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The structuring role of rangeland products in the regional livestock supply chain of west Africa

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Abstract

This study examines the impact of environmental shocks on livestock supply chains and consumption patterns in West Africa, focusing on three coastal capitals—Dakar (Senegal), Abidjan (Côte d'Ivoire), and Abuja (Nigeria). Using surveys of 4,000 households and 45 focus group discussions, we analyze how socio-demographic factors, such as income and household size, influence meat demand and the price and income elasticity of various types of meat. The findings show that beef and lamb have high price sensitivity, especially among low-income households, while fish is the most consumed protein across all income groups. Environmental shocks, including climate change and land degradation, disrupt supply chains, leading to higher meat prices and altered consumption patterns. The study highlights the importance of sustainable rangeland management practices, such as rotational grazing and agroforestry, to enhance the resilience of livestock systems and ensure food security in the face of these challenges.

Introduction

West Africa region spans arid, semi-arid, and sub-humid zones (Sahara, Sahel, Sudanian), with warm to hot temperatures year-round. It exhibits significant north-south heterogeneity, with rainfall ranging from 200mm to 1200mm annually, concentrated between July and September, influenced by the Inter-Tropical Convergence Zone. Coastal areas experience two rainy seasons: April to July and a shorter one in September-October. Frequent droughts and rising temperatures (1.7°C to 3.2°C) contribute to a 4% decline in annual rainfall, shortening crop and fodder growing periods by an average of 20%. Population growth around rural centres is increasing, but remote areas are declining. The region is home to significant livestock populations, including 25% of Africa's cattle, 33% of sheep, 40% of goats, and 20% of camels. To better understand the dynamics of livestock supply chains, it is crucial to analyze the interaction between rangeland ecosystems, livestock production, demand patterns, food security and value chain performances across the region.

Climate change and anthropogenic shocks can significantly impact livestock products' availability, quality, and safety, potentially leading to higher prices and increased price volatility (Godfray et al., 2018). Temperature fluctuations may also influence consumer preferences, though the specific effects on livestock consumption remain

underexplored. Rising production costs and feed availability challenges are expected to increase prices, while supply chain inefficiencies will likely exacerbate price volatility (Muhammad et al., 2017; Mbow et al., 2019).

In addition, climate change is reshaping the socio-economic dynamics of the livestock sector, particularly for small-scale producers who are especially vulnerable (Hallegatte & Rozenberg, 2017). These changes are influencing both consumption patterns and the structure of the livestock industry, with significant implications for global and regional food security (Hasegawa et al., 2018; Amin et al., 2023) and growing awareness of climate change's impact on livestock challenges the sector's social license. However, the limited research on the evolution of meat demand and consumption in West Africa hinders a comprehensive understanding of how climate-related shocks could diffuse across the region's highly concentrated and coordinated livestock supply and value chain. Therefore, complex ecological, economic, and socio-demographic factors shape the relationship between environmental shocks to rangelands and regional supply chains in West Africa. Understanding these interconnections is critical for ensuring the region's sustainable livestock systems and food security. To accomplish this, we must refine our understanding of the demand for and consumption of meat, which remains a prominent under-explored aspect in West Africa.

This paper bridges the knowledge gap by comprehensively understanding the dynamics of the demand for and consumption of meat in three West African coastal capitals: Dakar (Senegal), Abidjan (Côte d'Ivoire), and Abuja (Nigeria). It further explores how improved rangeland management, within a context of multi-dimensional shocks, could help secure the livestock supply chain and improve the livelihoods of millions across West Africa.

Method

This paper builds on the comprehensive literature review conducted by Godde et al. (2021) and the survey developed by Amin et al. (2023) on the impacts of climate change on livestock supply chains. Then, it addresses the missing link in the analysis of consumption nodes, especially for West Africa. Our approach combines quantitative and qualitative methods to analyze meat consumption and demand trends across Senegal, Nigeria, and Côte d'Ivoire. It explores perceptions of meat quality and attributes and the influence of sociodemographic factors (e.g., household size, age and gender of head, and location) on demand. The quantitative analysis uses the Almost Ideal Demand System (AIDS) model to examine family structure effects on meat consumption based on surveys of 4,000 households. Qualitative data were collected through 15 focus group discussions in each capital. Both surveys were conducted between July and September 2023.

Results

In Senegal, meat consumption varies significantly based on income, price sensitivity, and sociodemographic factors. Fish is the primary source of animal protein, followed by chicken and beef. Goat and pork consumption remains low, influenced by geographic and religious factors, particularly Islam's prohibition on pork. A baseline demand exists for beef, lamb, goat, chicken, and fish, largely unaffected by changes in income or price. Key sociodemographic factors include household size, which minimally impacts meat demand, except for eggs. Gender notably influences lamb consumption, especially during religious events like Aïd-el-Adha, when male heads of household typically purchase a ram for sacrifice. Geographic location also impacts regional consumption patterns, with certain areas displaying mimetic effects in demand for beef, lamb, goat, chicken, and fish.

