Supplementary Materials

Scheme S1: Description of the test plots.

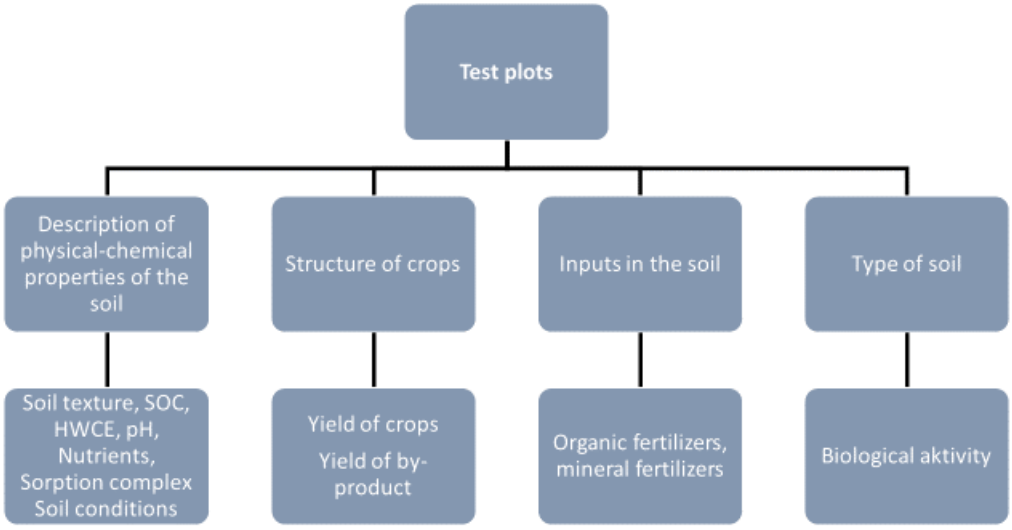

Table S1: Average values of SOC according to the type of soil.

	SOC 2018	HWEC 2018	HWEC 2018 - 2016
	%	mg/kg	mg/kg
Albic Luvisol	1.14	335.00	-123.25
Cambisol	1.28	448.91	-116.36
Chernozem	1.92	456.00	-84.22
Fluvisol	1.49	374.60	-149.00
Luvisol	1.38	364.36	-168.18
Planosol	1.14	500.50	-38.00

Table S2: The organic inputs to the soil as a by-product and organic matter of organic fertilizers and digestate.

	Yield of by-product	Organic matter of by-product	Digestate (t)	Organic matter of the digestate	Organic matter of Organic fertilizers	Organic matter of all fertilizers	Organic matter including the by-product on land
	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha
Albeluvisol	50.39	7.06	46.25	0.46	8.08	8.54	15.6
Cambisol	29.71	8.2	25	0.25	3.17	3.42	11.62
Chernozem	38.97	18.38	23.78	0.25	2.6	2.85	21.23
Fluvisol	53.64	14.89	38	0.38	2.89	3.27	18.16
Luvisol	45.75	14.48	68.33	0.68	3.37	4.05	18.53
Planosol	28.42	6.36	35	0.35	7.23	7.58	13.94

Note: There are given the organic inputs to the soil as a by-product and organic matter of organic fertilizers and digestate, which might be also converted into organic matter. Inputs from the by-products were taken into the account in the case when they stayed in the fields and were not removed. As it is evident, the total amount of organic matter differs with soil type. While chernozems are characterised by a low amount of applied organic fertilizers, the total amount of organic matter entering the soil is very high due to the very high yields of arable crops. A description of the variables entering into the calculations is given in Supplementary Materials (Table S4 and S5). This appendix lists all the variables that were included in the following regression analyses. Because some variables were insignificant in the regression analyses, only some are used.

Table S3: Mean values of the soil chemical, physical and biological properties.

