Transitioning Towards Sustainable Intensification: The Adoption of Zero/Minimum Tillage Among Smallholder Farmers in Northern Ghana

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Introduction

Transitioning towards Sustainable Intensification (SI) is necessary for addressing the twin challenges of low productivity and land degradation in Northern Ghana. Zero/Minimum Tillage (Z/MT), a cornerstone of conservation agriculture, is promoted as a pathway to build resilient and productive farming systems. However, its adoption remains uneven, determined by the intersections of farmers' socio-economic characteristics, institutional dynamics, and the biophysical features of land. Hence, for many farmers in Northern Ghana, the decision to adopt Z/MT may not simply be a matter of accessing knowledge or recognizing its environmental benefits; it may be a negotiation within a precarious agrarian landscape characterized by resource scarcity and institutional neglect.

Research Objectives

- To explore the factors that influence the adoption of MT among smallholder maize farmers, and how these factors reflect broader socio-ecological vulnerabilities.
- To determine the impact of Z/MT on maize yields

Material and Methods

The study draws on survey data from the Mixed Farming Systems (MFS) Initiative covering 1320 farm households across 19 districts in five regions of Northern Ghana (IITA 2023). Farmers were interviewed with a structured questionnaire. The questions were centered on plot-level characteristics, farmers' demographics and socio-economic characteristics, crop preoduction, etc

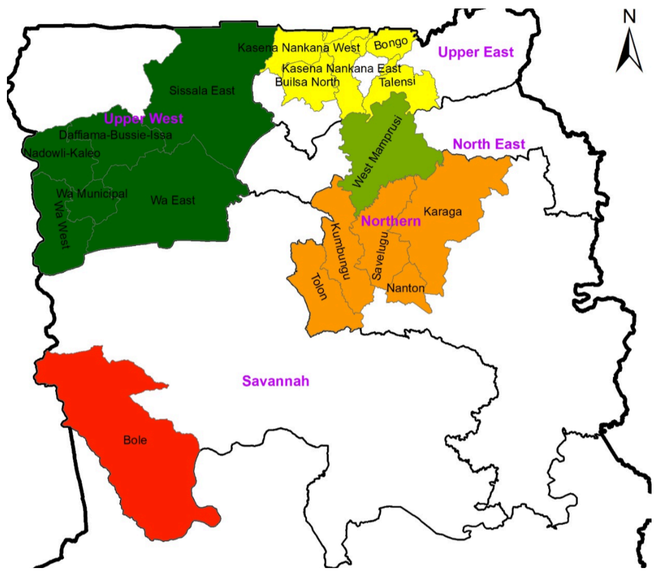

Figure 1: MFS Initiative communities in Northern Ghana

- The study conceptualized the adoption and impact of Z/MT through a Socio-Ecological Systems (SES) framework.
- The Inverse Probability Weighted Regression Adjustment (IPWRA) model was used to explore the adoption of Z/MT as well as estimate the impact of Z/MT adoption on maize yield. Estimated effects were the Average Treatment Effect (ATE), Average Treatment Effect on the Treated (ATT), and the Average Treatment Effect on the Untreated (ATU).

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Findings

1. Rates of adoption

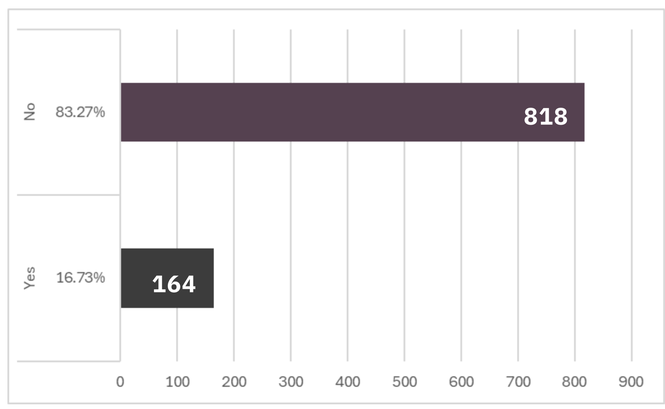

Figure 2: Z/MT Adoption by farmers

Land prepared through minimal tillage with some residue retention for maize production

2. Determinants of Adoption

The model estimates show that;

- Household composition: more active labor increased adoption, while larger household size reduced it, reflecting trade-offs in resource allocation within farming families.
- Plot-level ecology mattered: intercropped fields and those managed with mulching/compost encouraged adoption, while loamy soils and distant plots discouraged it.
- Land obtained through family heads strongly promoted adoption, while significant regional disparities illustrate how governance and ecological zones jointly shape technology uptake.
- Farmers with access to extension services and training were significantly more likely to adopt, highlighting how institutions enable knowledge flows and build capacity.

2.1. Impacts of Z/MT on Maize Yield (kg/ha)

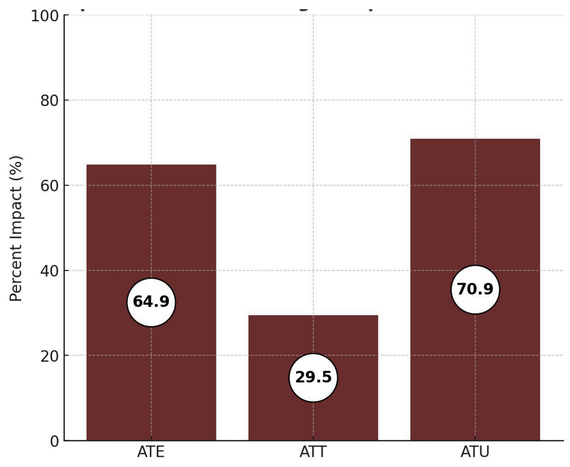

Figure 3. Treatment Effects of Z/MT on Maize Yield (kg/ha)

ATE indicates that the average yield in the study areas will increase by 64.9% if all farmers adopt Z/MT.

The results show that ATE is greater than ATT. Hence, Z/MT generating a high impact if scaled up to the whole population.

The larger percentage of ATU (than ATT) shows non-adopters can get better benefits from Z/MT than the current adopters.

Conclusions

- Adoption is context-specific: Decisions to adopt ZMT are shaped by interacting social (household labor, size), ecological (soil type, intercropping), and institutional (extension, training) factors, underscoring that scaling cannot follow a one-size-fits-all model.
- Institutions matter: Access to extension services, training, and supportive tenure arrangements significantly enabled adoption, showing the critical role of governance and institutional trust in shaping technological transitions.
- Yield impacts are tangible: Adoption of ZMT was associated with significant increases in maize productivity, demonstrating its potential contribution to the productivity dimension of sustainable intensification.
- Policies must embrace adaptive, place-based strategies that respond to local social-ecological realities, recognizing partial adoption pathways and addressing labor, tenure, and regional disparities.

Reference

IITA (International Institute of Tropical Agriculture) (2023). Characterization of mixed farming systems in Ghana: sustainable intensification of mixed farming systems: Initiative Baseline Evaluation Survey Report. Ibadan, Nigeria: IITA, (63 p.). https://hdl.handle.net/10568/134795

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