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## Exploring Symbiotic Cooperation of Smallholders for Sustainability and Food Security: A Spatio-Temporal Modelling Approach

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### Abstract

Sustainable development of the vulnerable rural areas remains a highly complex issue nowadays. Among the main goals, it should consider ecosystem services protection while supporting the most insecure but crucial actors in food production — agricultural smallholders. Such an approach can provide a multi-benefit effect — increase of productivity along with maintaining ecosystem quality and strengthening social and human capitals. As individual farmers are often lacking resources, information and skills to make optimal land-use decisions, the hypothesis is that multiple benefits can be achieved through creating symbiotic cooperation networks of agricultural smallholders. Such networks or clusters could be a means for sharing/exchanging resources, performing collective actions and coordinating land-use, sharing knowledge and eventually adopting new agricultural policies. Nowadays there is practical evidence of usefulness of such approach (e.g. CATALIST project; Agreco organisation), however it is lacking a methodology and a tool for systematic assessment and testing different solutions in different conditions.

This study is aimed at in-depth analysis of an agricultural smallholders-based network and its environment as a complex dynamic system, where technical, economic, social and environmental components are mutually dependent. We are moving towards a conceptual framework and a quantitative simulation tool to study the dynamics of a symbiotic cluster/network in different conditions, to test the sensitivity of the system to the changes in objective functions and input variables, as well as to evaluate the impacts of the implementation of new policies and incentives. As a first step in that direction, we present a simple game model to illustrate and test how smallholders-based networks for sharing resources can work. The model can be used with stakeholders to identify and record their preferences and strategies and inform further development of more sophisticated agent-based models and tools.

**Keywords:** Dynamic modelling, ecosystem services, food security, networks, optimisation