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BOOSTING THE USE OF ORGANIC SEED AND CULTIVARS – HOW TO ASSESS PUBLIC AND PRIVATE SECTOR INTERVENTIONS

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Abstract: Organic seed and cultivars markets are highly distorted. Political or private sector interventions to overcome market failures need to be found to comply with the demands of organic agriculture. Simulation models are useful tools to assess such interventions in ex-ante assessments. This study outlines a conceptual framework to simulate the seed value chain of EU organic agriculture: We deem a positive recursive-dynamic model with decision-making through a combination of mathematical programming and heuristics of a multi-agent system as the most suited approach. Potential modelling scenarios comprise a number of regulatory measures, as well as public and private investments in training and research along the seed value chain.

Introduction: In the EU, market failure can be observed for organic seed and cultivars, with the seed market being dominated by conventionally bred varieties and conventionally multiplied seed (Döring *et al.*, 2012). By 2036, the EU plans to achieve 100% organic seed for the sector (New Organic regulation 848/2018). However, there is not yet a strategy in place how to secure sufficient organic seed supply.

The conflicting interests of different value chain actors and the lack of implementing the present EU organic regulation contribute to the failure of the organic seed market. Thus, we propose an ex-ante value chain assessment approach to evaluate potential strategies. Existing frameworks for value chain analysis are largely qualitative, but quantitative methods are recommended for more rigour (Nang'ole *et al.*, 2011). The objective of this study is to develop a quantitative ex-ante assessment tool to test the effect of interventions on increases in organic seed share and sustaining the competitiveness of the sector.

Material and methods: To develop a suitable *ex ante* assessment tool, different existing approaches were evaluated, combined and extended. Existing models focus on the farm level (Janssen and van Ittersum, 2007). Here, either typical or representative farms, or agent populations are considered. Agent based modelling best captures heterogeneous characteristics and behaviour in a population as each entity has unique resource endowments, takes individual decisions

and reacts to decisions of others (Schreinemachers and Berger, 2006; Gjerdrum *et al.*, 2010). As actors along the seed value chain and actors at each level of the chain feature heterogeneity, a multi-agent system is best suited when modelling the seed value chain.

Mathematical programming (MP) is used to find optimal solutions for economic decision-making, such as the optimal production plan at farm level under given resource constraints and gross margins per crop. Based on standard microeconomic theory, it allows flexibility for agent behaviour by offering a vast range of decision options. This makes it particularly suitable for modelling detailed input decisions, such as seed use. Heuristics offer only a far reduced flexibility of choices as compared to MP through a pre-defined decision-tree (Schreinemachers and Berger, 2006), which is less appropriate for this study.

As regards MP models, there are, on the one hand, static models that do not show intermediate results, but solely the outcome. One the other hand, dynamic models explicitly model outcomes across time periods (Janssen and van Ittersum, 2007). As we want to model several processes with different time horizons, a dynamic approach is required. Within the group of dynamic models, a recursive-dynamic model seems most suited. It optimises over all periods at once, using the end values of a period as starting values for the subsequent period (Janssen and van Ittersum, 2007) and can thus provide a feedback loop between value chain levels.

Numerous normative value chain models using MP techniques in the field of operations research exist. Their aim is to re-allocate resources to eliminate inefficiencies (Gjerdrum *et al.*, 2010). The objective of a positive model or simulation model is to depict a real-world situation and to simulate the development of this situation if certain factors change (Schreinemachers and Berger, 2006). Therefore, a positive model will be needed to assess seed interventions.

Results: As laid out in detail in the section above, we propose a simulation model to show how circumstances in the seed value chain for EU organic agriculture change in different future settings. Further, the model needs to be recursive-dynamic, so that developments over time can be endogenously modelled and observed. The decision-making of individual entities in a multi-agent system is simulated by mathematical programming. Heuristics may be considered where appropriate. The combination of these existing modelling techniques, as well as the extension to include actors of different value chain levels seems to make this new framework well suited for the purposes of analysing the seed value chain in EU organic agriculture.

The proposed model is currently being developed and parameterised for 3 different case studies, i.e. the seed value chain of organic carrot production in Germany, of organic durum wheat production in Italy, and organic perennial ryegrass as permanent pasture in England. The chosen crop-country combinations represent important and at the same time diverse seed value chains. Thus, meaningful conclusions can be drawn from the results, covering leading regions and crops in organic agriculture and a variety of issues in their seed value chains.

A range of scenarios are deemed promising for the sector. Regulations as well as economic (dis-)incentives may feed into possible simulation scenarios and can be tested both in isolation as well as in the form of intervention packages in comparison to the base-line scenario. Policies such as a stricter EU organic regulation, taxes or penalties on conventional seed or cultivar use, subsidies on organic seed or cultivar use will be tested. Furthermore, different kinds of investments will be taken into consideration, such as public investment in training and research on organic seed and organic cultivars at different levels of the value chain, innovations by private companies to improve organic seed and cultivars and pre-financing of breeding by a public-private cooperation or by value chain actors. Preliminary results based on expert consultation have shown that the following scenarios are deemed suitable for the respective case studies (Table 1):

Table 1: Suitable scenarios for three case studies

Scenarios	Organic carrot – Germany	Organic durum wheat – Italy	Perennial ryegrass - England
Increasing organic seed production	Public and private investment in research for pest management, i.e. lygus beetle	Public and private investment in seed producer training to handle e.g. common bunt and other diseases	Public and private investment in research for more efficient fertilisation management
Increasing organic seed use	Step-wise phasing out of derogations	Step-wise phasing out of derogations	Step-wise phasing out of derogations
Increasing organic breeding activity	Public and private investment in research for diverse breeding systems (populations), Private investment in value chain collaborations through networks	Encouraging farmer-driven organic breeding activity, Private investment in value chain collaborations through networks, Establishing Value for Cultivation and Use tests under organic conditions	Not deemed urgent, similar goals organic and conventional breeding

Sensitivity and uncertainty analyses including Monte-Carlo simulations will be carried out where appropriate in order to give greater insight into the variations of the outcomes caused by specific model parameters, e.g. input prices or expected yields.

The ultimate outcome of this research will be recommendations on cost-effective national and European policy and private sector interventions, based on real-world examples to support upscaling of the organic seed and breeding sectors. These outcomes will be available at the time of the conference.

Discussion: To the best of our knowledge, this study is the first attempt for modelling an entire value chain using MP and agent-based approach. It can thus give more comprehensive insights into policy implications at all value chain levels of interest than models focusing only on farm or sector level. In order for the model to produce meaningful results, economic data needs to be made available for all levels. This is likely to be a limiting factor for the model's validity. Nevertheless, the model outcomes are likely to be of substantial use to find strategies to smooth the transition period until organic seed will be mandatory and to find long-term solutions. It may additionally prove useful in further *ex ante* assessments where a whole value chain perspective makes sense.

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