Participatory Environmental Empowerment for Climate Resilience of Women in Buzi Community, Karu Local Government Area, Nasarawa State, Nigeria

Salamatu Abraham Ekpo., Aminu Ibrahim Abdullahi., and A. S. Ogah

Environmental Management Department, Nasarawa State University, Keffi

DOI: https://doi.org/10.51244/IJRSI.2026.1309000185

Received: 28 September 2026; Accepted: 03 October 2026; Published: 16 October 2026

ABSTRACT

Women play a critical role in environmental management and climate adaptation in rural communities, yet they remain disproportionately vulnerable to environmental degradation, climate-related risks, and limited economic opportunities. This study evaluates the impact of a community-based climate resilience and environmental empowerment intervention implemented among 45 women in Buzi Community, Karu Local Government Area, Nasarawa State, Nigeria. Using a Participatory Action Research (PAR) approach, the six-month intervention combined climate change education, waste management awareness, indigenous tree planting, organic soap production training, entrepreneurship development, and a ₦500,000 Community Revolving Fund (CRF) to support sustainable livelihood activities. Baseline findings showed that 60.0% of participants had only primary or no formal education, highlighting significant socio-economic vulnerability. Following the intervention, participants demonstrated improved environmental awareness, enhanced waste management practices, and increased understanding of climate change adaptation and ecosystem restoration. The indigenous tree-planting campaign strengthened community participation in environmental conservation, while the establishment of eight organic soap-production clusters promoted green entrepreneurship and livelihood diversification. Access to the revolving fund significantly improved economic opportunities, resulting in a 234.8% increase in average monthly discretionary income, from ₦5,600 to ₦18,750 ($p < 0.001$). The revolving fund recorded a 100% loan repayment rate through a peer-guarantee accountability mechanism, demonstrating strong community ownership and sustainability. The findings indicate that integrating environmental education, climate action, green enterprise development, and community-based financing mechanisms can simultaneously enhance climate resilience, environmental stewardship, and women's economic empowerment. The study concludes that linking environmental knowledge with practical livelihood incentives creates a self-reinforcing pathway for sustainable development and offers a promising model for gender-responsive climate adaptation in vulnerable rural communities. However, because the evidence comes from a single community, a sample of 45 women and a six-month monitoring period, the findings should be regarded as preliminary, and the model requires testing across more communities and over a longer period before it can be considered scalable across Nigeria and sub-Saharan Africa.

Keywords: Climate resilience; environmental empowerment; women's participation; climate change adaptation; indigenous tree planting

INTRODUCTION

Environmental degradation resulting from the negative impact of Climate change threatens global sustainable development, with Sub-Saharan Africa bearing high impact burden despite contributing minimally to global emissions (IPCC, 2023). Nigeria exemplifies this vulnerability, experiencing escalating environmental crises including deforestation (losing 3.5% of forest cover annually), severe soil erosion affecting 70% of agricultural lands, recurrent flooding displacing hundreds thousands of persons annually, and inadequate waste management systems serving less than 30% of rural populations (FAO, 2024; Nigerian Meteorological Agency [NiMet], 2024; World Bank, 2023). Between 2020 and 2024, climate-related disasters affected over 3.2 million Nigerians,

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

with rural communities experiencing 2.3 times higher vulnerability indices compared to urban counterparts due to limited adaptive capacity, financial resources, and institutional support (NiMet, 2024; UNDP, 2024).

The North-Central geopolitical zone of Nigeria faces compounded environmental challenges due to rapid peri-urban expansion driven by proximity to the Federal Capital Territory (FCT), Abuja. Karu Local Government Area (LGA) in Nasarawa State exemplifies this dynamic, experiencing exponential unplanned population growth that overwhelms municipal capacities for solid waste management, water provision, and environmental regulation (Adeyemi et al., 2024). This demographic pressure has intensified deforestation (43% forest cover loss in Karu LGA over the past decade), unmanaged waste accumulation affecting 67% of households, and degradation of indigenous vegetation critical for microclimate regulation and soil stabilization (Nasarawa State Ministry of Environment, 2024; Okafor & Eze, 2023).

Women constitute approximately 52% of Nigeria's rural population and serve as primary managers of household environmental systems, including fuel wood sourcing, water procurement, waste disposal, and natural resource harvesting (World Bank, 2023). Despite their frontline interaction with local ecosystems and critical roles in environmental stewardship, women face systematic barriers limiting their participation in environmental governance and climate adaptation planning. These barriers include restricted access to environmental education (only 23% of women receive formal environmental training versus 58% of men), financial exclusion (women access only 12% of agricultural credit and 7% of extension services), limited decision-making power in community environmental matters, and socio-cultural constraints reinforcing gendered division of labor (FAO, 2024; UN Women, 2023).

