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Food Security:

Representing reality in an agent-based model of Malawian smallholders.

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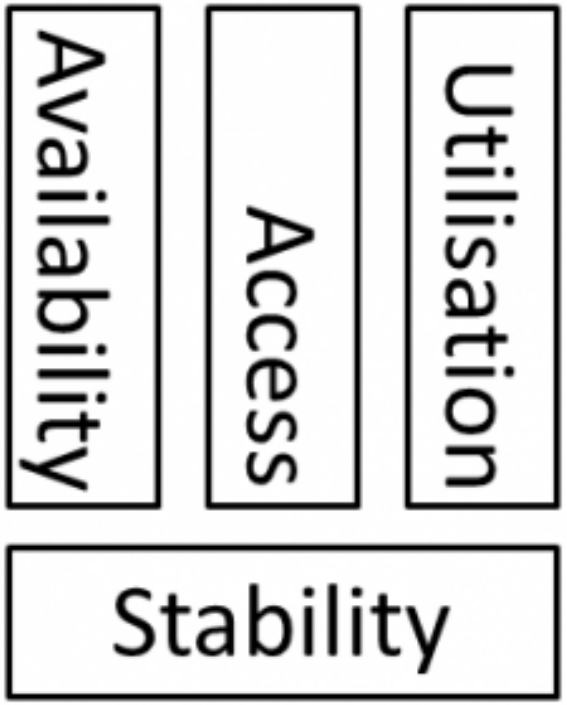
Introduction

What is food security?

- "when all people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" FAO – 1996

- The four pillars of food security



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My Research

Motivation

- Understanding how food security can be realised in rural Malawi.
- Complex social, ecological & political factors propel food insecurity currently.

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The use of Agent-based Modelling

- Agents interact within an environment through predisposed rules.
- Patterns at the macro-level emerge as a result of interactions at the local-level.
- Can be abstract, experimental, historical or empirical.
- Offers potential for greater understanding of food security.

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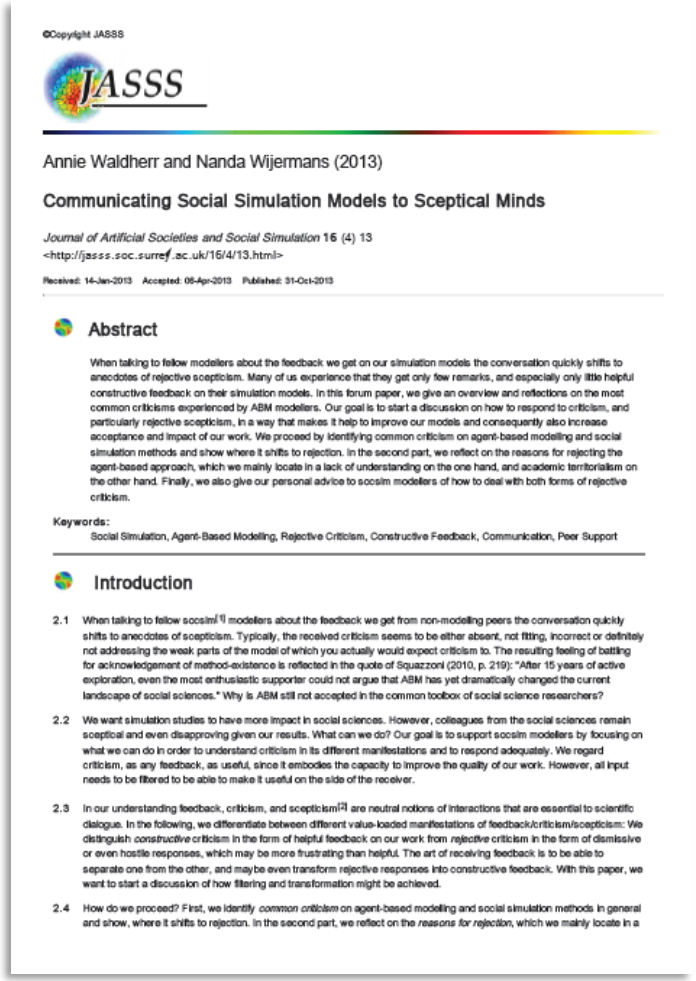
Managing Complexity

