

## **Simulating the Diffusion of Agricultural Innovations with Multi-agent Systems: An Empirical Application to Northern Thailand**

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The diffusion of agricultural innovations – including improved crops, agricultural chemicals, and farm mechanization usually has profound impacts on agricultural land use. These changes in land use have both economic as well as environmental dimensions. For instance, the substitution of vegetables for paddy rice, as presently observed in many parts of tropical Asia, is often motivated by greater cash returns yet might at the same time worsen the erosion of topsoil. Existing models of technology diffusion, like information-contagion models and economic constraint models, focus on the decision-makers and are usually not spatial; these models are therefore not directly suitable for analyzing the changes in agricultural land use. Multi-Agent Systems models of land-use/cover change (MAS/LUCC) have to potential to overcome this drawback as they couple a cellular component that represents a landscape with an agent-based component that represents human decision-making (Parker *et al.*, 2003).

This paper describes a novel method for simulating agricultural technology diffusion based on MAS/LUCC. The method integrates farm household models and technology diffusion models within the framework of MAS. The model was based on the MP-MAS model developed at the University of Hohenheim (Berger, 2001; Berger *et al.*, 2007; Schreinemachers, 2006). Each model agent represents an individual farm household and agent decision-making is simulated by solving mathematical programming (MP) models. The use of MP is suitable for it allows building the MAS on existing models of farm household decision-making in agricultural economics and facilitates the integration with biophysical models (Schreinemachers and Berger, 2006). The MP-MAS model can, for instance, optionally include a hydrology or a crop yield model.

For this study, the model was calibrated to two neighboring villages in the mountainous areas of Northern Thailand including 140 households. Data were collected in 2005 from a random sample of 60% of the households while the remaining 40% of the agents were generated using a Monte Carlo method (Berger and Schreinemachers, 2006). The diffusion process was calibrated by estimating binary choice models, which were linked to the constraint set of the MP models. The

agents in the model were allowed to communicate their experience with the new technologies through social networks.

The paper describes the empirical calibration and validation of the model in detail. It then explores the diffusion of vegetables and agricultural chemicals with respect to economic returns, environmental sustainability, and changing land use patterns. As each farm household is represented, the model also allows assessing the distributional consequences of innovation diffusion, which has great relevance to policy making.

## References

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