In Buzi Community, Karu LGA, these gendered environmental vulnerabilities manifest acutely. Preliminary community assessments revealed that women manage 78% of household waste, source 85% of cooking fuel, and collect 92% of household water, yet generate average monthly incomes below ₦5,000 from environmental-dependent activities (Buzi Community Development Association, 2024). The loss of indigenous vegetation cover to charcoal production and real estate development has altered local microclimates, reduced water table levels by 2.3 meters over five years, and removed natural soil-stabilization mechanisms, directly impacting women's livelihood security and household environmental management capacity (Nasarawa State Ministry of Environment, 2024).

Traditional environmental management interventions in Nigeria have predominantly adopted top-down approaches characterized by external expert-driven planning, limited community participation, and inadequate attention to local knowledge systems and socio-economic realities. Evaluation studies indicate that such approaches achieve sustainability rates below 30% after two years, primarily due to limited community ownership, misalignment with local priorities, and failure to address underlying economic vulnerabilities driving environmental degradation (Okafor & Eze, 2023; Akinbami et al., 2024). Conversely, emerging scholarship emphasizes participatory, community-based approaches integrating environmental education, economic empowerment, practical skills training, and gender-sensitive programming, achieving sustainability rates of 76-82% and demonstrating superior outcomes for both environmental restoration and livelihood improvement (Akinbami et al., 2024; UNDP, 2024).

The United Nations Sustainable Development Goals (SDGs) provide normative frameworks supporting integrated environmental sustainability interventions, particularly Goal 5 (Gender Equality), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action), and Goal 15 (Life on Land). These goals recognize the interconnectedness of environmental, economic, and social dimensions of sustainability, emphasizing that addressing single dimensions rarely achieves lasting outcomes (UNDP, 2024; IPCC, 2023). Contemporary climate adaptation frameworks increasingly emphasize Community-Based Climate Adaptation (CBCA) approaches that build local capacity, leverage indigenous knowledge, and integrate adaptation with livelihood development (World Bank, 2023; FAO, 2024).

Despite growing recognition of participatory approaches, significant gaps remain in empirical literature documenting integrated environmental empowerment interventions targeting women in rural Nigerian communities. Most existing studies focus on single intervention components (environmental education alone, tree planting alone, or economic empowerment alone) rather than examining synergistic effects of multi-

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

dimensional approaches. Additionally, limited research specifically examines how participatory environmental education combined with economic empowerment can enhance women's climate resilience while achieving environmental restoration outcomes (Akinbami et al., 2024; UN Women, 2023).

This study addresses these gaps by documenting and evaluating a participatory environmental empowerment intervention implemented in Buzi Community, Karu LGA, Nasarawa State. The intervention integrated four interconnected components: (1) environmental enlightenment on waste management and climate change, (2) indigenous tree planting campaign, (3) community revolving fund establishment for sustainable businesses, and (4) organic soap production training. The program's distinctive feature lies in its multi-dimensional approach addressing environmental, economic, and social sustainability simultaneously while specifically targeting women as primary agents of environmental change and climate resilience.emphasizing community ownership, co-creation of knowledge, practical skill development, and sustained engagement beyond initial implementation.

The structural framework, execution dynamics, and empirical outcomes of this integrated participatory environmental empowerment intervention. Specifically, the study addresses five research objectives: (1) assess changes in women's understanding of waste management and climate change before and after environmental enlightenment; (2) evaluate participation rates, outputs, and outcomes of indigenous tree planting campaigns; (3) examine revolving fund management practices, utilization patterns, and economic sustainability among participating women; (4) measure organic soap production skill acquisition, quality outcomes, and economic potential; and (5) identify factors influencing program effectiveness, sustainability, and scalability for broader replication. This research contributes empirical evidence supporting participatory community-based approaches for enhancing women's climate resilience while achieving environmental restoration in rural Nigerian contexts.

MATERIALS AND METHODS

Study Area

The intervention was conducted in Buzi, a peri-urban community located in Karu Local Government Area (LGA), Nasarawa State, North Central Nigeria (8^\circ 45' {N}, 7^\circ 55' {E}). Buzi is situated within a high-density migration corridor sharing a boundary with the eastern axis of the Federal Capital Territory (FCT), Abuja. The community has approximately 1,200 residents whose livelihoods primarily center on subsistence farming, livestock management, and informal trading. The region experiences a tropical climate with mean annual rainfall of 1,100mm and temperatures ranging from 24^\circ {C} to 36^\circ {C}. Environmental stressors in Buzi include unregulated solid waste accumulation, significant deforestation for charcoal production, and a documented lack of climate change awareness (Buzi Community Development Association, 2023).

Research Design and Participant Selection

This study utilized a Community-Based Participatory Research (CBPR) framework, integrating Action Research principles to drive social and environmental change (Cornell & Kahovec, 2022). A mixed-methods pre-test/post-test design was employed, with baseline assessments followed by a six-month outcome evaluation.

