Popular science summary

Agriculture increasingly relies on external inputs like pesticides and fertilisers to provide the world with food. This damages nature and in turn reduces its ability to support agriculture with pollination, pest control, and healthy soils. Not all agriculture is equally damaging, and in fact, there are many examples of good agricultural practices that contribute to preserve and restore nature. European policymakers agree that agriculture needs to be transformed to reduce its impact on nature and climate change. To help policymakers in designing policy actions that are good for society, science is needed to understand the costs and benefits of doing agriculture in different ways.

Soils are living ecosystems that are affected by the farming methods used in cropland. Good farming methods contribute to healthy soils, which increase yields and store more carbon. Storing carbon in soils is regarded as an important measure to fight climate change, but it is difficult to know how much more carbon good farming methods store over time. My thesis contributes to fill this gap by looking at many experiments in cropland that have measured carbon in soils over periods longer than 30 years. **Chapter 1** shows that some farming methods in cropland can increase carbon stocks in soils, and by how much. Following up on these results, **chapter 2** estimates how much carbon can be stored in croplands across the EU if all farmers were to implement good farming methods. A relevant finding from this chapter is that the amount of carbon that would be stored varies a lot between regions. This is an important insight for policymakers, because not all land would provide the same benefit to society and hence policy actions should be adjusted to reflect these differences.

Farming regions are shaped by thousands of individual farmers trying to make a living. Policy actions affect the decisions that farmers take in relation to their farm, e.g., whether to grow cereal crops or grass fodder. So, what will a farming region look like if there is a policy reform, say a price on greenhouse gas emissions, or a subsidy to include grass in crop rotations to promote carbon sequestration? **Chapters 3 and 4** study the effects of policy reforms in contrasting farming regions and implications for nature and climate change by simulating the behaviour of farmers and using life cycle assessment of environmental impacts. This allows to study the environmental impacts and benefits of policy reforms before they are implemented and contributes to faster transformation of agriculture by identifying concerns before they appear in reality. The results show that farming regions can respond very differently to the same policy reform, which supports a regional focus of policy action concerned with the transformation of agriculture.