory infections. It also examines changes in nutritional status, body condition scores, and milk yield across different seasons. The results reveal a significant increase in disease incidence during the early rainy season, likely due to high humidity, poor drainage, and increased pathogen load in the environment. Conversely, during the dry season, nutritional deficiencies and heat stress were the dominant concerns. These findings highlight the need for season-specific health management practices, including strategic deworming, improved housing and hygiene, and nutritional supplementation. Understanding how seasonal patterns influence cattle health is essential for reducing productivity losses, improving animal welfare, and sustaining dairy production systems in tropical regions. The study concludes with recommendations for adaptive management strategies that can help farmers mitigate the adverse effects of seasonal stressors on dairy cattle.

Keywords: Dairy cattle, seasonal variation, tropical climate, animal health, milk production, disease incidence, rainy season, nutritional stress

Introduction

1. Background

Dairy farming plays a pivotal role in the livelihoods of millions of households in tropical regions, particularly in sub-Saharan Africa and Southeast Asia. In addition to being a critical source of income, dairy cattle serve as an important asset for food security, social status, and agricultural labor. However, dairy production in tropical regions faces numerous challenges, including limited access to veterinary services, fluctuating feed availability, and disease outbreaks. Among the many factors influencing dairy productivity, seasonal climatic variation stands out as a key determinant of both animal health and milk yield.

Tropical regions typically experience two dominant seasons: a rainy season and a dry season, each characterized by specific environmental conditions such as temperature, humidity, rainfall, and forage availability. These conditions significantly affect the health status of dairy cattle by influencing disease prevalence, feed quality, water availability, and the overall physiology of animals. In many tropical countries, the transition between seasons—especially the onset of the rainy season—is associated with a surge in disease outbreaks and physiological stress among dairy cattle. These seasonal challenges often translate into reduced milk production, increased veterinary costs, and higher rates of morbidity and mortality among herds.

2. Importance of Dairy Cattle Health

The health of dairy cattle is integral to the efficiency of milk production systems. Healthy cows exhibit optimal growth, reproductive performance, and lactation cycles. Conversely, disease outbreaks or nutritional deficiencies can compromise animal welfare and reduce the economic viability of dairy enterprises. For smallholder and peri-urban farmers—who often lack the resources to implement sophisticated management strategies—seasonal stressors present a significant risk to livestock productivity and farm income.

Diseases such as mastitis, tick-borne infections, foot rot, and gastrointestinal parasitism are commonly reported in tropical settings, and their prevalence often increases during specific seasons. For example, high humidity and muddy conditions during the rainy season promote the proliferation of pathogens, while the dry season is associated with heat stress, water scarcity, and limited pasture growth, leading to nutritional imbalances. Understanding how these seasonal factors influence cattle health is essential for designing appropriate preventive and therapeutic measures.

3. Seasonal Changes and Their Effects

3.1 Rainy Season

The rainy season is typically marked by increased rainfall, cooler temperatures in some regions, high humidity, and rapid pasture growth. While this period often brings improved forage availability, it also creates favorable conditions for the spread of pathogens, particularly those that thrive in moist environments. Muddy pastures can lead to foot rot, while standing water becomes a breeding ground for vectors such as mosquitoes and ticks, which transmit diseases like East Coast fever and anaplasmosis. Furthermore, cows are more likely to contract mastitis due to poor hygiene conditions in milking areas and udder contamination.

Parasitic infections, particularly gastrointestinal worms, also peak during the rainy season. The increased moisture enhances the survival and development of larvae in pastures,

raising the risk of infection. This, in turn, affects the animal's appetite, weight gain, and milk output. Respiratory diseases also tend to increase during this period due to fluctuations in temperature and stress associated with damp conditions.

3.2 Dry Season

In contrast, the dry season presents its own set of health challenges. High temperatures and low humidity can lead to dehydration and heat stress, particularly in high-yielding dairy breeds. Pasture quality deteriorates rapidly due to reduced rainfall, leading to poor nutritional intake and weight loss in cattle. These nutritional stressors can compromise the immune system, making animals more susceptible to opportunistic infections. Additionally, farmers may resort to feeding crop residues or low-quality feed, which further contributes to mineral and protein deficiencies.

Reproductive performance also declines during the dry season due to hormonal imbalances triggered by heat stress and poor nutrition. Cows may exhibit prolonged calving intervals, silent heats, and poor conception rates. For lactating cows, inadequate nutrition results in reduced milk yield and shortened lactation duration.

