Supplementary material

Table S1. Mean values and standard error of the means of einkorn, emmer and rivet entries in 2016/17 and 2017/18. Cover at GS31 = crop canopy cover at the onset of stem extension; Foliar diseases = severity of foliar diseases at full anthesis (BBCH GS65); Height = canopy height after full anthesis. LSD = Tukey's honestly significant difference based on linear model accounting for the effect of entry over the variable of interest.

	Cover at GS31 (%)		Foliar diseases (%)		Height (cm)		Ear density (ears/m^2)		Grain yield (t/ha)	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Einkorn										
COL 112	39.0 ± 4.5	32.0 ± 6.6	1.0 ± 0.2	4.0 ± 0.5	87.3 ± 3.5	130.1 ± 1.5	309.6 ± 55.9	404.3 ± 32.7	1.21 ± 0.17	3.47 ± 0.30
Einkorn CCP	35.0 ± 2.5	30.0 ± 7.5	2.0 ± 0.3	4.0 ± 0.3	94.5 ± 1.9	132.0 ± 4.2	332.7 ± 24.9	401.1 ± 68.0	1.06 ± 0.15	3.32 ± 0.15
Mv Alkor	60.0 ± 3.5	28.0 ± 6.3	2.0 ± 0.4	5.0 ± 0.6	103.2 ± 0.6	114.7 ± 7.5	440.4 ± 22.5	416.7 ± 69.1	1.76 ± 0.09	3.12 ± 0.19
Mv Menket	35.0 ± 2.5	18.0 ± 3.1	1.0 ± 0.4	5.0 ± 4.2	66.8 ± 1.1	84.0 ± 6.7	228.9 ± 34.1	320.0 ± 78.4	0.67 ± 0.12	2.23 ± 0.46
Nödik Alakor	68.0 ± 2.6	25.0 ± 6.1	2.0 ± 0.4	17.0 ± 2.5	103.1 ± 5.6	113.3 ± 4.6	436.5 ± 24.1	460.0 ± 77.6	1.72 ± 0.11	3.52 ± 0.42
LSD	*16.0*	*32.0*	*2.0*	*6.0*	*4.4*	*4.8*	*174.6*	*331.7*	*0.66*	*1.35*
Mean Sq Error	*0.53*	*1.45*	*5.7e^{-3}*	*0.05*	*18.7*	*3.19*	*6390.8*	*15237.3*	*0.0911*	*0.25*
Emmer										
Mv Heyges	26.7 ± 3.5	45.0 ± 2.0	34.5 ± 3.5	7.5 ± 5.0	88.5 ± 5.6	132.7 ± 2.6	130.8 ± 29.4	243.3 ± 13.4	0.57 ± 0.07	2.13 ± 0.04
Nödik Tonke	36.7 ± 2.9	45.0 ± 2.4	35.0 ± 2.9	27.4 ± 3.1	99.2 ± 3.8	124.2 ± 2.7	170.3 ± 29.1	249.9 ± 20.7	0.67 ± 0.07	2.87 ± 0.49
Weisser	30.0 ± 0.0	47.0 ± 4.1	37.0 ± 7.4	14.6 ± 4.4	91.9 ± 11.8	131.7 ± 1.3	148.2 ± 9.3	167.8 ± 24.4	0.60 ± 0.09	1.72 ± 0.30
LSD	*9.3*	*13.0*	*13.0*	*16.4*	*16.5*	*6.4*	*102.9*	*107.1*	*0.32*	*1.62*
Mean Sq Error	*0.14*	*0.28*	*0.27*	*0.43*	*43.59*	*6.49*	*1688.6*	*1827.1*	*0.016*	*0.42*
Rivet										
Gigante LN	30.0 *(n.a.)*	50.0 ± 9.0	8.0 *(n.a.)*	3.4 ± 0.3	139 *(n.a.)*	133.1 ± 2.1	*n.a.*	187.8 ± 26.1	0.85 *(n.a.)*	2.28 ± 0.32
Blue Cone	55.0 ± 9.2	67.0 ± 6.3	6.5 ± 1.6	2.0 ± 0.2	105.1 ± 8.8	137.6 ± 2.6	*n.a.*	253.3 ± 29.2	0.98 ± 0.22	2.89 ± 0.15
Rampton	27.0 ± 2.1	62.0 ± 4.9	5.3 ± 0.8	2.3 ± 0.2	78.5 ± 2.8	141.3 ± 2.7	*n.a.*	178.9 ± 20.0	0.45 ± 0.12	3.56 ± 0.57
LSD	*n.a.*	*32.0*	*n.a.*	*1.2*	*n.a.*	*13.6*	*n.a.*	*114.5*	*n.a.*	*2.03*
Mean Sq Error	*0.30*	*1.66*	*0.06*	*2.4e^{-3}*	*64.91*	*29.38*		*2087.7*	*0.086*	*0.66*