Variable	Unit	N	Mean	Std. Deviation	Geometric Mean	Variance
Soil texture topsoil <0,001	%	517	18.503	6.587	17.181	43.391
Soil texture topsoil [<0,01;0,001]	%	517	18.751	4.439	18.253	19.705
Soil texture topsoil [<0,05;0,01]	%	517	46.362	11.482	44.525	131.836
Soil texture topsoil [<0,25;0,05]	%	517	10.865	8.297	8.090	68.844
Soil texture topsoil [<0,2;2.00]	%	517	5.734	8.136	2.543	66.203
Coefficient of stoniness	-	513	0.997	0.014	0.996	0.000
Coefficient of slope	-	513	0.991	0.020	0.991	0.000
Depth of soil	category	513	1.000	0.000	1.000	0.000
pH (KCl)	degree	498	6.167	0.735	6.124	0.540
Cox	%	498	1.550	0.417	1.499	0.174
Total N	Kg/ha	425	132.214	82.245	104.999	6764.274
Mineral N	Kg/ha	345	139.051	64.027	122.695	4099.467
Mineral P_2O_5 dosage	Kg/ha	501	31.597	41.364	0.000	1710.991
K_2O inputs	Kg/ha	501	37.757	78.097	0.000	6099.084
Organic matter of byproduct	Kg/ha	487	5.078	7.013	0.000	49.185
Technological and organic matter	%	487	0.000	0.004	0.000	0.000
Digestate organic matter	%	487	0.053	0.144	0.000	0.021
Digestate and technological watter organic matter	%	487	0.053	0.145	0.000	0.021

Organic matter of animal origin	%	517	0.908	2.740	0.000	7.509
Organic matter of green manure	%	517	1.812	4.173	0.000	17.412
Organic matter of by-products and green manure	%	517	4.694	7.686	0.000	59.082
Organic matter total	%	517	6.506	8.990	0.000	80.812
Biological life in soil	category	513	4.209	0.751	4.137	0.564
Soil texture range in topsoil, <0,01 mm	%	513	35.883	6.227	35.296	38.782
Soil texture range in undersoil, <0,01 mm	%	513	37.863	5.770	37.349	33.291
Variation range of soil texture undersoil <0,001 mm	%	513	39.842	4.365	39.588	19.053
Altitude	MSL	513	328.738	91.564	317.310	8383.926
Texture of soil grain six ranges	category	513	2.830	0.671	2.750	0.450
Depth of the topsoil	cm	447	25.593	5.231	0.000	27.363
Overall expert assessment of soil condition	category	470	2.103	0.357	2.074	0.127
Soil adsorption complex characteristics 2018	%	439	29.325	29.096	23.055	846.563
Maximum adsorption capacity topsoil 2018	**mmol+/100g**	439	30.551	28.702	24.678	823.810
Saturation of exchangeable bases content (mmol+/100g) Topsoil 2018	**mmol+/100g**	439	93.551	4.895	93.421	23.965
Number of Years before 2018, 2018 = 1	1	198	2.136	0.778	1.971	0.606

Table S4: Mean values of the crops.

Crop	Area (ha)	Nitrogen mineral kg/ha	P2O5 mineral kg/ha	K2O mineral kg/ha	Yield t/ha	Ploughing 1yes/0 no	Organic matter t/ha	Digestate t OM/ha
Potatoes	17.43	102.94	59.49	98.77	28.73	0.38	7.44	0.0375
Sugar beet	19.75	86.70	26.78	56.36	71.13	0.45	8.87	0.0404
White mustard	15.52	98.50	11.70	15.47	1.79	0.80	2.56	0.0000
Peas sown	35.58	12.00	26.00	0.00	11.17	0.00	14.52	0.0000
Table peas	36.01	12.00	52.00	0.00	5.91	0.67	4.73	0.0000
Spring barley	36.56	86.22	49.66	31.75	7.41	0.20	4.82	0.0236
Corn on pressed grain	18.90	114.98	12.79	16.37	8.49	0.62	4.49	0.0000
Corn for silage	26.01	151.17	54.09	69.11	45.72	0.51	12.29	0.1422
Legume cereal mixture + clover (undersowing)	36.30	199.72	90.69	113.18	10.89	0.35	11.68	0.1241
Poppy seed	27.89	64.55	34.05	17.04	0.98	0.63	4.85	0.0000
Ergot	21.82	-	0.00	0.00	1.29	0.83	5.17	0.0000
Oat	10.70	81.00	19.27	7.60	7.23	1.00	9.54	0.0333
Spring wheat	39.35	108.97	26.30	26.30	7.21	0.33	6.89	0.0000
Winter wheat	18.24	169.04	14.66	30.27	7.24	0.41	4.05	0.0460
Winter rape	22.19	192.47	37.87	21.31	3.88	0.44	7.88	0.0389
Lucerne	13.03	26.25	6.83	8.00	26.68	0.50	0.13	0.0333
Rye Biogas	21.40	-	0.00	0.00	9.70	1.00	8.06	0.0000
Winter rye	16.48	99.92	7.75	2.75	15.30	0.50	9.03	0.0000
Total	24.51	139.05	31.60	37.76	19.82	0.42	6.51	0.0531

Table S5. Multidimensional linear regression model for HWEC content (the year 2018).

