ENHANCING RESILIENCE TO CLIMATE CHANGE TO SUPPORT FOOD SECURITY IN VULNERABLE COMMUNITIES ACROSS CENTRAL AFRICA

Adeleye Joshua Adeyemi[1], Nontobeko Zakhona Andiswa Ngubane[2], Mushe Khomola[3]

[1]*Bachelor of Agriculture (B. Agric) in Agricultural Economics, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria*

[2]*Bachelor of Community Development (ComDev), University of the Free State, Free State in QwaQwa*

[3]*Bachelor of Earth Science (Hons) in Hydrology and Water Resources, University of Venda, Limpopo in Thohoyandou*

Corresponding Author: Adeleye Joshua Adeyemi

Email ID: joshuaadeleye436@gmail.com , **Contact No.:** +2347061116217

ABSTRACT

Climate change remains to cripple food security across Central Africa, where a large proportion of the population depends on rain-fed agriculture survival. This study evaluated the environmental, economic, energy and agricultural factors shaping climate resilience and food security in vulnerable communities, using secondary time-series data spanning 2000 to 2025 across 14 variables, including 2 climate resilience variables (mean annual temperature and annual rainfall). Descriptive statistics, pre- and post-2013 period comparisons, Pearson correlation analysis, detrended correlation and multiple regression analysis were applied using SPSS. Findings show that undernourishment averaged 30% over the period, with persistently low cereal yields and minimal electricity access. Rising mean annual temperature ($r = -0.610$, $p = 0.002$) was significantly correlated with declining cereal yields ($r = -0.880$, $p < 0.001$). In the multiple regression model ($R^2 = 0.907$), electricity access and GDP per capita are the two strongest independent predictors of undernourishment, while political stability remained a significant bivariate correlate. These results suggest that energy infrastructure and governance, above agricultural land use or GDP, are central to food security outcomes defining how resilience-building efforts should be concentrated.

Keywords: Climate resilience, Food security, Agricultural productivity, Governance, Policy, Central Africa.

1. INTRODUCTION

The impact of climate change on global food security is one of the most pressing challenges of the 21st century, with the evidence that rising temperatures, erratic rainfall and intensified drought and heat stress undermine agricultural productivity and ecosystem stability (Abebaw, 2025). Moreover, Central Africa stands as one of the most susceptible region as a significant percentage of its population depends on rain-dependent agriculture, fishing, forestry and livestock for livelihood and sustenance (Bi et al., 2025).

Rising temperatures, extended droughts, unpredictable rainfall patterns, floods, land degradation, and biodiversity loss continue to have an awful effect on vulnerable people in Central Africa. These climatic changes significantly disrupted agricultural productivity, weakened rural economies and increased food insecurity among already marginalized populations (IMF African Dept., 2024). As such, this research holds significance as it tackles the increasing difficulties posed by climate change and its impact on food security in Central Africa. This research will enhance scholarly understanding in the areas of climate change adaptation, food security and sustainable development by exploring the connection between climate resilience and the well-being of communities.

1.1 General objective

The main objective of the study is to evaluate the environmental, economic, energy and agricultural factors that enhance resilience to climate change in order to support food security among vulnerable communities across Central Africa.

1.2 Specific objectives:

- To describe the prevailing food security and climate vulnerability conditions across Central Africa.
- To evaluate the relationship between agricultural land use, cereal productivity and food availability across Central Africa.

- To assess the effect of political instability and weak economy on food security outcomes in Central Africa.
- To investigate how low energy access constrains communities from adapting to climate-related food insecurity.

2. LITERATRURE REVIEW

2.1 Climate Change Trends and Projections in Central Africa

The climate of Central Africa is getting out of hand, marked by intensed heat, chaotic rains and brutal weather extremes (Simane et al., 2025). There is an alarming temperature spike of roughly 0.3°C per decade across the continent, leaving Central African sub-regions cornered by a vicious double-threat of drought and deluge (Simane et al., 2025). Our worst fears projected climate hazards from blistering heat stress to erratic rainfall are intensifying, pushing the Congo Basin toward total ecological collapse (IPCC, 2022). These grim projections demand immediate, hyper-local adaptation strategies engineered for central Africa's specific socio-ecological realities, not generic subsidies (Chabwera et al., 2025).

