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# Comparison of GHG fluxes from conventional and energy crop production from adjacent fields in the UK, using novel technologies

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With combustion of fossil fuels driving anthropogenic climate change, allied to a diminishing global reserve of these resources it is vital for alternative sources of energy production to be investigated. One alternative is biomass; ethanol fermented from corn (*Zea mays*) or sugar cane (*Saccharum* spp.) has long been used as a petroleum substitute, and oilseed rape (OSR, *Brassica napus*) is the principal feedstock for biodiesel production in Germany, the third biggest producer of this fuel globally. Diverting food crops into energy production would seem counterproductive, given there exists genuine concern regarding our ability to meet future global food demand, thus attention has turned to utilising lignocellulosic material: woody tissue and non-food crop by-products such as corn stover. For this reason species such as the perennial grass *Miscanthus* (*Miscanthus x giganteus*) are being cultivated for energy production, and these are referred to as second generation energy crops. They are attractive since they do not deplete food supplies, have high yields, require less fertiliser input than annual arable crops, and can be grown on marginal agricultural land. To assess the effectiveness of a crop for bioenergy production, it is vital that accurate quantification of greenhouse gas (GHG) fluxes is obtained for their cultivation in the field. We will present data from a series of studies investigating the GHG fluxes from the energy crops OSR and *Miscanthus* under various nutrient additions in a comparison with conventional arable cropping at the same site in the United Kingdom (UK).

A combination of methods were employed to measure fluxes of $CO_2$, $CH_4$ and $N_2O$ from both soil and vegetation, at various temporal and spatial scales. Conventional manual chambers were deployed on a monthly regime to quantify soil GHG fluxes, and were supplemented with automated soil flux chambers measuring soil respiration at an hourly frequency. Additionally, two novel automated chamber systems allowed, for the first time, continuous ecosystem exchange of all three biogenic GHGs to be measured from OSR and *Miscanthus* at high spatial resolution ($< 1$ m$^2$).

Highest GHG emissions were seen from arable crops, but despite low fertiliser input, tillage caused *Miscanthus* to be a net carbon source, and compost addition increased $N_2O$ emissions. OSR represented a net carbon sink during its growth, but $N_2O$ emissions resulting from application of mineral nitrogen fertiliser reduced this sink by 50%. Automated measurements revealed a hitherto unreported temperature-independent diurnal pattern in soil respiration under *Miscanthus*, which was in stark contrast to an adjacent barley (*Hordeum vulgare*) crop. Consequently, the time of day at which any comparison of soil respiration between these two crops is made strongly biases the findings.

Our data highlight the delicate balance which energy crops must maintain in order to ensure carbon-neutrality, and suggest that crops requiring fertiliser input will potentially become a net GHG source once indirect emissions (e.g. from fertiliser production) are accounted for. Furthermore, diurnal patterns of GHG flux should be assessed and used to guide suitable future manual measurement regimes.