

Supplementary Information

Enhanced Wind Erosion Control by Alfalfa Grassland Compared to Conventional Crops in Northern China.

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Supplementary Methods

1. Calculation of the RWEQ model

The potential and actual wind erosion was calculated based on the RWEQ model which is a tool that is widely used to understand and manage soil erosion caused by wind (Fryrear et al., 1998; Fryrear et al., 2000). The model can be expressed as follows:

$$SLr = \frac{2z}{sr^2} \times Qr_{\max} \times e^{-\left(\frac{z}{sr}\right)^2}$$

$$Qr_{\max} = 109.8 \times (WF \times EF \times SCF \times K')$$

$$sr = 150.71 \times (WF \times EF \times SCF \times K')^{-0.3711}$$

$$SLv = \frac{2z}{sv^2} \times Qv_{\max} \times e^{-\left(\frac{z}{sv}\right)^2}$$

$$Qv_{\max} = 109.8 \times (WF \times EF \times SCF \times K' \times COG)$$

$$sv = 150.71 \times (WF \times EF \times SCF \times K' \times COG)^{-0.3711}$$

where Qr_{\max} (kg/m) and Qv_{\max} (kg/m), respectively, represent the maximum transport capacity for a given wind speed over a specific bare soil surface and vegetation cover; sr (m) and sv (m) are the critical field length. SLr (t/ha) and SLv (t/ha), respectively, indicate the amount of potential soil erosion under bare soil surface and vegetation cover. This study mainly focused on the SLv of alfalfa grassland and cropland. z (m) is the critical field length, indicating as the distance from the upwind edge of the field, which equals 50 m in this study.

1.1. Weather factor

The weather factor (WF, kg/m) was calculated by wind speed, soil wetness factor

21 (SW), and snow cover factor (SD) using the following formula:

$$22 \quad WF = \frac{\sum_{i=1}^{N_d} u_2 (u_2 - u_t)^2 \times N \times \rho}{N_d \times g} \times SW \times SD$$

$$23 \quad SW = \frac{ET_p - (R + I) \times \frac{R_d}{N}}{ET_p}$$

$$24 \quad SD = 1 - P(\text{snow depth} > 25.4 \text{ mm})$$

25 where u_2 (m/s) equals wind speed at the height of 2 m; u_t (m/s) is threshold wind
 26 speed at 2 m, assumed 5 m/s in this study; N_d is the number of wind speed
 27 observations; ρ (kg/m³) is air density; g (m/s²) is acceleration due to gravity; ET_p
 28 (mm) is the potential relative evapotranspiration; $(R + I)$ (mm) equals rainfall and
 29 irrigation; R_d is the number of precipitation and/or irrigation days; N is number of
 30 days in time period, which equals eight in this study; and P is probability of snow
 31 depth greater than 25.4 mm.

32 1.2. Soil factors

33 The erodible fraction (EF) is computed from physical and chemical soil properties. The
 34 soil crust factor (SCF) is computed from clay and organic matter content. The soil
 35 roughness factor (K') is related to the chain random roughness (cm), and soil ridge
 36 roughness (cm). The formulas are given as follows:

$$37 \quad EF = \frac{29.9 + 0.31Sa + 0.17Si + 0.33 \frac{Sa}{CL} - 2.59OM - 0.95CaCO_3}{100}$$

$$38 \quad SCF = \frac{1}{1 + 0.0066 \times CL^2 + 0.021 \times OM^2}$$

$$39 \quad K' = e^{(1.86K_r - 2.41K_r^{0.934} - 0.124C_r)}$$

where Sa (%) is the sand content; Si (%) is the silt content; $\frac{Sa}{CL}$ is sand to clay ratio; OM (%) is the organic matter content; $CaCO_3$ (%) is the calcium carbonate content; and C_{rr} is considered as 0 in this study due to the difficulty in data collection.

1.3. Vegetation and land management factors

The combined vegetation factor (COG) is determined by fractional vegetation cover which was calculated from satellite images in this study.

$$COG = e^{ai \times FCOV}$$

$$FCOV = \frac{NDVI - NDVI_{soil}}{NDVI_{veg} - NDVI_{soil}}$$

where FCOV is the fraction of surface covered with vegetation which was calculated by NDVI values; ai equals -0.1151 for alfalfa grassland and -0.0438 for cropland.

