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Climate-Resilient Sustainable Agriculture Adoption Among Smallholder Farmers in Northern Ghana

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Article

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Abstract

Smallholder farmers in northern Ghana are caught in a difficult bind. On one side, climate variability is pressing harder than ever, erratic rains, extended dry spells, and land degraded by decades of over-cultivation. On the other, the transition to climate-resilient sustainable agriculture (CRSA) remains frustratingly uneven, more talked about than practised. This paper presents findings from a Knowledge, Attitudes and Practices (KAP) study carried out at the conclusion of the four-year Northern Ghana Integrated Development Programme (NGIDP, 2019–2023), an EU-funded initiative implemented by ActionAid Ghana, Tree Aid, and URBANET across 15 districts and 300 communities in the Northern, Upper East, Upper West, and Savannah Regions. The study, designed using a convergent parallel mixed-methods approach, collected data from 247 respondents, primarily women smallholder farmers, female extension volunteers (FEVs), and civil society organization (CSO) leaders. What the data show is striking in its tensions. Knowledge of specific CRSA techniques is high: cover cropping (74.3%), mulching (62.1%), and compost or organic manure use (53.8%) are widely recognized. Attitudinal openness to adoption is similarly encouraging, 83.1% of smallholders express willingness to invest in sustainable practices, and 74.9% say they would take credit to do so. Yet consistent practice remains elusive. Only 18.9% report practising what they were taught very frequently, and just 17.1% say they do it always. The barriers farmers identify are structural rather than motivational: the labour intensity of CRSA techniques (47.3%), slow returns on investment (50.1%), the relative cost of sustainable inputs (53.1%), land tenure insecurity (33.4%), and the near-total absence of enforced biodiversity conservation bylaws (80.6%). Bridging the gap between knowledge and practice, this article argues, is not a matter of more training. It requires complementary investments in rural financial services, meaningful land tenure reform, and extension models that support farmers season by season, not just at a demonstration farm.

1. Introduction

Anyone who has spent time in the farming communities of Ghana's North understands, intuitively, what the data confirm in aggregate: rain-fed agriculture in these landscapes is a precarious business. The five regions that form this area (Northern, Upper East, Upper West, North-East and Savannah) share an agro-ecological character that makes climate variability not a distant forecast but a recurring fact of life. Rainfall patterns have grown more erratic over recent decades, compressing the growing season at both ends, intensifying dry spells between rains, and feeding a cycle of soil degradation that undermines farmers' capacity to respond (Antwi-Agyei & Nyantakyi-Frimpong, 2021). Bushfires, driven partly by traditional land management practices and partly by the Guinea Savannah's dry-season climate, compound both farmland loss and biodiversity destruction. Against this backdrop, the question of how smallholder farmers are understanding, accepting, and actually practising available climate-resilient technologies is not a peripheral academic concern. It has direct implications for food security, livelihood stability, and the long-term viability of communities whose survival depends on what they can coax from the soil each year.

Climate-resilient sustainable agriculture (CRSA) covers a wide range of techniques (cover cropping, mulching, agroforestry, zero tillage, compost and organic manure preparation, terracing, and green manuring, among others) all oriented toward improving soil health, buffering farmers against climate shocks, and contributing to broader ecosystem function (Khatri-Chhetri et al., 2020). These are not new ideas in northern Ghana. Elements of several have long been embedded in indigenous farming knowledge, adapted over generations to local soil and climatic conditions. What development research has increasingly clarified, however, is that knowing a practice and consistently using it are two very different things. The gap between knowledge and behaviour is mediated by a complex set of structural realities: who has access to labour and capital, how secure one's land tenure is, what the market conditions look like, what peers are doing, and how the institutions around farming operate, or fail to operate (Agyekum et al., 2024).

This article presents findings from a Knowledge, Attitudes and Practices (KAP) study conducted at the conclusion of the Northern Ghana Integrated Development Programme (NGIDP), a four-year initiative (2019–2023) funded by the European Union and implemented by ActionAid Ghana (AAG) in partnership with Tree Aid and URBANET. The NGIDP was built around result areas that focused specifically on building smallholder resilience to climate change through biodiversity preservation and the uptake of sustainable agricultural practices. The KAP study was commissioned to take stock of what the programme had achieved, not just in the language of outputs (training sessions held, demonstration farms established, extension volunteers deployed), but in terms of real shifts in knowledge, attitudes, and behaviour.

Three core empirical questions organize this article. What is the state of CRSA knowledge among smallholder farmers who participated in NGIDP activities? What shapes their attitudes toward adoption, and where does the gap between positive intention and actual behaviour lie? And what structural, institutional, and social constraints most significantly block consistent practice uptake? In engaging these questions, the article contributes to a growing body of work on climate-smart agriculture adoption in West Africa and offers grounded, evidence-based insights for agricultural development programming in northern Ghana and comparable agrarian contexts.

