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1 **Supplementary material**

2 **Tables**

3 Table S1. Results of the linear mixed models fitted with restricted maximum likelihood
4 (REML) for forage composition (fixed terms). Forage total carbon concentration (TC, %),
5 total nitrogen concentration (TN, %), C:N ratio, and isotope ratios (δ^{13}C and δ^{15}N, ‰).
6 Interaction between factors is expressed with ":". LSD = Approximate least significant
7 difference (5% level) of REML means.

		Pasture	Treatment	Cut event	Pasture: Treatment	Pasture: Cut	Treatment: Cut	Pasture: Treatment: Cut	LSD
	n.d.f.	2	3	1	5	2	3	5	
TC	F	1.38	1.25	44.75	0.48	0.5	3.49	0.58	1.1130
	d.d.f.	6.3	18.2	21.9	19.4	22.3	23.9	24.5	
	p- value	0.32	0.32	**<0.001**	0.79	0.62	**0.03**	0.72	
TN	F	16.74	11.09	8.98	4.56	18.33	0.93	1.83	0.5693
	d.d.f.	7.2	17.4	24	18.5	24.6	27.4	27.7	
	p- value	**0.002**	**<0.001**	**0.006**	**0.007**	**<0.001**	0.442	0.14	
C:N	F	11.37	14.34	7.37	7.1	21.15	1.23	2.03	4.0010
	d.d.f.	7	16	24	17.2	24.5	27.7	27.8	
	p- value	**0.006**	**<0.001**	**0.012**	**<0.001**	**<0.001**	0.319	0.105	
δ^{13}C	F	12.1	2.32	141.54	1.9	7.42	4.49	0.58	0.6819
	d.d.f.	6.8	17.4	22.2	18.3	22.7	24.4	25.1	
	p- value	**0.006**	0.111	**<0.001**	0.143	**0.003**	**0.012**	0.715	
δ^{15}N	F	9.07	1.88	113.42	1.24	5	4.19	1.1	1.7840
	d.d.f.	7	26.1	17.9	24	18.1	18.1	18.5	
	p- value	**0.011**	0.158	**<0.001**	0.323	**0.019**	**0.02**	0.392	

8

9   Table S2. Results of two-ways ANOVA for baseline soil health indicators before dung and
10   urine application (timepoint 1). Pasture: HS, high sugar grass monoculture; PP, permanent
11   pasture; WC, white clover/high sugar grass mix. Treatment: Fertilised and no fertilised plots.

|	Pasture $F_{2,30}$	Pasture p-value	Treatment $F_{1,30}$	Treatment p-value	Pasture:Treatment $F_{2,30}$	Pasture:Treatment p-value
SOC (%)	22.762	**< 0.001**	0.001	0.976	0.586	0.563
TN (%)	29.171	**< 0.001**	0.002	0.961	0.502	0.610
C:N	1.005	0.378	0.022	0.882	0.556	0.580
$\delta^{13}C$ (‰)	10.791	**< 0.001**	1.272	0.268	0.544	0.586
$\delta^{15}N$ (‰)	10.304	**< 0.001**	0.384	0.540	0.871	0.429
DOC (mg g^{-1})	25.983	**< 0.001**	0.178	0.676	0.185	0.832
pH	8.304	**< 0.001**	0	0.996	0.594	0.559
Ergosterol (%)	5.571	**< 0.001**	0.562	0.459	0.300	0.743

12

13   Table S3. Results of linear mixed models fitted with restricted maximum likelihood (REML) for

14   soil health indicators.

