



## **Building Resilience through Sustainable Livelihoods and Technology: Climate Change and Food Security in West Africa**

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### **Abstract**

Climate change has emerged as a critical driver of the ongoing food crisis, particularly in vulnerable regions such as West Africa. The study provided one of the few empirical investigations that examine how climate change and livelihood strategy interact to affect food security. Focusing on Nigeria and Senegal, the research compares households severely impacted by climate variability with those less affected, aiming to understand the role of Climate change and sustainable livelihood strategies in shaping food outcomes. The research was grounded on the Resilience theory, which explores household capacity to withstand environmental shocks, and the Sustainable Finance Theory, which highlights the importance of inclusive and stable economic systems. The study employed a mixed-methods approach. Quantitative data was sourced from the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) while qualitative insights were generated through an in-depth interview conducted in the largest soilless farm Lab in Africa. Findings revealed a significant impact of climate change and technology on food consumption. The results showed an interaction between climate change, livelihood, and food security in Nigeria and Senegal. The qualitative approach revealed a significant positive effect of techno-driven agriculture smart strategy on food consumption as well reduction of climate impact. The research recommended that climate-resilient, tech-driven agriculture should be embedded in national development frameworks, with a focus on scalability, local adaptation, and sustainability in climate-affected regions of West Africa, especially Nigeria and Senegal.

**Keywords:** Climate Change; Livelihood; Sustainability; Technology; Food Security

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## **INTRDUCTION**

Climate change has emerged as one of the most pressing global challenges of the 21st century, with disproportionately severe impacts on regions already facing structural vulnerabilities, such as West Africa (World Bank, 2023). Recent shifts in climate patterns, rising global temperatures, frequent extreme weather events, and sea-level rise have intensified the risk to human well-being, ecosystems, and economic development (Jha and Dev, 2024; Daniel, 2021). According to the Intergovernmental Panel on Climate Change (IPCC, 2022), global temperatures have risen by approximately 0.3 to 0.6 °C over the last century, and projections suggest a further increase of 0.5 to 1.0 °C per decade if greenhouse gas emissions remain unchecked. These changes are already manifesting in the form of prolonged droughts, erratic rainfall, flooding, and desertification, all of which impact rural livelihoods and food security.

The impacts of climate change are mostly in the context of food security. Agricultural production, which buttresses food availability and income generation for most West African households, is increasingly undermined by weather variability and climate-induced shocks (Tesfamichael et al, 2018). These shocks contribute to declining crop yields, disrupted food supply chains, and reduced household purchasing power (Ani, 2021). The 2022 Global Food Security Index (GFSI) reports that West African countries, including Nigeria and Senegal, score well below the global average in key food security indicators such as affordability, availability, and sustainability. Nigeria scored 42.0%, while Senegal scored slightly higher at 51.3%, reflecting a troubling regional trend of food insecurity and economic vulnerability (GFSI, 2022).

Climate-related stressors intersect with pre-existing socio-economic challenges, including land degradation, poor infrastructure, limited access to credit, and high population growth (El-Maradny, 2025; Stephen et al, 2023). In both Nigeria and Senegal, the agricultural sector employs approximately 70% of the population and contributes around 35% to GDP (World Bank/OECD, 2022). Yet, recurring drought, erratic rainfall, and deforestation have reduced crop and livestock productivity. In Nigeria, food inflation surged to 32.84% by November 2023 (Edeh, 2023), while in Senegal, 1.3 million people were acutely food insecure during the 2023 lean season (WFP, 2023). These developments call for urgent and coordinated interventions to enhance resilience, particularly among smallholder farmers and vulnerable rural populations.

One pathway to addressing these challenges lies in the integration of sustainable livelihood strategies and appropriate technological innovations. The experiences of countries like Ethiopia demonstrate how the adoption of yield-enhancing technologies such as improved seed varieties, irrigation systems, and soil conservation techniques can improve food availability, increase household income, and reduce poverty (Goshu et al., 2023; Moreno & Sunding, 2003). However, the successful adoption of such technologies is often shaped by farmers' adaptive capacities, socio-economic conditions, and institutional support systems (Feder et al., 1985; Kidane et al., 2006).

Technology-driven solutions in agriculture, including biotechnology, precision farming, and information and communication technologies (ICTs), offer promising avenues to build resilience against climate shocks. The green revolution of the twentieth century significantly improved global food production; today, emerging technologies have the potential to deliver further gains if they are contextually adapted and equitably disseminated (Kasturi, 2009; De Raymond, 2020). However, technoscientific interventions must be embedded within broader ethical, political, and socio-cultural frameworks to ensure they serve inclusive and sustainable development goals.

