Supplementary methods

S1. Empirical data collection

The following section describes the methods used to collect data from Wardlow to be used in calibrating the model and later testing its performance. It also details how empirical data was converted into model-compatible data. The variables for which data were collected are aboveground biomass (converted to aboveground biomass carbon for the model), soil organic carbon and soil organic nitrogen. Total soil phosphorus data was taken from work previously carried out at Wardlow. Data were collected from mesocosms extracted from the acidic and calcareous grasslands at Wardlow.

S1.1. Biomass data

Biomass data from the acidic and calcareous grasslands at Wardlow is not used within the cost function to determine the P_{Weath0} and $P_{\text{CleaveMax}}$ values due to the high inter-annual variability associated with it. However, as it was not included, it could be used to blindly assess the model's performance at simulating biomass carbon stocks.

In addition, as provision of the limiting nutrient to an ecosystem increases productivity (as by their definition of a limiting nutrient), we used the biomass data to assess the model's ability to simulate the nutrient-limited behaviour of the two grasslands. Despite both the acidic and calcareous grasslands showing signs of nutrient co-limitation (positive growth response to either nutrient addition), the acidic grassland behaves more symptomatically of an N limited ecosystem and the calcareous more as a P limited. As such, it is suitable for the model (with a Liebig's law restriction) to expect N limited and P limited behaviour from the modelled acidic and calcareous grasslands respectively.

To collect data on standing biomass stocks for the acidic and calcareous grasslands, two separate harvest were required; a 'partial' and a 'full' harvest. In the former, all above ground biomass down to a height of 5 cm in the acidic and 2.5 cm in the calcareous is harvested, with a frequency of twice a year, once in the summer and again in autumn. This is to replicate the low intensity grazing of the Wardlow site. The full clip harvest removes all standing biomass down to the soil surface from a small area (0.07*0.07 m^2) of each mesocosm. This is done once a year and is never repeated in the same spot.

To convert the biomass data from a single year into the model-equivalent above-ground carbon stocks, the following Equation (Eq. S1) was used:

$$\frac{(P_1.\frac{1}{A_P}) + (P_2.\frac{1}{A_P}) + (F.\frac{1}{A_F})}{2} \qquad \text{(Equation S1)}$$

Here, P_1 and P_2 represent the first (spring) and second (summer) partial harvest biomass dry weight (grams) and F represents the full harvest biomass by dry weight. A_P and A_F are the areas from which the biomass was harvested and are 0.35*0.35 m^2 and 0.07*0.07 m^2 respectively. Dividing 1 by the harvest area converts the data from grams to grams per metre squared. Finally, as per Chapin *et al.*

(2011), we assume 50% of dry biomass is carbon and hence divide the total above ground biomass by 2 to estimate the above ground carbon stocks.

The equivalent modelled data is the annual sum of the soft tissue carbon for plant types 1 and 2, which represent two end-members with different C:N ratios and are used to dictate plant responses to nitrogen supplementation (see Davies *et al*. 2016b for more details).

S.1.2. Soil organic carbon and soil nitrogen data collection

Six replicates for each grassland-treatment combination where analysed for soil organic carbon and total soil nitrogen content (note that total soil nitrogen is assumed equivalent in pool size to the organic nitrogen pool within the model). The deeper soil profile of the acidic grasslands produces two distinct horizons; organic and mineral, whereas the calcareous grassland consists of a single humic horizon. As such, separate samples were taken from the two distinct acidic horizons (Table S1).

Table S1: A summary of the samples analysed for organic carbon and total nitrogen content. Soil samples were collected from all four nutrient treatments of the two grasslands and where necessary, both soil horizons (represented by depth column)

Grassland	Treatment	Depth (cm)	Replicates
Acidic	0N	0-10	6
		10-20	6
	LN	0-10	6
		10-20	6
	HN	0-10	6
		10-20	6
	P	0-10	6
		10-20	6
Calcareous	0N	0-10	6
	LN	0-10	6
	HN	0-10	6
	P	0-10	6

While the boundary between horizons differed between samples (most noticeably those from different sample blocks), the acidic horizons could be approximately distinguished into depths of 0 - 10 cm and 10 – 20 cm for organic and mineral horizons respectively. The calcareous horizon depth was classified as 0 -10 cm depth. To account for spatial heterogeneity within soil conditions at the field site, where possible, 2 replicates of each block (A, B or C) were taken for sampling. Acidic samples from both horizons were paired.

