The rape was transplanted on November 1 each year and harvested on May 15 of the following year, with row spacing and nest spacing of 0.33 m, single litter and single plant with a density of 90,000 plants·hm^{-2}, and applied with 180 kg·hm^{-2} pure nitrogen, 60 kg·hm^{-2} pure phosphorus, and 60 kg·hm^{-2} pure potassium. Forage rape was sown on November 1 each year, and the whole plant biomass was harvested on March 30 of the following year, with row spacing and nest spacing of 0.33 m, single litter and two plants, density of 180,000 plants·hm^{-2}, and pure nitrogen of 135 kg·hm^{-2}, pure phosphorus of 45 kg·hm^{-2} and pure potassium of 45 kg·hm^{-2} were applied. Wheat was sown on November 1 each year and harvested on May 15 of the following year, with net row spacing of 0.2 m, nest spacing of 0.1 m, basic seedling guarantee of 24 million plants·hm^{-2}, pure nitrogen 150 kg·hm^{-2}, pure phosphorus 90 kg·hm^{-2}, and pure potassium 90 kg·hm^{-2}. The total bandwidth of wheat intercropping was 2.2 m (the same as below), the row spacing was 0.2 m, the nest spacing was 0.1 m, and the width was 1 m. The bare seedlings of wheat were guaranteed to be 1090,000 plants·hm^{-2}, and the pure nitrogen was 75 kg·hm^{-2}, the pure phosphorus was 45 kg·hm^{-2}, and the pure phosphorus was 45 kg·hm^{-2}. The potatoes were sown on December 1 and harvested on April 20 of the following year, with 1 m of ridge and 2 rows each, hole spacing of 0.2 m, density of 100,000 plants·hm^{-2}, applied with 150 kg·hm^{-2} of pure nitrogen, 30 kg·hm^{-2} of pure phosphorus, and 150 kg·hm^{-2} of pure potassium. The density of maize was 60,000 plants·hm^{-2}, with 225 kg·hm^{-2} pure nitrogen, 75 kg·hm^{-2} pure phosphorus, and 75 kg·hm^{-2} pure potassium. The net summer maize was sown on May 16 and harvested on September 14 each year, with row spacing of 0.7 m and nest spacing of 0.24 m. The corn was planted in narrow rows, double rows, with row spacing of 0.4m, nest spacing of 0.15m, single nest, and single plant. Among them, T4, T5, and T6 spring corn was sown on April 1 and harvested on July 31 of that year, and T7 and T8 spring corn was buried on April 21 and harvested on August 20 of that year. The soybean density was 150,000 plants·hm^{-2}, and only 45 kg·hm^{-2} of pure phosphorus was applied. The soybeans were sown on June 5 and harvested on October 31. Net summer soybean row spacing was 0.5 m, nest spacing was 0.13 m, single nest, and single plant. Intercropping peanut density of 180,000 plants·hm^{-2}, pure nitrogen 60 kg·hm^{-2}, pure phosphorus 45 kg·hm^{-2}, pure potassium 45 kg·hm^{-2}, row spacing of 0.3 m, planting 4 rows, wide width of 1.2 m, intercropping corn 0.3 m side row spacing, nest spacing of 0.2 m, single litter with two plants. Among them, T6 mode peanuts were sown on April 1 and harvested on August 10, and T7 mode peanuts were sown on April 21 and harvested on August 30. In other fields, tillage and weeding, disease, and insect pest control are the same as high-yield cultivation measures in the area.

Table S1 Field Density and Fertilizer Application Amount of Different Cropping Modes

Treatment	$N:P_2O_5:K_2O(kg \cdot hm^{-2})$			Density（$plant \cdot hm^{-2}$）		
Mature	1st mature	2nd mature	3rd mature	1st mature	2nd mature	3rd mature
T1	180:60:60	0:45:00		90000	150000	
T2	180:60:60	225:75:75		90000	60000	
T3	150:90:90	225:75:75		2400000	60000	
T4	75:45:45	225:75:75	0:45:00	1090000	60000	150000
T5	135:45:45	225:75:75	0:45:00	180000	60000	150000
T6	135:45:45	225:75:75	60:45:45	180000	60000	180000
T7	150:30:150	225:75:75	60:45:45	100000	60000	180000
T8	150:30:150	225:75:75	0:45:00	100000	60000	150000