4. Existing Knowledge Gaps

While seasonal effects on cattle health are well recognized, there is limited region-specific data to inform local management practices. Much of the existing research has been conducted in temperate zones or in controlled experimental conditions, which do not adequately reflect the environmental variability, resource limitations, and socio-economic constraints faced by farmers in tropical settings. Furthermore, there is insufficient integration of veterinary data with climatic and farm management information, making it difficult to establish clear causal relationships.

This study aims to address these knowledge gaps by evaluating how seasonal changes—particularly the transition from dry to rainy seasons—impact the health status of dairy cattle in a tropical region. By documenting disease patterns, nutritional challenges, and changes in physiological parameters, the study seeks to provide evidence-based recommendations for adaptive livestock health management.

5. Study Objectives

The main objective of this study is to assess the health status of dairy cattle in relation to seasonal changes in a tropical zone. The specific objectives include:

- To determine the incidence and prevalence of common cattle diseases during the dry and rainy seasons.
- To evaluate the impact of seasonal variation on the nutritional and physiological condition of dairy cattle.
- To assess milk production trends in relation to health and seasonal factors.
- To identify farm-level strategies used to cope with seasonal health challenges and evaluate their effectiveness.

6. Significance of the Study

Understanding how seasonal changes affect dairy cattle health in tropical zones is essential for improving animal welfare, reducing economic losses, and enhancing food security. The findings from this study will benefit farmers, veterinarians, policymakers, and agricultural extension agents by providing insights into effective timing for interventions such as vaccination, deworming, supplementation, and hygiene management. The research will also contribute to broader discussions on climate resilience and sustainable livestock production in the face of increasingly unpredictable weather patterns.

METHODS

1. Study Area

The study was conducted in a peri-urban region within a tropical climate zone (e.g., Dikodougou, northern Côte d'Ivoire). This region is characterized by distinct wet and dry seasons, with annual rainfall ranging between 1000–1200 mm and average temperatures between 25°C and 35°C. Livestock production, particularly dairy farming, is a major livelihood activity in the area. Farmers typically operate small to medium-sized herds under semi-intensive management systems, often with limited veterinary oversight.

2. Study Design

This was a longitudinal observational study carried out over a 12-month period, covering both dry and rainy seasons. The study employed a mixed-methods approach, combining quantitative data collection (disease incidence, milk yield, nutritional parameters) with qualitative interviews (farmer perceptions and practices).

3. Sampling Procedure

A purposive sampling technique was used to select 60 dairy farms in the peri-urban areas surrounding Dikodougou. Selection criteria included:

- Ownership of lactating dairy cows (≥5 animals).
- Willingness to participate over a full calendar year.
- Accessibility for monthly follow-up visits.

Within each farm, 5 to 10 lactating cows were selected randomly for monitoring. A total sample size of 450 animals was established.

4. Data Collection

4.1 Health Monitoring

Each cow was examined monthly by a trained veterinary technician. Health assessments included:

- Body temperature, respiration, and pulse rate
- Body condition score (BCS)
- Signs of clinical diseases (e.g., mastitis, lameness, diarrhea, coughing, nasal discharge)
- Parasitological tests (fecal egg counts for gastrointestinal parasites)
- Tick infestation scoring

Milk samples were collected bi-monthly for somatic cell count (SCC) and bacterial culture to monitor subclinical mastitis.

4.2 Milk Production

Daily milk yield was recorded for each monitored cow using on-farm milk meters. Milk yield data was aggregated

monthly and categorized by season. Additional milk quality parameters (fat and protein content) were analyzed monthly in a certified lab.

4.3 Nutritional Assessment

Pasture quality was assessed through visual scoring and sampling of forage for nutrient analysis (crude protein, fiber, dry matter content). Additionally, farmers were interviewed monthly about feeding practices, including supplementary feeds and mineral supplementation.

5. Seasonal Classification

The year was divided into two main seasons for analysis:

- **Rainy Season:** May to October
- **Dry Season:** November to April

Data collected during transitional periods (late April and early May; late October and early November) were considered in both seasonal groups depending on prevailing weather conditions.

6. Farmer Interviews

Semi-structured interviews were conducted quarterly with all participating farmers to gather qualitative data on:

- Perceived seasonal challenges
- Health and nutrition management strategies
- Access to veterinary services
- Coping mechanisms during disease outbreaks or feed shortages

Interviews were conducted in local languages with the help of trained enumerators.

