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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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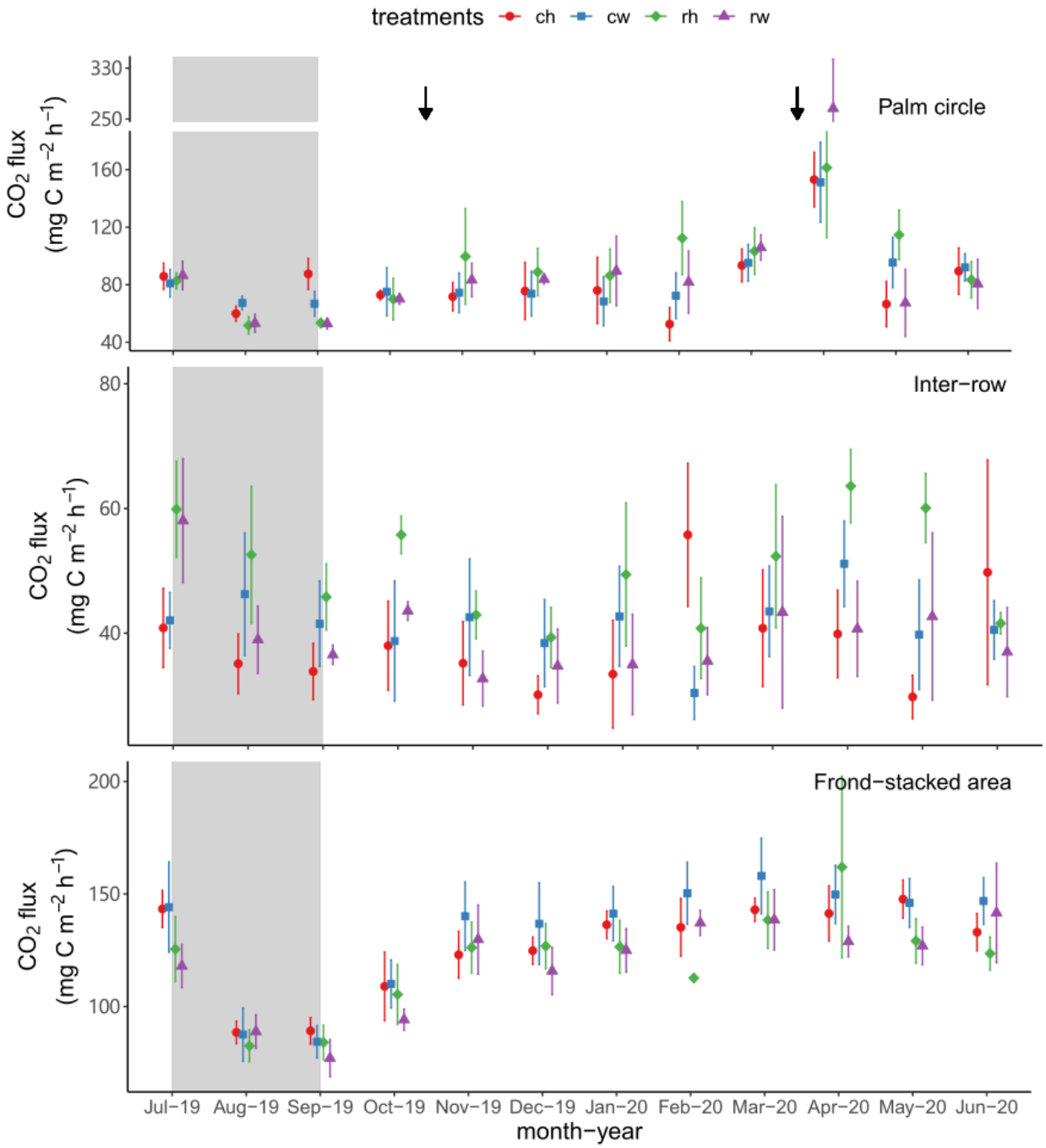

Fig. S1 Soil CO_2 emissions (mean ± SE, n = 4 plots) from different fertilization and weeding treatments in an ⩾ 18-year old, large-scale oil palm plantation, Jambi, Indonesia, measured monthly from July 2019 to June 2020. Gray shadings mark the dry season (precipitation ⩽ 80 mm month^{-1}) and black 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

