

Reconfiguring Agricultural Innovation Linkages through Art-Based Extension Pedagogy: Implications for Climate Change Adaptation among Smallholder Farmers in Southeast Nigeria

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ABSTRACT

This study examined whether art-based extension pedagogy reconfigured agricultural innovation linkages and strengthened climate change adaptation outcomes. A cluster-randomized controlled trial involving 420 farmers across 24 rural communities in Imo and Ebonyi States compared an art-integrated extension model with a conventional advisory approach over nine months. The intervention employed participatory visual mapping, agro-ecological storytelling, and performance-based knowledge exchange to strengthen interactive learning among farmers, extension agents, and researchers. Multilevel regression results showed higher adoption of climate-smart agricultural practices in treatment communities ($\beta = 0.29$, $p < 0.01$) and improved adaptive capacity scores ($p < 0.05$) relative to controls. Network analysis indicated a 21% increase in farmer–extension–research interactions, while seasonal yield variability declined by 15% in treatment sites. Mediation tests confirmed that strengthened innovation linkages significantly predicted behavioural adaptation outcomes. The findings demonstrated that art-based extension integration enhanced institutional connectivity and climate resilience among smallholder farmers. The study concluded by providing a robust and empirical evidence that art-based extension pedagogy could significantly enhance agricultural innovation processes and climate change adaptation among smallholder farmers in Southeast Nigeria.

Keywords: Agricultural innovation systems; Climate change adaptation; Extension pedagogy

INTRODUCTION

Ayurveda always tells us to examine the patient properly before we start any treatment. In college we learn Nadi, Climate variability in Southeast Nigeria continues to expose structural weaknesses in farmer–extension–research linkages, limiting adaptive capacity among smallholder farmers. It also has emerged as one of the most critical challenges confronting agricultural systems in sub-Saharan Africa, particularly among smallholder farmers whose livelihoods are highly dependent on climate-sensitive production systems (Intergovernmental Panel on Climate Change, 2022; Food and Agriculture Organization, 2021). In Southeast Nigeria, increasing variability in rainfall patterns, rising temperatures, and the frequency of extreme weather events have intensified production uncertainties, thereby undermining food security and rural livelihoods (World Bank, 2020). Despite sustained investments in agricultural extension services, the capacity of smallholder farmers to adapt to these changes remains uneven and, in many cases, insufficient (Davis & Sulaiman, 2014).

At the core of this limitation lies a persistent structural weakness in the configuration of agricultural innovation systems specifically, the fragmented and often linear interactions among farmers, extension agents, and research institutions (Klerkx, van Mierlo, & Leeuwis, 2012). Conventional extension approaches in Nigeria have largely followed a top-down, technology-transfer model, where knowledge flows unidirectionally from experts to farmers (Anderson & Feder, 2007). While such approaches have achieved limited success in disseminating standardized practices, they have proven inadequate in fostering the adaptive, context-specific, and interactive learning processes required for climate change resilience (Leeuwis & van den Ban, 2004). Increasingly, scholars argue that effective climate adaptation depends not merely on access to information, but on the quality of relationships, knowledge co-creation, and feedback loops within innovation networks (Hall, Janssen, Pehu, & Rajalahti, 2006). In response to these limitations, recent interdisciplinary scholarship has begun to explore participatory and creative methodologies that enhance engagement, inclusivity, and experiential learning in rural development contexts (Pretty, 1995; Chambers, 2008). Among these, art-based pedagogical approaches such as visual storytelling, participatory mapping, and performance-based communication have gained attention for their potential to translate complex scientific knowledge into culturally resonant and locally meaningful forms (Leavy, 2015). As a corollary of the foregoing, in her capacity to produce rich, experiential data and promote holistic knowledge, art-based research (ABR) methodologies have become increasingly popular in the health sciences; using a variety of artistic media, such as theater, music, visual arts, and literature, to explore and explain intricate health-related issues (Onyebuchi-Igbokwe, et al, 2025). However, by fostering dialogue, reflection, and collective sense-making, art-based methods may strengthen social learning processes and reconfigure innovation linkages in ways that conventional extension systems often fail to achieve (Bandura, 1977; Kolb, 1984).

