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Agricultural systems modelling and stakeholder engagement: a review of approaches and impact in Sub-Saharan African Cropping and Farming systems

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Introduction

- Climate extremes and weak infrastructure threatens SSA agriculture, discouraging farmers from investing in improved agricultural practices (Shah et al., 2021; Zougmore et al., 2018).
- Crop and farm system models support decision-making but are often too complex for stakeholders to access (Ewert et al., 2015).
- While integrating scientific models with local knowledge can improve relevance and inclusivity, limited stakeholder participation and weak communication reduce real-world impact (Kotir et al., 2024; Yami et al., 2024).
- This study reviews crop and farm system models in SSA, comparing project intentions vs. outcomes and analysing enablers and barriers to stakeholder engagement.

Methodology

This study performed a **systematic literature review** with searches from Web of Science (WOS) & SCOPUS.

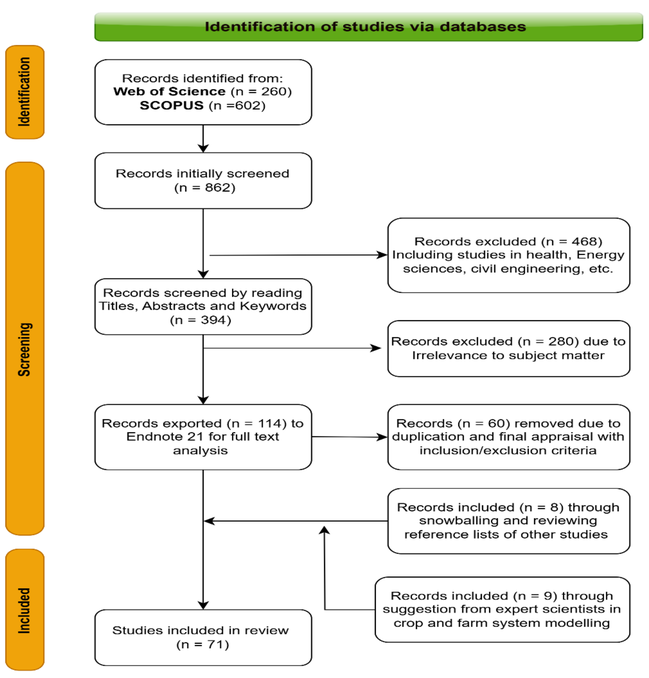

Figure 1: PRISMA flowchart for identification and selection of studies using "system modelling", "Positive change" and "sub-Saharan Africa" as keywords with their respective synonym

Keyword	Code	Synonyms
System Model	#1	Crop system model, farm model, farm system model, agricultural model, agriculture model, system dynamic
Positive change	#2	Positive impact, Improved capacity, improved investment, increased investment, yield improvement, yield increase, enhanced productivity, risk reduction, technology uptake, market access, improved resilience, market growth, risk mitigation, cost reduction, productivity boost, enhanced capability
Sub-Saharan Africa	#3	Sub-Saharan Africa, SSA, (including all individual countries)

Table 1: Keywords, synonyms and search strings used in the literature search on Web of science and SCOPUS

Results

Review of 71 studies on crop and farm system modelling in SSA

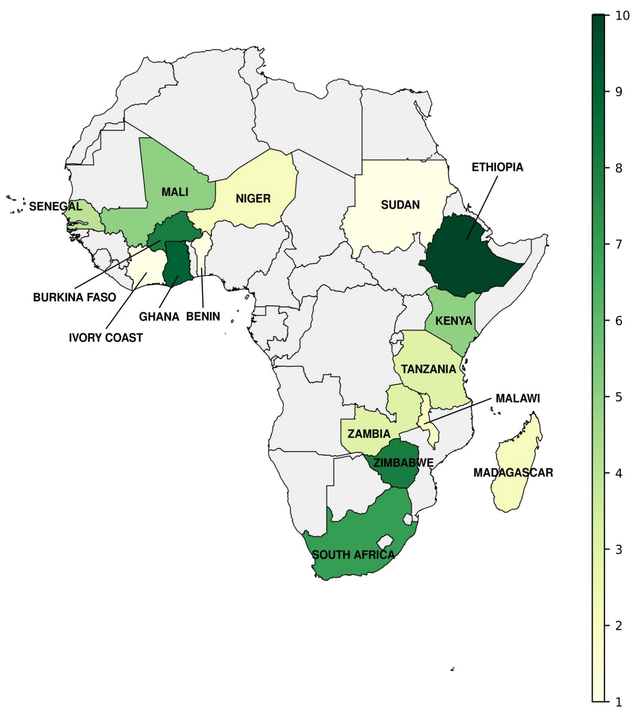

Figure 2a: The geographical scope of the documents. The map shows the number of documents included in the review by country

