remote sensing

MDPI

Supplementary Information

Mapping Forage Biomass and Quality of the Inner Mongolia Grasslands by Combining Field Measurements and Sentinel-2 Observations

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The SI contains Tables S1–S6 and Figures S1–S5.

Table S1. A summary of initial vegetation status and gradient-cutting experiments of all 19 grassland sites.

Site ID	Latitude (°N)	Longitude (°E)	Dominant species	Initial coverage (%)	Number of cutting	Initial yield (g m^{-2})	Initial CF (g m^{-2})	Initial CP (g m^{-2})
1	43.93	116.30	*L. chinensis*	50	5	178.8	53.2	18.4
2	43.86	116.42	*S. Krylovii*	65	6	260.6	81.6	30.3
3	43.60	116.67	*S. Krylovii & L. chinensis*	68	6	344.0	74.1	34.0
4	43.73	116.75	*S. Krylovii*	65	6	375.8	123.1	38.4
5	44.18	116.37	*L. chinensis*	65	6	324.1	89.8	39.8
6	44.18	116.37	*L. chinensis*	90	8	386.3	120.9	41.0
7	44.15	116.36	*L. chinensis*	60	7	230.2	67.2	25.7
8	44.22	116.26	*S. Krylovii*	60	7	422.0	152.1	28.9
9	44.22	116.26	*S. Krylovii*	55	7	378.9	132.1	20.6
10	44.39	116.86	*S. Krylovii & L. chinensis*	52	7	308.3	99.4	34.6
11	44.38	117.38	*S. grandis*	45	7	412.1	132.0	56.8
12	44.77	117.66	*L. chinensis*	45	6	302.2	85.7	49.1
13	44.01	115.89	*L. chinensis*	62	8	324.0	90.1	42.4
14	44.41	115.93	*S. Krylovii & L. chinensis*	55	7	438.8	148.3	31.5
15	44.61	115.85	*L. chinensis*	65	7	408.5	106.0	70.8
16	45.06	116.43	*S. Krylovii & L. chinensis*	76	7	312.5	100.5	34.3
17	44.09	116.20	*S. grandis*	53	7	757.0	211.2	53.3
18	44.27	116.55	*S. grandis*	90	7	996.4	366.1	88.5
19	44.24	116.31	*S. Krylovii*	50	7	640.9	202.6	66.4

Table S2. Spectral specifications of the Sentinel-2 MSI instrument.

Band name	Band number	Central wavelength (nm)	Bandwidth (nm)	Wavelength (nm)	
Blue	2	490	65	458	523
Green	3	560	35	543	578
Red	4	665	30	650	680
NIR	8	842	115	785	900
Red-edge-1	5	705	15	698	713
Red-edge-2	6	740	15	733	748
Red-edge-3	7	783	20	773	793
Narrow NIR	8A	842	20	832	852
SWIR-1	11	1610	90	1565	1655
SWIR-2	12	2190	180	2100	2280

Table S3. A summary of multiple regression analysis for forage biomass.

	Df	Sum square	Mean square	F value	Pr(>F)
LSWI	1	6.43	6.43	4281.7	<0.001
Site	18	2.28	0.13	84.43	<0.001
Cut	7	0.88	0.13	83.88	<0.001
LSWI:Site	18	0.19	0.01	7.08	<0.001
LSWI:Cut	7	0.14	0.002	1.30	**0.26**
Residuals	70	0.11	0.002		

Table S4. A summary of multiple regression analysis for forage CF_{area}.

	Df	Sum square	Mean square	F value	Pr(>F)
LSWI	1	5.77	5.77	2549.2	<0.001
Site	18	3.62	0.20	88.86	<0.001
Cut	7	1.25	0.18	79.17	<0.001
LSWI:Site	18	0.24	0.01	5.97	<0.001
LSWI:Cut	7	0.01	0.002	0.67	**0.70**
Residuals	70	0.16	0.002		

Table S5. A summary of multiple regression analysis for forage CP_{area}.

	Df	Sum square	Mean square	F value	Pr(>F)
LSWI	1	7.23	7.23	5381.8	<0.001
Site	18	1.36	0.08	56.27	<0.001
Cut	7	0.62	0.09	65.92	<0.001
LSWI:Site	18	0.21	0.01	8.63	<0.001
LSWI:Cut	7	0.13	0.002	1.4	**0.21**
Residuals	70	0.09	0.001		

Table S6. Livestock carrying capacity (AU per ha) estimated using forage biomass (DM), crude protein (CP), and the metabolizable energy (ME) respectively. AU refers to a national standard sheep with a mass of 50 kg which consumes 1400g of dry matter (forage biomass), 182g crude protein per day (reference to the national standard NY/T635-2015 and NY/T3647-2020; Ministry of Agriculture and Rural affairs of the People's Republic of China) and 18.46 MJ metabolizable energy per day [1].

