

Average cumulative values				
Factors	df	ABG	Nyield	Nfixed
<b>System (S)</b>	1	0.82	0.30	0.17
<b>Area (Ar)</b>	1	0.17	0.54	0.20
<b>Crop (C)</b>	1	*	***	na
<b>S x Ar</b>	1	0.35	0.21	*
<b>S x C</b>	1	*	0.44	na
<b>C x Ar</b>	1	0.56	0.34	na
<b>S x C x Ar</b>	1	0.22	0.14	na

**Table S1** – *p*-values of the effects of System (S), Area (Ar), Crop (C) and their interactions on averaged values of the two fields/years of total Above-ground biomass (ABG), N content (Nyield), measured on sulla and ryegrass, and content of N derived from N<sub>2</sub>-fixation in mass units (Nfixed), measured only on sulla. Asterisks indicate significance levels where \**p* ≤ 0.05, \*\**p* ≤ 0.01 and \*\*\**p* ≤ 0.001. na means not applicable.

Field/year	Factors	df	Shoot			Root		
			N%	$\delta^{15}\text{N}$	%Ndfa	N%	$\delta^{15}\text{N}$	%Ndfa
Field 1	System (S)	1	0.22	*	0.12	0.62	*	*
	Area (Ar)	1	0.59	**	***	0.92	*	*
	Crop (C)	1	***	na	na	***	na	na
	S x Ar	1	0.26	0.89	0.89	0.62	0.21	0.21
	S x C	1	0.86	na	na	0.71	na	na
	C x Ar	1	0.52	na	na	0.21	na	na
	S x C x Ar	1	0.83	na	na	0.89	na	na
Field 2	System (S)	1	0.57	0.16	0.27	0.07	0.06	0.08
	Area (Ar)	1	0.54	0.07	0.1	0.95	*	*
	Crop (C)	1	***	na	na	***	na	na
	S x Ar	1	0.62	0.59	0.83	0.97	0.36	0.37
	S x C	1	0.93	na	na	0.65	na	na
	C x Ar	1	0.77	na	na	0.83	na	na
	S x C x Ar	1	0.63	na	na	0.57	na	na

**Table S2** – *p*-values of the effects of System (S), Area (Ar), Crop (C) and their interactions on total N concentration (N%),  $^{15}\text{N}$  atom excess respect to the atmosphere ( $\delta^{15}\text{N}$ ) and concentration of N derived from  $\text{N}_2$ -fixation (%Ndfa), measured on shoots and roots of sulla in the two field experiments (Field 1 and Field 2). Asterisks indicate significance levels where \* $p \leq 0.05$ , \*\* $p \leq 0.01$  and \*\*\* $p \leq 0.001$ . na means not applicable.

Experiment	Factors	df	Height increment	Diameter at 130 cm increment	Diameter at foot increment
1	Crop (C)	1	0.91	0.35	0.86
2	Crop (C)	1	0.55	0.44	**

**Table S3** – *p*-values of the effect of Crop (C) on the increment of poplar trunk height, diameter at 130 cm and diameter at the foot in the two field experiments in the SIPAST system (Field 1 and Field 2). Asterisks indicate significance levels where \* $p \leq 0.05$ , \*\* $p \leq 0.01$  and \*\*\* $p \leq 0.001$ .