2.2 Food Security Status and Vulnerabilities

The hunger crisis gripping Central Africa is a direct symptom of deep, historical inequalities colliding violently with climate chaos. The four pillars of food security availability, access, stability, and utilization are being systematically dismantled by Sub-Saharan Africa's weather volatility (Yiridomoh et al., 2025). Take the Democratic Republic of Congo (DRC): 70% of its people scratch a living from rural dirt, meaning climate vulnerability is weaponized by crushing poverty, overcrowding, and relentless armed conflict (Mugumaarhahama et al., 2025). The socioeconomic realities like education and farm size dictate whether a farmer can even anticipate these risks, proving poverty and vulnerability are jointly linked (Vivalya et al., 2024).

2.3 Climate Change Impacts on Agriculture and Food Systems

Erratic rain cycles and extreme heat are tanking crop yields, breaking fragile supply chains, and forcing rural families into starvation (Tholstrup and Vazquez, 2025). A devastating 5% drop in crop yields for every single degree of warming above baseline historical norms, placing vital cereal production on the chopping block (Simane et al., 2025). In the eastern

DRC, mountain smallholders witness these microclimate shifts firsthand, noting that parched Bafuliru communities face far bleaker horizons than their neighbors. Because rain-fed farming dominates Central Africa, the entire region's survival hangs on unpredictable skies, triggering a cruel domino effect of malnutrition for already discarded communities (Amani et al., 2022).

2.4 Adaptation Strategies and Resilience-Building Approaches

Vulnerable communities aren't just fading fast, they are actively fighting back with various adaptation tactics. Climate-smart agriculture (CSA) is gaining real ground, planting CSA sorghum in South Kivu's fragile wetlands significantly boosts harvest yields (Mutwedu et al., 2025). CSA tricks like agroforestry, tougher seed varieties, and crop mixing directly keep African kitchens stocked (Yiridomoh et al., 2025). Crop diversification and conservation farming bolster defenses, yet desperate smallholders usually rely on frantic, short-term band-aids rather than permanent structural adaptations, revealing massive resource gaps (IPCC, 2022).

2.5 Theoretical Frameworks

This study draws on a multi-layered theoretical foundation to examine climate resilience and food security. The Climate Risk and Vulnerability Framework is applied, which conceptualizes risk as the interaction of hazard, exposure, and vulnerability. Recent research on drought risk in Africa reinforces this, demonstrating that social instability, rather than climate uncertainty alone, is a primary driver of elevated nutritional risk in Central African countries (Sharma et al., 2024). Also, the Sustainable Food Systems Framework emphasizes the nexus between food systems and climate change responses, highlighting the importance of developing climate-resilient crops and agricultural practices alongside local food storage and distribution to build resilience (Alliance for Food Sovereignty in Africa, 2025). These frameworks are further supported by regional initiatives promoting Climate-Smart Agriculture to combat climate impacts on farming (ASARECA, 2025). Together, these frameworks guide the investigation into how communities in Central Africa can build resilience to climate change to support food security, focusing on the interplay of vulnerability and systemic challenges like governance and infrastructure.

2.6 Policy, Governance and Institutional Frameworks

All the climate data in the world means nothing without functional governance to operationalize it. Early warning networks, secure land ownership, social safety net and honest local leadership as the ultimate enablers of true resilience (IPCC, 2022). Instead, Central African countries are crippled by structural decline, empty treasuries, broken promises and political bloodshed especially in the DRC and vulnerability is hardwired into governance failures that starve farmers of markets and adaptation tools (Mugumaarhahama et al., 2025). Without unified institutional backbone at national levels, grassroots survival efforts remain isolated, underfunded and doomed to fail at scale (Ecology and Society, 2024).

