The impact of diversifying understory vegetation in oil palm plantations on greenhouse gas emissions

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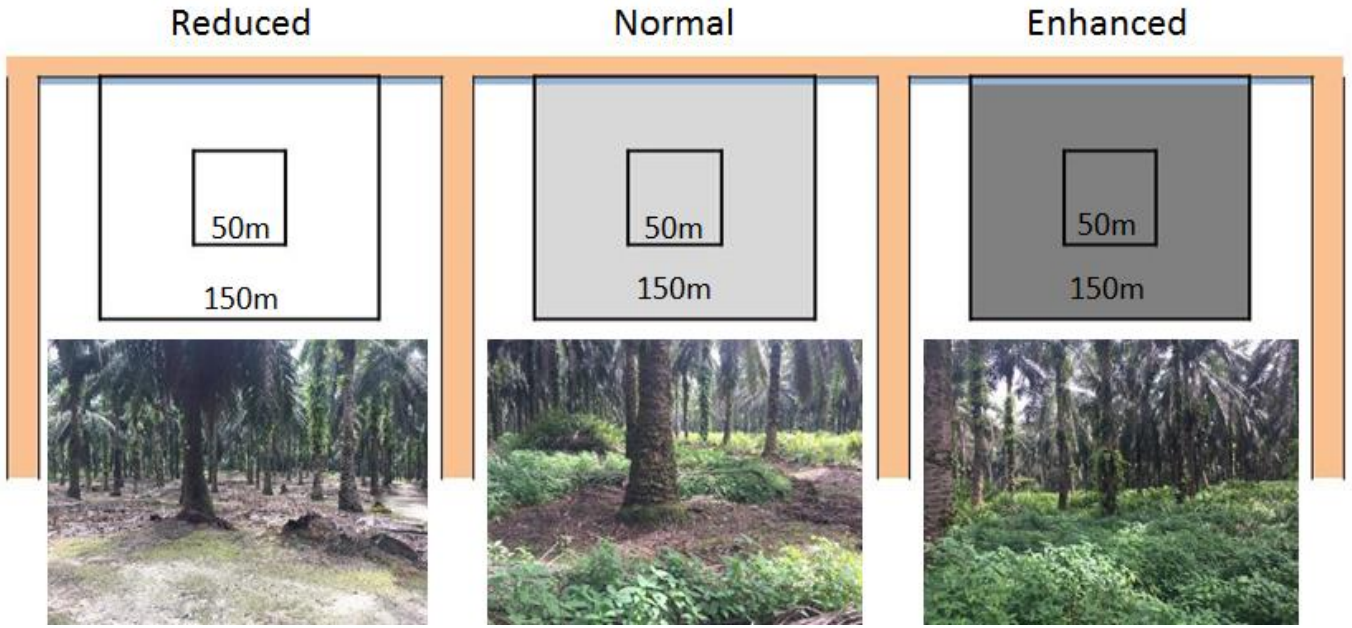
The three different understory management treatments in the Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) programme



