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Multi-annual fluxes of carbon dioxide from an intensively cultivated temperate peatland

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East Anglia contains the largest continuous area of lowland fen peatlands in the United Kingdom (UK) which store vast quantities of terrestrial carbon (C) that have accrued over millennia. These long term C stores have largely been drained and converted for agricultural land use over the last 400 years due to their high agricultural production potential. Initial drainage of these peatlands leads to surface lowering and peat wastage. Prolonged exposure of carbon dense peat soils to oxygen through continued agricultural management results in sustained losses of carbon dioxide (CO_2) to the atmosphere. An increasing population in the UK has the potential to put further stress on these productive but rapidly diminishing Grade 1 agricultural land. Improving our understanding of land management impacts on CO_2 emissions from these soils is crucial to improving their longevity as an important store of C and as an economic resource.

Our measurements at an intensively cultivated lowland peatland in Norfolk, UK, are the first multi-annual record using the micrometeorological eddy covariance (EC) technique to measure CO_2 fluxes associated with the production of horticultural salad crops. Three full years of flux measurements over leek (2013), lettuce (2014) and celery (2015) cropping systems found that the site was a net annual source of CO_2 with a net ecosystem exchange (NEE) of 6.59, 7.84 and 7.71 t C-CO_2 ha-1 a-1 respectively.

The leek crop, with its longer growing period, had a lower annual NEE due to its long growth period from early spring through to late autumn, whereas the shorter growing periods of lettuce and celery meant their peak growth (CO_2 uptake, Gross Primary Productivity, GPP) took place during early/mid-summer with post-harvest weeds exploiting the later growing season but exhibited lower CO_2 assimilation than the leek crop. Periods of high CO_2 emissions from the soil to the atmosphere were measured during mechanical disruptions to the soils at the site, namely during and after ploughing prior to crop establishment, and following post-harvest disking. The duration of the post-ploughing period prior to planting of the crop varied from 2 weeks to 2 months; similarly disking did not always take place directly after harvest, causing significant differences in seasonal NEE patterns. Further notable differences in net CO_2 fluxes as they relate to agricultural management practises will be discussed, including an account of the lateral C imports and exports occurring during crop planting and harvest.