

Table S1. Soil types and physicochemical properties stratified by horizon. *WRB - World Reference Base for Soil Resources.

Soil Type (WRB ¹)	Horizon (WRB ¹)	Depth cm	Bulk Density Mg m ⁻²	> 2mm wt.-%	fine-earth mass (1m) kg m ⁻²	AWC ² vol.-%	sand wt.-% of humus-/carbonate-free fine-earth (<2mm)	silt	clay	SOC wt.-%	N _t g kg ⁻¹	CaCO ₃ wt.-%	pH 0.01M CaCl ₂	SOC (1m) kg m ⁻²	N _t (1m) g m ⁻²	AWC (1m) L m ⁻²
Calcaric Regosol (Rg-ca)	Ap	0 - 26	1,64	4	409	13	60	28	12	0,51	0,62	9,9	7,5	2,1	254	34
	Ck	-48	1,66	5	347	13	61	27	12	0,10	0,15	11,7	7,7	0,3	52	29
	CBkl	-85	1,86	4	661	12	61	27	12	0,10	0,19	11,7	7,7	0,7	126	44
	Bkl	-200	1,84	3	268	12	61	26	13	0,10	0,15	11,8	7,7	0,3	40	18
														3,4	472	125
Nudiargic Luvisol (LV-ng)	Ap	0-30	1,66	3	483	15	59	28	13	0,88	0,80	0,0	7,0	4,3	386	45
	Bt	-50	1,74	3	338	9	55	27	19	0,37	0,35	0,0	7,2	1,3	118	18
	Ck	-105	1,79	4	516	12	59	26	15	0,10	0,18	8,8	7,7	0,5	93	60
	CBkl	-175	1,87	4	-	-	61	26	13	0,10	0,14	11,1	7,7	6,0	598	123
Calcic Luvisol (LV-cc)	Ap	0 - 30	1,63	3	489	16	59	32	9	0,78	0,77	0,0	5,5	3,8	378	48
	E	-45	1,79	2	263	12	51	39	10	0,30	0,28	0,0	6,2	0,8	74	18
	Bt	-100	1,76	2	949	9	50	31	19	0,29	0,28	0,0	6,8	2,8	261	50
	Ck	-200	1,79	3	-	-	53	34	13	0,10	0,12	12,2	7,5	7,4	713	116
Gleyic-Colluvic Regosol (Rg-co.gl) 50m to the S and 1m higher in terrain compared to Rg-co.gl in Fig.1	Ap	0 - 30	1,62	2	486	18	63	27	10	0,90	0,90	0,0	5,1	4,4	437	54
	Ab	-67	1,62	2	587	10	59	30	11	0,44	0,48	0,0	5,9	2,6	282	37
	2Ab	-107	1,65	3	528	12	57	28	15	0,56	0,60	0,0	6,4	3,0	317	40
	Btl	-140	1,81	1	-	-	57	24	19	0,17	0,33	0,0	7,1	9,9	1036	131

¹ WRB - World Reference Base for Soil Resources (IUSS, 2006) ² Available Water Capacity (pF2.0 - pF4.2)

Table S2. Simulation results of various soil water content scenarios across different soil erosion gradients.

	Soil water [cm ³ cm ⁻³]	RG-ca	Lv-ng	Lv-cc	Rg-co.gl
Ostpreußischer			Root biomass [g m ⁻²]		
	18.5	208	354	345	279
	21.5	171	357	345	273
	24.3	202	363	350	284
	27	213	363	362	297
	30	219	366	366	306
slope linear regression		2.2	1.1	2.1	2.7
Hadmerslebener	18.5	185	289	330	215
	21.5	181	291	334	211
	24.3	210	292	340	229
	27	252	362	419	293
	30	266	381	418	311
slope linear regression		8.3	8.9	9.1	9.6
Ponticus	18.5	182	320	315	223
	21.5	168	322	317	219
	24.3	198	321	319	226
	27	220	340	350	259
	30	229	346	352	274
slope linear regression		5.1	2.4	3.8	5

