

Table S1. The fertilizer application rate and fertilization time of different N treatments.

Fertilization time/Treatment	Urea (kg N ha ⁻¹)				Polymer-coated urea (kg N ha ⁻¹)	Organic fertilizer (kg ha ⁻¹)	P fertilizer (kg P ₂ O ₅ ha ⁻¹)	K fertilizer (kg K ₂ O ha ⁻¹)	Total N (kg N ha ⁻¹)	Total P (kg P ₂ O ₅ ha ⁻¹)	Total K (kg K ₂ O ha ⁻¹)	
	Pre-transplanting	Early tillering	Panicle initiation	Initial spikelet differentiation	Pre-transplanting	Pre-transplanting	Pre-transplanting	Pre-transplanting	Panicle initiation	/	/	/
2022	-1 DAT	7 DAT	39 DAT	56 DAT	-1 DAT	-1 DAT	-1 DAT	-1 DAT	39 DAT	/	/	/
2023	-1 DAT	7 DAT	40 DAT	59 DAT	-1 DAT	-1 DAT	-1 DAT	-1 DAT	40 DAT	/	/	/
0N	/	/	/	/	/	/	90	54	36	0	90	90
CK	108	54	54	54	/	/	90	54	36	270	90	90
T1	/	/	/	/	240	/	90	54	36	240	90	90
T2	72	/	/	/	168	/	90	54	36	240	90	90
						4500 (organic matter						
T3	72	/	/	/	168	45.2%, N 1.8%, P ₂ O ₅ 1.2%, K ₂ O 2.3%)	90	54	36	321	144	193.5

Treatments: 0N, no N fertilizer applied; CK, urea at the full local standard rate of 270 kg N ha⁻¹; T1, PCU with a reduced rate of 240 kg N ha⁻¹; T2, 70% PCU, 30% urea at a reduced rate of 240 kg N ha⁻¹; and T3, T2 blended with OF at 4500 kg ha⁻¹. DAT, days after transplanting; N, nitrogen; P, phosphate; K, potassium; PCU, polymer-coated urea; and OF, organic fertilizer.

Table S2. The prices of the agricultural inputs and estimated outputs.

Items	Units	Prices	Sources
Agricultural inputs			
Labor	CNY day ⁻¹	120.00	NDRC (2022) [55]
Mechanical farming	CNY ha ⁻¹ season ⁻¹	1300.00	Lin et al., (2021) [56]
Mechanical harvesting	CNY ha ⁻¹ season ⁻¹	1300.00	Lin et al., (2021) [56]
N (PCU)	CNY kg ⁻¹	4.20	NDRC (2022) [55]
N (urea)	CNY kg ⁻¹	2.00	NDRC (2022) [55]
Organic fertilizer	CNY kg ⁻¹	0.65	NDRC (2022) [55]
P (superphosphate)	CNY kg ⁻¹	1.05	NDRC (2022) [55]
K (potassium chloride)	CNY kg ⁻¹	2.30	NDRC (2022) [55]
Electricity for irrigation	CNY KWh ⁻¹	0.40	NDRC (2022) [55]
Herbicides	CNY kg ⁻¹	175.00	Lin et al., (2021) [56]
Insecticides	CNY kg ⁻¹	100.00	Lin et al., (2021) [56]
Fungicides	CNY kg ⁻¹	90.00	Lin et al., (2021) [56]
Rice seed	CNY kg ⁻¹	50.00	NDRC (2022) [55]
Agricultural Outputs			
Rice grain	CNY kg ⁻¹	2.75	NDRC (2022) [55]

CNY, Chinese Yuan; N, nitrogen; P, phosphate; K, potassium; PCU, polymer-coated urea; and OF, organic fertilizer.

Table S3. The agricultural material and service inputs under different N treatments.

