75th EAAP 2024
Firenze, Italy, 1-5, September 2024

Inclusion of poplar leaves and stems in ewes' diet: effect on milk yield and quality and oxidative status

Martina Re[1], Paolo Bàrberi[1], Giuseppe Conte[2], Eleni Tsiplakou[3], Panagiota Kyriakaki[3], Alexandros Mavromamtis[3], Marcello Mele[2], Alberto Mantino[2]

Institute of Plant Sciences, Scuola Superiore Sant'Anna, Italy
Department of Agriculture, Food and Environment, University of Pisa, Italy
Department of Animal Science, Agricultural University of Athens, Greece

Funded by the European Union

Problem Mediterranean summer droughts and soil erosion affect pasture availability

Need for on-farm fresh fodder for destagionalised lactating ewes

Silvopastoral systems represent a **possible solution while providing Ecosystem Services**

Alternatives to intensive models have been developed (including traditional knowledge)

Francesco Paolo Michetti (1872) Pastorella con gregge

Funded by the European Union

agromix

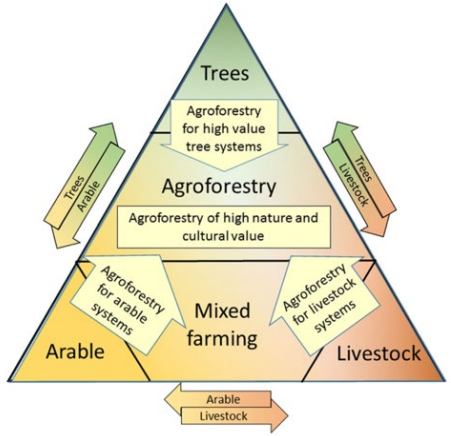
Can poplar leaves and stems be integrated in the diet of sheep ?

What is the acceptance of fresh poplar by sheep in late-lactation?

Are there effects on milk yield and quality and/or on animal welfare?

Funded by
the European Union

agromix



agromix

2021
Poplar trees plantation

2022-2023
Sheep feeding trial

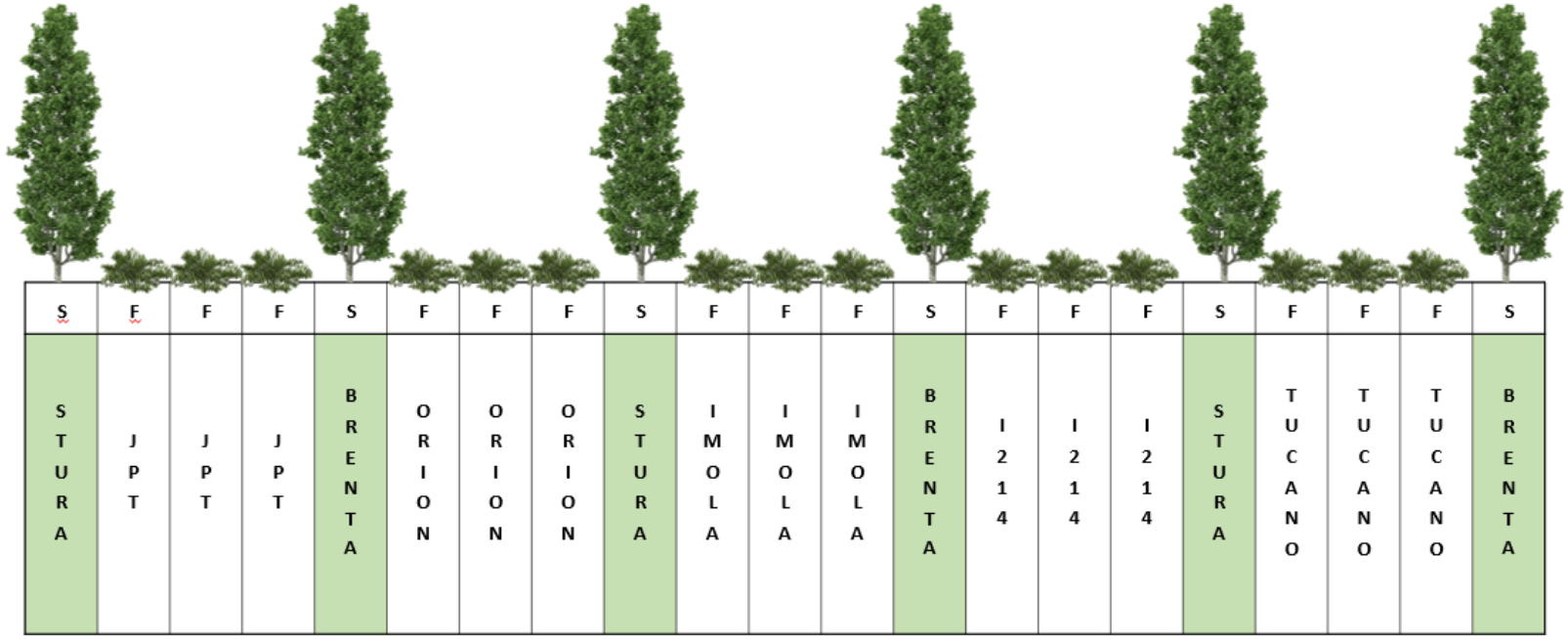
2023-2024
Milk quality analysis
Blood analysis

Experimental design: randomized block design with **3** replicates

2 sites (farms):
(**i**) Manciano GR
(**ii**) Magliano GR

2 tree typologies:
(**i**) shade poplar (**S**) with 2 clones (STURA and BRENTA)
(**ii**) forage poplar (**F**) with 5 clones (TUCANO, I214, IMOLA, JPT, ORION)

BLOCK EXAMPLE



S	F	F	F	S	F	F	F	S	F	F	F	S	F	F	F	S	F	F	F	S
STURA	JPT	JPT	JPT	BRENTA	ORION	ORION	ORION	STURA	IMOLA	IMOLA	IMOLA	BRENTA	I214	I214	I214	STURA	TUCANO	TUCANO	TUCANO	BRENTA

Poplar leaves contain Phenolic acids and Flavonoids with an antioxidant potential

