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Climate variability and cocoa vulnerability in West Africa: Projection and reality

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Abstract

Africa is among the most affected continents by climate variability and change. Cocoa is an important agricultural export in West Africa (Cameroon, Côte d'Ivoire, Ghana, Liberia, Nigeria, and Sierra Leone). Cocoa production systems in Africa are particularly rain-fed systems and are highly vulnerable to climate variability, with significant implications for crop yields, food security, and livelihoods.

This study assesses climate suitability projections against observed climate variability, evaluates their impact on sustainable cocoa production in West Africa from 2014 to 2023, and identifies potential adaptation strategies. The study combines a systematic review of climate variability projections with quantitative analysis of 10-year secondary data (2014–2023) from FAOSTAT (cocoa yield and production), WorldClim2 (precipitation and temperature), and Global Forest Watch (tree cover loss). The secondary data were analysed in R using regression models, trend and anomaly analyses, and a climate vulnerability index, and the results were interpreted alongside evidence from literature.

Results confirm pronounced climate variability across Cameroon, Côte d'Ivoire, Ghana, Liberia, Nigeria, and Sierra Leone, with rainfall anomaly indices indicating unstable precipitation patterns and rising temperatures. Ricardian regression analysis identifies temperature and precipitation as significant determinants of cocoa yield, reinforcing the sensitivity of cocoa systems to climatic conditions. Observed temperature increases, with dry-season values already reaching 35–36 °C, confirming earlier projections of further warming (1.7–2.1 °C by 2050) and suggest that heat stress is becoming an immediate constraint. While total rainfall remains within optimal ranges (1,200–2,500 mm), increasing variability and evapotranspiration are intensifying moisture stress, particularly in transition zones. The Climate Vulnerability Index (CVI) reveals clear spatial differences, with Sierra Leone being consistently more vulnerable.

Addressing these challenges requires transitioning to sustainable, diversified production systems to boost resilience and prevent forest encroachment, supported by well-resourced extension services that provide climate information and farmer training. Targeted financial mechanisms and incentives are also needed to promote climate-smart practices and compliance with sustainability standards across the cocoa value chain.

Keywords: Climate, cocoa, productivity, suitability, sustainability

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