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Land use conversions involving afforestation and bioenergy production and their impact on the greenhouse gas budget

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Land use conversions involving afforestation or bioenergy production are often thought to be ways of enhancing C-sequestration. However, their impact on the full greenhouse gas balance at the ecosystem level has not been well-categorised. To address this issue we are examining the greenhouse gas balance of two grassland land use conversions, afforestation (sitka spruce) and bioenergy production (Miscanthus). Afforestation significantly increased carbon sequestration, although this was dependent on stand age, but was associated with increases in soil respiration and nitrous oxide production and a reduction in methane emissions. These changes in greenhouse gas emissions were largely a consequence of reductions in soil water content and this was confirmed using measurements made under rain-out shelters. Although the establishment of Miscanthus involves much greater land preparation the influence of ploughing on carbon dioxide efflux was transitory, with ultimately only a relatively small impact on the greenhouse gas budget. Overall, soil respiration was higher in the grassland, although trace gas emissions increased after conversion of land for bioenergy production. High photosynthetic productivity at the leaf level in the Miscanthus stands was consistent with significant carbon uptake, as measured using eddy covariance techniques, although almost 50% of this may have been influenced by extensive weed production. These results indicate that the impact of different land use conversions on the greenhouse gas balance may be species, site and climate-specific, as well as related to previous land use history. This argues for a more concerted approach if we are to make any generalities about the potentially wide-ranging impacts of land use change.