Year	Treatment	Chemical input (kg ha ⁻¹)								Seed (kg ha ⁻¹)	Electricity for irrigation (KWh ⁻¹)	Labor (8 hour day ⁻¹)			
		Nitrogen (PCU)	Nitrogen (urea)	Organic fertilizer	Phosphorus	Potash	Herbicide	Insecticides	Fungicide			Sowing	Transplanting	Spary	Fertilization
2022	0N	0	0	0	90	90	1.2	1.88	1.15	40	935	2	12	2	2
	CK	0	270	0	90	90	1.2	1.88	1.15	40	935	2	12	2	6
	T1	240	0	0	90	90	1.2	1.88	1.15	40	935	2	12	2	2
	T2	168	72	0	90	90	1.2	1.88	1.15	40	935	2	12	2	2
	T3	168	72	4500	90	90	1.2	1.88	1.15	40	935	2	12	2	3
2023	0N	0	0	0	90	90	1.39	2.25	0.95	40	789	2	12	2	2
	CK	0	270	0	90	90	1.39	2.25	0.95	40	789	2	12	2	6
	T1	240	0	0	90	90	1.39	2.25	0.95	40	789	2	12	2	2
	T2	168	72	0	90	90	1.39	2.25	0.95	40	789	2	12	2	2
	T3	168	72	4500	90	90	1.39	2.25	0.95	40	789	2	12	2	3

Treatments: 0N, no N fertilizer applied; CK, urea at the full local standard rate of 270 kg N ha⁻¹; T1, PCU with a reduced rate of 240 kg N ha⁻¹; T2, 70% PCU, 30% urea at a reduced rate of 240 kg N ha⁻¹; and T3, T2 blended with OF at 4500 kg ha⁻¹. N, nitrogen; PCU, polymer-coated urea; and OF, organic fertilizer.

Table S4. The protein components of milled rice under different N fertilizer application treatments in 2023.

Treatment	Albumin (%)	Globulin (%)	Prolamin (%)	Glutelin (%)
0N	0.39±0.02b	0.42±0.00b	0.58±0.00c	4.83±0.07b
CK	0.45±0.02a	0.57±0.04a	0.91±0.04a	6.46±0.07a
T1	0.44±0.03ab	0.54±0.05a	0.86±0.02ab	6.43±0.07a
T2	0.44±0.00ab	0.50±0.00ab	0.83±0.01b	6.36±0.03a
T3	0.44±0.00ab	0.51±0.00ab	0.80±0.01b	6.45±0.01a

Different letters indicated significant differences among treatments ($p < 0.05$). Treatments: 0N, no N fertilizer applied; CK, urea at the full local standard rate of 270 kg N ha⁻¹; T1, PCU with a reduced rate of 240 kg N ha⁻¹; T2, 70% PCU, 30% urea at a reduced rate of 240 kg N ha⁻¹; and T3, T2 blended with OF at 4500 kg ha⁻¹. N, nitrogen; PCU, polymer-coated urea; and OF, organic fertilizer.

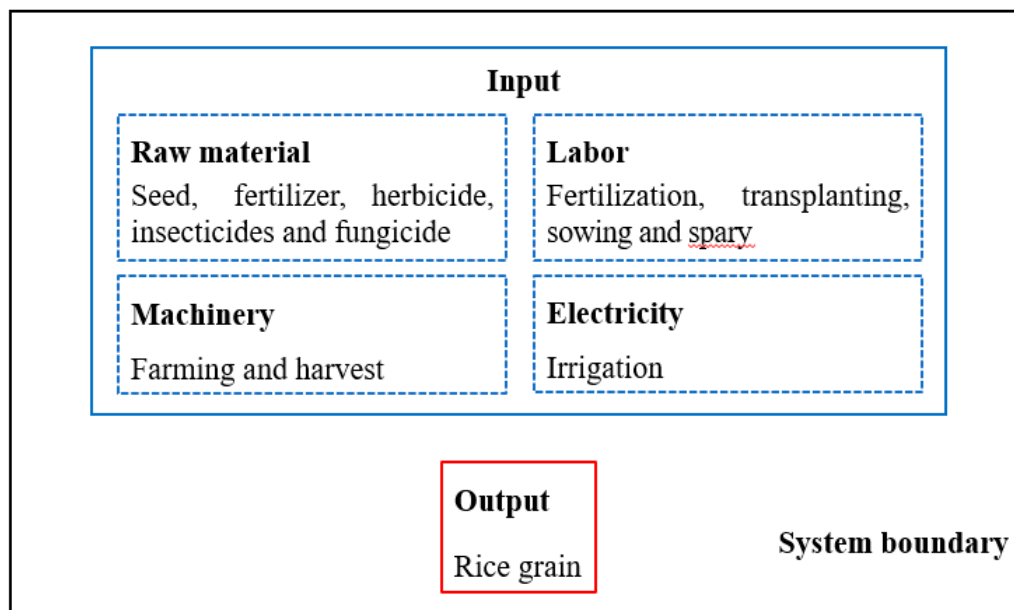


Figure S1. The system boundary of the life cycle assessment for calculating the economic benefits in rice season.

