

1 Supplementary Information

2 Table S1: Initial soil chemical properties and basic information about the six long-term 3 experiment sites.

Sites	FAO soil classification	Original year	SOC (g·kg ⁻¹)	TN (g·kg ⁻¹)	AN (mg·kg ⁻¹)	TP (g·kg ⁻¹)	AP (mg·kg ⁻¹)	TK (g·kg ⁻¹)	AK (mg·kg ⁻¹)	pH	C/N	Cropping system
GZL	Luvic Phaeozems	1990	13.2	1.40	114.0	1.39	27.0	22.1	190	7.6	9.4	MC-MMM
ZZ	Calcaric Cambisol	1990	6.7	0.67	76.6	0.65	6.5	16.9	74	8.3	10.0	DC-MW
UM	Haplic Calcisol	1990	8.8	0.87	55.2	0.67	3.4	19.8	288	8.1	10.1	MC-MWW
YL	Cumulic Anthrosol	1990	7.4	0.83	63.0	0.61	9.6	21.6	194	8.6	9.0	DC-MW
ZY	Anthrosol	1982	11.5	0.86	28.1	0.82	21.7	19.8	99	8.5	13.4	MC-MWW
QY	Eutric Cambisol	1990	7.9	1.07	79.0	0.45	13.9	13.7	104	5.7	7.4	DC-MW

4 GZL, Gongzhuling; ZZ, Zhengzhou; UM, Urumqi; YL, Yangling; ZY, Zhangye; QY, Qiyang; SOC, soil
5 organic carbon; TN, total nitrogen; AN, available nitrogen; TP, total phosphorous; AP, available
6 phosphorous; TK, total potassium; AK, available potassium; C/N, ratio of SOC with TN; MC, mono-
7 cropping; DC, double-cropping; MMM, maize-maize-maize; MWW, maize-wheat-wheat; MW, maize-
8 wheat.

9 **Table S2: Application rates (kg·ha⁻¹) of fertilizer N (inorganic N + N in manure) for each growing**
 10 **season under five treatments.**

Sites	Experimental Periods	Crops	CK	NPK	NPKM	hNPKM	NPKS	Types of manure
GZL	1990–2018	Maize	0	165	50+115	74+173	123	CM, PM
ZZ	1990–2011	Maize	0	188	188	282	188	CM, HM
		Wheat	0	165	50+115	74+173	123	CM, HM
UM	1990–2011	Maize	0	242	85+297	152+595	217	GM
		Wheat	0	242	85+297	152+595	217	GM
YL	1990–2014	Maize	0	188	188	282	188	CM
		Wheat	0	165	50+115	74+173	123	CM
ZY	1982–1990	Maize	0	240	240+240	NA	NA	PM
		Wheat	0	120	120+120	NA	NA	PM
ZY	1991–2002	Maize	0	300	300+300	NA	NA	PM
		Wheat	0	150	150+150	NA	NA	PM
QY	1990–2012	Maize	0	210	63+147	95+221	210	PM
		Wheat	0	90	27+63	41+95	90	PM

11 GZL, Gongzhuling; ZZ, Zhengzhou; UM, Urumqi; YL, Yangling; ZY, Zhangye; QY, Qiyang. Fertilizer
 12 regimes: CK, unfertilized control; NPK, inorganic N, phosphorus and potassium; NPKM, inorganic NPK
 13 plus manure; hNPKM, high application rate of NPKM; NPKS, inorganic NPK with stover return; In front
 14 and behind of the "+" represents the application rate of N from inorganic fertilizer and manure,
 15 respectively; CM, cow manure; PM, pig manure; HM, horse manure; GM, goat manure. NA, data not
 16 available because the treatments are not included.

17 **Table S3: Results of principal components analysis (PCA) of nutrient content and soil**
 18 **stoichiometry in the first decade and later period of the experiment.**

Factors	PC1
Soil nutrients of the first decade	
soil total nitrogen content (TN, g· kg ⁻¹)	-0.776**
Soil available content (AN, mg· kg ⁻¹)	-0.432*
Soil total phosphorus (TP, g· kg ⁻¹)	-0.772**
Soil available phosphorus (AP, mg· kg ⁻¹)	-0.772**
Soil total potassium (TK, g· kg ⁻¹)	0.191
Soil available potassium (AK, mg· kg ⁻¹)	-0.661**
Cumulative (%)	40.93
Soil stoichiometry of the first decade	
C/N ratios	-0.474*
N/P ratios	-0.944**
C/P ratios	-0.994**
Cumulative (%)	98.67
Soil nutrients of the later period	
soil total nitrogen content (TN, g· kg ⁻¹)	-0.912**
Soil available content (AN, mg· kg ⁻¹)	-0.870**
Soil total phosphorus (TP, g· kg ⁻¹)	-0.915**
Soil available phosphorus (AP, mg· kg ⁻¹)	-0.936**
Soil total potassium (TK, g· kg ⁻¹)	0.202
Soil available potassium (AK, mg· kg ⁻¹)	-0.827**
Cumulative (%)	67.11
Soil stoichiometry of the later period	
C/N ratios	-0.106
N/P ratios	0.971**
C/P ratios	0.954**
Cumulative (%)	62.18

19 *, significant correlation at P < 0.05. **, significant correlation at P < 0.01.

