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## Transitioning toward sustainable intensification: the adoption of zero/minimum tillage among smallholder farmers in northern Ghana

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### Abstract

Zero and minimum tillage, central to sustainable land management in Sustainable Intensification (SI), hold immense promise for mitigating soil degradation, enhancing water retention, and promoting climate resilience in sub-Saharan Africa. The study examines the adoption dynamics of zero/minimum tillage among smallholder farmers in Northern Ghana, utilising data from the Sustainable Intensification-Mixed Farming Systems initiative by IITA. Binary logistic model reveals, among others, that older farmers (OR = 1.016,  $p < 0.05$ ) are more likely to adopt, reflecting their experience and openness to adaptive practices. Fertiliser (OR = 1.367,  $p < 0.05$ ) and pesticide application (OR = 1.439,  $p < 0.05$ ) positively correlate with adoption, highlighting the practice's synergy with input-based farming systems. Land tenure modalities, particularly plots allocated by family heads (OR = 0.229,  $p < 0.05$ ), emerge as a significant but negative determinant, signaling the household (in)decisions that shape adaptive responses of farmers in agrarian systems. While some farmers view zero/minimum tillage as a pathway to improved soil health and productivity, others express skepticism, driven by concerns over yield stability and unfamiliarity with the practice. Non-adoption (87.45 %) is primarily influenced by a lack of technical know-how, perceived risks, labour requirements, and disinterest, highlighting the need to promote adaptive practices that instill confidence through the setup of experimental farms that encourage participatory action while meeting the labour and technical needs of farmers. Qualitative data, including farm observations, are conducted to reveal further how adoption decisions are deeply intertwined with farmers' perceptions of risk, resource availability, and socio-cultural norms. The technology, which contrasts intensive tillage, encourages the utilisation of conservative practices like retention of crop residue and mulching, which necessitate ripple effects on production outcomes and soil health, while reducing production cost—although often portrayed as a ‘win-win’ scenario, the anticipated rapid scaling of the technology has yet to materialize, with adoption remaining persistently modest despite supportive narratives. Targeted interventions, including tailored extension services, land tenure reforms, and community-based demonstration programs, are essential for addressing structural and perceptual barriers. The findings contribute nuanced insights into scaling conservation agriculture across resource-limited agrarian contexts, offering actionable pathways for sustainable intensification transitions.

**Keywords:** Adoption dynamics, conservation agriculture, sustainable intensification, zero and minimum tillage