Evaluating the Effectiveness of Conservation Agriculture as a Climate Change Adaptation Strategy for Smallholder Farmers in Atwima Mponua District, Ghana

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Abstract
Confronted by climate change, smallholder farmers in Ghana's Atwima Mponua District are successfully adopting Conservation Agriculture (CA) practices like agroforestry, mulching, and minimum tillage. Farmers report CA as highly effective, citing significant yield increases, improved soil health, and reduced climate hazards. However, major barriers, including severe financial constraints and a lack of government support, limit wider adoption. The study also reveals significant gender disparities in knowledge access. We conclude that while CA is a viable climate adaptation strategy, its success depends on targeted interventions like subsidized inputs and gender-equitable training programs.

1. Introduction

Smallholder farmers in Sub-Saharan Africa are disproportionately vulnerable to climate change impacts like erratic rainfall and rising temperatures. This study evaluates the effectiveness of Conservation Agriculture (CA) as a resilience strategy for farmers in the climate-vulnerable Atwima Mponua District of Ghana.

Research Objectives:

- Identify the most adopted CA practices.
- Assess their effectiveness in enhancing resilience.
- Analyze key socioeconomic factors influencing adoption.
- Determine the major barriers to widespread adoption.

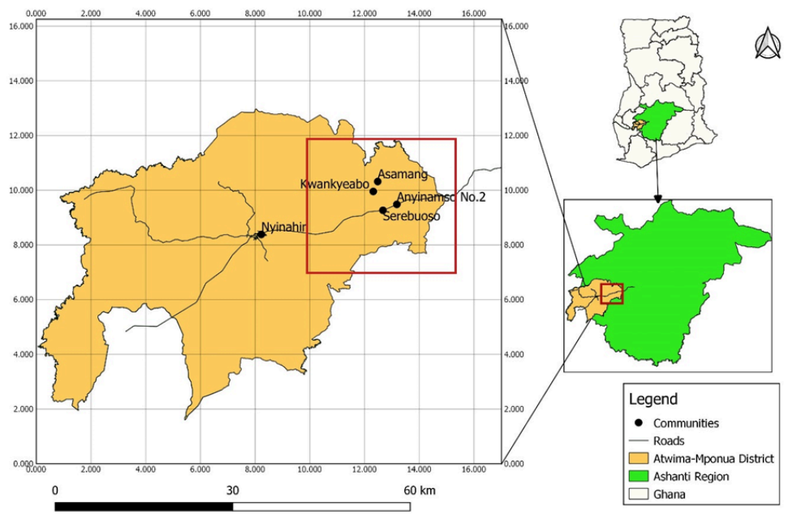
2. Methodology

A mixed-methods approach was employed in four farming communities.

- Quantitative Data: Surveys of 200 smallholder farmers.
- Qualitative Data: Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs).

Data Analysis:

- Relative Importance Index (RII) to rank practices.
- Binary Logistic Regression (BLR) to identify adoption predictors.
- Problem Confrontation Index (PCI) to rank barriers.
- Hybrid Yield Model combining deterministic (APSIM-based) and probabilistic (Monte Carlo) simulations for robust yield impact assessment.

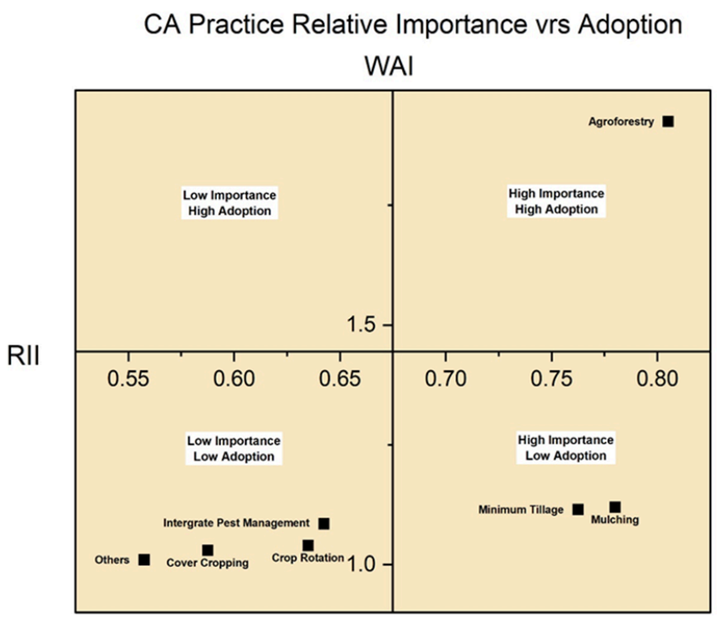


Study Area Map: Atwima Mponua District, Ashanti Region

3. Result and Discussion

3.1 High Adoption of Effective Practices

- The most adopted CA practices were driven by economic benefits (92.5%) and have been used long-term (>6 years by 81.5% of farmers).
- Agroforestry: 61%
- Mulching: 56%
- Minimum Tillage: 52.5%



