

Impacts of Climate Finance on the Resilience and Food Security of Agricultural Producers in Northern Benin

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Abstract

Following COP21 in 2015, developed countries committed to mobilizing climate finance to support mitigation and adaptation efforts in developing countries. In Benin, the National Fund for the Environment and Climate (FNEC) channels these resources, particularly toward the agricultural sector, which is highly exposed to climate hazards. This study assesses the impacts of climate finance on the resilience and food security of agricultural producers in northern Benin who benefited from FNEC-funded projects. Data were collected from 300 producers in the municipalities of Kouandé, Tchaourou, and Copargo. Propensity score matching based on inverse probability weighted regression adjustment (IPWRA), combined with multiple linear regression, was used to estimate average treatment effects (ATEs) of FNEC financing on beneficiary households. The results indicate that FNEC financing significantly improves households' anticipatory and absorptive capacities, strengthening their ability to cope with ex post climate shocks, while the effects on adaptive capacity and overall resilience are not statistically significant at the 5% level. Regarding food security, FNEC support increased dietary diversity (HDDS; ATE = 0.401; $p = 0.011$) and improved food access (ATE = 0.352; $p = 0.023$), although its effect on recent food insecurity (HFIAS) was positive but not statistically significant at the 5% level (ATE = 0.467; $p = 0.083$). Overall, the findings reveal that climate finance strengthens short-term resilience mechanisms and food access, notably through the adoption of sustainable agricultural practices, the use of improved seeds, and improved access to climate information. The results also highlight the importance of complementing financial support with technical and institutional measures to sustainably enhance producers' adaptive capacities.

Keywords

Climate Finance, Agricultural Resilience, Food Security, Climate Change, Northern Benin

1. Introduction

Climate change is increasingly disrupting agricultural systems in developing countries, especially where production relies on rainfed farming. In Benin, rising temperatures, greater rainfall variability, and more frequent extreme weather events are reducing crop productivity, undermining rural incomes, and threatening household food security (Abdul-Jalil et al., 2023; FAO, 2017). Therefore, strengthening the resilience of agricultural producers is central to climate adaptation policy.

Climate finance is a key instrument for supporting adaptation in vulnerable countries. Through international and national mechanisms, it aims to reduce exposure and sensitivity to climate shocks and to improve livelihoods over time (Khan et al., 2020; Weikmans & Roberts, 2019). In Benin, the National Fund for the Environment and Climate (FNEC) mobilizes and allocates climate finance to adaptation and mitigation initiatives, with a particular focus on agriculture.

Since its establishment, FNEC has supported projects that promote climate-resilient practices, improved natural resource management, and capacity building among producers, particularly in vulnerable northern areas. Despite the strategic importance of these interventions, rigorous evidence on their effects at the farm-household level remains limited. Much of the existing literature focuses on tracking financial flows or on aggregate assessments, leaving a gap regarding impacts on beneficiary households (Baker & Velasco-Guachalla, 2018).

Against this background, this article estimates the impacts of FNEC-funded projects on the resilience and food security of agricultural producers in northern Benin by comparing beneficiary and non-beneficiary households using quasi-experimental methods. The findings are intended to inform the design of climate-finance interventions and complementary support measures that can deliver sustained improvements in resilience and food security.

2. Theoretical Framework

2.1. Theories of Climate Resilience

Resilience is a multidimensional concept that has evolved across disciplines. The term was initially used in materials science to describe the capacity of metals to absorb energy during an impact without fracturing. Georges Charpy developed an impact test (the Charpy test) to quantify this property, defining resilience as the energy dissipated per unit area during impact (Arnaud, 2003; Yaro, 2019). In this early formulation, resilience refers to the ability of a material to return to (or maintain) its structure after a shock.

The concept was later adopted in ecology, psychology, economics, and sustain-

able development. Across these applications, resilience generally encompasses 1) the capacity to absorb disturbances and 2) the capacity to maintain or recover essential functions. In ecology, [Holling \(1973\)](#) defined resilience as the persistence of ecological systems and their ability to absorb change while maintaining key relationships among components. In development practice, [FAO \(2017\)](#) extends the concept to individuals, households, communities, and countries, emphasizing the ability to absorb shocks, adapt to changing conditions, and, over the longer term, transform institutions and systems.