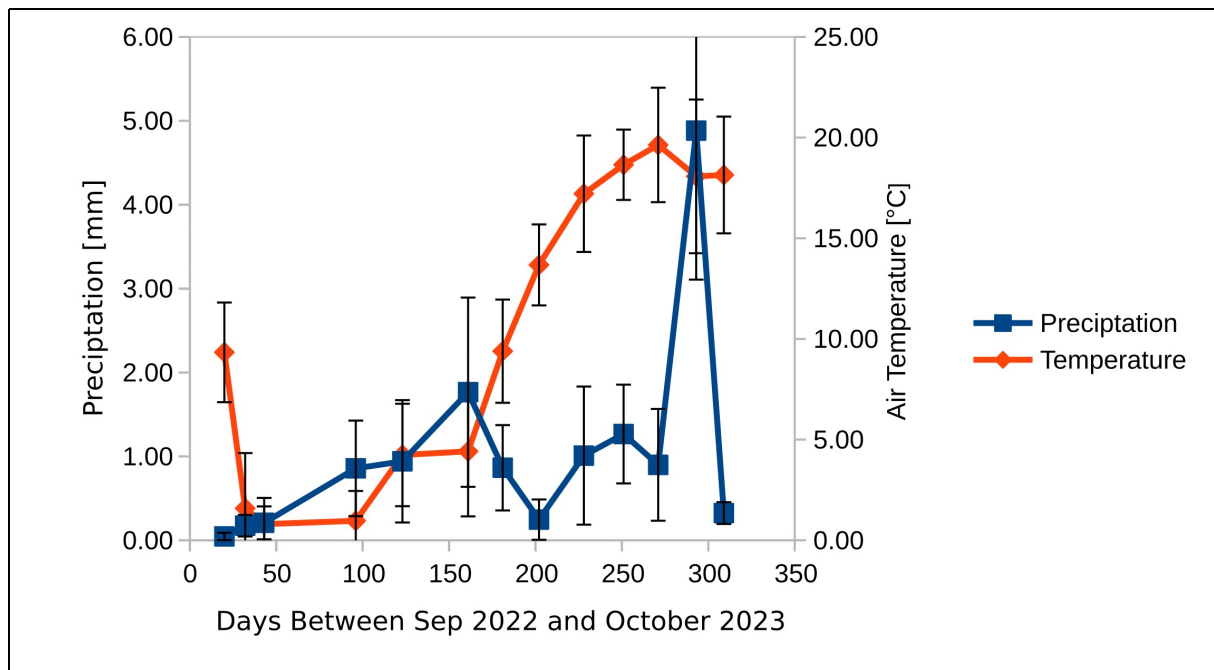


Figure S1. Precipitation and air temperature from September 2022 to October 2023.

