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Supplement of

Large contribution of soil N_2O emission to the global warming potential of a large-scale oil palm plantation despite changing from conventional to reduced management practices

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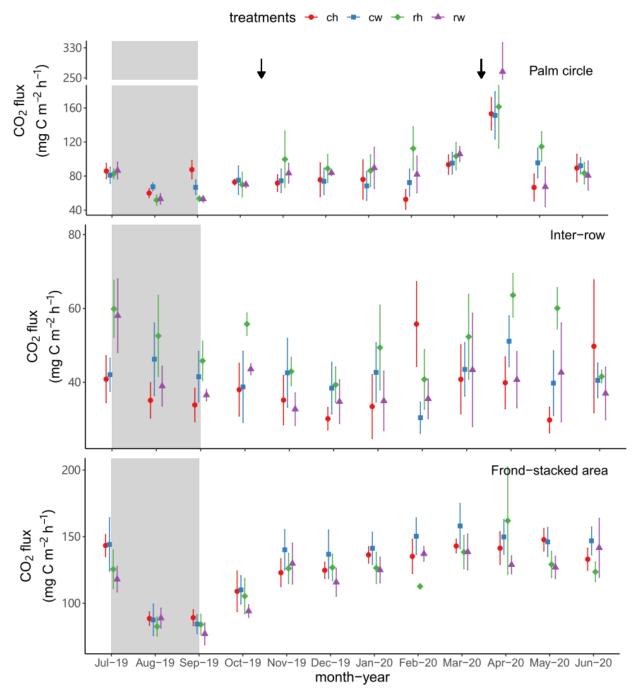


Fig. S1 Soil CO₂ emissions (mean \pm SE, n=4 plots) from different fertilization and weeding treatments in an \geq 18-year old, large-scale oil palm plantation, Jambi, Indonesia, measured monthly from July 2019 to June 2020. Gray shadings mark the dry season (precipitation ≤ 80 mm month⁻¹) and black arrows indicate fertilizer applications on the palm circle. Note the different y-axis ranges for the three management zones. ch: conventional fertilization – herbicide weeding, cw: conventional fertilization – mechanical weeding, rh: reduced fertilization – herbicide weeding, rw: reduced fertilization – mechanical weeding

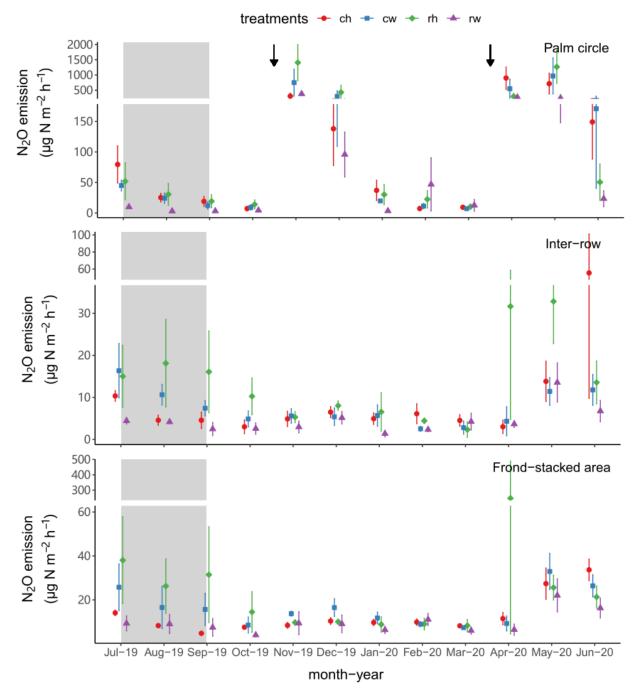


Fig. S2 Soil N₂O emissions (mean \pm SE, n=4 plots) from different fertilization and weeding treatments in an \geq 18-year old, large-scale oil palm plantation, Jambi, Indonesia, measured monthly from July 2019 to June 2020. Gray shadings mark the dry season (precipitation ≤ 80 mm month⁻¹) and black arrows indicate fertilizer applications on the palm circle. Note the different y-axis ranges for the three management zones. ch: conventional fertilization − herbicide weeding, cw: conventional fertilization − mechanical weeding, rh: reduced fertilization − herbicide weeding, rw: reduced fertilization − mechanical weeding

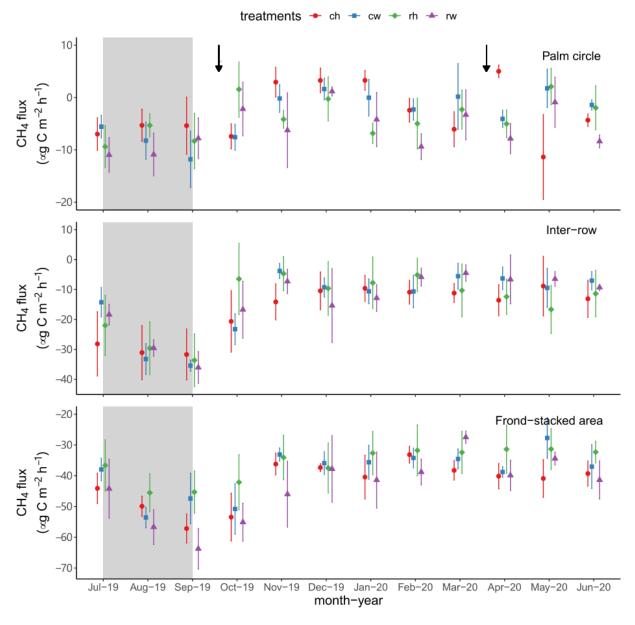


Fig. S3 Soil CH₄ fluxes (mean \pm SE, n = 4 plots) from different fertilization and weeding treatments in an \geq 18-year old, large-scale oil palm plantation, Jambi, Indonesia, measured monthly from July 2019 to June 2020. Gray shadings mark the dry season (precipitation \leq 80 mm month⁻¹) and black arrows indicate fertilizer applications on the palm circle. Note the different y-axis ranges for the three management zones. ch: conventional fertilization – herbicide weeding, cw: conventional fertilization – mechanical weeding, rh: reduced fertilization – herbicide weeding, rw: reduced fertilization – mechanical weeding