In sustainable development, resilience is often framed within socio-ecological systems. A socio-ecological system is considered resilient when it can absorb disturbances of natural origin (e.g., drought) or human origin (e.g., land-use change or policy reforms) and reorganize while maintaining core functions and identity ([Mathevet & Bousquet, 2014](#), cited by [Yaro, 2019](#)).

Climate resilience can be defined as the capacity of socio-ecological systems to absorb climate-related disturbances, adapt to change, and transform when necessary, while maintaining essential functions ([Walker et al., 2004](#)). [Tyler and Moench \(2012\)](#) propose a systems perspective in which resilience emerges from interactions among systems (infrastructure, ecosystems, institutions), agents (individuals, households, organizations), and the rules governing them (formal and informal institutions). This perspective recognizes humans as integral components of ecosystem dynamics rather than as external stressors ([Folke et al., 2010](#)).

In applied research, resilience to climate change is frequently operationalized through three complementary capacities: anticipatory capacity, absorptive capacity, and adaptive capacity ([Bahadur et al., 2015](#)). Anticipatory capacity refers to the ability to foresee risks and implement preventive measures through information and planning ([Bahadur et al., 2015](#); [Béné et al., 2012](#)). Absorptive capacity reflects the ability to cope with shocks while maintaining core functions. Adaptive capacity relates to the ability to make sustained adjustments in response to observed or expected change ([Smit & Wandel, 2006](#)). These capacities are interdependent and jointly shape household resilience ([Constas et al., 2014](#)).

Within this framework, climate finance may strengthen resilience by relaxing key constraints faced by farm households. For example, it can raise and stabilize income through productivity-enhancing investments and livelihood diversification; expand access to climate information and early warning systems; facilitate risk-transfer mechanisms such as index-based insurance; improve climate-resilient infrastructure (e.g., irrigation, storage, and rural roads); and support targeted social interventions. These channels are particularly relevant in northern Benin, where exposure to climate variability and limited access to services constrain farm-household decision-making.

2.2. Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework (SLF) was introduced by [Chambers and Conway \(1992\)](#), further developed by [Scoones \(1998\)](#), and institutionalized by

DFID (1999). The framework posits that rural households draw on five interdependent forms of capital: human (skills, health, labor capacity), social (networks and trust-based relations), natural (land, water, biodiversity), physical (infrastructure and equipment), and financial (savings, credit, transfers). A livelihood is considered sustainable when it can cope with shocks and stresses, maintain or enhance its asset base, and avoid undermining natural resources over the long term (DFID, 1999; Scoones, 2009). Because these capitals interact, household resilience depends on how assets are combined to manage climatic shocks, structural trends, and seasonal variability (Ellis, 2000; Scoones & Thompson, 2009).

Operationalizing livelihood resilience raises methodological challenges, including selecting the appropriate scale of analysis and defining measurable indicators (d'Errico et al., 2018). At the household level, food security indicators—such as dietary diversity, food consumption measures, or experiential food insecurity scales—capture key dimensions of availability, access, and utilization (d'Errico et al., 2018). Importantly, changes in food consumption between two points in time provide a dynamic signal of resilience. The Resilience Measurement Technical Working Group highlights three typical post-shock trajectories: deterioration (limited absorptive capacity), recovery to baseline (adequate absorptive capacity), and improvement beyond baseline (transformative capacity) (Béné et al., 2016; Constan et al., 2014).

Applied to northern Benin, climate finance can strengthen sustainable livelihoods by improving multiple forms of capital simultaneously. It may expand financial capital through grants or subsidized inputs; strengthen human capital through training in climate-resilient practices; build social capital by supporting farmer organizations; enhance physical capital via adapted infrastructure; and help protect natural capital through sustainable land and water management (Lipper et al., 2014; Tall et al., 2018). In this study, the SLF motivates the analysis of how climate-finance interventions translate into resilience and food-security outcomes at the household level.