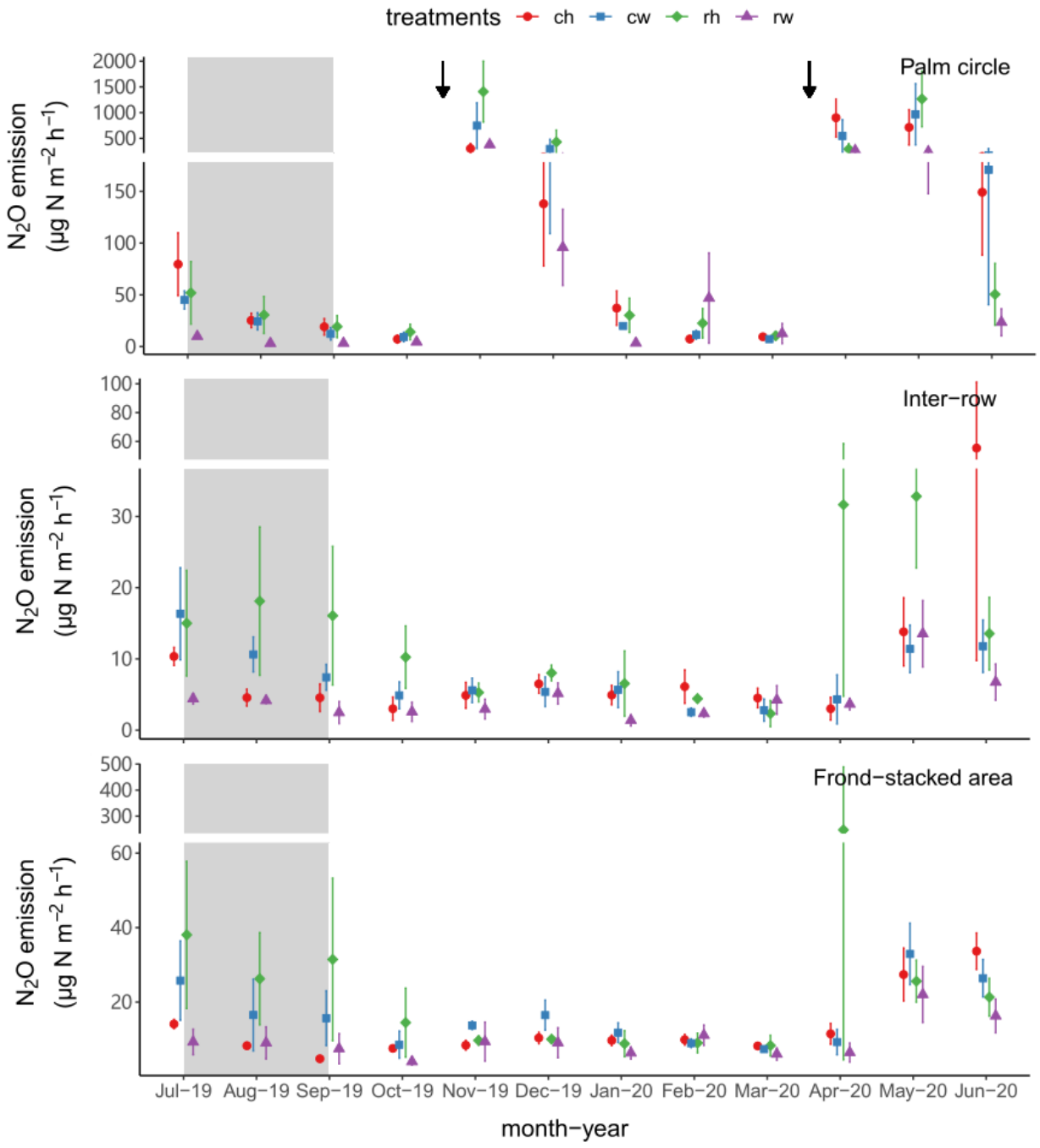

Fig. S2 Soil N_2O emissions (mean ± SE, n = 4 plots) from different fertilization and weeding treatments in an ⩾ 18-year old, large-scale oil palm plantation, Jambi, Indonesia, measured monthly from July 2019 to June 2020. Gray shadings mark the dry season (precipitation ⩽ 80 mm month^{-1}) and black 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