However, despite growing theoretical interest, empirical evidence on the effectiveness of art-based extension pedagogy in agricultural innovation systems remains limited, particularly within the context of climate change adaptation in sub-Saharan Africa. Existing studies have largely focused on participatory extension models without systematically examining how creative pedagogies influence the structure and functionality of innovation networks, nor how such transformations translate into measurable adaptation outcomes among smallholder farmers (Kiptot, Franzel, Hebinck, & Richards, 2007).

This study addresses this gap by investigating whether and how art-based extension pedagogy can reconfigure agricultural innovation linkages and enhance climate change adaptation among smallholder farmers in Southeast Nigeria. Adopting a cluster-randomized controlled trial design, the study compares an art-integrated extension model with a conventional advisory approach across rural communities in Imo and Ebonyi States. By integrating multilevel regression, social network analysis, and mediation modeling, the study not only evaluates behavioural and productivity outcomes but also examines the underlying relational mechanisms that drive adaptation processes.

The contribution of this study is threefold. First, it extends Agricultural Innovation Systems theory by introducing art-based pedagogy as a mechanism for strengthening interactive learning and institutional connectivity. Second, it provides rigorous empirical evidence on the role of creative extension approaches in enhancing climate resilience among smallholder farmers. Third, it offers practical insights for policymakers and development practitioners seeking to design more inclusive, participatory, and context-responsive agricultural extension systems in climate-vulnerable regions.

Accordingly, the study was guided by the following research objectives:

1. To examine the effect of art-based extension pedagogy on the adoption of climate-smart agricultural practices among smallholder farmers.
2. To assess the extent to which art-based approaches reconfigure farmer–extension–research linkages within agricultural innovation systems.
3. To evaluate the impact of strengthened innovation linkages on farmers’ adaptive capacity and productivity outcomes.
4. To determine whether innovation linkages mediate the relationship between extension pedagogy and climate adaptation outcomes.

2. LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Agricultural Innovation Systems (AIS) Perspective

The Agricultural Innovation Systems (AIS) framework provides a comprehensive lens for understanding how agricultural knowledge is generated, disseminated, and utilized through interactions among multiple actors, including farmers, extension agents, researchers, policymakers, and private sector stakeholders (Klerkx et al.,

2012; Hall et al., 2006). Unlike linear models of technology transfer, AIS emphasizes **networks, institutional linkages, and interactive learning** as central to innovation processes.

Within the context of climate change adaptation, AIS highlights that farmers' adaptive capacity is not solely determined by access to technologies but by the **strength and quality of relationships** within the innovation system (World Bank, 2006). Weak or fragmented linkages often result in poor feedback mechanisms, limited knowledge co-creation, and low adoption of context-specific innovations. In many parts of sub-Saharan Africa, including Nigeria, extension systems remain inadequately integrated with research institutions and farmer networks, thereby constraining adaptive responses to climate variability (Davis & Sulaiman, 2014).

This study builds on the AIS framework by proposing that **art-based extension pedagogy** can serve as a catalytic mechanism for strengthening linkages, enhancing communication flows, and fostering collaborative problem-solving within agricultural systems.

2.1.2 Social Learning Theory

Social Learning Theory, advanced by Albert Bandura (1977), posits that learning occurs through observation, interaction, and imitation within social contexts. In agricultural settings, farmers often acquire knowledge not only from formal extension services but also through peer interactions, demonstration, and shared experiences.

Applied to climate change adaptation, social learning facilitates **collective understanding, behavioural change, and innovation diffusion** (Reed et al., 2010). Participatory approaches that encourage dialogue and experiential engagement tend to produce more sustainable outcomes than didactic knowledge transfer models. Art-based pedagogies through storytelling, drama, and visual expression align strongly with social learning principles by enabling farmers to **observe, interpret, and internalize knowledge in culturally meaningful ways**.

2.1.3 Experiential Learning Theory

Experiential Learning Theory, developed by David Kolb (1984), emphasizes learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. In agricultural extension, experiential learning enables farmers to engage directly with new practices, reflect on outcomes, and adapt innovations to local conditions.

Art-based extension methods operationalize experiential learning by transforming abstract climate information into **tangible, participatory experiences**. For instance, participatory visual mapping and performance-based communication allow farmers to actively engage with climate scenarios, fostering deeper understanding and retention. This aligns with emerging calls for **transformative learning approaches** in climate adaptation, where knowledge is co-created rather than passively received (Mezirow, 1997).

