ISSN: 3043-467X



AD ULT EDUCATION FOR CLIMATE ADPTATION AND FOOD SECURITY: COMMUNITY DEVELOPMENT PRACTICE IN CLIMATE-RESILIENT FARMING COMMUNITIES IN NIGERIA

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Abstract

Smallholder farmers in Nigeria make agricultural decisions under changing rainfall patterns, rising temperatures and other climate-related pressures. These conditions affect planting decisions, crop production and rural livelihoods, while farmers' responses are shaped by their access to reliable climate information, agricultural resources and institutional support. Addressing these challenges therefore requires more than disseminating climate information; it requires learning processes that enable farmers to critically examine their experiences, assess

adaptation options and participate in decisions affecting their livelihoods. This conceptual paper examines how adult education, informed by Transformative Learning Theory (TLT), can contribute to climate adaptation and food security through community development practice. It adopts a focused narrative literature review and conceptual synthesis of relevant theoretical publications, empirical studies and policy documents. The paper identifies a conceptual gap in explaining how transformative adult learning connects with community participation, environmental justice and the institutional conditions necessary for agricultural adaptation. In response, it proposes an integrated framework that explains how critical reflection, dialogue and practical learning can strengthen climate literacy, while community development practitioners facilitate inclusive participation, collective decision-making and connections with relevant institutions. The framework further distinguishes these learning and facilitation processes from the enabling conditions, including finance, agricultural inputs, extension services and infrastructure, required to translate knowledge into adaptation practices. Its distinctive contribution lies in specifying these relationships within the context of Nigerian farming communities and developing five propositions for empirical investigation. The paper argues that adult education can support climate-resilient farming and food security when learning is connected to meaningful participation, equitable access to resources and responsive institutional support.

Keywords: Adult education; climate adaptation; climate resilience; food security; community development; environmental justice; Nigeria; transformative learning.

1. Introduction

Agriculture in Nigeria is closely connected to seasonal rainfall, temperature conditions and the availability of natural resources. Changes in rainfall patterns, prolonged dry periods, flooding and rising temperatures affect farming decisions, crop production and rural livelihoods. Farmers must interpret climate information, assess possible responses and make decisions within economic and institutional conditions that may restrict their choices. These challenges require educational and development interventions that connect knowledge with practical action.

Food insecurity is a major concern for households and agricultural communities. The State of Food Security and Nutrition in the World 2024 estimated that approximately 2.33 billion people experienced moderate or severe food insecurity in 2023 (Food and Agriculture Organization of the United Nations [FAO] et al., 2024). This is a global estimate and should not be interpreted as evidence that climate change caused every instance of food insecurity. Nevertheless, climate change affects food systems through its consequences for agricultural production, livelihoods and the stability of food supplies (Intergovernmental Panel on Climate Change [IPCC], 2023).

Research conducted in Nigeria illustrates the different conditions shaping farmers' responses to climate change. Madaki et al. (2023), using evidence from 1,080 smallholder farmers across six

agroecological zones, examined farmers' knowledge and perceptions of climate change. Their findings show that information received through extension services, environmental organisations and radio is associated with farmers' climate knowledge. Ayanlade et al. (2018) examined farmers' attitudes towards climate variability and adaptation technologies in selected rural Nigerian communities. Ebenehi et al. (2018) assessed extension-service delivery for climate adaptation among crop farmers in Niger State and identified limitations involving information, credit and agricultural inputs.

Other studies demonstrate the relationship between adaptation, finance and food security. Ojo et al. (2024) examined climate vulnerability and adaptive capacity from a financing perspective, using data from smallholder farmers in three plantain-producing states in southwestern Nigeria. Aroyehun et al. (2024) investigated factors associated with melon farmers' adaptation strategies in South-South Nigeria. Omotoso and Omotayo (2025) examined the relationship between climate-smart agricultural practices, dietary diversity and food security among rural farming households in southwestern Nigeria. These studies provide evidence from particular locations and agricultural settings; their findings should not be generalised to every Nigerian farming community without further investigation.

In this paper, climate resilience refers to the capacity of individuals and communities to anticipate, respond to and recover from climate-related pressures while sustaining livelihoods and essential needs (IPCC, 2023). Adaptive capacity concerns the knowledge, skills, resources and institutional conditions that enable such responses, while adaptation involves practical adjustments to actual or expected climate conditions. Food security exists when people have access to sufficient, safe and nutritious food, and is understood through four dimensions: availability, access, utilisation and stability (FAO et al., 2023).

