

## S2. Supplementary material to results – ANOVA tables

Table S2.1. ANOVA table for the analyses of service crop (SC) establishment, biomass in oats and soil cover in autumn. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy Early Intra and Late Inter, and all three experiments (SK1, SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs and system strategy Late Adjacent. Here only the OG2 experiment was analysed. See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	Establishment		Biomass		Soil cover	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
SC mixture	1	2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
System strategy	1	1	< 0.001	0.0081	< 0.001	< 0.001	< 0.001	0.0013
Experiment	3	1	< 0.001	0.17	< 0.001	< 0.001	< 0.001	0.16
Mixture*System	1	2	0.91	0.63	0.62	< 0.001	< 0.001	0.0022
Mixture*Experiment	3	2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
System*Experiment	3	1	< 0.001	< 0.001	< 0.001	< 0.001	0.0030	< 0.001
Mixture*System*Experiment	3	2	< 0.001	< 0.001	< 0.001	< 0.001	0.020	0.011

Table S2.2. ANOVA table for the analyses % nitrogen derived from air in the service crop (SC) species. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy Early Intra and Late Inter, and all three experiments (SK1, SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs and system strategy Late Adjacent. Here only the OG2 experiment was analysed. See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	Species		DF	DF	Species and system strategy	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
Species	4	6	< 0.001	< 0.001	4	5	< 0.001	< 0.001
System	-	-	-	-	1	1	0.62	0.67
Experiment§	3	1	< 0.001	< 0.001	1	-	< 0.001	-
Species*System	-	-	-	-	4	5	0.23	< 0.001
Species*Experiment	11	5	< 0.001	0.010	3	-	< 0.001	-
System*Experiment	-	-	-	-	1	-	0.58	-
Species*System*Experiment	-	-	-	-	3	-	0.012	-

§For the analysis of both species and system strategy only data from the experiments SK2 and OG2 were used.

Table S2.3. ANOVA table of winter wheat grain yield, nitrogen yield and nitrogen concentration. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy Early Intra and Late Inter, and all three experiments (SK1, SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs and system strategy Late Adjacent. Here only the OG2 experiment was analysed. See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	Grain yield		Nitrogen yield		Nitrogen concentration	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
SC mixture	2	3	0.068	0.72	0.57	0.0060	0.52	< 0.001
System strategy	1	2	0.98	< 0.001	0.37	< 0.001	0.15	0.16
Experiment	2	-	< 0.001	-	< 0.001	-	< 0.001	-
Mixture*System	2	6	0.81	< 0.001	0.82	< 0.001	0.25	0.38
Mixture*Experiment	4	-	0.0035	-	< 0.001	-	0.068	-
System*Experiment	2	-	0.94	-	0.96	-	0.76	-
Mixture*System*Experiment	4	-	0.80	-	0.93	-	0.0019	-

Table S2.4. ANOVA table of winter wheat plants, tillers, heads, heads plant<sup>-1</sup>, kernels head<sup>-1</sup> and thousand kernel weight<sup>-1</sup>. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy Early Intra and Late Inter, and all three experiments (SK1, SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs and system strategy Late Adjacent. Here only the OG2 experiment was analysed. See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	Plants		Tillers		Heads		Heads plant <sup>-1</sup>		Kernels head <sup>-1</sup>		Thousand kernel weight	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
SC mixture	2	3	0.42	0.018	0.55	0.027	< 0.001	0.18	0.17	0.0022	0.34	0.30	0.51	0.0062
System strategy	1	2	0.58	0.083	0.86	0.89	0.54	0.85	0.81	0.22	0.89	0.28	0.77	0.84
Experiment	2	-	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	-
Mixture*System	2	6	0.77	0.028	0.83	0.36	0.90	0.43	0.72	0.56	0.52	0.16	0.13	0.082
Mixture*Experiment	4	-	0.19	-	0.25	-	< 0.001	-	0.60	-	0.0067	-	0.72	-
System*Experiment	2	-	0.48	-	0.78	-	0.51	-	0.81	-	0.64	-	0.38	-
Mixture*System*Experiment	4	-	0.39	-	0.46	-	0.57	-	0.60	-	0.70	-	0.45	-