The article proceeds as follows. Section 2 reviews the relevant literature on CRSA adoption, KAP frameworks, and the specific challenges of agricultural behavioural change in patriarchal, land-insecure contexts. Section 3 describes the study methodology. Section 4 presents findings across the three KAP domains. Section 5 discusses the implications, and Section 6 offers conclusions and recommendations.

2. Literature Review

2.1 CRSA Adoption in Sub-Saharan Africa: What the Evidence Shows

Research on climate-smart agriculture (CSA) adoption in sub-Saharan Africa has accumulated substantially over the past decade. A consistent finding across multiple country contexts is that adoption rates of CRSA techniques remain far below their agronomic potential, not because farmers are unaware of them or uninterested, but because adoption depends on a set of enabling factors that many smallholders, particularly women smallholders, are systematically denied (Agyekum et al., 2024; Antwi-Agyei et al., 2021). Those enabling factors include secure land access, affordable credit, quality inputs, practical knowledge of technique-specific details, and the social capital that makes peer learning and collective action possible.

A systematic review of CSA adoption in West Africa by Agyekum et al. (2024) found that access to credit and financial resources, gender, household size, and membership of farmer organizations were consistently among the most important determinants of practice uptake. Critically, resource-constrained households, those with limited land, few assets, and no access to credit, showed the lowest adoption rates, regardless of their knowledge levels. This framing matters for interpreting KAP study findings: high knowledge in the presence of persistent structural barriers does not represent a programme failure; it identifies exactly where complementary investments are most needed.

Cover cropping, mulching, and organic soil amendments, the three practices most widely recognized among NGIDP participants, are relatively accessible compared to precision irrigation or large-scale agroforestry systems. Even so, they impose additional labour demands at peak farming seasons when rural labour markets are at their tightest (Khatri-Chhetri et al., 2020). For women smallholders, who carry primary responsibility for household food production alongside substantial unpaid care and domestic work, these labour constraints are especially binding. Development programmes that promote CRSA without attending to the gendered dimensions of labour allocation will find their adoption impact moderated by these realities (Quisumbing et al., 2021).

2.2 KAP Frameworks as Evaluation Tools in Agricultural Development

Knowledge, Attitudes and Practices surveys have been used in public health and social development research for decades, offering a structured way to map the pathway from information exposure to behavioural change (Delil et al., 2022). Their application in agricultural contexts is more recent and less standardized, but a growing number of agricultural extension programmes have adopted KAP frameworks as evaluation tools, recognizing that training statistics tell only part of the story about programme effectiveness (Davis et al., 2021).

The fundamental insight the KAP framework offers is that change unfolds in stages and at different rates along the knowledge–attitude–practice continuum. A farmer may acquire knowledge of a technique relatively quickly, particularly through participatory channels like demonstration farms and farmer field schools, but attitudinal change takes longer, requiring not just cognitive uptake but the renegotiation of beliefs, norms, and habits formed by experience and social context. Practice change is slower still, because it depends not only on positive attitudes but on enabling conditions in the external

environment (Oo et al., 2022). Evaluations that conflate these stages, treating knowledge as a proxy for behaviour change will systematically overestimate impact.

The KAP gap, the discrepancy between what people know and what they do, is now widely acknowledged as one of the central challenges for agricultural programme design (Antwi-Agyei et al., 2021). Several explanatory frameworks have been applied: the theory of planned behaviour (which highlights perceived behavioural control alongside attitudes and social norms), adoption diffusion theory (which maps the social spread of innovations through populations), and the sustainable livelihoods framework (which foregrounds the asset base within which decisions are made). Each, in different ways, underlines the insufficiency of knowledge transmission as a standalone strategy.

2.3 Female Extension Volunteers and Gender-Responsive Extension

Extension services in northern Ghana have historically been delivered through government agricultural extension agents (AEAs), but the ratio of agents to farmers has remained chronically inadequate, a structural deficit that the NGIDP attempted to address through the deployment of female extension volunteers (FEVs) drawn from within the communities they serve. The FEV model rests on a well-established principle in extension theory: that peer-to-peer knowledge transfer, mediated by community members who share the social context and daily realities of their audience, tends to be more effective than top-down expert instruction (Davis et al., 2021).

The gender dimension of extension service delivery in patriarchal agrarian contexts deserves particular attention. Women farmers in Northern Ghana frequently report difficulty accessing the services of male extension agents due to social norms governing mixed-gender interactions, distance, and time constraints related to care work (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Quisumbing et al., 2021). Female extension volunteers, positioned within communities and operating inside women's social networks, lower these barriers considerably. They also tend to communicate agricultural advice in ways that are more sensitive to women's specific production contexts such as the crops women manage, the labour constraints they face, and the household decision-making dynamics they navigate.