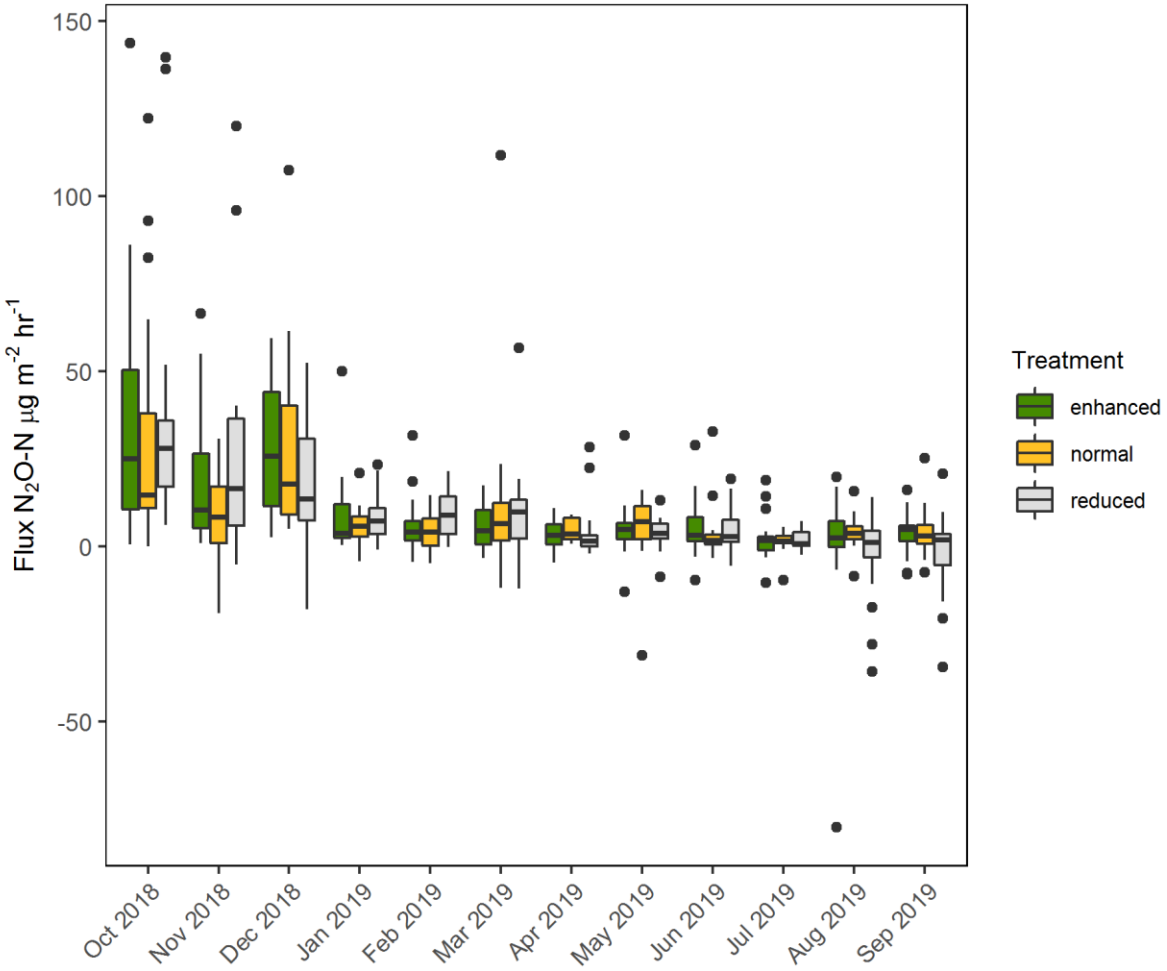
Rationale: Tropical oil palm (OP) plantations are major emitters of greenhouse gases (GHGs), but there are management options which may reduce these emissions, including increasing understory biomass.

Timeliness: Half of Indonesian OP plantations are due for replanting in the next decade and research will be directly relevant to replanting protocols, with long-term impact.

- **Reduced** biodiversity complexity: spraying/removing all understory vegetation with herbicides.
- **Normal** biodiversity complexity: standard industry practice, intermediate level of herbicide use in harvest circles.
- **Enhanced** biodiversity complexity: reduced-input management with no herbicide application and limited understory cutting.

