Capturing Carbon in Perennial Cropping Systems

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Introduction

This thesis proposal is a part of a FORMAS funded project called *Capturing Carbon in Perennial Cropping Systems* (summary below) which aim to estimate possibilities for soil carbon sequestration through cropping of perennial grains. In this case will Kernza ® (intermediate wheatgrass) be grown on a farm in Skåne while the progress will be monitored through measurement of fluxes of carbon and water (eddy covariance), meteorology, and measurement of soil carbon and other soil properties as well as recording of management actions. Based on measurements done and, initially more important data from the scientific literature, will the agricultural ecosystem model EPIC (Environmental Policy Integrated Climate) be set up, parametrized and executed.

Aim

Set up and execute the EPIC model in order to quantify effects of perennial cultivation and land management on soil carbon and soil properties in south Sweden.

Methodology

Based on measurements done and, initially more important data from the scientific literature, will the agricultural ecosystem model EPIC (Environmental Policy Integrated Climate) be set up, parametrized and executed

FORMAS-Project summary (from application)

The project will investigate whether a transition from annual to perennial grain crops can become an effective way to help Sweden reach its climate target to have zero net emissions in 2045, and net-negative emissions thereafter. Studies in USA and Sweden point to the possibility of starting to replace our annual monocultures with perennial polycultures within 10-20 years. The potential effect on soil carbon storage is enormous – theoretically such a change on Sweden's current cereal area would mean that 30% of the target was met. At the same time, such a transition could result in a wide range of positive synergies, such as a significant reduction in erosion and nutrient leaching, reduced use of pesticides, herbicides and energy in agriculture, improved economy in agricultural communities, and improved conditions for biodiversity. The first semi-commercial cultivations of the newly domesticated perennial cereal, intermediate wheatgrass (IWG, Kernza) are underway. Breeding of IWG is progressing fast and agroecological studies are urgent. The project has four parts: 1/ determine the theoretical potential for carbon storage in perennial polycultures and compare with other approaches; 2/ measure fluxes of greenhouse gases in IWG and conventional rotations; 3/ model perennial polycultures to investigate options for scaling; 4/ discuss strategies for upscaling of perennial polycultures. The last research task contains extensive work with stakeholders from the entire food chain.

From the application

Task 3: Modelling for upscaling

We will use modelling for scaling our results to the national level using the EPIC model (Environmental Policy Integrated Climate). It has been used especially for analysing the soil carbon sequestration potential of agriculture (*18*) at a variety of scales, from field to the global. The EPIC model is particularly well suited for modelling the effect of deep-rooted species because it works with up to 12 soil layers. Izaurralde et al. (*18*) compared modelled and observed soil carbon accumulation down to 3 m with high accuracy. The model is also well suited for studying polycultures because it is set up for modelling up to 12 interacting species. Recent studies have shown large discrepancies between empirical measurements using eddy covariance, and modelling (*6*). Our aim in this research task is twofold: to calibrate the model in order to better scale up to the national level, and to gain mechanistic understanding of the ecological processes. The EPIC model will be parameterised to run over all agricultural lands (about 3 Mha) in Sweden. We will follow the regionalisation based on national agricultural crop yield/manuring statistics defined by (*19*). Scenarios to be used will include a baseline (current agricultural practices and crops) and a number of scenarios where IWG will be introduced both as a monoculture and in polyculture with legumes. IWG will be introduced gradually in different regions. The EPIC model has also advanced functions for studying nutrient balances (N, P, K) and soil erosion. We can therefore also simulate environmental co-benefits in terms of nutrient leaching, soil erosion, and impacts on water bodies. Economic and farm management aspects of shifting from conventional grain crops to perennials will also be studied.

References

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