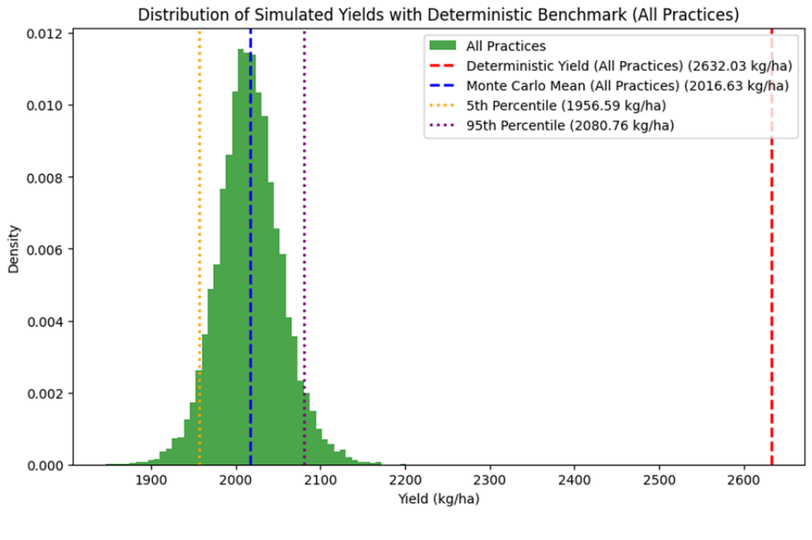
3.2 Significant Perceived & Modelled Effectiveness

Farmers rated CA as a highly effective climate adaptation strategy (WAI = 3.13/4).
Reported Benefits:

- **93.5%** experienced improved crop yields.
- **86%** observed better soil health.
- **64.5%** reported reduced impact of climate hazards.

Validated by a Novel Hybrid Model:
Our model quantified yield increases while accounting for real-world constraints.

- Deterministic Yield (Theoretical Max): **2632 kg/ha**
- Probabilistic Mean Yield (Realistic): **2017 kg/ha**
- The **~600 kg/ha** difference underscores the impact of socioeconomic barriers on potential gains.



3.3 Key Barriers to Adoption

Financial constraints are the most severe barrier, with significant gender disparities in knowledge access.

1. Financial Constraints (PCI = 286)
2. Lack of Government Support (PCI = 180)
3. Limited Access to Resources (PCI = 166)
4. Lack of Knowledge (Significantly higher for women, ***p* = 0.002**)

3.4 What Drives Adoption?

Binary Logistic Regression identified:

- Farming Experience (β = 1.193, ***p* = 0.02**)
- Gender (β = 1.868, ***p* = 0.03**)

"*The adoption challenge is not one-size-fits-all... younger farmers, especially women, are more receptive to training but lack decision-making power.*" — Key Informant

Socio-demographic Characteristics	Coefficient (β)						
	CAP1	CAP2	CAP3	CAP4	CAP5	CAP6	CAP7
Gender	**1.868****	1.050	0.945	0.896	1.036	0.702	0.650
Age	0.800	1.299	0.992	1.092	0.737	1.030	0.803
Household Size	1.112	0.834	0.736	1.038	**1.522****	1.272	0.955
Education Level	0.797	0.949	1.519	1.195	**0.607****	0.879	1.021
Primary Occupation	**0.583****	0.760	0.698	1.154	0.764	**0.571****	**0.492****
Year of Farming Experience	**1.193****	1.292	1.444	1.017	0.762	1.149	1.527
Nagelkerke R^2 values	0.165	0.158	0.222	0.064	0.158	0.189	0.156

Socioeconomic factors influencing the Conservation agricultural adoption practices of the respondents

Conclusion & Policy Recommendations

Conservation Agriculture is a proven, effective strategy for building climate resilience and ensuring food security in the Atwima Mponua District. However, its full potential is limited by critical barriers.

We Recommend:

1. Targeted Financial Support: Implement microcredit and input subsidy programs specifically for smallholders to overcome the primary financial barrier.
2. Gender-Equitable Extension: Design and deploy training programs that actively involve and empower female farmers, addressing the significant knowledge gap.

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