OSUN GEOGRAPHICAL REVIEW
Published by the Department of Geography, Osun State University, Osun State, Nigeria
ISSN: 2695 - 1959 Volume 7, 2025; 36 - 44

THE IMPACT OF GENE POOL DEPLETION AND CLIMATE CHANGE ON SUSTAINABLE LIVELIHOOD IN NIGERIA

[1*]M. O. Lawal, [1]G. F. Adeleke, [2]S. A. Adeniyi and [3]O. B. Oyediran

[1.]Department of Sociology and Criminology, Osun State University, Osogbo, Nigeria
[2.]Department of Geography, Osun State University, Osogbo, Nigeria
[3.]Department of Leisure and Tourism Management, Federal College of Wildlife Management, New Bussa, Niger State, Nigeria
**Corresponding Email: musediq.lawal@uniosun.edu.ng*

Abstract

The socio-economic advancement of Nigeria faces significant challenges due to the dual impacts of gene pool depletion and climate change. Gene pool depletion, defined as the reduction of genetic diversity within native crops, livestock, and wild species, diminishes the ecological resilience and adaptability of food systems. This predicament is exacerbated by climate change, which results in unpredictable rainfall patterns, desertification, flooding, and increased temperatures, placing additional stress on already vulnerable agricultural and ecological systems. The intersection of these two environmental challenges threatens sustainable livelihoods, particularly for rural communities that rely on biodiversity for their food, medicinal needs, income, and cultural traditions. This article investigates the interconnected effects of gene pool depletion and climate change on sustainable livelihoods in Nigeria, utilizing a review of theoretical, empirical, and policy-related literature. The study employs the Sustainable Livelihood Framework and environmental vulnerability theory to analyze the ways in which environmental degradation interacts with poverty, food insecurity, and conflicts over resources. Principal findings indicate that climate-induced pressures and genetic erosion disrupt agricultural systems, diminish both crop and livestock yield, intensify poverty levels, and heighten vulnerability among marginalized populations. The paper advocates comprehensive policy approaches aimed at conserving agro-biodiversity, fostering climate-smart agricultural practices, and empowering local communities. In conclusion, safeguarding Nigeria's genetic legacy and bolstering climate resilience are imperative for achieving enduring sustainability and equity in development efforts.

Keywords: Gene Pool, Climate Change, Sustainable Livelihood, Biodiversity, Vulnerability

Introduction

Nigeria is endowed with both natural and genetic endowments but has growing threats to people's livelihoods because of genetic variety loss and climate change (Menton *et al.,* 2020). These two interrelated environmental issues are significant impediments to national development, particularly in rural regions where natural endowments drive economic and social activities. Gene pool depletion entails progressive loss of genetic diversity in plants, animals, and microbes (Salgotra & Chauhan, 2023). It compromises ecological resilience, agricultural productivity, and communities' capacity to adapt to shifting environmental conditions. Concurrently, climate change manifests through extreme weather, rising temperature, expansion of deserts, rising sea levels, and altered rainfall patterns, all of which amplify vulnerabilities in Nigeria's social and economic frameworks (Benjamin *et al.,* 2024).

Sustainable livelihood, in these respects, means that households, families, and communities can access resilient, productive ways of living that entail all people without destroying natural resources (Morse, 2025; Guo *et al.,* 2023). To most Nigerians, especially small farmers, fishermen, cow-herders and people depending on forests, sustainable livelihood depends on accessing different types of plant and animal sources and a stable climate (Morse, 2025, Ola, 2022). Loss of local crop species and animal types, and deterioration of ecosystems, limit their ability to

control problems like pests, droughts, and floodings (Farooq *et al.,* 2022).

Gene pool depletion and climate change are often researched individually, but their simultaneous impact has never been considered together in Nigerian policy or studies (Abdulkadir *et al.,* 2017; Oluwaseyi, 2017). These two problems reinforce one another: climate change accelerates species loss and habitat deterioration, and genetic diversity loss constrains choices for adapting to environmental pressure (Hoffmann *et al.,* 2021). Their intersection imperils food sovereignty, water security, public health, and cultural identity, all of which are key components of a sustainable living (Adeyemi *et al.,* 2023; Fatoki *et al.,* 2021).

This study aims to address the existing gap by thoroughly analyzing the relationship between the reduction of gene pools and climate change, alongside their joint effects on sustainable livelihoods within Nigeria. Employing the Sustainable Livelihood Framework and the theory of environmental vulnerability, this research investigates how these environmental pressures intensify poverty, inequality, and conflict. Furthermore, it pinpoints avenues for cohesive intervention, highlighting the importance of conserving agro-biodiversity, implementing climate-smart agricultural practices, and fostering inclusive governance. By undertaking this analysis, the study adds to the expanding dialogue regarding sustainable development and ecological justice within Nigeria's dynamic environmental context.