2.4 Land Tenure, Institutional Environment, and CRSA Adoption

Land tenure insecurity stands out as one of the most consistently documented barriers to CRSA adoption in northern Ghana. Customary land tenure systems in the region vest ownership in families, skins (traditional political authorities), and communities, with women typically accessing land through male relatives and holding only secondary or conditional use rights (Doss et al., 2020). The practical implication for CRSA adoption is direct: farmers who cannot be sure of long-term access to the land they cultivate have limited rational incentive to invest in practices whose benefits accrue over multiple seasons. Composting builds soil-carbon over years; agroforestry investments may take a decade to mature; terracing is meaningless on land one may not access next year.

The institutional environment for biodiversity conservation and land restoration is similarly fragile. Local bylaws on land use and bushfire management exist in some communities but are inconsistently enforced, particularly where traditional authorities who hold customary authority over land are not actively engaged. Recent scholarship has emphasized that sustainable land management in smallholder contexts depends critically on alignment between statutory frameworks and customary governance systems (Dery et al., 2021). Where that alignment is absent, community-level conservation practices remain vulnerable to defection by actors who face no credible enforcement consequences.

3. Methodology

3.1 Study Setting

The study was conducted across eight purposively selected districts from the 15 in which the NGIDP operated: Nanumba South, Kpandai, Gushegu, Mion, Zabzugu, Tatale/Sanguli, Central Gonja, Builsa South, Bawku West, Nabdam, Kassena Nankana East, Lawra, Lambusie, Sisala East, and Wa East. These districts span Ghana's Northern, Upper East, Upper West, and Savannah Regions and were selected to provide geographic and ecological representation across the NGIDP's implementation footprint. Within selected districts, 16 communities were sampled for data collection.

The study area is characterized by a Guinea Savannah ecology with a single rainy season lasting approximately five months (May–September) and a prolonged dry season marked by the Harmattan wind. Subsistence and small-scale commercial farming (predominantly maize, sorghum, millet, groundnuts, and legumes) underpin the livelihoods of the vast majority of rural households. Average farm sizes are small (typically 1–3 hectares), labour is largely family-supplied, and market access is constrained by poor road infrastructure and limited storage facilities.

3.2 Research Design

The evaluation adopted a convergent parallel (concurrent triangulation) mixed-methods design following Creswell and Creswell (2023). Under this design, quantitative and qualitative data were collected during a single unified fieldwork phase, analyzed independently, and integrated at the stage of interpretation. The logic is that the two data streams complement rather than duplicate each other: quantitative survey data establish the frequency and distribution of knowledge, attitudinal, and practice indicators across the sample, while qualitative data from key informant interviews (KIIs) and focus group discussions (FGDs) illuminate the meanings, mechanisms, and contextual specificities that numbers alone cannot convey.

Three survey instruments were administered, each tailored to a specific respondent category: a 59-question instrument for smallholder farmers (men and women); a 32-question instrument for youth in agribusiness (men and women); and a 52-question instrument for CSO leaders, women farmer group (WFG) members, and FEVs. Each instrument covered the same three domains (knowledge, attitudes, and

practices) but adapted specific questions to the roles and experiences of the target group. The CRSA-focused questions (Result 2) comprised 23 items: 9 on knowledge, 9 on attitudes, and 5 on practices.

3.3 Sampling and Sample Size

Sample sizes were determined using the Raosoft online sample size calculator, applying a 95% confidence interval and a 5% margin of error against programme beneficiary lists, which served as the sampling frame. The total sample was 247 respondents: 160 women (65%) and 87 men (35%). The deliberate overrepresentation of women reflected both the programme's primary targeting of women as beneficiaries and the evaluation's interest in understanding CRSA adoption from a gendered perspective.

Within communities, respondents were selected through systematic random sampling from beneficiary lists. Research assistants were recruited locally and trained for two days before fieldwork, with a pre-test of all instruments to identify ambiguities and standardize administration. Interviews were conducted in local languages (Dagbanli, Gurune, Kusaal, Dagaari, Buili and others) with trained interpreters supporting non-local-language research assistants where needed.

3.4 Data Analysis

Quantitative data were entered into SPSS and cleaned before analysis. The primary analytical approach was descriptive (frequencies and percentages for each survey item) with results disaggregated by gender, region, and district where sample sizes permitted. Cross-tabulations were used to explore associations between key variables such as practice frequency by knowledge level and gender. Qualitative data from KIIs and FGDs were transcribed, translated where necessary, and subjected to thematic analysis. Content analysis was applied to policy and programme documents. All participants provided informed consent, and anonymity was maintained throughout data collection, storage, and reporting.

3.5 Limitations

Several limitations bear directly on the interpretation of findings presented in this article and should be considered when assessing the strength of conclusions drawn. First, the study employed a cross-sectional, end-of-programme design without a formally measured pre-programme baseline or a comparison group of non-beneficiary farmers. This design cannot establish causal attribution of observed knowledge, attitudinal, or practice levels to NGIDP activities; it describes the state of the programme population at end-line without the counterfactual necessary to isolate programme effects from pre-existing conditions, concurrent initiatives, or secular trends in agricultural practice. Statements about programme impact in this article should accordingly be read as associations consistent with programme theory rather than as demonstrated causal effects.