2.7 Conceptual Framework

This analysis operates on a raw, interconnected framework that maps how direct climate exposure translates into empty stomachs, mediated entirely by community resilience (Yiridomoh et al., 2025). Borrowing teeth from the IPCC AR6 Risk Framework, the Sustainable Livelihoods Framework and the FAO's metrics, this model views climate hazards scorching droughts, sudden floods, and heat waves as ruthless external invaders attacking vulnerable agrarian societies (IPCC, 2022; Yiridomoh et al., 2025). Food security outcomes across availability, access, utility, and stability are the final scorecard of this brutal wrestling match between environmental exposure and human adaptability. It's a realistic blueprint for building survival.

2.8 Gaps in Existing Literature

Despite a lot of recent academic papers, the current literature suffers from massive, inexcusable blind spots regarding Central African realities (Ecology and Society, 2024). First, field data remains frustratingly scarce compared to the over-researched East and West regions which render broad continental conclusions useless here. Second, researchers blindly ignore gender-specific survival strategies, even though women do the heavy lifting in these fields. Third, we have zero long-term tracking data on whether these adaptation projects actually work over decades. Fourth, the terrifying specter of urban hunger in climate-stressed central African mega-cities is virtually ignored. Fifth, the toxic nexus of war, climate disaster, and starvation is shockingly under-theorized.. Sixth, trans-boundary agricultural governance across these fractured nations remains totally unmapped. These failures scream for rigorous, localized research.

3. METHODOLOGY

3.1 Research Design

This study adopts a quantitative research design rooted in secondary data analysis. It relies on existing time-series variables rather than primary data collection which allows for the examination of long-term structural patterns linking climate vulnerability, economic conditions and food insecurity across Central Africa between 2000 and 2025.

3.2 Study Population and Sampling

The study focuses on Central African countries, particularly in vulnerable communities. These regions are selected due to their high vulnerability to climate change and persistent food insecurity. A purposive sample of 25 years of time-series data stretching across 2000 to 2025: all available annual observations (n = 26 years), spanning 14 variables across four thematic domains. Food security indicators include undernourishment (%), cereal yield (kg/ha), total protein (g/cap/d) and staple share (%). Climate and land use indicators include forest area (%), agricultural land (%), mean annual temperature (°C) and annual rainfall (mm). Macroeconomic indicators include GDP per capita (PPP $) and FDI net inflows (% GDP). Infrastructure and governance indicators include electricity access (%), renewable energy (%), energy adequacy

(%) and the political stability index. Undernourishment (%) was treated as the dependent variable against which the remaining 13 indicators were analyzed.

3.3 Data Collection

Data were obtained from established international repositories, the World Bank's World Development Indicators and the Food and Agriculture Organization (FAO). Data were compiled into a single merged dataset and screened for missing values, inconsistencies and outliers prior to analysis.

3.4 Analytical Methods

Descriptive statistics (mean, standard deviation, minimum, maximum, range) summarized baseline patterns. Pre- and post-2013 comparisons assessed the effect of regional political and economic shocks on key indicators. Pearson correlation analysis examined the strength and direction of relationships between undernourishment and climate, economic and infrastructure variables. A detrended correlation was applied to the cereal yield-undernourishment relationship to test whether the observed positive correlation reflected a genuine association or a false shared time trend. Multiple regression analysis was subsequently conducted with undernourishment as the dependent variable and electricity access, GDP per capita, political stability, cereal yield, mean annual temperature and annual rainfall as independent variables simultaneously, to determine which factors independently predict food insecurity when others are controlled for. Analysis was performed using SPSS.

3.5 Limitations

The study is constrained by a small sample size (26 annual observations), reliance on secondary data subject to reporting gaps common in conflict-affected and data-scarce settings, an inability to capture sub-national or household-level variation and correlation-based methods that establish association rather than causation. Some indicators also contain estimated values from source agencies, which may affect precision.