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
11	Constant	-1364.042	959.365		-1.422	0.167
	Mineral P_2O_5 dosage (kg/ha)	-4.433	1.591	-0.586	-2.787	0.010
	Digestate and technological water organic matter	1658.075	574.035	0.561	2.888	0.008
	Saturation of exchangeable bases content (mmol+/100g) in the topsoil 2018	24.437	10.926	0.398	2.237	0.034
	Total N	-2.521	1.335	-0.387	-1.888	0.070

Table S6. Refined multidimensional linear regression model for HWEC in 2018.

Variable	B (approx.)	Std. Error	Result	Probability	Lower limit	Upper limit
Constant	-800.3514	175.9486	Sign.	8.87E-05	-1160.21	-440.496
Mineral P_2O_5 dosage (kg ha^{-1})	-0.6288	0.2335	Sign.	0.0116	-1.1065	-0.1511
Digestate and technological water organic matter	166.8419	65.3105	Sign.	0.0161	33.2668	300.417
Saturation of exchangeable bases content (mmol+ $100g^{-1}$) Topsoil 2018	13.7785	1.9198	Sign.	6.71E-08	9.85203	17.7051
Total N	-0.3154	0.1519	Sign.	0.0468	-0.6260	-0.0047

Table S7. Multidimensional linear regression model for HWEC difference (period 2008–2018).

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
7	Constant	-1998.4895	881.3441		-2.2675	0.0256
	Digestate organic matter	570.2867	203.3981	0.2836	2.8038	0.0061
	K_2O inputs	-0.8128	0.6343	-0.1393	-1.2815	0.2030
	pH (KCl)	-99.9548	104.6603	-0.2608	-0.9550	0.3419
	Maximum adsorption capacity (mmol+/100g) topsoil 2008	-33.2229	6.1221	-0.7234	-5.4267	0.0000
	Overall expert assessment of soil condition	-445.8829	91.1054	-0.5115	-4.8941	0.0000
	Soil texture topsoil [<0,25;2.00]	8.2161	2.1590	0.3415	3.8055	0.0002
	Saturation of adsorption capacity (mmol+/100g) topsoil 2018	40.1689	16.2613	0.7154	2.4702	0.0152

Table S8. Refined multidimensional linear regression model for HWEC Difference (period 2018-2016).

Variable	B (approx.)	Std. Error	Result	Probability	Lower limit	Upper limit
Constant	542.6295	47.5988	Sign.	0	448.3453	636.9137
Digestate organic matter	156.3642	34.5987	Sign.	1.51E-05	87.83075	224.8978
K_2O inputs	*-0.1025*	*0.07174*	*NotSign.*	*0.155613*	*-0.24466*	*0.039563*
pH (KCl)	-114.4247	10.0059	Sign.	0	-134.245	-94.605
Maximum adsorption capacity (mmol+/100g) topsoil 2008	*1.6734*	*1.10854*	*NotSign.*	*0.133894*	*-0.52238*	*3.869259*
Overall expert assessment of soil condition	-37.8306	13.5679	Sign.	0.006203	-64.7061	-10.9552
Soil texture topsoil [<0,25;2.00]	*0.9948*	*0.59528*	*NotSign.*	*0.097403*	*-0.18431*	*2.173987*
Saturation of adsorption capacity (mmol+/100g) topsoil 2018	2.3033	0.17213	Sign.	0	1.962344	2.644258