Funded by the European Union

agromix

Protocol-a pilot study

- 14 days (7 + 7)
- Real-farm
- Indoor trial (3+3 individual box)
- Animal weighting (n=3)
- Blood sampling (n =3)
- Milk sampling (twice a day)
- Milk quality analysis (n=6 + t0)
- Feeding sampling (twice a day)
- Poplars cutting and feeding (once a day)

X3

X3

Funded by the European Union

agromix

Animal diets

Year	Ingredient	Control	Treatment	CP	NDF	ADF	ADL	Ash
		(g DM)	(g DM)	(%)	(%)	(%)	(%)	(%)
2022	Poplar	0	456	13.14	36.62	32.31	15.61	7.69
	Oat-bean Grains	246	246	11.80	35.64	22.33	2.60	3.88
	Purchased mix	144	144	18.86	17.18	7.95	1.90	5.36
	Oat-clover Hay	1899	1887	7.32	55.67	37.87	5.98	8.61
	Alfalfa Hay	1394	941	15.61	36.56	31.11	8.46	7.73
	Total amount	3675	3682					
2023	Poplar	0	462	13.28	38.30	35.00	17.08	10.36
	Oat-bean Grains	384	384	18.06	25.70	8.95	3.08	6.83
	Purchased mix	229	229	21.13	19.90	9.78	2.32	8.62
	Oat-clover Hay	2037	2005	12.89	48.88	37.18	9.24	9.09
	Alfalfa Hay	1794	1356	23.74	39.80	35.01	10.52	12.22
	Total amount	4444	4436					

Funded by the European Union

agromix

Results - Individual intake 2022

Intake ~ Treatment*Day + (1|Animal)

Fixed factor: Treatment (n=2) and Day (n=14)
Random factor: Animal (n=6)

	N	Intake (g per day)		se
Control (C)	**42**	**2219**	**±**	**34**
Treatment (T)	**42**	**2342**	**±**	**51**

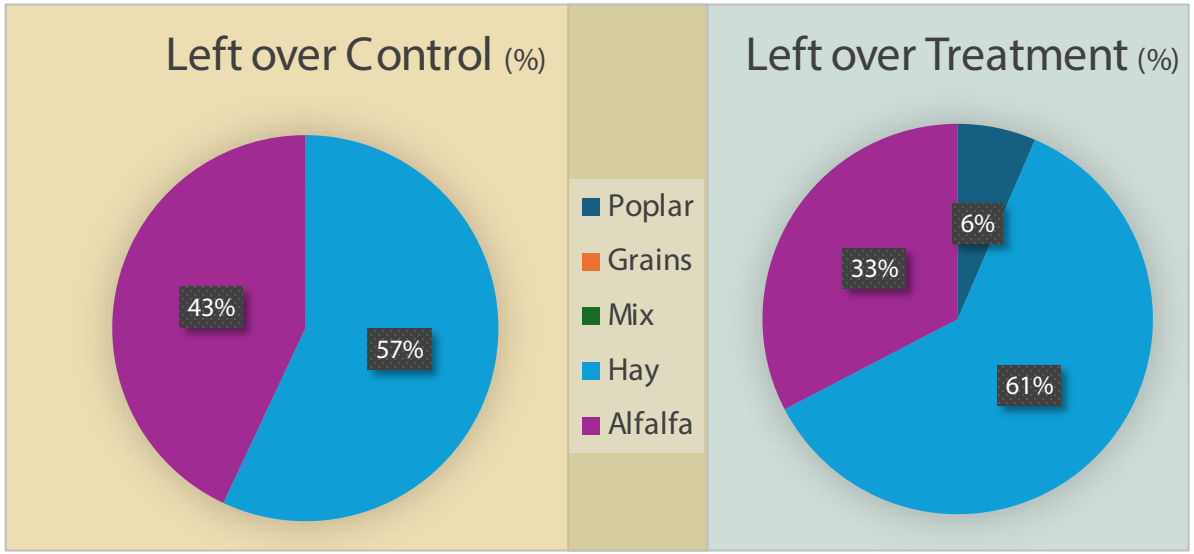
	Sum Sq	Mean Sq	F	P	
Treatment	33939	33939	0.8468	0.41	
Day	1790801	137754	3.4370	**<0.001**	*
Treatment:Day	898121	69086	1.7237	0.084	

Left over ~ Treatment*Day + (1|Animal)

Fixed factor: Treatment (n=2) and Day (n=14)
Random factor: Animal (n=6)

	N	Left over (g per day)		se
Control (C)	**42**	**1463**	**±**	**33**
Treatment (T)	**41**	**1308**	**±**	**55**

	Sum Sq	Mean Sq	F	P	
Treatment	61040	61040	1.1474	0.344424	
Day	1774398	136492	2.5657	**0.008155**	**
Treatment:Day	807243	62096	1.1672	0.328935	