Approximately 5 g of dry soil was taken for each sample prior to processing. Dry soil was emptied into a pestle and mortar and excess roots, stones and plant material were removed with forceps. Samples were homogenised in a pestle and mortar until they were fine dust, and any remaining plant material or stones were removed.

Approximately 60 mg of fine soil was placed into a 1.5 ml Starstedt Eppendorf tube prior to acid stripping. 700 µl of 6M hydrochloric acid was pipetted into the Eppendorf tubes ensuring that soil dust adhered to the side was washed into the bottom. A blunt needle was used to mix the acid with the soil to ensure all soil was in contact with the acid. The tubes were left for 15 minutes before a further 100 µl of acid was added and the mixture stirred again before leaving in a fume cupboard for 24 hours.

After 24 hours, the samples were mixed again and put in a Techne DB 200/3 Dri-Block for 24 hours at 105 degrees ^{o}C until the acid had evaporated. The pellets were crushed into a fine powder prior to analysis in the isotope-ratio mass spectrometer. Samples were separated into calcareous and acidic and randomised with a number between 1 – 24 for calcareous and 25 – 72 for acidic to account for any potential systematic drift of the mass spectrometry equipment.

S1.3. Converting empirical to modelled C and N data

The modelled organic carbon and nitrogen units represent total stocks in grams per metre squared as opposed to percent dry weight for the empirical data. To incorporate empirical data into the model, a number of adjustments were required to make the data model-compatible.

Firstly, the mass of soil in the organic and mineral horizons (MH_O and MH_M respectively) was calculated by multiplying each treatment's mean horizon depth (DH_O, DH_M) by its bulk density (BD_O, BD_M). To convert this to grams per metre squared, this value was multiplied by 10,000 (Eq. S2a, S2b).

The mass (grams) of carbon in each horizon (MC_O, MC_M) was calculated by multiplying the horizon mass derived from Eq. S2a and S2b by the empirical organic carbon percentage (SOC_{empO}, SOC_{empM}). As the empirical data is presented as a percentage, the data were multiplied by 0.01 (Eq. S3a, S3b).

Finally, to calculate the organic carbon stocks within the model, the differing depths of the topsoils of the empirical versus modelled grassland needed to be considered. The total soil depths were 20 cm and 10 cm for the acidic and calcareous grasslands respectively but the modelled topsoil, which corresponds to the layer of soil that plants can interact with, was 15 cm.

As the calcareous grassland soil profile rarely exceeds 15 cm in depth, it was assumed that the empirical SOC value (in g m^{-2}) applied to the whole modelled topsoil component. Conversely for the acidic profile which exceeds 15 cm, adjustments were required to ensure that the mineral horizon was not overrepresented and thus SOC underestimated. To account for this, the mass of carbon in the organic horizon (10 cm) was added to half the mass of carbon in the mineral (20 cm) to give an approximation of the carbon in the top 15 cm of soil (Eq. S4).

$$MH_O = DH_O \,.\, BD_O \,.\, 10{,}000$$ (Equation S2a)

$$MH_M = DH_M \,.\, BD_M \,.\, 10{,}000$$ (Equation S2b)

$$MC_O = MH_O \,.\, SOC_{empO} \,.\, 0.01$$ (Equation S3a)

$$MC_M = MH_M \,.\, SOC_{empM} \,.\, 0.01$$ (Equation S3b)

$$SOC_{mod} = MC_O + \frac{MC_M}{2}$$ (Equation S4)

The same process was used to convert empirical organic N into model-compatible N data.

Note that the above Equations apply to the acidic grassland where the profile is split into an organic and mineral horizon. To convert the C and N data from the calcareous grassland, a similar procedure was followed as in Equations S2 to S4 but with a single horizon and no adjustment to soil depth (Eq. S5 and S6):

$$MH = DH \,.\, BD \,.\, 10{,}000$$ (Equation S5)

$$MC = MH \,.\, SOC_{emp} \,.\, 0.01$$ (Equation S6)

S1.4. Total soil phosphorus data

Total soil phosphorus (TP) data was compared to TP simulated by the model in Figure 1, but soil organic P is presented and analysed in Figure 2 and data pertaining to it. This is due to total but not soil organic P data being available for Wardlow. To calculate total soil P in the model, the SOP pool is added to the sorbed P pool.