Conceptual and Theoretical Framework

This work utilizes two fundamental conceptual frameworks to identify interlinkages for gene pool degradation, climate change, and sustainable livelihoods in Nigeria: Environmental Vulnerability Theory and the Sustainable Livelihood Framework (SLF). These models describe how ecological and environmental stress impacts socio-economical vulnerability and well-being, most notably in natural resource-dependent communities.

The Sustainable Livelihood Framework, created by the UK Department for International Development (DFID), offers a comprehensive framework for examining the elements that limit or promote individuals' livelihoods. It delineates five primary categories of assets, natural, physical, human, financial, and social capital, through which individuals and households engage in livelihood strategies. In Nigeria, environmental assets, including genetic resources and climate stability, are essential for rural livelihoods (Odo, 2012). A decline in gene pools or the emergence of unpredictable climatic patterns leads to a reduction of these assets, thereby diminishing individuals' capacities to manage stress, recover from disturbances, and cultivate long-term resilience.

Environmental Vulnerability Theory builds on the Sustainable Livelihoods Framework by highlighting to what extent a system, society, or household is at risk of environmental threats (Naylor *et al.,* 2020). The degree of vulnerability is dictated by a level of vulnerability to stressors (e.g., flooding and drought), sensitivity (e.g., depending on agriculture), and adaptive capacity (access to diverse crops or other sources of income). In rural Nigeria, high exposure to climate-related threats combined with low adaptive capacity and high use of local genetic material makes people extremely vulnerable.

Additionally, loss of agro-biodiversity, which is characterized by diversity and differences of animals, plants, and microorganisms directly or indirectly utilized for agricultural and food intents, undermines provision of ecosystem services and adaptation mechanisms (Muluneh, 2021). For example, traditional crop species tend to carry traits such as drought resistance, resistance to pests, and cultural importance that are often absent in commercially developed hybrid species. Their extinction imposed by monocultural agricultural practices or loss of their habitats undermines adaptive action and escalates vulnerability of livelihoods (Gepts, 2023, Muluneh, 2021).

This conceptual landscape highlights the importance of promoting resilience through environmental governance, biodiversity conservation, and climate change adaptation (Adebayo, 2025). In addition, it highlights the importance of knowledge system integration from local communities, often of ecological nature obtained from indigenous knowledge of land and seed management (Adefila *et al.,* 2024; Carver *et al.,* 2021). In effect, the dual vision of the Sustainable Livelihood Framework (SLF) and vulnerability theory facilitates a holistic grasp of how ecological degradation and climatic shifts meet to impact livelihoods' sustainability in Nigeria.

Gene Pool Depletion in Nigeria

Gene pool degradation in Nigeria is a significant, yet thus far overlooked, threat to environmental sustainability, as well as to the long-term security of livelihoods. Gene pools, which encompass the full complementarity of genetic diversity that exists within populations of animals as well as plants, play significant roles in the conservation of ecological resilience, the generation of agricultural innovation, as well as the stability of food systems. However, rapid population growth, lack of regulation of the use of the land, deforestation, fragmentation of habitats, and the substitution of local plant species with high-yield monocultures, has, in Nigeria, considerably diminished the nation's genetic biodiversity. According to FAO (2019) estimations, Nigeria has incurred extensive loss of indigenous plant varieties as well as livestock during the past half-century, jeopardizing the country's abilities to adapt to the increasing climate as well as ecological challenges.

The loss of specific indigenous seed crops, such as drought-resistant millet, sorghum, and yam, reduces the pool of opportunities for adaptation-based agricultural practice in climate-affected regions like the Sahel and the Middle Belt (Adefila *et al.,* 2024; Benjamin *et al.,* 2024). Agricultural homogenization, encouraged by market-based production programs and seed policy reforms, has increasingly excluded traditional farming systems that formerly preserved variable genetic resources (Hoffmann *et al.,* 2021; Bélanger & Pilling, 2019). This shift has negatively impacted local systems of indigenous knowledge necessary for seed conservation and genetic diversity (Oluwaseyi, 2017). In addition, indigenous livestock that is locally adapted to the ecological belts of Nigeria is being replaced by exotic stocks, which, although more productive, are more vulnerable to diseases as well as environmental stresses.