	AU per day	AU per ha
DM (g)	1400	1.46
CP (g)	182	1.25
ME (MJ)	18.46	1.27

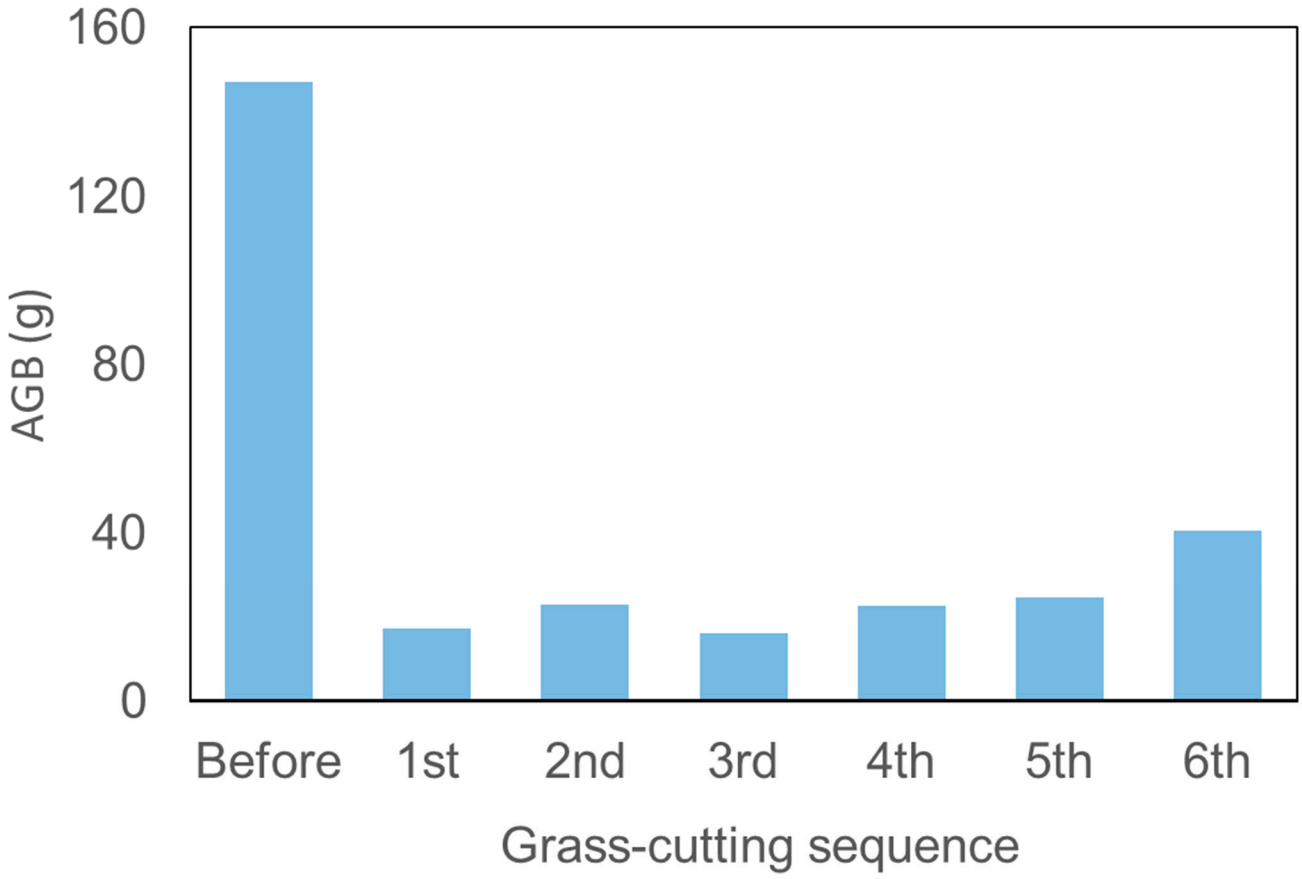

Figure S1. The amount of grass biomass (above-ground biomass, AGB) corresponding to each grass-cutting in an example quadrat.