Due to time constraints, total soil phosphorus data was not collected explicitly for this work like biomass, SOC and total N data were. Instead, we use P data collected previously from the same two grasslands used within the current study [*P Horswill et al.*, 2008].These data were in mmol kg^{-1} and like soil C and N data, were converted into the model-compatible g m^{-2}. Details are given below:

The starting units of the total phosphorus data are in mmol P kg^{-1} of soil dry weight [*P Horswill et al.*, 2008] and the model simulates data in g P m^{-2}. First, the TP data is divided by 1000 to give the value in moles kg^{-1} and multiplied by the atomic mass of P (AM_P) to convert to g kg^{-1} (Eq. S7).

$$P\ (g\ kg^{-1}) = \frac{P\ (mmol\ kg^{-1})}{1000}\ .AM_P \qquad \text{(Equation S7)}$$

As the TP data for the acidic grassland is separate for the organic and mineral horizons, we used similar techniques as with C and N data conversion, again assuming 0-10 cm depth for the organic and 10-20 cm depth for the mineral horizon respectively. The mean depth of the organic and mineral horizon ($\overline{\mathrm{H}_{\mathrm{O,M}}}$) was calculated and converted to a proportion of the total soil depth represented by each horizon by dividing it by the total soil depth (T_D). The proportion for both the organic and mineral horizon was multiplied by the depth of the modelled topsoil (M_D) to give the relative depth of each within the model (D_O, D_M for modelled organic and mineral depth) (Eq. S8).

$$D_{O,M} = \frac{\overline{H_{O,M}}}{T_D}.M_D \qquad \text{(Equation S8)}$$

To get the mass of P m^{-3} of each horizon (P_O, P_M for organic and mineral respectively), the mass of P g kg^{-1} was multiplied by the mean bulk density of each horizon (BD_O, BD_M) (Eq. S9). This was then multiplied by the modelled organic and mineral horizon depth (M_D) to give g TP m^{-2}, and both horizons were summed to give total P in the model topsoil (Eq. S10).

$$P_{O,M} = P\ (g\ kg^{-1}).BD_{O,M} \qquad \text{(Equation S9)}$$

$$P\ (g\ m^{-2}) = (P_O.D_O) + (P_M.D_M) \qquad \text{(Equation S10)}$$

Note that as with the SOC and total N conversions, the depth adjustments were only required for the acidic and not calcareous data.

Supplementary data

The following supplementary data section provides more information regarding the empirical grasslands and data for model input, calibration (and testing). The latter data were collected via the above methods. Model output data are also included. The headings pertain to the locations where the tables are referenced in the main manuscript.

2.1. Field experiment description

Table S2: Soil and vegetation characteristics of the Wardlow grasslands

Grassland type	Soil type	Soil texture	Vegetation type	NVC
Acid	Paleo-agrillic brown earth	Silt loam	Acidic grassland	U4e, *Festuca-Agrostis-Galium*
Calcareous	Humic rendzina	Sandy loam	Calcareous grassland	CG2d, *Festuca-Avenula*

2.3.2. Input drivers

Table S3: A summary of the input driver data used to run the model and their sources. All units are presented as they are included in the model, following any necessary required conversions.

Variable	Units	Notes	Source
Mean quarterly temperature	^{o}C	The nearest weather station to Wardlow was selected using Pythagoras' theorem	UKPC09 Met office CEDA database
Mean annual precipitation	mm	(same as above)	UKPC09 Met office CEDA database
N deposition	g m^{-2} $year^{-1}$	Nearest site to Wardlow's grid reference	CEH deposition maps
BC deposition	g m^{-2} $year^{-1}$	(same as above)	CEH deposition maps
S deposition	g m^{-2} $year^{-1}$	(same as above)	CEH deposition maps
Plant functional type history	-	Annual basis, determined by pollen stratigraphy – specific history detailed in main text	Taylor *et al*. (1994)
Nutrient additions	g m^{-2} $year^{-1}$	Details of seasonal fertiliser additions	Morecroft *et al*. (1994)

2.3.3. Model parameters for the acidic and calcareous grasslands

The below data in the 'Obs' column of table S4 were collected via the above methods and following the aforementioned unit conversions, with exception of P data.

