

## Smart farming technologies for pesticide use reduction in bio-economic farm models

Language: English, Contacts: Dr. Till Kuhn, [till.kuhn@ilr.uni-bonn.de](mailto:till.kuhn@ilr.uni-bonn.de)

Crop protection is essential to ensure the production of safe food in sufficient quantities (Savary et al., 2019). It currently strongly relies on the use of pesticides, which are often effective and efficient in pest control (Cooper & Dobson 2007), but cause negative externalities on the environment and human health (e.g. Sánchez-Bayo & Wyckhuys 2019). Policymakers and food-value chain actors worldwide have therefore put in place ambitious pesticide reduction targets (Möhring et al., 2023). Digital farming technologies such as sensor supported spot spraying or mechanical weeding robots offer the potential to reduce pesticide use and could be an important cornerstone in reaching those targets (Möhring et al., 2020). To foster the implementation of such technologies, insights on their economic impacts, most promising fields of application, and environmental benefit are needed. Farm models are helpful tools to research such novel technologies before their large-scale adoption can be observed empirically (Kuhn et al., 2022). However, the missing or restricted access to data on technology characteristics make their ex-ante assessment challenging.

The aim of this master thesis is the data collection of selected digital farming technologies and their implementation and assessment with the bio-economic farm model FarmDyn (Britz et al. 2021). After a criteria-based selection of relevant technologies, data on their impacts on yields, pesticide reduction, labor need, and costs under the most important production conditions have to be collected. This will be done based on a literature review. The estimated technology characteristics, and potentially their uncertainty, will be implemented in FarmDyn which has been previously used to assess the economic potential of novel technologies (Kuhn et al. 2022). In the final step, possible policy scenarios to foster the adoption of the considered technology are implemented in the model.

The master thesis is supervised in cooperation with the Chair of Production Economics (Prof. Niklas Möhring). The candidate should have a background in agriculture and an interest in modelling with the programming language GAMS. However, the focus of the master thesis can be shifted between data collection and the modelling based on the candidate's interest. Furthermore, the supervisor will assist the candidate with the modelling tasks. This thesis is especially suitable for candidates who can envision to develop the topic further after their master thesis (for example in the context of a PhD).

### References:

- Britz, W., Ciaian, P., Gocht, A., Kanellopoulos, A., Kremmydas, D., Müller, M. et al. 2021. A design for a generic and modular bio-economic farm model. *Agr. Syst.* 191, 103133.
- Cooper, J., Dobson, H. 2007. The benefits of pesticides to mankind and the environment. *Crop. Prot.* 26, 1337–1348.
- Kuhn, T., Möhring, N., Töpel, A., Jakob, F., Britz, W., Bröring, S., et al. 2022. Using a bio-economic farm model to evaluate the economic potential and pesticide load reduction of the greenRelease technology. *Agr. Syst.* 201, 103454.
- Möhring, N., Ingold, K., Kudsk, P., Martin-Laurent, F., Niggli, U., Siegrist, M., et al. 2020. Pathways for advancing pesticide policies. *Nat. Food.* 1(9), 535-540.
- Möhring, N., Kanter, D., Aziz, T., Castro, I. B., Maggi, F., Schulte-Uebbing, L., et al. 2023. Successful implementation of global targets to reduce nutrient and pesticide pollution requires suitable indicators. *Nat. Ecol. Evol.* 7, 1556–1559
- Sánchez-Bayo, F., Wyckhuys, K.A.G. 2019. Worldwide decline of the entomofauna: A review of its drivers. *Biol. Conserv.* 232, 8–27.
- Savary, S., Willocquet, L., Pethybridge, S. J., Esker, P., McRoberts, N., & Nelson, A. 2019. The global burden of pathogens and pests on major food crops. *Nat. Ecol. Evol.* 3(3), 430-439.