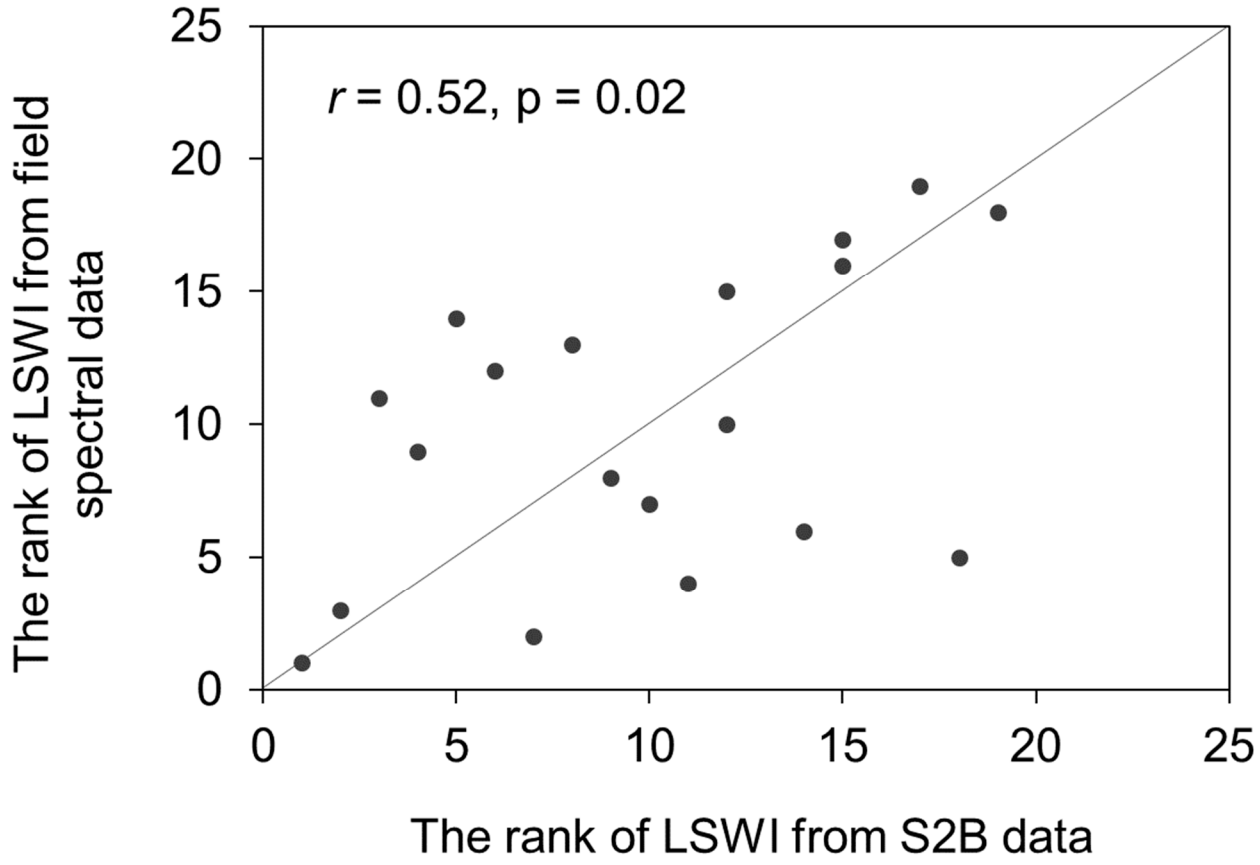

Figure S2. Correlations between LSWI retrieved from field spectral data and *in-situ* S2 dataset (2021/07/31) for 19 sampling plots.