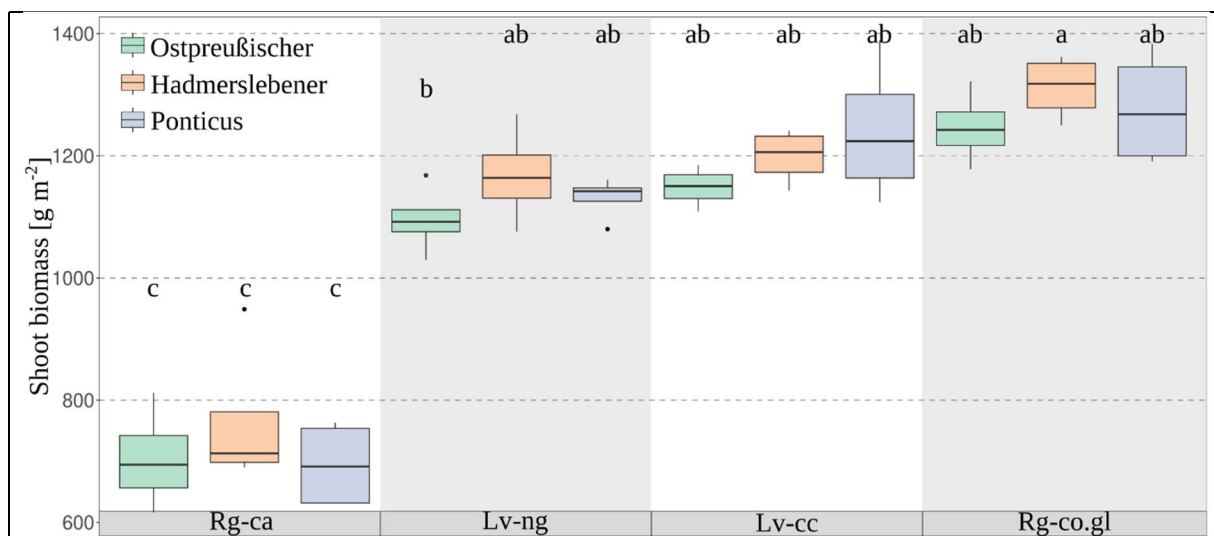


Figure S2. Shoot biomass (g m^{-2}) of three wheat cultivars (Ostpreußischer, Hadmerslebener, and Ponticus) under different soil erosional status: Calacric Regosol (RG-ca), Nudiargic Luvisol (LV-ng), Calcic Luvisol (LV-cc) and Gleyic-Colluvic Regosol (RG-co.gl). The letters above the boxplots indicate significant differences in grain yield between treatments ($p < 0.05$), based on post-hoc tests.

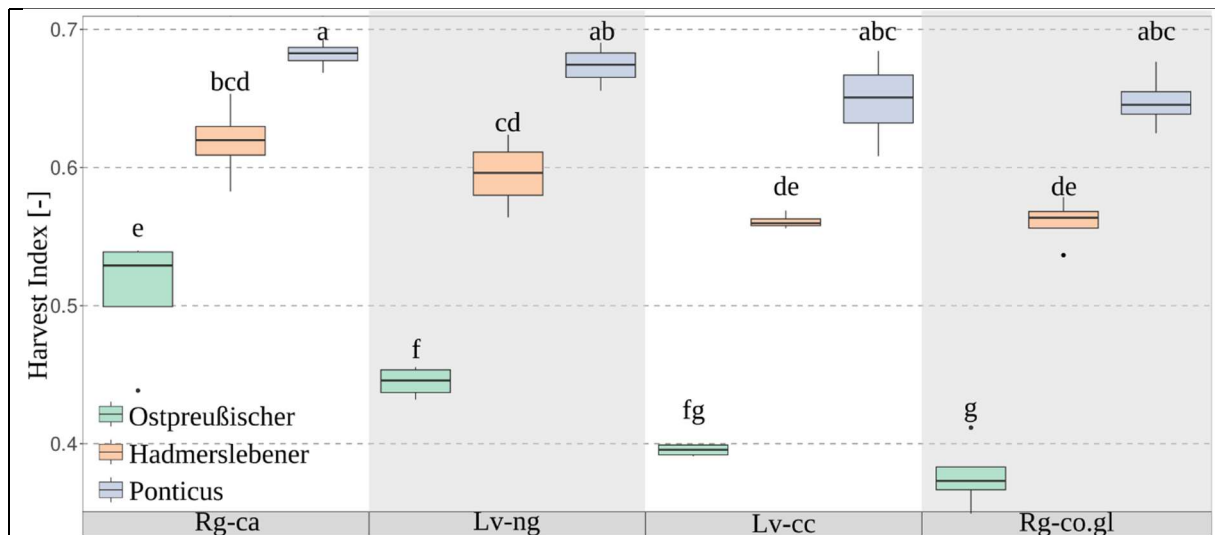


Figure S3. Harvest index (-) of three wheat cultivars (Ostpreußischer, Hadmerslebener, and Ponticus) under different soil erosional status: Calacric Regosol (RG-ca), Nudiargic Luvisol (LV-ng), Calcic Luvisol (LV-cc) and Gleyic-Colluvic Regosol (RG-co.gl). The letters above the boxplots indicate significant differences in grain yield between treatments ($p < 0.05$), based on post-hoc tests.