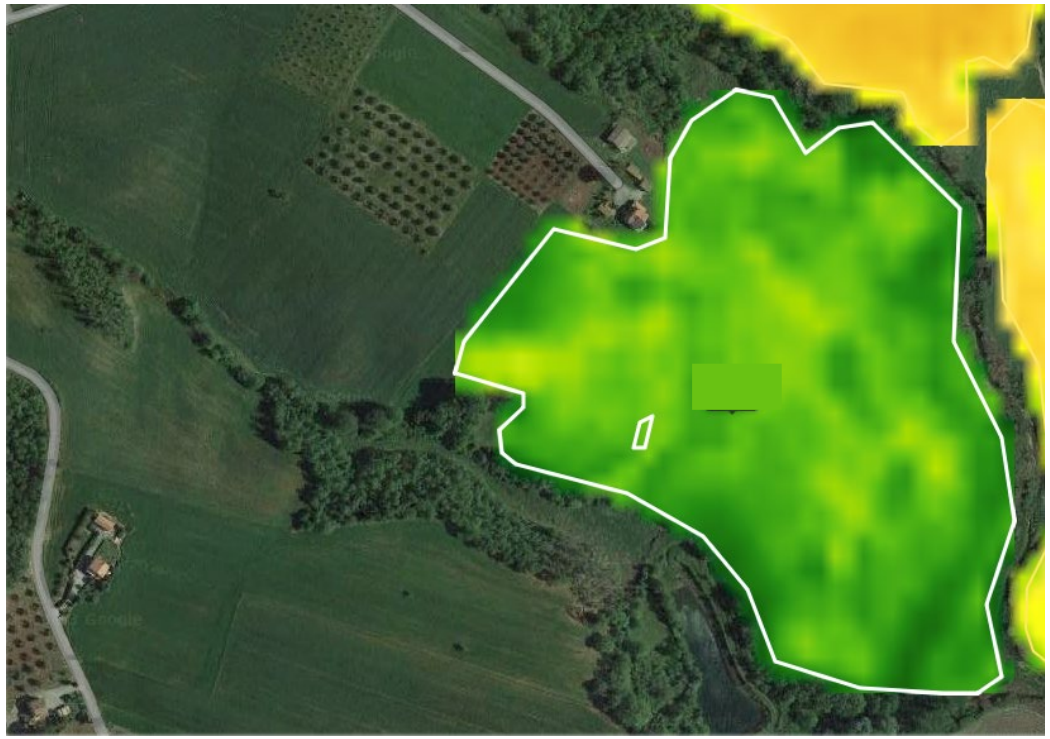
Funded by the European Union

agromix

Pasture availability: 1° and 2° year of on farm experiment

Normalized Difference Vegetation Index (NDVI)

June 2022



June 2023

Results - Individual intake 2023

Intake ~ Treatment*Day + (1|Animal)

Fixed factor: Treatment (n=2) and Day (n=14)
Random factor: Animal (n=6)

	N	Intake (g per day)		se
Control (C)	42	2567	±	37
Treatment (T)	42	2802	±	51

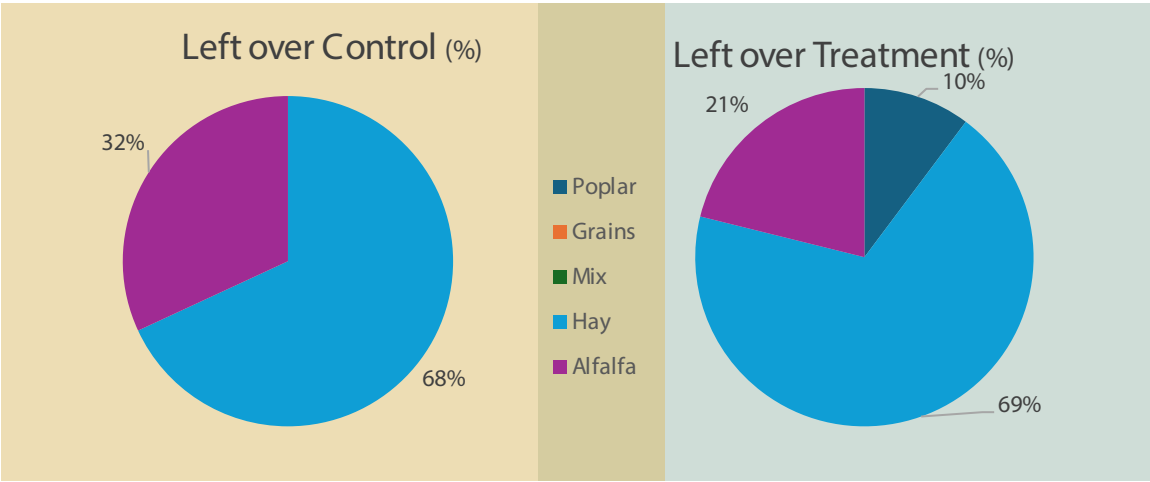
	Sum Sq	Mean Sq	F	P	
Treatment	275404	275404	4.018	0.11	
Day	1305477	100421	51.045	0.16	
Treatment:Day	728256	56020	51.045	0.63	

Left over ~ Treatment*Day + (1|Animal)

Fixed factor: Treatment (n=2) and Day (n=14)
Random factor: Animal (n=6)

	N	Left over (g per day)		se
Control (C)	42	1877	±	39
Treatment (T)	41	1664	±	54

	Sum Sq	Mean Sq	F	P	
Treatment	195683	195683	2.6656	0.18	
Day	1375884	105837	1.4417	0.17	
Treatment:Day	906735	69749	0.9501	0.51	



