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"Reconcile land system changes
with planetary health"

Regenerative agriculture for planetary health: Empirical assessment and probabilistic modelling of soil, agronomic, and economic outcomes in Kenya

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Abstract

Balancing agricultural transformation with planetary health requires decision-support systems integrating empirical field data with knowledge-based modelling. Regenerative agriculture (RA) is increasingly promoted as a pathway to improving soil health, biodiversity, and farmer livelihoods. Yet its long-term and context-specific outcomes, particularly those incorporating agroforestry practices, remain underexplored. This study combines structured field monitoring and probabilistic modelling to assess the impacts of RA on land health, rural livelihood outcomes and resilience across four counties in Kenya.

We surveyed 400 maize-growing farms in Makueni, Kitui, Embu, and Tharaka Nithi, using a stratified pairwise design to compare RA and conventional practices under similar biophysical conditions. Soil health was evaluated using physical, chemical, and biological indicators, and maize tissue, biomass, and grain samples were analysed for nutrient uptake, yield, and quality. Short-term financial performance was estimated from farm-level cost and return data. We will discuss our work on a stochastic model informed by our survey data and a Structured Expert Elicitation (SIE) process to assess longer-term impacts. The model will capture uncertainty in potential agronomic and financial outcomes over 25 years.

Participatory methods, including focus groups, were used to explore farmers' perceptions of soil and plant health and to align scientific assessments with local knowledge. Integrating field evidence, expert modelling, and farmer perspectives offers a holistic evaluation of RA's role in transforming land systems. The findings contribute to understanding how regenerative practices can enhance productivity and ecological function while supporting equitable rural development. The approach provides a replicable model for reconciling land system changes with planetary health objectives.

Keywords: Agronomic gain, expert elicitation, farm profitability, Kenya, planetary health, regenerative agriculture, soil health, stochastic modelling

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