

## Supplementary Information

Manuscript Title

### **Predicting long-term effects of alternative management practices in conventional and organic agricultural systems on soil carbon stocks using the DayCent model**

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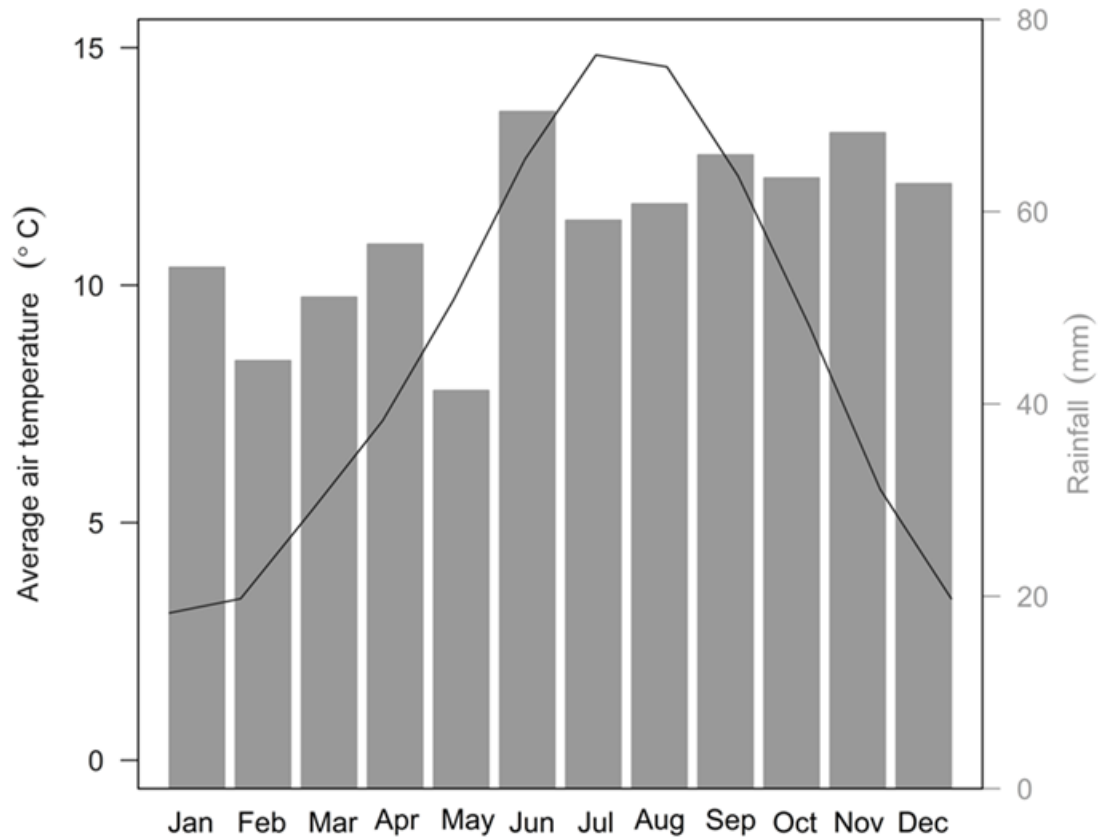
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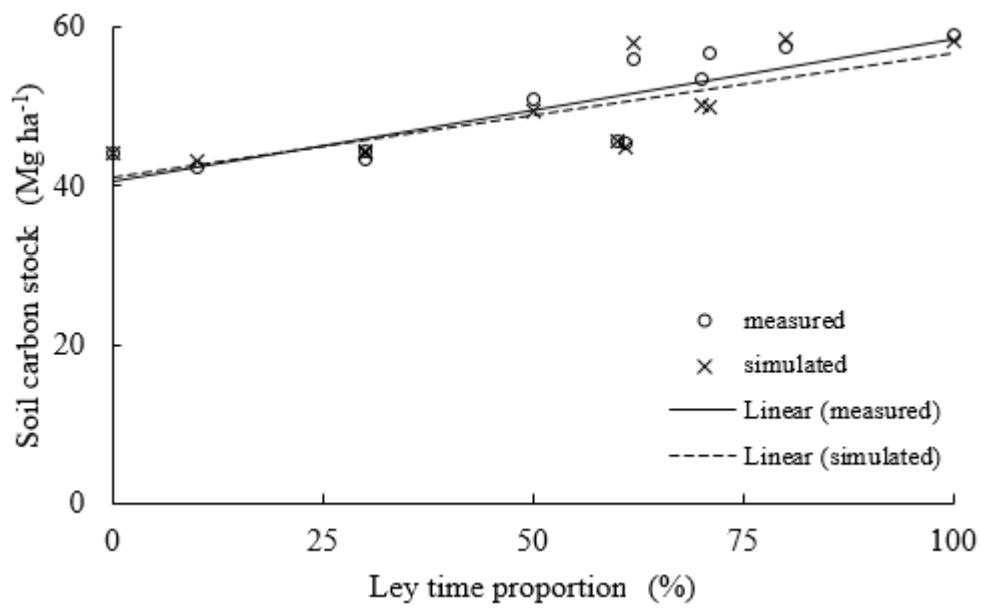