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Supplementary Tables

53 **Table S1.** Study sites and regions.

Study sites	Region 1	Region 2	Alfalfa grassland		Cropland		MAP (mm)	MAT (°C)	WS (m/s)
			Lat	Lon	Lat	Lon			
Hulunbuir	E1	C2	49.317	120.033	49.300	120.044	365	1.1	3.6
Suihua	E1	C2	46.321	126.262	46.324	126.242	784	5.5	1.7
Chifeng	E1	C3	43.529	120.369	43.681	120.411	499	8.7	1.8
Dongying	E2	C4	39.199	112.607	39.207	112.634	717	15.0	1.6
Shuozhou	E2	C4	37.219	118.202	37.370	118.278	418	8.6	1.3
Yanchi	E2	C4	38.494	106.634	38.488	106.548	206	10.3	1.4
Zhangye	E3	C3	39.092	100.125	38.278	101.462	136	9.1	2.2
Changji	E3	C3	44.486	84.122	44.490	84.142	130	9.3	2.1
Shihezi	E3	C3	44.244	86.632	44.240	86.644	97	9.7	1.8

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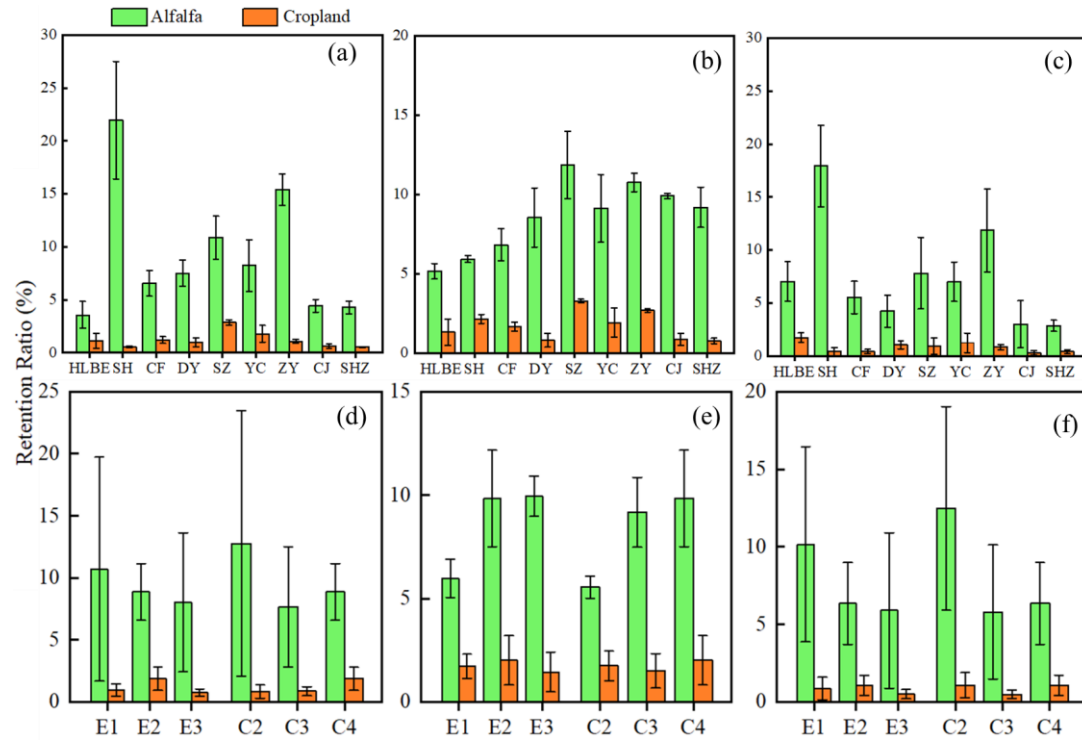
55 **Table S2.** Regional sand fixation by alfalfa grassland.

