From empirical findings to a formalized model: An agent-based approach to represent farmer decision-making on agri-environmental schemes

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Model-based analyses can effectively contribute to investigate leverage points for sustainability transformations in agriculture. They allow for a systematic assessment of policies under changing environmental, economic, or institutional conditions and can be used to evaluate the efficiency of different policy designs. This makes them an important tool for critically evaluating agricultural policies and shaping them appropriately to achieve the desired effect. For analyzing agricultural systems, agent-based modeling is particularly useful as it allows to represent individual farmers – the crucial actors at the landscape level. This approach can explicitly incorporate farmer behavior to map, for example, the conditions for adopting sustainable practices that lead to more diverse agroecosystems.

In order to provide policy makers with an effective tool, an adequate representation of farmers' decision-making is crucial. However, formalizing empirically observed farmer behavior in model rules is difficult because, as in all models describing human behavior, complex decision-making must be simplified into clear cause-effect relationships. Following established behavioral theories, on the other hand, also entails difficulties: First, theories often consider only certain aspects of decision-making and fall short when it comes to incorporating the multiple influences that farmers face. In addition, a rather low degree of formalization of theories as well as limited data availability for model parameterization are problematic. As a consequence, many ABMs remain rather stylized, reducing the external validity of the emerging results and leading to limited potential to help policy makers identify suitable measures for a sustainable transformation of agriculture.

We aim to address this gap with a methodological contribution by developing an empirically driven decision framework for the adoption of agri-environmental schemes (AES). To capture the most important processes of the decision-making in this context, we first collected possible influence factors in an extensive literature search. Based on this overview, we derived a semi-structured interview protocol covering open questions and a standardized questionnaire that provided the basis for an interview campaign in five case study regions across Europe (Czech Republic, Germany, Serbia, Spain and United Kingdom). With the help of local case study experts, we were able to derive key factors for farmer decision-making on AES adoption from the obtained qualitative and quantitative data. We condensed these observations in a formalized conceptual framework that covers a three-step decision process. It incorporates (1) whether farmers are in general open toward the adoption of specific AES, (2) which of their fields are suitable for AES adoption and (3) the final deliberation whether farmers adopt specific AES that is not only driven by economic factors but also includes ecological and social aspects as well as whether an AES fits to the established farm practice. To parameterize the framework and capture regional differences more specifically, we plan to conduct a discrete choice experiment with which the influence factors can be further quantified. We conclude with illustrating examples of research questions that can be addressed using this framework.