Table S4: Empirical data from Wardlow used to a) calibrate P_{Weath0} and $P_{CleaveMax}$ to the acidic and calcareous grasslands individually and to b) compare the modelled data (Sim) to empirical observations (Obs). Mean SOC and SON stocks of empirical data are presented as is the mean total soil P. All units are in grams per square metre. Cells contain NA if empirical data is not available for that treatment. SE represents the standard error of the mean of observed data.

Grassland	Treatment	Nutrient	Obs	Sim	Year	SE
Acidic	0N	P	123.10	46.01	2017	21.92
	LN	P	NA	45.09	2017	NA
	HN	P	82.60	44.02	2003	17.61
	P	P	NA	77.05	2017	NA
	0N	C	4739.95	6938.16	2017	228.04
	LN	C	4907.84	7639.43	2017	110.24
	HN	C	6273.48	8205.12	2017	225.50
	P	C	5478.91	6938.16	2017	165.48
	0N	N	403.06	396.68	2017	28.51
	LN	N	415.52	430.59	2017	23.62
	HN	N	527.08	528.32	2017	25.57
	P	N	447.92	396.68	2017	51.45
Calcareous	0N	P	85.30	94.14	2017	2.85
	LN	P	NA	94.14	2017	NA
	HN	P	92.60	94.14	2003	5.70
	P	P	NA	124.29	2017	NA
	0N	C	6151.48	6588.09	2017	287.75
	LN	C	5639.41	6560.32	2017	379.51
	HN	C	6374.83	6505.15	2017	370.76
	P	C	6762.00	6950.21	2017	739.31
	0N	N	543.12	438.74	2017	22.33
	LN	N	508.35	465.02	2017	35.63
	HN	N	609.07	501.41	2017	30.94
	P	N	590.72	437.41	2017	62.89

3. Results

3.1. Varying phosphorus source parameters

The below differences were calculated using the empirical data (Obs) as the original data, hence a positive difference (Diff) or percentage change (Percent) means the simulated data (Sim) is that much less and a negative percent value means the simulated data is that much higher than the observed. The Percent column was calculated by dividing the Diff column by the Obs and multiplying by 100. Note that the 'Obs' column in Table S5 is a repeat of the empirical data in Table S4 but is provided again for convenience. Table S6 provides the mean of each nutrient from Table S5 and is the data plotted in Figure 2.

Table S5: A collation of the observed data (Obs) and simulated data (Sim) for soil organic carbon (C), soil organic nitrogen (N – assumed equivalent to total soil N), total soil phosphorus (P) and aboveground biomass carbon (AGB_C). The SE column represents the standard error of the mean of observations and are the error bars plotted on Figure 2. The difference between the observed and simulated data (Diff) and the percentage difference (Percent) are present. All data are in grams per metre squared.

