Front. Agr. Sci. Eng.
https://doi.org/10.15302/J-FASE-2025602
Verso: Front. Agr. Sci. Eng.
Recto: Tianxiang HAO et al. Towards carbon neutrality in China's crop production
REVIEW

Optimizing crop production toward agricultural carbon neutrality in China

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Received June 18, 2024;
Accepted December 19, 2024.
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SUPPLEMENTARY MATERIALS

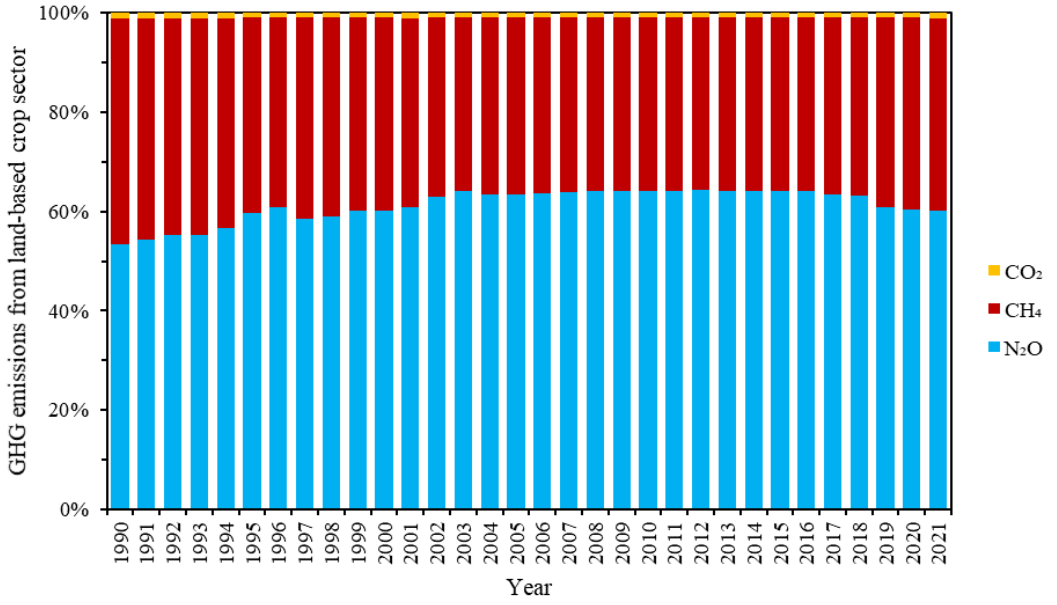

Fig. S1 Overview of three main greenhouse gas emissions (CO_2, CH_4 and N_2O) from cropland sector in China. Data from FAOSTAT.

