

Supplement:

1. Yield of switchgrass

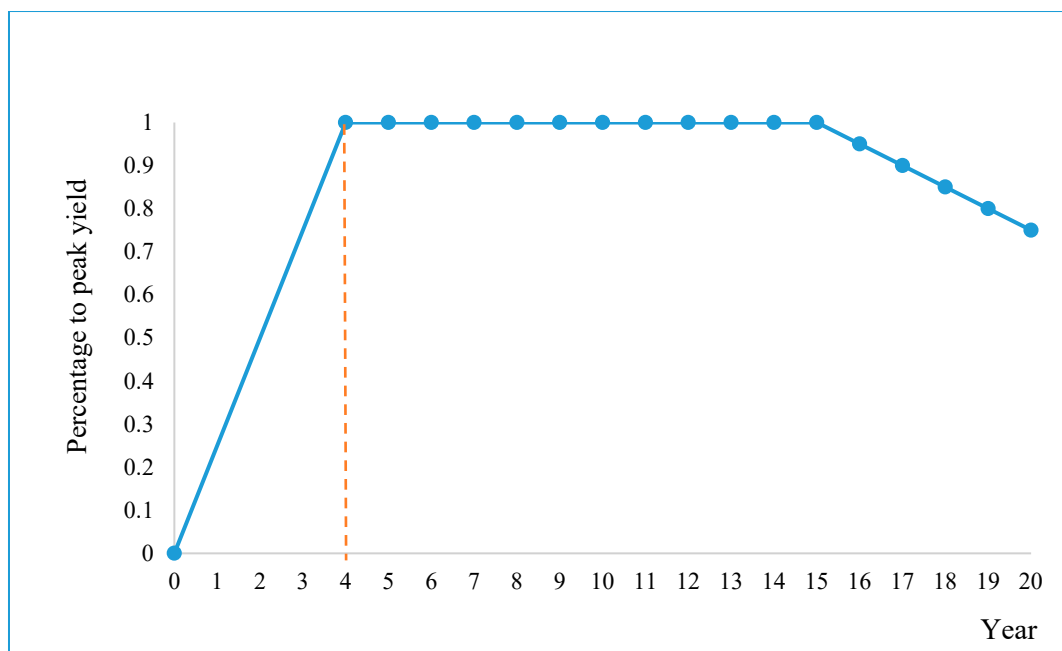


Figure S1. The dynamic yield of switchgrass during the 20-year life cycle of switchgrass. The switchgrass starts to accumulate biomass yield in the 0th year, and the yield reaches the peak in the 4th year. The peak yield remains constant until the 15th year and declines by 5% per year from the 15th year until the 20th year.