Participants were selected via purposive sampling targeting women (N=45) aged 25–65. Eligibility required a minimum of two years of residency in Buzi, endorsement by community leadership, and a commitment to the full intervention cycle. The cohort primarily comprised women engaged in the informal economic sector with no prior access to formal banking credits.

The Integrated Intervention Framework

The project was executed over six months, structured into four sequential modules designed to link ecological literacy with economic resilience:

Module 1: Environmental and Climate Literacy

A series of workshops were conducted to bridge the gap between global climate theory and local action. The curriculum covered:

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

- **Waste Management:** Characterization, segregation of organic and non-biodegradable materials, and composting.
- **Climate Change:** Regional causes, impacts on household water/food security, and adaptation strategies.
- **Pedagogy:** Interactive sessions were conducted in English and translated into Hausa to ensure deep comprehension and cultural relevance.

Module 2: Indigenous Reforestation Campaign

To address local deforestation, a community-led planting campaign was launched using 250 indigenous seedlings. Unlike exotic species, these were selected for their climate resilience and socio-economic utility:

- *Khaya senegalensis* (African Mahogany) for carbon sequestration and soil stability.
- *Parkia biglobosa* (Locust Bean) and *Vitellaria paradoxa* (Shea Butter) for nitrogen fixation and non-timber forest products.

Participants were trained in sapling custody, utilizing household "greywater" for micro-irrigation, and survival monitoring.

Module 3: Circular Economy Organic Soap Production

Practical vocational training was provided to establish green micro-enterprises. The manufacturing process utilized circular economy tenets—replacing petroleum-based chemicals with locally sourced vegetable oils (coconut and palm), honey, and shea butter. This ensured the end-products were 100\% biodegradable, protecting the local water table while lowering production costs.

Module 4: Financial Engineering via the Community Revolving Fund (CRF)

To sustain the soap-making enterprises, a seed-funded CRF was established with ₦1,200,000. A five-member elected committee managed the fund using a Peer-Group Guarantee Framework (clusters of 5 women). The fund's structural parameters are detailed in Table 1:

To ensure the long-term sustainability of the newly established enterprises, the author provided seed capital of **₦500,000** to establish a managed Community Revolving Fund (CRF). A governance board elected from among the participants oversaw the fund. The financial structure was organized into micro-credit allocations as detailed in Table 1:

Table 1: Structural Parameters of the Buzi Community Revolving Fund

Parameter	**Specification**
Initial Seed Capital	₦500,000
Individual Micro-Loan Ceiling	₦20,000 to ₦25,000 per cycle
Loan Tenure / Cycle Length	60{ days}
Interest Rate	0\% (With a flat 2\% administrative upkeep fee)
Collateral Structure	Peer-Group Guarantee Framework (5{ women per cluster})

Data Collection and Quality Assurance

Data collection was staggered across three phases:

1. **Baseline (Pre-test):** Structured questionnaires measured knowledge of waste management (10 items, \alpha = 0.82) and climate change understanding (8 items, \alpha = 0.79).

2. **Implementation Tracking:** Continuous monitoring of tree survival rates, fund utilization, and soap production quantities.

3. **Endline (6-Month Follow-up):** Evaluation of sustained practices and household income shifts. Semi-structured interviews (n=15) explored the perceived benefits and challenges of the intervention.

Quality Assurance: Instrument reliability was established through pilot testing (n=10), yielding coefficients >0.75. Data validity was further ensured through daily quality checks and participant validation during community feedback sessions. Because the knowledge outcomes were measured with questionnaires administered by the research team, the scores may be affected by social desirability bias; where possible, self-reported responses were therefore cross-checked against direct field observation of household waste disposal practices (see Table 2).

Data Analysis

Data were analyzed using SPSS v.28. Descriptive statistics and paired t-tests were used to compare pre- and post-intervention scores, with significance set at $p < 0.05$. Knowledge improvement was calculated as: [({Post-test} - {Pre-test}) / {Pre-test}] \times 100.

Interview transcripts were analyzed using Braun and Clarke's (2022) thematic framework. Findings from both datasets were integrated through triangulation to identify convergent patterns in environmental stewardship and economic empowerment.

Ethical Considerations

The study received ethical approval from [Your Institution] Ethics Committee. Informed consent was obtained from participants (written or verbal for those with limited literacy) and community leadership. Confidentiality was maintained through anonymization. Beyond the micro-credit access and training kits, no direct financial compensation was provided to ensure findings reflected the program's intrinsic sustainability.

RESULTS AND DISCUSSION

Socio-Demographic Profile of Participants

The baseline diagnostic survey captured the cross-sectional socio-demographic features of the intervention cohort (N = 45). These indices underscore the socio-economic pressures and structural positions held by women within the peri-urban landscape of Buzi community.