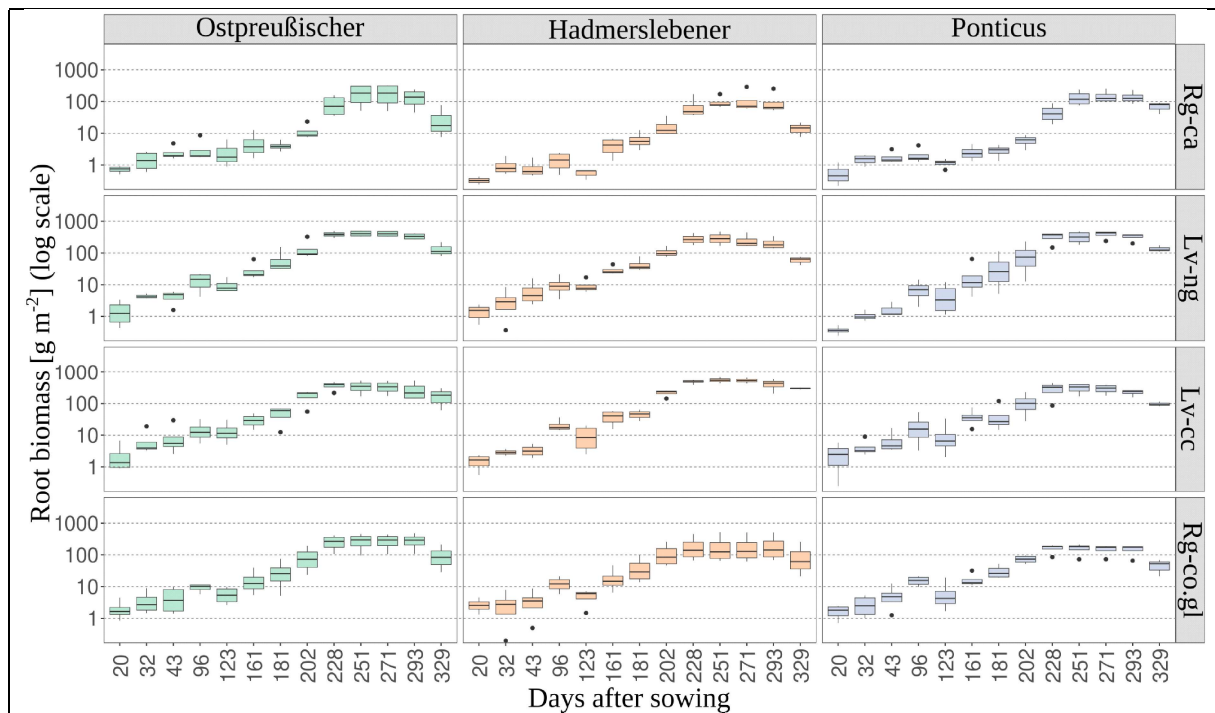


Figure S4. Crop season root biomass (g m^{-2}) evolution for the three wheat cultivars (Ostpreußischer, Hadmerslebener, and Ponticus) under different soil erosion-deposition gradient: Calacric Regosol (RG-ca), Nudiargic Luvisol (LV-ng), Calcic Luvisol (LV-cc) and Gleyic-Colluvic Regosol (RG-co.gl).