- How empirical is empirical?
- Stakeholder expectations
- Common criticisms:
  - Your model is too complex
  - Your model is too simple
  - Your assumptions & parameters are arbitrary
  - Your model is a black box



JASSS

Annie Waldherr and Nanda Wijermans (2013)

Communicating Social Simulation Models to Sceptical Minds

Journal of Artificial Societies and Social Simulation 16 (4) 13
<http://jasss.soc.surrey.ac.uk/16/4/13.html>

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Abstract

When talking to fellow modellers about the feedback we get on our simulation models the conversation quickly shifts to anecdotes of rejective scepticism. Many of us experience that they get only few remarks, and especially only little helpful constructive feedback on their simulation models. In this forum paper, we give an overview and reflections on the most common criticisms experienced by ABM modellers. Our goal is to start a discussion on how to respond to criticism, and particularly rejective scepticism, in a way that makes it help to improve our models and consequently also increase acceptance and impact of our work. We proceed by identifying common criticism on agent-based modelling and social simulation methods and show where it shifts to rejection. In the second part, we reflect on the reasons for rejecting the agent-based approach, which we mainly locate in a lack of understanding on the one hand, and academic territorialism on the other hand. Finally, we also give our personal advice to socsim modellers of how to deal with both forms of rejective criticism.

Keywords:
Social Simulation, Agent-Based Modelling, Rejective Criticism, Constructive Feedback, Communication, Peer Support

Introduction

2.1 When talking to fellow socsim[1] modellers about the feedback we get from non-modelling peers the conversation quickly shifts to anecdotes of scepticism. Typically, the received criticism seems to be either absent, not fitting, incorrect or definitely not addressing the weak parts of the model of which you actually would expect criticism to. The resulting feeling of battling for acknowledgement of method-existence is reflected in the quote of Squazzoni (2010, p. 219): "After 15 years of active exploration, even the most enthusiastic supporter could not argue that ABM has yet dramatically changed the current landscape of social sciences." Why is ABM still not accepted in the common toolbox of social science researchers?

2.2 We want simulation studies to have more impact in social sciences. However, colleagues from the social sciences remain sceptical and even disapproving given our results. What can we do? Our goal is to support socsim modellers by focusing on what we can do in order to understand criticism in its different manifestations and to respond adequately. We regard criticism, as any feedback, as useful, since it embodies the capacity to improve the quality of our work. However, all input needs to be filtered to be able to make it useful on the side of the receiver.

2.3 In our understanding feedback, criticism, and scepticism[2] are neutral notions of interactions that are essential to scientific dialogue. In the following, we differentiate between different value-loaded manifestations of feedback/criticism/scepticism: We distinguish *constructive* criticism in the form of helpful feedback on our work from *rejective* criticism in the form of dismissive or even hostile responses, which may be more frustrating than helpful. The art of receiving feedback is to be able to separate one from the other, and maybe even transform rejective responses into constructive feedback. With this paper, we want to start a discussion of how filtering and transformation might be achieved.

2.4 How do we proceed? First, we identify *common criticism* on agent-based modelling and social simulation methods in general and show, where it shifts to rejection. In the second part, we reflect on the *reasons for rejection*, which we mainly locate in a

- How can the challenges of representing reality, technical constraints and meeting the expectations of stakeholders be overcome?

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Using Participatory Methods?

- Can Participatory Rural Appraisals (PRA) be used to parameterise ABM?
- PRA techniques include:
  - Matrix scoring
  - Seasonal calendars
  - Mapping
  - Wellbeing ranking

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Defining Agent Types

- Using ASSETS wellbeing exercises, 4 agent types were identified:

– Type 1: Male Heads of Household (HH) of medium or rich wellbeing

– Type 2: Male HH of poor or very poor wellbeing

– Type 3: Female HH of medium or rich wellbeing

– Type 4: Female HH of poor or very poor wellbeing

		Perceived Wellbeing	
		Poor & Very Poor	Medium & Rich
Gender of Household Head	Female/Male	• < 1.0 ha of cultivated land • Own poultry only • Inadequate food availability for the year • Access to public healthcare only	• > 1.0 ha of cultivated land • Own livestock including goats and poultry • Adequate food availability for the year • Access to both private and public healthcare

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Inferring Behavioural Rules

- Participant selection based upon agent types.
- PRA exercise designed to investigate farmer decisions
- Each month a total of 60 counters are split between 15 activities.
- Exercise repeated for a drought year
- Interview style questions explore the impact of input subsidies upon food security.