Table S9. The multidimensional linear regression model for the model SOC Difference between the years 2018 and 2008.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
10	Constant	1.395	0.351		3.977	0.000		
	Difference HWEC 2018 – 2008	0.001	0.000	0.346	3.001	0.004	0.936	1.069
	Soil texture, percentage of particles smaller than 0,01 - 0.001 mm (ST01)	-0.016	0.006	-0.305	-2.632	0.011	0.926	1.080
	Soil texture of topsoil - percentage of particles 0.25-2.00 mm (ST2)	-0.013	0.004	-0.439	-3.408	0.001	0.748	1.336
	Organic matter from applied organic manures farmyard manure (FYM_OM)	0.011	0.006	0.212	1.735	0.089	0.834	1.198
	pH (KCl)	-0.079	0.041	-0.249	-1.910	0.062	0.731	1.369
	Energy of NPK + the energy of the by-product left on the field (ENPKB)	-2.305E-07	0.000	-0.302	-2.519	0.015	0.865	1.156
	Subsoil depth (SSD)	-0.006	0.003	-0.232	-1.957	0.056	0.887	1.127

Notes on the regression model: In the analysis of variables in the model, the variables that correlated with the difference in humus between 2018 and 2008 were considered. The following variables were included: the HWEC values from 2018 minus the HWEC values from 2008 (Difference HWEC 2018 – 2008), energy difference (ED), maximum adsorption capacity (MACT), V_topsoil, Soil texture - the percentage of particles smaller than 0.001 mm (STS001), Soil texture of topsoil, - the

percentage of particles 0.01-0.05 mm (ST05), Soil texture of topsoil - the percentage of particles 0.05-0.25 mm (ST025), Soil texture of topsoil – the percentage of particles 0.25-2.00 mm (ST2), Organic matter from applied FYM (t), pH (KClBiological activity of soil Category (BAC), Subsoil depth (SSD) and Topsoil depth (TSD). Of these variables, the energy potential of the soil (EPT), which was excluded in the last design of the model, and the maximum sorption capacity in topsoil (MACT), which was excluded in the 8th model, were of great importance for the creation of the regression model.

Table S10. Refined multidimensional linear regression model for the dependence of the model SOC Difference between the years 2018 and 2008.

Variable	B (approximation)	Std. Error	result	Probability	Lower limit	Upper limit
Constant	1.249448	0.133894	Significant	1.56E-12	0.980515	1.518382
Difference HWEC	0.000326	7.99E-05	Significant	0.000162	0.000166	0.000487
ST01	-0.01226	0.002007	Significant	1.48E-07	-0.0163	-0.00823
ST2	-0.01388	0.00141	Significant	2.70E-13	-0.01671	-0.01105
FYM_OM	0.009112	0.002108	Significant	7.34E-05	0.004878	0.013346
pH (KCl)	-0.06761	0.015058	Significant	4.21E-05	-0.09786	-0.03737
ENPKB	-3.68E-07	3.79E-08	Significant	4.38E-13	-4.44E-07	-2.92E-07
SSD	-0.00537	0.001016	Significant	2.79E-06	-0.00741	-0.00333

Note: Difference HWEC - difference HWEC 2018 - 2008, ST01 - soil texture, percentage of particles smaller than 0,01-0.001 mm, ST2 - soil texture of topsoil - the percentage of particles 0.25-2.00 mm, FYM_OM - organic matter from applied organic manures farmyard manure, pH (KCl) - soil reaction, ENPKB - the energy of NPK + the energy of the by-product left on the field, SSD - subsoil depth.

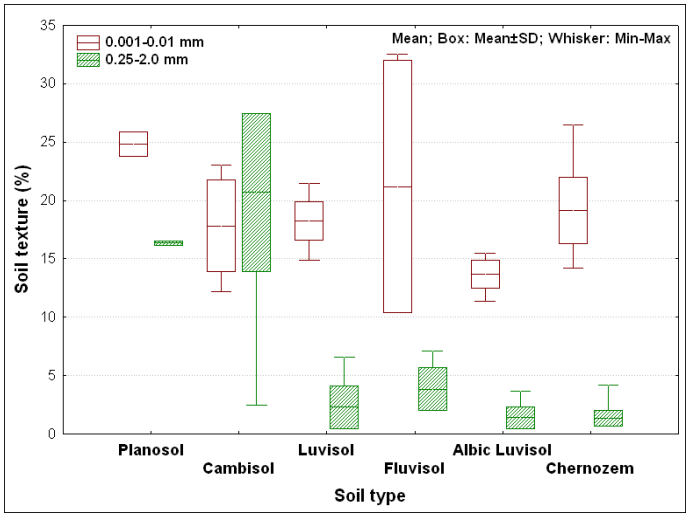

Figure S1: The average soil texture (%) according to the soil type (2008–2018).