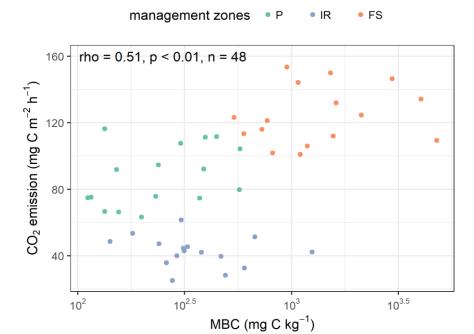


Fig. S4 Spearman rank correlation between soil CO_2 emissions and microbial biomass carbon (MBC). Each data point for soil CO_2 emissions was the average of 12-monthly measurements and MBC was measured once in 2018, as reported by Formaglio et al. (2021). P – palm circle, IR – inter-row, FS – frond-stacked area

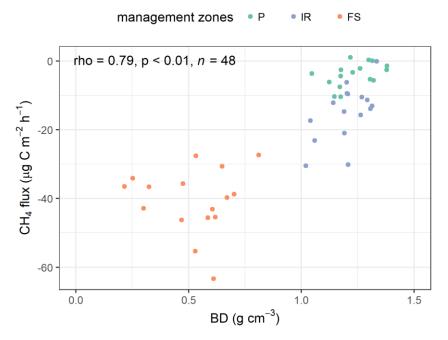


Fig. S5 Spearman rank correlation between soil CH_4 fluxes and soil bulk density (BD). Each data point for soil CH_4 fluxes was the average of 12-monthly measurements and BD was measured once in 2018 (Formaglio et al. 2021). P – palm circle, IR – inter-row, FS – frond-stacked area

Table S1 Soil biochemical and physical characteristics (means \pm SE, n = 16 plots) in 0–50 cm depth determined in 2018 and soil texture in the 50–150 cm depth determined in 2021, reported for each management zone in an \geq 18-year old, large-scale oil palm plantation, Jambi, Indonesia

Characteristics	Palm circle	Inter-row	Frond-stacked area	
Soil organic C (kg C m ⁻²)	$6.2 \pm 0.6 \text{ b}$	$6.4 \pm 0.2 \text{ b}$	$9.1 \pm 0.8 \; a$	
Total N (g N m ⁻²)	$402 \pm 31 \text{ b}$	$426 \pm 15 \text{ ab}$	571±39 a	
ECEC (mmol _{charge} kg ⁻¹)	35 ± 2 a	$18 \pm 1 b$	28 ± 2 a	
pH (1:4 soil-to-H ₂ O)	$5.05 \pm 0.08 \ a$	$4.81 \pm 0.05 b$	$5.00\pm0.08~ab$	
Bulk density (g cm ⁻³)	1.37 ± 0.01 a	1.36 ± 0.01 a	$0.89 \pm 0.01~b$	
Clay (%)	23.30 ± 1.31 a	23.60 ± 1.00 a	25.47 ± 1.37 a	
Silt (%)	$7.80 \pm 1.19 a$	7.73 ± 1.23 a	6.47 ± 1.21 a	
Sand (%)	68.90 ± 1.52 a	$68.67 \pm 1.35 \text{ a}$	$68.07 \pm 1.97 \text{ a}$	

⁵³ ECEC: effective cation exchange capacity. For each parameter, different letters indicate significant differences among management zones (one-way ANOVA with Tukey

HSD at $P \le 0.05$). Except for soil texture, soil characteristics were reported by Formaglio et al. (2020)

Table S2 Cumulative fruit yield from 2017–2020 (means \pm SE, n=4 plots) in different fertilization and weeding treatments in an \geq 18-year old, large-scale oil palm plantation, Jambi, Indonesia

Treatments		Cumulative yield (Mg ha ⁻¹)				
	2017	2018	2019	2020		
ch	26.64 ± 1.91	57.55 ± 2.74	83.41 ± 3.63	114.60 ± 4.26		
cw	31.24 ± 1.12	66.51 ± 1.57	96.75 ± 3.55	130.37 ± 4.45		
rh	28.18 ± 2.35	56.31 ± 4.86	86.59 ± 5.21	116.01 ± 6.20		
rw	29.38 ± 4.69	60.62 ± 5.35	90.94 ± 5.25	118.50 ± 5.92		

There are no significant differences among treatments for each column (2^2 factorial ANOVA; fertilization: P = 0.35-0.96; weeding control: P = 0.07-0.32; interaction: P = 0.23-0.57). ch: conventional fertilization – herbicide weeding, cw: conventional fertilization – mechanical weeding, rh: reduced fertilization – herbicide weeding, rw: reduced fertilization – mechanical weeding. Fruit yield was reported by Iddris et al. (2023)

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