

ABM FOR AGRI-FOOD SUSTAINABILITY

Sustainability transitions in agri-food systems through the lens of agent-based modelling: a systematic review

SHORT SUMMARY FOR PRACTITIONERS

EN version

RUSTICA is aimed at developing circular business models for bio-based fertilisers, what implies a sustainability transition of the agri-food sector. Dynamic and diverse agri-food systems still need a better understanding of the evolving environmental, economic, and social dimensions of sustainability. These transitions of complex systems is not evident, and a systemic approach is required to represent the complexity of the context and processes involved.

Modelling approaches are well suited to provide insights into transitions toward sustainability, however such modelling of sustainability transitions in agri-food systems has been generally overlooked in the past. Agent-based models are computational resources that represent individuals or agents in an environment in which they interact with each other. The performed systematic review revealed that agent-based models capture core characteristics of sustainability transitions, resulting in a powerful method to understand transitions in agri-food systems. Here, we present some recommendations for researchers that could benefit from using this modelling approach in the study of sustainability transitions.

SHORT SUMMARY FOR PRACTITIONERS

NATIVE version

RUSTICA is gericht op de ontwikkeling van circulaire bedrijfsmodellen voor biogebaseerde meststoffen, wat een duurzaamheidstransitie van de agrovoedingssector impliceert. Dynamische en diverse agrofoodsystemen hebben nog steeds een beter begrip nodig van de evoluerende ecologische, economische en sociale dimensies van duurzaamheid. Deze transitie van complexe systemen zijn niet vanzelfsprekend en er is een systemische aanpak nodig om de complexiteit van de context en de betrokken processen weer te geven.

Modellerings technieken zijn zeer geschikt om inzicht te verschaffen naar duurzaamheidstransities, maar dergelijke modellering van duurzaamheidstransities in agrovoedselsystemen is in het verleden over het hoofd gezien. Agent-gebaseerde modellen zijn computermiddelen die individuen of agenten voorstellen in een omgeving waarin ze met elkaar interageren. De uitgevoerde systematische review toonde aan dat agent-gebaseerde modellen de belangrijkste kenmerken van duurzaamheidstransities vastleggen, wat resulteert in een krachtige methode om transitie in agrofoodsystemen te begrijpen. Hier presenteren we enkele aanbevelingen voor onderzoekers die baat zouden kunnen hebben bij het gebruik van deze modelbenadering in de studie van duurzaamheidstransities.

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implementation of optimized
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CONTEXT

Agri-food systems and their value chains are currently under pressure to minimise environmental degradation and secure a more sustainable future. RUSTICA's objective to develop circular bio-based fertilisers requires the understanding of such sustainability transitions in agri-food systems. Sustainability transitions in complex systems like agri-food systems must take the complexities, non-linearity, and interactions involved into consideration.

PROBLEM

Investigating the potential and suitability of agent-based modelling for improving our understanding of sustainability transitions in agri-food systems by reviewing a variety of transition models in agri-food system studies.

APPROACH

A sustainability transition characteristics framework is proposed, covering feedback loops between social and environmental systems, the detection of systemic change, temporal and spatial scales, changes in social values in transitions, diversity and heterogeneity, uncertainty and non-linearity, and multidisciplinary approaches. Furthermore, generic elements of models such as the representation of sustainability dimensions, sectors within agri-food systems, and complementary methods used in the study are analysed.

OUTCOME

1. Recently, there is an increasing interest in studying sustainability transitions using agent-based models, specifically for agri-food systems. In the past, agri-food system transitions have been overlooked.
2. Characteristics of sustainability transitions like detection of systemic change, temporal and spatial scales, changes in social values and norms, diversity and heterogeneity, uncertainties and non-linearities, and multidisciplinary approaches can be observed and represented using agent-based models. This helps in understanding sustainability transitions in agri-food systems.
3. An advantage of agent-based models is that they are flexible to represent processes that require either a longer time span, such as landscape transformations, or shorter temporal scales. Furthermore, they can combine multiple timescales in one model by using a multiscale modelling approach that incorporates both social and biophysical dynamics. However, the understanding of a system in the past cannot guarantee the prediction of future behaviours and long-system dynamics in a complex system.
4. Agent-based models currently have limited consideration of social learning, risk aversion, social norms, or social aspects contributing to social norms, in contrast to natural system components that often appear in models. Surveys, expert knowledge, interviews, and participatory approaches are helpful methods to include the behaviour characteristics in agent-based models.

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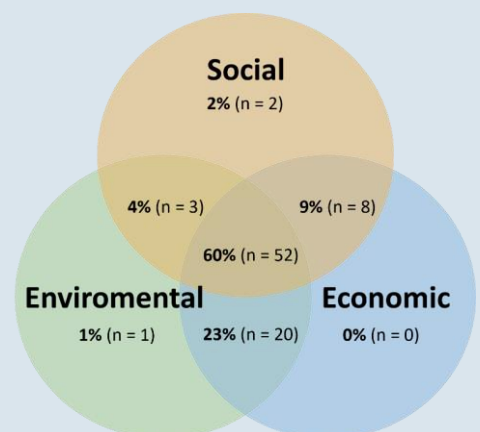
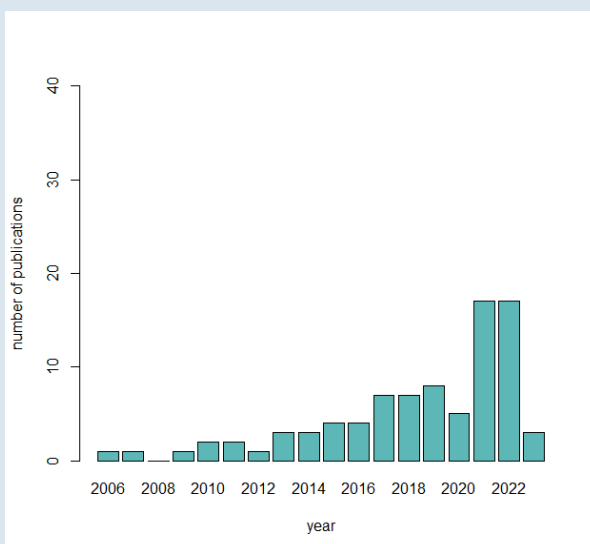
OUTCOME

5. A focused study of at least two activities of the agri-food supply chain can still provide valuable insights regarding sustainability transitions. Activities such as processing and distribution are still lacking in models.
6. It is highly recommended to follow a participatory approach, especially in agri-food systems sustainability transition papers using agent-based models, as these tend to be broad, multidisciplinary systems.
7. The combination of agent-based model with other suitable methods like GIS can increase the power of these analyses.

PRACTICAL RECOMMENDATIONS

- ✓ Due to the urgent need to understand sustainability transitions, using agent-based models to simulate agri-food systems could help researchers, together with other stakeholders, to understand how transitions happen. Exploring potential sustainable solutions, like the development and adoption of bio-based fertilisers, could be done by using this modelling approach.
- ✓ Agri-food models could benefit from using complementary methods adapted to the needs of the simulation. It must first be evaluated which complementary methods should be integrated, and what outcomes may they yield.
- ✓ Good code publishing practices could be done by keeping modelling notebooks, which helps to communicate and share models' results.
- ✓ However, it should be noted that agent-based modelling is highly time-intensive and requires some degree of expertise in software tools. Therefore, we should critically think about what can we achieve with this modelling method versus the time and effort we need to invest in it.

FIGURES



Sustainability dimensions included in the analysis of the selected final records

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