Second, the sample is drawn exclusively from programme beneficiaries identified through programme implementer lists. This sampling frame introduces a selection bias: respondents are those already enrolled in NGIDP activities and therefore likely to exhibit higher awareness, more positive attitudes, and greater reported practice than the broader smallholder population in the same districts. Findings should

not be generalized to non-beneficiary populations or to northern Ghana smallholders more broadly without appropriate caution.

Third, all knowledge, attitudinal, and practice data are self-reported and collected in the context of a programme evaluation commissioned by the implementing organization. This context heightens the risk of social desirability bias, wherein respondents provide answers they believe are expected rather than candid accounts of their actual knowledge or behaviour. The high proportions reporting awareness of conservation priorities (92%) and willingness to invest in CRSA (83.1%) should be interpreted with this risk in mind. Practice data are particularly susceptible to over-reporting because actual field behaviour cannot be directly observed through a survey instrument.

Fourth, the total sample of 247 respondents limits the statistical power of sub-group comparisons disaggregated by district, gender, and region. Several sub-group cells are too small to support robust inferences, and cross-tabulation results should be treated as indicative rather than conclusive. Fifth, instruments were administered in multiple local languages through interpreters, introducing potential variation in how questions were understood across language groups. Finally, the apparent inconsistency between low awareness of terracing (8%) and zero tillage (11.6%) and their high reported practice (both 74.6%) cannot be resolved from the existing data and warrants methodological investigation in future evaluations, as discussed in Section 4.3.2.

4. Findings

4.1 CRSA Knowledge Among Smallholder Farmers

4.1.1 Awareness of Specific Sustainable Agricultural Practices

Among smallholder respondents, awareness of CRSA techniques was high across the most commonly promoted practices. Table 1 summarizes awareness of specific sustainable agricultural practices (SAPs) based on NGIDP training.

Table 1
Smallholder Awareness of CRSA Practices (n = 247)

CRSA Practice	% Aware
Cover cropping	74.3%
Mulching	62.1%
Compost / organic manure	53.8%
Green manuring	37.8%
Agroforestry	22.4%
Tree-crop-livestock integration	22.1%
Woodlots	14.9%
Zero tillage	11.6%
Terracing	8.0%

Source: NGIDP KAPs Evaluation Survey, 2023.

Cover cropping, mulching, and composting (the three most widely known practices) share a practical characteristic: they are the most regularly featured in FEV-led demonstration farms and community durbars. Their prominence in awareness rankings is consistent with the programme's training emphasis and suggests that respondents' awareness of these practices may have been reinforced by programme activities, though the cross-sectional design precludes attributing awareness gains exclusively to FEV-led extension. The lower awareness of terracing (8%) and zero tillage (11.6%) likely reflects less frequent promotion of these more capital- and knowledge-intensive techniques, or an assessment by FEVs that they are less immediately applicable in the flat, rain-fed landscapes typical of parts of the study area.

Across two measurement points in the survey, one asking about CRSA practices extended by FEVs (Result 1), and one asking about general SAP awareness (Result 2), cover cropping and mulching consistently ranked highest, with compost use close behind. This internal consistency lends confidence to the reliability of the findings on awareness.

4.1.2 Community Adaptation Plans: Awareness Versus Implementation Knowledge

Knowledge of Community Adaptation Plans (CAPs) produced a striking and programmatically important contrast. Nine in ten smallholders (88.9%) reported awareness that a CAP existed in their community, a high figure reflecting the programme's systematic effort to develop these plans at community level. But when asked whether the CAP was being actively implemented, only 27.4% could confirm it was. Nearly three quarters (72.6%) either believed it was not being implemented or did not know.

The gap between knowing a plan exists and knowing whether it functions is not simply a communication problem. It signals a governance and accountability deficit with direct implications for programme sustainability. CAPs represent the institutional architecture through which CRSA practices are supposed to be collectively managed and enforced. If the majority of community members are unaware of their operational status, the plans cannot generate the collective action they were designed to enable. This aligns with broader findings on community natural resource management in Ghana, which consistently show that plan development outpaces implementation (Dery et al., 2021).

4.1.3 Bushfire Prevention Knowledge

Awareness of bushfire prevention and management was mixed in depth. While 55.4% of respondents described themselves as moderately or completely aware of bushfire prevention measures, only 7.3% identified 'at all times' as the most important period for bushfire vigilance, a gap of concern given the rapid spread potential of fires in Guinea Savannah ecosystems. The majority (33.5%) correctly identified the harvest period as a high-risk window, and 28.3% the peak dry season.

On prevention methods, respondents demonstrated reasonably broad knowledge: creation of fire belts (48.9%), enforcement of community bushfire bylaws (53.1%), strengthening community fire committees (54.9%), and sensitization of hunters and herdsmen (50.3%) were each cited by approximately half of respondents. The inclusion of institutional and governance mechanisms alongside technical measures in respondents' knowledge suggests that the programme's sensitization activities succeeded in communicating the collective dimensions of bushfire management.