Despite this body of research, an important conceptual issue remains. Studies on climate knowledge, agricultural adaptation, extension services and food security often examine particular aspects of the problem. Less attention is given to how adult education can connect critical learning with community development processes, environmental justice and the institutional conditions required for farmers to act on what they learn. This paper addresses that gap by examining the educational and facilitative processes through which farmers may interpret climate information, participate in collective decisions and connect with relevant agricultural services.

Community development practitioners are relevant to this discussion because they can facilitate community learning, support inclusive participation and connect residents with institutions. They do not replace agricultural extension personnel or technical specialists. Rather, their proposed contribution lies in helping communities identify shared concerns, deliberate on possible responses and communicate their priorities to institutions responsible for agricultural support.

The paper has three objectives: to explain the relevance and limitations of Transformative Learning Theory for adult climate adaptation education; to examine how community

development practitioners can connect adult learning with participation, environmental justice and agricultural support; to propose an integrated conceptual framework linking adult learning and community development practice with adaptive capacity, climate resilience and food security in Nigeria.

2. Approach to the Literature

This paper adopts a focused narrative literature review and conceptual synthesis to examine the relationship between adult education, climate adaptation, community development practice and food security in Nigerian farming communities. This approach is appropriate because the paper seeks to connect relevant theoretical perspectives, empirical findings and policy discussions to develop a conceptual understanding of how adult education and community development practice can support climate-resilient farming communities. It does not seek to measure the effects of a particular intervention or provide a systematic review of all available studies.

Relevant literature was identified through academic discovery services, journal websites, publisher platforms and institutional repositories. Sources consulted included Google Scholar, Nature, ScienceDirect, SpringerLink, African Journals Online (AJOL), Wiley Online Library and other relevant academic and institutional platforms. The literature was identified through its relevance to the paper's central themes, including adult education, transformative learning, climate change education, agricultural adaptation, community development, environmental justice and food security.

No fixed publication-year range was imposed because the review considered both foundational theoretical works and relevant contemporary scholarship. Literature was selected based on its relevance to the paper's objectives and conceptual focus, with priority given to peer-reviewed theoretical publications, empirical studies, policy documents and institutional reports addressing adult learning, climate adaptation, agricultural practices, community participation and food security. Particular attention was given to Nigerian studies and relevant African contexts, while selected international publications provided broader theoretical and policy perspectives. Publications without a substantive connection to the identified themes were not prioritised.

The literature was examined across four interconnected themes: adult education and transformative learning, particularly critical reflection and dialogue; climate change knowledge, agricultural adaptation and farmers' adaptive capacity; community development, participation, environmental justice and institutional support; and the relationship between agricultural adaptation and the four dimensions of food security: availability, access, utilisation and stability. The conceptual synthesis examined how adult climate education can support critical reflection and informed decision-making, how community development practitioners can facilitate dialogue, inclusive participation and institutional linkages, and how material and institutional resources influence farmers' ability to translate knowledge into practical adaptation. These relationships informed the development of the proposed conceptual framework and its propositions.

The review has some limitations. It was not conducted as a systematic review and did not follow a pre-established search protocol, fixed search terms, formal inclusion and exclusion criteria or a documented screening procedure. Consequently, it does not claim exhaustive coverage of the available literature. Rather, it provides a focused narrative interpretation of relevant scholarship to develop a conceptual framework that can inform further research and practice on adult education, climate adaptation and food security in Nigerian farming communities.

3. Theoretical Framework: Transformative Learning Theory

Transformative Learning Theory (TLT), developed by Mezirow (1978, 1991, 2000), explains how adults critically examine established assumptions and develop new ways of interpreting their experiences. Its central processes include disorienting dilemmas, critical reflection, rational dialogue and perspective transformation. These processes are relevant to climate adaptation because changing environmental conditions may challenge farmers' established knowledge and agricultural practices.

A disorienting dilemma occurs when an experience challenges previously held assumptions. For farmers, unpredictable rainfall, prolonged dry spells or declining agricultural productivity may raise questions about the suitability of familiar farming practices. Critical reflection enables them to examine these experiences, compare local knowledge with climate information and reconsider the assumptions informing their decisions. Rational dialogue provides opportunities to exchange experiences, question proposed responses and assess alternative adaptation practices through farmer groups, community meetings and facilitated learning sessions. Such processes may lead to perspective transformation, whereby farmers develop new understandings and reconsider decisions concerning planting dates, crop choices, soil conservation and water management.