Months :	Jan	Feb	Mar
Season :	Rainy Season		
Activity			
Maize			
Sweet Potato			
Rice			
Pigeon Pea			
Tobacco			
Cassava			
Fishing			
Hunting			
Livestock			
Wild Foods			
Wood fuel			
Ganyu			
Sell at market			
Buy at market			
Other			

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Building a Model

- Results from the PRA exercises used to construct behavioural rules for agent types.
- Log-normal distributions calculated for each activity.
- Impact of input subsidies taken into account by set-exo-onset () & set-exo-impact ().
- Model parameterisation also aided by literature.

ABM structure

define-landscape ()

define-agents ()

LOOP

- **set-month ()**
- **set-drought ()**
- **set-agent-type-options ()**
- **set- exo-onset ()**
- **set- exo-impact ()**
- **set-agent-type-decisions ()**
- **calculate-agent-wealth ()**
- **calculate-agent-food adequacy ()**

END LOOP

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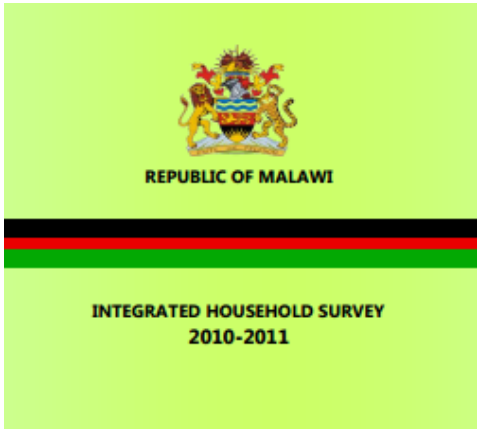
Define-agents ()

- Each of the 15, 808 households to be given an agent type.
- Requires existing household survey data as PRA participants targeted in an un-stratified manner.
- K-means cluster analysis identifies four clusters within the survey data corresponding to four agent types.
- Monte Carlo techniques employed to generate the entire agent population.



K-means cluster analysis

	Gender			
	Male		Female	
Cluster	1	2	3	4
Area of land (ha)	0.96	0.74	0.65	0.22
No. of livestock	4	0	4	0
No. of poultry	15	0	15	0
Health care	2	2	2	2
Food adequacy	2	2	2	1
Proportion of sample population (%)	28.9	48.9	4.4	1.8

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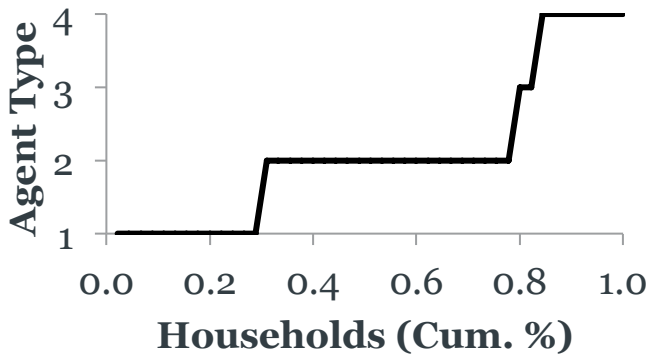
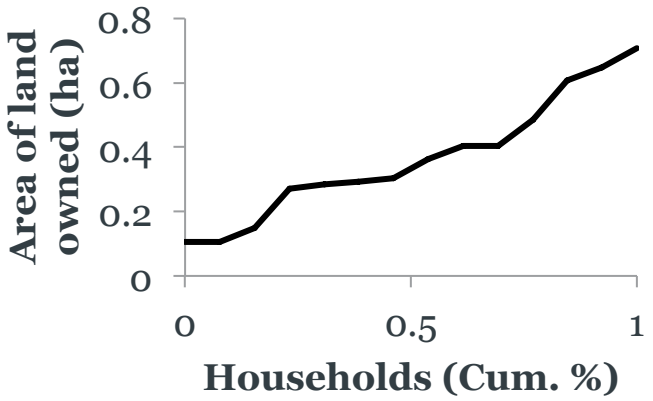
Monte Carlo Techniques