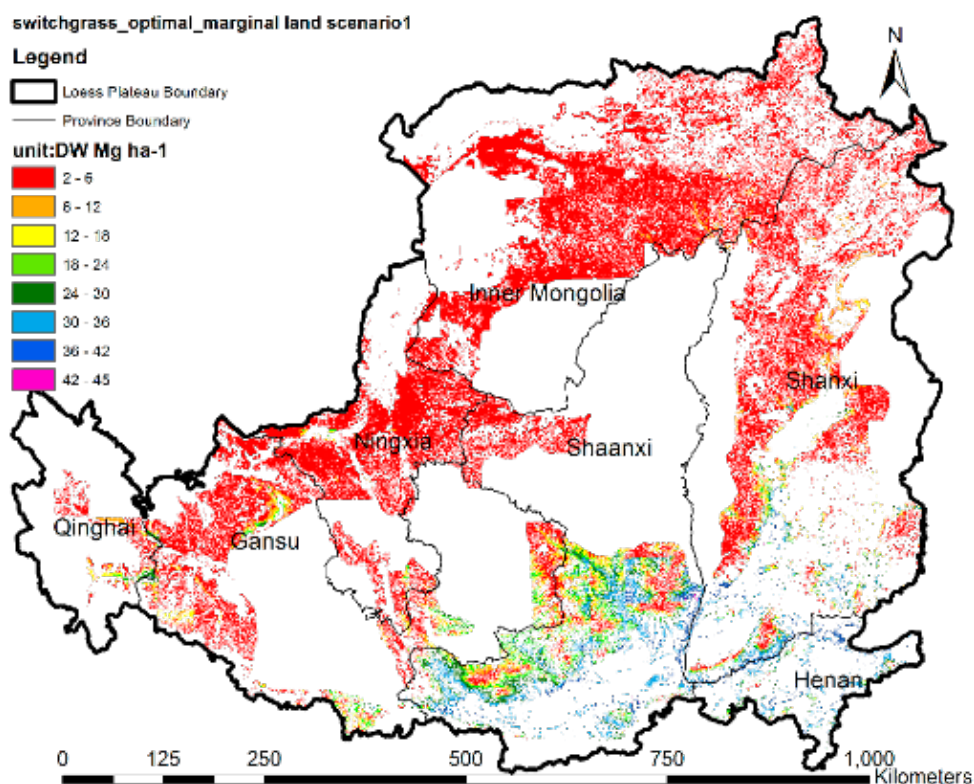


Figure S2. The spatially explicit yield of the peak yield of switchgrass on the marginal land of the Loess Plateau. The yield map was the optimal yield map derived from the research of Liu et al. [1]. In the Liu et al.'s research, the upland and lowland

switchgrass yields were estimated separately using a genotype-specific SwitchFor model and the optimal switchgrass yield distribution map was generated by comparing the upland and lowland switchgrass yields and extracting the higher yield in each 1 km² grid.

2. Land rent

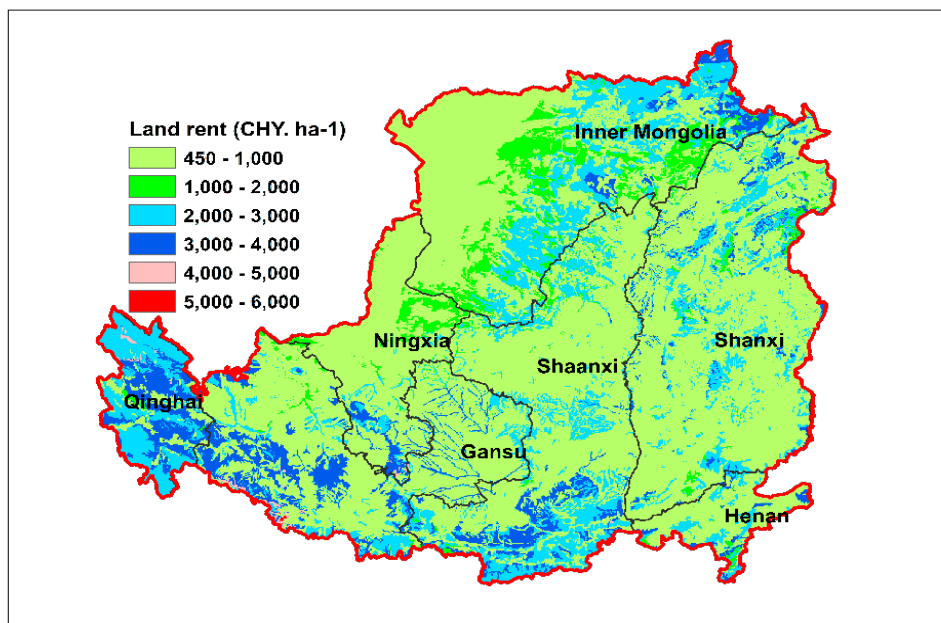


Figure S3. The spatially explicit rent of the marginal land.

3. Soil PH

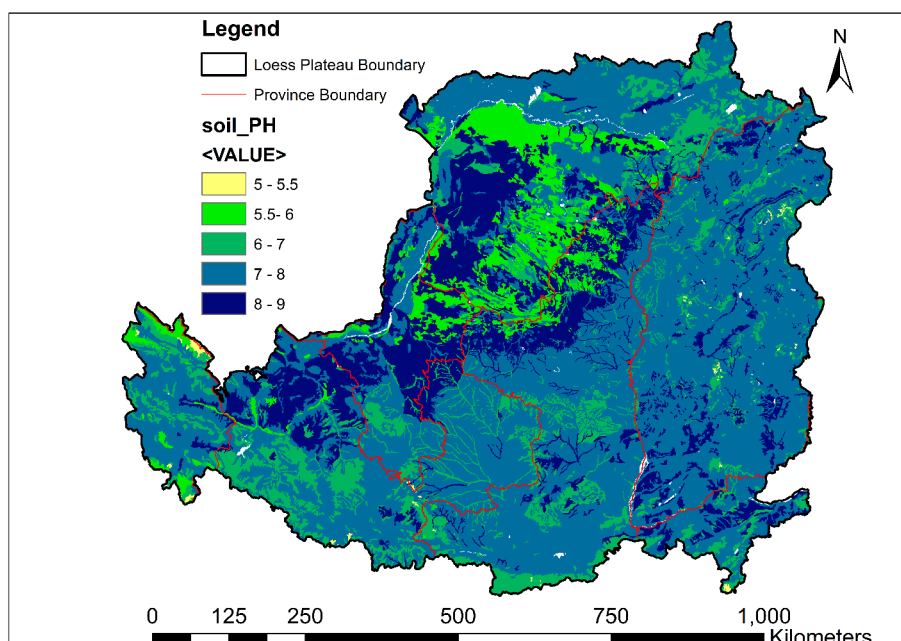


Figure S4. The spatially explicit of soil PH.