However, changes in understanding do not automatically translate into adaptation. Farmers may recognise the importance of improved seeds, irrigation or other climate-resilient practices but lack the financial resources, infrastructure or institutional support required to adopt them. Furthermore, Mezirow's emphasis on individual reflection and perspective transformation gives limited attention to the unequal power relations, gender constraints and institutional conditions that influence collective adaptation. Dialogue may also reproduce existing inequalities where influential community members dominate decision-making.

The paper therefore complements TLT with participatory and community-oriented perspectives. Freire's (1970) critical and dialogical approach to education emphasises learners' active involvement in examining their realities and addressing shared problems. Community development practice extends this perspective by facilitating collective learning, participation and engagement with institutions, while environmental justice draws attention to whose knowledge is recognised, who participates in decisions and how adaptation resources are distributed (Schlosberg, 2012; Yahaya, 2025). Together, these perspectives provide a broader basis for understanding how critical adult learning can contribute to collective climate action,

while recognising the social and material conditions necessary to translate learning into adaptation.

4. Adult Education, Climate Resilience and Food Security

Adult education can support climate adaptation through formal, non-formal and informal learning. In farming communities, such learning may occur through farmer groups, community learning sessions, extension programmes, radio discussions, demonstrations, cooperative meetings and exchanges among farmers. Its effectiveness depends on approaches that recognise adults' experiences, local knowledge, literacy levels, language preferences and livelihood responsibilities.

Four related concepts are important in understanding the contribution of adult education. Climate awareness involves recognising climate change and its possible effects, while climate literacy extends to understanding climate information, interpreting risks and evaluating possible responses. Adaptive capacity concerns the knowledge, skills, resources and institutional conditions that enable people to respond to climate-related challenges. Adaptation, in contrast, refers to the practical adjustments made in farming practices and livelihood decisions, such as changing planting dates, diversifying crops and adopting soil and water conservation practices.

Adult education contributes to these processes by developing climate knowledge, practical skills, critical attitudes and collective problem-solving capacities. Madaki et al. (2023) highlight the relevance of information from extension services, environmental organisations and radio to farmers' climate knowledge. Similarly, Yahaya and Halliru (2026a) report that farmers in Tofa Local Government Area, Kano State, obtain climate information through fellow farmers, extension workers, radio, community meetings and non-governmental organisations, while facing constraints involving access to climate-resilient seeds, equipment, institutional support and reliable information.

Consequently, climate education should extend beyond awareness campaigns (Yahaya & Halliru, 2026b). Learning activities should enable farmers to interpret climate information, assess the reliability of forecasts, compare adaptation options, develop practical skills and collectively examine the resources required to implement appropriate responses. Farmer learning groups, demonstrations and participatory discussions can connect knowledge with practical decision-making.

Adult education also has implications for the four dimensions of food security. Learning about crop diversification, soil management and water conservation can contribute to food availability by supporting agricultural production. Education about markets, cooperatives, income-generating opportunities and livelihood diversification can strengthen household food access. Nutrition education, food preparation and safe storage practices can contribute to food utilisation. Finally, learning about seasonal climate risks, agricultural planning and post-harvest management can support food stability by helping households anticipate and manage disruptions.

These contributions should, however, be understood within broader social and institutional conditions. Increased agricultural production does not automatically guarantee household access to sufficient and nutritious food. Income, food prices, market access, storage facilities, gender relations and public infrastructure also influence food security. Omotoso and Omotayo (2025) identify relationships between climate-smart agricultural practices, dietary diversity and food security among rural farming households in Nigeria. Their findings illustrate the potential connections between agricultural adaptation and food security, although outcomes may vary across communities and farming contexts.

Thus, adult education can strengthen the knowledge, skills and collective capacities needed for climate adaptation and improved food security, but its contribution depends on whether farmers can access the resources, services and institutional support required to translate learning into action.

5. Community Development Practitioners' Roles

Community development practitioners can connect adult learning with community participation, collective planning and institutional support. In the Nigerian context, this functional category may include local government community development officers, community-based organisation and NGO facilitators, cooperative development personnel and practitioners involved in adult and non-formal education. Their roles and professional mandates vary across institutions; therefore, the paper does not assume that they constitute a single, uniformly regulated profession or that they already have a specific climate-adaptation mandate. Rather, it proposes their potential contribution to community-level adaptation.