- An empirical cumulative distribution function (CDF) created to determine agent type.
- A random integer between 0 and 100 drawn for each agent and the agent type read from the y-axis.
- Conducted for all 15,808 agents to recreate the empirical distribution.
- Repeated to allocate resource endowments: land area, numbers of livestock, number of poultry & food-adequacy value.





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Model Implementation

- **Baseline scenario:**
  - 30 % chance of drought, input subsidies available from September to December and accessed by 47 % of the population. Model run for 120 time-steps (10 yrs).
- **Drought scenario:**
  - Probability of drought varied between 0 to 100 % in 20% intervals.
- **Input subsidy scenario:**
  - Timing of input subsidies varied to be early, typical and late.

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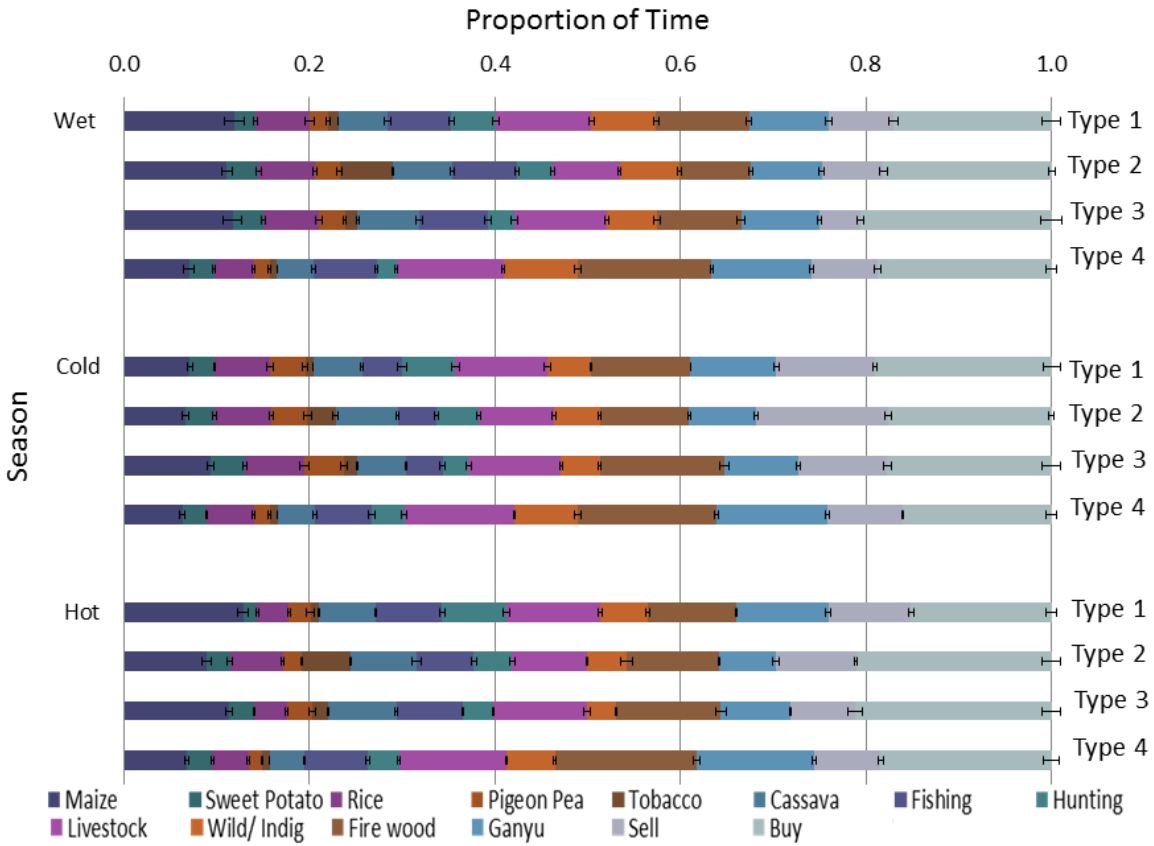
Model Results