		Pasture	Treatment	Timepoint	Pasture: Treatment	Pasture: Timepoint	Treatment : Timepoint	Pasture: Treatment: Timepoint
SOC (%)	n.d.f.	2	3	6	5	12	18	30
	F	45.37	4.71	12.15	1.06	2.97	1.29	0.74
	d.d.f.	6.1	18.8	148.9	18.7	148.9	148.9	148.9
	p- value	**<0.001**	**0.013**	**<0.001**	0.414	**<0.001**	0.201	0.829
SOC (Mg ha^{-1})	n.d.f.	2	3		5			
	F	1.96	1.74		0.75			
	d.d.f.	6.0	17.2		17.2			
	p- value	0.221	0.197		0.597			
TN (%)	n.d.f.	2	3	2	5	4	6	10
	F	35.68	3.03	16.02	0.50	3.39	1.52	0.67
	d.d.f.	6.1	19.0	50.0	19.0	50.0	50.0	50.0
	p- value	**<0.001**	0.055	**<0.001**	0.773	**0.016**	0.191	0.746
C:N	n.d.f.	2	3	2	5	4	6	10
	F	0.24	2.26	15.22	1.20	0.95	0.40	0.22
	d.d.f.	6.0	19.0	50.0	19.0	50.0	50.0	50.0
	p- value	0.794	0.115	**<0.001**	0.345	0.442	0.872	0.993
$\delta^{13}C$ (‰)	n.d.f.	2	3	2	5	4	6	10
	F	0.53	4.4	16.59	0.82	18.01	3.74	0.52
	d.d.f.	6.0	19.0	50.0	19.0	50.0	50.0	50.0
	p- value	0.615	**0.016**	**<0.001**	0.548	**<0.001**	**0.004**	0.865
$\delta^{15}N$ (‰)	n.d.f.	2	3	2	5	4	6	10
	F	19.96	4.95	1.07	0.24	0.95	1.55	0.48
	d.d.f.	6.3	19.0	50.0	19.0	50.0	50.0	50.0
	p- value	**0.002**	**0.011**	0.351	0.938	0.444	0.18	0.892
DOC (mg g^{-1})	n.d.f.	2	3	2	5	4	6	10
	F	19.03	4.39	11.48	0.22	4.16	2.14	0.78
	d.d.f.	6.1	18.8	48.7	19.0	48.9	48.9	49.0
	p- value	**0.002**	**0.017**	**<0.001**	0.951	**0.006**	0.066	0.643
pH	n.d.f.	2	3	6	5	12	18	30
	F	2.37	0.27	66.79	0.53	2.03	5.04	1.39
	d.d.f.	6.4	19.0	149.0	19.0	149.0	149.0	149.0
	p- value	0.17	0.848	**<0.001**	0.754	**0.025**	**<0.001**	0.103
BD (g cm^{-3})	n.d.f.	2	3		5			
	F	30.94	0.04		1.23			
	d.d.f.	6.4	18.0		17.9			
	p- value	**<0.001**	0.989		0.335			
MWD (mm)	n.d.f.	2	3		5			

	F	1.26	1.16		0.27			
	d.d.f.	6.3	19.0		19.0			
	p- value	0.347	0.353		0.922			
Soil lost (%)	n.d.f.	2	3		5			
	F	1.43	0.73		1.4			
	d.d.f.	6.2	19.0		19.0			
	p- value	0.308	0.548		0.269			
Ergosterol (%)	n.d.f.	2	3	1	5	2	3	5
	F	2.27	0.89	45.09	0.12	2.31	0.55	0.41
	d.d.f.	6.2	19.0	25.0	19.0	25.0	25.0	25.0
	p- value	0.182	0.467	**<0.001**	0.987	0.12	0.654	0.835
Earthworm mass (g, g m^{-2})	n.d.f.	2	3		5			
	F	5.91	6.6		0.14			
	d.d.f.	6.7	19.0		19.0			
	p- value	**0.033**	**0.003**		0.982			
Earthworm abund. (N) and density (N m^{-2})	n.d.f.	2	3		5			
	F	15.76	12.56		0.39			
	d.d.f.	7.3	19.0		19.0			
	p- value	**0.002**	**<0.001**		0.848			