Their role is distinct from, but complementary to, those of adult educators and agricultural extension personnel. Adult educators contribute expertise in adult-learning principles, programme design and facilitation, while extension personnel provide specialised agricultural information and technical advice. Community development practitioners facilitate community assessment, inclusive participation, collective decision-making and connections between residents and relevant institutions. Although these functions may overlap in practice, practitioners should not replace the technical responsibilities of extension personnel.

5.1 Facilitating Local Learning and Participation

Practitioners can work with farmers and extension personnel to identify locally experienced climate risks and facilitate learning sessions that combine farmers' observations with credible forecasts and agricultural advice. Activities may include farmer-to-farmer exchanges, demonstrations, participatory discussions and farmer field-school approaches addressing rainfall variability, planting decisions, soil conditions and water management. These activities enable farmers to examine familiar practices, assess alternatives and reflect on their experiences, consistent with the critical reflection and dialogue emphasised in Transformative Learning Theory (Mezirow, 1991, 2000) and UNESCO's (2024) action-oriented approach.

Practitioners can also facilitate community identification of shared risks and adaptation priorities. For example, in a rain-fed farming community in Kano State, a facilitator might organise discussions in which farmers compare changing rainfall patterns, identify affected farming activities and consult extension personnel about suitable responses. The practitioner's responsibility would be to organise dialogue, ensure that different groups contribute and connect agreed priorities with relevant services: not to prescribe technical farming solutions.

Meaningful participation also requires attention to unequal access to learning and decision-making. Women, young people and resource-constrained households may face barriers involving literacy, language, time, household responsibilities, land ownership, credit and distance to learning activities. Local power relations may further allow influential groups to dominate community decisions. Practitioners should therefore use accessible languages and participatory methods, provide appropriate opportunities for under-represented groups to contribute and ensure that their concerns inform collective priorities.

5.2 Connecting Institutions and Promoting Environmental Justice

Farmers may require climate-resilient seeds, equipment, finance, extension services, market information and infrastructure to implement adaptation decisions. Practitioners can help communities identify these needs, establish links with extension agencies, cooperatives, local authorities, research institutions, financial providers and civil-society organisations, and communicate community priorities to relevant decision-makers. The importance of addressing financial and institutional constraints is reflected in studies of farmers' adaptive capacity in Nigeria (Ojo et al., 2024; Yahaya & Halliru, 2026a). However, institutional connections should be assessed by whether they improve access to services and resources, rather than simply by the number of meetings or partnerships established.

Environmental justice further requires attention to the distribution of climate risks and adaptation benefits, recognition of local knowledge and meaningful participation in decisions (Schlosberg, 2012). Yahaya (2025) relates these concerns to community development and equitable climate action. Practitioners can therefore facilitate community discussions about who receives climate information, who can access adaptation resources, whose knowledge is recognised and who influences decisions. This role is particularly important where resource inequalities restrict the ability of vulnerable households to benefit from climate programmes.

5.3 Linking Learning to Food-Security Priorities

Practitioners can help communities connect climate learning with locally relevant food-security priorities, including crop diversification, soil and water conservation, agroforestry, post-harvest management and improved storage. Working with agricultural specialists, they can facilitate discussions about the suitability, costs and risks of these practices and identify institutional barriers requiring collective action. Such facilitation can help farmers relate adaptation decisions to food availability, access, utilisation and stability. Nevertheless, improved climate knowledge

or adoption of a farming practice does not automatically guarantee better household food security; outcomes also depend on income, markets, infrastructure, access to land and other material conditions.

Taken together, these roles position community development practitioners as facilitators of learning, participation, institutional linkages and environmental justice. Their contribution is not to replace adult educators, extension personnel or public institutions, but to help ensure that farmers' knowledge and priorities inform adaptation decisions and that learning is connected to the support required for practical action.

6. Existing Frameworks and the Proposed Contribution

The proposed framework builds on existing approaches that have already established important connections between climate education, community participation and adaptation. However, these approaches differ in their primary emphasis and do not fully explain how transformative adult learning and community development practice can jointly connect farmers' learning with adaptation and food-security outcomes in Nigeria.

