Supplementary

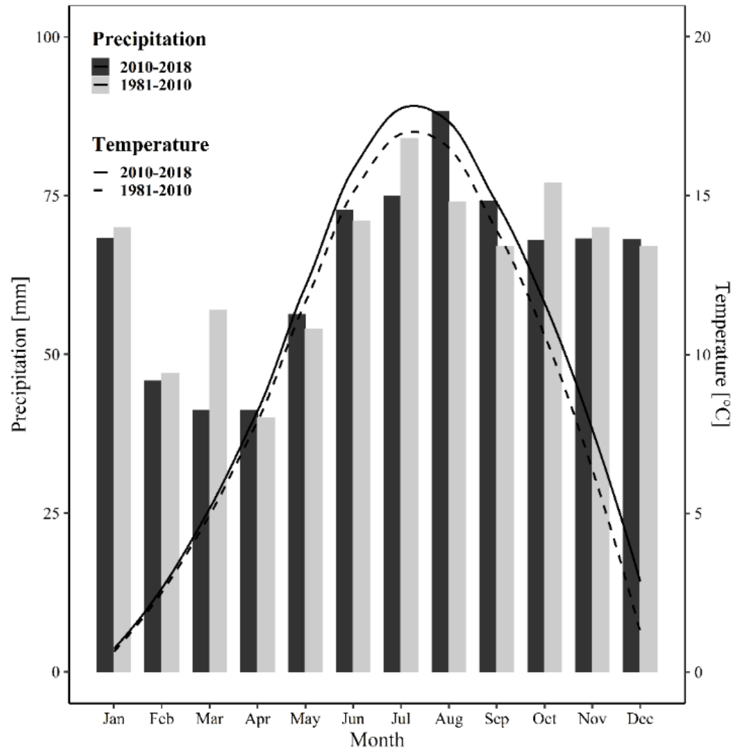

Figure S1 Average monthly weather recorded during the study period (2010 – 2018) and average monthly long-term weather measured in the 30 years prior the study period (1981 – 2010). The mean annual temperature was 0.6 °C higher compared to the long-term average (1981 – 2010) of 8.9 °C. The difference between total annual precipitation recorded during the study period (784 mm yr^{-1}) and the long-term mean annual precipitation (778 mm yr^{-1}) was minor.