Table S2.5. ANOVA table of oat yield, plants, tillers, heads, heads plant<sup>-1</sup>, kernels head<sup>-1</sup> and thousand kernel weight<sup>-1</sup>. The analysis was divided into two steps (here reported as S & P, and S, P & W). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy Early Intra and Late Inter, and all three experiments (SK1, SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs and system strategy Late Adjacent. See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	Yield		Plants		Tillers		Heads		Heads plant <sup>-1</sup>		Kernels head <sup>-1</sup>		Thousand kernel weight	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
SC mixture	2	3	0.83	< 0.001	0.34	0.12	0.14	0.97	0.99	0.79	0.64	0.41	0.78	0.14	0.76	0.85
System strategy	1	2	0.10	0.26	0.72	0.81	0.59	0.91	0.74	0.84	0.77	0.91	0.98	0.40	0.06	0.16
Experiment	3	1	< 0.001	< 0.001	< 0.001	0.47	< 0.001	-§	< 0.001	0.89	< 0.001	0.33	< 0.001	0.20	< 0.001	< 0.001
Mixture*System	2	6	0.47	0.0057	0.76	0.54	0.35	0.68	0.56	0.34	0.74	0.22	0.73	0.58	0.36	0.38
Mixture*Experiment	6	3	0.0030	0.73	0.46	0.16	0.44	-	0.62	0.79	0.98	0.42	0.47	0.89	0.69	0.73
System*Experiment	4	2	0.018	0.071	0.21	0.37	0.33	-	0.069	0.44	0.34	0.20	0.32	0.28	0.60	0.72
Mixture*System*Experiment	6	6	0.65	0.33	0.58	0.88	0.77	-	0.59	0.70	0.65	0.89	0.64	0.92	0.031	0.37

§this data was only available from OG2

Table S2.6. ANOVA table of weed biomass in oats and winter wheat. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) service crops (SCs) and no SC as SC mixture levels and system strategy Early Intra and Late Inter, in oats with all four experiments. S, P & T also included treatments with frost tolerant annual (T) SCs which was present only in OG. See Materials and method for and Table 1 for treatment explanations

Effect	DF	DF	In oats		In winter wheat	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
SC mixture	2	3	0.072	0.027	0.0022	0.018
System strategy	1	1	0.61	0.53	0.97	0.19
Experiment	3 (2)§	1 (-)**	< 0.001	0.28	< 0.001	-
Mixture*System	2	3	0.75	0.70	0.16	0.90
Mixture*Experiment	6 (4)	3 (-)	0.74	0.96	0.0023	-
System*Experiment	3 (2)	1 (-)	0.41	0.73	0.96	-
Mixture*System*Experiment	6 (4)	3 (-)	0.26	0.52	0.011	-

§In winter wheat only SK1, SK2 and OG2 was included in the analysis.

\*\*In winter wheat only OG2 was included in the analysis.

Table S2.7. ANOVA table of weed biomass in different subsections of the oats and winter wheat plots. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) service crops (SCs) and no SC as SC mixture levels and system strategy Early Intra and Late Inter, in oats with all four experiments. S, P & T also included treatments with frost tolerant annual (T) SCs which was present only in OG. See Materials and method for and Table 1 for treatment explanations

<b>In oats</b>	<b>DF</b>	<b>DF</b>	<b>S &amp; P</b>			<b>S, P &amp; T</b>		
<b>Effect</b>	<b>S &amp; P</b>	<b>S, P &amp; T</b>	<b>ir</b>	<b>cr</b>	<b>ic</b>	<b>ir</b>	<b>cr</b>	<b>ic</b>
SC mixture	2	3	0.4	0.1	0.8	0.4	0.07	0.05
System strategy	1	1	0.9	0.6	0.001	0.9	0.9	0.4
Experiment	3	1	0.05	0.003	< 0.001	0.9	0.3	0.04
Mixture*System	2	3	0.4	0.5	0.2	0.2	0.6	0.2
Mixture*Experiment	6	3	0.5	0.7	0.9	0.6	0.8	0.6
System*Experiment	3	1	0.3	0.9	0.02	0.2	0.6	0.2
Mixture*System*Experiment	6	3	0.2	0.4	0.009	0.4	0.2	0.05