3. Materials and Methods

3.1. Study Area

The study was conducted in three communes in northern Benin: Kouandé, Copargo, and Tchaourou.

Kouandé is located in the Atacora Department (9°57'N-10°55'N; 1°22'E-2°01'E) and is characterized by the Atacora mountain range, hills, and valleys with small cultivated plains (DGCS-ODD, 2018). Copargo is located in the Donga Department, while Tchaourou is located in the Borgou Department (8°40'N-9°45'N; 1°55'E-3°11'E) (DGCS-ODD, 2018). Tchaourou is the largest commune in Benin, and its landscape includes plateaus, hills, and lowlands that support agricultural and pastoral activities (Kora & Guidibi, 2006). The three communes were selected due to their strong dependence on agriculture, high exposure to climate hazards, and the presence of FNEC-funded projects. They lie within the Sudano-Guinean

zone, with a tropical Sudanian climate characterized by a rainy season (May-October) and a dry season (November-April).

The communes possess substantial natural resources, including forests, wooded savannahs, and seasonal watercourses, but these are increasingly threatened by anthropogenic pressures and climate change. Key waterways include the Upper Ouémé in Tchaourou; tributaries of the Pendjari and Mékrou in Kouandé; and several rivers in Copargo, such as sections of the Ouémé River. These resources are crucial for rainfed crop production, livestock rearing, artisanal fishing, and fuelwood extraction.

Selecting these three communes allowed for comparison across diverse agroecological and socioeconomic contexts, while examining similarities and differences in the uptake and impacts of climate finance.

3.2. Sampling and Data Collection

The study surveyed 300 agricultural producers across Kouandé, Tchaourou, and Copargo. This included 150 beneficiaries of FNEC-funded projects and 150 non-beneficiaries. Beneficiaries were identified from the administrative lists of FNEC-supported projects. Within each municipality, respondents were then selected by simple random sampling from the corresponding lists. In addition, beneficiary producers received different forms of support under FNEC-funded projects, including technical training, agricultural input support, improved seeds, agricultural equipment, and guidance on climate change adaptation practices. These forms of support were generally provided over a period of two to three years. The same procedure was applied to identify and randomly select comparable non-beneficiary producers. Producer lists were obtained from local farmer organizations, municipal agricultural development officers, and local project coordinators. Producers classified as non-beneficiaries had not received any direct support from the FNEC at the time of the survey. Selection takes in account comparability criteria such as agricultural production as main activity, geographic location, crops produced, and production conditions. Simple random sampling without replacement was then used to select the surveyed non-beneficiary producers. **Table 1** summarizes the distribution of sampled producers by municipality and village.

3.3. Data Collection and Analytical Approach

3.3.1. Data Collection

Data were collected through a field survey combining quantitative and qualitative approaches. The household questionnaire captured socioeconomic characteristics, agricultural practices, climate-change adaptation strategies, and indicators of resilience and food security. The qualitative component consisted of semi-structured interviews and focus group discussions with producers, community leaders, and project staff to document perceptions, constraints, and implementation experiences. This mixed-method design provided both comparable quantitative evidence and contextual insights to interpret observed impacts.

Table 1. Distribution of surveyed producers by municipality and village.

Commune	Village/neighborhood	Sample size
Tchaourou	Ayélawá	20
	Kasouala	18
	Kera	21
	Tchatchou	34
	Tchaorou	36
	Subtotal	129
Kouandé	Mary	43
	Subtotal	43
Copargo	Kataban	43
	Kpabegou	42
	Tchoutchou	43
	Subtotal	128
Grand Total		300

Source: Field survey, November 2025.

3.3.2. Analytical Methods

The primary variable measured were 1) resilience and its three components (anticipatory, absorptive, and adaptive capacity), and 2) household food security.

The resilience capacity was constructed as a composite index measured by the average of its three components to form an overall resilience score.