Table 1: Participant Socio-Demographic Baseline Matrix (N = 45)

Characteristic Variable	Stratified Categories	Frequency (n)	Percentage (%)
Age Cohort (Years)	25–35	12	26.7
	36–45	18	40.0
	46–55	11	24.4
	56–65	4	8.9
Educational Attainment	No Formal Education	10	22.2

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

	Primary School Leaving Certificate	17	37.8
	Secondary / WASSCE	14	31.1
	Tertiary Diploma / Degree	4	8.9
Marital Status	Married	35	77.8
	Single	6	13.3
	Widowed	3	6.7
	Divorced	1	2.2
Household Dependency Size	3–5 Members	19	42.2
	6–8 Members	18	40.0
	9–12 Members	8	17.8
Primary Economic Livelihood	Agrarian / Subsistence Farming	25	55.6
	Micro-Retail Trading	13	28.9
	Artisanal Services	4	8.9
	Public Salary / Pension	3	6.7

Note: Primary field data generated through baseline survey instrument.

The cohort's mean age was 42.3 years ({SD} = 8.7), revealing an adult demographic deeply involved in household management. Educational backgrounds highlighted structural gaps: 22.2\% had no formal schooling, and 37.8\% completed only primary education, bringing the total proportion of low-literacy participants to 60.0\%. This distribution confirms the importance of translating the environmental pedagogy modules into the local vernacular (Hausa) to lower literacy barriers.

Household dependency risks were high, with a mean size of 6.2 persons ({SD} = 2.1) and 17.8\% of families supporting between 9 and 12 members. Livelihood profiles showed a heavy reliance on vulnerable economic sectors: 55.6% of the women depended entirely on climate-sensitive agricultural farming, while 28.9% relied on informal micro-retail trading. These baselines confirm that the cohort lacked reliable secondary financial options, keeping them vulnerable to local climate and ecological shocks.

Quantitative Evaluation of Environmental and Climate Literacy

Solid Waste Management Literacy

The baseline assessment revealed a substantial gap between environmental awareness and the adoption of appropriate waste management practices among participants. Prior to the intervention, approximately 85.0% (n = 38) of the women disposed of household waste through environmentally unsustainable methods such as open-air burning, indiscriminate dumping in unauthorized locations, or disposal into drainage channels. Consequently, participants recorded a relatively low baseline mean waste management literacy score of 3.8 out of 10 **(**SD = 1.4**),** indicating limited knowledge of proper waste segregation, recycling, and environmentally sound disposal practices.

Following the implementation of practical waste separation and environmental education workshops, a significant improvement was observed. At the six-month post-intervention evaluation, the mean waste

management literacy score increased to 8.2 out of 10 **(**SD = 0.9**).** This represents an increase of 4.4 points and a 116.0% improvement over the baseline score. A paired-samples t-test confirmed that the improvement was statistically significant **(**$t = 18.7$, $p < 0.001$**),** demonstrating the effectiveness of the intervention in enhancing participants' environmental knowledge and waste management competencies.

The findings suggest that participatory environmental education, when combined with practical demonstrations and community engagement, can substantially improve environmental literacy among rural women. Improved knowledge translated into greater adoption of environmentally responsible waste management practices, thereby contributing to local environmental sustainability and climate resilience.

Table 2: Pre- and Post-Intervention Waste Management Literacy Scores (N = 45)

Indicator	**Pre-Intervention**	**Post-Intervention**	**Change**	**% Increase**	**t-value**	**p-value**
Mean Waste Management Literacy Score (Max = 10)	3.8 ± 1.4	8.2 ± 0.9	+4.4	116.0%	18.7	<0.001
Participants Using Improper Waste Disposal Methods	85.0% (38)	17.8% (8)*	-67.2 percentage points	-79.1%	—	—

*Post-intervention value derived from field observations indicating widespread adoption of improved waste handling and segregation practices.

The substantial increase in waste management literacy scores indicates that the intervention successfully addressed critical knowledge gaps regarding environmental sanitation and waste disposal. The reduction in the proportion of women engaging in improper waste disposal practices further demonstrates the practical application of acquired knowledge. These results support the growing body of evidence that community-based environmental education can serve as an effective tool for promoting sustainable environmental behavior and strengthening local climate adaptation capacity among vulnerable populations.

Table 3 Mean Waste Management Literacy Scores Before and After Intervention (N = 45)

Assessment Period	**Mean Score (Max = 10)**
Pre-Intervention	3.8
Post-Intervention	8.2

The increase from 3.8 to 8.2 demonstrates a statistically significant improvement in participants' understanding of waste management principles following the environmental education programme ($t = 18.7$, $p < 0.001$).

Climate Change Comprehension

The baseline assessment revealed limited understanding of climate change concepts among participants. Prior to the intervention, approximately 68.0% (n = 31) of the women attributed observed climatic variations solely to supernatural causes, seasonal rainfall fluctuations, or other localized explanations, with little awareness of anthropogenic drivers such as greenhouse gas emissions, deforestation, and unsustainable land-use practices. Consequently, the mean climate change literacy score was relatively low at 3.2 out of 8 points (SD = 1.6).

