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Using an input manipulation experiment to partition greenhouse gas fluxes from a commercial Miscanthus plantation in the UK

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Miscanthus is a lignocellulosic C4 crop that can be grown for a number of practical end-uses but recently interest has increased in its viability as a bioenergy crop; both providing a renewable source of energy and helping to limit climate change by reducing carbon (C) emissions associated with energy generation. Recent studies have shown that *Miscanthus* plantations may increase stocks of soil organic carbon (SOC) however there is still considerable uncertainty surrounding estimates of net C exchange and the best management practices to achieve the best greenhouse gas (GHG) mitigation potential. Using an input manipulation experiment, we monitored emissions of N_2O, CH_4 and CO_2 from living *Miscanthus* roots, aboveground plant litter and soil individually to quantify and partition these emissions and better understand the influence of abiotic factors on SOC and GHG dynamics under *Miscanthus*.

In January 2009 twenty-five 2 m^2 plots were set up in a three-year old 11 hectare commercial *Miscanthus* plantation in Lincolnshire, UK; with five replicates of five treatments. These treatments varied plant input (roots or senesced aboveground plant litter) to the soil by way of controlled exclusion techniques. The delta 13C value of soil C and CO_2 emitted from each treatment was measured monthly between March 2009 and March 2013. Measurements of CH_4 and N_2O emissions were also taken at the soil surface from each treatment. *Miscanthus*-derived emissions were determined using the isotopic discrimination between C4 plant matter and C3 soil, and the treatments were compared to assess their effects on C inputs and outputs to the soil.

Both CH_4 and N_2O emissions were below detection limits, mainly due to a lack of fertiliser additions and limited disturbance of the agricultural site. However, results for CO_2 emissions indicate a strong seasonal variation; litter decomposition forms a large portion of the CO_2 emissions in winter and spring whereas root respiration dominates the summer and autumn fluxes. After four years of aboveground plant litter removal there was no significant change in total soil C stocks indicating that earlier harvests and more thorough litter removal from the site would have little impact on C inputs to the soil.

Outside the input manipulation treatments we also compared the top 30cm of soil from beneath the *Miscanthus* plantation with that below an adjacent arable field cropped with a winter wheat and oil seed rape rotation (the prior land use of the *Miscanthus* site). Results showed a greater soil C stock in the *Miscanthus* soils, although the difference was not statistically significant after 7 years of growth. Additionally, physiochemical soil fractionation of the top 30cm of soils below the input manipulation treatments indicates that soil fractions describing particulate organic matter, sand and soil aggregates all contain significantly more *Miscanthus* C in the top 15cm than in the 15-30cm layer, and when both roots and aboveground plant litter are present.