4. FINDINGS

4.1 Prevailing food security and climate vulnerability conditions

Descriptive analysis of the 2000-2025 dataset showed undernourishment averaging 30.03% (SD = 3.97), ranging from 24.40% to 37.10%, indicating that roughly one in three people experienced food insecurity at points during the study period. Cereal yield averaged 922.92 kg/ha (SD = 80.30), with a minimum of 713.00 kg/ha and a maximum of 1,048.30 kg/ha. Total protein intake averaged 56.22 g/cap/d (SD = 6.50), below recommended thresholds, while staple foods made up an average of 48.57% of the diet. Forest area declined marginally across the period (mean = 36.21%, range: 35.66-36.76%) and agricultural land averaged 8.16% (range: 7.85-9.10%). Electricity access remained low throughout, averaging 10.84%

(range: 5.70-17.60%), while renewable energy averaged 91.74%. Political stability remained consistently negative (mean = -1.90, range: -2.70 to -1.12) and GDP per capita averaged $1,215.76 (PPP), ranging from $997.00 to $1,578.00. Mean annual temperature averaged 25.72°C (range: 25.32°C -26.19°C), reflecting a warming trend of approximately +0.035°C per year. Annual rainfall averaged 1,386.00 mm (range: 1,289-1,432 mm), with the lowest recorded in 2013, coinciding with the period of political crisis.

Table 1: Descriptive statistics of study variables (2000–2025)

Variables	Mean	Std. Dev.	Minimum	Maximum	Range
Undernourishment (%)	30.03	3.97	24.40	37.10	12.70
Cereal Yield (kg/ha)	922.92	80.30	713.00	1,048.30	335.30
Total Protein (g/cap/d)	56.22	6.50	47.10	64.10	17.00
Staple Share (%)	48.57	5.06	43.00	55.00	12.00
Forest Area (%)	36.21	0.34	35.66	36.76	1.11
Agricultural Land (%)	8.16	0.44	7.85	9.10	1.25
GDP per Capita (PPP $)	1,215.76	151.92	997.00	1,578.00	581.00
FDI Net Inflows (% GDP)	1.30	1.34	0.07	5.87	5.80

Variables	Mean	Std. Dev.	Minimum	Maximum	Range
Electricity Access (%)	10.84	3.66	5.70	17.60	11.90
Renewable Energy (%)	91.74	1.78	88.90	95.10	6.20
Energy Adequacy (%)	97.91	3.44	92.00	103.00	11.00
Political Stability Index	-1.90	0.34	-2.70	-1.12	1.58
Mean Annual Temperature (°C)	25.72	0.25	25.32	26.19	0.87
Annual Rainfall (mm)	1386.00	35.25	1289.00	1432.00	143.00

Table 2: Regional Comparison of Selected Variables Across Central African Countries (Latest Available Year)

Country	Undernourishment (%)	Electricity Access (%)	Cereal Yield (kg/ha)	Political Stability Index
Central African Republic	29.8 (2024)	17.6 (2023)	878.1 (2023)	-2.14
Democratic Republic of Congo	42.0 (2022)	19.1 (2021)	915.0 (2022)	-2.30
Chad	37.5 (2022)	11.2 (2021)	1,100.0 (2022)	-1.98

Country	Undernourishment (%)	Electricity Access (%)	Cereal Yield (kg/ha)	Political Stability Index
Cameroon	10.5 (2022)	66.4 (2021)	1,840.0 (2022)	-0.72
Republic of Congo	37.0 (2022)	50.9 (2021)	890.0 (2022)	-0.89

The regional comparison reveals a consistent pattern with countries with the lowest electricity access like CAR (17.6%), Chad (11.2%) and DRC (19.1%) record the highest undernourishment rates, while Cameroon, with 66.4% electricity access records the lowest undernourishment at approximately 10.5%. Political instability similarly tracks food insecurity across all five countries supporting my findings from the bivariate analysis.

4.2 Agricultural land use, cereal productivity and food availability

Cereal yield showed a strong, statistically significant positive correlation with undernourishment ($r = 0.771$, $p < 0.001$, $N = 22$). Agricultural land area showed a weak, non-significant negative correlation with undernourishment ($r = -0.386$, $p = 0.076$, $N = 22$). To test whether the cereal yield-undernourishment relationship was genuine or a shared time-

trend lies, a detrended correlation was computed after removing the linear time trend from both variables. The detrended correlation collapsed to $r = 0.256$ ($p = 0.249$), confirming the raw correlation was false rather than causal.