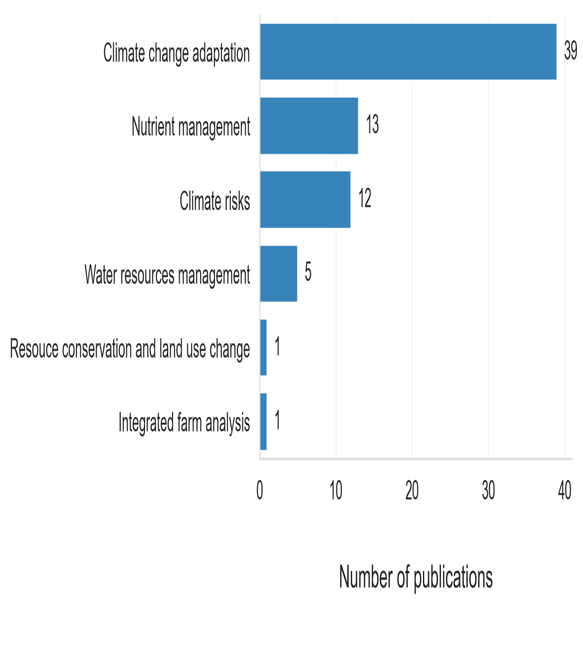

Figure 2b: Distribution of main problem types covered by studies

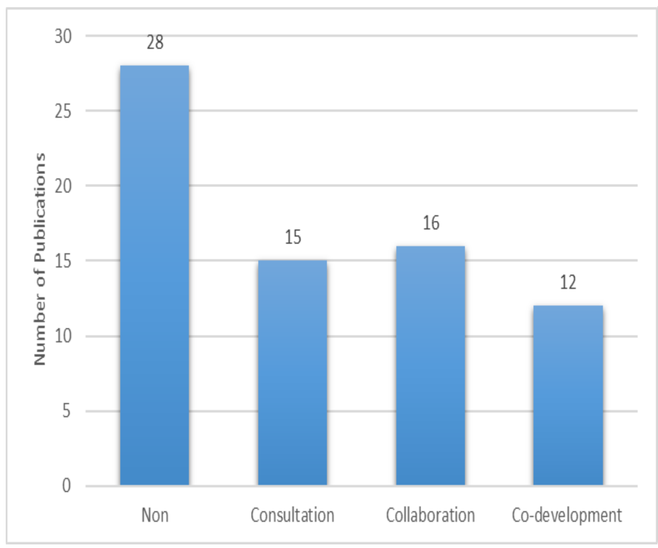

Figure 3a: Distribution showing whether non-scientific stakeholders participated and their level or type of participation in the study

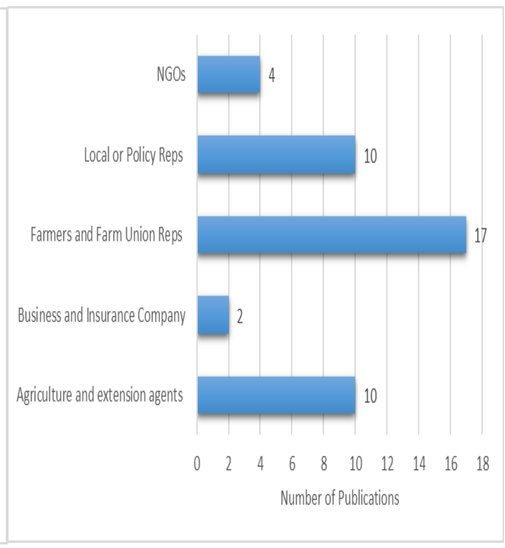

Figure 3b: Distribution of the type of non-research stakeholders in studies

- **Climate change adaptation** and nutrient management emerged as the most common problem types addressed by modelling studies.
- While **farmers** were the **main stakeholders** involved, the inclusion of **extension agents** and **policy actors** highlights ongoing but still limited scientist–stakeholder collaboration needed for context-relevant decision support.

