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Conversion from cropland to short rotation coppice willow and poplar: Accumulation of soil organic carbon

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Title:
Conversion from cropland to short rotation coppice willow and poplar: Accumulation of soil organic carbon

Abstract:
Increased demand for bioenergy has intensified the production of Short Rotation Coppice (SRC) willow and poplar in temperate zones. We used a combined chronosequence and paired plot approach to study the potential of SRC willow and poplar stands to increase the soil carbon stock compared to stocks of the previous arable land-use. The study focused on well-drained soils. We sampled soil from 30 SRC stands in Denmark and southern Sweden including soils from their adjacent arable fields. The 18 willow and 12 poplar stands formed a chronosequence ranging between 4 and 29 years after conversion. The soil was sampled both with soil cores taken by fixed depths of 0-5, 5-10, 10-15, 15-25, and 25-40 cm and by genetic horizons from soil pits to 1m depth. The aim of the study was to estimate the difference and the ratio between soil carbon contents of the SRC and annual crop land and analyze the results as a chronosequence to examine the effect of age after conversion on the difference. Covariates such as soil type, fertilization type and harvest frequency were also taken into account.
Preliminary results suggest an overall increase in carbon stocks over time with average accumulation rates ranging from 0.25 to 0.4 Mg ha-1 yr-1 in willow and poplar stands. Poplar stands had higher rates of C gain, probably due to less frequent harvesting. The differences in carbon between the SRC and the paired cropland were initially negative but changed to positive over time, implying loss of carbon after conversion and a later gain in soil carbon with stand age. Pairwise differences ranged from -25 Mg C ha-1 to 37 Mg C ha-1 for the top 40 cm. The carbon stock ratio of the SRC stand to the arable land was estimated to minimize the effect of site-related factors. The results of this analysis suggested that the ratio increased significantly with age after conversion for the top 10 cm of the soil, both for poplar and willow. A slight increase with age was also noticed at the deeper depths, but it was not significant.
The increasing soil carbon stocks in SRC stands on former cropland can be attributed to the increased leaf and litter input from the perennial SRC plantations as well as less stimulation of organic matter decomposition after cessation of annual. Initial losses of soil carbon after the land use change have also been reported by other studies, but the soil carbon accumulation high rates suggest that SRC can act as sinks at least for some decades. Our results indicate that a steady state has not yet been reached after 29 years.

Key words:
Bioenergy,Land Use Change, poplar, Short Rotation Coppice, Soil Organic Carbon, willow,