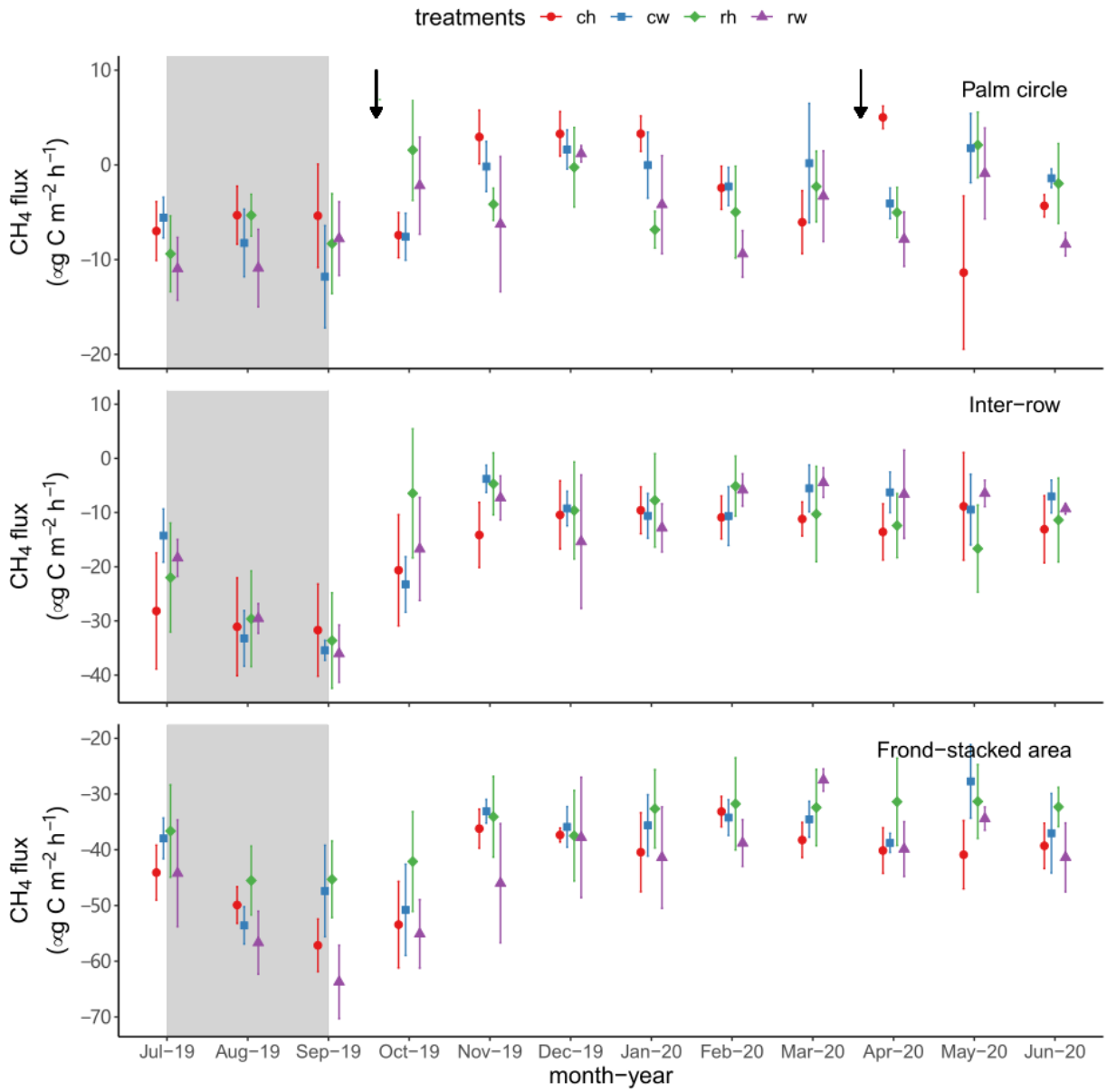

Fig. S3 Soil CH_4 fluxes (mean ± SE, n = 4 plots) from different fertilization and weeding treatments in an ⩾ 18-year old, large-scale oil palm plantation, Jambi, Indonesia, measured monthly from July 2019 to June 2020. Gray shadings mark the dry season (precipitation ⩽ 80 mm month^{-1}) and black arrows 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