2.1.4 Conceptual Integration

By integrating AIS, Social Learning Theory, and Experiential Learning Theory, this study conceptualizes art-based extension pedagogy as a **multidimensional intervention** that:

- Strengthens **innovation linkages** (AIS)
- Enhances **interactive and observational learning** (Social Learning)
- Promotes **active engagement and reflection** (Experiential Learning)

This integrated framework provides the basis for examining how creative pedagogical approaches can influence both **network structures** and **adaptation outcomes** among smallholder farmers.

2.2 Empirical Review

2.2.1 Agricultural Extension and Climate Change Adaptation

Empirical studies consistently highlight the critical role of extension services in promoting climate-smart agricultural practices. For instance, Anderson and Feder (2007) found that access to extension services significantly improves technology adoption among smallholder farmers. Similarly, Deressa et al. (2009) reported that extension access enhances farmers' ability to perceive and respond to climate risks in Ethiopia.

However, the effectiveness of extension systems in sub-Saharan Africa has been widely criticized due to issues such as limited coverage, inadequate funding, and weak institutional coordination (Davis & Sulaiman, 2014). In Nigeria, extension delivery has often been characterized by top-down communication and insufficient farmer participation, leading to low adoption rates of climate-resilient practices (Aker, 2011).

2.2.2 Innovation Linkages and Network-Based Approaches

Recent research emphasizes the importance of **network-based approaches** in agricultural innovation. Strong linkages among farmers, researchers, and extension agents have been shown to enhance knowledge exchange, innovation uptake, and adaptive capacity (Klerkx et al., 2012). Social network analysis studies reveal that farmers

embedded in dense and diverse networks are more likely to adopt climate-smart practices and respond effectively to environmental changes (Isaac et al., 2007).

Despite this evidence, many rural communities in Africa continue to experience **fragmented innovation systems**, where interactions among key actors are limited or inefficient. Strengthening these linkages is therefore critical for improving agricultural resilience.

2.2.3 Participatory and Creative Extension Approaches

Participatory approaches to extension have gained prominence as alternatives to conventional models. Techniques such as farmer field schools, participatory rural appraisal, and community-based learning have been shown to enhance knowledge co-creation and adoption outcomes (Pretty, 1995; Chambers, 2008).

More recently, scholars have explored the role of **creative and art-based methods** in development communication. Patricia Leavy (2015) highlights the potential of arts-based research and pedagogy to improve engagement, accessibility, and knowledge translation. In agricultural contexts, storytelling, theatre, and visual arts have been used to communicate complex information, foster participation, and stimulate behavioural change (Pringle, 2011).

However, empirical evidence on the integration of art-based methods into formal extension systems remains limited, particularly in relation to **measurable outcomes such as network restructuring, adoption rates, and productivity improvements**.

2.2.4 Research Gap

While existing literature highlights the importance of participatory approaches and innovation networks in agricultural adaptation, key gaps persist. First, limited attention has been given to art-based pedagogical approaches as structured tools for enhancing extension effectiveness and knowledge co-creation (Pretty, 1995; Chambers, 2008). Second, although the Agricultural Innovation Systems (AIS) framework emphasizes interaction among actors, few studies empirically examine how specific interventions can reconfigure innovation linkages (Klerkx et al., 2012). Third, much of the evidence on extension effectiveness in sub-Saharan Africa relies on observational designs, with insufficient use of rigorous experimental methods to establish causal relationships (Davis & Sulaiman, 2014). Finally, in the Nigerian context, there is limited empirical research linking extension pedagogy, network dynamics, and measurable climate adaptation outcomes among smallholder farmers.

This study addresses these gaps by employing a cluster-randomized controlled design to examine how art-based extension pedagogy influences innovation linkages and climate adaptation outcomes in Southeast Nigeria.

3. METHODOLOGY

3.1 Research Design

This study employed a **cluster-randomized controlled trial (CRCT)** to examine the effects of art-based extension pedagogy on agricultural innovation linkages and climate change adaptation outcomes among smallholder farmers. The cluster design was considered appropriate due to the community-based nature of agricultural extension delivery, where interventions are typically administered at the group or village level rather than to isolated individuals (Hayes & Moulton, 2017).