Table S2. Linear mixed-effect model analysis of the effect of rotational position (Field), tillage system, entry, field-by-entry and field-by-tillage interaction over agronomic parameters in 2017-18 for einkorn, emmer and rivet wheat. (Cover at GS22 = canopy cover during tillering; Cover at GS31 = canopy cover at the onset of stem extension). Chi-square (X^2) and p-values are obtained through the likelihood ratio test between models with and without the effect of interest. Individual fixed effects were progressively added in the other they appear.

Variable		Fixed effects				
		Field	Tillage	Entry	Field-by-Entry	Tillage-by-Entry
Einkorn	(d.f.)	(1)	(1)	(3)	(3)	(3)
Cover at GS22	X^2	6.419	1.886	19.252	4.420	0.914
	p-value	0.0113*	0.1697	2.00E-04***	0.2196	0.822
Cover at GS31	X^2	7.172	10.631	4.991	1.343	6.120
	p-value	0.0074**	0.0011**	0.1725	0.7189	0.1059
Height at maturity	X^2	1.748	2.873	14.675	0.889	4.160
	p-value	0.1861	0.0901	2.10E-03***	0.8281	0.2447
Ear density	X^2	6.585	3.209	4.190	6.433	3.096
	p-value	0.0103*	0.07325	0.24	0.0924	0.377
Diseases severity (sqrt)	X^2	5.906	0.125	3.635	4.450	5.680
	p-value	0.0151*	0.7233	0.3037	0.2168	0.1283
Grain Yield	X^2	2.296	1.678	1.628	1.735	7.181
	p-value	0.1297	0.1952	0.6534	0.6291	0.0664
Emmer	(d.f.)	(1)	(1)	(2)	(2)	(2)
Cover during tillering	X^2	0.004	2.544	1.646	4.090	16.140
	p-value	0.9488	0.1107	4.39E-01***	0.1294	0.0003
Cover at GS31	X^2	0.894	0.346	11.403	3.181	0.229
	p-value	0.3602	0.5567	0.0033**	0.2039	0.8917
Height at maturity	X^2	81.910	4.051	16.929	0.347	1.436
	p-value	2.20E-16***	0.0442	2.00E-04***	0.8405	0.187
Ear density	X^2	1.292	0.090	4.359	1.001	1.668
	p-value	0.2557	0.7643	0.11	0.606	0.4342
Diseases severity (sqrt)	X^2	4.769	2.129	0.206	1.206	0.588
	p-value	0.0289*	0.1445	0.9020	0.5470	0.7450
Grain Yield	X^2	0.437	0.340	1.067	2.438	2.896
	p-value	0.5088	0.5600	0.5860	0.2950	0.2350
Rivet	(d.f.)	(1)	(1)	(2)	(2)	(2)
Cover during tillering	X^2	0.024	4.495	3.613	0.215	0.662
	p-value	0.8773	0.0340*	0.1643	0.8982	0.7181
Cover at GS31	X^2	3.330	0.268	8.388	0.172	3.527
	p-value	0.0680	0.6047	0.0151*	0.9178	0.1710
Height at maturity	X^2	1.943	2.072	2.245	1.807	10.625
	p-value	0.1634	0.1500	0.3250	0.4050	0.0049**
Ear density	X^2	1.546	2.446	6.505	0.022	0.602
	p-value	0.2167	0.1178	0.0387*	0.9890	0.7402

Diseases severity (sqrt)	X²	2.618	0.101	15.237	0.605	13.462
	p-value	0.1056	0.7505	0.0005***	0.7390	0.0012**
Grain Yield	X²	2.046	0.345	0.410	1.449	6.357
	p-value	0.1527	0.5570	0.8147	0.4850	0.0417*

(sqrt) = values are square-root transformed to better fit with normality and homoscedasticity conditions

Table S3. Linear mixed-effect model analysis of the effect of rotational position (Field), tillage system, entry, field-by-entry and field-by-tillage interaction over grain quality parameters in 2017/18 for einkorn, emmer and rivet wheat. Chi-square (X²) and p-values are obtained through the likelihood ratio test between models with and without the effect of interest. Individual fixed effects were progressively added in the other they appear.