The income elasticity of demand is positive for all meats. Among low-income households (average monthly income: 244,025 FCFA), demand for all meats is positively elastic, though beef and eggs exhibit inelastic demand when prices rise. Lamb, chicken, and fish show higher elasticity, responding more sensitively to price changes. For high-income households (average monthly income: 861,946 FCFA), income elasticity is generally more significant, particularly for beef (elasticity >1), indicating a higher responsiveness to income increases. Price elasticity is negative across all meats, with beef and lamb displaying significant reductions in demand with price

increases. For instance, a 1% increase in beef prices leads to a 2.7% decrease in demand, and a 1% rise in lamb prices results in a 3.6% reduction in demand.

In Côte d'Ivoire, fish dominates meat consumption (98% of households), followed by beef (92%), eggs (73%), and lamb (43%). Pork (32%) and goat (7%) are less commonly consumed, with a marked decline in wild meat consumption due to diseases such as Ebola and COVID-19. Consumption patterns vary significantly with income. Beef, chicken, goat, and fish are consumed equally across income groups, while pork consumption is higher in low-income households (36%) compared to high-income households (23%). Lamb is primarily consumed by high-income households (60%), with lower consumption in intermediate (40%) and low-income (36%) groups. Egg consumption is notable across all income groups, ranging from 67% to 75%. Weekly meat consumption averages in Côte d'Ivoire are as follows: fish (1.5 kg in low-income, 2.1 kg in intermediate, 2.4 kg in high-income households), beef (1.1 kg in low-income, 1.8 kg in intermediate, 2.2 kg in high-income households), chicken (0.8 kg in low-income, 1.0 kg in intermediate, 1.5 kg in high-income households), goat (0.008 kg across all households), and lamb (0.8 kg in high-income households). Elasticity analyses show that all meats, except eggs, exhibit positive income elasticity, meaning demand increases with income. A 1% rise in income results in a 0.1% increase in beef demand and a 2.9% rise in lamb demand. Most meats show negative price elasticity, with lamb and pork being more price-sensitive than beef and fish. Cross-elasticities indicate that lamb and pork serve as substitutes for beef.

In Nigeria, fish, beef, and goat meat are the primary meats consumed. Fish is consumed by 87% of households, beef by 78%, goat meat by 67%, chicken by 64%, and eggs by 52%. Sheep and pork have relatively low consumption rates (29% and 8%, respectively), and bushmeat consumption has diminished due to bans associated with zoonotic diseases like Ebola and COVID-19. Beef is the most consumed meat, with an average weekly intake of 1.1 kg, followed by fish (0.8 kg) and chicken (0.7 kg). Pork is consumed the least, averaging just 0.2 kg. Among income groups, beef remains the dominant meat choice in low- and middle-income households, while fish and chicken are more commonly consumed in high-income households. Household size has a marginal impact on the demand for lamb, fish, and eggs but does not significantly influence the demand for beef, goat, pork, or chicken. Larger households tend to substitute lamb and eggs with more accessible fish, while beef, goat, pork, and chicken consumption remains stable. Gender influences pork demand but does not significantly affect other meats. Regarding price and income elasticity, all income elasticities are positive, except for beef. A 1% increase in income results in a 0.9% decrease in beef demand, while demand for lamb (2.3%), goat (0.4%), chicken (1.3%), pork (2.6%), fish (1.2%), and eggs (1.8%) increases. Price elasticities are negative for all meats, with pork, goat, chicken, and eggs showing higher price sensitivity than beef and fish.

Discussion

Rangelands in West Africa are vital for livestock production, forage and water, and livestock supply and value chain. However, environmental shocks degrade these ecosystems, including climate change, overgrazing, and land-use change. Climate change, marked by irregular rainfall and rising temperatures, accelerates land degradation and reduces grazing resources, directly affecting livestock productivity. Overgrazing leads to soil erosion, reduced biodiversity, and decreased land fertility, further limiting the capacity of rangelands to support livestock. Additionally, agricultural expansion and urbanization reduce available grazing areas, heightening competition for land and disrupting pastoral mobility.

Shocks to rangelands disrupt livestock supply chains by reducing herd sizes and meat production. This may lead to supply shortages and price increases across markets. Price elasticity studies indicate that a 1% rise in beef prices results in a 2.7% drop in demand, particularly impacting low-income households. Livestock trade flow across borders, especially between Sahelian and Coastal regions, is disrupted, increasing reliance on imports. If Sahelian supply sources are depleted due to multiple shocks, they may be substituted by imports from Latin America, Europe, or alternative protein sources.

Income levels, cultural preferences, and gender roles influence consumption patterns in West Africa. Price increases during supply shocks can lead wealthier consumers to reduce meat consumption or switch to cheaper proteins, while poorer households face more immediate nutritional deficits. Cultural preferences, such as the demand for specific meats during festivals, can also shift when certain types of beef become scarce.

Conclusion

The potential impacts of climate change on global livestock systems are a growing concern. Still, they are often underrepresented in major climate assessments like those by the Intergovernmental Panel on Climate Change (IPCC). This article explores how multifaceted shocks—climate change acting as both a direct and compounding factor—interact with rangelands along the land-based livestock supply chain, from production to consumption. Although quantifying the net impacts remains challenging, there is strong evidence that climate change will disrupt critical stages of the livestock supply chain, especially at consumption nodes. The study fills the knowledge gaps and underscores the importance of sustainable rangeland management practices, such as rotational grazing and agroecological practices, in enhancing livestock system resilience, supply and value chain performances, and ensuring regional food security.

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