Rural communities served as the unit of randomization to minimize contamination effects arising from information spillovers among farmers. The study adopted a **parallel-group design**, consisting of a treatment group exposed to the art-based extension intervention and a control group receiving conventional extension services. The intervention lasted for **nine months**, covering a full agricultural cycle to capture seasonal variations in farming practices and outcomes.

3.2 Study Area

The study was conducted in Southeast Nigeria, specifically in rural communities across Imo State and Ebonyi State. These states were selected due to their high dependence on rain-fed agriculture and increasing vulnerability to climate variability, including erratic rainfall patterns and soil degradation.

The region is characterized by smallholder farming systems dominated by crops such as cassava, yam, maize, and vegetables. Limited access to extension services, coupled with weak institutional linkages, makes the area suitable for examining the effectiveness of innovative extension approaches.

3.3 Population and Sampling Procedure

The target population comprised smallholder farmers engaged in crop production within selected rural communities. A multi-stage sampling technique was employed.

First, two states (Imo and Ebonyi) were purposively selected based on agro-ecological relevance and climate vulnerability. Second, **24 rural communities** were randomly selected and constituted the study clusters. Third, within each community, eligible farmers were identified using extension records and community registers.

A total sample of **420 farmers** was drawn, with approximately equal representation across treatment and control groups. Inclusion criteria required participants to:

- Be actively engaged in smallholder farming
- Have resided in the community for at least two years
- Be willing to participate throughout the intervention period

Random assignment of communities into treatment and control groups ensured baseline comparability and minimized selection bias.

3.4 Description of Intervention

The treatment group received an **art-based extension pedagogy intervention**, designed to enhance interactive learning and strengthen innovation linkages. The intervention integrated the following components:

Participatory Visual Mapping: Farmers collaboratively mapped climate risks, farming practices, and resource flows using locally relevant symbols and drawings.

- **Agro-ecological Storytelling:** Narrative techniques were used to communicate climate adaptation strategies, incorporating indigenous knowledge and lived experiences.
- **Performance-Based Knowledge Exchange:** Drama, role-play, and community theatre facilitated experiential learning and peer-to-peer knowledge sharing.

These activities were co-facilitated by trained extension agents and local facilitators, ensuring contextual relevance and cultural appropriateness.

The control group received **conventional extension services**, characterized by periodic advisory visits, lectures, and distribution of informational materials without participatory or creative engagement.

3.5 Data Collection Methods

Data were collected using a combination of quantitative and network-based instruments:

Structured Questionnaire: Captured socio-economic characteristics, adoption of climate-smart agricultural practices, and adaptive capacity indicators.

Adaptive Capacity Index (ACI): Constructed using indicators such as access to information, resource availability, and livelihood diversification (Deressa et al., 2009).

Social Network Survey: Measured interactions among farmers, extension agents, and researchers, including frequency and intensity of communication.

Farm Production Records: Documented seasonal yields and variability across the study period.

Baseline data were collected prior to the intervention, while endline data were gathered after nine months.

3.6 Measurement of Variables

Key variables were operationalized as follows:

Adoption of Climate-Smart Practices (Dependent Variable): Measured as the number of recommended practices adopted by each farmer.

Adaptive Capacity (Outcome Variable): Assessed using composite index scores derived from multiple indicators.

Innovation Linkages (Mediator Variable): Measured through network density, centrality, and frequency of interactions.

Extension Pedagogy (Independent Variable): Binary variable indicating participation in art-based (1) or conventional (0) extension.

Control variables included age, education, farm size, and farming experience.

3.7 Data Analysis Techniques

Data analysis was conducted using a combination of statistical and network analysis methods:

Descriptive Statistics: Summarized socio-economic characteristics and baseline conditions.

Multilevel Regression Analysis: Accounted for clustering at the community level and estimated the effect of the intervention on adoption and adaptive capacity outcomes.

Social Network Analysis (SNA): Examined changes in interaction patterns using metrics such as network density and degree centrality (Borgatti et al., 2009).

Mediation Analysis: Tested whether innovation linkages mediated the relationship between extension pedagogy and adaptation outcomes, following the approach of Baron and Kenny (1986) and subsequent refinements (Zhao et al., 2010).

All statistical analyses were conducted at a **5% significance level**, ensuring robustness of findings.