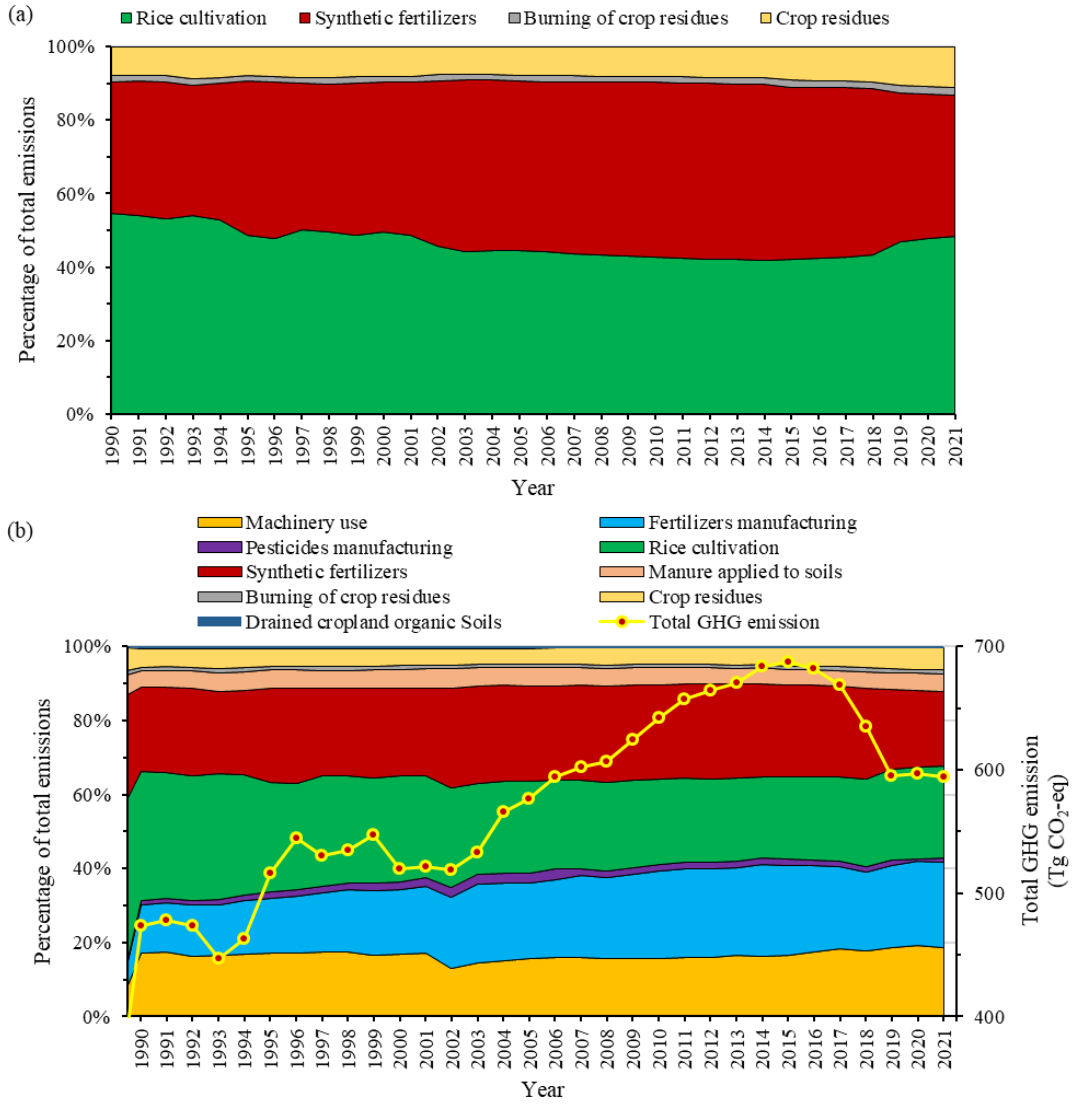

Fig. S2 GHG emission structures of cereal production without (a) and with (b) emissions from industry (fertilizer and pesticide) and energy use in China. Data from FAOSTAT. Cereal crops include Barley, Maize, Millet, Oats, Rice, Rye, Sorghum and Wheat. GHG emission from cropland energy use was assessed by multiplying the on-farm energy use (FAO) with the multi-year average ratio of cropping systems energy use to on-farm energy use (~0.402) published by Liang et al.[1].