Table 3: Correlation between undernourishment and agricultural land use

Variables	Pearson r	Sig. (p)	N	Range (Min–Max)
Cereal Yield (kg/ha)-Raw	0.771**	0.000	22	335.30

Variables	Pearson r	Sig. (p)	N	Range (Min–Max)
Cereal Yield (kg/ha)-detrended	0.256	0.249	22	-
Agricultural Land (%)	-0.386	0.076	22	1.25

****Significant at the 0.01 level**

4.3 Political instability, economic weakness and food security outcomes

The political stability index showed a strong, statistically significant positive correlation with undernourishment (r = 0.649, p = 0.001, N = 21). GDP per capita showed a negligible, non-significant correlation with undernourishment (r = 0.008, p = 0.969, N = 23). Comparing pre- and post-2013 periods, GDP per capita declined from a mean of $1,327.23 to $1,095.00 and the political stability index worsened from -1.70 to -2.14. Undernourishment, however, declined from 32.33% pre-2013 to 27.92% post-2013, a trend that runs counter to the deteriorating economic and governance indicators in the same window.

Table 4: Correlation and Period Comparison for Governance and Economic Variables

Variables	Pearson r	Sig. (p)	N	Range
Political Stability Index	0.649**	0.001	21	1.58
GDP per Capita (PPP $)	0.008	0.969	23	581.00

****Significant at the 0.01 level**

Period	GDP per Capita (Mean, PPP $)	Political Stability Index (Mean)	Undernourishment (Mean, %)
Pre-2013	1,327.23	-1.70	32.33
Post-2013	1,095.00	-2.14	27.92

4.4 Energy access and climate-related adaptation constraints

Electricity access showed a strong, statistically significant negative correlation with undernourishment ($r = -0.758$, $p < 0.001$, $N = 22$). Renewable energy share showed a weak, non-significant negative correlation with undernourishment ($r = -0.386$, $p = 0.084$, $N = 21$).

Table 5: Correlation between undernourishment and energy indicators

Variables	Pearson r	Sig. (p)	N	Range (Min–Max)
Electricity Access (%)	-0.758**	0.000	22	5.70 - 17.60
Renewable Energy (%)	-0.386	0.084	21	88.90 - 95.10

****Significant at the 0.01 level**

4.5 Climate variables and Food Security

Mean annual temperature showed a significant negative correlation with undernourishment ($r = -0.610$, $p = 0.002$, $N = 23$) and a very strong negative correlation with cereal yield ($r = -0.880$, $p < 0.001$, $N = 24$), indicating that rising temperatures have tracked closely with declining agricultural productivity. Annual rainfall showed no significant relationship with either undernourishment or cereal yield.

Table 6: Correlation of Climate Variables with Undernourishment and Cereal Yield

Variable	r with Undernourishment	Sig. (p)	N	r with Cereal Yield	Sig. (p)	N
Mean Annual Temperature (°C)	-0.610**	0.002	23	-0.880**	0.000	24
Annual Rainfall (mm)	0.204	0.349	23	-0.235	0.269	24

**Significant at the 0.01 level.

4.6 Multiple Regression Analysis

A multiple regression was conducted with undernourishment as the dependent variable and electricity access, GDP per capita, political stability, cereal yield, mean annual temperature and annual rainfall as independent variables (N = 21). The model explained 90.7% of variance in undernourishment ($R^2 = 0.907$, Adjusted $R^2 = 0.867$).

Table 7: Multiple Regression-Predictors of Undernourishment (%)

Variable	B	Std. Error	t	p
Constant	-184.770	106.110	-1.741	0.104
Electricity Access (%)	-1.200	0.312	-3.841	0.002**
GDP per Capita (PPP $)	-0.013	0.003	-4.375	0.001**
Mean Temperature (°C)	8.383	4.182	2.005	0.065†
Political Stability Index	1.814	1.760	1.031	0.320
Cereal Yield (kg/ha)	0.021	0.013	1.636	0.124