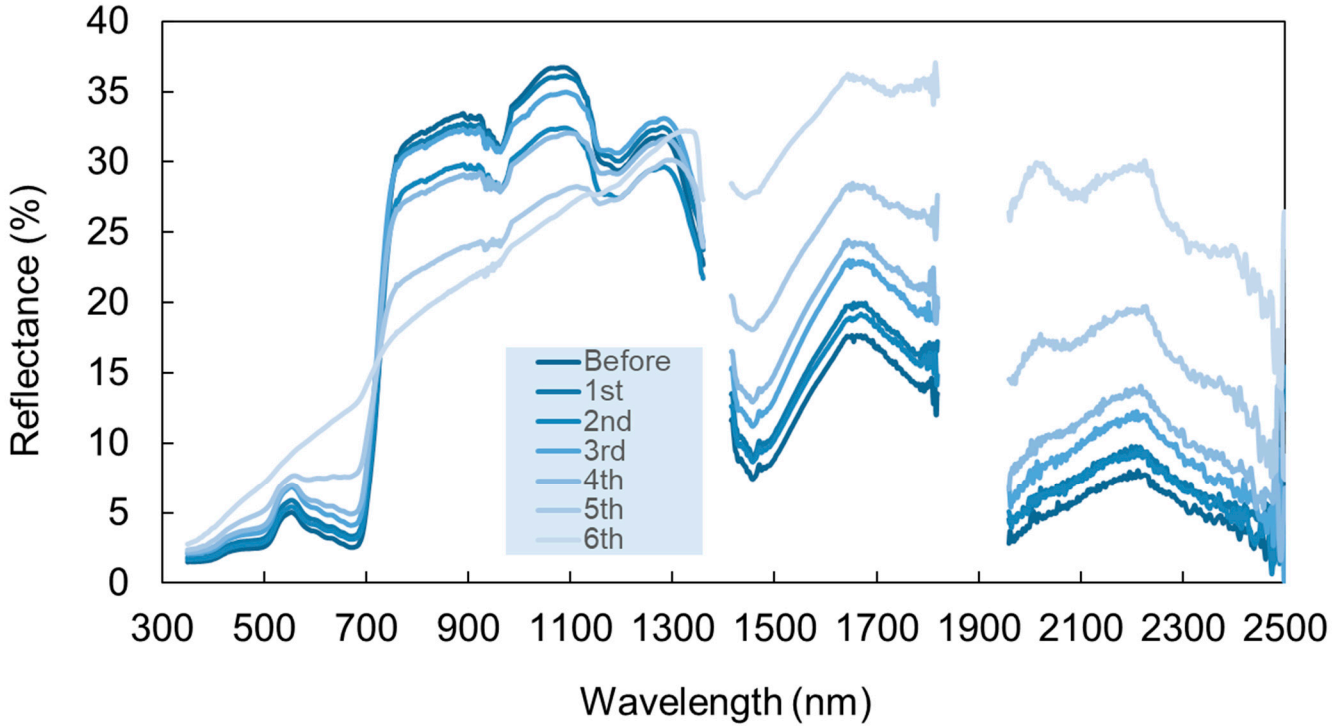

Figure S3. An example of spectral changes after each grass-cutting.

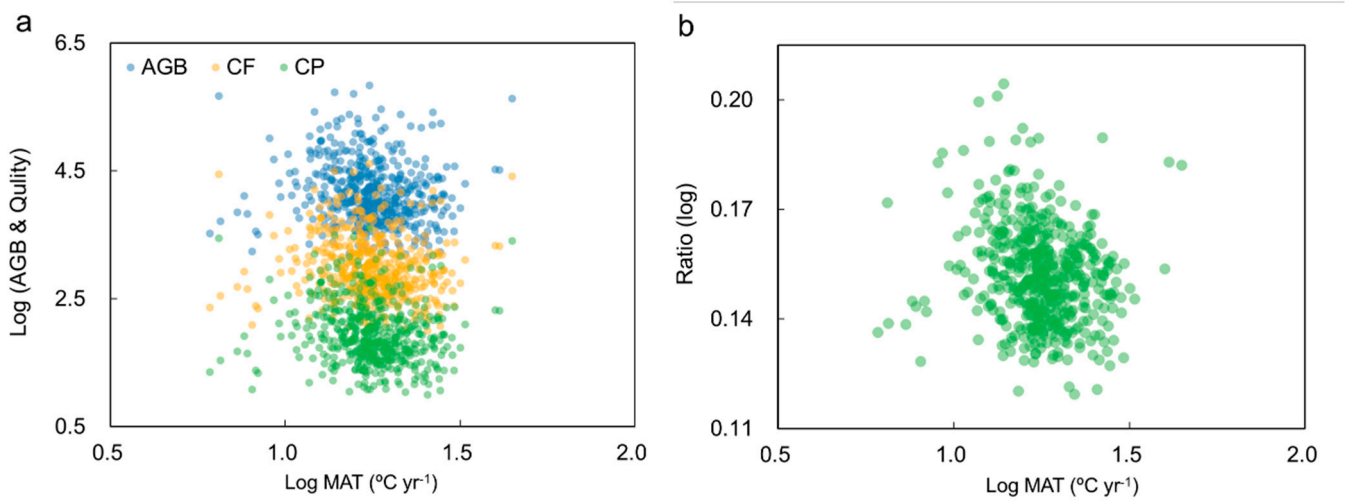

Figure S4. Changes in predicted forage biomass, CFarea and CParea (a) and the ratio between biomass based and CParea based carrying capacity (b) with mean annual temperature (MAT).