Variable		Field	Tillage	Entry	Field-by-Entry	Tillage-by-Entry
						Fixed effects
Einkorn	(d.f.)	(1)	(1)	(3)	(3)	(3)
Protein content	X^2	13.82	1.85	4.42	1.09	4.04
	p-value	0.0002***	0.1736	0.2199	0.7794	0.1272
Total dietary fibre	X^2	1.32	0.83	13.50	1.89	3.37
	p-value	0.2507	0.3223	0.0037**	0.5948	0.3377
Fat content	X^2	6.45	0.12	5.36	6.39	6.20
	p-value	0.0111*	0.7322	0.1474	0.0939	0.1023
Total Polyphenols	X^2	20.66	0.21	7.34	5.46	6.84
	p-value	5.47E-06***	0.6470	0.0619	0.1410	0.0770
Total Flavonoids	X^2	3.06	6.33	5.24	9.72	4.54
	p-value	0.0804	0.0119*	0.1553	0.0211*	0.2088
FRAP	X^2	21.96	1.93	2.89	6.09	18.00
	p-value	2.77E-06***	0.1649	0.4091	0.1072	0.0004***
DPPH	X^2	12.29	1.46	9.02	5.07	2.13
	p-value	0.0005***	0.2271	0.0290*	0.1666	0.5463
Emmer	(d.f.)	(1)	(1)	(2)	(2)	(2)
Protein content	X^2	2.090	5.411	8.997	7.327	1.455
	p-value	0.1483	0.0200*	0.0111*	0.0256*	0.4831
Total dietary fibre	X^2	0.628	0.006	3.045	9.493	6.908
	p-value	0.4282	0.9404	0.2180	0.0087**	0.0316*
Fat content (sqrt)	X^2	10.633	1.100	20.420	24.315	8.186
	p-value	0.0011**	0.2945	3.68E-05***	5.24E-06***	0.0167*
Total Polyphenols	X^2	4.092	1.046	0.902	34.124	1.257
	p-value	0.0431*	0.3065	0.6371	3.89E-08***	0.5334
Total Flavonoids	X^2	4.066	11.641	12.306	5.098	14.135
	p-value	0.0437*	0.0001*	0.0012**	0.0781	0.0009***
FRAP	X^2	2.478	0.035	1.433	31.686	10.171
	p-value	0.1155	0.8516	0.4885	1.32E-07***	0.0062**
DPPH	X^2	0.048	0.052	3.953	26.176	0.049
	p-value	0.8278	0.8201	0.1385	2.07E-06***	0.9757
Rivet	(d.f.)	(1)	(1)	(2)	(2)	(2)
Protein content	X^2	6.93	0.10	14.64	2.87	8.64
	p-value	0.0084**	0.7515	0.0007***	0.2380	0.0133*
Total dietary fibre	X^2	3.89	0.31	4.41	6.53	26.87
	p-value	0.0485*	0.5770	0.1101	0.0381*	1.46E-06***
	X^2	1.90	0.08	14.20	6.84	15.47

Fat content (sqrt)	p-value	0.1681	0.7826	0.0008***	0.0327*	0.0004***
Total Polyphenols	X^2	0.06	0.02	24.96	0.12	0.54
	p-value	0.7998	0.8810	3.81E-06***	0.9411	0.7634
Total Flavonoids	X^2	4.34	0.04	2.97	4.63	17.01
	p-value	0.0373*	0.8515	0.2265	0.0987	0.0002***
FRAP	X^2	0.33	1.54	2.98	7.05	0.10
	p-value	0.5645	0.2144	0.2252	0.0295*	0.9527
DPPH	X^2	6.78	0.01	2.96	2.25	2.82
	p-value	0.0092**	0.9240	0.2275	0.3240	0.2440