UNESCO's (2024) Greening Curriculum Guidance promotes action-oriented, scientifically grounded and justice-focused climate education. It provides important educational principles for developing climate knowledge, competencies and action across different learning contexts. However, its primary emphasis is on curriculum and education systems, rather than the specific community-level processes through which adult farmers critically examine climate information, participate in adaptation decisions and connect learning with agricultural support.

Similarly, the Community-Driven Climate Resilience Planning framework of the National Association of Climate Resilience Planners (2017) emphasises community-defined priorities, power-building, vulnerability assessment and locally developed solutions. It offers a valuable basis for participatory resilience planning. Nevertheless, it gives less explicit attention to the transformative learning processes through which adults reconsider established assumptions, develop new understandings and translate learning into collective agricultural decisions. Its treatment of food-security dimensions is also less central.

Imran et al. (2026) explicitly connect climate change education with locally led and community-led adaptation, highlighting climate literacy, agency, participation and local knowledge. This contribution demonstrates that the education–adaptation relationship is already recognised in recent scholarship. However, the present paper develops a more specific explanation of how Transformative Learning Theory and community development practitioners can connect adult learning with inclusive decision-making, environmental justice, agricultural support and food security in Nigerian farming communities.

Table 1. *Comparison of Existing Frameworks and the Proposed Framework*

Existing framework	Main contribution	Issue addressed by the present paper
UNESCO (2024) Greening Curriculum Guidance	Action-oriented, scientifically grounded and justice-promoting climate education.	Application of adult learning to rural farming communities and community development practice.
National Association of Climate Resilience Planners (2017)	Community-defined resilience priorities, power-building and vulnerability assessment.	Connection between community planning, transformative adult learning and food-security concerns.
Imran et al. (2026)	Climate education as a foundation for locally led and community-led adaptation.	Specific practitioner roles, environmental justice and the material conditions linking learning with agricultural adaptation.
Present framework	Integrates adult learning, critical reflection, participation, environmental justice and community development facilitation.	Explains how these processes may connect with adaptive capacity and food security, subject to institutional and material conditions.

The comparison shows that the proposed framework does not claim to introduce an entirely new theory of climate adaptation or to be the first to connect education with community-led adaptation. Its distinctive contribution is to specify the relationships among transformative adult learning, community development facilitation, inclusive participation and environmental justice, while recognising the institutional and material conditions that influence whether learning informs agricultural adaptation and food security. It therefore provides a context-focused conceptual explanation for examining these relationships in Nigerian farming communities. These proposed relationships remain open to empirical assessment.

7. An Integrated Conceptual Framework

The proposed framework (Figure 1) explains how adult education and community development practice may contribute to climate adaptation, resilience and food security in Nigerian farming communities. It brings together five interconnected elements: transformative adult learning, inclusive community participation, environmental justice, community development facilitation,

and farmers' agency within enabling institutional and material conditions. These elements are linked to adaptive capacity, adaptation practices, climate resilience and food security.

Adult climate education provides opportunities for farmers to access, interpret and discuss relevant climate information. Through critical reflection and dialogue, informed by Transformative Learning Theory, farmers can examine established assumptions, compare local experience with other sources of knowledge and reconsider agricultural decisions. These processes may strengthen climate literacy and understanding of adaptation options, although learning does not automatically lead to practical change.