Supplementary Figures
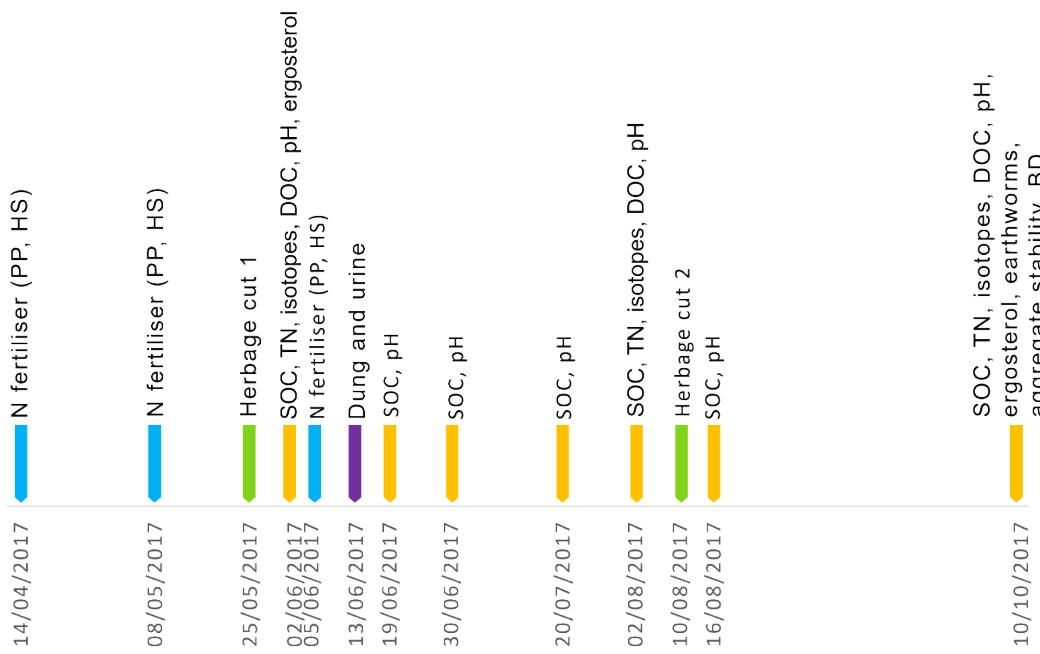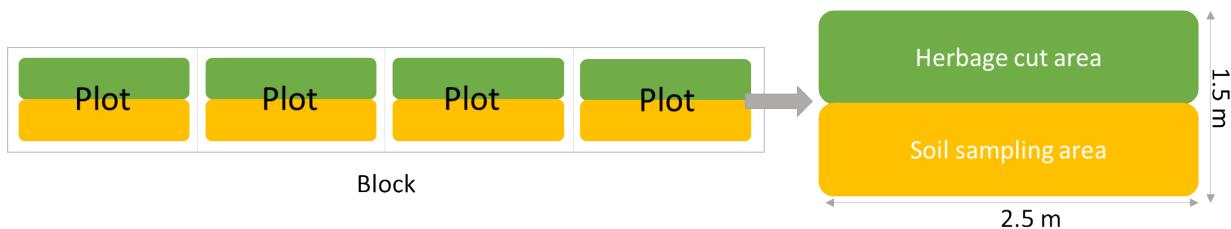
Figure S1. Summary of the main events and soil health measurements in each plot during the

20 experiment. SOC (%)= soil organic carbon; TN (%)= soil total nitrogen; C:N = soil C:N ratio;

21 isotopes are $\delta^{13}C$ (‰)= soil $\delta^{13}C$ value and $\delta^{15}N$ (‰) = soil $\delta^{15}N$ value; DOC (mg g^{-1})=

22 dissolved organic carbon; Ergosterol (%)= ergosterol concentration in soil; Earthworms: total

23 earthworm mass (g) and total earthworm abundance (number of individuals); aggregate

24 stability measured using the mean diameter weight of aggregates (mm) and the percentage

25 of soil lost through the 50 μm mesh (%); BD (g cm^{-3})= bulk density. Notice that inorganic N

26 fertiliser was applied in the permanent pasture (PP) and high sugar grass monoculture (HS)

27 systems. For this study, four plots from the original 6 plots established in each block (15 m)

28 were used.