Field/Year	Factors	df	SPRING				AUTUMN			
			STN		NO <sub>3</sub> <sup>-</sup>		STN		NO <sub>3</sub> <sup>-</sup>	
			0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Field 1	<b>System (S)</b>	1	0.48	0.22	0.27	0.64	0.76	0.73	0.76	0.82
	<b>Area (Ar)</b>	1	0.68	0.53	*	*	0.52	0.29	0.14	0.8
	<b>Crop (C)</b>	1	0.37	0.38	0.88	0.15	0.48	0.7	0.43	0.25
	<b>S x Ar</b>	1	0.86	0.45	0.57	0.44	0.67	0.79	0.17	0.08
	<b>S x C</b>	1	0.47	0.37	0.83	0.07	0.57	0.25	0.54	0.08
	<b>C x Ar</b>	1	0.47	0.51	*	0.33	0.91	0.89	0.41	0.16
	<b>S x C x Ar</b>	1	0.97	0.96	0.32	0.96	0.94	0.62	0.93	0.6
Field 2	<b>System (S)</b>	1	**	0.13	0.57	0.26	**	*	0.74	0.35
	<b>Area (Ar)</b>	1	**	0.27	***	**	*	0.07	***	*
	<b>Crop (C)</b>	1	0.10	0.34	**	0.20	0.15	0.19	*	*
	<b>S x Ar</b>	1	0.44	0.82	0.75	0.11	0.96	0.97	0.09	0.8
	<b>S x C</b>	1	0.27	0.84	0.83	0.06	0.35	0.11	0.09	0.38
	<b>C x Ar</b>	1	0.63	0.17	*	0.09	0.50	0.79	0.17	0.10
	<b>S x C x Ar</b>	1	0.41	0.82	0.43	0.40	0.70	0.88	0.92	0.38

**Table S4** – *p*-values of the effects, System (S), Area (Ar), Crop (C) and their interactions on the soil total N (STN) (g N kg<sup>-1</sup>) and soil NO<sub>3</sub><sup>-</sup> (mg NO<sub>3</sub><sup>-</sup> kg<sup>-1</sup>) measured on soil sampled at 0-30 and 30-60 cm of depth in spring and autumn in the two field experiments (Field 1 and Field 2). Asterisks indicate significance levels where \**p* ≤ 0.05, \*\**p* ≤ 0.01 and \*\*\**p* ≤ 0.001.

Field	Factors	Levels	SPRING				AUTUMN			
			STN		NO <sub>3</sub> <sup>-</sup>		STN		NO <sub>3</sub> <sup>-</sup>	
			0-30	30-60	0-30	30-60	0-30	30-60	0-30	30-60
1	System (S)	PAST	1.31 ±	1.04 ±	4.70 ±	4.07 ±	1.30 ±	1.08 ±	8.84 ±	7.03 ±
			0.03	0.03	0.78	0.58	0.03	0.04	1.49	2.13
		SIPAST	1.28 ±	0.97 ±	5.71 ±	4.47 ±	1.29 ±	1.06 ±	8.37 ±	7.56 ±
			0.02	0.03	0.88	0.83	0.02	0.03	1.05	2.15
	Area (Ar)	SWARD	1.28 ±	0.99 ±	4.08 ±	3.31 ±	1.28 ±	1.04 ±	9.81 ±	7.58 ±
			0.03	0.04	0.75 b	0.57 b	0.03	0.04	1.34	2.11
		DITCH	1.30 ±	1.02 ±	6.33 ±	5.23 ±	1.30 ±	1.10 ±	7.40 ±	7.00 ±
			0.02	0.10	0.79 a	0.73 a	0.02	0.03	1.14	2.17
	Crop (C)	RYE	1.31 ±	1.03 ±	5.14 ±	3.64 ±	1.31 ±	1.08 ±	9.23 ±	8.65 ±
			0.03	0.04	0.99	0.53	0.02	0.04	1.23	2.03
		SUL	1.27 ±	0.98 ±	5.27 ±	4.90 ±	1.28 ±	1.06 ±	7.99 ±	5.93 ±
			0.03	0.03	0.67	0.82	0.03	0.03	1.32	2.17
	C x Ar	RYE DITCH			7.53 ±					
					1.15 a					
		RYE SWARD			2.75 ±					
					0.83 b					
		SUL DITCH			5.13 ±					
					0.94 ab					
		SUL SWARD			5.41 ±					
					1.06 ab					
2	System (S)	PAST	1.03 ±	0.88 ±	3.59 ±	3.54 ±	1.02 ±	0.92 ±	7.26 ±	2.49 ±
			0.02 b	0.03	0.92	0.53	0.02 b	0.03 b	1.07	0.49
		SIPAST	1.13 ±	0.96 ±	4.03 ±	4.18 ±	1.12 ±	1.02 ±	7.34 ±	2.97 ±
			0.03 a	0.04	0.88	1.18	0.02 a	0.03 a	1.55	0.57
	Area (Ar)	SWARD	1.13 ±	0.95 ±	5.46 ±	5.11 ±	1.11 ±	1.00 ±	9.78 ±	3.38 ±
			0.03 a	0.04	0.96 a	1.01 a	0.02 a	0.03	1.02 a	0.62 a
		DITCH	1.03 ±	0.89 ±	2.16 ±	2.53 ±	1.04 ±	0.93 ±	4.59 ±	2.02 ±
			0.02 b	0.03	0.46 b	0.65 b	0.02 b	0.03	1.06 b	0.34 b
	Crop (C)	RYE	1.05 ±	0.89 ±	2.53 ±	3.19 ±	1.05 ±	0.95 ±	5.88 ±	2.02 ±
			0.03	0.03	0.54 b	0.60	0.02	0.03	1.09 b	0.31 b
		SUL	1.10 ±	0.94 ±	5.09 ±	4.62 ±	1.09 ±	1.00 ±	8.60 ±	3.39 ±
			0.03	0.04	1.02 a	1.18	0.02	0.02	1.35 a	0.63 a
	C x Ar	RYE DITCH			1.86 ±					
					0.66 b					
		RYE SWARD			3.20 ±					
					0.81 b					
		SUL DITCH			7.73 ±					
					1.18 a					
		SUL SWARD			2.46 ±					
					1.69 b					