The reduction of genetic diversity in populations has significant repercussions for ecological equilibrium and pharmaceutical research (Arimoto *et al.,* 2023). Numerous wild species, encompassing both flora and fauna, contribute to essential processes such as pollination, soil enhancement, and the regulation of diseases (Kent *et al.,* 2020; Meyer-Rochow, 2017). The extinction of these species limits the potential for biotechnological advancements and undermines the economic foundations of rural communities reliant on forest resources, traditional medicine, and ecosystem services (Shafi *et al.,* 2021; Omokhafe *et al.,* 2017). Importantly, local healers and communities dependent on forests in areas like Cross River and Ogun States have indicated a decrease in access to vital plant species because of habitat deterioration (Adebowale *et al.,* 2025; Basiru *et al.,* 2022).

Drivers of gene pool erosion in Nigeria are diverse, ranging from policy abandonment, lack of strong environmental regulation, urban growth, to socioeconomics that value short-term benefits rather than long-term sustainability (Muhammad *et al.,* 2022). Lack of effective national genetic conservation strategies, combined with inadequate spending on seed banks as well as research, further intensifies the crisis. Unless Nigeria takes desperate measures to save the genetic heritage, the nation stands the risk of eroding agricultural resilience as well as undermining the very basis of sustainable livelihoods both in the rural as well as peri-urban areas (Osunsina *et al.,* 2022; Oluremi *et al.,* 2021).

Climate Change and Livelihood Vulnerability in Nigeria

Climate change presents an increasingly looming threat to sustainable livelihoods in Nigeria because of diverse mechanisms that affect food systems, freshwater sources, human health, and cash-generating activities (Okafor *et al.,* 2024; Oluwaseyi, 2017). Ecological zones of the nation from the Sahel-desert region in the north to the humid tropical region in the south are suffering negative consequences resulting from altered temperatures that are increasingly higher, irregular rainfall patterns, frequent droughts, coastal flooding, and loss of land (Oluremi *et al.,* 2021). These climatic changes present a major threat to the livelihood of millions of Nigerians living on rain-fed farmlands, fishing activities, grazing activities, and other activities that are highly responsive to climate changes (Okafor *et al.*, 2024).

The vulnerability of livelihoods is especially acute in rural areas, where 70% of the population lives off agriculture as a source of sustenance and revenue (Akpan & Zikos, 2023). Uncertain rainfall patterns have disrupted cycles of planting and harvesting, leading to lower crop harvests, intensified food insecurity, and a dip in household incomes (Aluko, 2018). In the northern region, long drought periods

have intensified desertification and reduced grazing lands available, causing resource-based conflicts between herders and farmers. Meanwhile, in the southern and coastal areas, rising sea levels and intensified rainfall have caused seasonal flooding that is displacing populations and devastating farmlands, infrastructures, and settlements.

In addition to this, climate change exacerbates existing socio-economic inequalities as it disproportionately affects poor people, women, and vulnerable groups that often do not have adaptation resources. Limited capacity of such high-risk groups to diversify income sources, migrate, or access credit and information renders them even more vulnerable to climatic stressors. Consequences reach far beyond the economic space into social aspects as interruptions of livelihood have negative bearings on schooling, medicine, as well as social cohesion, especially in conflict zones like Middle Belt and North-East.

Nigeria remains highly vulnerable to the impacts of climate change. However, institutional responses to these challenges are not sufficiently robust (Adelekan & Fregene, 2022). The country has developed national adaptation strategies, such as the National Adaptation Plan Framework (NAPF) and the National Climate Change Policy (Adeleke *et al.,* 2020). Despite these efforts, implementation progress has been slow. This is largely due to bureaucratic bottlenecks, funding shortfalls, and weak coordination across sectors and levels of government (Iroha *et al.,* 2024, Okonkwo, 2024). In many cases, local communities rely on traditional coping mechanisms. Yet, these strategies are increasingly ineffective as climate extremes intensify (Ngcamu, 2023). Overall, climate change seriously undermines livelihood sustainability in Nigeria. Its cumulative impact, particularly when combined with loss of biodiversity and government effectiveness problems, necessitates a joined-up approach that is inclusive and anticipatory to safeguard people and ecosystems in a changing climate.

Interlinkages and Integrated Impact on Sustainable Livelihood

The interaction of gene pool depletion and climatic change in Nigeria forms a highly connected set of vulnerabilities that cumulatively compromise the core of sustainable livelihoods (Wakdok & Bleischwitz, 2021). While each presents a distinctive threat, their overlap creates compounded results that are more than a simple summative effect of their individual impact. Gene pool depletion reduces the resistance of ecosystems as well as of agronomic systems to climatic shocks, whereas climatic change accelerates loss of biodiversity by altering habitats, shifting species' geographic ranges, and disintegrating breeding patterns (Muluneh, 2021). Individually, these processes threaten the stability of the systems that feed people, sources of income, and of socio-ecological balances, especially in rural parts of Nigeria.