Funded by the European Union

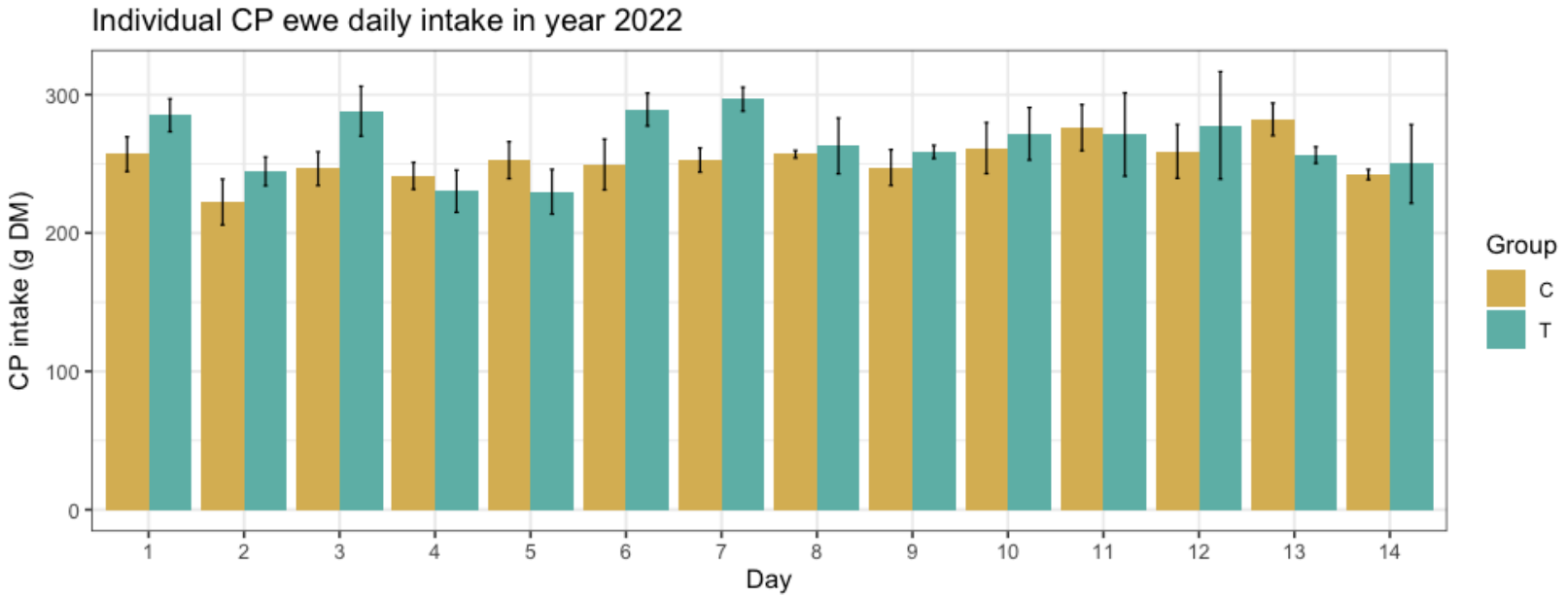
agromix

Results – Crude protein intake 2022 and 2023

2022

	N	Intake (g per day)		se
Control (C)	**42**	**253.35**	**±**	**3.72**
Treatment (T)	**42**	**265.13**	**±**	**5.38**

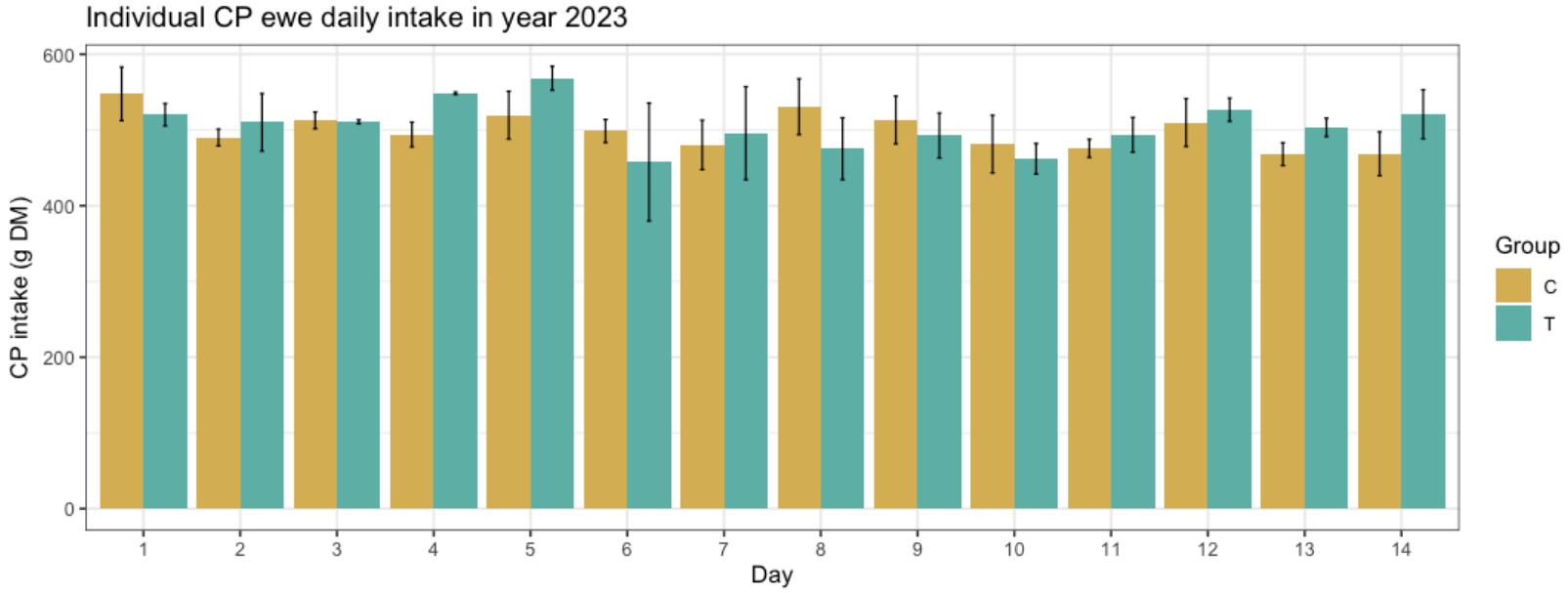
	Sum Sq	Mean Sq	F	P	
Treatment	386.4	386.43	0.6696	0.459	
Day	**16465.5**	**1266.58**	**2.1946**	**0.023**	*
T:D	9884.9	760.38	1.3175	0.63	



2023

	N	Intake (g per day)		se
Control (C)	**42**	**499.31**	**±**	**6.93**
Treatment (T)	**42**	**506.12**	**±**	**8.90**

	Sum Sq	Mean Sq	F	P	
Treatment	275	275.38	0.1137	0.75	
Day	34812	2677.82	1.1058	0.37	
T:D	24321	1870.81	0.7726	0.68	



