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Towards a default soil carbon sequestration rate after cropland to Miscanthus conversion in Europe

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In Europe, an estimated 17-21 million hectares (Mha) of land will need to be converted to bioenergy crop production to meet the EU bioenergy targets for 2020. Conventional bioenergy crops, such as maize and oilseed rape, are known for high greenhouse gas emissions. Perennial grases, such as Miscanthus, are seen as sustainable alternative, due to low fertilizer demand, relatively high yields and the potential to sequester soil organic carbon (SOC). However, the variability of currently published SOC stock changes is huge, ranging from -6.8 to +7.7 Mg ha-1 yr-1, which we attribute to different organic manure applications and differences in the baseline SOC stocks between the sampled plots in the paired plot approach. The conversion from cropland to Miscanthus involves a C3-C4 vegetation change, which allows following the incorporation of C4 Miscanthus-derived carbon into the soil by measuring the abundance of the stable isotope 13C. This was done for six different Miscanthus plantations across Europe, which were older than ten years. C3 carbon decomposition was estimated using the carbon turnover model RothC. Both, C4 and C3 carbon dynamics were summed to obtain the vegetation change-induced SOC stock change. We subsequently applied this approach to all European sites, where C4 carbon dynamic after cropland to Miscanthus conversion has been investigated (n=14) and derived a temperature dependant SOC sequestration rate. We found a mean annual accumulation of 0.40$\pm$0.20 Mg C ha-1. Furthermore, we conducted a SOC fractionation to assess the incorporation of C4 carbon into different SOC fractions. After a mean time of 16 years, the particulate organic matter (POM) fraction consisted of 68% Miscanthus-derived carbon in 0-10 cm soil depth. The NaOCl resistant fraction, which is considered “inert”, consisted of 12% Miscanthus-derived carbon in 0-10 cm soil depth.