Simulating tree-crop interactions in semi-arid areas for targeting and scaling of agroforestry

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Agroforestry Systems

- Complex with various interrelating factors ecologically and economically,
- Involve multiple products and services (intended and non-intended), with tradeoffs and synergies occurring both on- and off-site and varying over time.
- Have attracted considerable attention in the recent years due to:
  - potential to reduce poverty,
  - improve food security,
  - reduce land degradation and mitigate climate change,
- However progress in promoting agroforestry has been held back
Adoption Challenges

- Mainly emanating from the varied outcomes from different tree-crop interactions,
- A number of technical areas still require scientific investigation
- Decision makers lack reliable information and tools to predict benefits and services from tree-crop mixtures.
- Imperative to develop tools to understand the conditions under which competition and complementarity occurs across different environments and socio-economic conditions.

Distribution of maize yield differences ($Y_d$, t ha$^{-1}$) for four agroforestry systems
Coe et al., 2016
Agroforestry Systems Modeling

• Potential to achieve many of the environmental, economic and social objectives which field experiments and other participatory approaches might not be able fathom.

• Targeting of relevant and significant interventions in farming systems

• Facilitates analysis of individual components to understand simplistic relationships, evaluation of more complex interactions and determine overall systems efficiency.

• Ex-ante impact assessments and interactions from increased management input and increased diversity, along with determining efficient risk reduction strategies in the context of climate change
A number have been developed
Here we evaluate the predictive capacity of the APSIM AF model in simulating tree-crop interactions in semi-arid agroforestry systems.
Model has capability to:
- Long-term effects of N-fixation by trees and herbaceous legumes in the soil,
- Effects of above-ground tree litter inputs for C and N cycling,
- Rain and light shading effects of trees
- Root competition for water and N
- Reduced population density of crops near trees

Luedeling et al., 2016
Model evaluation

- The model satisfactorily simulated crop yields and soil water across seasons in Machakos, Kenya and Warra, Australia.
- The model was sensitive to soil water and nutrient use across different transects and with limited parameterization.
- Can be tailored to simulate tree-crop interactions spatially and temporally across different environments.
Key messages

- Agroforestry is increasingly being advocated as a low-cost and sustainable way to reduce poverty, improve food and nutrition security, reduce land degradation and mitigate climate change.
- Performance is often variable and dependent on context and technology recommendations are mainly based on a few pilot studies in limited number of contexts.
- Systems modeling can assist to:
  - Improve our understanding on impacts across contexts,
  - Scaling and targeting of relevant interventions to improve, systems efficiency
  - Trade-off analyses
- Participatory approaches, stakeholder participation, capacity building, data collection, information sharing
THANK YOU

A tale of two villages https://www.youtube.com/watch?v=KmlAjuZ6Hw
Trees for food security project (East Africa)
Value chain Innovation platforms for food security (East and southern Africa)
Sustainable Agricultural Intensification Research and Learning in Africa (East and southern Africa)
Agricultural model Intercomparison and Improvement project (Global)