The paper explored the interlinkages between climate change and household livelihood and the adoption of sustainable agricultural technologies on food security in West Africa, with a particular focus on Nigeria and Senegal, using a mixed-method approach. The study aims to assess how household-level adaptation strategies and technological innovations can mitigate food

insecurity and build resilience in a region at the frontline of climate vulnerability. By identifying key barriers and enablers of technology adoption and evaluating the effectiveness of different livelihood strategies, the paper contributes to ongoing policy discussions on food systems transformation, climate resilience, and sustainable development in West Africa.

Reviewed literature highlights the complex interplay between climate change, household livelihood, and strategies for food security. Rusmayandi et al. (2023) demonstrated that rural communities adopt diverse adaptation strategies such as shifting agricultural practices and income diversification to cope with climate stress. However, these strategies often marginalize vulnerable groups, particularly women and children. Behera et al. (2024) and Benjamin et al. (2021) revealed how erratic rainfall, temperature increases, and CO<sub>2</sub> emissions threaten food security, advocating for climate-resilient and decarbonized agricultural practices. In Burkina Faso, Charles et al. (2023) found strong correlations between climate indices and crop yields, recommending climate-smart policies and drought-tolerant crop varieties.

Gender emerges as a critical dimension. Odoh et al. (2024) identified significant gender disparities in empowerment and resource access, which exacerbate food insecurity among women in Nigeria. Horton et al. (2021) argued that agriculture must undergo urgent reform to meet global climate and food security goals, proposing technologies for carbon sequestration and sustainable intensification. Finally, Asfaw et al. (2014) underscored that climate variability influences farmers' technology adoption, with proximity to extension services enhancing the use of modern inputs. They emphasized system-level adaptive capacity as key to enabling household-level resilience. Collectively, these studies suggest that climate adaptation must be multi-scalar, integrating technological, institutional, and gender-responsive strategies to ensure equitable food security and agricultural sustainability. Gender emerges as a critical dimension. Odoh et al. (2024) identified significant gender disparities in empowerment and resource access, which exacerbate food insecurity among women in Nigeria. Horton et al. (2021) argued that agriculture must undergo urgent reform to meet global climate and food security goals, proposing technologies for carbon sequestration and sustainable intensification. Finally, Asfaw et al. (2014) underscored that climate variability influences farmers' technology adoption, with proximity to extension services enhancing the use of modern inputs. They emphasized system-level adaptive capacity as key to enabling household-level resilience. Collectively, these studies suggest that climate adaptation must be multi-scalar, integrating technological, institutional, and gender-responsive strategies to ensure equitable food security and agricultural sustainability.

## **METHODOLOGY RESEARCH**

### **Description of Study Area**

West Africa, comprising 16 countries including Nigeria and Senegal, is ecologically diverse and home to over 419 million people as of 2021. It features a range of climatic zones, from humid tropical forests to the arid Sahel, and is increasingly affected by environmental degradation, rapid population growth, and climate change. These dynamics have severe implications for biodiversity, livelihoods, and food security, particularly in rural areas where agricultural productivity is threatened by erratic weather patterns and land degradation.

Senegal, situated in the Sahel, exemplifies the region's vulnerability. With nearly 70% of its 18 million population reliant on rain-fed agriculture, Senegal faces acute exposure to climate variability, including droughts and floods. The country experiences a single rainy season governed by the movement of the Inter-Tropical Convergence Zone (ITCZ), with rainfall ranging from 300 mm in the arid north to 1,200 mm in the humid south. Temperatures average 27.8°C annually. Given its Francophone identity and availability of Living Standards Measurement Study (LSMS)

data, Senegal serves as a representative case for Sahelian West Africa. Ongoing partnerships, such as that between the World Food Program and IRI, support targeted research on vulnerability and adaptation strategies.

Nigeria, the most populous West African country with over 225 million people, spans three climatic zones: Sahelian, savannah, and monsoon. Agriculture, which provides livelihoods for a significant portion of the population, is highly susceptible to climate-related shocks, including drought, flooding, and desertification. Regional disparities in rainfall and temperature, combined with escalating climate extremes, have made Nigeria one of the top ten countries most vulnerable to climate change. As a regional economic and demographic leader, Nigeria offers critical insights into the broader implications of climate change for food security and sustainable development across West Africa.

