Extended Abstract
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Paper/Poster Title	The role of risk perceptions in the adoption of a pesticide-free production system

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Abstract	***200 words max***
We explore the risk-related barriers to the adoption of a novel pesticide-free wheat production system in Switzerland. More specifically, we study adoption and its postponement in relation to risk preferences and risk perceptions. Our analysis is based on a framework derived from Real Options theory to describe farmer behaviour. We use an econometric analysis based on survey data from more than 1,000 Swiss wheat producers. We find that especially production and institutional risks as perceived by farmers, are relevant for their adoption decisions. Farmers with high perceived risks in these domains are more likely to postpone the adoption decision. In contrast, the perception of market and investment risks do not seem to play a role. Moreover, we observe that the perceived probability of experiencing losses due to adoption (e.g., complete crop failure or very low yield), is a strong predictor of farmers' adoption decisions, more than the magnitude of the expected yield loss. Finally, we find evidence that stronger willingness to take risks is associated with more adoption and less postponing behaviour. Our analysis suggests that reducing farmers' (perceived) risks can be a key instrument for policy and industry to facilitate the adoption of pesticide-free production systems.	

Keywords	*Agricultural investment, Pesticides, Agricultural policy, Real options*
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Introduction ***100 – 250 words***

Pest management plays a central role to reduce the adverse environmental and health impacts of agriculture (e.g., Larsen et al., 2017; Stehle and Schulz, 2015). More specifically, decreasing pesticide pollution of soils, water bodies and its impacts on biodiversity and human health has gained relevance in recent European agricultural policies (e.g., the European Green Deal). To achieve these goals, adjustments in farming practices and farmers' uptake of new production systems are required (Möhring et al. 2020). In this study, we investigate the role of risk preferences and risk perceptions on farmers' decision to adopt a novel pesticide-free, yet not organic, production system in Switzerland (Möhring and Finger, 2022).

The pesticide-free wheat production system is at the interface of private and public efforts to reduce pesticide use and risks. On the one hand, the federal government

provides monetary compensations to farmers for the renunciation of pesticides. On the other hand, the Swiss producer organization IP-SUISSE offers marketing channels and price-mark ups to farmers for producing pesticide-free wheat. The conditions to participate, however, entail complexities in pest and weed management, that turn into new production requirements and new or amplified sources of uncertainty. We explore the role of such uncertainties on adoption. The contribution of this paper is twofold. First, by studying the prospective timing of adoption, we enrich the dominant approach that considers adoption as a dichotomous decision (now-or-never adoption). Second, we complement the role of production and market perceived risks with institutional and investment risks, which have received significantly less consideration in previous studies.

Methodology ***100 – 250 words***

Our conceptual framework comes from Real Options Theory and indicates that investment decisions can be deferred to a later point in time when uncertainties regarding the investment option resolve. For the pesticide-free production system, if adoption induces high initial risks, for example, of low yields due to the inability to intervene the crops with pesticides, farmers have an incentive to postpone adoption. Moreover, the higher the risk aversion, the lower the utility farmers get from adoption as no pesticide production systems are often considered riskier. We empirically test this prediction with a linear regression analysis to explain how risks relate to the adoption and prospective timing of adoption.

Our analysis is based on survey data from 1073 farmers with detailed information on farmers' characteristics, risk preferences, perceptions, participation in the program in previous periods and the intention to join at a later point. We capture four sources of risk, namely, institutional risk (i.e., changes in federal direct payments), market risk (i.e., the continuation of the IP-SUISSE program), production risk (i.e., risk of yield loss, weed pressure and quality of wheat), and investment risk (i.e., machinery not being used). Additionally, we use a rich set of farm and farmer-specific control variables.

We test the robustness of the main results by means of i) an alternative model (i.e., Logit and Ordered Logit), ii) the progressive inclusion of control variables, iii) with different samples of farmers (e.g., level of specialization in wheat, farmers with ex-ante assessments), iv) a test for collinearity, and iv) Oster bounds (Oster, 2019) to test for robustness to non-observables.

Results ***100 – 250 words***

Descriptive analysis shows that risks of weeds in crop rotation and changes in direct payments are the most important in farmers' risk assessments. Moreover, there is heterogeneity in risk assessments across farmers (i.e., early adopters, prospective adopters and never adopters). For all domains of risk studied, the risk levels are lowest for early adopters and highest for never adopters. The regression analysis suggests that production risks are relevant for the decision to delay adoption regarding risks of yield loss and weed pressure in crop rotations. Although the risks regarding federal direct payments are as prevalent as risks of high weed pressure, they seem to influence farmers' decision to adopt only to a small extent. Market and investment risks do not seem to play a role in farmers' adoption decisions. While the expected yield decrease is not of relevance for farmer's decision, the perceived probability of loss is

highly significant and appears to discourage adoption. As expected from our conceptual framework, farmers tend to postpone less and adopt more, the more risk willing they are.

Our approach has three main challenges. First, risk preferences and risk perceptions are likely to be correlated. Second, risk perceptions, being a cognitive construct, depend on the context and characteristics of farmers, raising concerns of omitted variable bias. Third, issues of reverse causality as early adopters assess risk based on both expectations and ex-post assessments in our sample. The robustness checks show that across specifications, production risks remain to be the main source of risk that farmers consider for adoption.

Discussion and Conclusion	***100 – 250 words***

We study pesticide-free wheat production in Swiss agriculture. Our analysis is based on an econometric analysis of a stand-alone survey that allows us to observe farmers' heterogeneity in terms of their (subjective) risk assessments, risk preferences and their past and prospective adoption decisions. The pesticide-free wheat production scheme is based on a comprehensive set of incentives including price mark-ups, direct payments and marketing channels. Whether such tools and others such as cost-sharing of conversion, should be used to encourage the adoption of sustainable practices is a current question in the literature (e.g., Lefebvre, et al, 2020).

In the context of Real Options, the presence of risks implies that larger economic incentives are needed to induce adoption. Our analysis suggests that despite the prevalence of several risks, only production and institutional risks are relevant for the prospective timing of adoption as they tend to increase the waiting behavior, unlike market and investment risks, that do not seem to play a role. This result suggests that to ease the transition from conventional to less pesticide-intensive agriculture, production risks need to be prioritized, particularly in terms of weed pressure and yield decrease. On this basis, the participation of different value chain actors in the promotion of pesticide-free systems remains to be crucial alongside policy instruments to reduce farmers' (perceived) risks. The results highlight the importance of considering the risk-related barriers for adoption and have relevance to other countries and production systems where agri-environmental programs are implemented.