**Table S5** - average value (mean ± standard error) of soil total N (STN g N kg<sup>-1</sup>) and soil NO<sub>3</sub><sup>-</sup> (mg NO<sub>3</sub><sup>-</sup> kg<sup>-1</sup>) measured on soil sampled at 0-30 and 30-60 cm of depth in spring and autumn in the two field experiments (Field 1 and Field 2). Within each depth where a significant effect of shade was observed, treatments with the same letter were not significantly different at  $p \leq 0.05$  (Tukey's HSD test). PAST means pastoral, SIPAST means silvopastoral, DITCH means sampling area between ditch and the first row of the crop, SWARD means the central area of the crop, i.e. 4 m apart from the first row of the crop, RYE means ryegrass and SUL means sulla.

			SPRING				AUTUMN			
System: SIPAST			Ntot		NO <sub>3</sub> <sup>-</sup>		Ntot		NO <sub>3</sub> <sup>-</sup>	
Field/Year	Factors	df	0-30	30-60	0-30	30-60	0-30	30-60	0-30	30-60
Field 1	Area (Ar)	2	0.93	0.24	*	0.25	0.46	0.74	0.53	0.58
	Crop (C)	1	*	0.11	0.22	0.09	*	0.05	0.49	0.07
	C x Ar	1	0.66	0.89	*	0.65	0.95	0.73	0.59	0.30
Field 2	Area (Ar)	2	0.05	0.75	**	**	0.21	0.21	*	*
	Crop (C)	1	0.84	0.51	**	*	0.89	0.67	0.15	0.05
	C x Ar	1	0.92	0.49	0.18	*	0.70	0.45	0.10	0.29

**Table S6** – *p*-values of the effects of Area (Ar), Crop (C) and their interactions on soil total N (STN g N kg<sup>-1</sup>) and soil NO<sub>3</sub><sup>-</sup> (mg NO<sub>3</sub><sup>-</sup> kg<sup>-1</sup>) measured on soil sampled at 0-30 and 30-60 cm of depth in spring and autumn in the two field experiments (Field 1 and Field 2) only for the silvo-pastoral system (SIPAST). Asterisks indicate significance levels where \**p* ≤ 0.05, \*\**p* ≤ 0.01 and \*\*\**p* ≤ 0.001.