Central to these interconnections is a feedback mechanism: climate change intensifies genetic erosion by placing additional stress on ecosystems that are already compromised, whereas the reduction of genetic diversity restricts the available options for adapting to climate change. For instance, as precipitation patterns become erratic and temperatures increase, the necessity for crops and livestock that can withstand drought and tolerate heat becomes imperative. Nevertheless, the earlier loss of native varieties that were suited to local environmental conditions hampers farmers' ability to adapt, thereby exacerbating food insecurity and poverty (Oyinloye *et al.,* 2018). This phenomenon is particularly evident in regions such as the North-East and North-West, where both desertification and diminished seed diversity contribute to persistent food shortages and compulsory displacement (Badewa & Dinbabo, 2023).

The comprehensive influence is also evident in the disintegration of conventional livelihood systems, including shifting cultivation, transhumance, and agroforestry (Nath *et al.,* 2021). Historically, these systems depended on biodiversity and reliable climatic patterns to maintain sustainable operations. As the degradation of both biodiversity and climatic stability intensifies, these systems become increasingly unviable, compelling communities to resort to unsustainable alternatives such as illegal logging, overfishing, and urban migration (Bélanger & Pilling, 2019). Consequently, this exerts new demands on urban infrastructures, social services, and labor markets, thereby generating further layers of vulnerability.

Furthermore, the doubly devastating effects of genetic diversity loss and climatic shifts have tremendous implications for social health and gender

equity. Women, as central to conserving seeds, storing water, and sustaining community-based diets, bear a disproportionate burden of negative consequences of environmental degradation. Moreover, nutritional outcomes suffer as diversified diets that rely on indigenous crops give way to fewer, less wholesome staple foods.

Overcoming such inter-linking challenges necessitates a broader approach that is supra-sectorial in character and seeks coordinated sustainability frameworks (Lah, 2025). This necessitates integrating policies across sectors of agriculture, environment, health, and development to be responsive to site realities and adaptive capacity. Finally, safeguarding livelihoods in Nigeria necessitates systemic intervention that accepts inherent ecosystem integrity-climatic resilience linkage.

Policy, Institutional, and Community Responses

Nigeria's methods of dealing with gene pool degradation and susceptibility of livelihoods caused by climate change include an array of national policy instruments, institutional structures, and adaptations among communities (Benjamin *et al.,* 2024). These efforts, however, quite often suffer from a lack of coherence, coordination, and long-term implementation. At the policy level, Nigeria has signed many international instruments, such as the Convention on Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and the Paris Agreement on Climate Change. Within Nigeria, many strategic papers, such as the National Biodiversity Strategy and Action Plan (NBSAP) and the National Climate Change Policy (NCCP), outline obligations to conservation, environmental protection, and adaptation to climate change.

Despite such frameworks, implementation is weak due to overlapping of functions, lack of adequate funding, bureaucratic snags, and absence of inter-ministerial coordination. Institutional structure of environmental governance by Federal Ministry of Environment, Nigerian Agricultural Seed Council, and National Biotechnology Development Agency operates without proper synergy and limited community engagement. National seed policy is a good example: national seed policy frameworks tend to promote improved and commercially viable seeds into use rather than indigenous landraces and thus foster gene pool loss. Reforestation and climate-resilience programs are similarly frequently short-term and donor-driven and poorly integrated into community-based systems of governance.

Community responses, although often overlooked in national policy discourse, show creativity and adaptability. Local farmers and nomadic pastoralists in rural Nigeria continue to practice traditional methods of seed preservation, in-situ conservation of crops and ecosystem management. In some parts of Benue, Ebonyi, and Plateau States, community-based seed banks have emerged as informal systems of preserving indigenous crop species. Similarly, some communities in Cross River as well as Taraba states have maintained sacred groves and biodiversity hotspots through customary systems of land ownership that necessarily foster conservation activities.

The role of non-governmental organisations (NGOs) and civil society organisations is critical in advocacy work, community-based education, and brokering linkages between policy and practice. Programmes such as training in climate-smart agricultural practice, setting up agroforestry demonstration plots, and conducting alternative livelihood activities are making steady gains, but challenges of scalability and sustainability remain. Furthermore, integrating gender-responsive methodologies into community activities has proven to be valuable, especially in enhancing women empowerment, as women have a critical role to play in seed systems and household food security (Adeyemi *et al.,* 2023; Oyinloye *et al.,* 2018).

In brief, although Nigeria possesses a normative and institutional foundation of action, its inefficiency in vertical and horizontal coordination militates against its effectiveness. Focusing on further deepening connectivity between national policy and local setting is requisite in developing inclusive frameworks that are responsive and sustainable to addressing biodiversity and climate matters.