Treatment	Nutrient	Obs	Sim	SE	Grassland	Diff	Percent
'0N'	'P'	123.10	46.01	21.92	'Acid'	77.09	62.63
'LN'	'P'	NaN	45.09	NaN	'Acid'	NaN	NaN
'HN'	'P'	82.60	44.02	17.61	'Acid'	38.58	46.70
'P'	'P'	NaN	77.05	NaN	'Acid'	NaN	NaN
'0N'	'C'	4739.95	6938.16	228.04	'Acid'	-2198.22	-46.38
'LN'	'C'	4907.84	7639.43	110.24	'Acid'	-2731.59	-55.66
'HN'	'C'	6273.48	8205.12	225.50	'Acid'	-1931.64	-30.79
'P'	'C'	5478.91	6938.16	165.48	'Acid'	-1459.25	-26.63
'0N'	'N'	403.06	396.68	28.51	'Acid'	6.38	1.58
'LN'	'N'	415.52	430.59	23.62	'Acid'	-15.06	-3.62
'HN'	'N'	527.08	528.32	25.57	'Acid'	-1.24	-0.23
'P'	'N'	447.92	396.68	51.45	'Acid'	51.24	11.44
'0N'	'P'	85.30	94.14	2.85	'Calc'	-8.84	-10.36
'LN'	'P'	NaN	94.14	NaN	'Calc'	NaN	NaN
'HN'	'P'	92.60	94.14	5.70	'Calc'	-1.54	-1.66
'P'	'P'	NaN	124.29	NaN	'Calc'	NaN	NaN
'0N'	'C'	6151.48	6588.09	287.75	'Calc'	-436.60	-7.10
'LN'	'C'	5639.41	6560.32	379.51	'Calc'	-920.91	-16.33
'HN'	'C'	6374.83	6505.15	370.76	'Calc'	-130.32	-2.04
'P'	'C'	6762.00	6950.21	739.31	'Calc'	-188.21	-2.78
'0N'	'N'	543.12	438.74	22.33	'Calc'	104.38	19.22
'LN'	'N'	508.35	465.02	35.63	'Calc'	43.32	8.52
'HN'	'N'	609.07	501.41	30.94	'Calc'	107.66	17.68
'P'	'N'	590.72	437.41	62.89	'Calc'	153.31	25.95
'0N'	'AGB_C'	477.60	576.18	85.67	'Acid'	-98.58	-20.64
'LN'	'AGB_C'	613.59	772.84	92.64	'Acid'	-159.24	-25.95
'HN'	'AGB_C'	717.98	915.70	66.00	'Acid'	-197.72	-27.54
'P'	'AGB_C'	743.92	576.18	23.35	'Acid'	167.74	22.55
'0N'	'AGB_C'	332.05	438.56	24.94	'Calc'	-106.51	-32.08
'LN'	'AGB_C'	419.09	427.96	44.92	'Calc'	-8.86	-2.11
'HN'	'AGB_C'	330.24	406.79	33.40	'Calc'	-76.55	-23.18
'P'	'AGB_C'	582.26	530.69	181.94	'Calc'	51.56	8.86

Table S6: Mean percentage difference across nutrient treatments between observed and simulated data, derived from Table S5. The SE is the standard error of the mean of each nutrient - grassland combination.

Nutrient	Grassland	Mean	SE
'C'	'Acid'	-39.86	6.77
'N'	'Acid'	2.29	3.23
'P'	'Acid'	54.67	7.96
'AGB_C'	'Acid'	-12.90	11.91
'C'	'Calc'	-7.06	3.28
'N'	'Calc'	17.84	3.59
'P'	'Calc'	-6.01	4.35
'AGB_C'	'Calc'	-12.13	9.40

3.2 and 3.3 – limiting nutrients, C, N, P budgets and temporal trends

The below section is combined into one with a header different from those in the main manuscript as the data cross over and are used in different sections. The below tables (S7 – S14) are used to construct the C, N and P budgets (Fig 5) and provide additional information about the limiting nutrient and organic P access. Figure S1 explicitly examines the organic P access of each grassland under different nutrient manipulations. Tables S15 – S17 relate to figure 4 and look at how plant and soil C, N and P have responded to N deposition and experimental nutrient additions.

Acidic

Carbon budget

Table S7: Carbon budget for the modelled acidic grassland in 2020, under different nutrient additions in grams per metre squared. The table shows the sizes of and changes to different C pools within the model following nutrient manipulation.

Treatment	Subsoil SOC	Topsoil SOC	Biomass C
0N	2748.84	6987.28	1146.51
LN	2789.99	7789.21	1560.98
HN	2820.38	8425.72	1853.93
P	2748.84	6987.28	1146.51

Nitrogen budget

Table S8: Nitrogen budget for the modelled acidic grassland in 2020, under different nutrient additions in grams per metre squared. The table shows the sizes of and changes to different N pools within the model following nutrient manipulation.

Treatment	Subsoil SON	Topsoil SON	Available N	Fixed N	Biomass N
0N	175.37982	399.98694	15.56958	0	30.18691
LN	176.53285	438.88054	22.47605	0	45.50620
HN	179.72432	546.54556	40.40837	0	61.93123
P	175.37982	399.98694	15.56958	0	30.18691

Phosphorus budget

Table S9: Phosphorus budget for the modelled acidic grassland in 2020, under different nutrient additions in grams per metre squared. The table shows the sizes of and changes to different P pools within the model following nutrient manipulation.

