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# Carbon balance of biomass production on a rewetted agricultural fen peatland

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Rewetting and abandoning drained peatland to restore the carbon sink function and to reduce greenhouse gas emission (GHG) have often been recommended. Paludiculture, the combination of peatland rewetting and cultivation of flooding tolerant perennial grass for biorefining, biomaterials or bioenergy, has gained interest as a possible alternative land use option. However, more knowledge on the effect of various types of paludiculture on the Net Ecosystem Carbon Balance (NECB) as well as the related biomass yields is needed. In 2013, field plots were established with reed canary grass in an agricultural fen peatland in Denmark. From spring 2015 to spring 2017, the level of groundwater table (GWT) in four plots was raised to -1 cm (annual mean) below soil surface by pumping water back from the drainage ditch leaving side-by-side plots with slightly lower ground water tables (-3 and -9 cm). Plots were fertilised with 80 kg N ha-1in early spring and 80 kg N ha-1 after first cut, and the biomass was harvested mid-June and around 1 October in both years. Emissions of $CO_2$ and CH4 were measured from March 2015 to February 2017 with opaque chambers at about two-weeks intervals and Net Ecosystem Exchange (NEE) of $CO_2$ was assessed with temperature controlled transparent chambers.

Harvested biomass yield was on average 13.1 Mg DM ha-1 yr-1 across year and treatment without significant effect of GWT. Mean annual estimates of Ecosystem Respiration (ER) and Gross Primary Production (GPP) significantly decreased with increasing GWT, but differences in NEE (-5.0 to -3.8 Mg $CO_2$-C ha-1 yr-1) between the three GWT treatments were insignificant. In contrast, significant effects of the GWT treatments on CH4 emissions were measured. For annual mean GWT of -1, -3 and -9 cm, we found emissions of 0.74, 0.39 and 0.05 Mg CH4-C ha-1 yr-1, respectively. When the carbon exported from the field with the harvested biomass was included in the balance, defined as NECB, all GWT treatments turned into carbon sources. NECB of 1.50, 2.36 and 2.24 Mg C ha-1 yr-1 were found for the annual mean GWT of -1, -3 and -9 cm, respectively. Thus, no carbon accumulation was evident within the first two years after peatland rewetting. The most shallow GWT provided the best option in terms of reducing peat degradation, but due to the 34-fold stronger global warming potential of CH4 compared to $CO_2$, the GWT of -9 cm was the most efficient of the investigated GWT regarding GHG mitigation, however, still being a source with emissions of 10.3 Mg $CO_2$-eq ha-1 yr-1.