Funded by the European Union

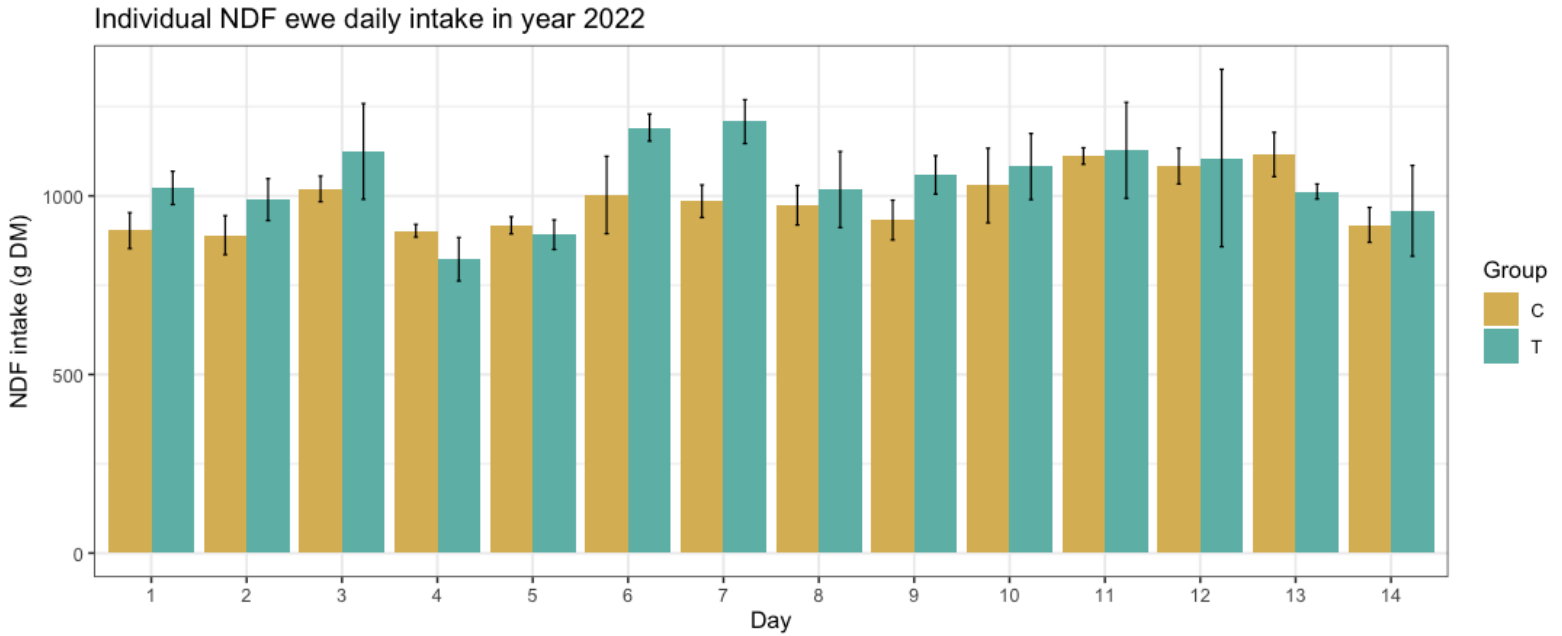
agromix

Results – NDF intake in 2022 and 2023

2022

	N	Intake (g per day)		se
Control (C)	**42**	**984.76**	**±**	**17.53**
Treatment (T)	**42**	**1043.87**	**±**	**28.28**

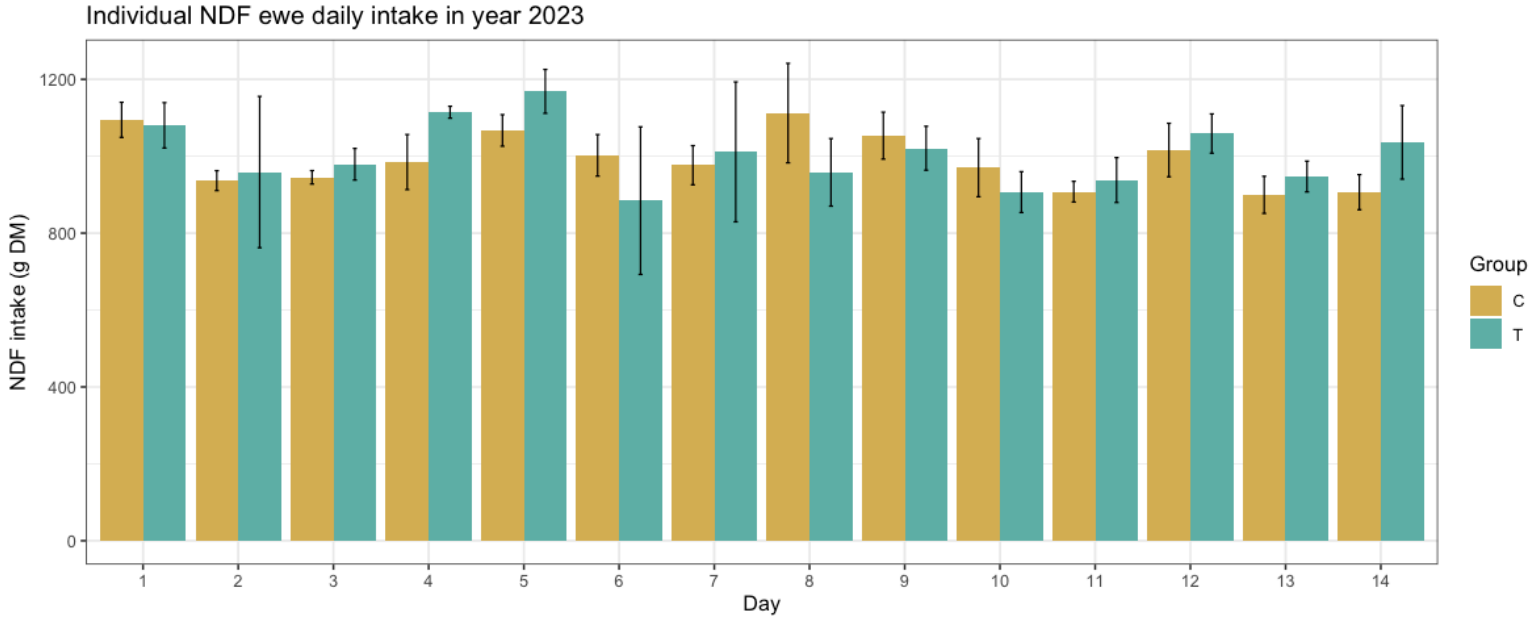
	Sum Sq	Mean Sq	F	P	
Treatment	386.4	6835	0.5375	0.50	
Day	**530382**	**40799**	**3.2085**	**0.001**	**
T:D	168568	12967	1.0197	0.44	



2023

	N	Intake (g per day)		se
Control (C)	**42**	**990.95**	**±**	**6.93**
Treatment (T)	**42**	**1004.52**	**±**	**8.90**