Variable	B	Std. Error	t	p
Annual Rainfall (mm)	0.009	0.012	0.724	0.481

$R^2 = 0.907$ | Adjusted $R^2 = 0.867$ | $^{**}p < 0.01$ | $^{\dagger}p < 0.10$

5. DISCUSSION

5.1 Objective 1: Descriptive statistics of study variables (2000–2025)

The numbers in Table 1 shows a region that has been food insecure for a long time. Nearly a third of the population, on average, didn't have enough to eat across the 26-year window and the spread between the best and worst year was only 12.7 points. What stands out more is how little infrastructure exists to support people through shocks: electricity access averaged just fewer than 11%, meaning most households had no reliable power for things like food storage or irrigation pumps. This supports FAO (2023) reporting Central Africa as the worst-affected sub region on the continent. The regional comparison in Table 2 reinforces this across five Central African countries, those with the lowest electricity access such as Chad (11.2%), DRC (19.1%) and CAR (17.6%), they all record undernourishment above 29%, while Cameroon at 66.4% electricity access sits at just 10.5%.

5.2 Objective 2: Agricultural land use, cereal productivity and food availability

According to Table 3, cereal yield goes up alongside undernourishment ($r = 0.771$) looking backwards, this implies more grain should mean less hunger, not more. But pulling apart the years, it's clear both variables were simply drifting in the same direction over time rather than one causing the other. Tessema et al. (2025) found something similar across the wider region where yields and climate stress moving together. While, agricultural land use showed basically nothing ($p = 0.076$), suggesting that just farming more land was never going to fix the underlying problem.

5.3 Objective 3: Political instability, economic weakness and food security outcomes

Based on Table 4, governance is really important than the economy. Political stability tracked closely with undernourishment (r = 0.649), while GDP per capita showed almost no relationship at all (r = 0.008). That is consistent with Andam et al.s (2023) argument that institutions, not just income, shape food outcomes in this part of the world. The one setback is that undernourishment actually dropped after 2013 even as both GDP and stability got worse.

5.4 Objective 4: Energy access and climate-related adaptation constraints

Electricity access produced the strongest result in the whole analysis (r = -0.758). Communities with more reliable power consistently showed lower undernourishment which aligns with Dassou et al. (2023) findings stating elsewhere in Sub-Saharan Africa. Renewable energy share didn't show the same pattern, likely because most of it comes from biomass rather than electricity people can actually use.

6. POLICY RECOMMENDATION

Improving food security in Central Africa requires integrated policies that address both structural and environmental challenges. First, governments should prioritize rural electrification as a core component of food security strategies rather than treating it solely as a mere objective. Expanding reliable electricity access in rural communities can improve agricultural productivity, support food processing and storage, and strengthen rural livelihoods. Development partners should work with national governments to establish clear rural electrification targets that are aligned with broader food security objectives.

In post-conflict settings, policymakers should prioritize governance reforms and peace building efforts before scaling up economic investment programmes. Stable institutions and effective governance create an enabling environment for agricultural development, service delivery, and sustainable food security interventions. Regional organizations and international development partners should therefore support conflict resolution and institutional capacity building as essential components of long-term food security strategies.

Given the growing impacts of climate change on agricultural production, governments should also promote climate-smart agriculture by investing in drought and heat-tolerant crop varieties, strengthening agricultural extension services, and supporting farmers to adopt climate-resilient farming practices. Increased investment in climate adaptation programmes will help improve agricultural productivity and reduce the vulnerability of farming communities to changing weather patterns.

Finally, energy policies should place greater emphasis on expanding access to productive electricity rather than focusing primarily on biomass-based renewable energy. Investments in technologies such as solar mini-grids and micro-hydropower can provide reliable electricity for irrigation, food processing, refrigeration, and storage, thereby improving agricultural value chains and reducing post-harvest losses.

6. CONCLUSION

This study set out to understand what actually shapes food security under climate stress in Central Africa and what shape it is how energy gaps, weak governance and agricultural strain complement one another. Electricity access stood out as the clearest lever available to policymakers, while political stability mattered more than raw economic growth in determining whether people had enough to eat. Consequently, resilience in this region will not come from boosting GDP or expanding farmland alone, but from rebuilding the infrastructural foundations that let communities adapt to shocks in the first place.