Following six months of participatory environmental education delivered in Hausa and contextualized using locally relevant examples, a substantial improvement in climate change comprehension was observed. The mean climate literacy score increased to 7.1 out of 8 points (SD = 0.7), representing a gain of 3.9 points and a 122.0% increase over baseline levels. A paired-samples t-test confirmed that this improvement was statistically significant ($t = 21.4$, $p < 0.001$).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

Furthermore, the proportion of participants attaining the minimum threshold for adequate climate change knowledge (score ≥ 6) increased significantly from 17.8% at baseline to 86.7% at endline. Chi-square analysis indicated that this improvement was highly significant ($\chi^2 = 48.7$, $p < 0.001$).

The findings demonstrate that climate literacy interventions are most effective when scientific concepts are translated into local languages and linked to everyday environmental experiences. Participants were able to relate global climate change processes to local practices such as indiscriminate tree felling, bush burning, and improper waste disposal. The observed knowledge gains exceeded retention levels reported for conventional environmental education programmes, suggesting that participatory and culturally adapted learning approaches enhance long-term understanding and behavioural change.

Table 4: Climate Change Literacy Scores Before and After Intervention (N = 45)

Indicator	**Pre-Intervention**	**Post-Intervention**	**Change**	**% Increase**	**Test Statistic**	**p-value**
Mean Climate Literacy Score (Max = 8)	3.2 ± 1.6	7.1 ± 0.7	+3.9	122.0%	t = 21.4	<0.001
Participants with Adequate Climate Knowledge (Score ≥ 6)	17.8% (8)	86.7% (39)	+68.9 percentage points	387.1%	$\chi^2 = 48.7$	<0.001
Participants Attributing Climate Change to Anthropogenic Causes	24.4% (11)	88.9% (40)	+64.5 percentage points	264.3%	$\chi^2 = 42.6$	<0.001

Indigenous Tree Planting and Ecological Stewardship

A total of 250 indigenous climate-resilient tree seedlings were distributed across Buzi Community as part of the ecosystem restoration component of the intervention. All participating women (100.0%) assumed responsibility for tree establishment and maintenance, with an average allocation of 3.5 trees per participant (SD = 1.2).

Field monitoring conducted three months after planting assessed the survival performance of 156 sampled saplings. Overall, 131 saplings were healthy and actively growing, resulting in an aggregate survival rate of 84.0%. Species-specific analysis revealed considerable variation in performance, with Vitellaria paradoxa (Shea Butter Tree) recording the highest survival rate (92.3%), followed by Acacia nilotica (87.5%). Diverse indigenous species recorded the lowest survival rate (76.2%).

Table 5: Species Composition and Survival Rates of Indigenous Tree Saplings (N = 156)

Tree Species	**Number Planted**	**Percentage (%)**	**Surviving Saplings**	**Survival Rate (%)**
Acacia nilotica (Gum Arabic)	32	20.5	28	87.5
Adansonia digitata (Baobab)	28	18.0	22	78.6
Vitellaria paradoxa (Shea Butter)	26	16.7	24	92.3
Diospyros mespiliformis	25	16.0	21	84.0
Parkia biglobosa (Locust Bean)	24	15.4	20	83.3
Other Indigenous Species	21	13.4	16	76.2
Total	**156**	**100.0**	**131**	**84.0**

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

Further analysis revealed significant differences in survival rates based on planting location. Saplings established within household compounds recorded a survival rate of 91.0%, compared with 74.0% among saplings planted in open communal lands and degraded forest areas. The difference was statistically significant ($\chi^2 = 12.8$, $p < 0.001$). It should be noted that these survival figures are based on a single monitoring point three months after planting and therefore indicate early establishment of the saplings rather than long-term ecosystem restoration.

Table 6: Tree Survival Rates by Planting Location

Planting Location	Survival Rate (%)
Household Compounds	91.0
Communal/Degraded Forest Areas	74.0
Difference	+17.0
χ^2-value	12.8
p-value	<0.001

The results suggest that assigning individual custodianship of planted trees substantially enhances survival outcomes. Household ownership encouraged regular watering, protection from grazing animals, and ongoing maintenance, thereby improving ecosystem restoration success.

Organic Soap Production and Green Enterprise Development

The green entrepreneurship component resulted in the establishment of eight organic soap production clusters operated by participating women. Prior to the intervention, only 12.0% of participants possessed basic soap-making knowledge. Following training, 83.0% demonstrated competency levels equivalent to mastery (score ≥ 7/10) across key quality assessment criteria including texture, fragrance, consistency, appearance, and cleaning efficiency.

The intervention also generated significant economic benefits. Average monthly discretionary income increased from ₦5,600 before the intervention to ₦18,750 after participation, representing a 234.8% increase. The difference was statistically significant ($t = 5.42$, $p < 0.001$).

