

Supplementary material

Table S1 Data for the field application process of biochar.

Project	Other crops			Paddy		
	Black soil	Loess	Laterite	Black soil	Loess	Laterite
Biochar carbon content (%)	74.55					
Biochar stabilizes carbon content (%)	64.83					
Reduction rate of nitrogen fertilizers (%)	10					
Reduction rate of phosphate fertilizers (%)	5					
Reduction rate of potash fertilizers (%)	5					
Crop increased yield (%)	10					
Reduction rate of SOC mineralization (%)	10					
Reduction rate of N ₂ O emission (%)	19	33	65.60	19	33	65.60
Reduction rate of CH ₄ emission (%)	-	-	-	30	30	45.2
SOC average reserve (t/ha)	66.6	44.8	51.02	66.6	44.8	51.02

Table S2 Data for the field application process of biochar-based fertilizer.

Project	Other crops			Paddy		
	Black soil	Loess	Laterite	Black soil	Loess	Laterite
Biochar content in biochar-based fertilizer (%)	24					
Nutrient content in carbon-based fertilizers (N: P ₂ O ₅ : K ₂ O)	18:9:10					
Crop increased yield (%)	10					
Reduction rate of SOC mineralization (%)	10					
Reduction rate of N ₂ O emission (%)	19	33	65.60	19	33	65.60
Reduction rate of CH ₄ emission (%)	-	-	-	20	20	25
SOC average reserve (t/ha)	66.6	44.8	51.02	66.6	44.8	51.02

Table S3 Sensitivity analysis parameters of biochar.

Number	Parameter	-20%	Basic value	+20%
F1	Energy consumption of straw collection (kWh)	55.184	68.98	82.776
F2	Power consumption of pyrolysis plant (kWh)	164.376	205.47	246.564
F3	Water resource consumption in pyrolysis plant (kg)	217632	272040	326448
F4	Conversion efficiency of bio-oil and syngas to electricity(%)	26.4, 28	33, 35	39.6, 52.5
F5	Power consumption of biochar seeding (kWh)	42.28	52.85	63.42
F6	Biochar application ratio (t/ha)	40	50	60
F7	Reduction rate of nitrogen fertilizers(%)	8	10	12

Table S4 Sensitivity analysis parameters of biochar-based fertilizer.

Number	Parameter	-20%	Basic value	+20%
F1	Energy consumption of straw collection (kWh)	55.184	68.98	82.776
F2	Power consumption of the pyrolysis plant (kWh)	164.376	205.47	246.564
F3	Water resource consumption in pyrolysis plant (kg)	217632	272040	326448
F4	Fertilizers processing (kWh)	13.96	17.45	20.94
F5	Conversion efficiency of bio-oil and syngas to electricity(%)	26.4, 28	33, 35	39.6, 52.5
F6	Power consumption of biochar-based fertilizer seeding (kWh)	56.60	70.75	84.90
F7	Biochar-based fertilizer application ratio (t/ha)	40	50	60
F8	Nitrogen fertilizer content in biochar-based fertilizer(%)	8	10	12