### **Method of Analysis**

This study employed the mixed method of analysis, which includes quantitative and qualitative techniques. A mixed-methods research is a research approach that involves the integration of both quantitative and qualitative research methods within a single study. It aims to leverage the strengths of both methods to provide a more comprehensive and nuanced understanding of the research topic. By combining the two approaches, the researchers can gain a deeper understanding of the challenges posed by climate change, the effectiveness of existing strategies, and the potential pathways to enhancing food security in the face of environmental changes.

### **Quantitative Approach**

The study used data from the Living Standards Measurement Study (LSMS). The dependent variable, food security, was measured using the Food Consumption Score (FCS), a World Food Program (WFP) index based on dietary diversity, frequency, and the nutritional value of food groups consumed over a 7-day recall period. FCS categorizes households as "Poor," "Borderline," or "Acceptable" based on consumption thresholds and caloric sufficiency. It is widely used for comparing food security status across regions and time. Logistic regression was employed to assess the probability of a household being food secure ( $Y=1$ ) or food insecure ( $Y=0$ ). This binary model was appropriate given the nature of the data. The logistic function estimates the odds of food security based on various predictors ( $X$ ), including climate variables, demographic factors, and access to agricultural inputs.

### **Model Specification:**

The estimation techniques used for this study were the Logistics Regression model. The technique was used to examine the association of (categorical or continuous) independent variable(s) with one *dichotomous dependent variable* (Rusmayandi, 2023). Binary Logistics regression and the Direct Nearest Neighbor Matching (PSM) method were used. The equation is as stated below: Following a binary outcome,  $P_i$  represents the probability of a household being food secure or not.  $1 - P_i$  represents the probability of a household being food insecure. The study observed the outcome  $Y=1$  if the household is food secure and  $Y=0$  if the household is food insecure. A logit model can be generated by taking the natural logs of the equation and making sure that the odds ratio's log,  $L$ , is linear in both  $X$  and the parameters;  $L$  is called the Logit, and hence the name Logit model.

$$\text{Ln} \left[ i \frac{P_i}{1 - P_i} \right] = L_i = (\beta_0 + \beta'xi)$$

This study used both descriptive statistics and econometric tools because of the dichotomous nature of the data, which makes Logistic regression the most appropriate. The Logistic regression

is also applicable because it will help explain the nexus between climate change, female wages, and food security.

**Qualitative Approach**

Focus Group Discussions (FGDs) and in-depth interviews were conducted with diverse stakeholders which including female and male farmers, women leaders, community heads, and farm managers. Four FGDs, each comprising 5 to 15 participants, were held. These sessions allowed for in-depth discussions on how climate change affects livelihoods, food security, and adaptive capacities.

Ethical approval was obtained from the Covenant Health Research Ethics Committee (CU/HRE/OLC/434/24), ensuring compliance with confidentiality and data protection standards. Anonymity was maintained throughout.

**RESULTS AND DISCUSSION**

**Quantitative Approach**

**1. Descriptive Statistic**

This summary provides an overview of key variables comprising food consumption (fcons1\_cat), climate change (CC), food purchase (food\_pur), total households (total\_HH), household wage (HH\_wage), and female agricultural wage earners (NFWA) and their implications in the Nigerian context. Also, food consumption (FCONSS), climate change (CCS), food purchase (FOOD\_PURS), total households (TOTAL-HHS), household wage (HH\_WAGESS3), and female agricultural wage earners (FWA) in the Senegal context.

**Table 1: Summary Analysis of Food Consumption and Related Factors in Nigeria**

Nigeria (A)					
Variable	Observation	Mean	Std. Dev.	Min	Max
FCONS1_CAT	555,060	0.980	0.138	0	1
CC	555,055	0.007	0.083	0	1
FOOD_PUR	555,060	0.99	0.044	0	1
TOTAL_HH	555,060	2.98	0.581	1	15
HH_WAGE	555,060	0.170	0.376	0	1
NFWA	555,055	0.999	0.028	0	1
Senegal (B)					
FCONSS	500,000	0.795	0.404	0	1
CCS	544,906	0.017	0.127	0	1
FOOD_PURS	190,861	1.77	3.58	0	400
TOTAL_HHS	544,906	28.46	28.44	1	627
HH_WAGESS3	544,906	2.99	0.105	1	7
FWA	859	1.28	0.596	1	4

Source: Researcher’s Estimate with STATA, 2024

**2. Summary of Descriptive Statistics for Nigeria and Senegal**

The descriptive statistics reveal distinct socio-economic and climate-related characteristics for Nigeria and Senegal, with implications for food security and household resilience. In Nigeria, food consumption is generally high, with a mean value of 0.98, indicating that nearly all households report adequate consumption. The standard deviation (0.138) suggests low variability, although some households still face food insecurity. In Senegal, food consumption is moderately high (mean = 0.795), but with greater variability (SD = 0.404), suggesting disparities in household food access.

