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Drivers of potential GHG fluxes under bioenergy land use change in the UK

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The greatest contributors to global greenhouse gases (GHG's) are CO_2 emissions from fossil fuel use and following land use change (LUC). Globally, soils contain three times more carbon than the atmosphere and have the potential to act as GHG sources or sinks. A significant amount of land may be converted to bioenergy production to help meet UK 2050 renewable energy and GHG emissions reduction targets. This raises considerable sustainability concerns with respect to the effects of LUC on soil carbon (C) conservation and GHG emissions.

Forests are a key component in the global C cycle and when managed effectively can reduce atmospheric GHG concentrations. Together with other dedicated bioenergy crops, Short Rotation Forestry (SRF) could be used to meet biomass requirements. SRF is defined as high density plantations of fastgrowing tree species grown on short rotational lengths (8-20 years) for biomass (McKay 2011). As SRF is likely to be an important domestic source of biomass for energy it is imperative that we gain an understanding of the implications for large-scale commercial application on soil C and the GHG balance.

We utilized a paired-site approach to investigate how LUC to SRF could potentially alter the underlying processes of soil GHG production and consumption. This work was linked to a wider soil C stock inventory for bioenergy LUC, so our major focus was on changes to soil respiration. Specifically, we examined the relative importance of litter, soil, and microbial properties in determining potential soil respiration, and whether these relationships were consistent at different soil temperatures (10 ˚C and 20 ˚C).

Soils were sampled to a depth of 30 cm from 30 LUC transitions across the UK and incubated under controlled laboratory conditions, with gas samples taken over a seven day enclosure period. CO_2, N_2O and CH_4 gas fluxes were measured by gas chromatography and were examined together with other soil properties measured in the field and laboratory.

LUC to SRF resulted in a significant reduction in CO_2 fluxes overall at 0-15 cm (on both a soil mass and carbon mass basis). Furthermore, this response of CO_2 flux to LUC was similar at both 10 ˚C and 20 ˚C. Reductions in CO_2 flux at 0-15 cm are significantly related to decreased bacterial biomass, as measured by Phospholipid Fatty Acids (PLFA), soil pH and bulk density. These patterns suggest that changes in the quality and quantity of organic inputs under SRF may drive a reduction in soil respiration. While changes in soil C were limited, reduced respiration was supported by the increase in litter C stock under SRF. These findings indicate that LUC to SRF can strengthen the soils potential as a C sink whilst contributing successfully towards meeting GHG emissions reduction targets.

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