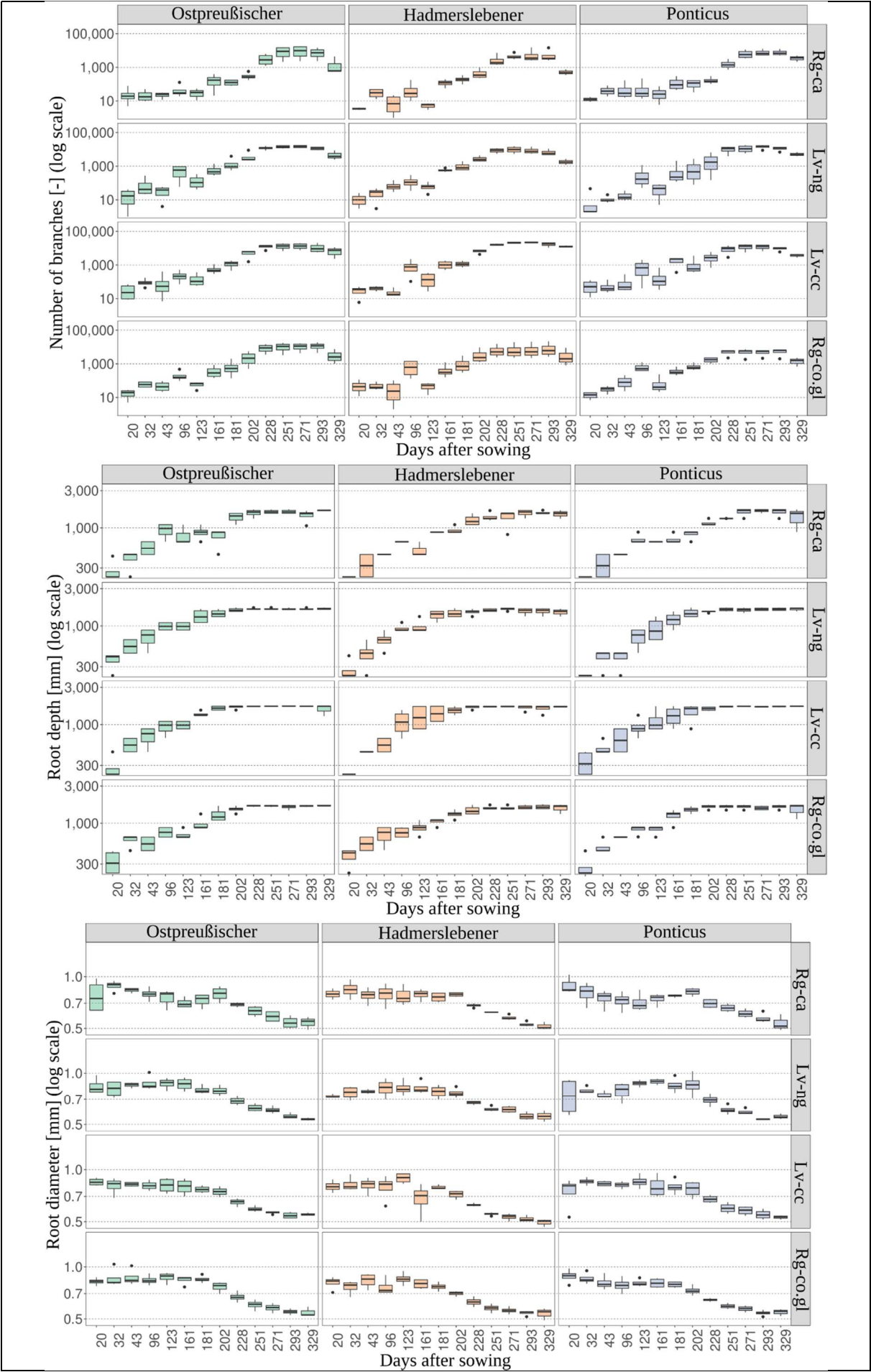


Figure S5. Number of root branches (-), root depth (mm) and root diameter (mm) evolution for the three wheat cultivars (Ostpreußischer, Hadmerslebener, and Ponticus) under different soil erosional status: Calacric Regosol (RG-ca), Nudiargic Luvisol (LV-ng), Calcic Luvisol (LV-cc) and Gleyic-Colluvic Regosol (RG-co.gl). The letters above the boxplots indicate significant differences in grain yield between treatments ($p < 0.05$), based on post-hoc tests.