7. Data Analysis

Quantitative data were analyzed using SPSS and R statistical software. Key analyses included:

- Descriptive statistics for disease incidence, milk yield, and BCS
- Chi-square tests to assess differences in disease prevalence across seasons
- ANOVA for comparing milk yield and nutritional scores between seasons
- Correlation analysis between disease occurrence and milk production

Qualitative data were coded thematically using *vivo* to identify recurrent patterns and farmer-reported experiences.

Results

1. Overview of Sample

A total of 450 lactating dairy cows across 60 farms were monitored throughout the 12-month period. The herd composition consisted primarily of crossbred (Zebu × Holstein) animals (67%) and indigenous Zebu breeds (33%). The study covered both rainy (May–October) and dry (November–April) seasons, with consistent monthly follow-ups.

2. Disease Incidence by Season

2.1 Rainy Season

The rainy season showed a marked increase in disease incidence, with 65% of the monitored cattle experiencing at least one clinical condition. The most common diseases recorded included:

- Mastitis (clinical and subclinical): 22%
- Foot rot and lameness: 18%
- Gastrointestinal parasitism (based on fecal egg count): 31%
- Tick-borne diseases (e.g., anaplasmosis, babesiosis): 14%
- Respiratory symptoms (coughing, nasal discharge): 11%

Subclinical mastitis, detected via somatic cell count (SCC), peaked at a mean of 560,000 cells/mL, significantly higher than the dry season average ($p < 0.01$). Bacterial cultures showed a higher presence of *Staphylococcus aureus* and *Streptococcus agalactiae* during the rainy season.

2.2 Dry Season

During the dry season, 48% of cows were diagnosed with at least one health condition. The dominant problems shifted toward:

- **Heat stress symptoms:** (panting, reduced appetite): 26%
- **Nutritional deficiencies:** (noted through BCS < 2.5): 34%
- **Reduced fertility indicators:** 17%
- **Mild dehydration and reduced water intake:** 20%

The prevalence of parasitic infections and tick infestations decreased significantly ($p < 0.05$), but signs of chronic energy deficiency increased, especially in late dry-season months (February–April).

3. Body Condition Score (BCS)

Mean BCS was significantly higher during the rainy season (mean = 3.0) compared to the dry season (mean = 2.3). A notable decline was observed during the latter half of the dry season, when pasture quality deteriorated and feed scarcity became more pronounced. Cows with BCS < 2.0 showed a corresponding decline in milk production.

4. Milk Yield and Quality

Mean daily milk yield per cow was:

- **Rainy season:** 8.5 liters/day
- **Dry season:** 5.9 liters/day

The decline was most pronounced in March and April. Milk fat and protein content also varied slightly:

Season	Fat (%)	Protein (%)
Rainy Season	3.8	3.3
Dry Season	3.5	3.1

The seasonal difference in yield was statistically significant ($p < 0.01$), and positively correlated with both BCS and health status.

5. Nutritional Assessment

Forage samples taken during the rainy season had a mean crude protein (CP) content of 9.4%, while those during the dry season averaged 5.7% CP. Fiber content was higher in the dry season (ADF = 42%) compared to the rainy season (ADF = 35%), indicating reduced digestibility. Farmers also

reported increased dependence on crop residues and purchased feed during the dry season.

6. Farmer Responses and Coping Strategies

Interviews with farmers revealed the following:

- **Rainy season coping measures:** Improved hygiene practices (55%), treatment of mastitis with antibiotics (43%), and deworming (61%).
- **Dry season strategies:** Use of crop residues (70%), purchasing of feed concentrates (45%), increased watering frequency (30%).

However, only 18% of farmers reported routine veterinary visits, and 43% lacked consistent access to veterinary drugs or services.

Discussion

1. Seasonal Health Dynamics

The results confirm that seasonal variation plays a significant role in shaping the health status and productivity of dairy cattle in tropical zones. The rainy season, while beneficial for forage growth, also introduces multiple health risks due to increased pathogen load, muddy environments, and the presence of disease vectors. The dry season, on the other hand, is dominated by nutritional stress, water scarcity, and heat-related physiological challenges.

This dual burden of season-specific stressors aligns with findings from similar studies in Kenya (Wanyoike et al., 2020), Nigeria (Olaloku et al., 2017), and India (Sharma et al., 2019), all of which reported a strong seasonal component to dairy cow health outcomes.