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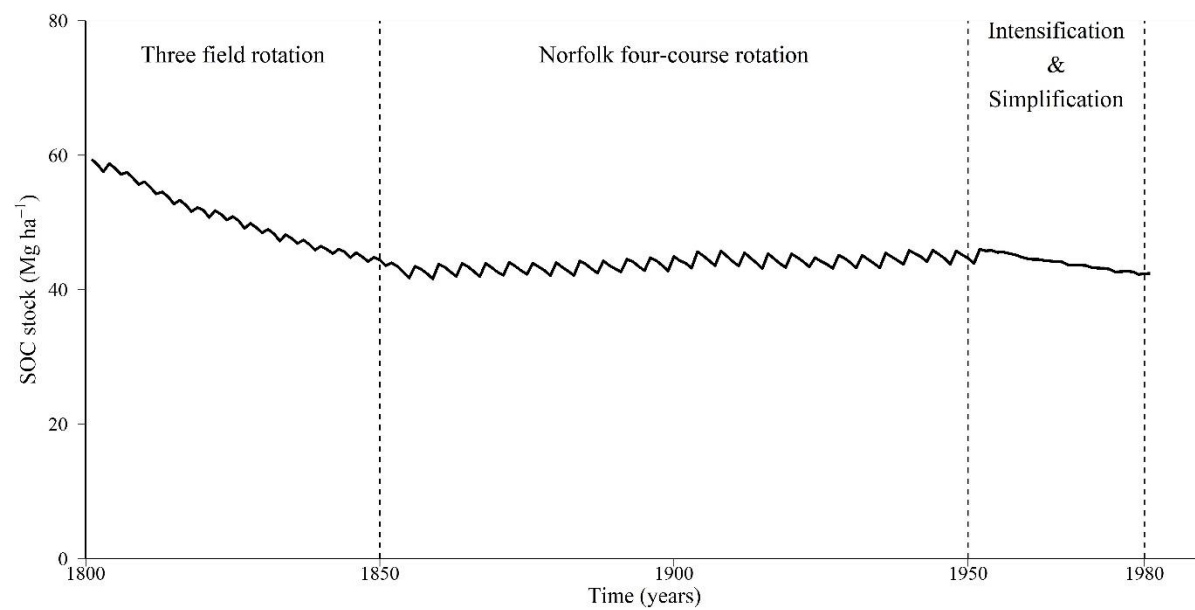
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**Figure S1.** Average monthly air temperature (line) and rainfall (bars) at Nafferton farm, Stocksfield, Northumberland, Northeast England, UK, between 1900-2020.