Table 7: Economic and Enterprise Outcomes of Organic Soap Production (N = 45)

Indicator	**Baseline**	**Post-Intervention**	**Change**
Mean Monthly Income (₦)	5,600	18,750	+234.8%
Women with Soap-Making Skills (%)	12.0	83.0	+71.0 percentage points
Weekly Cluster Output (Units)	0	140	New Enterprise Activity
Household Waste Segregation (%)	5.0	72.0	+67.0 percentage points

By the third month of operation, 82.2% of participants were actively producing soap, while 64.4% were engaged in commercial sales. Product distribution occurred primarily through direct household sales (52.0%), local markets (28.0%), cooperative networks (14.0%), and informal digital marketing channels (6.0%).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

Table 8: Major Challenges Reported by Soap Production Clusters

Challenge	**Frequency (%)**
Rising Raw Material Costs	31.0
Limited Packaging Materials	24.0
Competition from Commercial Products	19.0
Marketing Constraints	16.0
Other Challenges	10.0

Community Revolving Fund Performance

The Community Revolving Fund (CRF), capitalized with an initial seed grant of ₦500,000, provided affordable financing for women-led enterprises and climate-smart livelihood activities. By the third month, the fund had achieved an 85.0% utilization rate and supported 38 micro-loans with an average value of ₦3,355 (SD = ₦1,120).

The revolving fund recorded a 100.0% repayment rate within the six-month study period, indicating that the peer-guarantee lending model functioned effectively while the programme was under active supervision by the research team. Whether this rate can be sustained after external supervision ends, and under future economic pressures such as rising raw material costs, remains to be verified. Average repayment duration was 2.4 months (SD = 0.8), enabling rapid capital recycling and expansion of credit access.

Table 9: Community Revolving Fund Performance Indicators

Indicator	**Value**
Initial Fund Capital	₦500,000
Capital Utilization Rate	85.0%
Number of Loans Issued	38
Average Loan Size	₦3,355
Loan Repayment Rate	100.0%
Average Repayment Period	2.4 Months
Administrative Revenue Generated	₦4,890
Additional Beneficiaries Reached	12

Financial literacy also improved substantially, with participants demonstrating increased understanding of loan management, record keeping, and savings principles. The proportion of women achieving satisfactory financial literacy scores increased from 23.0% at baseline to 92.0% at endline ($t = 19.8$, $p < 0.001$).

Table 10: Financial Literacy Outcomes

Indicator	Baseline (%)	Endline (%)	Change
Adequate Financial Literacy	23.0	92.0	+69.0 percentage points

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

Loan Repayment Success	-	100.0	Achieved
Record-Keeping Competence	27.0	89.0	+62.0 percentage points

These findings collectively demonstrate that integrating climate education, ecological restoration, green enterprise development, and community-based finance can simultaneously improve environmental outcomes, household incomes, and women's adaptive capacity to climate change.

CONCLUSION

The Buzi community intervention demonstrates that environmental degradation and rural poverty cannot be solved effectively in isolation. By testing an integrated, multi-component framework, this study provides preliminary evidence that grounding climate literacy in local languages, providing structured environmental custody, and establishing micro-enterprises can create a self-reinforcing socio-ecological system. Over six months, the program successfully shifted baseline community behaviors—moving away from open waste burning and tree cutting toward active waste sorting, conservation, and sustainable production.

The quantitative results underscore the potential of this approach. The significant increases in solid waste literacy (+116.0%) and climate change comprehension (+122.0%) show that low formal education is not a barrier to environmental action when lessons are practical and delivered in the local language. Furthermore, linking environmental education to economic incentives via organic soap-making and the Community Revolving Fund successfully addressed the financial barriers that often stall grassroots conservation. The resulting 234.8% increase in average monthly income did more than just lift households out of immediate financial vulnerability—it provided a degree of financial security that may support continued ecological care, as suggested by the high early (84.0%) three-month tree survival rate.

Ultimately, the perfect repayment rate (100.0%) of the revolving fund and its expansion to include additional community members highlight the potential scalability of this model. When grassroots women are given independent financial tools and clear resource custody, they transform from passive victims of climate vulnerability into active ecological stewards. The Buzi model therefore offers a promising blueprint for gender-responsive climate adaptation and circular economic development, which should now be validated through larger, multi-community and longer-term studies before wider adoption across sub-Saharan Africa.

Limitations of the Study

This study has several limitations that should be considered when interpreting the findings. First, the sample was small and drawn from a single location: the intervention involved only 45 women in one peri-urban community. The results may therefore not represent the diverse socio-ecological conditions found in larger rural regions and other agroecological zones of Nigeria, which limits the generalizability of the findings.

Second, the monitoring period was short. The evaluation covered only six months, which is not sufficient to measure long-term climate adaptation outcomes. It is therefore not yet possible to confirm whether the organic soap clusters will remain viable, or whether the 100% repayment rate of the revolving fund will be maintained under future economic pressures once active supervision by the research team ends.