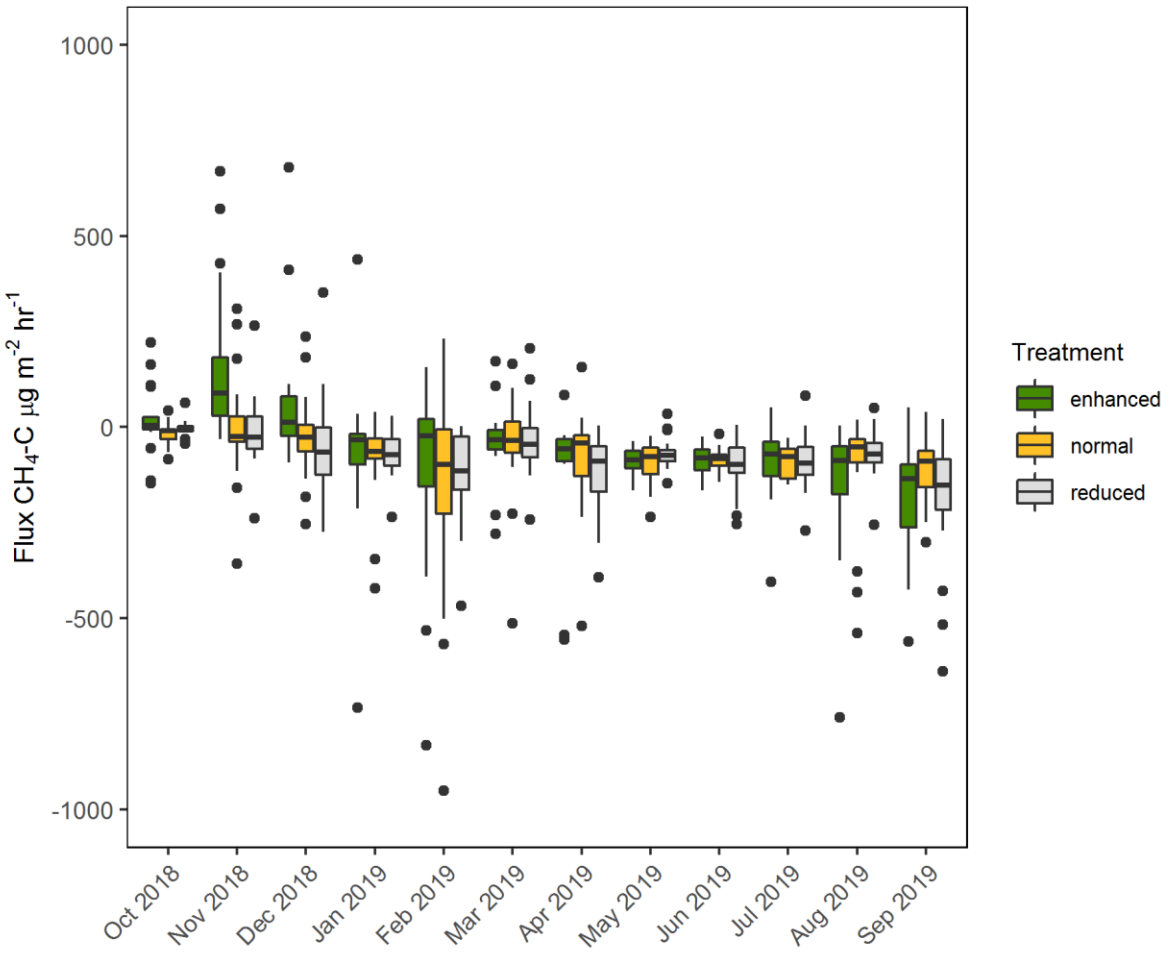
- Static chambers
- GC FID/µECD
- Monthly