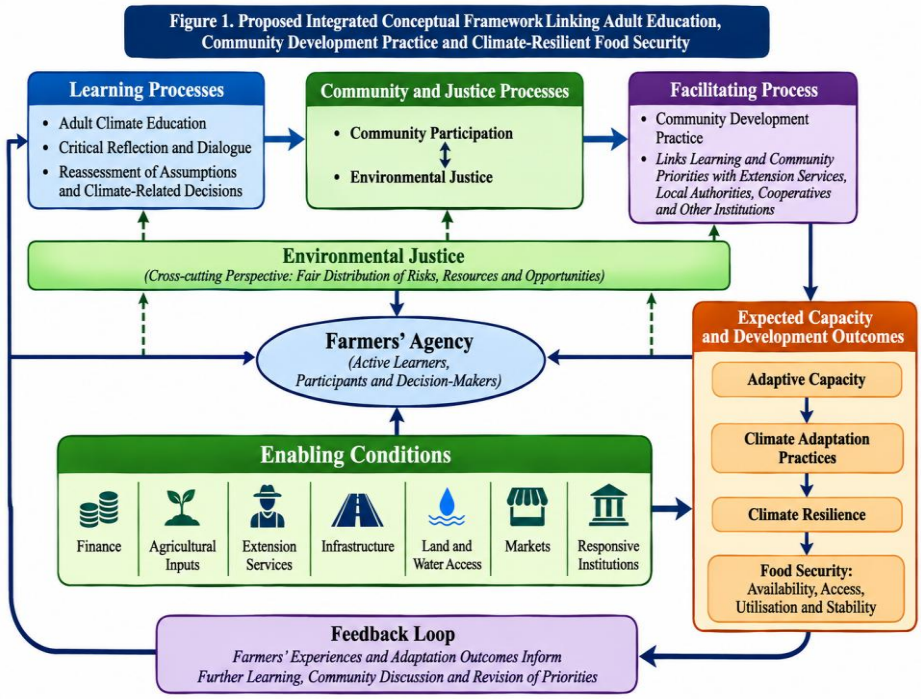
Community participation connects learning with collective identification of climate risks, priority-setting and adaptation decisions. Environmental justice cuts across these processes by emphasising fair access to information and resources, recognition of local knowledge, and meaningful representation of women, young people and resource-constrained households. Participation can help reveal inequalities, while environmental justice principles can guide more inclusive decisions.

Community development practitioners facilitate the connection between learning, community priorities and relevant institutions. Their roles include organising learning activities, facilitating inclusive dialogue, supporting collective planning and linking communities with extension services, cooperatives, local authorities and other development institutions. They complement rather than replace the technical responsibilities of agricultural extension personnel.

Farmers are positioned as active learners, participants and decision-makers. Their ability to translate learning and collective decisions into adaptation practices, however, depends partly on enabling conditions such as finance, suitable agricultural inputs, land and water access, infrastructure, markets, extension services and responsive institutions (Yahaya, et al., 2026). These conditions influence whether improved knowledge and participation can produce practical adaptation.

The interaction of these processes and conditions may strengthen farmers' adaptive capacity and support the adoption of appropriate adaptation practices. These, in turn, may contribute to climate resilience and the four dimensions of food security: availability, access, utilisation and stability. The framework does not assume that these outcomes follow automatically; their achievement remains influenced by wider socioeconomic, environmental and institutional circumstances. It also incorporates feedback, as farmers' experiences and adaptation outcomes can inform further learning, dialogue and revision of community priorities. The arrows in Figure 1 therefore represent proposed conceptual relationships, not proven causal effects.

Figure 1. *Proposed Integrated Conceptual Framework Linking Adult Education, Community Development Practice and Climate-Resilient Food Security.*



Source: Authors' conceptual synthesis of the reviewed literature (2026).

7.1. Propositions for Empirical Investigation

The framework generates five propositions for future empirical investigation:

Proposition 1: Adult climate education that combines locally relevant information, critical reflection and dialogue may strengthen farmers' climate literacy and understanding of adaptation options.

Proposition 2: Inclusive community participation may strengthen farmers' involvement in identifying climate risks, setting priorities and making collective adaptation decisions.

Proposition 3: Environmental justice may influence the extent to which different groups access climate information, participate in decisions and benefit from adaptation support.

Proposition 4: Community development practitioners may facilitate connections between adult learning, community priorities, agricultural extension services and other institutional resources.

Proposition 5: The contribution of adult learning and community development practice to climate adaptation and food security depends partly on enabling conditions, including finance, agricultural inputs, infrastructure, land and water access, markets and responsive institutions.

These propositions are intended for empirical testing rather than as established causal relationships. Participatory action research and mixed-methods case studies across different Nigerian agroecological zones could examine them using indicators such as climate literacy,

quality of participation, representation in decisions, practitioner–institutional collaboration, access to resources, adaptation practices and household food-security outcomes. Evidence that learning improves without corresponding changes in adaptation, or that adaptation occurs despite limited learning, would help refine the proposed relationships.

8. Contribution to Knowledge and Practice

The paper's conceptual contribution lies in explaining how transformative adult learning and community development practice can jointly connect climate education with agricultural adaptation and food security in Nigerian farming communities. Unlike approaches that primarily emphasise climate knowledge, curriculum or community resilience planning, the proposed framework specifies how critical reflection, dialogue, inclusive participation, environmental justice and institutional facilitation may interact to strengthen farmers' adaptive capacity. It also identifies the material and institutional conditions that influence whether learning can translate into practical adaptation.