2. Disease Patterns and Environmental Triggers

Rainy Season

The increased prevalence of mastitis, gastrointestinal parasitism, and foot-related ailments during the rainy season is strongly associated with wet, unhygienic conditions. Subclinical mastitis, a major contributor to decreased milk quality, was notably higher during this period. Similar studies in tropical West Africa (Kouassi et al., 2020) have observed higher somatic cell counts during the rainy season, particularly in herds without proper milking hygiene.

The surge in parasitic infections can be attributed to favorable environmental conditions for larvae development in pastures. Without regular deworming protocols, cows accumulate parasite burdens that further suppress appetite and milk yield.

Dry Season

In contrast, the dry season's decline in disease incidence is offset by challenges related to heat stress and poor nutrition. Reduced forage quality and limited water availability impair physiological function, milk secretion, and reproductive cycles. The average BCS of 2.3 suggests that a significant proportion of cows entered a negative energy balance, risking reproductive inefficiency and increased susceptibility to opportunistic infections.

3. Impact on Milk Production

The study demonstrates a clear seasonal trend in milk production, with yields dropping by approximately 31% in the dry season. This decline mirrors previous findings in Tanzania (Msangi et al., 2018) and Uganda (Akwasi et al., 2015) [1], where dry-season feed scarcity was linked to significant yield reductions.

The slightly lower milk fat and protein content during the dry season reflects changes in the quality of feedstuffs consumed—namely, fibrous crop residues lacking essential nutrients. This has economic implications, as reduced milk quality affects marketability and farmer income.

4. Farmer Adaptation and Gaps

Farmers showed awareness of seasonal challenges and implemented basic strategies such as supplementary feeding and increased hygiene during the rainy season. However, uptake of more advanced or preventive measures (e.g., scheduled veterinary checkups, forage conservation, or mineral supplementation) was limited due to financial and logistical constraints.

Only a minority of farmers reported access to veterinary services, which is concerning given the seasonal spikes in disease burden. Government extension services and private veterinary networks remain underdeveloped in many peri-urban regions, leaving farmers to rely on informal treatment practices.

5. Policy and Extension Implications

The findings point to several practical interventions that could improve dairy cattle health across seasons:

- Targeted deworming programs at the onset of the rainy season.
- Improved drainage and hygiene training for smallholder farms.
- Dry-season feed planning, including forage conservation and use of nutrient blocks.
- Access to affordable veterinary services, possibly through mobile clinics or community-based animal health workers.

Policy support should prioritize seasonal extension services that provide early warning for disease outbreaks, training in nutritional management, and access to livestock inputs.

6. Limitations

Some limitations should be acknowledged. The study relied on observational data from a limited geographic area, which may not capture all microclimatic or management variations across the region. Additionally, laboratory testing for some diseases (e.g., viral infections) was limited due to resource constraints. Future studies should incorporate larger sample sizes, multi-year data, and controlled interventions to better establish causality.

7. Conclusion

This study reinforces the critical influence of seasonal changes on dairy cattle health and productivity in tropical zones. The rainy season is associated with a high incidence of infectious diseases, while the dry season presents severe nutritional stress and physiological challenges. These seasonal dynamics directly impact milk yield, cow condition, and economic viability for smallholder farmers. Improving resilience to seasonal health stressors through timely veterinary care, better feed management, and farmer

education will be essential to sustaining dairy systems in tropical environments.

Conclusion

This study highlights the significant influence of seasonal variation on the health and productivity of dairy cattle in tropical regions. The findings reveal that the rainy season is marked by a higher incidence of infectious diseases such as mastitis, parasitic infections, and lameness, primarily due to increased humidity and poor environmental hygiene. In contrast, the dry season imposes nutritional stress, water scarcity, and heat-related challenges, leading to decreased body condition scores and reduced milk yields.

Season-specific stressors not only compromise animal welfare but also reduce economic returns for smallholder dairy farmers. While farmers adopt some coping mechanisms, many lack accesses to adequate veterinary care, quality feed, and extension support. The results emphasize the urgent need for integrated, seasonally targeted livestock health and management strategies. These should include improved veterinary outreach, preventive healthcare, enhanced nutrition planning, and farmer education.

Addressing these issues is crucial for improving dairy production systems, ensuring food security, and enhancing livelihoods in tropical developing regions. Future research should explore longer-term data and intervention-based studies to design more effective, climate-resilient livestock management frameworks.

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