20 **Table S4: Climatic conditions (annual) in the first decade and later period at the six long-term**
 21 **experimental sites under five treatments.**

Sites	Years	Mean annual Precipitation (mm)	Mean annual Temperature (°C)	Mean annual Humidity (mm)	Mean annual Evaporation (mm)
GZL	1–10	619.50	7.37	63.70	1235.61
	11–28	544.68	7.23	62.08	1390.25
ZZ	1–10	617.99	14.62	67.40	1772.89
	11–22	682.58	15.35	61.42	1781.65
UM	1–10	14.71	14.93	40.80	2458.40
	11–22	15.41	15.72	37.33	2635.45
YL	1–10	358.06	8.81	55.40	1908.64
	11–25	457.15	10.67	52.33	1977.20
ZY	1–10	468.85	8.73	65.10	1331.89
	11–21	491.88	9.35	63.64	1497.59
QY	1–10	1497.05	18.00	78.50	1396.96
	11–23	1373.28	18.25	74.85	1326.50

22 GZL, Gongzhuling; ZZ, Zhengzhou; UM, Urumqi; YL, Yangling; ZY, Zhangye; QY, Qiyang.

23 **Table S5: Soil pH average value and coefficient variations in the first decade and the later period**
 24 **under five long-term treatments.**

Sites	Years	CK		NPK		NPKM		hNPKM		NPKS	
		pH	CV	pH	CV	pH	CV	pH	CV	pH	CV
GZL	1–10	7.60	0.02	6.60	0.05	7.48	0.01	7.64	0.02	7.89	0.02
	11–28	7.56	0.03	6.20	0.03	7.21	0.02	7.31	0.01	7.61	0.04
ZZ	1–10	8.57	0.03	8.42	0.01	8.42	0.01	8.23	0.02	8.25	0.02
	11–22	8.35	0.03	8.34	0.03	8.27	0.03	8.22	0.03	8.29	0.03
UM	1–10	8.10	0.03	8.01	0.04	7.92	0.04	7.83	0.04	7.74	0.04
	11–22	7.65	0.01	7.56	0.02	7.47	0.02	7.38	0.02	7.29	0.02
YL	1–10	8.23	0.03	8.23	0.04	8.10	0.04	8.07	0.04	8.06	0.04
	11–25	8.38	0.01	8.26	0.02	8.10	0.02	8.03	0.02	8.20	0.02
ZY	1–10	8.50	0.00	8.50	0.00	8.50	0.00	NA	NA	NA	NA
	11–21	8.50	0.00	8.50	0.00	8.50	0.00	NA	NA	NA	NA
QY	1–10	5.76	0.08	5.01	0.11	6.03	0.07	6.01	0.04	5.00	0.11
	11–23	5.68	0.03	4.50	0.03	5.82	0.03	5.85	0.03	4.57	0.05

25 CV, coefficient of variation. NA, data not available because the treatments are not included.

26 **Table S6: Annual rates of change (ARC, $\text{g}\cdot\text{kg}^{-1}\cdot\text{yr}^{-1}$) of SOC in the first decade and later period**
 27 **under five long-term treatments.**

Sites	Years	CK	NPK	NPKM	hNPKM	NPKS
GZL	1–10	0.08	0.10	0.16	0.26	0.09*
	11–28	-0.23	-0.38*	0.15	0.29	-0.09
ZZ	1–10	-0.03	0.05	0.22**	0.28**	0.13*
	11–22	0.10	0.09*	0.23**	0.33**	0.15**
UM	1–10	-0.12*	-0.04	0.24	0.44**	0.05
	11–22	0.58**	0.66*	1.27*	2.16**	0.49*
YL	1–10	0.19*	0.29**	0.67**	1.03*	0.29*
	11–25	0.09*	0.20	0.24	0.00	0.31**
ZY	1–10	-0.19	-0.05	0.00	NA	NA
	11–21	-0.23	-0.19	0.03	NA	NA
QY	1–10	0.05	0.27*	0.62**	1.02**	0.31*
	11–23	-0.07	-0.12	-0.18	-0.29	-0.13

28 NA, data not available because the treatments are not included; *, significant correlation at $P < 0.05$. **,
 29 significant correlation at $P < 0.01$.