4.1.4 Land Restoration and Biodiversity Conservation Knowledge

Knowledge about the need for land restoration and biodiversity conservation was near-universal: 92% of respondents affirmed that such efforts were necessary. Among those who did, the rationale was concrete and grounded: 68.6% cited maintenance of ecological integrity; 64.1% linked conservation to community survival; 63% associated land degradation with worsening food insecurity; and 62.6% identified species extinction prevention as a motivation. These are substantive arguments, not surface-level endorsements, they suggest that extension education has succeeded in connecting conservation concepts to the lived priorities of farming communities.

4.2 Attitudinal Dimensions of CRSA Adoption

4.2.1 Willingness to Invest in Sustainable Practices

Attitudinal disposition toward CRSA investment was broadly positive. More than eight in ten smallholders (83.1%) indicated willingness to invest in sustainable agricultural practices, and just over a quarter (27.3%) were willing to invest up to GHS 200 annually. A notable 18.5% expressed willingness to invest GHS 1,001 or more, a striking figure for communities where average daily wages typically range from GHS 0–50. This figure should be interpreted cautiously, as stated investment intentions derived

from survey instruments are prone to aspirational over-reporting, particularly in contexts where socially desirable responses may be influenced by interviewers associated with programme implementers. The disjuncture between stated investment willingness and the structural barriers identified in the same survey (Section 4.2.2) counsels against treating these figures as reliable predictors of actual investment behaviour. Credit willingness was also high: 74.9% said they would access credit to invest in sustainable practices, with 35.1% willing to borrow in the range of GHS 801-1,000 monthly.

These figures suggest a degree of attitudinal openness toward CRSA investment that adoption research focused predominantly on barriers sometimes underweights. That stated willingness to invest and borrow is relatively widespread is noteworthy, but cannot be straightforwardly interpreted as evidence that attitudinal preconditions for scaled adoption are fully in place, given the limitations of self-reported attitudinal data and the multiple structural barriers identified in the same survey. Access to appropriately designed financial products is one important enabling condition, but the data also point to land tenure insecurity, labour constraints, and governance deficits as simultaneous binding constraints that financial inclusion alone cannot address.

4.2.2 Perceived Barriers to CRSA Adoption

The same 83.1% who expressed willingness to invest in sustainable practices also identified significant challenges in doing so, an internal tension that neatly captures the attitudinal complexity documented in the broader adoption literature. Table 2 presents the distribution of perceived barriers.

Table 2
Perceived Barriers to CRSA Implementation Among Smallholders (n = 247)

Barrier	% Citing
High cost relative to conventional practices	53.1%
Slow return on investment	50.1%
Labour intensive and time consuming	47.3%
Climate and ecological constraints	43.6%
Pest and disease pressure	40.6%
Land tenure insecurity undermining investment willingness	33.4%
Inadequate access to biomass for composting	30.1%
Low inherent soil fertility	21.3%

Source: NGIDP KAPs Evaluation Survey, 2023.

The dominance of cost (53.1%), slow returns (50.1%), and labour intensity (47.3%) is consistent with what adoption research documents across comparable contexts in West Africa (Khatri-Chhetri et al., 2020; Antwi-Agyei et al., 2021). These are not perceptual errors, CRSA practices genuinely demand more

labour in the short term and generate returns on longer timescales than synthetic fertilizer applications. For households operating at or near subsistence margins, these are entirely rational deterrents.

Land tenure insecurity (33.4%) is particularly significant in the context of northern Ghana's customary land governance system, where women's access to land is mediated by male relatives and traditional authorities and can be withdrawn at any point (Doss et al., 2020). The disincentive effect is straightforward: investing labour and resources in soil-improving practices on land over which one holds no long-term security is an economically irrational act for most farmers in this position.

4.2.3 Attitudes Toward Land Restoration and Biodiversity Conservation

Despite widespread knowledge of the importance of land restoration and biodiversity conservation, responsiveness to conservation measures was moderate: 38.5% of respondents described themselves as somewhat responsive, 32.3% moderately responsive, and 18.1% completely responsive; suggesting a continuum of engagement rather than uniform commitment. Cooperation in CAP implementation followed a similar distribution: somewhat cooperative (34.1%), moderately cooperative (28.5%), and completely cooperative (22.6%).

Barriers to conservation engagement point clearly to institutional gaps rather than motivational deficits. The absence of local bylaws on land restoration and biodiversity conservation was cited by 80.6% of respondents as the single most frequently mentioned constraint in the entire survey. Inadequate cooperation from landowners and traditional authorities ranked second at 79.1%, and insufficient institutional support from state agencies such as the Lands Commission, Forestry Commission, and Land Use and Spatial Planning Authority (LUSPA) was cited by 61.4%. These findings situate conservation behaviour within a governance environment that is not yet adequate to the task.

