

Project *brief*

Thünen Institute of Farm Economics

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Reducing yield risks of extreme weather events by combining crop diversification and insurances

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- **Weather risks in German agriculture vary greatly from region to region, and droughts have been the weather risk with the highest monetary losses between 1995 and 2019.**
- **Growing multiple crops is often an effective strategy for significantly reducing a farm's overall yield risk in the event of drought.**
- **Multiple-yield insurance is one way of making yield insurance more affordable for farms with diverse crop rotations.**

Background and objectives

Extreme weather events such as droughts, floods, heat and frost can lead to significant yield losses in agriculture. However, a regional risk analysis of these extreme weather events for different arable crops at farm level is not yet available for Germany.

Farmers have several risk management tools at their disposal to mitigate these weather risks. On the one hand, they can rely on on-farm approaches such as variety selection and diversification. However, it is still unclear which crop combinations are most effective in reducing overall farm risk, how effective diversification is in the face of (increasingly extreme) drought, and how regional climate and soils influence the effectiveness of risk reduction. There is also the possibility of off-farm risk management, in particular insurance, to reduce weather risk. However, economically viable insurance is not widely available for all weather events. This is particularly relevant for weather events that occur infrequently but, when they do occur, affect a large number of farmers simultaneously and existentially (so-called systemic risks such as severe droughts).

In this project, we are exploring the synergies between crop diversification and insurance to improve weather risk management.

Approach

We started with conducting a comprehensive risk analysis for the most important arable crops in Germany for the period 1995-2019. This analysis was carried out at farm level (a total of about 424,000 observations) and is based on daily and spatially disaggregated information on weather, crop-specific soil moisture and crop-specific phenological phases (Schmitt et al., 2022).

Furthermore, we used copulas to analyse the risk or probability of simultaneous yield losses of different arable crops at farm level (about 250,000 observations in total). These analyses allow us to gain new insights into the risk-reducing effectiveness of crop diversification in coping with different levels of drought severity. They also provide information on the role played by the composition of the crop combination and regional soil and climatic conditions (Schmitt et al., 2023).

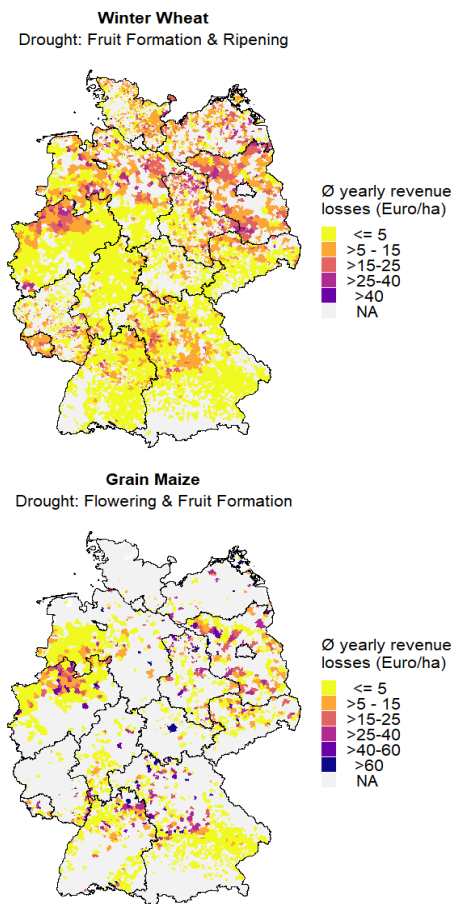
Finally, we analysed the synergies between crop diversification and insurance by conducting a utility analysis for single and multiple yield insurance (about 113,000 observations in total). These strategies are usually considered separately, but we show that including crop diversification in agricultural insurance can help make insurance more affordable and thus more accessible to many farmers.

Key findings

We find that droughts are a major cause of yield and income losses at farm level in German agriculture. For example, a single day of drought can reduce winter wheat yields by up to 0.36%. It is estimated that over the period 1995-2019, extreme summer droughts in winter wheat led to average annual income losses of more than €23 million across Germany.

We also show that the impact of extreme weather events varies greatly in space (see Figure 1) and time. For example, the eastern and northern parts of Germany are particularly affected by drought damage to winter wheat and grain maize. In contrast, winter rape in northern Germany was particularly susceptible to yield losses due to heat during flowering. Waterlogging and frost are generally less important from an economic and national perspective, but can still cause significant damage depending on the crop and region.

Figure 1: Estimated average annual yield losses due to summer drought in euro/ha for winter wheat and grain maize between 1995 and 2019.

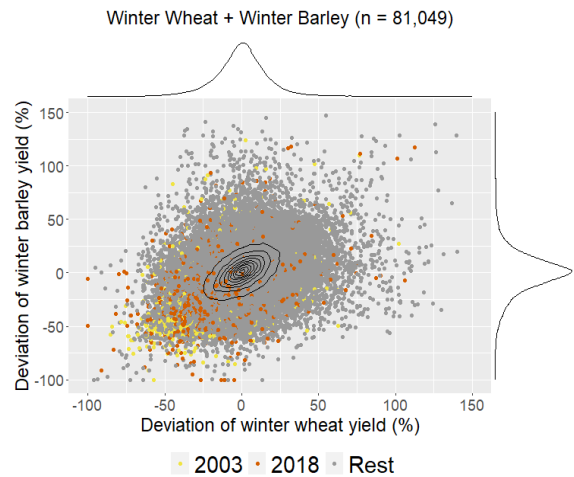


Source: Adapted from Schmitt et al. (2022), used under CC BY 4.0.

Our analyses show that growing several crops at the same time helps to manage drought risks. However, the effectiveness varies considerably depending on the region, the crop combination and the severity of the drought (see Figure 2; drought years 2003 and 2018 are highlighted). Our results emphasise that cropping system diversification alone does not sufficiently reduce drought risks, but that the right crop combinations are needed. For example, during a severe drought (1 in 20 years) in eastern Germany, 26% of farmers suffered simultaneous yield losses of at least 20% for winter wheat and winter barley, while only 19% of farmers suffered simultaneous yield losses of at least 20% for winter wheat and sugar beet.

Farmers should therefore be encouraged to grow crops with more diverse phenological requirements. The more crops are grown, the greater the reduction in yield risk. This can also be taken into account in multiple-yield insurance policies.

Figure 2: Simultaneous percentage deviations of winter wheat and winter barley yields at farm level from their long-term average yields.



Source: Schmitt et al. (2023).

Our results show that this type of multiple-yield insurance can be an attractive insurance option for many farms. The fair premiums of multiple-yield policies are lower overall, making them more affordable for farmers while still providing effective risk cover. As premiums are paid in advance, lower premiums also improve farm liquidity.

Recommendations

We derive the following recommendations for further action:

- Promote regionally adapted risk management to reflect regional soil and climate conditions.
- Encourage as much crop diversification as possible. Consideration should also be given to the extent to which the yield variability of different crops is correlated.
- Multiple-yield insurance can be an interesting solution to promote crop diversification while allowing farmers to protect themselves against extreme weather events.

Further informations

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Publications

Schmitt J, Offermann F, Söder M, Frühauf C, Finger, R. (2022) Extreme weather events cause significant crop yield losses at the farm level in German agriculture. *Food Policy* 112:102359, DOI:10.1016/j.foodpol.2022.102359. CC-BY-4.0.

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