3.8 Validity and Reliability

To ensure the validity and reliability of the study:

Instruments were pre-tested in a pilot community outside the study area.

Internal consistency of composite indices was assessed using **Cronbach's alpha**.

Randomization enhanced internal validity by reducing selection bias.

Triangulation of survey, network, and production data improved construct validity.

3.9 Ethical Considerations

Informed consent was secured from all participants, and confidentiality of responses was strictly maintained. Participation was voluntary, and respondents were free to withdraw at any stage without consequence.

4. RESULTS

4.1 Descriptive Statistics and Baseline Characteristics

Table 4.1 presents the baseline socio-economic characteristics of respondents across treatment and control groups. The results indicate no statistically significant differences between the two groups in terms of age, education, farm size, and farming experience ($p > 0.05$), confirming the effectiveness of randomization.

Table 4.1: Baseline Characteristics of Respondents

Variable	Treatment (n = 210)	Control (n = 210)	t-value	p-value
Mean Age (years)	45.3	44.8	0.62	0.53
Years of Education	8.6	8.4	0.48	0.63
Farm Size (hectares)	1.9	1.8	0.71	0.48
Farming Experience	17.5	16.9	0.59	0.55

These findings suggest that both groups were comparable prior to the intervention, thereby supporting the internal validity of subsequent impact estimates.

4.2 Effect of Art-Based Extension on Adoption of Climate-Smart Practices

To address Objective 1, a multilevel regression analysis was conducted to estimate the effect of the intervention on the adoption of climate-smart agricultural practices.

Table 4.2: Multilevel Regression Results for Adoption of Climate-Smart Practices

Variable	Coefficient (β)	Std. Error	t-value	p-value
Art-Based Extension (1 = Yes)	0.29	0.08	3.63	0.001**
Age	0.01	0.01	1.12	0.26
Education	0.03	0.02	1.45	0.15
Farm Size	0.07	0.03	2.10	0.04*
Farming Experience	0.01	0.01	0.98	0.33

*Significant at $p < 0.05$; ** $p < 0.01$

The results show that participation in the art-based extension intervention significantly increased the adoption of climate-smart practices ($\beta = 0.29$, $p < 0.01$). This indicates that farmers exposed to the intervention adopted a higher number of recommended practices compared to those in the control group.

4.3 Impact on Adaptive Capacity

To evaluate Objective 3, the effect of the intervention on adaptive capacity was analyzed using multilevel modeling.

Table 4.3: Effect of Intervention on Adaptive Capacity

Variable	Coefficient (β)	Std. Error	t-value	p-value
Art-Based Extension	0.21	0.09	2.33	0.02*
Education	0.05	0.02	2.50	0.01*
Farm Size	0.06	0.03	2.00	0.05*

*Significant at $p < 0.05$

The findings reveal a statistically significant improvement in adaptive capacity among farmers in the treatment group ($\beta = 0.21$, $p < 0.05$), suggesting that the intervention enhanced farmers' ability to respond to climate-related challenges.

4.4 Changes in Innovation Linkages (Social Network Analysis)

To address Objective 2, social network analysis was conducted to examine changes in interaction patterns among farmers, extension agents, and researchers.

Results indicate that:

Network density increased from **0.34 to 0.41** in treatment communities

Frequency of farmer–extension interactions increased by **21%**

Degree centrality scores for extension agents improved significantly

These findings suggest that the intervention strengthened **connectivity and information flow** within the agricultural innovation system.

4.5 Effect on Yield Variability

Seasonal production data were analyzed to assess changes in yield stability.

Table 4.4: Yield Variability across Groups

Group	Mean Yield (kg/ha)	Standard Deviation	% Change in Variability
Treatment	2,450	320	-15%
Control	2,180	375	—

The treatment group experienced a **15% reduction in yield variability**, indicating improved resilience to climate fluctuations.

4.6 Mediation Analysis: Role of Innovation Linkages

To address Objective 4, mediation analysis was conducted to determine whether innovation linkages mediated the relationship between extension pedagogy and adaptation outcomes.

Results indicate that:

Art-based extension significantly predicted innovation linkages ($p < 0.01$)

Innovation linkages significantly predicted adoption outcomes ($p < 0.01$)

The direct effect of extension pedagogy decreased but remained significant when the mediator was included

This confirms **partial mediation**, suggesting that strengthened innovation networks serve as a key mechanism through which the intervention influences behavioural adaptation.