4.3 Practice Uptake: How Much Have Farmers Changed What They Do?

4.3.1 Overall Practice Frequency

Across all CRSA-related practice items, the modal response was ‘sometimes’, a category that captures irregular, context-dependent practice rather than systematic behaviour change. More than four in ten smallholders (43.2%) reported practising what they were taught sometimes; 18.9% very often; and 17.1% always. At the lower end, 7.5% said they rarely practised and 3.1% never practised. The absence of a formally measured pre-programme baseline prevents direct quantification of change over time; these figures therefore describe the current state of practice rather than demonstrating progression from a prior measured state. Contextual evidence from the literature suggests that systematic CRSA practice was uncommon in these communities before programme implementation (Antwi-Agyei & Nyantakyi-Frimpong, 2021), but this cannot be confirmed from the evaluation data alone. The data indicate that the

majority of smallholders who have acquired CRSA knowledge have not yet made it a consistent feature of their agricultural lives.

Table 3 presents the distribution of self-reported practice intensity across specific CRSA indicators.

Table 3
Self-Reported CRSA Practice Uptake Among Smallholders (n = 247)

Practice Statement	Sometimes	Very Often	Always
Implementing SAPs and reaping improved yield benefits	49.5%	23.3%	17.1%
Resilient to climate change impacts due to SAPs and biodiversity knowledge	53.2%	16.0%	17.8%
Supporting implementation of CAPs; community resilience improved	52.6%	23.8%	15.9%
Implementing bushfire prevention and management measures	48.4%	25.0%	21.8%

Source: NGIDP KAPs Evaluation Survey, 2023.

Bushfire management shows the strongest practice uptake profile, with 21.8% reporting consistent practice (always) and 25% very often, a combined consistent practice rate of nearly 47%. This is likely attributable to the collective and community-governance nature of bushfire management, where fire committees and traditional authority involvement provide an external accountability structure that individual on-farm practices lack. The finding supports the literature's emphasis on the importance of collective action institutions for sustainable land management (Dery et al., 2021).

4.3.2 Practices Being Put to Use in the Field

When asked specifically which climate resilient strategies they were putting to use in their fields, respondents revealed a pattern that is both encouraging and revealing. Table 4 presents the distribution.

Table 4
Specific CRSA Strategies in Active Use Among Smallholders (n = 247)

CRSA Strategy	% Putting to Use
Compost / organic manure	94.4%
Terracing	74.6%
Zero tillage	74.6%
Green manuring	68.9%
Cover cropping	48.0%
Mulching	45.8%
Agroforestry	36.3%
Tree-crop-livestock integration	36.3%
Woodlots	19.8%

Source: NGIDP KAPs Evaluation Survey, 2023.

The strikingly high reported use of compost and organic manure (94.4%) deserves careful interpretation. Organic manure preparation, particularly cattle dung composting, is not new to northern Ghana; it long predates the NGIDP. What the programme's training may have done is formalize and improve an existing practice rather than introduce an entirely new behaviour. This would account for its much higher reported adoption relative to cover cropping (48%) or mulching (45.8%), both of which require more deliberate changes in farming technique. Distinguishing between newly adopted practices and improved or formalized existing ones matters for accurately attributing programme impact.

The high reported use of terracing and zero tillage (both 74.6%) is somewhat surprising given their low awareness figures (8% and 11.6% respectively in Table 1). This apparent inconsistency may reflect measurement differences, the awareness question asked about knowledge of specific labelled techniques, while the practice question may have been interpreted more broadly. It warrants closer investigation in follow-up evaluation work. It may also reflect the fact that some farmers practise these techniques without using the technical terminology associated with them.

4.3.3 Women's Confidence in Applying Knowledge

A specific finding that deserves particular emphasis concerns women smallholders' confidence in applying the knowledge gained through extension. While women demonstrated comparable knowledge levels to men in survey responses, their confidence in field application was notably lower: only 7.3% described themselves as moderately confident in applying FEV-transmitted knowledge to their own farms, and 7.1% as completely confident. The concentration of responses in the 'somewhat confident'

category (10%) and below suggests that knowledge acquisition has not yet been accompanied by the practical mastery and self-efficacy that consistent adoption requires.

This finding points to a gap in the extension model as implemented. Demonstration farms and community durbars are effective for knowledge transmission but provide limited opportunity for participants to practise new techniques themselves in a supported environment. Farmer field school approaches, where participants work through a full cropping season with sustained mentorship, have been shown to be more effective at building practical confidence (Davis et al., 2021). The low practice confidence scores suggest that a shift toward more experiential, season-long extension modalities would meaningfully strengthen practice outcomes.