Nitrous oxide (N_2O) fluxes



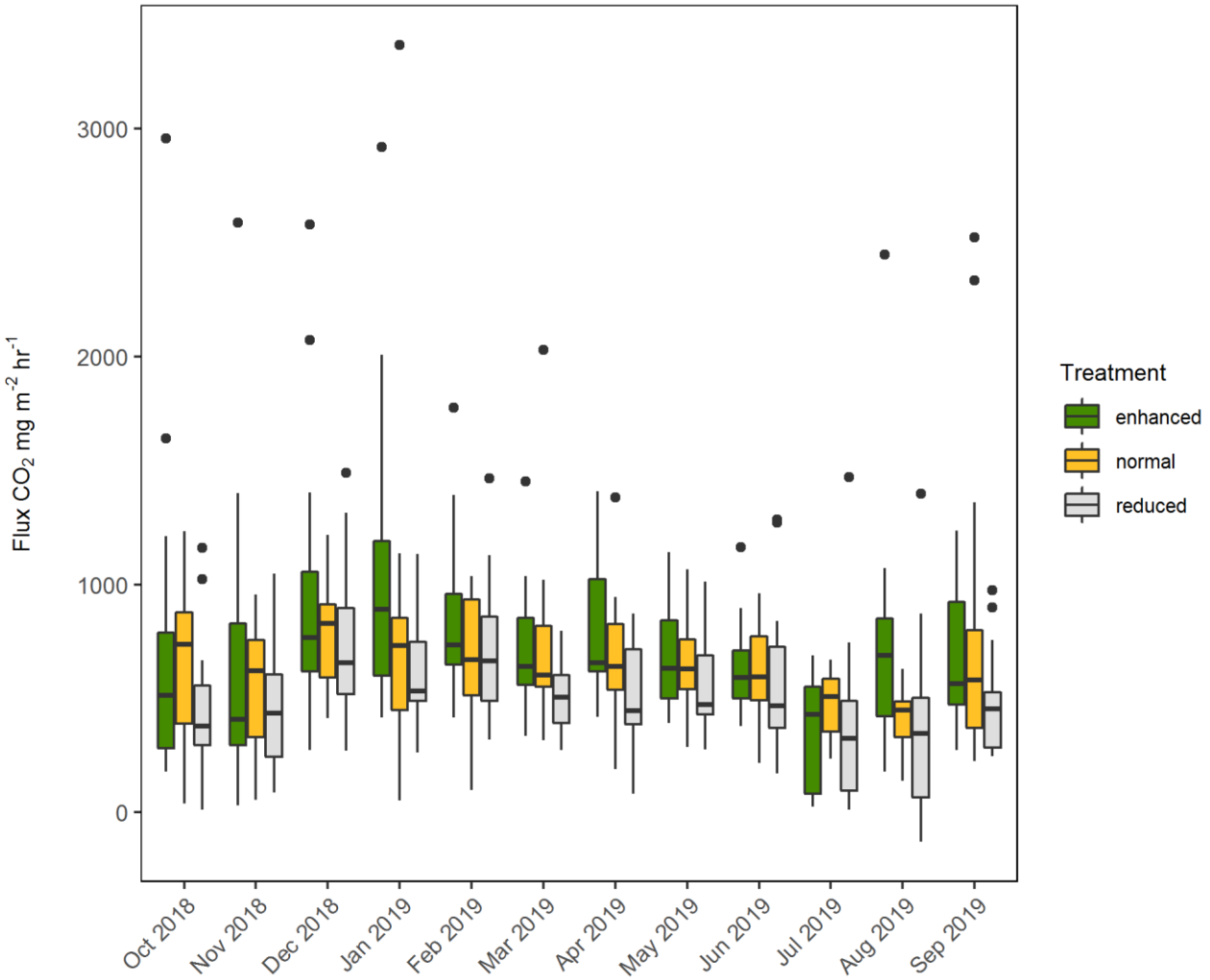
- Fluxes were **highest**, although with high variability, in all treatments during **Oct to Dec** 2018 which were the **wettest months** during the measurement period with maxima reaching between 100 and 150 µg N_2O-N m^{-2} h^{-1}.
- From **Jan to Sep** 2019 fluxes were a lot **smaller** with maxima of 25 µg m^{-2} h^{-1}. Variability was again high with a lot of the measured fluxes being zero or even slightly negative.
- Due to the age of the plantation and imminent replanting, the plots were not fertilised anymore.
- However, there is a trend towards **lower emissions during the drier months** compared to the first three months in the wet season with **no noticeable difference between the different treatments**.
- We are awaiting laboratory analysis of associated soil parameters and full statistical analysis will be carried out once all data is available.

Methane (CH_4) fluxes



- Methane (CH_4) fluxes showed positive emission fluxes as well as negative fluxes (uptake or oxidation) and ranged between -1000 and 700 µg CH_4-C m^{-2} h^{-1}.
- Despite the **large range** of measured fluxes, there were no determinable differences between the different treatments.
- However, from **Oct to Dec** 2018 when the **highest fluxes** were measured, fluxes were generally more positive, while fluxes from **Jan to Sep** were **smaller or more negative**, representing an uptake of methane, also called methane oxidation. This is usually associated with drier soil conditions.
- However, there are **no distinctive differences between the different treatments**.

Ecosystem respiration (CO_2) fluxes



- Carbon Dioxide (CO_2) fluxes measured with the chamber method are referred to as 'ecosystem respiration' as the chambers included soil as well as vegetation.
- There was **little difference** in CO_2 efflux of the different understory treatments but perhaps a trend to **slightly higher** (but not significant) from the plots **with understory** compared to the ones without.
- We have carried out a method comparison with a different technique to measure CO_2 efflux using an infrared analyser and the data has yet to be analysed.

Summary/Conclusion

- We measured the GHG fluxes of nitrous oxide (N_2O), methane (CH_4) and soil ecosystem respiration/carbon dioxide (CO_2) using static chambers and analysis by gas chromatography (GC-μECD/FID).
- Results for the **12 months of sampling** show little differences of the different understory treatments in terms of GHG fluxes.

- **In conclusion, initial results showed that the presence or absence of understory did not increase soil emissions of N_2O and CH_4. This suggests that the within-crop ecological benefits do not result in an increased GHG burden.**