			SPRING				AUTUMN			
System: SIPAST			STN		NO <sub>3</sub> <sup>-</sup>		STN		NO <sub>3</sub> <sup>-</sup>	
Field/Year	Factors	Levels	0-30	30-60	0-30	30-60	0-30	30-60	0-30	30-60
Field 1	Area (Ar)	SWARD	1.27 ± 0.03	0.98 ± 0.05	4.33 ± 1.12 ab	3.17 ± 0.90	1.28 ± 0.03	1.03 ± 0.06	8.49 ± 1.56	6.28 ± 1.40
		TREE	1.28 ± 0.03	1.08 ± 0.07	3.01 ± 0.78 b	4.03 ± 1.34	1.29 ± 0.02	1.06 ± 0.05	10.49 ± 1.57	6.48 ± 2.26
		DITCH	1.28 ± 0.03	0.97 ± 0.04	5.95 ± 0.42 a	5.76 ± 1.24	1.26 ± 0.02	1.08 ± 0.04	8.26 ± 2.72	9.43 ± 4.17
		RYE	1.32 ± 0.03 a	1.06 ± 0.05	3.80 ± 0.91	3.21 ± 0.54	1.31 ± 0.02 a	1.12 ± 0.04	9.69 ± 1.54	10.46 ± 2.90
		SUL	1.24 ± 0.01 b	0.96 ± 0.04	4.81 ± 0.67	5.44 ± 1.19	1.25 ± 0.01 b	1.00 ± 0.02	8.47 ± 1.70	4.32 ± 1.03
		RYE SWARD			2.44 ± 1.30 c					
	C x Ar	RYE TREE			3.33 ± 1.54 bc					
		RYE DITCH			6.58 ± 0.41 a					
		SUL SWARD			6.22 ± 1.00 a					
		SUL TREE			2.68 ± 0.75 c					
		SUL DITCH			5.53 ± 0.57 ab					
Field 2	Area (Ar)	SWARD	1.19 ± 0.02	0.98 ± 0.06	5.80 ± 1.33 a	6.25 ± 1.95 a	1.16 ± 0.02	1.05 ± 0.04	10.68 ± 1.76 a	3.58 ± 0.95 a
		TREE	1.14 ± 0.03	0.94 ± 0.05	3.77 ± 0.86 ab	3.12 ± 0.95 b	1.11 ± 0.02	0.93 ± 0.05	4.46 ± 1.14 b	1.39 ± 0.61 b
		DITCH	1.07 ± 0.03	0.93 ± 0.05	1.79 ± 0.57 b	2.12 ± 0.82 b	1.09 ± 0.03	0.98 ± 0.03	5.13 ± 2.00 b	2.36 ± 0.24 ab
		RYE	1.13 ± 0.03	0.93 ± 0.04	2.40 ± 0.58 b	2.90 ± 0.87 b	1.12 ± 0.02	0.98 ± 0.04	5.61 ± 1.36	1.81 ± 0.35
		SUL	1.13 ± 0.02	0.97 ± 0.05	5.24 ± 1.00 a	4.75 ± 1.43 a	1.12 ± 0.02	1.00 ± 0.03	7.90 ± 1.81	3.07 ± 0.73
		RYE SWARD			3.83 ± 1.84 ab					
	C x Ar	RYE TREE			3.04 ± 1.83 b					
		RYE DITCH			1.83 ± 1.13 b					
		SUL SWARD			8.66 ± 3.15 a					
		SUL TREE			3.20 ± 1.07 b					
		SUL DITCH			2.40 ± 1.40 b					

**Table S7** - Average values (mean ± standard error) of soil total N (STN, g N kg<sup>-1</sup>) and soil NO<sub>3</sub><sup>-</sup> (mg NO<sub>3</sub><sup>-</sup> kg<sup>-1</sup>) measured on soil sampled at 0-30 and 30-60 cm of depth in spring and autumn in the two field experiments (Field 1 and Field 2) only in the silvo-pastoral system (SIPAST). Within each depth where a significant effect of shade was observed, treatments with the same letter were not significantly different at  $p \leq 0.05$  (Tukey's HSD test). DITCH means sampling area between ditch and beginning of the crop, TREE means sampling area between central tree and

the beginning of the crop, SWARD means the central area of the crop, i.e. 4 m apart from the first row of the crop, RYE means ryegrass and SUL means sulla.