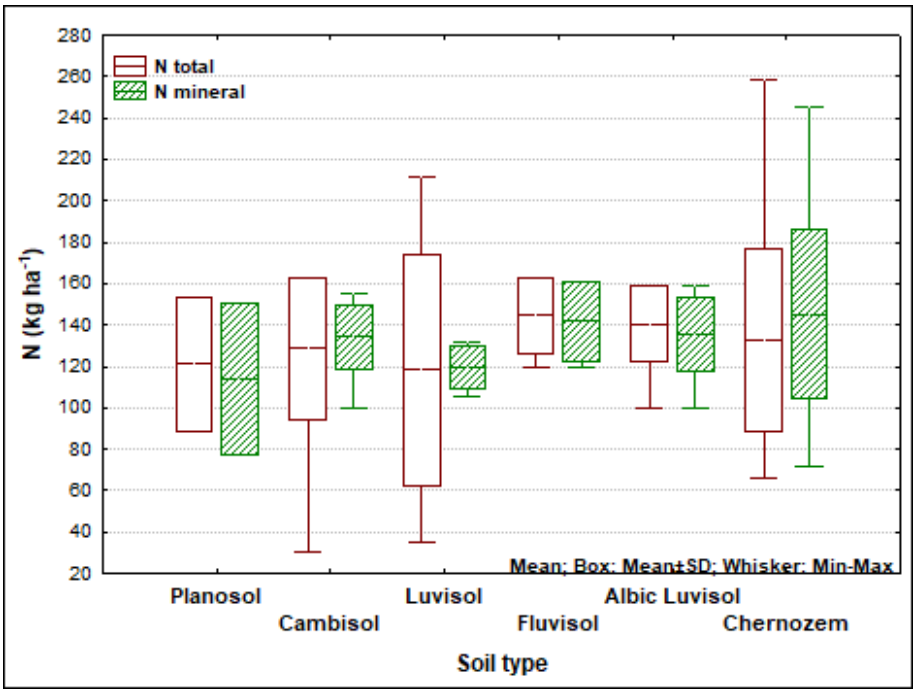

Figure S2: Average input of N (total and mineral) into the soil in fertilizers for the period 2008-2018 and individual soil types.