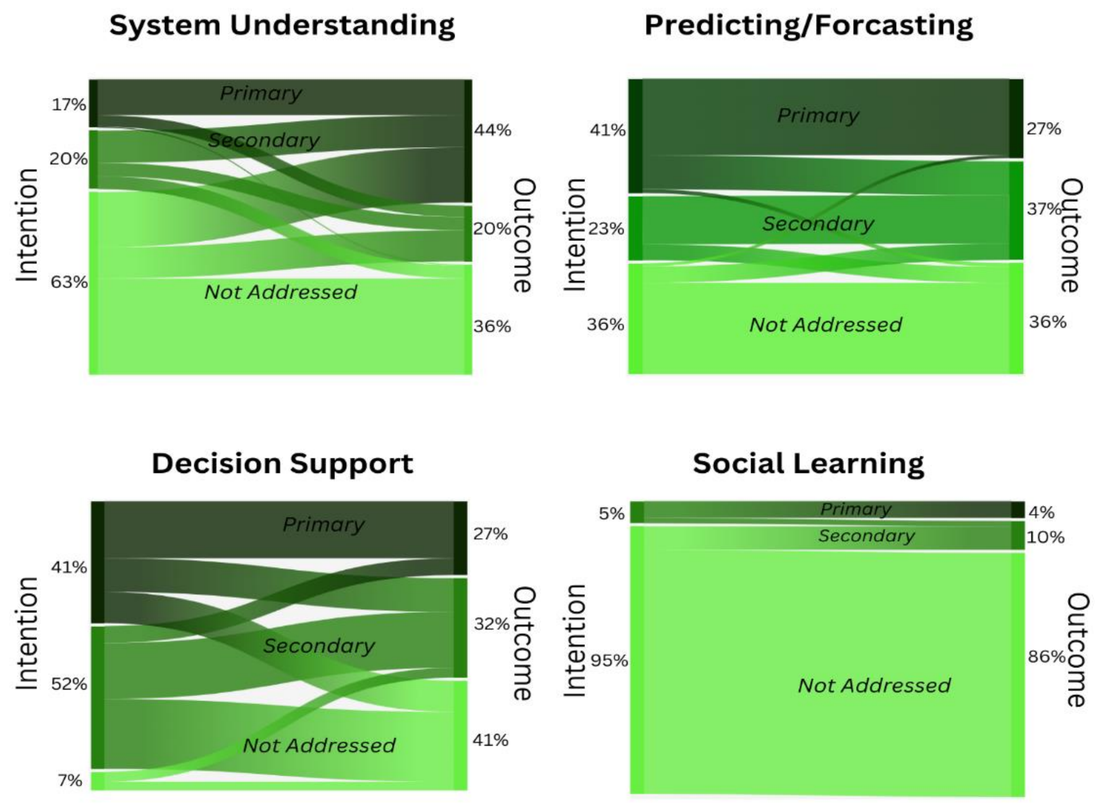

Figure 4: Number of papers per study purpose, for both intentions and outcomes (Expressed in percentages) adapted from Kelly et al. 2013

Intentions vs. outcomes revealed strong alignment for **prediction and forecasting**, while system understanding was often secondary benefit. Decision support and social learning were rarely achieved, underscoring the **limited practical impact** of models without deeper **stakeholder engagement** and participatory integration.

What this study adds

- Reveals a persistent gap between **model intentions and real-world impact**, where prediction and forecasting are often achieved but decision support and social learning remain limited.
- Underscores **stakeholder engagement**, context-sensitive design, and integrated data as pathways to make agricultural models more relevant, usable, and impactful in SSA.

Conclusion

- Enhanced **co-design** and **Transdisciplinary** collaboration can boost the relevance and impact of systems modelling in SSA, but greater investment in **scientific capacity** is vital to help modellers tackle complex agricultural challenges.

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