Traditional Double Cropping System :T1, oilseed rape-summer soybean; T2, oilseed rape-summer maize; T3, wheat-summer maize. Traditional Triple Cropping System: T4, wheat/spring maize/summer soybean. Novel Triple Cropping System: T5, forage oilseed rape-spring maize/summer soybean; T6, forage oilseed rape-spring maize/peanut; T7, potato-spring maize/peanut; T8, potato-spring maize/summer soybean.

Table S2 Energy Conversion Coefficients of Different Cropping Modes

Item	Unit	Economic yield	Straw
Wheat	10^4 J·g $^{-1}$	1.63	1.46
Rape	10^4 J·g $^{-1}$	2.63	1.46
Forage rape	10^4 J·g $^{-1}$	1.46	1.46
Potato	10^4 J·g $^{-1}$	0.38	1.46
Maize	10^4 J·g $^{-1}$	1.63	1.46
Soybean	10^4 J·g $^{-1}$	2.09	1.51
Peanut	10^4 J·g $^{-1}$	2.30	1.51

Table S3 Conversion Rates of Solar Energy Values for Major Energy Types in Agroecosystems

Item	Solar Transformity	Unit	Item	Solar Transformity	Unit
Solar radiation	1.00E+00	$sej \cdot j^{-1}$	Mechanical power	7.50E+07	$sej \cdot j^{-1}$
Rain potential energy	1.43E+04	$sej \cdot j^{-1}$	Fuel	6.60E+04	$sej \cdot j^{-1}$
Rain chemical energy	2.93E+04	$sej \cdot j^{-1}$	Labor force	8.70E+12	$sej \cdot j^{-1}$
Wind energy	2.45E+03	$sej \cdot j^{-1}$	Wheat	6.80E+04	$sej \cdot j^{-1}$
Net loss of topsoil	6.25E+04	$sej \cdot j^{-1}$	Rape	8.88E+04	$sej \cdot j^{-1}$
Nitrogen fertilizer	4.62E+09	$sej \cdot j^{-1}$	Potato	8.30E+04	$sej \cdot j^{-1}$
Phosphate fertilizer	1.78E+10	$sej \cdot j^{-1}$	Maize	6.03E+04	$sej \cdot j^{-1}$
Potash fertilizer	2.96E+09	$sej \cdot j^{-1}$	Soybean	7.65E+04	$sej \cdot j^{-1}$
Pesticide	1.62E+09	$sej \cdot j^{-1}$	Peanut	7.72E+04	$sej \cdot j^{-1}$
Film	6.12E+08	$sej \cdot j^{-1}$	Straw	2.70E+04	$sej \cdot j^{-1}$

Note: The data in the table are too large to be expressed by the scientific counting method. The same is true below.

Table S4 Emergy Input-Output Projects in Agroecosystems

Index	Formula
Renewable natural resources	R
Unrenewable natural resources	N
Total input of environmental resources	I=(R+N)
Unrenewable industrial auxiliary emergy	F
Renewable organic emergy	R_1
Total input of supplement emergy	U=(F+R_1)
Total input of emergy	T=(I+U)
Output emergy of economic yield	Y_1
Output emergy of straw	Y_2
Total emergy output	Y=(Y_1+Y_2)

Table S5 Emergy analysis index expression

Index	Formula
Emergy Self-sufficiency ratio (ESR)	I/T
Industrial auxiliary emergy ratio	F/T
Organic auxiliary emergy ratio	R_1/T
Environmental load ratio (ELR)	$(N+F)/R+R_1$
Purchasing emergy ratio	U/T
Emergy input ratio(EIR)	U/I
Emergy yield ratio(EYR)	Y/U
Emergy Density(ED)	T/A
System Emergy Sustainability Index	EYR/ELR
System Production Advantage	$\sum(Yi/Y)^2$
System Stability Index	$\sum(Y_i/Y)\ln(Y_i/Y)$