**Table 2: Interaction Effect of Climate Change and Livelihood on Food Security Nigeria**

Logistic regression			LR chi <sup>2</sup> (5)	2455.71	
			Prob > chi <sup>2</sup>	0.0000	
Log likelihood		- 51942. 641	Pseudo R <sup>2</sup>	0.0231	
FCONS1_CAT	Coefficient	Std. Err.	z	P> z	[95% Conf. Interval]
FOOD_PUR	1.67	0.096	17.39	0.000	1.48 1.86
TOTAL_HH	0.797	0.016	48.52	0.000	0.77 0.829
HH_WAGE	-3.32	0.233	-14.23	0.000	-3.77 -2.86
INTCCHW	1.72	0.118	14.56	0.000	1.49 1.96
NFWA	0.452	0.179	2.53	0.012	0.101 0.803
_Cons	-0.507	0.179	-2.82	0.005	-0.859 -0.155

**Table 3. Interaction Effect of Climate Change and Livelihood on Food Security in Senegal**

Logistic regression			LR chi <sup>2</sup> (5)	26.17	
			Prob > chi <sup>2</sup>	0.0001	
Log likelihood		-528. 5229	Pseudo R <sup>2</sup>	0.0242	
FCONSS	Coefficient	Std. Err.	Z	P> z	[95% Conf. Interval]
FOOD_PURS	0.071	0.034	2.08	0.038	0.004 0.139
TOTAL_HHS	-0.007	0.003	-2.70	0.007	-0.012 -0.002
HH_WAGES3	0.145	0.079	1.81	0.070	-0.012 0.302
INTCCSHW	0.267	0.137	1.95	0.052	-0.002 0.537
FWA	-0.490	0.163	-3.01	0.003	-0.810 -0.170
_Cons	0.180	0.263	0.68	0.494	-0.336 0.697

Source: researcher's estimate with STATA, 2024

The logistic regression analysis conducted for Nigeria and Senegal offers valuable insights into the interactive role of climate change and household livelihoods on food security. In Nigeria, the model was statistically significant (LR chi<sup>2</sup>(5) = 2455.71,  $p < 0.001$ ), with food purchases (FOOD\_PUR) emerging as a major positive predictor ( $\beta = 1.67$ ,  $p < 0.001$ ), confirming that economic access to food is central to food security. Household size (TOTAL\_HH) also had a strong positive effect ( $\beta = 0.797$ ,  $p < 0.001$ ), possibly reflecting economies of scale or internal support systems. Surprisingly, household wages (HH\_WAGES) had a significant negative effect on food consumption ( $\beta = -3.32$ ,  $p < 0.001$ ), suggesting that increased income might be diverted toward non-food expenditures or may mask hidden vulnerabilities. The interaction between climate change and household wage (INTCCHW) had a positive effect ( $\beta = 0.724$ ,  $p < 0.001$ ), indicating that household resilience improves when economic capacity is matched with adaptive strategies. Importantly, female agricultural wages (NFWA) also significantly improved food consumption ( $\beta = 0.452$ ,  $p < 0.05$ ), highlighting the role of women's empowerment in ensuring household food security.

In Senegal, the model was also significant (LR chi<sup>2</sup>(5) = 26.17,  $p = 0.0001$ ), although it explained a smaller share of variance (Pseudo R<sup>2</sup> = 0.0242). Increased food purchases ( $\beta = 0.071$ ,  $p = 0.038$ ) again positively affected food consumption. However, larger household size negatively influenced food security ( $\beta = -0.007$ ,  $p = 0.007$ ), contrasting with Nigeria. Household wages showed a borderline positive influence ( $\beta = 0.145$ ,  $p = 0.070$ ), while the climate-wage interaction ( $\beta = 0.267$ ,  $p = 0.052$ ) showed potential for improving food outcomes. Strikingly, female agricultural wages were negatively associated with food consumption ( $\beta = -0.490$ ,  $p = 0.003$ ), likely reflecting gender-based disparities in decision-making and income control.