The main explanatory variable was participation in an FNEC-funded project (beneficiary = 1; non-beneficiary = 0). Additional covariates included age, gender, household size, farming experience, farm income, cultivated area, education, membership in a farmer organization, and access to climate information were involved in analysis.

Exposure to climate finance was defined as participation in an FNEC-funded project. Accordingly, the treatment variable was coded as binary (1 = beneficiary; 0 = non-beneficiary).

Household resilience was measured along three dimensions: anticipatory capacity, adaptive capacity, and absorptive capacity. For each dimension, an index was constructed using specific parameters. After that, an overall resilience score was computed as the mean of the three indices.

Anticipatory capacity was constructed from two indicators relating to access to climate information and anticipation of climate risks. The resulting score ranges from 0 to 3, with higher values indicating a stronger capacity of households to foresee and anticipate climate shocks.

Adaptive capacity was based on three indicators related to the adoption of adapted agricultural practices, including the use of improved seeds, agricultural

diversification, and the ability to adjust farming activities in response to climate change. The score ranges from 0 to 3. The higher the score is, the greater the household's adaptive capacity.

Absorptive capacity was measured by four variables related to shock management (including farmer property; savings), the duration for which households can withstand difficult periods, the support mechanisms mobilized (credit; social support), and producers' ability to maintain their activities despite climate shocks. Some variables were reverse-coded to ensure consistency in score interpretation. The final score ranges from 0 to 9, with higher values indicating a stronger capacity of households to absorb climate shocks.

The overall resilience index corresponds to the sum of the scores of the three preceding dimensions. It ranges from 0 to 15. Higher values indicate a greater level of agricultural households' resilience to climate change.

The impact of FNEC funding on household resilience was estimated using propensity-score matching methods with inverse-probability weighted regression adjustment (IPWRA) through the following model:

$$ATE = E(Y_1 - Y_0) \quad (1)$$

where Y_1 and Y_0 represented, respectively, the resilience levels of beneficiary households and non-beneficiary households of FNEC-financed projects, holding other factors constant. Robust standard errors were used to ensure reliable inference.

To further examine relationship between climate finance, household resilience and others socioeconomic variables, an additional multiple linear regression model was estimated, incorporating socioeconomic, agricultural, and institutional characteristics alongside access to climate finance. The estimated model is specified as follows:

$$\text{Resilience} = \beta_0 + \beta_1 FNEC + \beta_2 X_i + \varepsilon_i \quad (2)$$

where $FNEC_i$ indicates access to climate finance and X_i is a vector of control variables. β (to-be-estimated) coefficients of the explanatory variables included in the model. ε the error term, assumed to follow a normal distribution.

$$\begin{aligned} RESI_i = & \beta_0 + \beta_1 AFNEC_i + \beta_2 AGE_i + \beta_3 SEX_i + \beta_4 TAILM_i \\ & + \beta_5 APARTORG_i + \beta_6 EXP_i + \beta_7 REVAGRI_i + \beta_8 NIVINSTRUCT_i \\ & + \beta_9 SUP_i + \beta_{10} INFOCLIM_i + \varepsilon_i \end{aligned} \quad (3)$$

Household food security was assessed using two complementary indicators, consistent with FAO analytical frameworks and comparable empirical studies (Ahmed, 2008; Swindale & Bilinsky, 2006): 1) Household Dietary Diversity Score (HDDS), based on food groups consumed the day before the survey; 2) Household Food Insecurity Access Scale (HFIAS), capturing recent experiences of food insecurity especially by perceived/experienced difficulty in accessing food. Higher values of HDDS indicate greater dietary diversity; higher HFIAS values indicate higher level of food insecurity.

The impact of FNEC funding on these dimensions of food security is estimated using the inverse-probability weighted regression adjustment (IPWRA) method.

$$ATE = E(L_1 - L_0). \quad (4)$$

where L_1 represents the level of food security among FNEC beneficiary households and L_0 that of non-beneficiaries (Table 2).

Table 2. Summary of variables included in the model.