**Figure S2.** Relationship between measured and simulated soil organic C stocks (SOC stock, Mg ha<sup>-1</sup>) at 0-0.20 m depth due to changes in ley time proportions (%). Each (○) symbol represents a study site SOC stock mean of a minimum of eight and a maximum of 15 spatial replications. Each (x) symbol represents the simulated SOC stock of the study site. The solid line is the linear regression line around the measured values, while the dashed line is the linear regression line around the simulated values.



**Figure S3.** Equilibrium to modern-day baseline simulation of soil organic C stocks (SOC stocks,  $\text{Mg ha}^{-1}$ ) at 0-0.20 m depth.

**Table S1.** Management history of the 12 study fields at Nafferton Farm over 10 years (2008-2017) indicating agricultural system (S) (conventional-CONV and organic-ORG), grazing regime (G) (non-grazed-NG and grazed-GG), ley time proportion (LTP), manure application proportions (MAP), and tillage event proportion (TEP) and further details including main crops grown and fertilisation rates. LTP, MAP and TEP shown as % of years in which the field was under ley, received manure application or it had activities that turned the soil over for at least 0.15 m depth prior sampling. Data from Zani et al. (2022).

Study Field n <sup>o</sup>	S	G	LTP %	MAP %	TEP*	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Further details
1	CONV	NG	0	10	80	W. Wheat	W. Wheat	W. Barley	W. Barley	W. OSR	W. Wheat	W. Wheat	W. Barley	W. Barley	W. OSR	Continuous arable rotation with annual fertilisation (mineral and organic forms) of roughly 89, 78 and 156 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
2	CONV	NG	10	10	50	Ley	W. Barley	W. OSR	W. Wheat	W. Wheat	S. Barley	W. Barley	W. OSR	W. Wheat	W. Wheat	Previously cultivated with ley-arable rotation but became a continuous arable rotation for the last nine years. Annual fertilisation (mineral and organic forms) of roughly 69, 56 and 111 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
3	CONV	GG	70	60	30	W. Wheat	W. Wheat	W. Barley	Ley	Ley	Ley	Ley	Ley	Ley	Ley	Ley-arable rotation with annual fertilisation (mineral and organic forms) of roughly 148, 46 and 93 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
4	CONV	GG	50	40	40	W. Barley	Ley	Ley	Ley	Ley	Ley	S. Barley	W. Wheat	S. Barley	S. Barley	Ley-arable rotation with annual fertilisation (mineral and organic forms) of roughly 89, 31 and 43 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
5	CONV	GG	100	50	0	Ley	Ley	Ley	Ley	Ley	Ley	Ley	Ley	Ley	Ley	Ley-arable rotation field but under ley for the last ten years. Annual fertilisation (mineral and organic forms) of roughly 130, 28 and 57 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
6	CONV	GG	60	40	30	Ley	Ley	Ley	W. Wheat	W. Wheat	W. Barley	Ley	Ley	Ley	Ley	Ley-arable rotation with annual fertilisation (mineral and organic forms) of roughly 190, 79 and 140 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
7	ORG	GG	80	60	20	Ley	S. Wheat	S. Barley	Ley	Ley	Ley	Ley	Ley	Ley	Ley	Ley-arable rotation with nnual fertilisation (only organic forms) of roughly 48, 52 and 141 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.

8	ORG	GG	60	70	40	S. Beans	Ley	Ley	S. Wheat	Beans Dried	S. Barley	Ley	Ley	Ley	Ley	Ley-arable rotation with annual fertilisation (only organic forms) of roughly 59, 61 and 150 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
9	ORG	GG	60	20	30	S. Barley	Potato s	Ley	Ley	Ley	Beans Dried	S. Barley	Ley	Ley	Ley	Ley-arable rotation with annual fertilisation (only organic forms) of roughly 59, 65 and 170 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
10	ORG	NG	30	70	70	S. Wheat	S. Barley	Ley	Ley	Ley	S. Wheat	Beans Dried	S. Barley	Beans Dried	Beans Dried	Ley-arable rotation with annual fertilisation (only organic forms) of roughly 67, 74 and 200 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
11	ORG	NG	30	60	50	S. Barley	Ley	Ley	Ley	S. Wheat	Beans Dried	S. Wheat	Beans Dried	S. Barley	S. Barley	Ley-arable rotation with annual fertilisation (only organic forms) of roughly 71, 79 and 200 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.
12	ORG	GG	70	40	30	Ley	Ley	Ley	Ley	Ley	Ley	S. Barley	Beans Dried	S. Barley	Ley	Ley-arable rotation with annual fertilisation (only organic forms) of roughly 65, 46 and 96 kg ha <sup>-1</sup> yr <sup>-1</sup> for N, P and K, respectively.

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\*Since conversion from conventional to the organic system across 50% of the farm area (i.e. from 2001 onwards), tillage practice was conducted using ploughing and disking practices to a maximum depth of 0.15 m at both sides of the farm.

**Table S2.** Summary of the input parameters entered in the DayCent model including climate data and general soil properties (0-0.20 m depth) encompassing the farm-scale study and the Nafferton Factorial Systems Comparison (NFSC) trial.

Input parameters	Unit	Value
<i>Climate data</i> <sup>a</sup>		
Latitude (only used as information, not an input)	degree	54.9857 N
Longitude (only used as information, not an input)	degree	1.8990 W
Yearly maximum of average daily temperature	°C	12.1
Yearly minimum of average daily temperature	°C	4.7
Yearly maximum accumulated precipitation	mm	1048
Atmospheric CO <sub>2</sub> concentrations	ppm	418
<i>Soil properties</i> <sup>b</sup>		
Soil texture (sand, silt, clay)	%	40, 43, 17
Bulk density	Mg m <sup>-3</sup>	1.15
pH (H <sub>2</sub> O)	-	6.3
Field capacity	%	28.09
Wilting point	%	10.64
Hydraulic conductivity	cm sec <sup>-1</sup>	0.001
Initial total carbon stock <sup>c</sup>	Mg ha <sup>-1</sup>	60

<sup>a</sup> Taken from a combination of the MetOffice database and site-specific inputs.

<sup>b</sup> Average of the measured/estimated site-specific features considering all the study fields in the farm-scale study (Zani et al., 2022; sampled in 2017) and the treatments in the NFSC trial (Zani et al., 2023 *under review*; sampled in 2018).

<sup>c</sup> Based on published data for the arable system for the whole UK (Tipping et al., 2012, 2017; Davies et al., 2016; Muhammed et al., 2018)