Treatment	Weatherable	Subsoil sorbed	Subsoil SOP	Topsoil sorbed	Topsoil SOP	Available	Biomass P
0N	15.8916	2.5512	7.4716	7.8463	38.1554	1.1155	3.0187
LN	15.8916	2.5512	7.5037	7.8463	36.4937	1.3903	4.5506
HN	15.8916	2.5512	7.5344	7.8463	34.7023	1.6477	6.1931
P	15.8916	4.2524	8.2002	66.8623	67.4159	5.3296	3.0187

Phosphorus cleaving

Table S10: $P_{CleaveMax}$ per growing season for the acidic grassland, and the amount of P cleaved from the SOP pool in 2020 under different nutriment treatments.

Treatment	$P_{CleaveMax}$ (g m^{-2} per growing season)	P cleaved in 2020 (g m^{-2})
0N	0.3162	0.221
LN	0.3162	0.429
HN	0.3162	0.632
P	0.3162	0.000

Calcareous

Carbon budget

Table S11: Carbon budget for the modelled calcareous grassland in 2020, under different nutrient additions in grams per metre squared. The table shows the sizes of and changes to different C pools within the model following nutrient manipulation.

Treatment	Subsoil SOC	Topsoil SOC	Biomass C
0N	2976.48	6613.41	869.21
LN	2973.17	6583.32	848.10
HN	2966.10	6523.45	806.09
P	3000.39	7015.10	1060.74

Nitrogen budget

Table S12: Nitrogen budget for the modelled calcareous grassland in 2020, under different nutrient additions in grams per metre squared. The table shows the sizes of and changes to different N pools within the model following nutrient manipulation.

Treatment	Subsoil SON	Topsoil SON	Available N	Fixed N	Biomass N
0N	207.75693	441.27447	14.14192	0	17.91213097
LN	208.87098	469.47608	19.68183	0	17.9009423
HN	209.08553	507.64361	30.58437	0	17.86741168
P	207.68085	440.32884	14.41858	0	24.08056454

Phosphorus budget

Table S13: Phosphorus budget for the modelled calcareous grassland in 2020, under different nutrient additions in grams per metre squared. The table shows the sizes of and changes to different P pools within the model following nutrient manipulation.

Treatment	Weatherable	Subsoil sorbed	Subsoil SOP	Topsoil sorbed	Topsoil SOP	Available	Biomass P
0N	31.7832	7.9625	12.9875	37.1784	56.9501	1.0327	1.7912
LN	31.7832	7.9653	12.9860	37.2774	56.8487	1.0245	1.7901
HN	31.7832	7.9711	12.9829	37.4777	56.6452	1.0084	1.7867
P	31.7832	10.1739	13.4534	113.1141	68.3534	5.1661	2.4081

Phosphorus cleaving

Table S14*:* $P_{CleaveMax}$ per growing season for the calcareous grassland, and the amount of P cleaved from the SOP pool in 2020 under different nutriment treatments.

Treatment	$P_{CleaveMax}$ (g m^{-2} per growing season)	P cleaved in 2020 (g m^{-2})
0N	0.0316	0.0632
LN	0.0316	0.0632
HN	0.0316	0.0632
P	0.0316	0.0000