Table S6 Analysis of Emergy Indicators of Different Ecosystems (Unit: sej)

Index		T1	T2	T3	T4	T5	T6	T7	T8
Renewable resource emergy ratio%		51.28	50.07	49.38	49.14	49.05	47.24	45.37	47.04
Unrenewable resource emergy ratio%		0.21	0.2	0.2	0.2	0.19	0.17	0.17	0.17
Industrial Auxiliary Energy Ratio%		40.58	41.2	41.04	40.46	40.63	39.46	37.99	39.05
Organic auxiliary energy ratio%		7.94	8.53	9.38	10.2	10.13	13.13	16.47	13.73
Purchasing emergy ratio%		48.51	49.72	50.42	50.66	50.76	52.59	54.46	52.79
Emergency Selfsufficiency Ratio %	ESR	51.49	50.28	49.58	49.34	49.24	47.41	45.54	47.21
Emergy input ratio	EIR	0.94	0.99	1.02	1.03	1.03	1.11	1.2	1.12
Emergy output ratio	EYR	0.31	0.38	0.35	0.36	0.35	0.33	0.35	0.36
Environmental load ratio	ELR	0.69	0.71	0.7	0.69	0.69	0.66	0.62	0.65
Emergy Density10^{13}	ED	1.11	1.14	1.16	1.16	1.16	1.21	1.26	1.21
System Emergy Sustainability Index	ESI	0.45	0.54	0.5	0.53	0.51	0.5	0.57	0.56
System Production Advantage		0.51	0.51	0.51	0.38	0.37	0.38	0.36	0.36
System Stability Index		0.68	0.69	0.68	1.04	1.04	1.04	1.06	1.05

Traditional Double Cropping System :T1, oilseed rape-summer soybean; T2, oilseed rape-summer maize; T3, wheat-summer maize. Traditional Triple Cropping System: T4, wheat/spring maize/summer soybean. Novel Triple Cropping System: T5, forage oilseed rape-spring maize/summer soybean; T6, forage oilseed rape-spring maize/peanut; T7, potato-spring maize/peanut; T8, potato-spring maize/summer soybean.

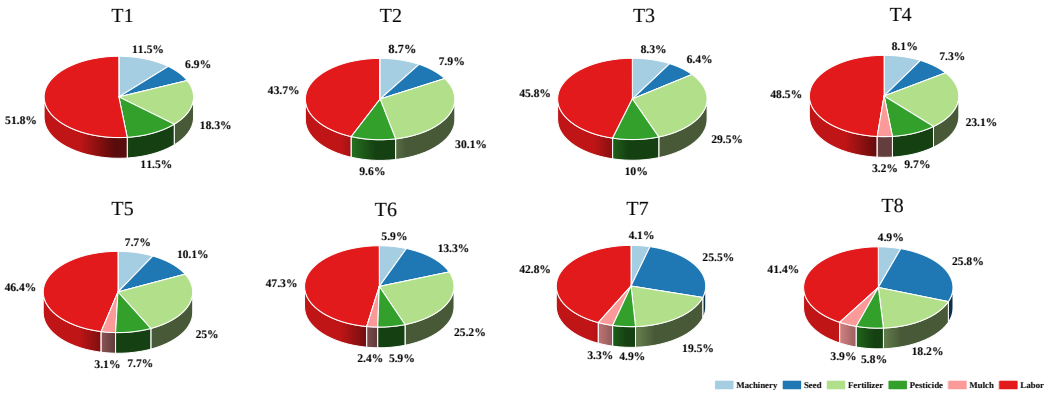

Figure S1

Cost composition ratio of different planting modes. Traditional Double Cropping System :T1, oilseed rape-summer soybean; T2, oilseed rape-summer maize; T3, wheat-summer maize. Traditional Triple Cropping System: T4, wheat/spring maize/summer soybean. Novel Triple Cropping System: T5, forage oilseed rape-spring maize/summer soybean; T6, forage oilseed rape-spring maize/peanut; T7, potato-spring maize/peanut; T8, potato-spring maize/summer soybean.