4. Soil P

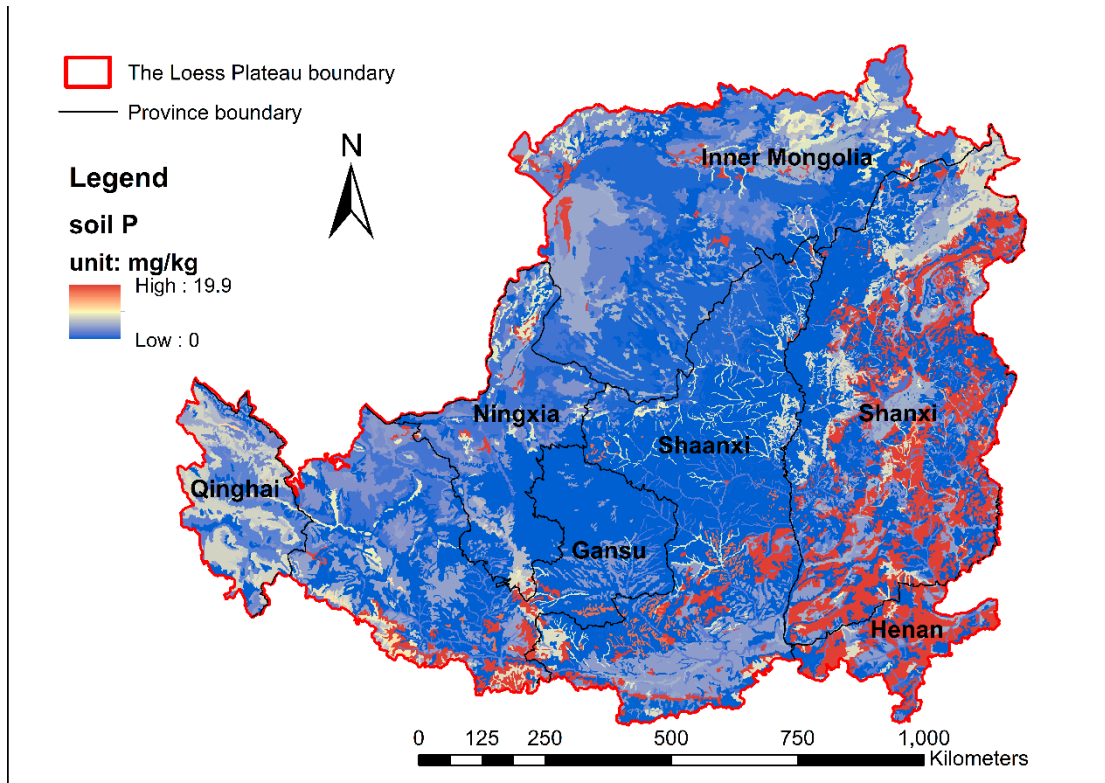


Figure S5. The spatially explicit of Soil P.