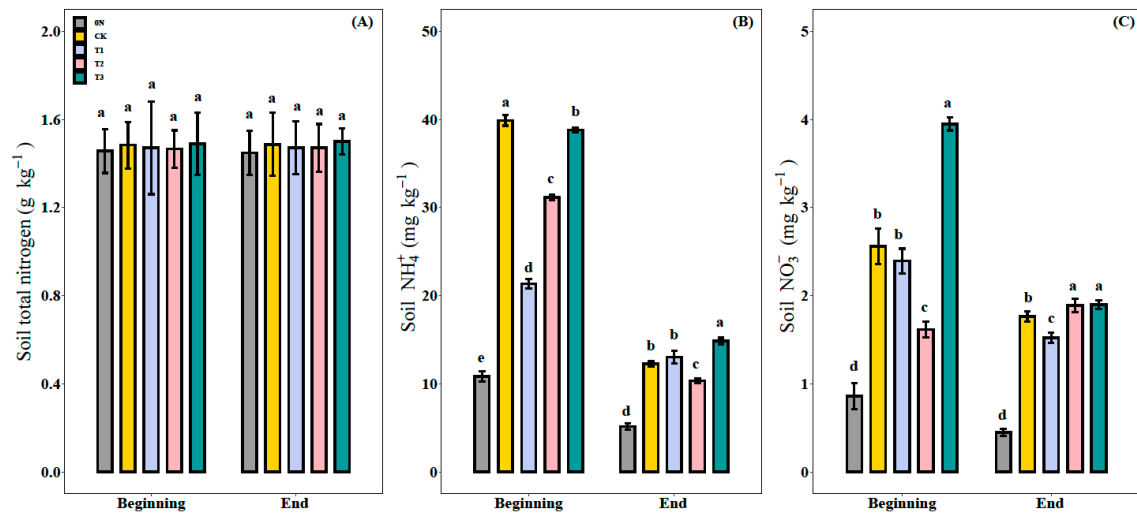


Figure S2. The soil total N (A), soil NH₄⁺ (B), and soil NO₃⁻ (C) under various N fertilizer application treatments at the beginning and end of this study in 2023. Different letters at the same stage indicated significant differences among treatments ($p < 0.05$). Treatments: 0N, no N fertilizer applied; CK, urea at the full local standard rate of 270 kg N ha⁻¹; T1, PCU with a reduced rate of 240 kg N ha⁻¹; T2, 70% PCU, 30% urea at a reduced rate of 240 kg N ha⁻¹; and T3, T2 blended with OF at 4500 kg ha⁻¹. and N, nitrogen; PCU, polymer-coated urea; OF, organic fertilizer.