Variables	Codes	Coding	Units	Expected sign
Dependent variable	RESI	-	-	-
Quantitative				
Producer age	AGE		years	+
Household size	TAILM	-	number of persons	+/-
Producer experience	EXP		years	+
Agricultural income	REVAGRI	-	F CFA	+
Total cultivated area	SUP	-	Ha	+
Qualitative				
Sex	SEXE	1 = male 0 = female		
Membership in a farmer organization	APORG	1 = yes 0 = no		+
Access to climate information	INFOCLIM	1 = yes 0 = no		
Access to FNEC financing	AFNEC	1 = yes 0 = no		
Education level	NIVINSTRUCT	1 = yes 0 = no		+

4. Results

4.1. Effects of FNEC Financing on Household Resilience

The IPWRA estimates indicate that FNEC financing is associated with statistically significant improvements in anticipatory and absorptive dimensions of resilience, suggesting that climate finance can strengthen households' capacity to manage climate-related shocks.

FNEC financing has a positive and statistically significant effect on anticipatory capacity at the 5% level ($ATE = 0.091$; $p = 0.043$). This suggests that projects support potentially through improved access to climate information, early warning messages, and strengthened social networks, enhances producers' ability to plan and adjust agricultural decisions in advance of climate risks.

FNEC financing also has a positive and statistically significant effect on absorp-

tive capacity at the 5% level ($ATE = 0.161$; $p = 0.041$), indicating that beneficiary households are better able to cope with ex post shocks through improved loss management, income smoothing, and use of support mechanisms.

By contrast, the estimated effects on adaptive capacity and overall resilience are positive but not statistically significant at the 5% level (adaptive capacity: $p = 0.067$; overall resilience: $p = 0.096$). These results suggest that, in the short run, climate finance alone may be insufficient to generate detectable improvements in more structural dimensions of resilience, which often require learning, sustained technical support, and institutional change.

Overall, the results indicate that climate finance primarily strengthens immediate capacities to anticipate and absorb shocks, while effects on longer-term adaptive processes are less pronounced. **Table 3** reports the mean scores for resilience dimensions and the estimated ATEs of FNEC financing.

Table 3. Effects of FNEC financing on farm-household resilience dimensions.

Resilience dimension (N = 300)	Mean	ATE (FNEC)	Robust SE	z	p-value
Anticipatory capacity	2.36	0.091**	0.045	2.02	0.043
Adaptive capacity	2.37	0.055	0.030	1.83	0.067
Absorptive capacity	4.41	0.161**	0.079	2.04	0.041
Overall resilience	9.14	0.415*	0.252	1.65	0.096

** = significant at 5%; * = significant at 10%. Source: Field survey, November 2025.

Household resilience is shaped by multiple factors beyond project participation, so we estimated a multiple linear regression including additional covariates. The model is jointly significant at the 1% level ($p < 0.01$) and explains 57.4% of the variation in resilience ($R^2 = 0.574$), which is reasonable given the multidimensional nature of the resilience.

The results reveal that access to FNEC funding has a positive and statistically significant effect at the 5% level on the agricultural household's resilience, confirming that climate finance contributes to strengthening producers' resilience through improvements in their anticipatory, adaptive, and absorptive capacities.

Membership in a farmer organization is positively associated with resilience at the 5% level. This suggests that collective action and social networks facilitate access to information, resources, and mutual support mechanisms that help households manage climate risks.

Formal education is also positively and significantly associated with resilience, consistent with the idea that education improves the ability to understand technical advice, adopt innovations, and integrate climate information into decision-making.

Access to climate information is positively and significantly associated with resilience at the 5% level, highlighting the contribution of climate services to anticipatory decision-making and timely adjustments in farm management.

Other covariates such as age, gender, household size, farming experience, and

farm income are not statistically significant in the model. This indicates that, in this setting, these characteristics do not explain observed differences in resilience once social and informational factors are accounted for.

Total cultivated area shows a positive association with resilience at the 10% level ($p = 0.052$), suggesting a potential role for scale and diversification. However, the evidence is not statistically significant at the conventional 5% threshold.