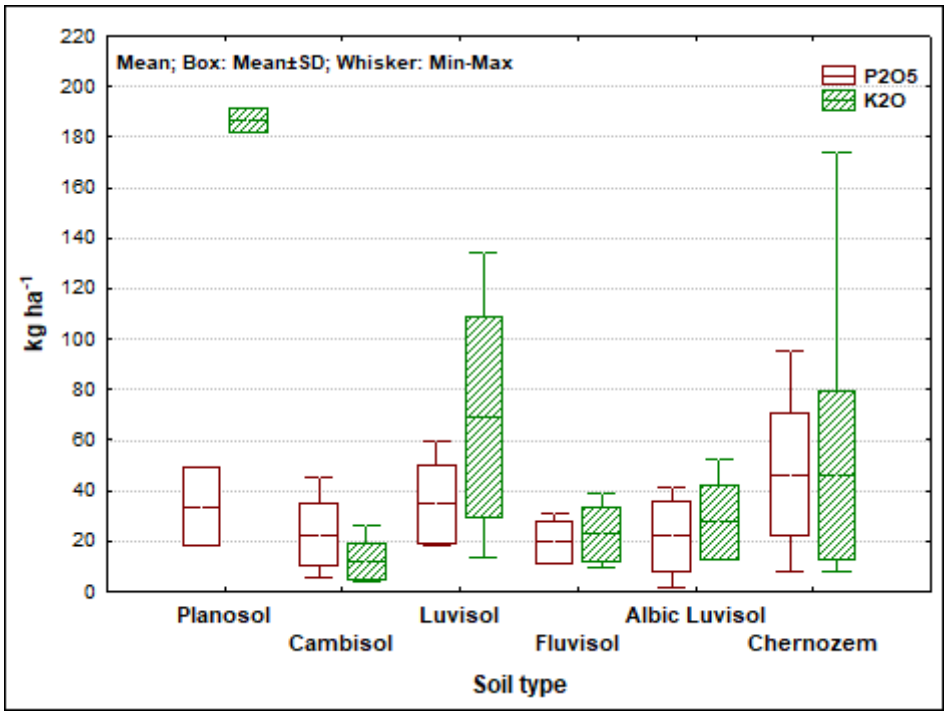

Figure S3: Average input of P and K (total and mineral) into the soil in fertilizers for the period 2008-2018 and individual soil types.

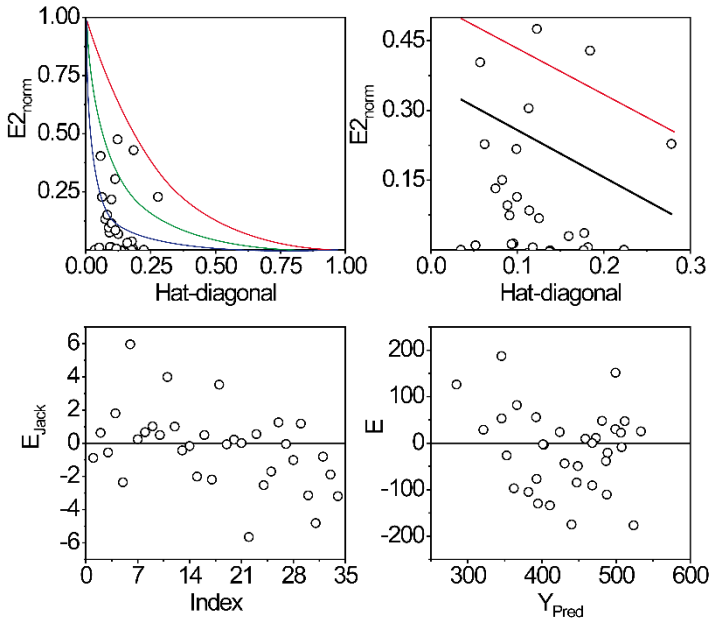

Figure S4. The residual analysis for multidimensional linear regression model by (a) L-R plot, (b) Pregibon, (c) Jackknife residues and (d) predicted residues after data filtering. The HWEC soil content in the 2018 model.

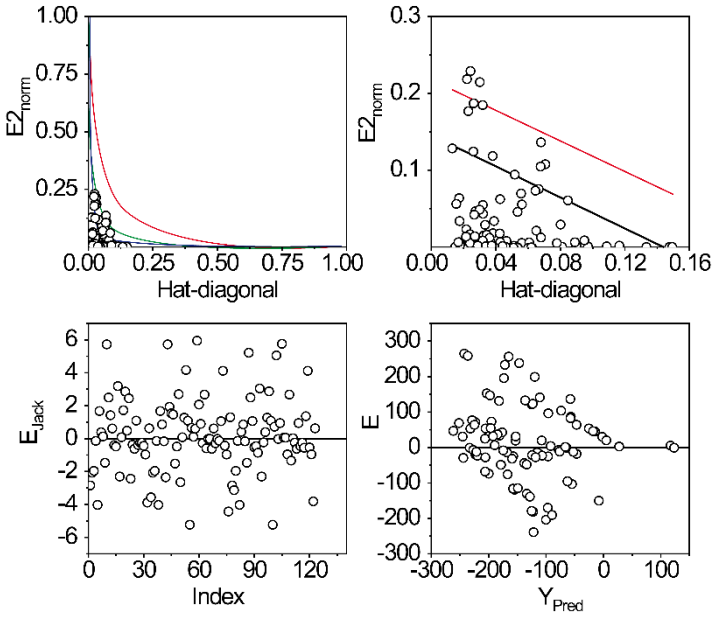

Figure S5. The residual analysis for multidimensional linear regression model by (a) L-R plot, (b) Pregibon, (c) Jackknife residues and (d) predicted residues after data filtering (the HWEC difference 2008–2018/).