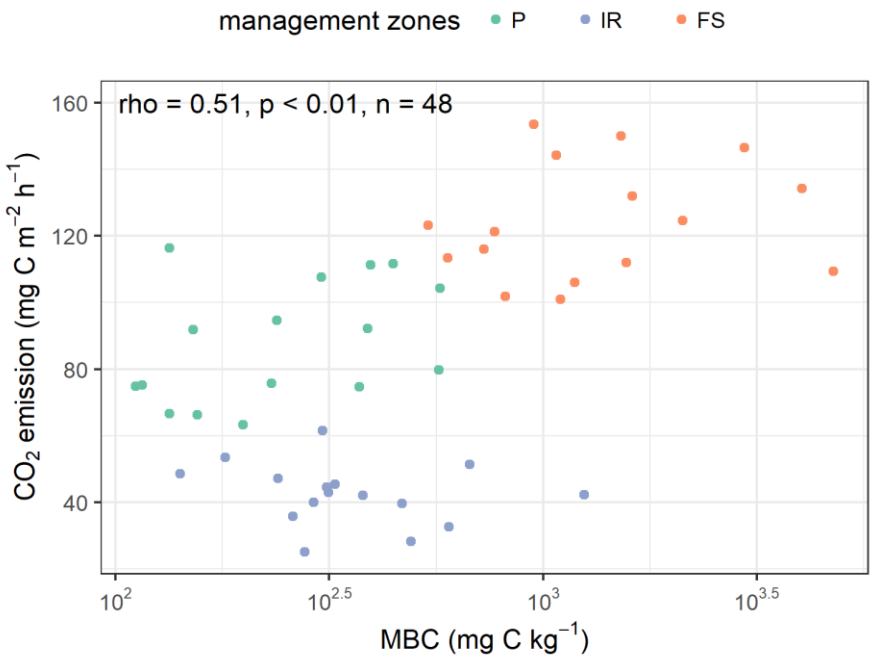

Fig. S4 Spearman rank correlation between soil CO_2 emissions and microbial biomass carbon (MBC). Each data point for soil CO_2 emissions was the average of 12-monthly measurements and MBC was measured once in 2018, as reported by Formaglio et al. (2021). P – palm circle, IR – inter-row, FS – frond-stacked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

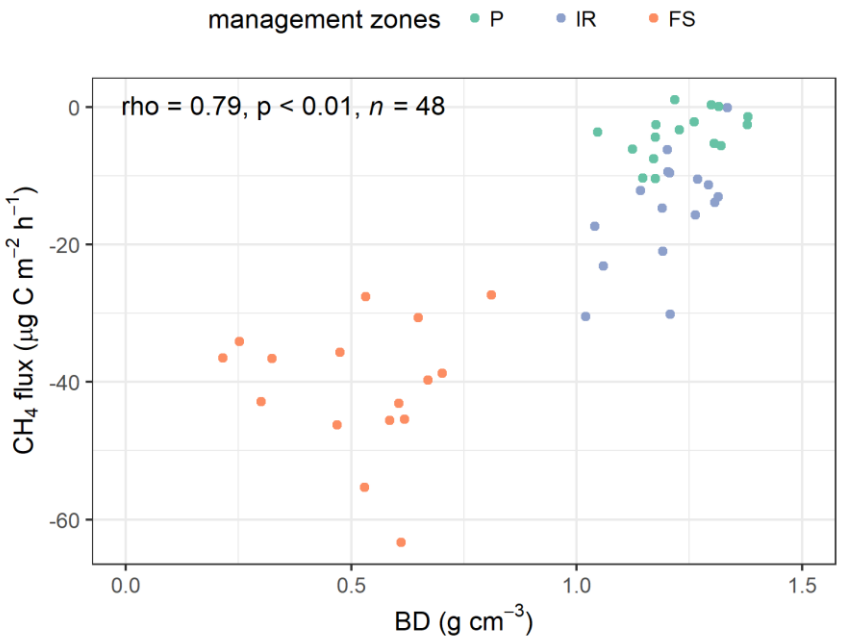

Fig. S5 Spearman rank correlation between soil CH_4 fluxes and soil bulk density (BD). Each data point for soil CH_4 fluxes was the average of 12-monthly measurements and BD was measured once in 2018 (Formaglio et al. 2021). P – palm circle, IR – inter-row, FS – frond-stacked area

Table S1 Soil biochemical and physical characteristics (means ± 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 ⩾ 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 ± 0.6 b	6.4 ± 0.2 b	9.1 ± 0.8 a
Total N (g N m^{-2})	402 ± 31 b	426 ± 15 ab	571±39 a
ECEC ($mmol_{charge}$ kg^{-1})	35 ± 2 a	18 ± 1 b	28 ± 2 a
pH (1:4 soil-to-H_2O)	5.05 ± 0.08 a	4.81 ± 0.05 b	5.00 ± 0.08 ab
Bulk density (g cm^{-3})	1.37 ± 0.01 a	1.36 ± 0.01 a	0.89 ± 0.01 b
Clay (%)	23.30 ± 1.31 a	23.60 ± 1.00 a	25.47 ± 1.37 a
Silt (%)	7.80 ± 1.19 a	7.73 ± 1.23 a	6.47 ± 1.21 a
Sand (%)	68.90 ± 1.52 a	68.67 ± 1.35 a	68.07 ± 1.97 a

ECEC: effective cation exchange capacity. For each parameter, different letters indicate significant differences among management zones (one-way ANOVA with Tukey HSD at $P \leqslant 0.05$). Except for soil texture, soil characteristics were reported by Formaglio et al. (2020)

Table S2 Cumulative fruit yield from 2017–2020 (means ± SE, n = 4 plots) in different fertilization and weeding treatments in an ⩾ 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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