Taken together, these results suggest that resilience is more strongly related to human capital, social integration, and access to climate information than to demographic characteristics alone. **Table 4** reports the regression results.

Table 4. Determinants of farm-household resilience (multiple linear regression).

Variables	Coef.	Robust Standard Error	t	p-value
Access to FNEC Funding	0.073**	0.031	2.35	0.021
Producer Age	-0.0008	0.0027	-0.30	0.765
Gender	-0.0584	0.0712	-0.82	0.414
Household Size	0.0051	0.0049	1.04	0.302
Membership in a Farmer Organization	0.0649**	0.0257	2.53	0.014
Farming Experience	-0.0013	0.0013	-1.00	0.321
Agricultural Income	-0.0615	0.0568	-1.08	0.283
Education Level	0.028**	0.011	2.45	0.015
Cultivated Area	0.019	0.010	1.95	0.052
Access to Climate Information	0.067**	0.026	2.58	0.011
Constant	0.982	0.085	11.55	0.000
N =	300			
R ² =	0.574			
Prob > F	0.01			

** = significant at 5%; * = significant at 10%. Source: Field survey data November 2025.

Overall, the multivariable regression results indicate that participation in an FNEC-funded project is not sufficient on its own to explain variations in overall household resilience once other covariates are included. Resilience is also associated with membership in farmer organizations, education, and access to climate information.

4.2. Effects of FNEC Financing on Household Food Security

Regarding food security, FNEC financing has a positive and statistically significant effect on food access at the 5% level (ATE = 0.352; $p = 0.023$). This suggests that beneficiary households are better able to access food, potentially due to higher or more stable farm income and resources.

FNEC financing also increases household dietary diversity (HDDS) at the 5%

level (ATE = 0.401; $p = 0.011$). The higher HDDS among beneficiaries is consistent with improved production performance and/or income effects linked to the adoption of climate-resilient practices, the use of improved seed, and better compliance with recommended technical packages.

The effect of FNEC financing on recent food insecurity (HFIAS) is positive but not statistically significant at the 5% level (ATE = 0.467 $p = 0.083$). This indicates that, while some dimensions of food security improve, residual vulnerability to recent food insecurity may persist.

Overall, climate finance improves food access and dietary diversity among farm households in northern Benin, suggesting short-term gains in food security. However, the absence of a statistically significant reduction in recent food insecurity underscores the need for complementary measures to address underlying vulnerability.

Table 5 presents descriptive statistics for the food-security indicators and the estimated ATEs of FNEC financing.

Table 5. Food-security indicators and estimated effects of FNEC financing.

Indicator (N = 300)	Mean	SD	ATE (FNEC)	Robust SE	z	p-value
Food access (score)	3.98	1.54	0.352**	0.155	2.27	0.023
Dietary Diversity (HDDS)	5.08	1.63	0.401**	0.251	2.54	0.011
Recent Food Insecurity (HFIAS)	3.65	2.01	0.467	0.270	1.73	0.083

** = significant at 5%; * = significant at 10%. Source: Field survey, November 2025.

Qualitative interviews corroborate the quantitative results. Approximately 66% of beneficiary households reported that their food security improved following FNEC support, indicating perceived short-term gains in household food conditions.

Perceived gains are larger for resilience: more than 81% of beneficiary households reported improved resilience after project implementation. This pattern suggests that improvements in shock management may precede measurable improvements in food outcomes. **Table 6** summarizes perceived changes in food security and resilience among beneficiary households.

Table 6. Perceived changes in food security and resilience among beneficiary households

Indicator	Status after FNEC support	Frequency	Percent (%)
Food security	Improved	99	66.0
	Improved Unchanged	51	34.0
	Total	150	100.0
Household resilience	Improved	122	81.3
	Unchanged	28	18.7
	Total	150	100.0

Source: Field survey data November 2025.

