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## Ex-ante evaluation of integrated soil fertility management as a sustainable intensification practice: A probabilistic modelling approach

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### Abstract

Northern Ghana's agricultural productivity is declining due to soil degradation resulting from the use of agricultural practices that are not locally adapted. This poses a significant threat to local food security and rural livelihoods. Strategies to address this productivity decline focus either on extension or on intensification of agricultural land, yet both options are constrained by land scarcity and low technology adoption rates, respectively. Farming practices with the potential to increase productivity without requiring additional land are available, yet their effectiveness varies depending on the local context. Integrated Soil Fertility Management (ISFM) holds promise as a sustainable intensification option, especially in smallholder farming systems. However, despite the widespread promotion of ISFM in the region, its adoption remains inadequate. Furthermore, the extent of its contribution to sustainable land management and its potential to foster sustainable business models remains largely unexplored. To address this gap, the proposed study implements an ex-ante evaluation of ISFM on sustainability-related outcomes. We operationalize our analysis using a probabilistic modelling approach to simulate the impacts of ISFM in maize-soybean agricultural systems. Through collaborative efforts, engagement with local experts, and survey data, our approach allows simulating the costs, benefits, and risks associated with various ISFM components. Using a decision analysis approach, we run Monte Carlo simulations to generate plausible distributions of intended economic outcomes of ISFM. Further, we applied a sensitivity analysis using Projection to Latent Structures (PLS) regression, which revealed variables that affect the outcome distribution of the business model. We also computed the Expected Value of Perfect Information (EVPI) to determine the monetary value of perfect information on specific variables. The outputs of this study include valuable insights of a sustainable business model of ISFM providing evidence-based models to support adoption and policy interventions for the benefit of local farming communities and the region. An additional advantage of our approach is its flexibility to assess other agricultural practices addressing soil degradation.

**Keywords:** Decision analysis, Monte Carlo Simulation, Participatory research, sustainable land management