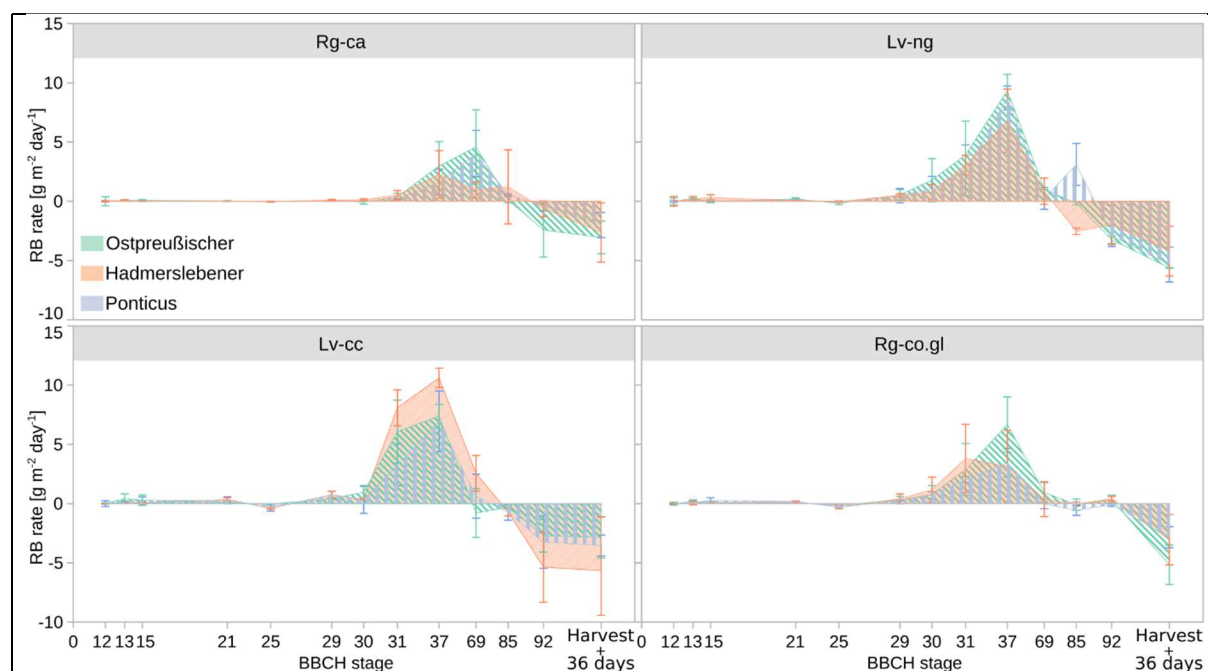


Figure S6. Root biomass rate ($\text{g m}^{-2} \text{ day}^{-1}$) and standard error for the entire crop season for the three wheat cultivars (Ostpreußischer, Hadmerslebener, and Ponticus) under different soil erosional status: Calacric Regosol (RG-ca), Nudiargic Luvisol (LV-ng), Calcic Luvisol (LV-cc) and Gleyic-Colluvic Regosol (RG-co.gl).