### 3. Policy Implications

The results underscore the importance of economic access to food as a determinant of household food security in both countries. In Nigeria, promoting female agricultural employment and ensuring that income gains translate into food access is crucial. Meanwhile, the paradoxical

role of household wages necessitates targeted financial literacy programs and expenditure tracking to ensure income boosts food security.

In Senegal, household size presents resource allocation challenges, and female earnings require structural gender-sensitive reforms. Across both contexts, climate-responsive economic policies, particularly those that integrate household income support with climate adaptation, are vital. These findings align with Philip's (2024) and Connolly-Boutin and Smit's (2016) framework, emphasizing multidimensional, integrated strategies to strengthen resilience and food systems under climate stress.

## **Qualitative Approach**

### **1. Climate Change, Technology, and Food Security Nexus – Evidence from Soiless Farm Lab, Abeokuta, Nigeria**

In light of the urgent challenges posed by climate change, which significantly impacts food security and agricultural productivity, exploring innovative agricultural approaches has become crucial. The largest soiless farm in Africa was visited on 30th July 2024 (see photos in Appendix 2c) as part of an effort to identify and understand sustainable coping mechanisms already in use. The soiless farm serves as a model for sustainable agriculture, utilizing hydroponic and aquaponic methods to grow crops instead of traditional soil planting (DePECOS Institute and Development Research Center (DIaDeRC), 2024).

The purpose of the visit was to discuss how soiless farming techniques could help combat climate change by engaging directly with farmers, agricultural specialists, and the local community. The visit aimed to provide insights into the role of soiless farms in improving resilience in the agriculture industry by analyzing their operational dynamics, challenges, and achievements. The socioeconomic impact of the farm on the local community, including its potential to generate employment, empower women and youth, and raise awareness about sustainable agricultural practices, was also assessed. The findings from the Interview session with Staff, trainees, and selected host community farmers are expected to inform broader technologically inclined strategies for climate adaptation and sustainable development in Africa.

*How big is the Farm, and what are the likely crops grown here?*

Situated on a 500-hectare plot (approximately 1,235 acres), Soiless Farm Lab cultivates a diverse range of crops. These include leafy vegetables such as amaranthus, bok choy, lettuce, and bitter leaf; fruiting vegetables like plum tomatoes and Carolina Reaper peppers; herbs and spices including rosemary, bay leaf, and coriander seed; and fruits such as bananas, blueberries, and avocados. Other cultivated crops comprise egusi, groundnuts, ginger, garlic, Irish potatoes, and flowers like roses, anthuriums (white and red), and chrysanthemums.

*What are your goals, and what is different about the farm, especially in the use of climate-smart and agricultural smart innovations?*

Soiless Farm Lab maximizes production while protecting the environment and reducing postharvest loss. They use a combination of electricity and solar panels for energy and minimize generator use. To maintain plant temperature, they use a locally constructed cool room made with charcoal. The farm is equipped with machines to aid in planting and harvesting, and much of their work occurs in the lab where crops are tested before being transplanted. The farm integrates cutting-edge practices such as tissue culture, machine learning, and AI-driven monitoring to optimize crop quality and yield. These innovations directly enhance food availability and contribute to climate-smart agriculture (CSA).

*What efforts has the farm made to disseminate this knowledge?*

Soilless Farm Lab not only develops and deploys tools but also emphasizes training as a core value. Through their platform EYAC (Enterprise for Youths in Agriculture), they transfer knowledge to a broader youth population. Youths are recruited via social media for internships lasting about three months, with the option to extend to six months, a year, or longer. So far, approximately 12,000 youths have been trained for free. At the end of their internships, these youths are not only trained but also become stakeholders and partners. Around 50 trainees set up a farm registered in their name. To date, 13,700 students have been trained, and about 400 farms have been established, co-owned by trainees. This initiative has significantly enhanced employability in the agriculture sector by fostering co-ownership of farms, collaborative growth, and increased food production through farm hubs.

*How does this strategy support females in Agriculture*

To reduce the marginalization of females in agriculture, Soilless Farm recruits 1,000 youths quarterly, with an age bracket of 18-29 for males and 18-35 for females. This approach promotes female inclusion in agriculture and provides incentives to improve their livelihoods.