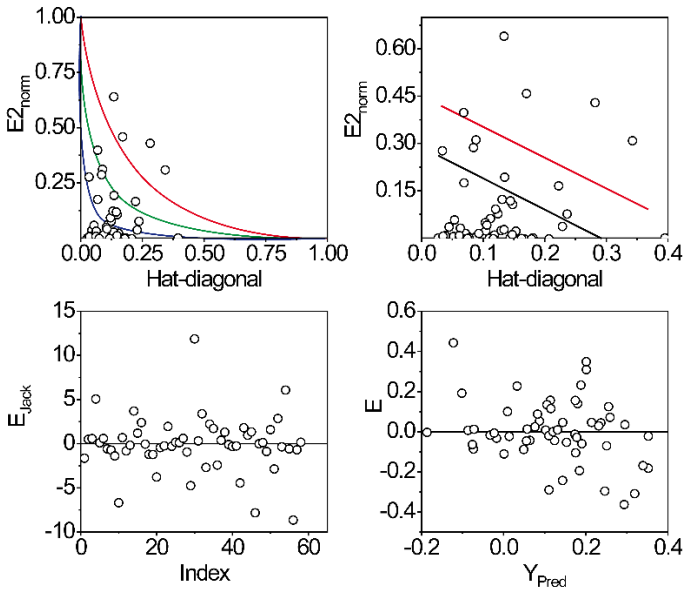

Figure S6. The residual analysis for multidimensional linear regression model by (a) L-R plot, (b) Pregibon, (c) Jackknife residues and (d) predicted residues after data filtering (Model: SOC Difference between the years 2018 and 2008).

Text S1: Expert assessment of the level of soil care for land monitored

Expert assessment of the soil evaluates the current condition of the land, i.e. how farmers take care to maintain natural soil fertility. Fertility is assessed by several qualitative parameters (kind of soil, soil-forming substrate, hydromorphic development, soil skeleton etc.), which are considerably different for some soil types. It would be difficult to achieve a reasonably objective evaluation of the care of the land that has significantly different soil types and thus qualitative parameters. Generally, the natural soil fertility is significantly different, for example, between the modal black soils formed on loess and the modal cambium (formerly brown soils). Soil care is evaluated mainly in a subjective way and places considerable demands on the expertise and experience of the relevant expert. Objective measurements (soil resistance measured by a penetrometer) and topsoil depth were used to evaluate the level of care.

Other evaluations are performed subjectively - the assessment of the topsoil structure, the compaction degree of the subsoil and the overall synthetic evaluation of the level of soil care. The structure evaluation in the topsoil is based on the classification levels set by Špička [1], but also on the work of other authors, e.g. Němeček [2], Šimon [3], Tomášek [4]. When assessing the structure of the topsoil, the following categories are regarded: I - very good structure (significant crumbly structure, crumbs mostly 1-10 mm in size), II - good structure (less pronounced crumbly structure, crumbs with a size mostly 1-20 mm), disturbed structure, crumbs with a size of 10-20 mm), III - lumpy or disturbed structure (unstable structures, which sometimes break down and can become even non-structural), IV - lumpy or powdery structure (due to precipitation it easily dissolves and hardens after drying v coherent, compact mass), V - non-structural soil (usually heavy soil, which, after tillage at excessive humidity, creates so-called pseudo–structured elements of larger dimensions, which are difficult to disconnect after soaking - the so-called benches.

Light textured soils, which tend to be non-structural and exclude a good level of soil care in their category, are excluded from this classification. Non-structural topsoils or subsoils, and some structural elements (eg. polyhedral, cube, prismatic, columnar) can be well cared for. The subsoil can have prismatic, columnar, plate-like and other structures, which are formed, for example, by pressure during the tillage. The following categories are used to evaluate compaction: I - low compaction, II - low to medium compaction, III - medium compaction, IV- medium to high compaction, high compaction. Biological activity can be evaluated according to the number of earthworms in a given probe: 1st category: more than 20 adult earthworms, 2: 5-20 earthworms, 3: up to 5 earthworms. The evaluation of the overall care of the land on a given plot (synthetic indicator) is as follows: 1 - good, 2 - medium, 3 - low.

References

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4. Tomášek Milan Soils of the Czech Rupublic (Půdy České republiky); 2. dopl. v.; Praha : Český geologický ústav: Praha, 2000.