4.7 Summary of Key Findings

Art-based extension significantly increased adoption of climate-smart practices

Adaptive capacity improved among treatment participants

Innovation linkages were strengthened through increased interaction

Yield variability declined, indicating enhanced resilience

Innovation linkages partially mediated adaptation outcomes

5. DISCUSSION

This study set out to examine whether art-based extension pedagogy can reconfigure agricultural innovation linkages and enhance climate change adaptation among smallholder farmers in Southeast Nigeria. The findings provide strong empirical support for the transformative potential of creative, participatory extension approaches in strengthening both **institutional connectivity** and **adaptive outcomes**.

5.1 Art-Based Extension and Adoption of Climate-Smart Practices

The results demonstrate that art-based extension pedagogy significantly increased the adoption of climate-smart agricultural practices. This finding reinforces existing evidence that participatory and experiential learning approaches are more effective than conventional top-down extension models in promoting behavioural change (Anderson & Feder, 2007; Pretty, 1995). However, this study extends prior research by showing that the **integration of artistic and performative elements** further enhances engagement and knowledge internalization. From a theoretical standpoint, this aligns with **Social Learning Theory**, as proposed by Albert Bandura (1977), which emphasizes learning through observation, interaction, and shared experiences. The use of storytelling, visual mapping, and performance-based communication likely facilitated **collective interpretation of climate risks**, thereby increasing farmers' willingness to adopt new practices. Unlike conventional extension approaches that prioritize information delivery, art-based methods appear to foster **meaning-making processes**, which are critical for sustained behavioural change.

5.2 Strengthening Innovation Linkages through Creative Pedagogy

A key contribution of this study lies in demonstrating that art-based extension pedagogy significantly strengthened farmer extension research linkages. The observed increase in network density and interaction frequency suggests that the intervention enhanced **communication flows and relational ties** within the agricultural innovation system.

This finding provides empirical support for the Agricultural Innovation Systems (AIS) perspective, which posits that innovation is driven by the **quality of interactions among actors rather than isolated knowledge transfer** (Klerkx et al., 2012). Importantly, this study moves beyond theoretical assertions by showing that **pedagogical design itself can serve as a mechanism for restructuring innovation networks**.

The results also resonate with findings from network-based studies (Isaac et al., 2007), which indicate that stronger and more diverse linkages improve access to information and facilitate innovation uptake. In this context, art-based approaches may have functioned as **social catalysts**, creating inclusive spaces for dialogue and reducing hierarchical barriers between farmers and extension agents.

5.3 Enhancing Adaptive Capacity and Resilience

The significant improvement in adaptive capacity among treatment participants highlights the effectiveness of art-based extension in building **climate resilience**. This supports earlier studies suggesting that participatory extension enhances farmers' ability to perceive, interpret, and respond to climate risks (Deressa et al., 2009).

From an experiential learning perspective, as articulated by David Kolb (1984), the intervention likely facilitated a cycle of **experience, reflection, and experimentation**, enabling farmers to adapt practices to their local contexts. By engaging farmers in active learning processes, the intervention moved beyond knowledge dissemination to foster **adaptive competencies**, which are essential in uncertain and dynamic climatic conditions. Furthermore, the observed reduction in yield variability suggests that improved adaptive capacity translated into **tangible production outcomes**, reinforcing the practical relevance of the intervention.

5.4 Mediation Role of Innovation Linkages

The mediation analysis provides critical insight into the mechanisms underlying the observed effects. The finding that innovation linkages partially mediate the relationship between extension pedagogy and adaptation outcomes indicates that **network restructuring is a key pathway through which behavioural change occurs**.

This finding advances the AIS literature by empirically validating the proposition that **stronger institutional linkages enhance innovation and adaptation** (Hall et al., 2006). It also aligns with emerging perspectives that emphasize the role of **relational dynamics and social capital** in shaping development outcomes.

However, the presence of partial rather than full mediation suggests that other factors such as individual motivation, cultural relevance, and experiential engagement also contribute to the effectiveness of art-based extension. This underscores the **multidimensional nature of learning and adaptation processes**.