  

<b>In winter wheat§</b>	<b>DF</b>	<b>DF</b>	<b>S &amp; P</b>			<b>S, P &amp; T</b>		
<b>Effect</b>	<b>S &amp; P</b>	<b>S, P &amp; T</b>	<b>ir</b>	<b>cr</b>	<b>ic</b>	<b>ir</b>	<b>cr</b>	<b>ic</b>
SC mixture	2	3	0.004	0.08	0.8	0.05	0.1	0.7
System strategy	1	1	0.08	0.7	0.3	0.7	0.08	0.2
Experiment	2	-	< 0.001	< 0.001	< 0.001			
Mixture*System	2	3	0.1	0.8	0.2	0.3	0.5	0.4
Mixture*Experiment	4	-	< 0.001	0.2	0.4			
System*Experiment	2	-	0.005	0.8	0.5			
Mixture*System*Experiment	4	-	0.01	0.06	0.9			

§In winter wheat only SK1, SK2 and OG2 was included in the analysis for S & P, and only OG2 for S, P and T.

Table S2.8. ANOVA table of soil mineral nitrogen (SMN) in autumn at three different depths (0-30, 30-60 and 60-90 cm) and in the whole soil profile. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy Early Intra and Late Inter, and all three experiments (SK1, SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs. See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	0-30 cm		30-60 cm		60-90 cm		0-60 cm§	0-90 cm	0-90 cm
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S & P	S, P & T
SC mixture	2	3	0.22	0.44	0.16	0.89	0.18	0.30	0.21	0.21	0.55
System strategy	1	1	0.69	0.33	0.94	0.57	0.98	0.40	0.99	0.74	0.44
Experiment	3 (2)**	1	0.0024	< 0.001	0.033	0.026	0.45	0.18	< 0.001	< 0.001	< 0.001
Mixture*System	2	3	< 0.001	< 0.001	0.040	0.028	0.52	0.66	0.0019	0.0024	0.0083
Mixture*Experiment	6 (4)	3	0.81	0.67	0.12	0.49	0.046	0.35	0.46	0.099	0.55
System*Experiment	3 (2)	1	0.28	0.49	0.76	0.65	0.76	0.28	0.42	0.45	0.15
Mixture*System*Experiment	6 (4)	3	0.58	0.19	0.70	0.69	0.26	0.22	0.59	0.57	0.63

§60-90 cm could not be sampled at SK2 due to a large amount of stones and hence only the two first layers were included in this analysis.

\*\*Numbers in parenthesis are DF for the depth 60-90 cm where there is only data from SK1, OG1 and OG2.

Table S2.9. ANOVA table of soil mineral nitrogen (SMN) in spring at three different depths (0-30, 30-60 and 60-90 cm) and in the whole soil profile. Only the SK2 and OG2 experiment were included in the analysis. The analysis was divided into two steps (here reported as S & P, and S, P & T). S & P included treatments with frost sensitive annual (S), perennial (P) SCs and no SC as SC mixture levels and system strategy A and B, and both experiments (SK2 and OG2). S, P & T also included treatments with frost tolerant annual (T) SCs (only OG2). See Materials and method for detailed treatment explanations and table 1 for treatment overview

Effect	DF	DF	0-30 cm		30-60 cm		60-90 cm		0-90 cm	
	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T	S & P	S, P & T
SC mixture	2	3	0.19	0.40	0.98	0.71	0.039	0.39	0.13	0.52
System strategy	1	1	0.48	0.54	0.95	0.53	0.92	0.87	0.57	0.45
Experiment	1	-	0.020	-	< 0.001	-	< 0.001	-	< 0.001	-
Mixture*System	2	3	0.60	0.37	0.046	0.33	0.34	0.32	0.67	0.20
Mixture*Experiment	2	-	0.82	-	0.66	-	0.85	-	0.96	-
System*Experiment	1	-	0.042	-	0.20	-	0.35	-	0.010	-
Mixture*System*Experiment	2	-	0.81	-	0.94	-	0.35	-	0.40	-