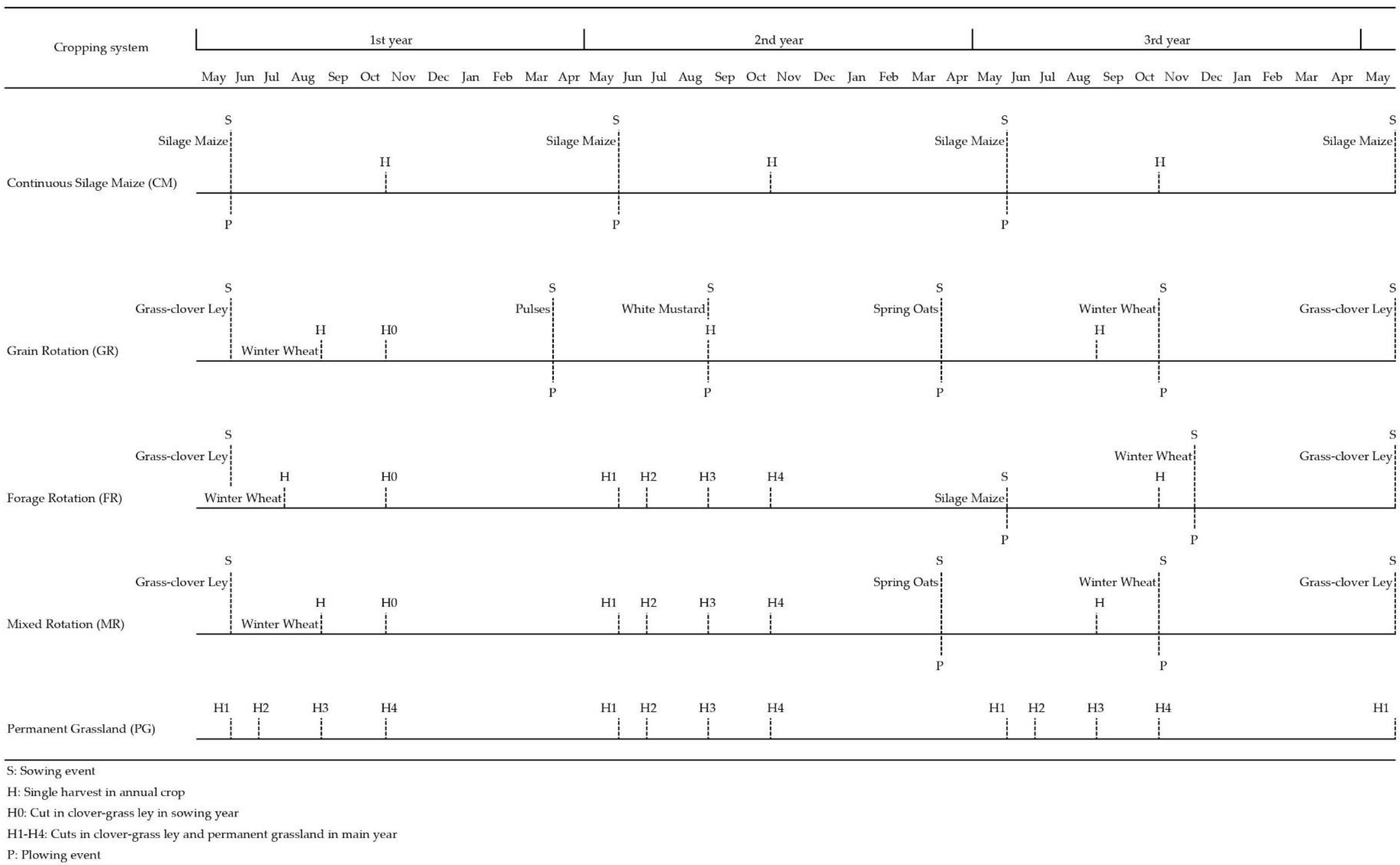

Figure S2. Diagram of the rotational cycles and crops belonging to each cropping system (CS) involved in the present study. For the permanent grassland and the transition between winter wheat and undersown (u.) clover-grass, the soils remain undisturbed. CM: continuous maize, GR: grain rotation, FR: forage rotation, MR: mixed rotation, PG: permanent grassland, N0: unfertilized, N1: fertilized using cattle slurry at a rate of 240 kg N ha^{-1} in non-leguminous crops.

Table S1. Mean annual crop yields (Y_P) (± standard deviation, (S.D)) of three replicates, measured for the different crops within each cropping system and N rate for the period 2011 – 2018.

Cropping System	**Crop**	**N rate**			
		N0		**N1**	
		Mean Y_P (S.D.) *(Mg ha⁻¹ yr⁻¹)*			
CM	Silage Maize	7.6	(2.9)	10.1	(3.8)
GR	Spring Oats	3.6	(1.1)	3.8	(1.1)
	Winter Wheat	2.2	(0.9)	2.7	(0.9)
	Pulses	2.3	(1.0)	2.5	(1.0)
	Clover-grass Ley (sowing year)	1.3	(0.6)	1.2	(0.5)
FR	Silage Maize	11.3	(3.9)	12.9	(3.9)
	Winter Wheat (whole-crop silage)	4.6	(1.0)	6.5	(1.2)
	Grass-clover Ley (sowing year)	1.6	(1.0)	1.6	(0.9)
	Grass-clover Ley (main year)	10.1	(3.3)	9.8	(3.3)
MR	Spring Oats	3.7	(1.2)	3.6	(1.2)
	Winter Wheat	2.1	(1.1)	2.8	(1.1)
	Grass-clover Ley (sowing year)	1.2	(0.6)	1.0	(0.6)
	Grass-clover Ley (main year)	9.9	(2.4)	8.8	(3.5)
PG	Grassland	5.9	(2.0)	6.8	(2.1)

CM: continuous silage maize, GR: grain rotation, FR: forage rotation, MR: mixed rotation, PG: permanent grassland, N0: unfertilized, N1: fertilized using cattle slurry at a rate of 240 kg N ha^{-1} in non-leguminous crops

Table S2. Yield-based allocation coefficients and fixed inputs used to calculate the annual soil C inputs from plants (Plant C_{in}) during and after the growing season, respectively.