	Sum Sq	Mean Sq	F	P	
Treatment	1072	1072.1	0.0595	0.82	
Day	310767	23905.1	1.3266	0.22	
T:D	138288	10637.5	0.5903	0.85	



Funded by the European Union

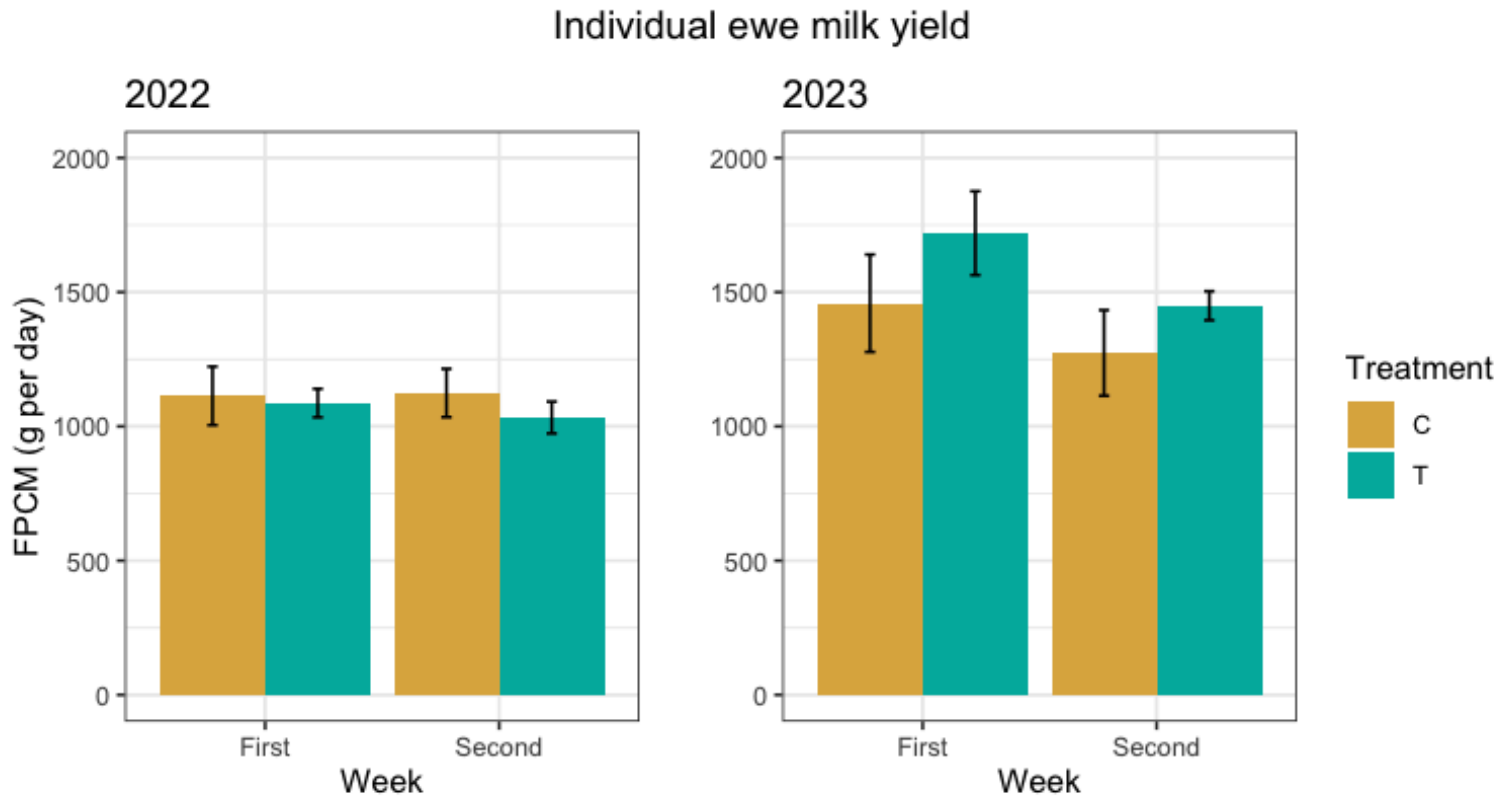
agromix

Results - Milk Yield 2022 - 2023

FPCM ~ Treatment*Week + CovFPCM + (1|Week:Day) + (1|Animal)
FPCM = Fat and Protein Corrected Milk (6.5; 5.8)

Fixed factor: Treatment (n=2), Week (n=2)
Nested: Factor (3 day per week)
Random factor: Animal (n=6)
CovFPCM: FPCM production at Day 0

Analysis of Deviance Table (Type II Wald chisquare tests)					
		2022		2023	
	Df	Pr(>Chisq)		Pr(>Chisq)	
Treatment	1	0.1620		0.1652311	
Week	1	0.8225		0.0749264	.
Cov	**1**	**< 0.001**	***	**0.0003236**	***
T x W	1	0.5047		0.6226358	



Funded by the European Union
agromix

Results - Fatty acids composition 2022-2023

FA ~ Treatment*Week + Cov + (1|Week:Day) + (1|Animal)

Fixed factor: Treatment (n=2), Week (n=2)

Nested: Factor (3 day per week)

Random factor: Animal (n=6)

FA: FA content at Day 0

Year 2022

Week 1	n	SFA			UFA			PUFA			MUFA			PUFAn6			PUFAn3		
Control	9	58.46	±	2.05	41.54	±	2.05	8.15	±	0.49	33.38	±	1.65	3.68	±	0.19	**2.26**	±	0.13
Treatment	9	58.20	±	2.18	41.80	±	2.18	9.19	±	0.42	32.61	±	1.79	4.04	±	0.17	**2.55**	±	0.09
Week 2	n																		
Control	9	68.69	±	1.11	31.31	±	1.11	6.54	±	0.37	**24.77**	±	0.84	3.11	±	0.18	**2.00**	±	0.10
Treatment	9	63.84	±	1.79	36.16	±	1.79	7.78	±	0.56	**28.38**	±	1.44	3.57	±	0.27	**2.31**	±	0.14