Security Implications of Gene Pool Depletion and Climate Change

Gene pool depletion and climatic change present widespread security issues that compromise severely sustainable livelihoods in Nigeria. Loss of genetic material in crops in farming systems, livestock, as

well as natural species, reduces resistance in agronomic systems to pests, ailments, and changing climatic variables. This situation presents grave implications for food security because lower productivity in farming leads to reduced availability of food that is less accessible and less affordable. Moreover, climatically induced events such as floods and droughts as well as desertification compound such vulnerabilities and threaten survival among farming families that make up a significant proportion of people in Nigeria.

Apart from food insecurity, health security is also threatened. Biodiversity loss constrains access to traditional medicine sources as well as bio-sources, while climatic variability propagates epidemics of a vector-borne nature such as malaria, cholera, and Lassa fever. Malnutrition caused by loss of diversified sources of nutrients reduces resistance to infections and exposes populations to more health risk. These processes indicate strong connection patterns between environmental change and social epidemics.

Just as important is economic and livelihood security. Those millions of Nigerians sustained by agriculture, fishing, and pastoralism have their activities destabilized by depreciating genetic diversity and shocks from the climate. This translates into lower incomes, escalating poverty, and growing unemployment that fuels social vulnerability as well as rural–urban migration. Additionally, access to imported or monopolized seed types undermines national sovereignty of the farms through degradation of Nigeria's ability to maintain locally independent systems of producing food.

At a broader level, concerns pertaining to environmental and national security become apparent. The depletion of biodiversity undermines ecosystems, exacerbating ecological crises such as deforestation, desertification, and flooding. These environmental pressures frequently incite conflict over limited resources, as illustrated by farmer-herder confrontations in various regions. As livelihoods deteriorate, the levels of displacement and migration rise, intensifying internal security issues. In summary, the convergence of gene pool reduction and climate change presents a multifaceted security threat, impacting food, health, economic, environmental, and national security domains. Tackling these issues necessitates an integrated human security framework that emphasizes the survival, resilience, and dignity of individuals while advocating for sustainable policies related to biodiversity preservation, climate adaptation, and protection of livelihoods in Nigeria.

Conclusion

The combined challenge of gene diversity declines, and climate change is a severe threat to the sustainability of livelihoods in Nigeria. As this paper has made clear, loss of genetic variety in agriculture, livestock rearing, and ecosystems undermines resilience, availability of foods, and financial stability in rural economies. Climate change attacks these vulnerabilities simultaneously through irregular climatic patterns, loss of land through degradation, and intensified pressure on ecosystems. This comingling of drivers presents a multifaceted challenge to socio-ecological systems of Nigeria through an economy that is predominant in agrarian and natural resource-based ways of life.

A significant finding from the examination reveals the reciprocal relationship between the degradation of the gene pool and susceptibility to climate change. Biodiversity should not be viewed solely as an issue of conservation; rather, it represents a vital resource for enhancing resilience. The depletion of genetic diversity results in communities having diminished capacities to adapt to ecological disturbances. As climate change exacerbates, it further hastens the depletion of these essential genetic resources. This intricate predicament necessitates comprehensive strategies that disrupt the cycle of deterioration and vulnerability.

Despite firm pledges made on policy and institutional fronts in Nigeria, gaps in implementation, coordination, and community engagement persist and constrain their effectiveness. Utilization of traditional knowledge systems as indigenous means of conservations and of informal institutions is yet under-explored despite demonstrated utility. Additionally, failure to integrate efforts into the environment and climate serves to weaken potential of combined action.

For its part, Nigeria's development trajectory must shift in a direction of sustainability that is based on ecological integrity and social justice. This requires preserving its gene pool as much as a heritage as a cornerstone of national resilience. This necessitates rethinking of agrarian models, community

empowerment, institution reform, and integration of environmental considerations into all aspects of economic planning. Policies must treat only its manifestations of climate and biodiversity crises and investigate its underlying structural drivers such as poverty, marginalization, and unsustainable land use.

Ultimately, the protection of livelihoods amidst the challenges posed by climate change and the decline of biodiversity serves as a measure of political resolve, scientific creativity, and collective societal engagement. Should Nigeria succeed in harnessing its human and natural resources in pursuit of inclusive and progressive policies, it can establish a trajectory that preserves both its ecological assets and the welfare of its population. The moment for comprehensive and proactive measures is upon us.

Recommendations

Against this background of commonly intertwined challenges caused by loss of gene pool and climatic shifts that hinder sustainable livelihood in Nigeria, a series of multi-dimensional and comprehensive recommendations should be proposed. These recommendations are a combination of top-down authoritative policy interventions and bottom-up community-based approaches that are guided by sustainability, equity, and resilience frameworks.