5. Discussion

5.1 The FEV Model: Strengths and Limitations

The NGIDP's deployment of female extension volunteers is associated with relatively high CRSA awareness levels among the programme beneficiaries surveyed, though the absence of a control group or pre-programme baseline means that the specific contribution of the FEV model to knowledge gains cannot be isolated from pre-existing knowledge or other information sources. The high reported uptake of demonstration farms as a knowledge channel (97.6% among those who received extension) suggests strong reach within the beneficiary population, while the physical proximity of FEVs to their communities is a notable feature in a context historically characterized by inadequate extension coverage. The fact that FEVs were within a 15-minute walk of 45.6% of their client smallholders, and within 30 minutes of a further 24.9%, is particularly significant for women farmers whose mobility is constrained by both distance and social norms.

But the model also carries limitations that the KAP findings make visible. FEVs are community members without formal agricultural training, and their knowledge base is bounded by what they have been taught in programme sessions. This matters because CRSA practice is context-specific and dynamic, what works on a demonstration farm under supervision may need adaptation for different soil types, micro-climates, and cropping systems. FEVs who are not equipped with adaptive problem-solving skills may find their effectiveness limited when farmers encounter challenges that go beyond standard training content. The low confidence levels reported by women smallholders in applying FEV-transmitted knowledge may partly reflect this gap between demonstration-based learning and field-level problem-solving capacity.

5.2 Unpacking the KAP Gap: Why High Knowledge Has Not Driven High Adoption

The core puzzle the NGIDP CRSA data present is this: knowledge of sustainable practices is high; attitudinal disposition toward investment is broadly positive; yet consistent practice remains

concentrated in the 'sometimes' category for the large majority of respondents. This KAP gap calls for an explanation that goes beyond the characteristics of the practices themselves.

Three structural factors emerge from the data as the most powerful mediators between intention and practice. The first is financial constraint: even low-cost CRSA techniques impose upfront costs in labour, time, and materials that are difficult for households operating at or near subsistence margins. The widespread willingness to invest (83.1%) and borrow (74.9%) is currently disconnected from available financial products because the Village Savings and Loans Associations (VSLAs) that serve as the primary credit mechanism in NGIDP communities operate at a scale too small to finance productive agricultural investment (Karlan et al., 2017). The gap between positive attitudinal disposition and financial capacity represents both a constraint and a programme opportunity.

The second factor is land tenure insecurity: a third of respondents (33.4%) identified it explicitly as a barrier, and this is almost certainly an undercount given the social sensitivity of land discussions in these communities. For women smallholders who access land through customary arrangements mediated by male relatives and traditional authorities, the rational calculus of CRSA investment is profoundly shaped by uncertainty about future land access. No amount of knowledge or attitudinal openness can override the basic logic that investing in land improvement on insecure tenure is economically irrational (Doss et al., 2020).

The third factor is an institutional gap in conservation governance: the identification of absent bylaws (80.6%) and inadequate traditional authority cooperation (79.1%) as barriers points to a governance environment not yet capable of converting individual knowledge and positive attitudes into collective behaviour. Sustainable land management is inherently a collective action problem, its benefits are partly public and its costs partly borne by individual actors, and it therefore requires institutional arrangements that align individual incentives with collective outcomes. The NGIDP's Community Adaptation Plans represent a step in this direction, but the finding that only 27.4% of aware smallholders know whether their CAP is being implemented suggests that these plans have not yet been embedded in governance systems with sufficient accountability and enforcement capacity.

5.3 What the Compost Finding Tells Us About Programme Attribution

The 94.4% reported adoption of compost and organic manure use is a striking figure that demands careful interpretation. Organic soil amendment through cattle dung and crop residues is deeply embedded in the traditional agricultural knowledge systems of northern Ghana, it precedes the NGIDP by generations. The programme's training may have done two things that are both valuable but analytically distinct: it may have formalized and standardized an existing practice, improving its technical quality; and it may have encouraged more systematic application among farmers who were already familiar with the concept. Neither represents zero-to-adoption impact, but both represent genuine programme value.

Future evaluations would benefit from more precisely distinguishing between newly adopted practices and improved or formalized existing practices in their outcome frameworks. Conflating the two tends to generate overly optimistic adoption statistics that do not serve programme learning.

5.4 Gender, Practice, and the Need for Transformative Approaches

Throughout the KAP data, gender differences in practice confidence and adoption intensity are visible even where knowledge levels are comparable. Women smallholders' lower confidence in applying field-level knowledge reflects broader structural constraints that extension programming alone cannot address. These include the labour burden of unpaid care work that limits time available for CRSA-intensive techniques; the land tenure insecurity that reduces the incentive to invest; and the social norms that restrict participation in the community governance forums where CAP implementation is discussed and monitored.

These constraints call for programming approaches that move beyond gender-targeted service delivery toward genuinely gender-transformative interventions, approaches that engage men, traditional leaders, and community governance structures in deliberate normative change processes (Quisumbing et al., 2021). In practice, this means including men in sensitization activities about women's land rights, working with district assemblies and traditional councils to formalize women's land tenure security, and designing extension activities that account for women's actual time availability rather than agricultural calendar conventions designed by and for male farmers.