For policy, this means prioritizing vulnerable communities' electrification and governance reform instead of agricultural investment. Government agencies should treat energy access as a food security intervention, not just a separate development goal. Future research should move beyond national aggregates to community-level data climate variables such as rainfall and drought indices and track long-term impacts of adaptation projects, so that resilience strategies can be built on evidence rather than assumption.

REFERENCES

Abebaw, S.E. (2025). *A global review of the impacts of climate change and variability on agricultural productivity and farmers' adaptation strategies*. Food Sci. Nutr., 13 (2025), Article e70260.

Amani, R.K., Riera, B., Imani, G., Batumike, R., Zafra-Calvo, N. and Cuni-Sanchez, A. (2022) *'Climate change perceptions and adaptations among smallholder farmers in the mountains of eastern Democratic Republic of Congo*', Land, 11(5), p. 628.

Andam, K. S., Diao, X., Ecker, O., Pauw, K., Thurlow, J., & Ellis, M. (2023). Nigeria's agrifood system structure and drivers of transformation (Agrifood System Diagnostics Country Series 14). International Food Policy Research Institute (IFPRI).

Bi, M., Ren, F., Xu, Y., Guo, X., Zhou, X., van den Bersselaar, D.…& Ren, H. (2025). *Impact Assessment of Climate Change on Climate Potential Productivity in Central Africa Based on High Spatial and Temporal Resolution Data*. Land, 14(8), 1535.

Chabwera, M. and Madhlopa, A. (2025) *'Impacts of climate change on food systems in Africa: a systematic review*', Frontiers in Sustainable Food Systems, 9.

Dake, F. A. A., & Christian, A. K. (2023). *Cold, dark and malnourished: A cross-sectional analysis of the relationship between energy poverty and household burden of malnutrition in sub-Saharan Africa*. *BMJ Open, 13*(12), e074601.

Ecology and Society (2024) *'Everyday climate adaptation practices in agriculture contribute to food security in Sub-Saharan Africa', Ecology and Society*, 29(4), p. 32.

Food and Agriculture Organization (FAO). (2023). *Food insecurity and malnutrition in West and Central Africa at 10-year high as crisis spreads to coastal countries*. FAO Regional Office for Africa.

International Monetary Fund. African Dept. (12 Dec 2024). *Climate Change in Chad: /Challenges and Opportunities*, 9798400295249.

IPCC (2022) 'Chapter 9: Africa', in Pörtner, H.-O. et al. (eds.) Climate change 2022*: impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, pp. 1285–1455.

Mugumaarhahama, Y. et al. (2025) *'Assessing smallholder farmers' vulnerability to climate change and coping strategies in South Kivu Province, eastern Democratic Republic of Congo'*, Environmental Systems Research, 14(1).

Mutwedu, V.B. et al. (2025) *'Climate-smart agronomic practices and their appraisal among smallholder sorghum farmers in eastern Democratic Republic of Congo wetlands'*, ScienceDirect.

Simane, B., Kapwata, T., Naidoo, N., Cissé, G., Wright, C.Y. and Berhane, K. (2025) *'Ensuring Africa's food security by 2050: the role of population growth, climate-resilient strategies, and putative pathways to resilience'*, Foods, 14(2), p. 262.

Tessema, Y. A., et al. (2025). *Specific article on crop yields. Scientific Reports, 15*, 2858.

Tholstrup, J. and Vazquez, C. (2025) *'Building Africa's climate resilience: understanding the impacts and future strategies in the face of climate change*', Frontiers in Climate, 7.

Vivalya, B.M.N. et al. (2024) *'Vulnerability and adaptation of maize smallholder farmers to climate change: a Sub-Saharan African context'*, Discover Agriculture, 2(1).

Wakweya R.B (2025). *Impacts of climate change on crop production and food security in Ethiopia*. Discov. Sustain., 6 , p. 158.

Yiridomoh, G.Y. and Derbile, E.K. (2025) *'Climate-smart agriculture adoption and food security in Sub-Saharan Africa: a systematic review', Climate Resilience and Sustainability*, 4(2), p. e70017.