Third, the improvements in solid waste literacy and climate change comprehension were measured mainly through questionnaire scores. Such self-reported data are susceptible to social desirability bias, as participants may have given answers they felt the research team expected.

Finally, the reported 84.0% survival rate for the 156 sampled saplings is based on a single monitoring point three months after planting. Without long-term ecological data on canopy closure, soil stabilization or microclimate change, the contribution of the tree-planting campaign to ecosystem restoration cannot yet be scientifically confirmed and should be regarded as provisional.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IX September 2026

RECOMMENDATIONS

Based on the findings and the limitations identified above, the following recommendations are made.

(a) For future research

1. Larger and more diverse samples: Future interventions should be implemented and evaluated across several communities and in different agroecological zones of Nigeria, using a larger sample, to improve the generalizability of the findings.

2. Longer monitoring: The tracking period should be extended from six months to several years in order to assess the long-term survival of the soap enterprises and the lasting performance of the revolving fund after external supervision ends.

3. Objective environmental measures: Researchers should complement self-reported questionnaire data with objective environmental indicators, such as satellite-derived vegetation indices (for example, NDVI), repeated tree survival and growth surveys, and long-term soil moisture measurements, to quantify actual ecosystem restoration outcomes.

(b) For policy and practice

4. Supply partnerships: The community soap clusters should form direct partnerships with regional agricultural cooperatives for the supply of oils and shea butter, to protect the women against volatile raw material prices and secure long-term commercial viability.

5. Policy integration: Local and state governments should integrate this grassroots framework into formal gender-responsive climate policies, by establishing dedicated vocational training pipelines and micro-credit guarantee schemes for women.

6. Stewardship incentives: A formal ecosystem stewardship incentive should be introduced into the peer-lending model, so that loan terms, such as access to larger or interest-free loans, are linked to verified tree survival records. This would strengthen the link between household economic security and active environmental protection.

REFERENCES

1. Adeleke, J. A., Omita, M. Y., & Fashola, T. S. (2023). Climate change impacts and adaptation strategies in North Central Nigeria: Evidence from household surveys. Journal of Environmental Management and Sustainability, 12(3), 45–62. https://doi.org/10.1016/j.jems.2023.03.002
2. Adeleke, S. A., Ibrahim, M. O., & Bello, Y. A. (2023). Decadal thermal anomalies and localized climate shifts in North Central Nigeria (1981–2021). African Environmental Review, 29(3), 112–128.
3. Adeyemi, T. O., Ibrahim, A. M., & Yusuf, H. A. (2024). Peri-urban expansion and environmental governance challenges in Nigeria's North-Central zone: Evidence from Karu LGA. Journal of Urban Environmental Planning, 15(2), 112–134. https://doi.org/10.1016/j.juep.2024.02.003
4. Akinbami, F. O., Oke, A. O., & Sanusi, G. B. (2024). Integrated environmental sustainability programming, waste literacy, and gender-responsive micro-entrepreneurship in sub-Saharan margins. Journal of Cleaner Production & Grassroots Development, 412, Article 120411.
5. Akinbami, L. O., Yusuf, H. A., & Ibrahim, M. Z. (2024). Integrated community-based environmental education programs in Nigeria: Outcomes and sustainability factors. Environmental Education Research, 30(5), 789–807. https://doi.org/10.1080/13504622.2024.2301456
6. Apeh, C. C., Agbugba, I. K., & Mdoda, L. (2023). Assessing the determinants of adopting urban tree planting as climate change mitigation strategy in Enugu Metropolis, Nigeria. Sustainability, 15(16), 12224. https://doi.org/10.3390/su151612224
7. Braun, V., & Clarke, V. (2022). Thematic analysis: A practical guide. Sage Publications.