5. Soil K

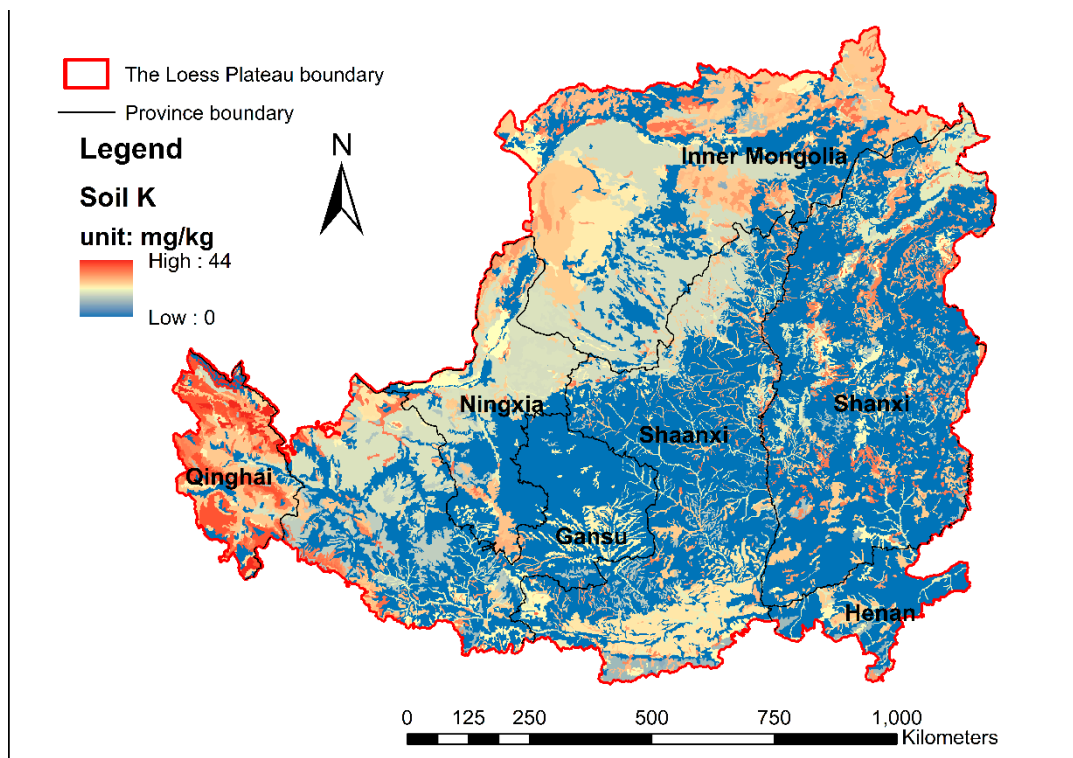


Figure S6. The spatially explicit of soil K.