(sqrt) = values are square-root transformed to better fit with normality and homoscedasticity conditions
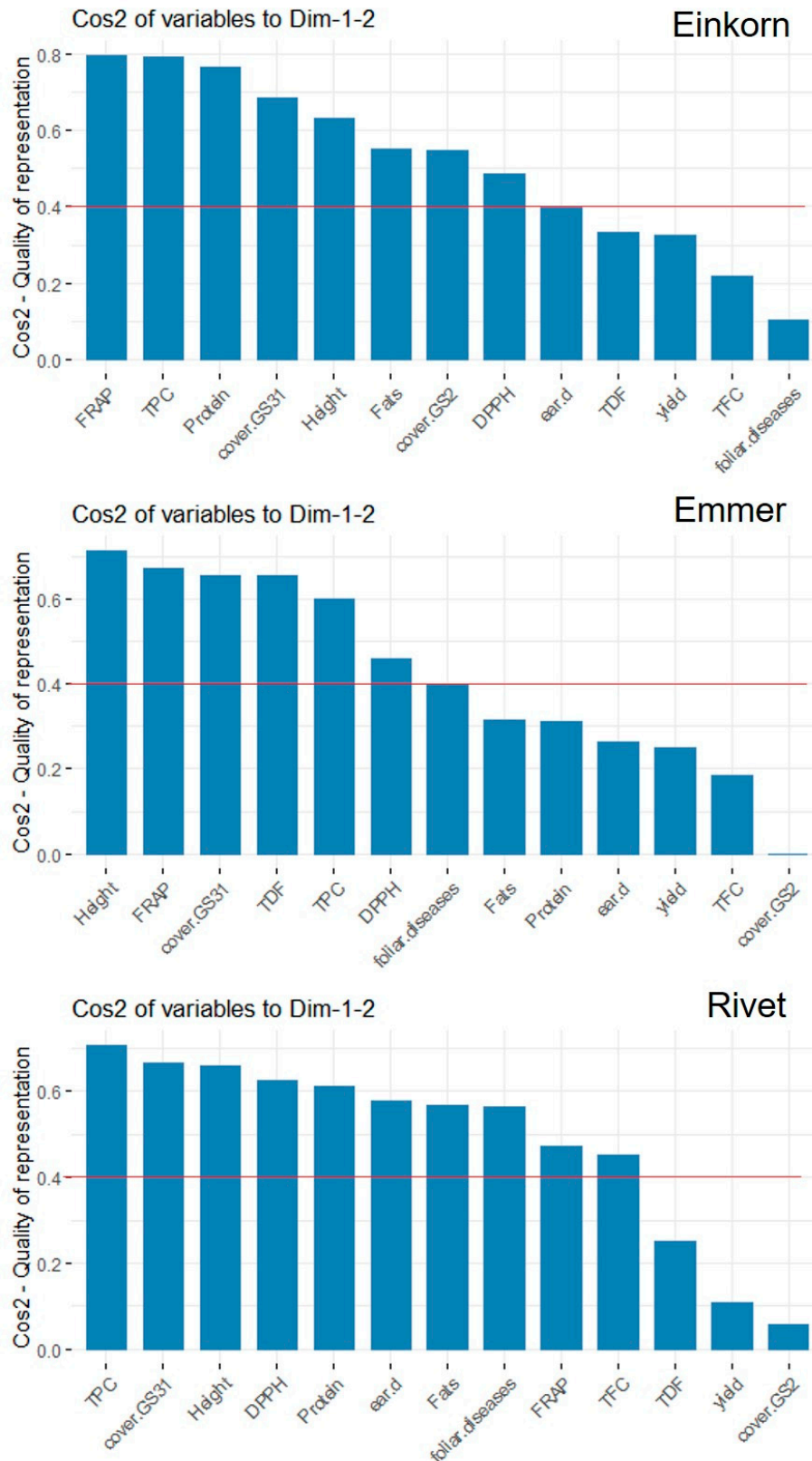
Figure S1. Quality of representation (Cos2) of tested variables in principal component analyses for Einkorn, Emmer and Rivet wheat. Variables with Cos2 ≥ 0.4 were included in the PCAs presented in the paper.