National policy of conserving genetic resources must first be renewed. This involves scaling up and funding national gene banks, enhancing on-farm conservation, and protection of indigenous crop and livestock species through legislation. Policy incentives must be reoriented to compensate farmers and societies conserving biodiversity, such as through payment for ecosystem services (PES) or biodiversity stewardship schemes. Moreover, intellectual property systems must appreciate and protect traditional systems of ecological wisdom, particularly in plant and animal germplasm selection and traditional medicine use.

Second, adaptation responses to climate should incorporate biodiversity considerations. Climate-resilience indigenous species should be promoted by agricultural extension services as well as by climate-smart agronomic practice and participatory varietal selection. Early warning systems and seasonal forecasting should be scaled up in flood-vulnerable and drought-vulnerable areas as well as by weather-indexed insurance programs to reduce shocks to livelihoods. These activities should be tailored to localized socio-ecological contexts through active engagements of women, youth, and marginalized groups.

Third, institutional coordination should be significantly strengthened. There is a need to have a national coordinating institution to harmonize agency efforts that work along sectors of agriculture, climate change, environment, and rural development. Such an institution should advocate policy coherence and enable joint planning and budgeting. Decentralized modes of governance such as community forest management boards or territorial biodiversity committees can allow decision-making that is sensitive to on-the-ground situations and empower actors at that scale.

Fourth, it is important to invest in education and capacity development efforts. Environmental literacy campaigns, farmer field schools, and vocational training programs focused on agroecology, seed keepership, and restoration of lands can bring about a new generation of environmental stewards. This is particularly important to engage rural youth and to mitigate migration trends that reduce rural workforces and customary wisdom.

Finally, linkages to research–policy have to be fortified. Universities and research centers must engage policymakers and societies to create locally appropriate data and innovations. Interdisciplinary studies that connect agriculture, ecology, economics, and social sciences will facilitate evidence-based action and long-term monitoring of consequences. Ultimately, a transition to integrated, inclusive, and evidence-informed solutions is necessary. These suggestions, if adopted comprehensively, will enable the protection of Nigeria's environmental capital while securing livelihoods against a background of ecological and climatic insecurity.

References

Abdulkadir, A., Lawal, A.M. & Muhammad, T.I. (2017). Climate change and its implications on human existence in Nigeria: a review. *Bayero Journal of Pure and Applied Sciences*, *10*(2), 152-158.

Adebayo, W.G. (2025). Resilience in the face of ecological challenges: Strategies for integrating environmental considerations into social policy planning in Africa. *Sustainable Development*, *33*(1), 203-220.

Adebowale, T.K., Ijose, O.A., Ibiyomi, B.B., Akintunde, O.O., Oduntan, O.O., Osunsina, I.O.O. & Shobowale, A.A. (2025) Utilization of fauna resources for therapeutic purposes as a barrier to species justice advocacy in Nigeria. *Frontiers in Conservation Science,* 6:1551597. doi: 10.3389/fcosc.2025.1551597

Adefila, A.O., Ajayi, O.O., Toromade, A.S. & Sam-Bulya, N.J. (2024). Integrating Traditional Knowledge with modern agricultural practices: A Sociocultural Framework for Sustainable development. *World Journal of Biology Pharmacy and Health Sciences*, *20*(02), 125-135.

Adeleke, B., Robertson-Andersson, D., Moodley, G. & Taylor, S. (2020). Aquaculture in Africa: A comparative review of Egypt, Nigeria, and Uganda vis-a-vis South Africa. *Reviews in Fisheries Science & Aquaculture*, *29*(2), 167-197.

Adeyemi, O., Van den Bold, M., Nisbett, N. & Covic, N. (2023). Changes in Nigeria's enabling environment for nutrition from 2008 to 2019 and challenges for reducing malnutrition. *Food Security*, *15*(2), 343-361.

Akpan, A.I. & Zikos, D. (2023). Rural Agriculture and Poverty Trap: Can Climate-Smart Innovations Provide Breakeven Solutions to Smallholder Farmers? *Environments*, *10*(4), 57. https://doi.org/10.3390/environments10040057

Aluko, Y.A. (2018). Women's use of indigenous knowledge for environmental security and sustainable development in Southwest Nigeria. *International Indigenous Policy J.* 9, 1-23.

Arimoto, K.I., Miyauchi, S., Troutman, T.D., Zhang, Y., Liu, M., Stoner, S.A., Davis, A.G., Fan, J.B., Huang, Y.J., Yan, M. and Glass, C.K. (2023). Expansion of Interferon inducible Gene Pool via USP18 inhibition promotes cancer cell pyroptosis. *Nature Communications*, 14(1), p.251.