*What is the current Production rate and future target of the Farm?*

With around 950 greenhouses, Soilless Farm Lab aims to dominate the Lagos market, which constitutes about 10% of the market population. Currently, there is a production of about 260,000 tons, which covers only 4-5% of the demand in Lagos, highlighting the need for more agricultural support in the country.

*Do you experience challenges that you relate to the impact of Climate Change?*

Soilless Farm crops are harvested year-round, unaffected by seasonal changes, including rainy and dry seasons. The farm is not in a flood-prone area, so flooding does not impact the crops. But the farm has some areas with erosion, which it mitigates by planting more trees around the farm. Consistent rainfall has minimal impact on the crops due to the protective greenhouses.

*How do you intend to reach other farmers with this technological innovation?*

Soilless Farm offers paid training on various aspects of Climate Smart Agriculture (CSA), soilless farming (hydroponics and aquaponics), machine learning, artificial intelligence in agriculture, trading, logistics, and tissue culture. They use integrated pest management for disease control and closely monitor the Brix score of their plants to ensure health. They also monitor all inputs provided to the plants. For efficiency and space maximization, Soilless Farm collaborates with existing data to create sustainable farm models and engage in trading commodities from their farm hubs and partner farmers.

*What is your relationship with the host community?*

Interaction with Host Community: Soilless Farm Lab positively impacts the host community by educating local farmers on productive planting techniques on plain land, identifying the best crops for existing soil, and high-demand crops. They link these farmers to markets and sometimes purchase from them. This initiative has significantly improved and will continue to enhance the livelihoods and food security of local traditional farmers affected by climate change. Introducing climate-smart agricultural knowledge to the host community will further boost productivity and food security. This was confirmed by Farmer Z, a rural farmer who plants a little portion for family consumption and had decided to increase the size of the farm by next year after being educated by representatives of the soilless farm during the farmers' community training organized by the soilless farm.

*Do you have other challenges (like insecurity, theft, lack of community or government support) that you think have or can limit the farm from achieving its goals?*

The farm came in through a grant given to the director of the farm. The grant is to last for some years, but with the strategy on the ground, we have created several other farms, and so we

may not be limited by support from the government, except in the area of getting more farm land outside the present location. On the issue of insecurity, we have not experienced any, like the farmer-herder crisis experienced in some places. This may be because the entire land is fenced. But we do experience theft by some trainees of who, once caught, would face the required punishment (dismissal). Our relationship with the host community is cordial.

*What advice do you have for policymakers to boost agricultural productivity and improve food security?*

Africa is such a large continent with agricultural prospects. Soilless farming should be replicated in all countries on the African continent, especially Western Africa, which depends so much on rain-fed agriculture and yet employs the majority of labor in the agriculture sector. Policy makers should include policies that promote agriculture-smart farming and climate-smart policies in their decisions on mitigation and resilience strategies in order to achieve a sustainable food security system. The rural farmers should be well involved as they make up a higher labor force in agriculture.

## **2. Policy Implications**

The qualitative study illustrates that integrating technology and climate adaptation strategies into agriculture can serve as a powerful lever for achieving food security in climate-vulnerable settings. Policymakers should prioritize support for soilless and climate-smart farming models through incentives, research grants, and infrastructure funding. Investment in youth and female-centered agricultural training programs would reduce unemployment and increase inclusivity. Promoting partnerships between high-tech farms and traditional farmers, facilitating knowledge transfer, and market linkages would result in sustainable food security. Incorporate climate-resilient farming systems into national food policies to ensure long-term sustainability and adaptation. Ultimately, Soilless Farm Lab exemplifies a replicable model of resilience-building that intersects climate change adaptation, technological innovation, and inclusive agricultural development.

## **CONCLUSION**

The study offers a novel contribution to the discourse on climate change, livelihoods, technology, and food security by integrating quantitative analysis of household dynamics in Nigeria and Senegal with qualitative field evidence from a technology-driven agricultural innovation, the largest Soilless Farm Lab in Africa, located in Nigeria. The logistic regression results confirm that climate change, livelihood and technology interactions significantly shape food consumption, a proxy for food security, although with notable contextual differences between countries.

The key novelty lies in the mixed-methods approach: while the statistical models highlight structural and socio-economic drivers, the qualitative findings demonstrate how technology, specifically soilless farming, provides a viable, climate-resilient solution to food insecurity. The innovative use of hydroponics and aquaponics, coupled with inclusive training programs and youth/women empowerment, illustrates a model that not only mitigates climate impacts but also transforms livelihoods and food systems.

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