A further contribution is the distinction between climate awareness, climate literacy, adaptive capacity, adaptation and food security. These concepts represent related but different processes and outcomes. Awareness does not necessarily demonstrate the ability to interpret climate information; climate literacy does not guarantee access to adaptation resources; and adopting adaptation practices does not automatically ensure household food security. The framework therefore provides a basis for examining these dimensions separately and their possible relationships.

For researchers, the five propositions provide a foundation for empirical studies examining adult learning, community participation, environmental justice, practitioner facilitation and the influence of enabling conditions on adaptation outcomes. Future studies can assess these relationships across different Nigerian agroecological settings rather than assume that findings from one locality apply nationally.

For adult educators, the paper highlights the need to move beyond information dissemination towards locally relevant learning programmes that combine climate information, practical demonstrations, critical reflection, dialogue and peer learning. For community development practitioners, it clarifies the importance of facilitating inclusive planning, identifying community priorities and connecting farmers with relevant institutions, while leaving specialised agricultural advice to extension personnel.

For policy institutions and development partners, the framework highlights the need to coordinate adult climate education with agricultural extension, finance, suitable inputs, infrastructure and meaningful community participation. Programme evaluation should therefore examine not only awareness and training attendance but also climate literacy, participation, access to resources, adaptation decisions and household food-security outcomes. This approach

recognises that education is an important contributor to climate resilience but cannot independently overcome structural and resource constraints.

9. Conclusion

This paper examined how adult education and community development practice may contribute to climate adaptation and food security in Nigerian farming communities. First, it established the relevance of Transformative Learning Theory by explaining how critical reflection, dialogue and the reassessment of established assumptions can support farmers' understanding of climate risks and adaptation options. However, learning alone cannot guarantee practical change where material and institutional constraints remain.

Second, the paper clarified the facilitative role of community development practitioners in connecting adult learning with inclusive participation, collective decision-making and relevant agricultural institutions. Their contribution complements, rather than replaces, the technical responsibilities of agricultural extension personnel. Environmental justice further highlights the importance of equitable access to information, resources and decision-making opportunities.

Third, the paper proposed an integrated conceptual framework linking transformative adult learning, community participation, environmental justice, community development facilitation and enabling conditions with farmers' adaptive capacity, climate adaptation, resilience and food security. The framework provides propositions for empirical investigation rather than established causal conclusions.

The central argument is that adult education can contribute meaningfully to climate-resilient farming and food security when learning is connected to collective action and the resources and institutional support required for adaptation. Its effectiveness therefore depends not only on what farmers learn but also on their opportunities and capacity to act.

10. Recommendations

Based on the proposed conceptual framework and its five propositions, the following recommendations are advanced:

1. Strengthen adult climate education programmes: Adult and non-formal education providers should design locally relevant programmes that combine climate information, critical reflection, practical demonstrations, dialogue and farmer-to-farmer learning. This recommendation reflects Proposition 1.

2. Promote inclusive community participation: Local governments and development organisations should facilitate participatory planning processes that enable women, young people, smallholder farmers and resource-constrained households to influence the identification of climate risks, adaptation priorities and community decisions. This addresses Proposition 2.

3. Integrate environmental justice into adaptation initiatives: Government agencies and development partners should assess whether climate information, adaptation resources and decision-making opportunities are equitably distributed, while ensuring that local knowledge and the voices of marginalised groups are recognised. This reflects Proposition 3.

4. Strengthen collaboration between community development practitioners and agricultural extension services: Local authorities and programme managers should establish clear arrangements through which community development practitioners facilitate learning, participation and institutional linkages, while extension personnel provide specialised agricultural information and technical guidance. This addresses Proposition 4.

5. Link climate education with material and institutional support: Government agencies, financial institutions and development partners should coordinate educational interventions with access to suitable agricultural inputs, finance, water facilities, storage, infrastructure, markets and responsive extension services. This recommendation reflects Proposition 5.

6. Strengthen programme monitoring and evaluation: Climate adaptation programmes should assess climate literacy, participation, representation in decision-making, access to resources, adaptation practices and the four dimensions of food security. Training attendance and increased awareness alone should not be treated as evidence of successful adaptation. Evaluation should examine the relationships proposed in the framework and recognise that educational interventions cannot independently overcome structural and resource constraints. This recommendation cuts across all five propositions.

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