Region 1	Area ($\times 10^4$ ha)	Sand fixation by alfalfa ($\times 10^4$ t/yr)			Excess sand fixation ($\times 10^4$ t/yr)		
		Annual	Spring	Autumn	Annual	Spring	Autumn
E1	1.60	1.20	0.54	0.22	0.69	0.21	0.16
E2	10.30	13.74	9.17	0.69	6.91	4.95	0.35
E3	4.74	11.74	9.38	0.96	8.39	7.58	0.60

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Supplementary Figures



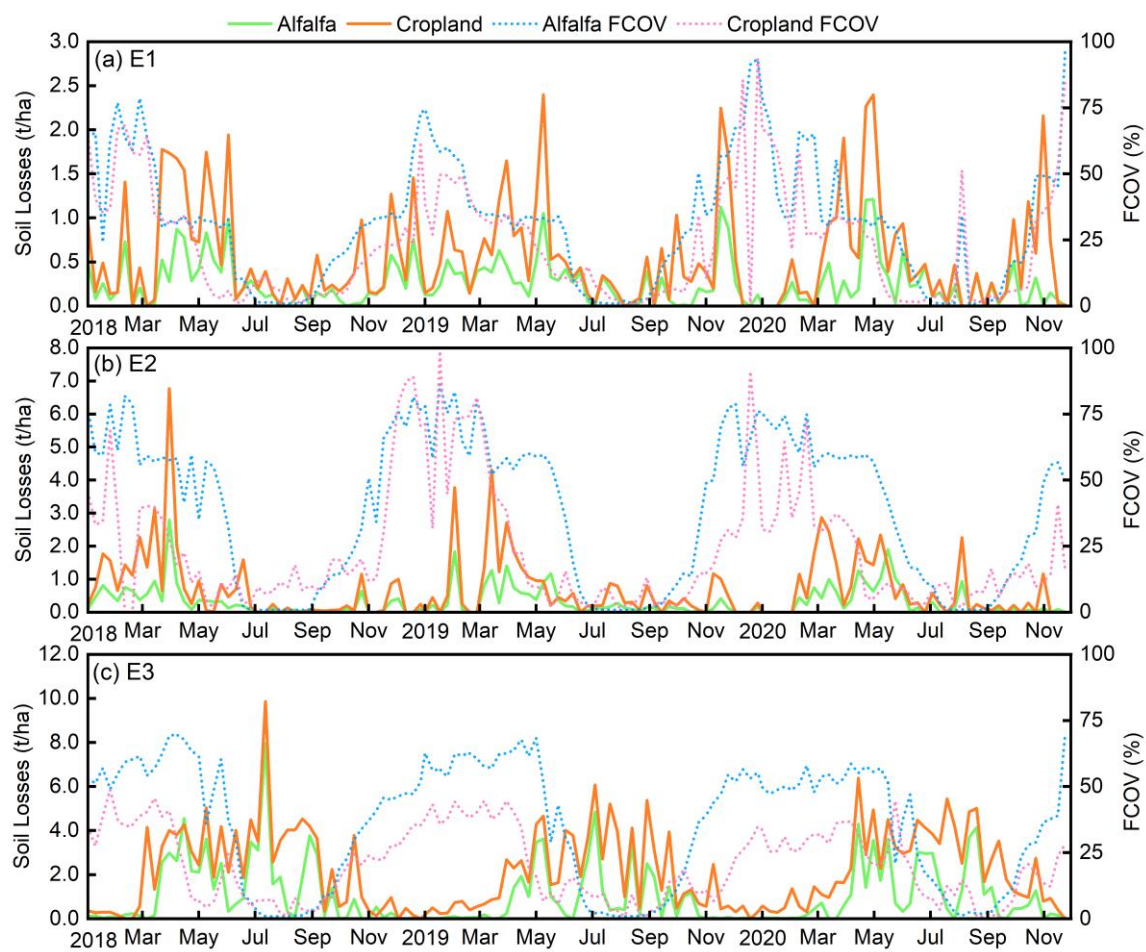
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Figure S1. Retention ratio (RR, %) of alfalfa and cropland at the study sites and different regions: annual (a, d), in spring (b, e), and in autumn (c, f).

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64 **Figure S2.** The trend of soil losses (SLv, t/ha) and FCOV per week of alfalfa grassland
 65 and cropland.

References

- Fryrear, D.W., Saleh, A., Bilbro, J.D., Schomberg, H.M., Stout, J.E., Zobeck, T.M., 1998. Revised Wind Erosion Equation. USDA, ARS, Technical Bulletin No. 1.
- Fryrear, D.W., Bilbro, J.D., Saleh, A., Schomberg, H., Stout, J.E., Zobeck, T.M., 2000. RWEQ: improved wind erosion technology. *Journal of Soil and Water Conservation*, 55(2): 183–189.