29

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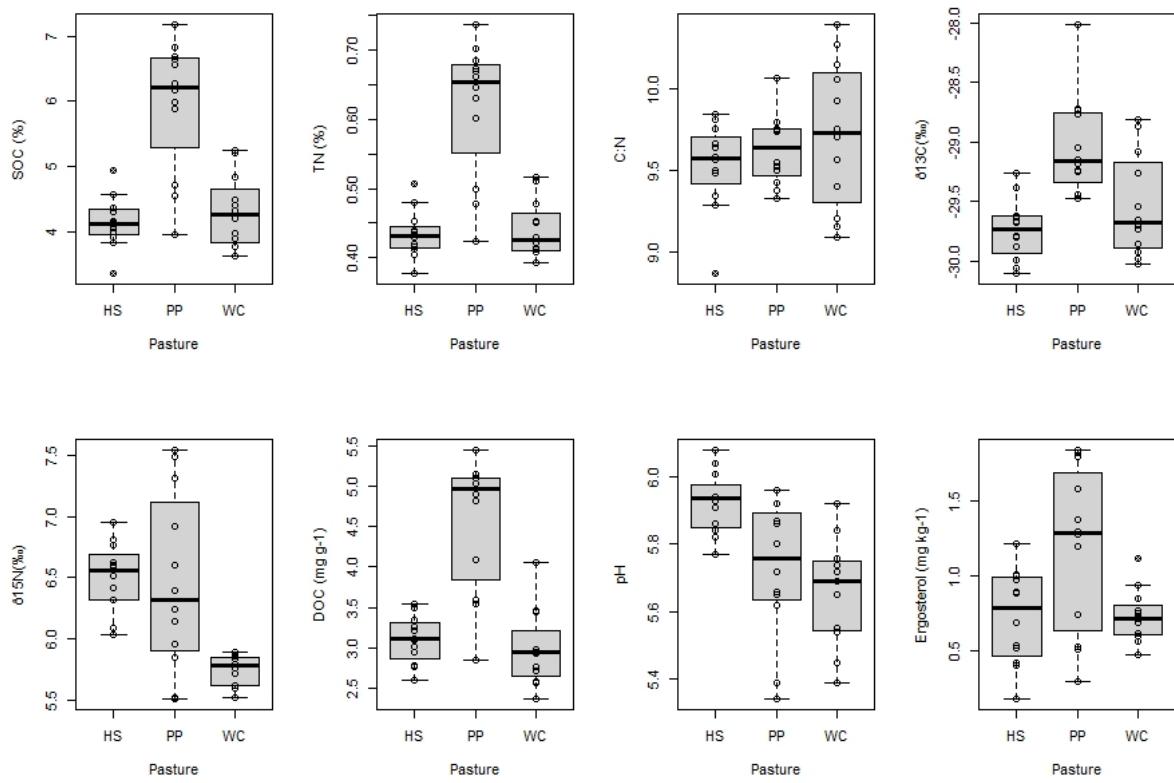
Fig. S2. Boxplots showing median, 25th percentile, 75th percentile and range in soil health indicators for the different grassland systems before dung and urine application (baseline, timepoint 1). HS= high sugar grass monoculture; PP= permanent pasture; WC =white clover/high sugar grass mix. SOC (%)= soil organic carbon; TN (%)= soil total nitrogen; C:N = soil C:N ratio; δ^{13}C (‰)= soil δ^{13}C value ; δ^{15}N (‰) = soil δ^{15}N value; DOC (mg g^{-1})= dissolved organic carbon.

38
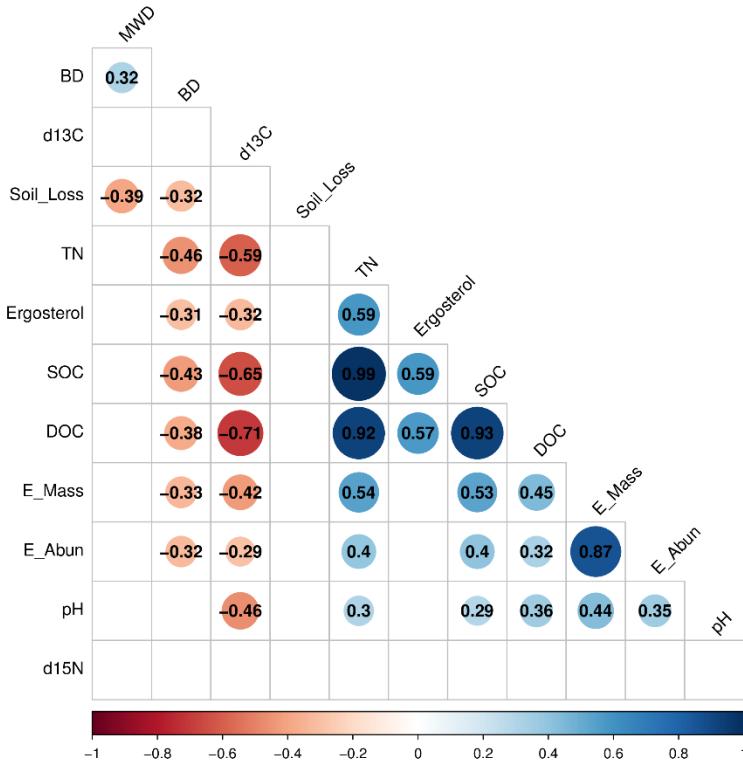
Figure S3. Correlation matrix analysis for soil health indicators at the end of the experiment (0–10 cm). Blue circles indicate significant (p < 0.05) positive correlations, red circles indicate significant negative correlations, and no significant correlation coefficient values (p > 0.05) are left blank. The size of the circles represents the strength of the correlation. Numbers indicate the correlation values. The matrix has been ordered following the angular order of the eigenvectors to show correlated variables closer together. MWD, mean weigh diameter of aggregates (mm); BD, soil bulk density (g cm−3); d13C, ⬚13C abundance in soil (‰); Soil_Loss, percentage of soil lost through the 50 µm mesh (%); Ergosterol, ergosterol content in the soil (mg kg -1 dry soil); TN, total nitrogen in the soil (% dry matter); DOC, dissolved organic carbon (mg g-1); SOC, soil organic carbon (% dry matter); E_Mass, the total mass of earthworms (g); E_Abun, the total abundance of earthworms; pH; d15N, ⬚15N abundance in soil (‰).

