

# Isotope geochemical dataset on subsoil management experiments at Campus Klein-Altendorf

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## Sheets:

**Table S1a** Chemical composition of pooled soil samples at central field trials (Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub> fusion).

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**Table S2a** Chemical composition of pooled soil samples at central field trials (microwave digestion).

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**Table S3** Soil pH of pooled soil samples at central field trials.

**Table S4** Chemical and magnesium and strontium isotope composition of the exchangeable fraction (1M NH<sub>4</sub>OAc) of pooled soil samples at central field trials.

**Table S5** Chemical and magnesium and strontium isotope composition of plant samples at central field trials.

Metric	Units	Sheet	Description
X	(wt%, µg/g, pg/g)		Oxide and element concentrations in bulk soil, exchangeable fractions and plant samples
δ <sup>26</sup> Mg, δ <sup>25</sup> Mg	(‰)		Magnesium isotope ratios expressed as delta values
<sup>87</sup> Sr/ <sup>86</sup> Sr			Radiogenic strontium isotope ratio
LOI	(%)		Loss on ignition
soil pH			pH of bulk soil

Table S1a Chemical composition of pooled soil samples at central field trials (Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub> fusion).

				Raw data (major oxides)												Raw data (trace elements)									
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	LOI*	Sum	Ba	Cd	Co	Cr	Cu	Pb	Sr	Zn		
(cm)				(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)		
CF 1-1 (winter wheat at flowering 2018)																									
CF S46b	C	Ap	15	75	0.80	8.7	3.3	0.12	0.65	0.80	0.97	2.1	0.19	4.2	96	388	<5	20	119	<40	<70	90	71		
CF S47b	C	E/B	40	73	0.80	10	4.3	0.10	0.82	0.72	0.91	2.3	0.14	4.7	98	401	<5	22	119	<40	<70	91	61		
CF S48b	C	Bt1	55	68	0.75	11	4.7	0.11	0.98	0.76	0.88	2.3	0.15	5.6	96	390	<5	22	129	<40	<70	84	68		
CF S49b	C	Bt2	65	71	0.76	11	4.8	0.11	1.00	0.76	0.89	2.3	0.15	5.4	99	372	<5	23	128	<40	<70	87	63		
CF S50b	C	Bt3	85	71	0.76	11	4.6	0.09	0.98	0.76	0.89	2.2	0.16	4.5	97	352	<5	22	127	<40	<70	84	65		
CF S51b	DL	Ap	15	76	0.78	8.8	3.3	0.12	0.67	0.85	0.95	2.1	0.19	4.4	99	385	<5	21	119	<40	<70	90	80		
CF S52b	DL	E/B	40	73	0.77	9.9	4.0	0.11	0.80	0.73	0.90	2.2	0.16	4.1	97	388	<5	21	113	<40	<70	90	63		
CF S53b	DL	Bt1	55	73	0.77	11	4.5	0.10	0.93	0.77	0.89	2.3	0.15	5.5	99	380	<5	22	123	<40	<70	88	69		
CF S54b	DL	Bt2	65	72	0.75	11	4.6	0.10	0.95	0.77	0.88	2.2	0.16	4.0	97	364	<5	21	122	<40	<70	84	65		
CF S55b	DL	Bt3	85	71	0.74	11	5.0	0.10	0.95	0.81	0.88	2.1	0.17	4.2	97	358	<5	22	124	<40	<70	86	68		
CF S56b	DLB	Ap	15	76	0.76	8.4	3.1	0.11	0.65	0.90	0.93	2.1	0.21	5.6	99	372	<5	20	117	<40	<70	92	68		
CF S57b	DLB	E/B	40	73	0.77	9.8	4.0	0.12	0.79	0.76	0.88	2.3	0.16	4.9	97	391	<5	21	111	<40	<70	88	65		
CF S58b	DLB	Bt1	55	71	0.75	11	4.5	0.09	0.90	0.73	0.85	2.2	0.14	5.0	97	374	<5	21	116	<40	<70	89	60		
CF S59b	DLB	Bt2	65	72	0.75	11	4.4	0.09	0.92	0.75	0.89	2.2	0.14	4.6	98	359	<5	21	121	<40	<70	84	58		