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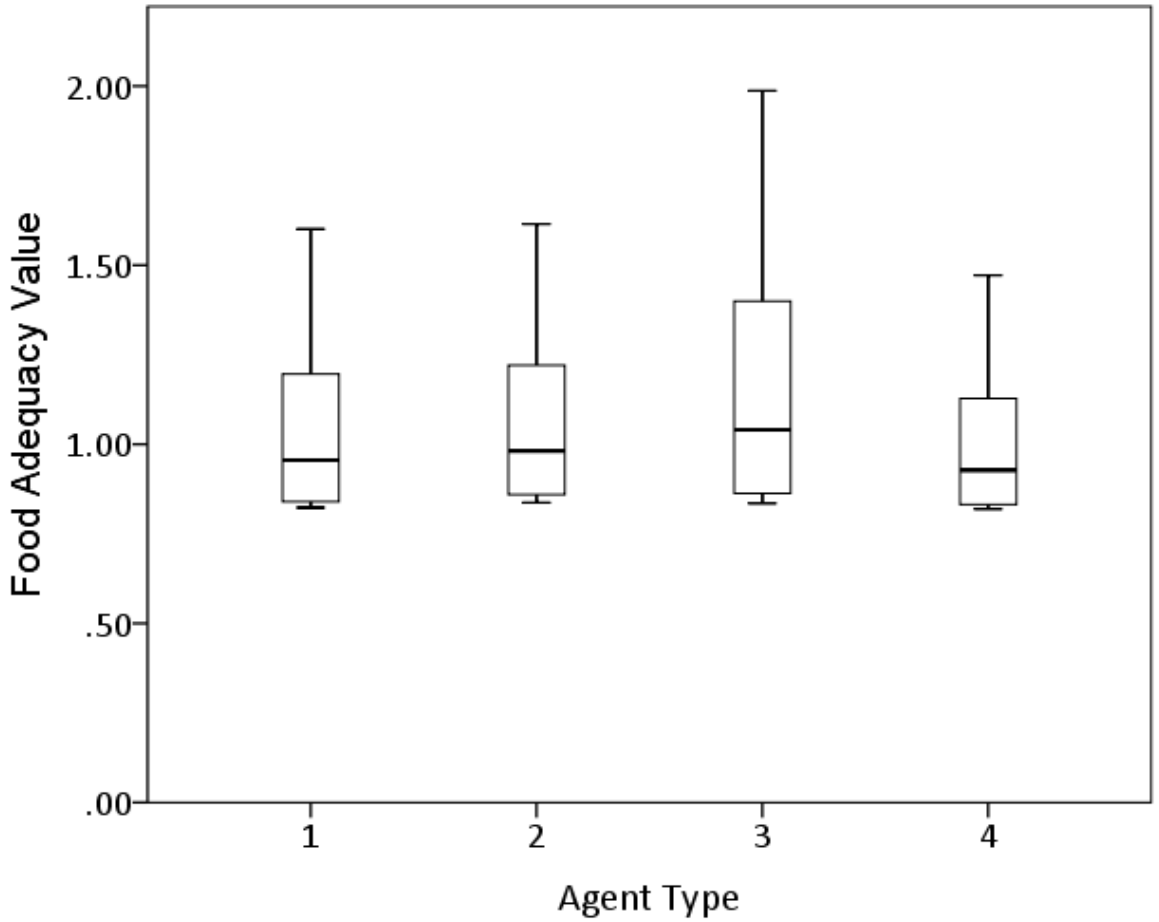