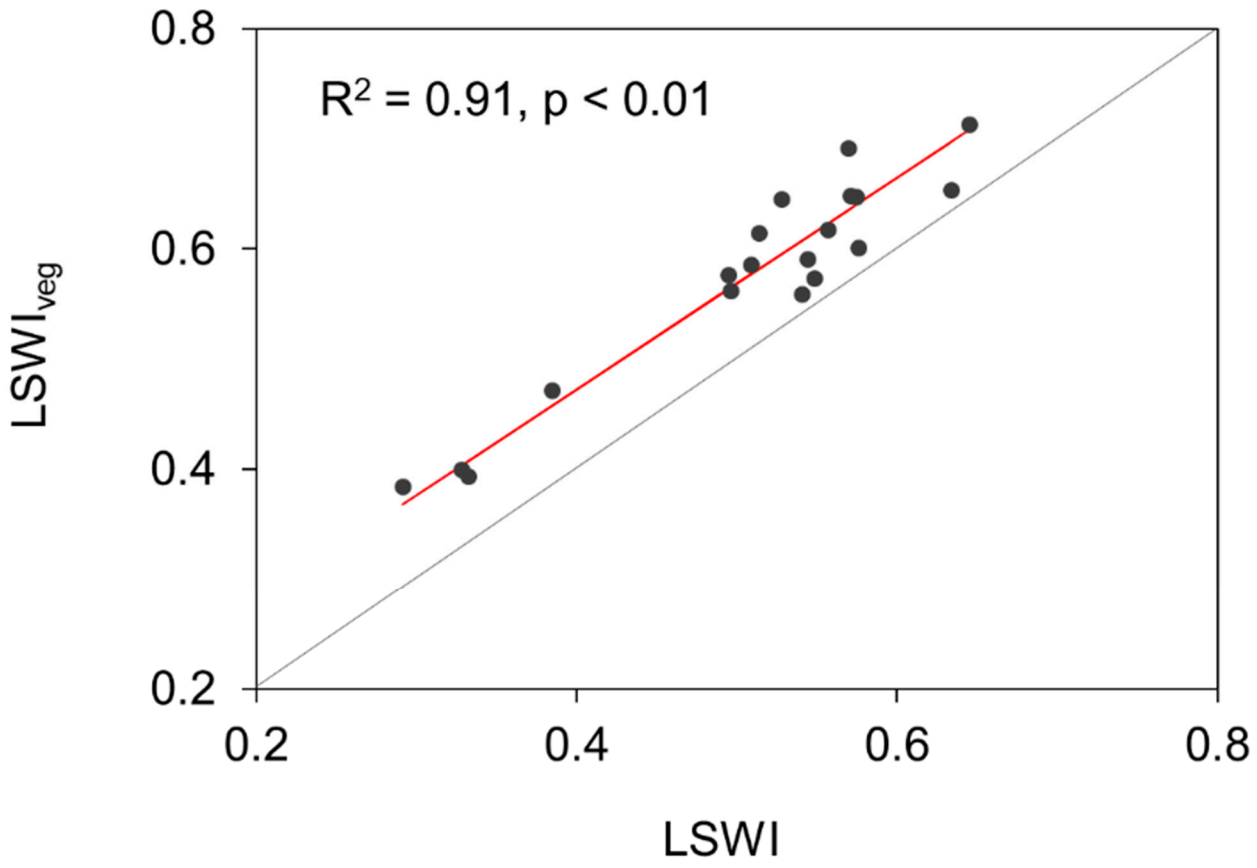

Figure S5. Correlations between LSWI retrieved from canopy reflectance with soil background (LSWI) and without soil background (LSWIveg) for 19 sampling plots.

Reference

1. Shi, Y.; Ma, Y.; Ma, W.; Liang, C.; Zhao, X.; Fang, J.; He, J. Large scale patterns of forage yield and quality across Chinese grasslands. *Chin. Sci. Bull*. **2013**, *58*, 1187–1199.