Badewa, A.S. & Dinbabo, M. F. (2023). Multisectoral intervention on food security in complex emergencies: a discourse on regional resilience praxis in Northeast Nigeria. *GeoJournal*, *88*(2), 1231-1250.

Basiru, A.O., Oladoye, A.O., Adekoya, O.O., Akomolede, L.A., Oeba, V.O., Awodutire, O.O., Charity, F. & Abodunrin, E.K. (2022). Livelihood vulnerability index: gender dimension to climate change and variability in REDD+ piloted sites, Cross River state, Nigeria. *Land*. 11(8):1240.

Bélanger, J. & Pilling, D. (2019). *The State of the World's Biodiversity for Food and Agriculture*. FAO.

Benjamin, K.T., Osasumwe, O.F., Amuche, E.O., Rebecca, K.K. & Isaa, K.S. (2024). Navigating Climate Action in Nigeria: Assessing Sustainable Development Goal 13 Implementation and Challenges. *Journal of Law and Sustainable Development*, *12*(1), e971. https://doi.org/10.55908/sdgs.v12i1.971

Carver, S., Convery, I., Hawkins, S., Beyers, R., Eagle, A., Kun, Z., Van Maanen, E., Cao, Y., Fisher, M., Edwards, S.R. & Nelson, C. (2021). Guiding Principles for Rewilding. *Conservation Biology.* 35(6):1882-93.

Farooq, M.S., Uzair, M., Raza, A., Habib, M., Xu, Y., Yousuf, M., Yang, S.H. & Ramzan Khan, M. (2022). Uncovering the research gaps to alleviate the negative impacts of climate change on food security: a review. *Frontiers in Plant Science*, 13, p.927535.

Fatoki, O., Oguntoye T., Arowolo O. & Ogunsola, A. (2021). Effect of climate change on rural farming households' food security in Ogun state, Nigeria, *Bulgarian Journal of Soil Science Agrochemisty and Ecology,* 55(1), 3-14.

Food and Agriculture Organization. (2019). *The State of the World's Biodiversity for Food and Agriculture*. FAO Commission on Genetic Resources for Food and Agriculture Assessments. https://www.fao.org/3/CA3129EN/CA3129EN.pdf

Gepts, P. (2023). Biocultural Diversity and Crop Improvement. *Emerging Topics in Life Sciences,* 7(2):151-196. doi: 10.1042/ETLS20230067.

Guo, M., Xie, M. & Xu, G. (2023). Sustainable Livelihood Evaluation and Influencing Factors of Rural Households: A Case Study of Beijing Ecological Conservation Areas. *Sustainability*, 15(13), 10743. https://doi.org/10.3390/su151310743

Hoffmann, A.A., Miller, A.D. & Weeks, A.R. (2021). Genetic mixing for population management: From Genetic rescue to Provenancing. *Evolutionary Applications*, 14(3), 634-652.

Iroha, E. V., Watanabe, T. & Satoshi, T. (2024). Flawed Institutional Structures: Project Managers Underutilized in Nigeria's Construction Industry. *Buildings*, *14*(3), 807. https://doi.org/10.3390/buildings14030807

Kent, S.A., Spires-Jones, T.L. & Durrant, C.S. (2020). The physiological roles of tau and Aβ: implications for Alzheimer's disease pathology and therapeutics. *Acta Neuropathologica*, 140(4), 417-447.

Lah, O. (2025). Breaking the Silos: Integrated Approaches to Foster Sustainable Development and Climate Action. *Sustainable Earth Reviews,* 8(1), https://doi.org/10.1186/s42055-024-00102-w

Menton, M., Larrea, C., Latorre, S., Martinez-Alier, J., Peck, M., Temper, L. & Walter, M. (2020). Environmental justice and the SDGs: From Synergies to Gaps and Contradictions. *Sustainability Science*, *15*(6), 1621-1636.

Meyer-Rochow, V.B. (2017). Therapeutic arthropods and other, largely terrestrial, folk-medicinally important invertebrates: a comparative survey and review. *Journal of Ethnobiology Ethnomedicine,* 13, 1–31. doi: 10.1186/s13002-017-0136-0

Morse, S. (2025). Having Faith in the Sustainable Livelihood Approach: A Review. *Sustainability*, 17(2), 539. https://doi.org/10.3390/su17020539

Muhammad, Z., Elisha I.L., Funmi O.K., Shehu, M.M., Zataat S.B., Usman J.G., Joseph, H., Itodo, A.E., James, A.E., Kpensalen, T.B. & Gofwan, G.J. (2022). Survey of animals and their products used in traditional medicine in Jos and Bukuru metropolis, Plateau State, Nigeria. *Journal of Complementary Medical Research,* 13, 40–40.