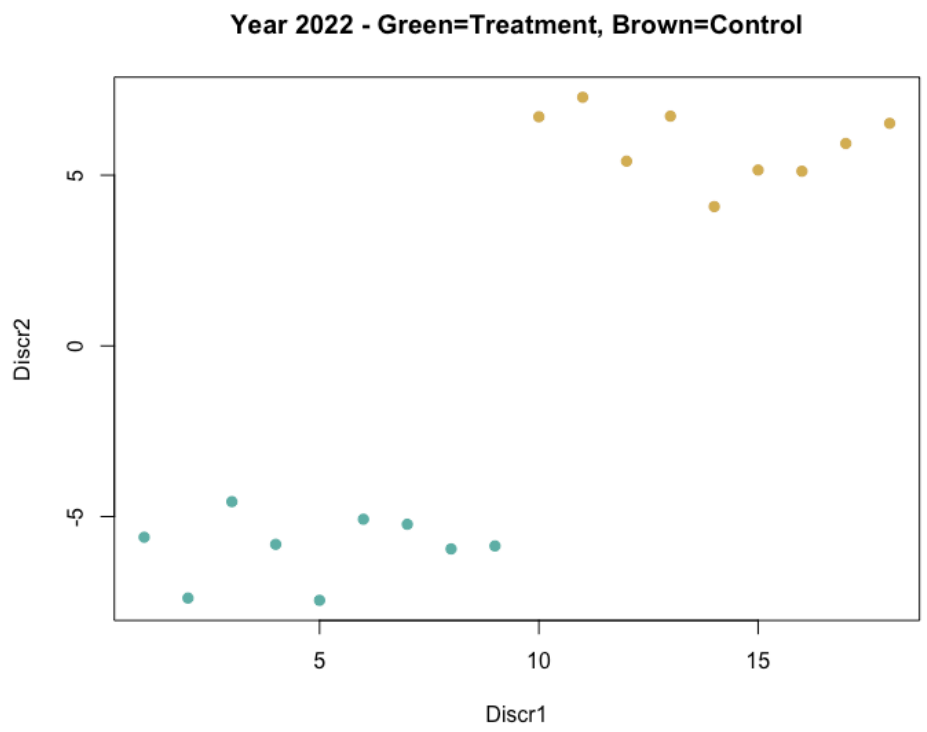
Year 2023

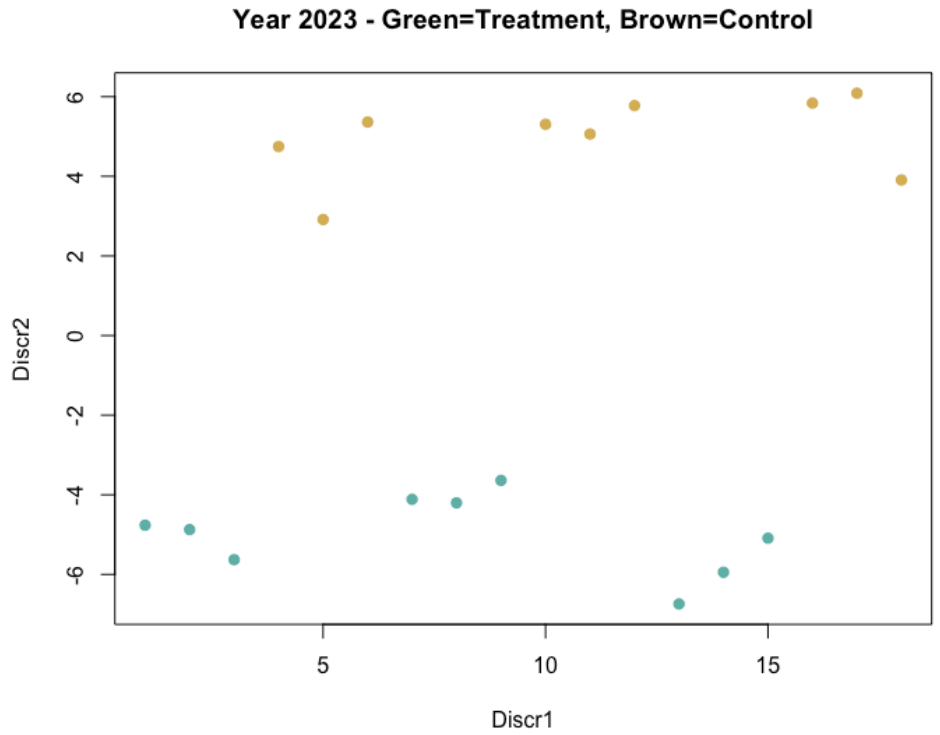
Week 1	n	SFA			UFA			PUFA			MUFA			PUFAn6			PUFAn3		
Control	9	67.17	±	1.67	32.74	±	1.66	7.92	±	0.39	24.82	±	1.37	3.69	±	0.22	2.52	±	0.15
Treatment	9	67.40	±	1.70	32.51	±	1.70	6.81	±	0.19	25.70	±	1.54	3.39	±	0.16	2.24	±	0.04
Week 2	n																		
Control	9	69.43	±	1.72	30.49	±	1.72	7.53	±	0.43	22.96	±	1.43	3.64	±	0.22	2.39	±	0.15
Treatment	9	68.39	±	1.89	31.53	±	1.89	7.17	±	0.36	24.36	±	1.57	3.61	±	0.21	2.27	±	0.10

Results - Fatty acids discriminant analysis 2022-2023 (2nd week data)

Year 2022	C6	C8	C14iso	C15iso	C16iso	C18_1t11	CLA9_11ct
Means group 1	2.100	1.073	0.151	0.326	0.288	1.314	1.076
Means group 2	2.477	1.392	0.156	0.363	0.296	1.075	0.759
LD1	-4.499	16.444	25.678	10.090	-7.547	5.061	-1.032

Year 2023	C6	C17iso	C16_1c7	C16_1c9	C17ante	C18_1t10	C18_2t9c12
Means group 1	2.355	0.423	0.404	0.986	0.481	0.507	0.049
Means group 2	2.340	0.456	0.352	1.154	0.529	0.578	0.053
LD1	0.721	94.118	-105.67	7.839	-17.357	23.160	-166.87

