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## Changes in soil carbon stocks and distribution under perennial and annual bioenergy crops

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Bioenergy crops are expected to provide biomass to replace fossil resources and reduce greenhouse gas emissions. In this context, their effect on soil carbon sequestration is of primary importance. There is a wide range of candidate crops including perennial C4 crops or annual crops but their impact on soil organic carbon (SOC) stocks remain very uncertain as shown by the wild variability in published experimental results.

In this study, we measured the changes in SOC stocks under perennial (miscanthus and switchgrass), semi-perennial (fescue and alfalfa) and annual (triticale and sorghum or maize) bioenergy crops managed with two N fertilisation rates. The experiment called “Biomass & Environment” is located in northern France on a deep loamy soil (Haplic Luvisol) and was set up in 2006. The soil was sampled at the start of the experiment, in 2011-2012 and again in 2018 (0-60 cm, 5 layers). SOC stocks were calculated at equivalent soil mass and  $\delta^{13}\text{C}$  was systematically measured and used to calculate changes in new and old SOC stocks. In 2018, the SOC distribution in different soil particle-size fractions was also characterized for some treatments.

After 12 years, there was a large increase in SOC concentration (+7.6 g kg<sup>-1</sup> on average) under perennial crops in the surface layer ( $\approx$  0-5 cm) but a slight decrease in deeper layers. Changes in  $\delta^{13}\text{C}$  also showed that more than half of the new SOC accumulated in the surface layer. In addition, the additional SOC storage in the first layer was found in coarse organic fractions (50-200 and 200-2000  $\mu\text{m}$ ) but also in the more stabilised 0-50  $\mu\text{m}$  fraction. SOC concentration under semi-perennial crops increased in the two first layers ( $\approx$  0-20 cm), from 10.2 g kg<sup>-1</sup> in 2006 to 11.6 g kg<sup>-1</sup> in 2018 on average and slightly decreased below. Under annual crops, a decrease in SOC concentration was observed in all layers and particularly in the third layer ( $\approx$  20-33 cm). There was no significant effect of the N fertilisation. Over the old ploughed layer ( $\approx$  0-33 cm), SOC stocks increased between 2006 and 2018 under perennial and semi-perennial bioenergy crops (by 3 and 2 t C ha<sup>-1</sup> on average respectively) and decreased by 7 t C ha<sup>-1</sup> on average under annual crops.

This study shows that different bioenergy crops can have contrasted impacts on SOC stocks but also on SOC distribution in the soil profile.