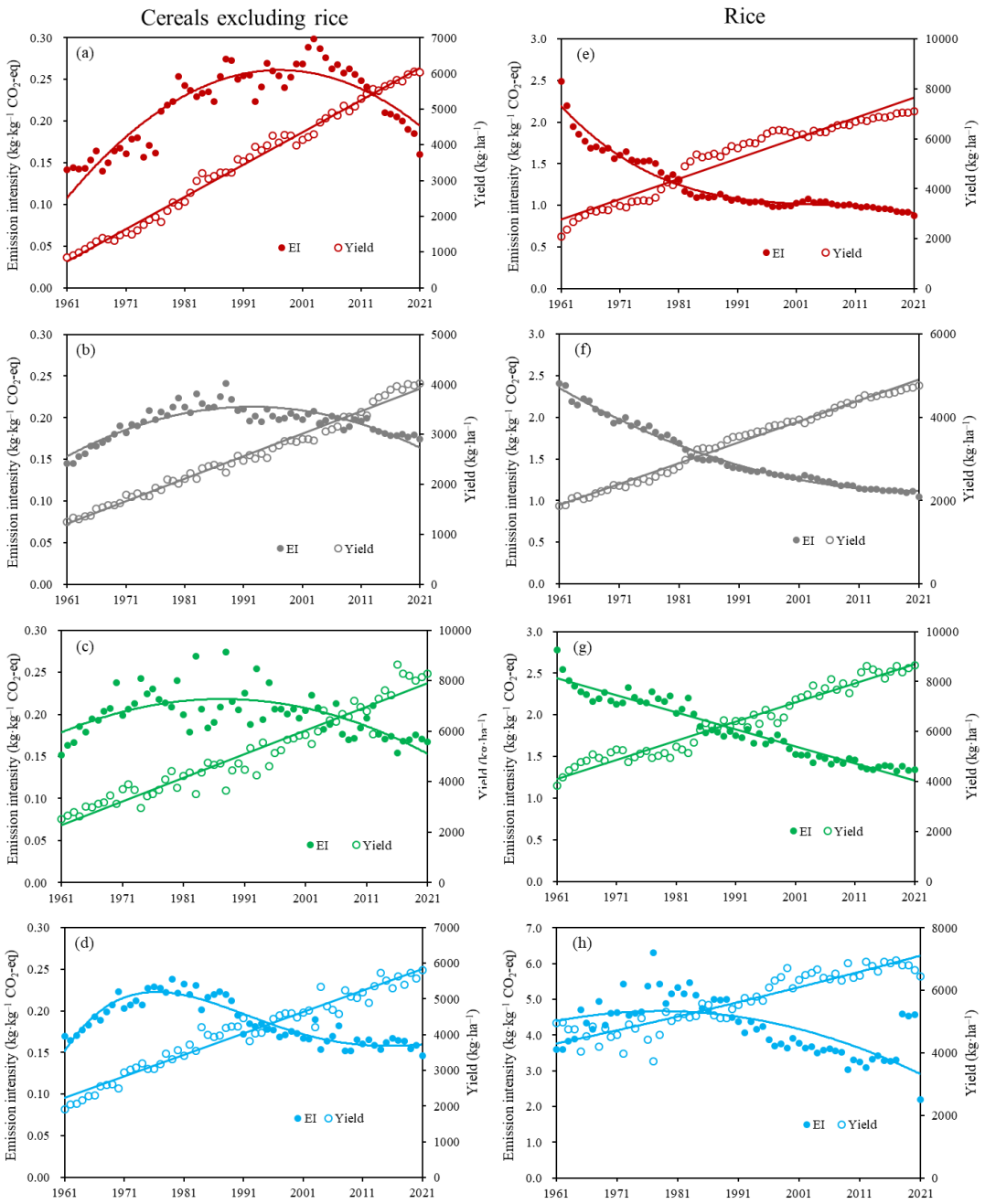

Fig. S3 Historical trends of GHG emissions intensity and yield for global and top agriculture countries during 1961–2021 in Mt CO_2-eq. (a) Cereals excluding rice in China; (b) world cereals excluding rice; (c) cereals excluding rice in USA; (d) cereals excluding rice in EU27; (e) rice in China; (f) world rice; (g) rice in USA; (h) rice in EU27. Data from FAOSTAT.

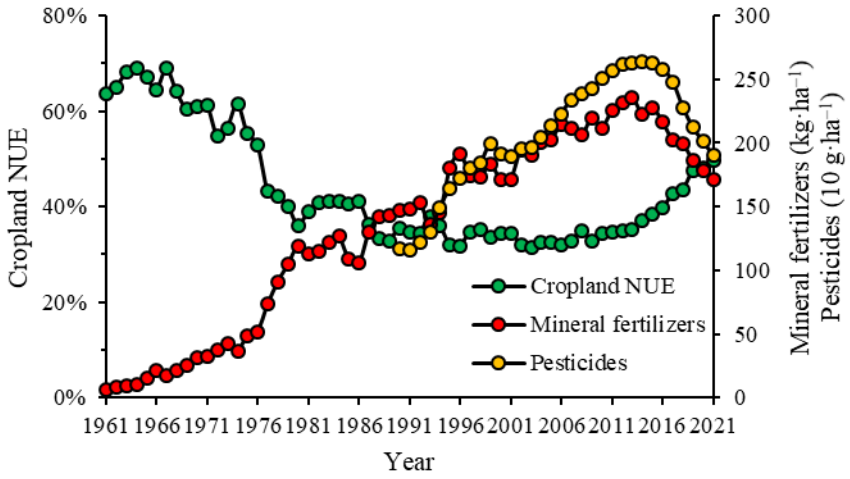

Fig. S4 Historical trends of cropland NUE, mineral fertilizers and pesticides application rates in China. Data from FAOSTAT. Cropland NUE = Crop Removal / Total N input × 100%.

Table S1 Effects of double (nitrification + urease inhibitors), nitrification and urease inhibitors (DIs, NIs and UIs)

Inhibitors		NH_3 (%)	N_2O (%)	Yields (%)	NUE (%)	References
DIs	NBPT+DMPP	44 ↓	N/A	N/A	N/A	[2]
	HQ+DCD	33 ↓	N/A	N/A	N/A	[3]
	NBPT+DCD	N/A	30 ↓	N/A	N/A	[4]
	DCD+NBPT	N/A	N/A	15 ↑	15 ↑	[5]
NIs	CP	2–56 ↑	46–77 ↓	16–36 ↑	34–84 ↑	[2,6]
	DCD	19–26 ↑	26–45 ↓	6–13 ↑	12–15 ↑	[2,4,5,7–10]
	DMPP	–34–19	33–49 ↓	6–9 ↑	3–8 ↑	[2,4,5,7,8]
	Nitrapyrin	N/A	42–43 ↓	3 ↑	N/A	[2,4]
UIs	HQ	27 ↓	N/A	N/A	14 ↑	[2,3]
	LIMUS	79 ↓	N/A	N/A	N/A	[2]
	NBPT	52–78 ↓	22 ↓	2–16 ↑	12–30 ↑	[3-5,9–12]
	PPD	56 ↓	N/A	N/A	20 ↑	[3,9]

Note: NBPT, DMPP, HQ, DCD, CP, PPD represent N-(N-butyl)thiophosphoric triamide, 3,4-dimethylpyrazole phosphate, 1,4-Dihydroxybenzene, Dicyandiamide, 2-Chloro-6-methylpyridine and Phenyl diamidophosphate; "↑" and "↓" mean increase and reduction, respectively. N/A means not applicable.

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