6. Farm-gate feedstock production (FGFP) cost

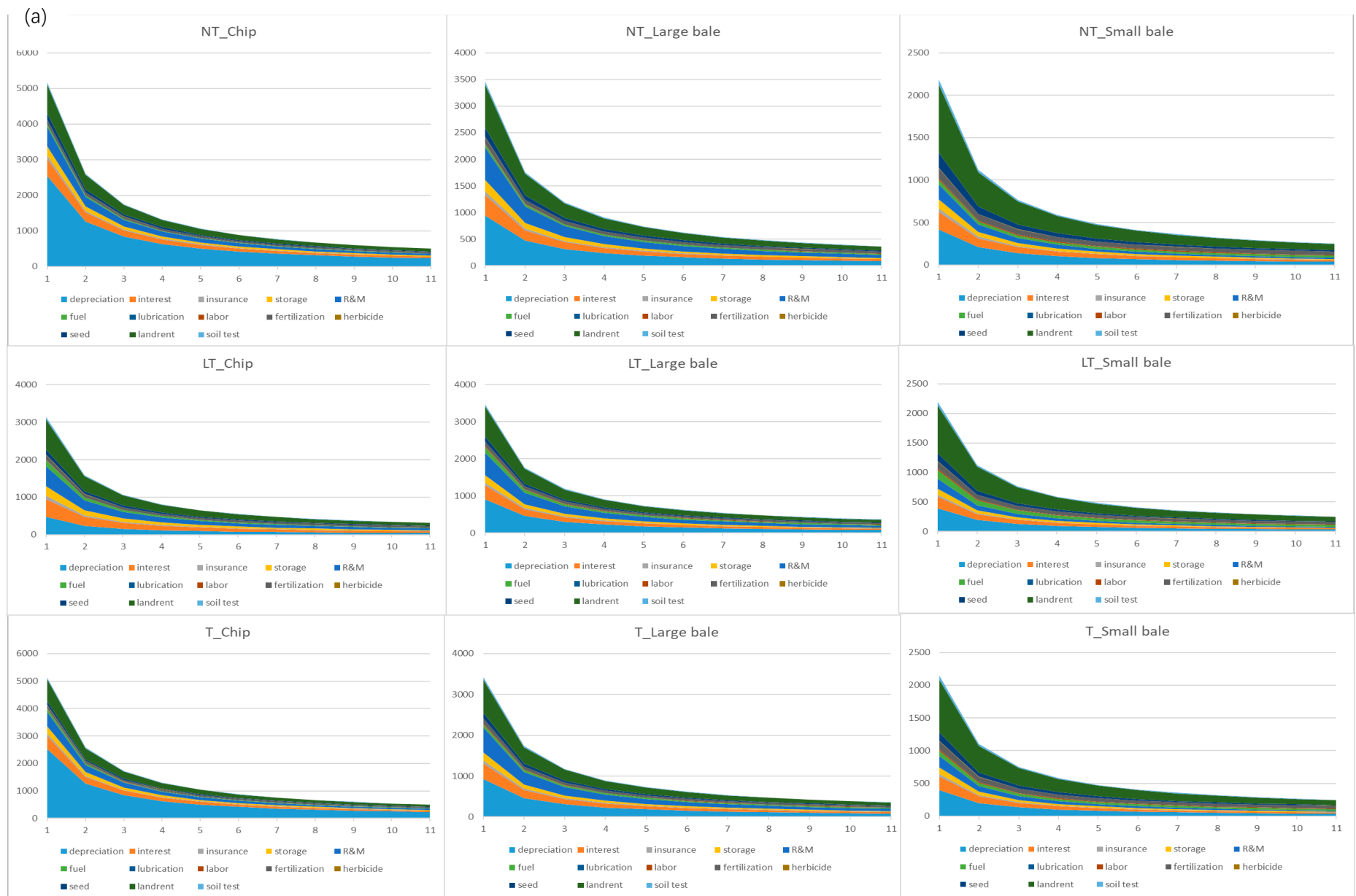




Figure S7. The cost breakdown of the switchgrass feedstock production cost. (a)Upland switchgrass; (b) Lowland switchgrass.

Cultivation method	Harvest method	Energy supply (PJ ·year ⁻¹)	Percentage (%)	Area (Mha)	Energy supply (PJ ·year ⁻¹)	Percentage (%)	Area (Mha)
		Thermal coal 2.0- 4.0 USD/GJ					
		13 CHY/GJ			26 CHY/GJ		
T	Small bale	945.6	49	2.0	1372.2	71	5.9
RT	Small bale	944.6	49	2.0	1351.1	70	5.7
NT	Small bale	945.1	49	2.0	1354.7	70	5.8
T	Large bale	809.5	42	1.5	1010.9	52	2.4
RT	Large bale	808.6	42	1.5	1010.0	52	2.4
NT	Large bale	809.2	42	1.5	1010.1	52	2.4
T	Chip	633.1	33	1.1	944.8	49	2.0
RT	Chip	629.8	33	1.1	944.7	49	2.0
NT	Chip	630.8	31	1.1	944.8	49	2.0
		Natural gas 2.2- 6.0 USD/GJ					
		14 CHY/GJ			38 CHY/GJ		
T	Small bale	971	50	2.1	1740	90	11.0
RT	Small bale	971	50	2.1	1735	90	10.9
NT	Small bale	970	50	2.1	1736	90	11.0
T	Large bale	856	44	1.7	1387	72	6.1
RT	Large bale	856	44	1.7	1382	72	6.0
NT	Large bale	855	44	1.7	1382	72	6.0
T	Chip	724	38	1.3	1016	53	2.4
RT	Chip	704	38	1.2	1015	53	2.4
NT	Chip	704	37	1.2	1015	53	2.4
		Crude oil 7.7-13.6 USD/GJ					
		50 CHY/GJ			87 CHY/GJ		

T	Small bale	1803	94	11.9	1898	98	14.3
RT	Small bale	1797	93	11.8	1897	98	14.3
NT	Small bale	1798	93	11.8	1897	98	14.3
T	Large bale	1630	85	9.1	1830	95	12.4
RT	Large bale	1629	85	9.1	1827	95	12.4
NT	Large bale	1629	85	9.1	1827	95	12.4
T	Chip	1188	62	3.9	1700	88	10.0
RT	Chip	1187	62	3.9	1697	88	10.0
NT	Chip	1187	60	3.9	1697	88	10.0
		Straw bale					
		22 CHY/GJ			28 CHY/GJ		
T	Small bale	1179	61	3.9	1410	73	6.3
RT	Small bale	1178	61	3.8	1405	73	6.2
NT	Small bale	1178	61	3.9	1405	73	6.2
T	Large bale	995	52	2.3	1047	54	2.6
RT	Large bale	982	51	2.3	1047	54	2.4
NT	Large bale	994	52	2.3	1047	54	2.4
		Straw chip					
		22 CHY/GJ			56 CHY/GJ		
T	Chip	904		1.8	964	50	3.9
RT	Chip	904		1.8	963	50	3.9
NT	Chip	904		1.8	963	50	3.9

Table S1. The energy supply on the marginal land of the Loess plateau

Reference

- [1] Y. Liu, A. Hasting, S. Chen, B. Xu, and A. P. C. Faaij, "SwitchFor: a new crop growth model for yield mapping of switchgrass," *GCB Bioenergy*, 2022.