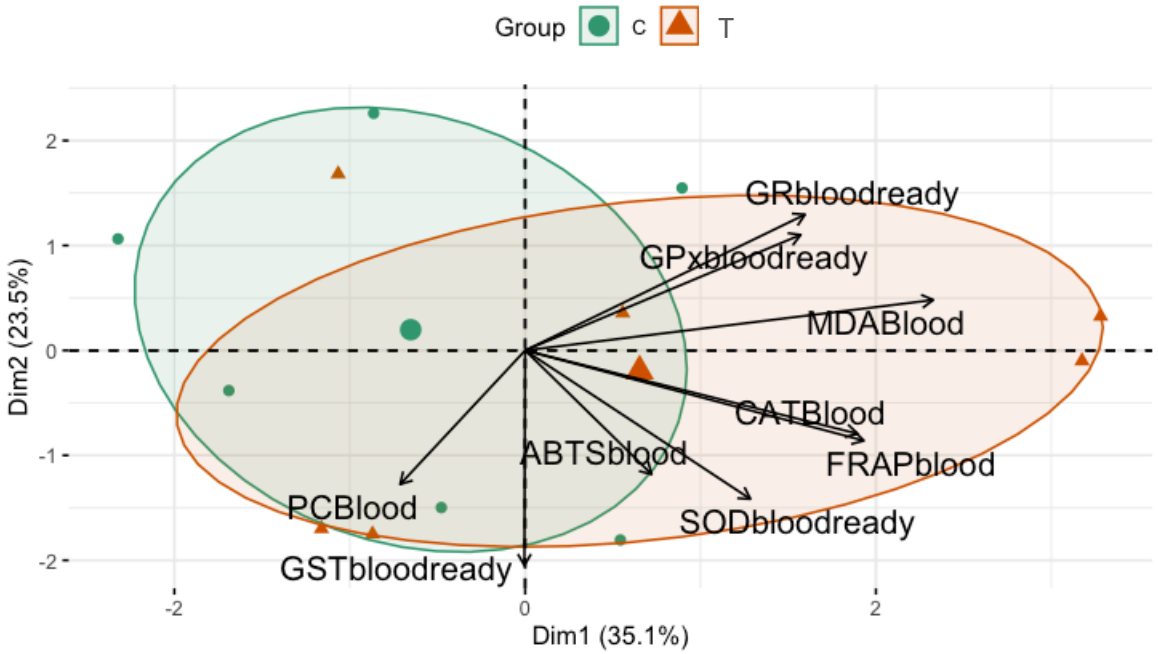




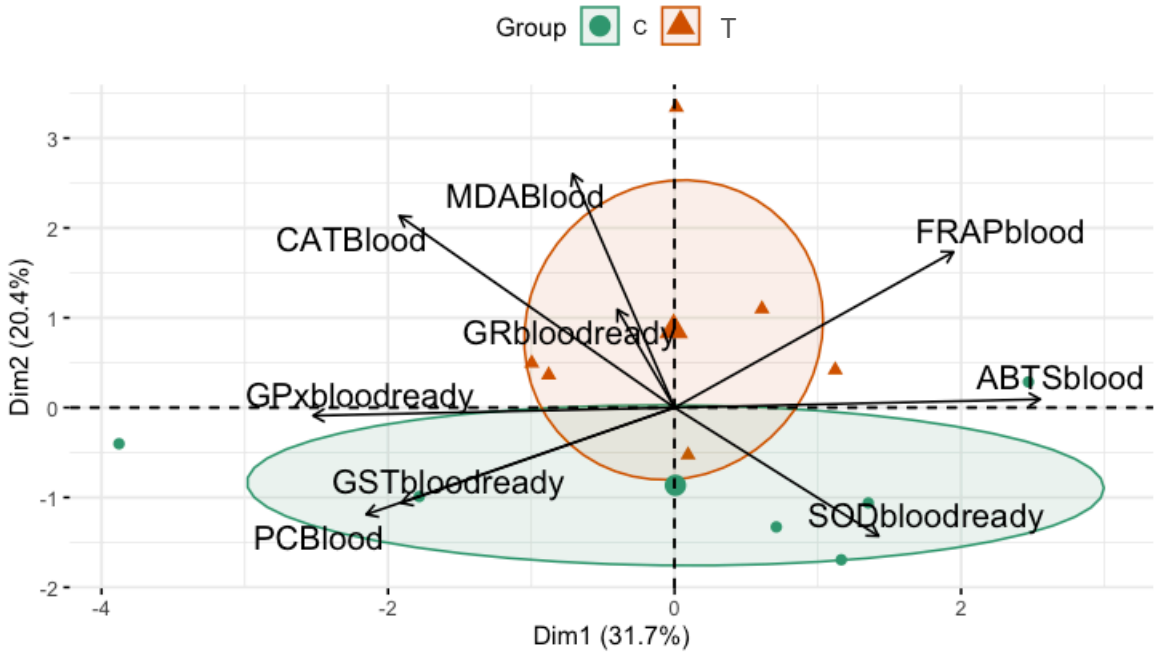
Results - Oxidative status analysis 2022-2023 (2nd week data)

No significant differences were observed in the oxidative system (OS) of sheep

Year 2022



Year 2023



PCA depicts a partial separation of the animal groups
Further and longer studies are mandatory to explore the effect on OS

Take home message

Poplar can effectively integrate sheep diets

Biomass estimation of poplar is a key factor for designing a silvopastoral system

Timing is crucial for exploiting the silvopastoral element system

Mechanization of tree trimming should be considered

Storing fresh poplar could be a valid option

Further studies could explore the influence of poplar on milk quality (e.g., fatty acids) and the oxidative status of sheep blood

Funded by the European Union

agromix

THANKS!

Martina Re m.re@santannapisa.it

CENTRO DI RICERCA SCIENZE DELLE PIANTE
Sant'Anna
Scuola Universitaria Superiore Pisa

Funded by the European Union

PLAS TEAM
Pisa Livestock farming, Animal food quality, and Sustainability