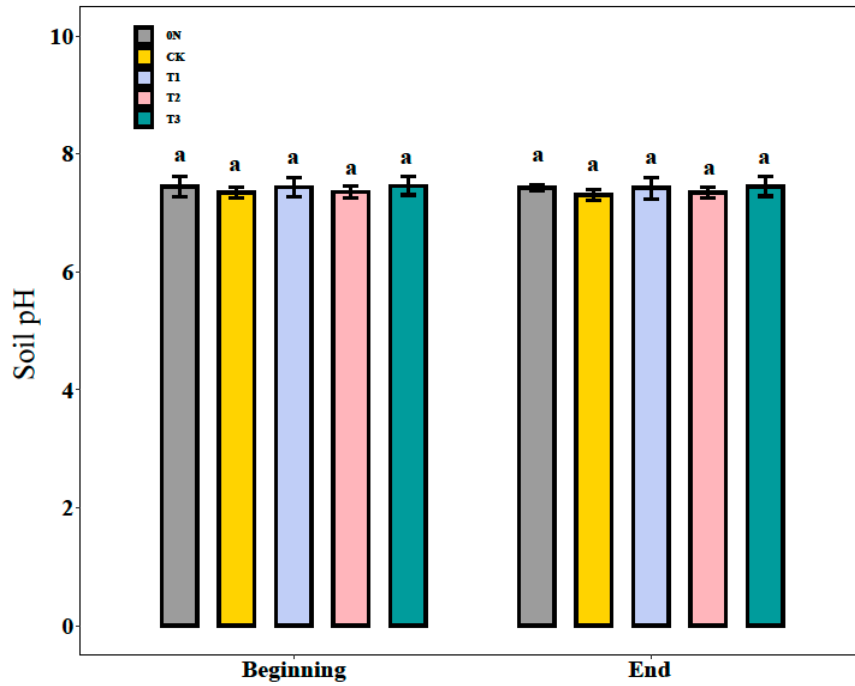


Figure S3. The soil pH under various N fertilizer application treatments at the beginning and end of this study in 2023. Different letters at the same stage indicated significant differences among treatments ($p < 0.05$). Treatments: 0N, no N fertilizer applied; CK, urea at the full local standard rate of 270 kg N ha⁻¹; T1, PCU with a reduced rate of 240 kg N ha⁻¹; T2, 70% PCU, 30% urea at a reduced rate of 240 kg N ha⁻¹; and T3, T2 blended with OF at 4500 kg ha⁻¹. N, nitrogen; PCU, polymer-coated urea; and OF, organic fertilizer.

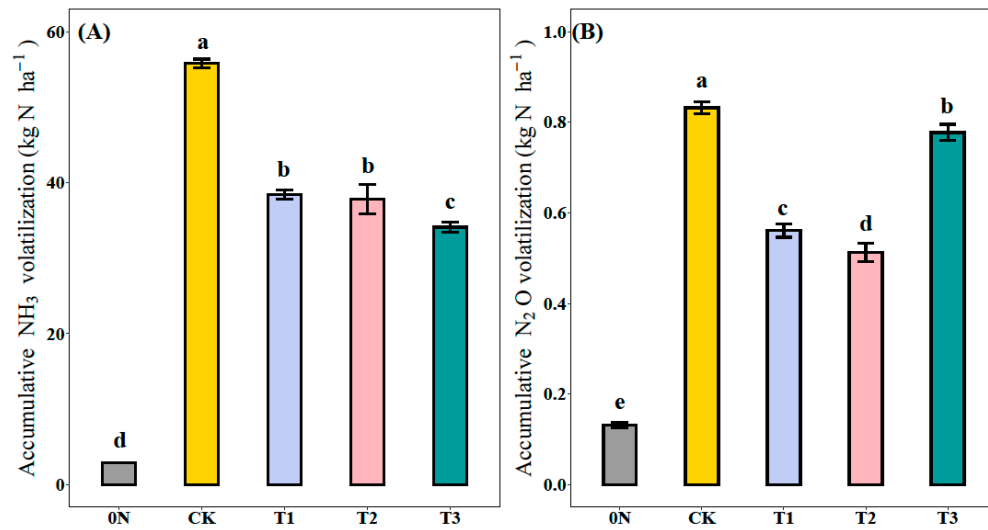


Figure S4. The accumulation of NH₃ volatilization (A) and N₂O emission (B) under various N fertilizer application treatments in 2023. Different letters at the same stage indicated significant differences among treatments ($p < 0.05$). Treatments: 0N, no N fertilizer applied; CK, urea at the full local standard rate of 270 kg N ha⁻¹; T1, PCU with a reduced rate of 240 kg N ha⁻¹; T2, 70% PCU, 30% urea at a reduced rate of 240 kg N ha⁻¹; and T3, T2 blended with OF at 4500 kg ha⁻¹. N, nitrogen; PCU, polymer-coated urea; and OF, organic fertilizer.

References

55. NDRC. National cost-benefit data of agricultural products (*In Chinese*). China Statistics Press, Beijing, China, **2022**.
56. Ling, L.; Shuai, Y.; Xu, Y.; Zhang, Z.; Wang, B.; You, L.; Sun, Z.; Zhang, H.; Zhan, M.; Li, C.; Wang, J.; Jiang, Y.; Ayitula, M.; Cao, C. Comparing rice production systems in China: Economic output and carbon footprint. *Sci. Total Environ.* **2021**, *791*, 147890.