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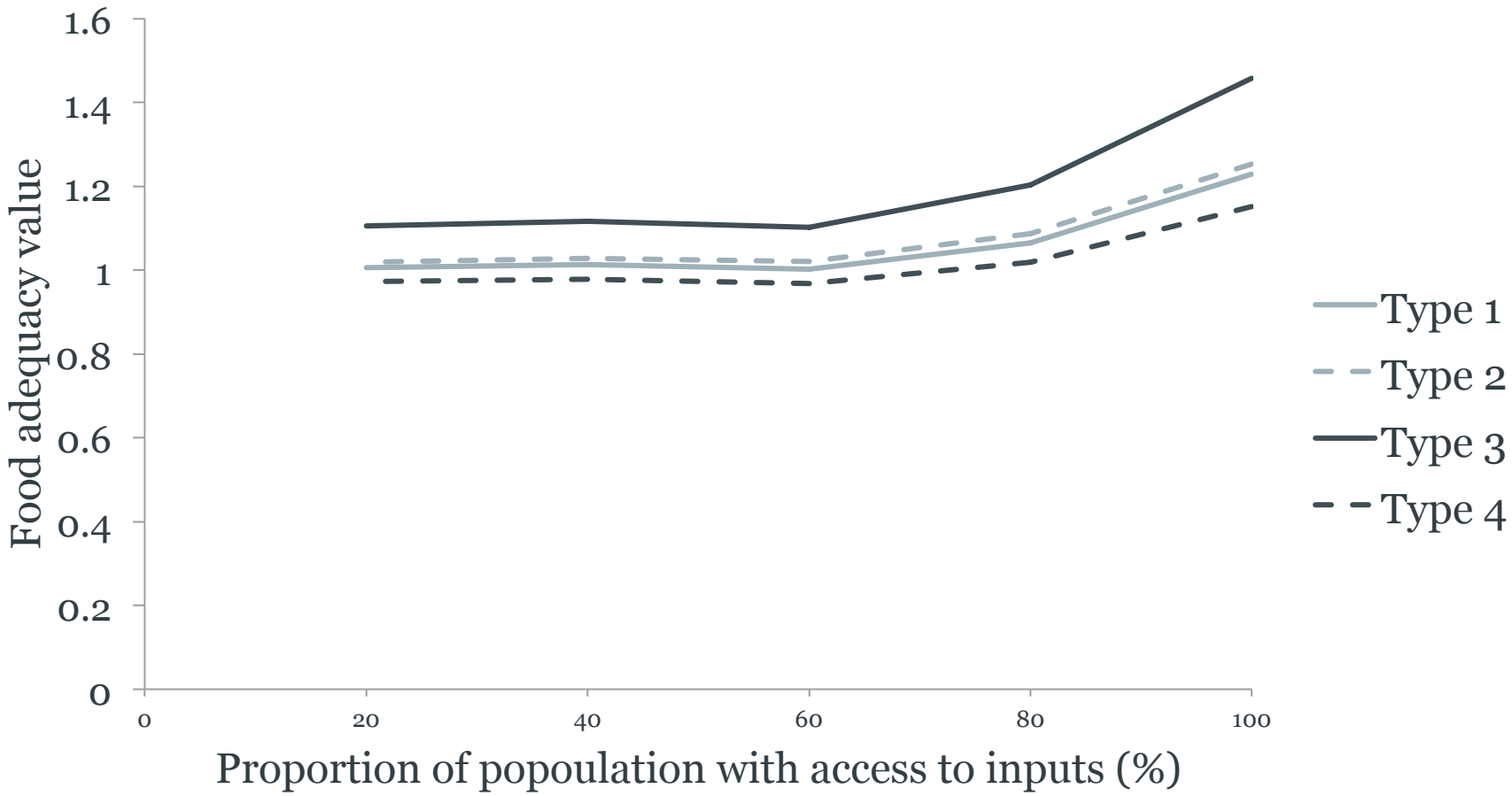

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Critique

Strengths

- PRA exercise brought greater understanding of the smallholder system and uncovered surprising behaviour.
- A simple yet effective method to parameterise empirical ABM.
- Participatory approach.

Weaknesses

- Data limitations – poor availability and reliability.
- Issue of aggregation – inter-village differences not accounted for.
- The need for Validation - preliminary results are speculative.

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Summary

- The primary objective:
  - Can PRA techniques be employed in the parameterisation of empirical agent-based models?
- In this case – yes!
  - Model implementation allowed complex social, ecological and economic factors to be explored.
- Future work:
  - Overcoming data limitations
  - Model validation and verification

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assets

espa ecosystem services for poverty alleviation

ICSS

EPSRC Engineering and Physical Sciences Research Council

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