5. Discussion

The findings show that FNEC climate finance yields differentiated effects across resilience dimensions. Significant gains are observed for anticipatory and absorptive capacities, indicating that climate finance can strengthen households' ability to prepare for and respond to climate shocks in the short term. These findings are consistent with [Béné et al. \(2016\)](#), who show that climate finance interventions primarily strengthen immediate risk-management capacities. They are also aligned with [FAO \(2022\)](#), which argues that climate finance instruments contribute to improving short-term climate risk management by strengthening producers' anticipation and response capacities.

The lack of statistically significant effects on adaptive capacity and overall resilience suggests that financial transfers alone may be insufficient to shift longer-term, structural determinants of resilience. Adaptive processes are typically mediated by sustained learning, access to timely climate information, technical extension, and supportive institutions ([Barrett & Constas, 2014](#)). Similar conclusions are reported by [Osuji et al. \(2025\)](#), who emphasize the importance of integrating climate finance with broader policy and institutional support to generate durable improvements in resilience.

The regression analysis further indicates that membership in farmer organizations, formal education, and access to climate information are important correlates of resilience. These findings highlight the role of social capital, human capital, and information services as complementary inputs that can amplify the effectiveness of climate finance on farmer resilience. This conclusion is consistent with [FAO \(2022\)](#), which emphasizes that agricultural resilience rests on a combination of financial resources, knowledge, and institutional arrangements.

With respect to food security, FNEC support improves food access and dietary diversity, indicating progress in both economic access and diet quality. This result aligns with prior evidence that financial interventions can improve diets through income and production pathways. These findings are consistent with [Béné et al. \(2019\)](#) and [Maxwell et al. \(2014\)](#), who argue that financial interventions primarily improve economic access to food and diet diversity. They are also in line with [UNICEF \(2023\)](#), which shows that financial interventions tend to improve access and dietary diversity before producing more structural effects. Similarly, [Citaristi \(2022\)](#) highlights that access to financial resources enables rural households to diversify diets and better secure their livelihoods. However, the absence of a statistically significant reduction in recent food insecurity suggests that climate finance alone may not be sufficient to address persistent food vulnerability, which often requires multisectoral approaches combining financing with technical assistance and social protection. This observation aligns with [UNICEF \(2018\)](#) findings, which emphasizes that reducing food insecurity requires multisectoral approaches integrating financing, technical support, and social protection mechanisms.

Overall, the results suggest that climate finance delivers measurable short-term benefits for resilience and selected food-security outcomes, while underscoring

the need for complementary technical and institutional mechanisms to generate sustained improvements.

6. Conclusion

This study assessed the effects of climate finance operationalized as participation in FNEC-funded projects on the resilience and food security of agricultural producers in northern Benin. Using survey data from 300 producers and quasi-experimental impact-evaluation methods, the results indicate that climate finance strengthens short-term resilience, particularly through higher anticipatory and absorptive capacities through better access to climate information, improved agricultural incomes, and the mobilization of support mechanisms. Effects on adaptive capacity and overall resilience are positive but not statistically significant at the 5% level, suggesting that longer-term resilience building requires more than financial support. FNEC support also improves food access and dietary diversity, although reductions in recent food insecurity are not statistically robust.

Policy implications following from these findings are: to achieve sustained gains in resilience and food security, climate-finance interventions should be implemented alongside 1) technical advisory services and capacity building, 2) investments in appropriate equipment and climate-resilient infrastructure, 3) strengthened farmer organizations and local institutions, and 4) reliable climate information services. In this sense, climate finance is a necessary lever for improving livelihoods, but it is unlikely to be sufficient on its own to ensure durable resilience and food security in Benin's agricultural sector.

Study Limits

This study has several limits that should be noted. First, the data used is cross-sectional, which limits the analysis of changes in resilience and food security over time. Second, despite the use of the IPWRA method to reduce selection bias, the existence of unobserved factors likely to simultaneously influence access to FNEC funding and household outcomes cannot be entirely ruled out. Finally, the results are based on data collected in only three municipalities of northern Benin. They can't then be generalized to the entire country.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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