Crop type†		N rate	Yield-based allocation coefficients				Fixed inputs	
			HI¶	SI#	$ACDM_{AGB}$*	R:S§	$AW–AG_{in}$	$AW–BG_{in}$
			(Fraction)			(Ratio)	(Mg ha^{-1})	
Forage	Permanent Grassland	N0	0.75	0.15	0.90	0.41	0.40	0.63
		N1	0.81	0.15	0.90	0.56	0.46	0.63
	Grass-clover Ley (sowing year)	N0	0.37	0.15	0.90	0.33	0.23	0.21
		N1	0.36	0.15	0.90	0.47	0.21	0.21
	Grass-clover Ley (main year)	N0	0.85	0.15	0.90	0.21	1.83	0.50
		N1	0.85	0.15	0.90	0.31	1.83	0.46
	Silage Maize (CM)	N0	0.94	0.06	0.96	0.21		
		N1	0.94	0.06	0.96	0.23		
	Silage Maize (FR)	N0	0.94	0.06	0.96	0.18		
		N1	0.94	0.06	0.96	0.24		
	Winter Wheat	N0	0.95	0.05	0.91	0.33		
		N1	0.95	0.05	0.91	0.26		
Grain	Winter Wheat	N0	0.38	0.08	0.95	0.70		
		N1	0.41	0.08	0.95	0.60		
	Spring Oats	N0	0.45	0.09	0.92	0.40		
		N1	0.48	0.09	0.92	0.40		
	Pulses	N0	0.47		0.96	0.40		
		N1	0.45		0.96	0.30		
Cover crop	Grass-clover Ley (sowing year)	N0					1.48	0.21
		N1					1.38	0.21
	White Mustard	N0					1.35	1.44
		N1					1.60	1.27

†: Forages were measured in 2012 and 2013 by [1], and grain and cover crops in 2019

¶: Harvest index to calculate the AGB produced during the growing season, and to calculate the straw remaining on the field (applied in the pulses only, see text for details)

#: Stubble index to calculate the stubbles produced during the growing season in forage crops, and in grain crops with straw removed (applied in winter wheat and spring oats, see text for details)

*: Fraction of ash-corrected dry matter in total AGB

§: Ash-corrected root:shoot ratio to calculate the BGB produced during the growing season.

The $AW–AG_{in}$ and $AW–BG_{in}$ stand for ash-corrected crop residue inputs from above- and belowground biomass, respectively, for those cropping systems containing clover-grass ley, grassland and cover crops after the growing season (during autumn and winter).

Table S3. Steps and equations followed to calculate annual soil C inputs (C_{in}) in each crop and cropping system, using annual yields (Y_P, Table S1) and yield-based allocation coefficients (Table S2). See main article, Tables S1 and S2 for explanations.

Steps	Equations
1	$AGB = Y_P/HI \times ACDM_{AGB}$
2	$Straw = AGB \times (1\text{-}HI)$
	$Stubbles = AGB \times SI$
3	$BGB = AGB \times R{:}S$
4	$AG\ C_{in} = (Straw + Stubbles + AW\text{–}AG_{in}) \times 0.48$
	$BG\ C_{in} = [BGB + AW\text{–}BG_{in} + (BGB + AW\text{–}BG_{in}) \times 0.5] \times 0.48$
5	$Plant\ C_{in} = AG\ C_{in} + BG\ C_{in}$
6	$Total\ C_{in} = Plant\ C_{in} + Slurry\ C_{in}$

In AG C_{in}, for crops with stubbles on the field (straw removed), straw = 0; for crops with straw remaining on the field, stubbles = 0.

In AG C_{in} and BG C_{in}, for crops without fixed inputs (Table S2), $AW\text{–}AG_{in}$ and $AW\text{–}BG_{in}$ = 0

References

1. Loges, R.; Bunne, I.; Reinsch, T.; Malisch, C.; Kluß, C.; Herrmann, A.; Taube, F. Forage production in rotational systems generates similar yields compared to maize monocultures but improves soil carbon stocks. Eur J Agron 2018, 97, 11–19, doi:10.1016/j.eja.2018.04.010.