6. Conclusions and Recommendations

The NGIDP’s four-year investment in CRSA knowledge-building and extension in northern Ghana is associated with encouraging end-line indicators across multiple KAP domains, albeit with the interpretive limitations inherent in a cross-sectional, end-of-programme evaluation without a formal baseline or comparison group. Cover cropping, mulching, and organic manure use are now widely known and variably practised across the programme communities. The FEV model appears to have facilitated access to extension for women farmers who face barriers to conventional extension services, though the absence of a control group prevents a definitive assessment of its effectiveness relative to alternative models. And the near-universal affirmation of land restoration and biodiversity conservation as important community priorities (92%) is consistent with effective knowledge sensitization, though self-reported attitudinal data of this kind may be subject to social desirability bias in an evaluation conducted immediately following a programme in which respondents were active participants.

At the same time, the KAP evaluation is honest about the gap between what farmers know, what they want to do, and what they consistently manage to do. That gap is not primarily an information problem, it is a structural problem rooted in land tenure insecurity, inadequate financial services, weak institutional enforcement of conservation bylaws, and a governance environment in which Community Adaptation Plans exist on paper more reliably than they do in practice.

Four recommendations emerge from the evidence. First, financial inclusion must become a core programme component rather than a peripheral concern. The willingness to invest and borrow for CRSA is demonstrably present; the appropriate financial products are not. Future programming should seek explicit linkages between VSLAs and formal microfinance institutions offering products with appropriate interest rates, grace periods, and repayment schedules, specifically designed for agricultural investment in CRSA techniques.

Second, land tenure reform must be treated as an agricultural development issue, not only a legal or governance matter. Programmes promoting CRSA in customary tenure contexts should include components working with traditional authorities to formalize women's land use rights, reduce the arbitrariness of tenure arrangements, and create the conditions under which investment in soil health makes rational sense.

Third, Community Adaptation Plans need institutional embedding. Development of CAPs without systematic efforts to integrate them into district medium-term development plans, with associated budget lines and accountability mechanisms, produces plans that are known but not implemented. The finding that fewer than three in ten aware smallholders can confirm their CAP is operational underscores the urgency of this work.

Fourth, the FEV model should be extended and deepened, moving from demonstration-based learning toward season-long farmer field school approaches that build practical problem-solving capacity and field-level confidence. It is this confidence, more than knowledge per se, that consistent adoption requires.

The people of northern Ghana's farming communities have shown, through this evaluation, that they understand what is at stake in the transition to climate-resilient agriculture. The task for development practitioners and policymakers is to build the institutional and financial environment that makes that transition genuinely possible.

Declarations

Ethics Approval and Consent to Participate

The end-of-project evaluation on which this article is based was conducted in accordance with the data protection and privacy policies of Friends of the Nation and applicable national data protection regulations of Ghana. Informed consent was obtained from all research participants prior to data collection. Data anonymization protocols, secure data storage, and ethical treatment of sensitive personal information were maintained throughout. Audio recording of interviews and focus group discussions occurred only with explicit participant consent. The evaluation was conducted by Endogen Global Consult Ltd. under the institutional oversight of the University for Development Studies (UDS), Tamale, Ghana. This study was approved by the University for Development Studies' Institutional Review

Board (IRB) in accordance with the guidelines and regulations set forth in the UDS Research Ethics Policy of 2022. The protocol number for this approval is UDS/RB/108/26. As an independently commissioned programme evaluation employing a participatory, non-experimental design with no clinical or biomedical procedures, the study was assessed as falling within the scope of standard social-research ethics protocols that do not require full institutional review board (IRB) approval under the UDS Research Ethics Policy. All data collection was governed by the following ethical principles, consistent with the guidelines of the UDS Research Ethics Committee and the OECD/DAC Evaluation Quality Standards: (1) all participants were provided with full information about the purposes, methods, and intended use of the evaluation prior to participation and gave their voluntary informed consent before engaging in any data collection activity; (2) the identities of all informants were anonymized at the point of transcription and no personally identifying information appears in this manuscript or in any underlying data files; (3) sensitivity protocols were applied during data collection in politically restricted and conflict-affected contexts, including the Sahel sub-region, to protect participants from any risk of harm arising from their participation; and (4) data were stored securely and are available only to the author and the commissioning organization. No incentives or inducements were offered to participants. Participation was entirely voluntary, and participants were informed of their right to withdraw at any point without consequence.

Author Contribution

J.A: I confirm sole responsibility for all aspects of this work. I conceptualized and designed the study; conducted data collection, analysis and interpretation; and drafted the manuscript. All critical revision of the manuscript for important intellectual content and approval of the final version for submission was solely my responsibility. I also agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Data Availability

The survey instruments and raw datasets generated and/or analyzed during the current study have been submitted as supplementary materials for editorial and peer-review consideration.

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