Muluneh, M.G. (2021). Impact of Climate Change on Biodiversity and Food Security: A Global Perspective - A Review Article. *Agriculture & Food Security,* 10, 36. https://doi.org/10.1186/s40066-021-00318-5

Nath, A.J., Reang, D. & Sileshi, G.W. (2022). The Shifting Cultivation Juggernaut: An Attribution Problem. *Global Challenges,* 6(8):2200051. doi: 10.1002/gch2.202200051.

Naylor, A., Ford, J., Pearce, T. & Van Alstine, J. (2020). Conceptualizing climate vulnerability in complex adaptive systems. *One Earth*, *2*(5), 444-454.

Ngcamu, B.S. (2023). Climate Change effects on Vulnerable Populations in the Global South: A Systematic Review. *Natural Hazards,* 118, 977–991. https://doi.org/10.1007/s11069-023-06070-2

Odo, S.O. (2012). Climate change and conflict in Nigeria: A Theoretical and Empirical Examination of the Worsening Incidence of Conflict between Fulani Herdsmen and farmers in Northern Nigeria. *Arabian Journal of Business and Management Review,* 2(1), 110-124

Ogundeji, A.A. (2022). Adaptation to Climate Change and Impact on Smallholder Farmers' Food Security in South Africa. *Agriculture*, *12*(5), 589.

Okafor, C.C., Ajaero, C.C., Madu, C.N., Nzekwe, C.A., Otunomo, F.A. & Nixon, N.N. (2024). Climate Change Mitigation and Adaptation in Nigeria: A Review. *Sustainability*, 16(16), 7048. https://doi.org/10.3390/su16167048

Okonkwo, O.S. (2024). Evaluating Nigeria's National Planning for Sustainable Development Goals. *Journal of Sustainable Equity and Social Research*, *1*(1), 39-48.

Ola, A. (2022). Climate change effects and livelihood-adaptation strategies by the urban poor in Ibadan, Nigeria. *Town and Regional Planning*, *81*, 24-38.

Oluremi, A.S., Ajadi, T.A., Opaleye, O.O., Alli, T.O.A., Ogbolu, D.O., Enitan, S.S., Alaka, O.O., Adelakun, A.A., Adediji, I.O., Ogunleke, A.O. & Suleiman, I.E. (2021). High seroprevalence of viral hepatitis among animal handlers in Abeokuta, Ogun State, Nigeria. *Journal Immunology and Immunochemistry*. 42 (1), 34-47. doi: 10.1080/15321819.2020.1814810

Oluwaseyi, A.B. (2017). Plant Genetic Resources (PGR) in Nigeria and the reality of Climate Change: A review. *Asian Journal of Environmental Ecology*, *2*, 1-24.

Omokhafe, K.O., Aghughu, O. & Imoren, E.A. (2017). Germplasm of Hevea brasiliensis in Nigeria. *GSC Biological and Pharmaceutical Sciences*. 1:20-25. doi: 10.30574/gscbps.2017. 1.2.0025

Osawaru, M.E., Ogwu, M.C. & Ahana, C.M. (2022). Current Status of Plant Diversity and Conservation in Nigeria. *Nigerian Journal of Life Sciences.* 3:168-178.

Osunsina, I.O.O., Shittu O.M., Yisau M.A., Adebowale T.K., Ogunjinmi A.A. & Osunsina O. (2022). Local Perception on the Impacts of Biodiversity Conservation on Livelihood activities in Old Oyo National Park, Nigeria. *Advanced Forestry Science,* 9, 1875–1884.

Oyinloye, O.D., Akinola, O.O., Akande, Y.O., Akinyele, A.A. & Mosimabale, M.M. (2018), Food insecurity in Africa, *Journal of Humanities and Social Science,* 23(9), 68-75.

Salgotra, R. K., & Chauhan, B. S. (2023). Genetic Diversity, Conservation, and Utilization of Plant Genetic Resources. *Genes*, 14(1), 174.

Shafi, A., Hassan, F., Zahoor, I., Majeed, U. & Khanday, F.A. (2021). Biodiversity, management and sustainable use of medicinal and aromatic plant resources. In Medicinal and aromatic Plants: Healthcare and Industrial Applications (pp. 85-111). Cham: Springer International Publishing.

Wakdok, S.S. & Bleischwitz, R. (2021). Climate Change, Security, and the Resource Nexus: Case Study of Northern Nigeria and Lake Chad. *Sustainability*, *13*(19), 10734. https://doi.org/10.3390/su131910734