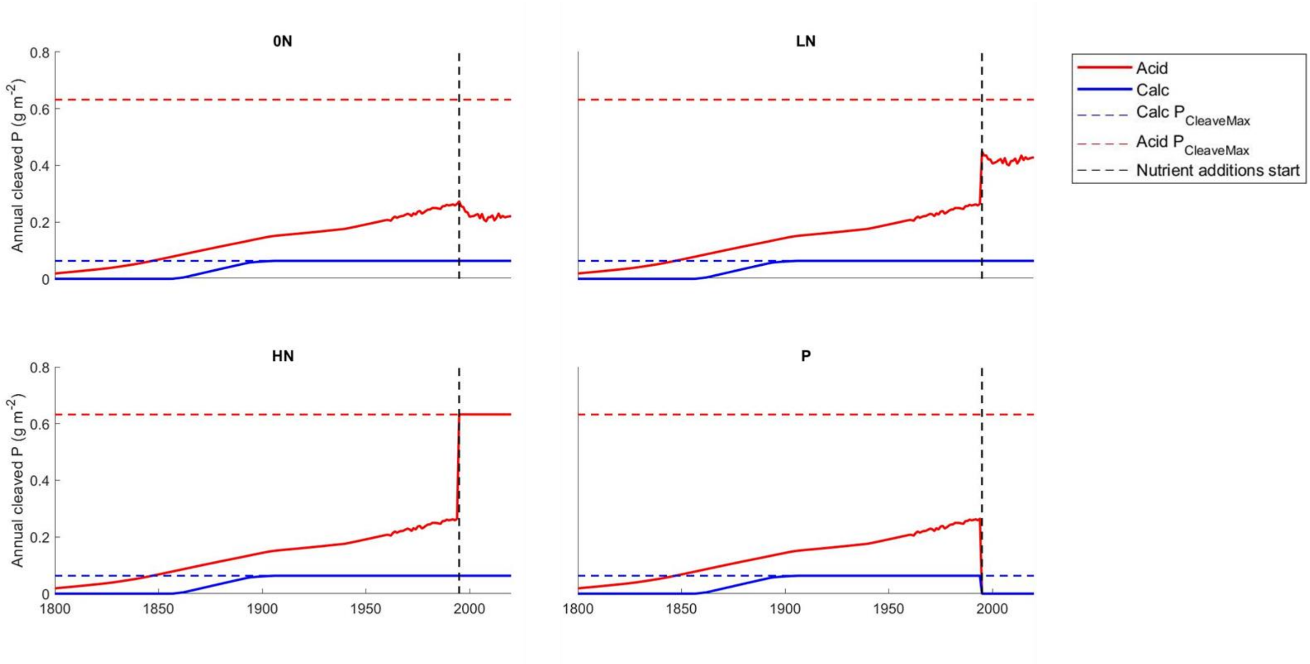

Figure S1: A time series showing the annual amount of P cleaved from the SOP pool by the modelled acidic and calcareous grasslands in the a) 0N, b) LN, c) HN and d) P treatments. The horizontal blue and red dashed lines represent the maximum potential cleaved SOP of the acidic and calcareous grasslands respectively, summed across both growing seasons. The vertical dashed line signals the start of the experimental period of nutrient manipulation. Where the solid line meets the dashed line of the same colour, plant P demand exceeds plant P acquisition ability and hence the ecosystem is P-limited.

The effect of N deposition alone – AGB_C, SOC, SON, SOP from 1800 - 2020

Table S15: Differences in nutrient pools (C, N, P and AGB_C are the same variables as in Tables S5 and S6) between 1800 (Y_1800) and the present (Y_2020) to show the effects of N deposition through time. Rows in bold highlight the 0N control treatments to show the effects of N deposition in isolation. As with Tables S5 and S6, the absolute and percentage difference are shown, and all data aside from percentage difference are in grams per metre squared.

Nutrient	Grassland	Treatment	Y_1800	Y_2020	Diff	Per_Diff
'C'	**'Acid'**	**'0N'**	**3839.63**	**6987.28**	**3147.65**	**81.98**
'C'	'Acid'	'LN'	3839.63	7789.21	3949.57	102.86
'C'	'Acid'	'HN'	3839.63	8425.72	4586.09	119.44
'C'	'Acid'	'P'	3839.63	6987.28	3147.65	81.98
'N'	**'Acid'**	**'0N'**	**229.09**	**399.99**	**170.90**	**74.60**
'N'	'Acid'	'LN'	229.09	438.88	209.79	91.58
'N'	'Acid'	'HN'	229.09	546.55	317.46	138.57
'N'	'Acid'	'P'	229.09	399.99	170.90	74.60
'P'	**'Acid'**	**'0N'**	**32.65**	**38.16**	**5.51**	**16.87**
'P'	'Acid'	'LN'	32.65	36.49	3.85	11.78
'P'	'Acid'	'HN'	32.65	34.70	2.05	6.29
'P'	'Acid'	'P'	32.65	67.42	34.77	106.50
'AGB_C'	**'Acid'**	**'0N'**	**163.12**	**573.25**	**410.13**	**251.43**
'AGB_C'	'Acid'	'LN'	163.12	780.49	617.37	378.47
'AGB_C'	'Acid'	'HN'	163.12	926.96	763.84	468.27
'AGB_C'	'Acid'	'P'	163.12	573.25	410.13	251.43
'C'	**'Calc'**	**'0N'**	**4607.99**	**6613.41**	**2005.42**	**43.52**
'C'	'Calc'	'LN'	4607.99	6583.32	1975.33	42.87
'C'	'Calc'	'HN'	4607.99	6523.45	1915.47	41.57
'C'	'Calc'	'P'	4607.99	7015.10	2407.12	52.24
'N'	**'Calc'**	**'0N'**	**289.38**	**441.27**	**151.89**	**52.49**
'N'	'Calc'	'LN'	289.38	469.48	180.10	62.24
'N'	'Calc'	'HN'	289.38	507.64	218.26	75.42
'N'	'Calc'	'P'	289.38	440.33	150.95	52.16
'P'	**'Calc'**	**'0N'**	**43.72**	**56.95**	**13.23**	**30.26**
'P'	'Calc'	'LN'	43.72	56.85	13.13	30.03
'P'	'Calc'	'HN'	43.72	56.65	12.92	29.56
'P'	'Calc'	'P'	43.72	68.35	24.63	56.34
'AGB_C'	**'Calc'**	**'0N'**	**192.34**	**434.61**	**242.26**	**125.96**
'AGB_C'	'Calc'	'LN'	192.34	424.05	231.71	120.47
'AGB_C'	'Calc'	'HN'	192.34	403.05	210.71	109.55
'AGB_C'	'Calc'	'P'	192.34	530.37	338.03	175.75