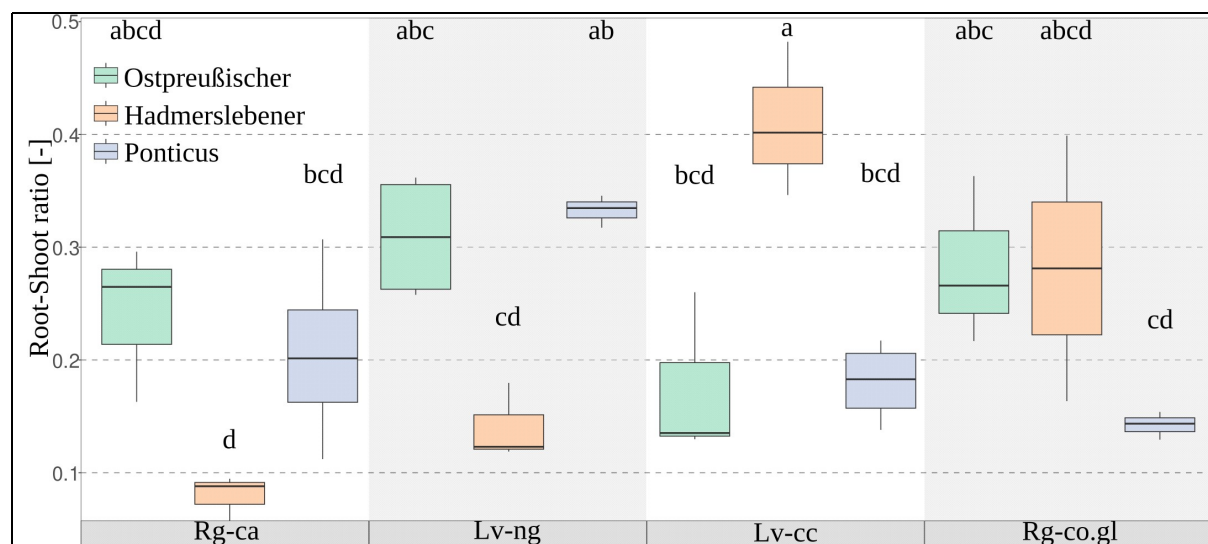


Figure S7. Root-shoot ratio (-) of three wheat cultivars (Ostpreußischer, Hadmerslebener, and Ponticus) under different soil erosion-deposition gradient: Calacric Regosol (RG-ca), Nudiargic Luvisol (LV-ng), Calcic Luvisol (LV-cc) and Gleyic-Colluvic Regosol (RG-co.gl). The letters above the boxplots indicate significant differences in grain yield between treatments ($p < 0.05$), based on post-hoc tests.

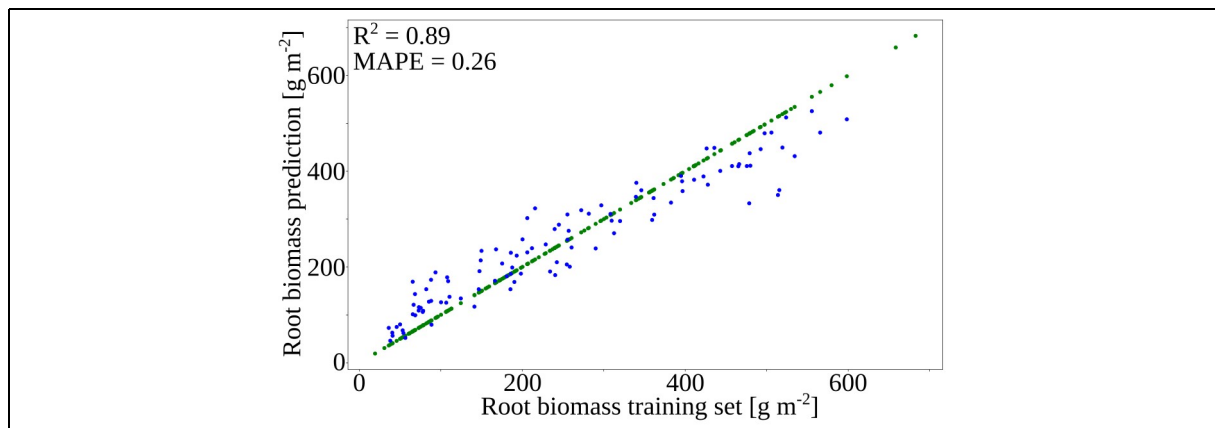


Figure S8. Metrics of supervised machine learning random forest (RF) meta-estimator (mean absolute percentage error (MAPE)).