51
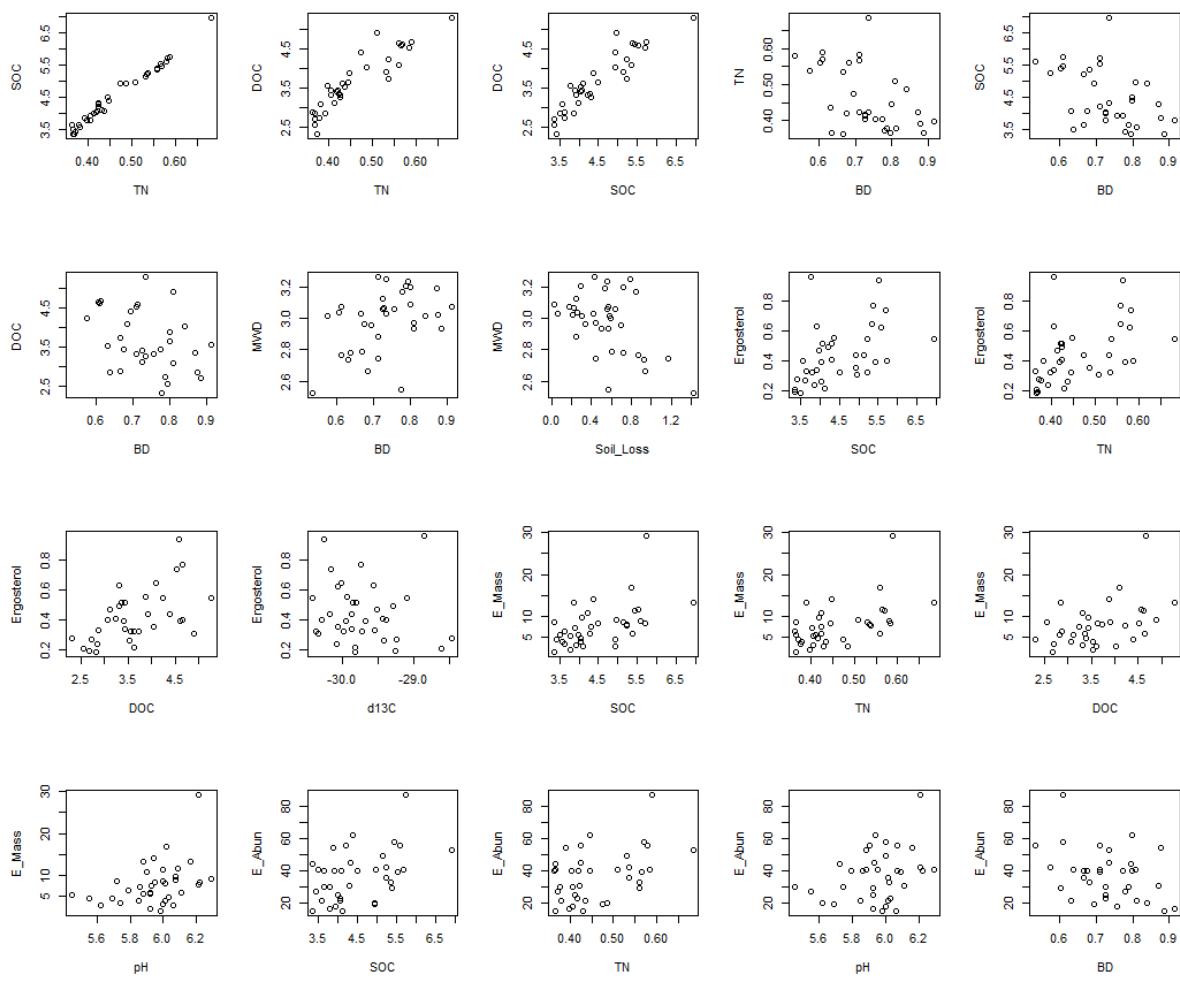
Fig. S4. Scatterplots with correlated variables at the end of the experiment. SOC (%)= soil organic carbon; TN (%)= soil total nitrogen; DOC (mg g^{-1})= dissolved organic carbon; BD (g cm^{-3})=bulk density; MWD (mm)= mean diameter weight of aggregates; Soil_Loss (%): the percentage of soil lost through the 50 μm mesh; Ergosterol (%)= ergosterol concentration; d13C (‰)= soil δ^{13}C value; E_mass (g)= total earthworm mass; E_Abun (number of individuals)= total earthworm abundance.