5.5 Contribution to Knowledge and Practice

This study makes several important contributions to both theory and practice. Theoretically, it extends the Agricultural Innovation Systems framework by introducing **art-based pedagogy as an active driver of network transformation**, rather than treating linkages as static features. It also integrates insights from social and experiential learning theories to provide a more holistic understanding of extension effectiveness.

Empirically, the study contributes to the limited body of rigorous evidence on creative extension approaches by employing a **cluster-randomized controlled trial**, thereby strengthening causal inference. This addresses longstanding methodological limitations in agricultural extension research (Davis & Sulaiman, 2014).

Practically, the findings suggest that policymakers and development practitioners should move beyond conventional advisory models and adopt **inclusive, participatory, and culturally embedded extension strategies**. Integrating art-based methods into extension systems may offer a scalable pathway for enhancing climate resilience among smallholder farmers, particularly in resource-constrained settings.

5.6 Summary of Interpretations

Overall, the findings indicate that:

Art-based pedagogy enhances **learning effectiveness and behavioural adoption**

Creative approaches strengthen **innovation linkages and institutional connectivity**

Improved linkages serve as a **mechanism for climate adaptation**

Experiential and participatory learning fosters **resilience and productivity stability**

6. CONCLUSION AND POLICY IMPLICATIONS

6.1 Conclusion

This study provides robust empirical evidence that art-based extension pedagogy can significantly enhance agricultural innovation processes and climate change adaptation among smallholder farmers in Southeast Nigeria. By moving beyond conventional top-down advisory models, the intervention demonstrated that creative, participatory approaches are capable of fostering deeper engagement, strengthening institutional linkages, and improving adaptive outcomes.

The findings reveal that farmers exposed to art-based extension methods exhibited higher adoption of climate-smart agricultural practices, improved adaptive capacity, and reduced yield variability. More importantly, the study establishes that these outcomes are not merely the result of increased information access, but are driven by **enhanced interaction, knowledge co-creation, and network connectivity** within the agricultural innovation system.

By integrating insights from Agricultural Innovation Systems, Social Learning Theory, and Experiential Learning Theory, this study advances a more holistic understanding of how extension pedagogy shapes both **relational structures and behavioural outcomes**. The use of a cluster-randomized controlled design further strengthens the credibility of the findings, providing rare causal evidence within the context of agricultural extension research in sub-Saharan Africa.

6.2 Policy Implications



The findings carry significant implications for agricultural policy and rural development practice:

Reorientation of Extension Systems:

Agricultural extension services should transition from linear, information-delivery models to **interactive and participatory systems** that emphasize learning, dialogue, and co-creation.

Integration of Art-Based Pedagogies:

Ministries of agriculture and development agencies should incorporate **art-based communication tools** such as storytelling, participatory mapping, and community theatre into extension programming to enhance accessibility and engagement.

Strengthening Innovation Linkages:

Policies should prioritize the development of **multi-actor platforms** that facilitate sustained interaction among farmers, researchers, and extension agents, thereby improving knowledge flows and innovation uptake.

Capacity Building for Extension Agents:

Training programs should equip extension personnel with skills in **facilitation, participatory learning, and creative communication**, enabling them to effectively implement non-traditional extension approaches.

Scaling Climate Adaptation Strategies:

Given the demonstrated impact on adaptive capacity and yield stability, art-based extension models should be **scaled across climate-vulnerable regions** as part of broader climate resilience strategies.

6.3 Limitations of the Study

Despite its contributions, the study has some limitations. First, the intervention was conducted within a specific geographical context (Southeast Nigeria), which may limit the generalizability of findings to other regions with different socio-cultural or agro-ecological conditions. Second, the study covered a nine-month period, which, while sufficient to capture short-term outcomes, may not fully reflect long-term adaptation dynamics. Third, although the study incorporated multiple analytical techniques, qualitative insights into farmers' lived experiences could further enrich understanding of the mechanisms underlying behavioural change.

6.4 Suggestions for Future Research

Future studies should explore the long-term sustainability of art-based extension interventions and their effects across multiple agricultural seasons. Comparative studies across different regions and cultural contexts would also help establish external validity. Additionally, integrating **mixed-methods approaches**, including in-depth qualitative analyses, could provide deeper insights into the socio-cultural dimensions of learning and adaptation. Further research may also examine the cost-effectiveness and scalability of art-based extension models within national agricultural systems.

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