# Personalizing crop choice to increase soil organic carbon with causal inference

Feeding a growing world population sustainably is crucial, but sustainable practices have varied, ever-changing impacts. This is because agriculture is a complex system, influenced by various local factors such as soil composition, soil health, land use, and climate variability. It is important to understand the heterogeneity of effects of practices at the field-level to help farmers personalise the decisions.

Analysing complex interactions and estimating effects boils down to answering causal queries. In recent years, observation-based causal inference approaches have emerged as a mature field. This research introduces a causal inference framework utilising Double Machine Learning to estimate Conditional Average Treatment Effects. The primary objective is to uncover the nuanced and spatially diverse impacts of crop rotation (farming practices of interest) on Soil Organic Carbon (SOC) levels in Lithuania's heterogeneous regions.

The study uses the farmers' declarations of the crops they cultivate (LPIS) from 2018-2022 to derive a binary crop rotation treatment, determined by cultivating at least 4 different crops in 5 years. We control for climate variables from ERA5 (e.g. surface net short-wave radiation, soil temperature), and soil properties (e.g. clay) to help us identify and estimate the impact of crop rotation on SOC content.

Beyond estimating local effects, the study explores the diversity of outcomes across space and time. This deeper analysis helps identify the key drivers influencing these variations, such as soil composition, climate, or even specific crop rotation combinations. The results indicate that crop rotation appears to be more effective in the western croplands of the country while exhibiting a negative impact on SOC in the central-northern regions.

Estimating the effects of practices at the field level allows farmers to make informed choices tailored to their specific conditions. This local-specific approach contrasts with traditional one-size-fits-all recommendations, empowering farmers to optimise their practices for both environmental and economic sustainability.