8. Buzi Community Development Association. (2023a). Community profile and environmental assessment report. Buzi Community Development Association.
9. Buzi Community Development Association. (2023b). Demographic profiles, land degradation patterns, and micro-livelihood status parameters within Buzi settlement. BCDA Communiqué Report.
10. Buzi Community Development Association. (2024). Community environmental and socio-economic assessment report 2024. Buzi CDA.
11. Cornell, S., & Kahovec, J. (2022). Community-based participatory research for environmental sustainability: Principles and practices. Sustainability Science, 17(4), 1123–1141. https://doi.org/10.1007/s11625-022-01089-3
12. Food and Agriculture Organization. (2023a). Nigeria forest landscape restoration action plan 2023–2030. FAO. https://www.fao.org/nigeria-forest-restoration
13. Food and Agriculture Organization. (2023b). State of the world's forests: Assessing structural deforestation and community forestry initiatives in West Africa (FAO Forestry Paper No. 184). https://doi.org/10.4060/cc5432en
14. Food and Agriculture Organization. (2024). Nigeria country programming framework 2024–2028: Environmental sustainability and climate resilience. FAO. https://www.fao.org/nigeria-cpf-2024
15. Intergovernmental Panel on Climate Change. (2023). Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the IPCC. IPCC. https://www.ipcc.ch/report/ar6/syr
16. Michael, T. O. (2024). Adapting to climate change-induced flooding: Insights from women traders in the riverine areas of Nigeria—A qualitative study. Frontiers in Sustainability, 5, 1385513. https://doi.org/10.3389/frsus.2024.1385513
17. Nasarawa State Environmental Protection Agency. (2023a). Annual waste management report 2023. Nasarawa State EPA.
18. Nasarawa State Environmental Protection Agency. (2023b). Solid waste diagnostics and municipal infrastructure capacity updates along the FCT corridor. NASEPA Annual Progress Brief.
19. Nasarawa State Ministry of Environment. (2023a). Asymmetric vegetative depletion: Fuelwood extraction and landscape metrics in Karu Local Government Area. State Environmental Assessment Folio.
20. Nasarawa State Ministry of Environment. (2023b). State environmental status report 2023. Nasarawa State Ministry of Environment.
21. Nasarawa State Ministry of Environment. (2024). State environmental status and climate vulnerability assessment report 2024. Nasarawa State Ministry of Environment.
22. Nigeria Organic Products Association. (2024a). Market size, value-chain trends, and consumer demand forecasts for bio-based commodities in Nigeria. NOPA Industrial Report.
23. Nigeria Organic Products Association. (2024b). Organic personal care products market analysis Nigeria 2024. NOPA.
24. Nigerian Meteorological Agency. (2024a). Extreme weather events and socio-demographic impacts dashboard (2020–2024). NiMet Federal Ministerial Report.
25. Nigerian Meteorological Agency. (2024b). Nigeria climate change impact and adaptation report 2024. NiMet. https://www.nimet.gov.ng/climate-report-2024
26. Ogbonnaya, K. A., & Ebere, O. A. (2023). Enhancing women's participation in community development through community education for sustainable development in South-East Nigeria. International Journal of Sustainable Development and Planning, 18(7), 2293–2300. https://doi.org/10.18280/ijsdp.180734
27. Okafor, C. E., & Eze, J. U. (2022). Community-based waste management interventions vs. top-down extension architectures in rural-urban transition settlements. Nigerian Journal of Environmental Management, 18(2), 89–104.
28. Okafor, C. E., & Eze, P. O. (2023). Environmental education effectiveness in rural Nigerian communities: A comparative analysis of top-down versus participatory approaches. Journal of Environmental Education, 54(3), 134–152. https://doi.org/10.1080/00958962.2023.2038741
29. Oladele, O. I., & Amara, A. (2024). Farmers' use of indigenous knowledge on climate change adaptation across farming systems and agroecological zones of Sierra Leone. Environment and Development. https://doi.org/10.1177/11771801241251862

30. Olaniyan, B. S., & Govender, N. (2023). Responding to climate change: Indigenous knowledge lessons from Nigerian root and tuber farmers. Environment and Development, 19(2). https://doi.org/10.1177/11771801231169051
31. Sam, K., & Zibima, T. (2024). Inclusive environmental decision-making in a developing nation: Insights from the Ogoni remediation project, Niger Delta, Nigeria. Environmental Management, 73(2), 323–337. https://doi.org/10.1007/s00267-023-01885-y
32. TGAS Foundation. (2025a). Evaluating long-term survivability matrices of indigenous vs. exotic silviculture in community-co-managed reserves. TGAS Conservation Monographs, 4(1), 14–29.
33. TGAS Foundation. (2025b). Tree planting initiative: Impact evaluation report 2025. TGAS Foundation. https://tgasfoundation.org/tree-planting-impact-2025
34. United Nations Development Programme. (2023a). Empowering vulnerable populations: Combining microfinance structures with green enterprise options for systemic climate resilience. UNDP-Nigeria Technical Strategy Paper.
35. United Nations Development Programme. (2023b). Sustainable livelihoods approach for environmental sustainability in Africa. UNDP.
36. United Nations Development Programme. (2024). Nigeria human development report 2024: Climate action and gender equality. UNDP Nigeria.
37. United Nations Environment Programme. (2024a). Ecosystem restoration in Nigeria: Progress and challenges. UNEP.
38. United Nations Environment Programme. (2024b). Nature-based solutions for urban and peri-urban climate adaptation pathways in Sub-Saharan Africa. UNEP Nairobi Blueprint Series.
39. United Nations Environment Programme. (2025). EmPower: Women for climate-resilient societies. UNEP.
40. UN Women. (2023). Progress on the sustainable development goals: The gender snapshot 2023. UN Women.
41. World Bank. (2023a). Gender, asset ownership, and financial inclusion gaps in rural Nigeria. World Bank Group.
42. World Bank. (2023b). Nigeria climate change country profile: Building resilience for sustainable development. World Bank.
43. World Bank. (2023c). Women's economic empowerment in rural Nigeria: Barriers and opportunities. World Bank.