Responses to nutrient treatments – changes in AGB_C, SOC, SON and SOP between 1995 - 2020

Table S16: Responses of nutrient pools to experimental nutrient additions (0N, LN, HN and P). 'Value' shows the modelled value for the size of the nutrient pool in the year 2020. Absolute and percentage difference are the difference between the size of the nutrient pool in 1995 and the size in 2020 (Value), hence a positive value is an increase. This table contains data for the acidic grassland. All data are in grams per metre squared.

Nutrients	Treatment	Value	Absolute difference	Percent difference
'C'	'0N'	6987.28	0.00	0.00
'C'	'LN'	7789.21	801.92	11.48
'C'	'HN'	8425.72	1438.44	20.59
'C'	'P'	6987.28	0.00	0.00
'N'	'0N'	399.99	0.00	0.00
'N'	'LN'	438.88	38.89	9.72
'N'	'HN'	546.55	146.56	36.64
'N'	'P'	399.99	0.00	0.00
'P'	'0N'	38.16	0.00	0.00
'P'	'LN'	36.49	-1.66	-4.35
'P'	'HN'	34.70	-3.45	-9.05
'P'	'P'	67.42	29.26	76.69
'AGB_C'	'0N'	573.25	0.00	0.00
'AGB_C'	'LN'	780.49	207.24	36.15
'AGB_C'	'HN'	926.96	353.71	61.70
'AGB_C'	'P'	573.25	0.00	0.00

Table S17: Responses of nutrient pools to experimental nutrient additions (0N, LN, HN and P). 'Value' shows the modelled value for the size of the nutrient pool in the year 2020. Absolute and percentage difference are the difference between the size of the nutrient pool in 1995 and the size in 2020 (Value), hence a positive value is an increase. This table contains data for the calcareous grassland. All data are in grams per metre squared.

Nutrients	Treatment	Value	Absolute difference	Percent difference
'C'	'0N'	6613.41	0.00	0.00
'C'	'LN'	6583.32	-30.09	-0.46
'C'	'HN'	6523.45	-89.96	-1.36
'C'	'P'	7015.10	401.69	6.07
'N'	'0N'	441.27	0.00	0.00
'N'	'LN'	469.48	28.20	6.39
'N'	'HN'	507.64	66.37	15.04
'N'	'P'	440.33	-0.95	-0.21
'P'	'0N'	56.95	0.00	0.00
'P'	'LN'	56.85	-0.10	-0.18
'P'	'HN'	56.65	-0.30	-0.54
'P'	'P'	68.35	11.40	20.02
'AGB_C'	'0N'	434.61	0.00	0.00
'AGB_C'	'LN'	424.05	-10.56	-2.43
'AGB_C'	'HN'	403.05	-31.56	-7.26
'AGB_C'	'P'	530.37	95.77	22.04

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