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Greenhouse gas fluxes from an oil palm plantation on mineral soil in Indonesia undergoing riparian restoration

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Oil palm (OP) growers are under pressure to reduce their environmental impact. Ecosystem function and biodiversity are at the forefront of the issue, but what effect do changes in management practices have on greenhouse gas (GHG) fluxes from plantations?

The Riparian Ecosystem Restoration in Tropical Agriculture (RERTA) Project is a collaboration between the University of Cambridge and the SMART Research Institute in Riau, Indonesia. This project explores the ecological changes resulting from the restoration of riparian margins between plantations and watercourses. Four management strategies were applied on both sides of a river to create 50m riparian buffers, 400m in length: (1) A control treatment of no restoration, the removal of mature OP and replanting of young OP to the river margin; (2) Little to no agricultural management of mature OP; (3) Clearance of mature OP and enrichment planting with native forest trees; (4) Little or no agricultural management of mature OP and enrichment planting with native forest trees. Here we present a specific objective to investigate the effect of riparian restoration – and related changes in soil characteristics, structure and vegetation cover – on fluxes of N_2O, CH_4 and CO_2 from mineral soils.

The experimental site began as a mature OP plantation, with monthly background measurements taken between January and April 2019. Palms were felled in April 2019 and monthly sampling was resumed when replanting and restoration began, in October 2019. We measured GHGs using static chambers; 6 in each riparian treatment and 16 in the actual OP plantation, 40 chambers in total. Samples were analysed using GC-FID/μECD.

Background measurements before felling showed high variability, but indicated no difference between the four experimental plots and the rest of the plantation. Fluxes measured following replanting were also highly variable, with no significant differences observed between treatments. N_2O fluxes were relatively low before felling as the mature palms were no longer fertilised. Higher emissions were seen in the disturbed immature OP and forest tree treatments following replanting. Though the sites appeared to recover quickly and emission fluxes decreased after a few months, presumably as the soil settled and new vegetation began to grow. CH_4 uptake was

seen in the immature OP treatment immediately after replanting. In subsequent months no clear trends of CH_4 uptake or emission were observed, with the greatest variability generally seen in the forest tree treatment. CH_4 emissions increased in October 2020 with the beginning of the rainy season, most notably in mature OP and mature OP with forest tree treatments. Following restoration CO_2 emissions were higher in treatments with established plant communities – mature OP and mature OP with forest trees.

These results suggest that riparian restoration had no significant effect on GHG fluxes from mineral soils, and would not alter the overall GHG budget of a plantation. If there is no additional GHG burden and riparian restoration results in enhancing biodiversity and ecosystem services as well as improving water quality, it will be a viable management option to improve the environmental impact of an OP plantation.