Soil-, management-, and climate-related drivers of yield stability in organic and conventional farming systems

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1 Background

Soils provide multiple ecosystem services that enable a continuous production of crops. Farming systems that promote ecosystem services are also expected to be more resilient against external stressors, enabling a more stable crop production. To better understand the soil-, management- and climatic- related drivers of yield stability in different farming systems, the EJP SOIL ARTEMIS project is analysing different long-term field experiments across Europe on these parameters.

2. Analysis of long-term data

This study was conducted using data from the Swiss DOK long-term comparison trial, that continously compares different typical farming systems since more than 45 years (Figure 1). To assess climate-related effects on yield stability, weather anomalies were characterized using both raw climatic data (total precipitation, mean temperature) and drought indices (n = 9, on a monthly basis) recorded by a meteorological station close to the experimental site.

3. Production Risk Assessment

We defined yield stability as the probability that the yield of the farming system i falls below the 70th percentile of the mean of a reference yield (here CONMIN2). This production risk assessment can be interpreted as the certainty (or risk) with which agronomists or farmer can predict the yield amount of their cropping systems. To assess crop-specific drought influences on yield, we first subset the monthly calculated climate variables per crop using only month during the average historical growing seasons. The resulting variables were then subjected to a principle component analysis to reduce multicollinearity. The principal component 1 was then used as a crop-specific drought indicator.

Figure 1 *DOK long term farming system comparison trial. The experimental design consists of eight different farming systems and fertilization intensities (half = 1; full = 2). Organic systems are characterized by fertilization through slightly (BIOORG) and fully (BIODYN) aerobically composted farmyard manure and slurry, and mechanical weed control. Conventional systems combine manure and mineral fertilization (CONFYM) and a system with only mineral fertilization (CONMIN2), and received chemical plant protection.*

4. Preliminary Results

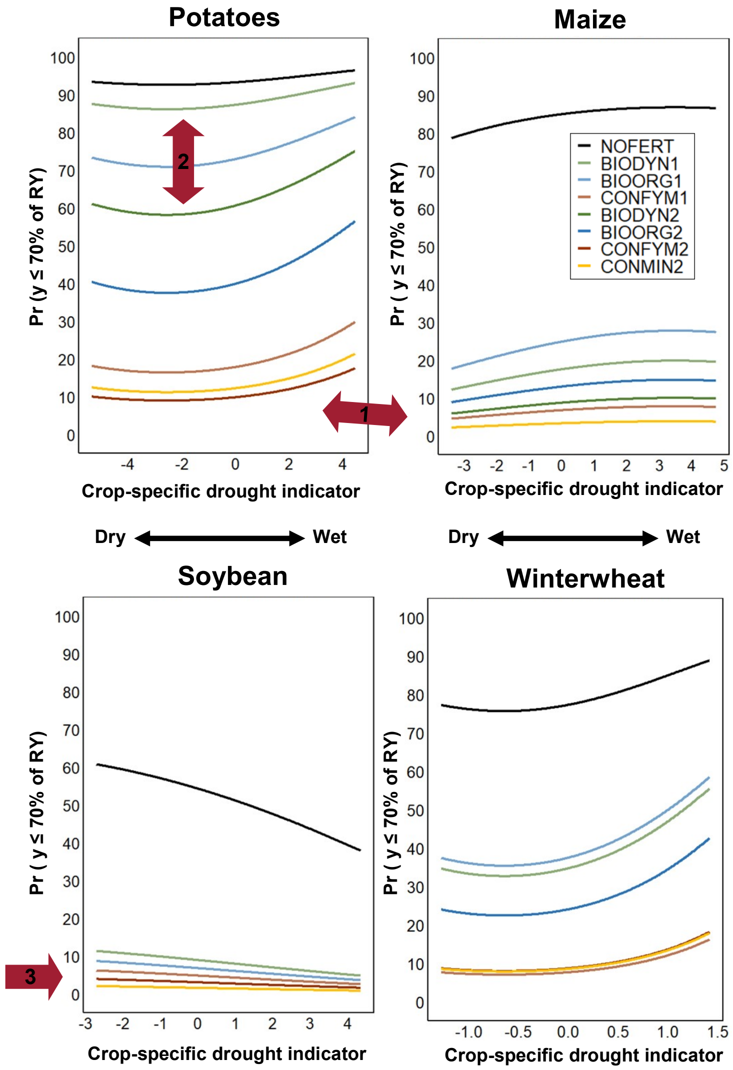

Figure 2 *Climate-related effects on yield stability of organic and conventional farming systems assessed through the probabilities of yield falling below the 70th percentile of the mean reference yield (RY) for potatoes, maize, soybean, and winter wheat. Chosen climate variables included standardized precipitation evapotranspiration index (SPEI), Palmer drought severity index (PDSI), and Palmer Z-Index, indicating different aspects of drought conditions*

Preliminary findings

1. Conventional farming systems have more stable yields during adverse climate conditions.
2. Fertilization-based differences in yield stability are more pronounced for organic farming systems.
3. Soybean yields are stable during adverse climate conditions and effect of farming systems are small.

Next steps

Include soil-related (fertilization, CN stock change) and management-related (plant protection, soil tillage) effects to find the most relevant drivers of yield stability.

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