CF S60b	DLB	Bt3	85	71	0.75	11	4.6	0.09	0.97	0.79	0.88	2.2	0.15	5.6	98	359	<5	24	119	<40	<70	90	61		
CF 1-2 (spring barley at flowering 2018)																									
CF S166b	C	Ap	15	71	0.78	8.4	3.1	0.12	0.62	0.74	0.98	2.0	0.15	3.9	91	373	<5	19	119	<40	<70	87	61		
CF S167b	C	E/B	40	76	0.80	9.6	3.7	0.10	0.78	0.67	0.94	2.2	0.11	4.5	100	397	<5	21	107	<40	<70	95	65		
CF S168b	C	Bt1	55	77	0.79	10	4.1	0.11	0.88	0.71	0.92	2.4	0.12	4.1	101	401	<5	22	111	<40	<70	92	65		
CF S169b	C	Bt2	65	75	0.76	10	4.3	0.10	0.91	0.73	0.89	2.3	0.12	4.6	100	389	<5	22	117	<40	<70	93	67		
CF S170b	C	Bt3	85	74	0.77	11	4.6	0.10	1.00	0.77	0.92	2.3	0.13	4.0	100	383	<5	21	125	<40	<70	92	62		
CF S171b	DL	Ap	15	79	0.80	8.5	3.2	0.11	0.65	0.71	0.97	2.1	0.15	3.7	99	381	<5	20	108	<40	<70	93	70		
CF S172b	DL	E/B	40	77	0.79	9.5	3.6	0.10	0.77	0.71	0.95	2.2	0.12	4.5	100	390	<5	20	129	<40	<70	93	59		
CF S173b	DL	Bt1	55	77	0.77	10	4.1	0.10	0.90	0.71	0.92	2.3	0.13	4.8	102	389	<5	21	116	<40	<70	94	61		
CF S174b	DL	Bt2	65	73	0.76	10	4.4	0.11	0.95	0.73	0.88	2.2	0.13	5.2	98	374	<5	20	119	<40	<70	89	65		
CF S175b	DL	Bt3	85	73	0.75	11	4.6	0.10	0.98	0.73	0.88	2.2	0.12	4.9	99	361	<5	23	125	<40	<70	87	70		
CF S176b	DLB	Ap	15	78	0.78	8.4	3.2	0.11	0.65	0.74	0.96	2.1	0.17	4.8	99	373	<5	19	114	<40	<70	91	66		
CF S177b	DLB	E/B	40	75	0.76	9.0	3.5	0.10	0.75	0.70	0.93	2.2	0.13	4.6	98	380	<5	20	115	<40	<70	90	65		
CF S178b	DLB	Bt1	55	73	0.74	11	4.8	0.08	1.02	0.77	0.88	2.2	0.13	5.6	100	357	<5	21	126	<40	<70	86	76		
CF S179b	DLB	Bt2	65	72	0.76	11	4.5	0.09	1.00	0.74	0.90	2.3	0.12	5.3	99	377	<5	22	120	<40	<70	89	64		
CF S180b	DLB	Bt3	85	73	0.75	11	4.6	0.10	1.02	0.76	0.92	2.2	0.12	5.2	99	367	<5	21	130	<40	<70	91	66		
CF S181b	DLG	Ap	15	77	0.77	8.4	3.2	0.11	0.66	0.76	0.98	2.1	0.16	4.5	99	379	<5	19	108	<40	<70	93	70		
CF S182b	DLG	E/B	40	74	0.77	9.4	3.7	0.09	0.80	0.68	0.93	2.2	0.13	4.7	98	381	<5	20	114	<40	<70	91	70		
CF S183b	DLG	Bt1	55	71	0.72	9.9	4.1	0.08	0.90	0.67	0.86	2.1	0.12	5.4	96	352	<5	20	108	<40	<70	86	59		
CF S184b	DLG	Bt2	65	73	0.75	10	4.5	0.09	0.96	0.71	0.88	2.2	0.12	5.6	99	359	<5	21	120	<40	<70	85	70		
CF S185b	DLG	Bt3	85	75	0.75	11	4.5	0.09	0.98	0.75	0.88	2.1	0.14	4.8	101	349	<5	20	120	<40	<70	78	71		
CF 1-2 (winter wheat at maturity stage 2019)																									
CF S403b	C	Ap	15	80	0.78	8.2	3.0	0.11	0.61	0.72	0.99	2.0	0.16	4.1	101	373	<5	19	105	<40	<70	86	61		
CF S404b	C	E/B	40	77	0.78	9.2	3.5	0.10	0.72	0.67	0.94	2.1	0.12	4.1	100	392	<5	20	106	<40	<70	85	59		
CF S405b	C	Bt1	55	76	0.79	10	4.2	0.10	0.87	0.72	0.88	2.2	0.13	4.9	101	394	<5	22	106	<40	<70	84	62		
CF S406b	C	Bt2	65	74	0.76	11	4.6	0.10	0.97	0.75	0.88	2.3	0.14	5.2	100	393	<5	22	115	<40	<70	84	65		
CF S407b	C	Bt3	85	73	0.75	11	4.7	0.10	1.03	0.77	0.91	2.2	0.14	5.0	100	373	<5	21	126	<40	<70	82	72		
CF S408b	DL	Ap	15	78	0.78	8.5	3.2	0.13	0.64	0.71	0.97	2.1	0.16	4.2	99	381	<5	21	106	<40	<70	85	75		
CF S409b	DL	E/B	40	77	0.77	9.1	3.6	0.11	0.71	0.68	0.92	2.1	0.14	4.1	99	379	<5	22	109	<40	<70	86	59		
CF S410b	DL	Bt1	55	75	0.78	11	4.3	0.10	0.91	0.72	0.91	2.2	0.13	1.3	97	391	<5	20	122	<40	<70	84	66		
CF S411b	DL	Bt2	65	74	0.75	11	4.6	0.10	0.95	0.73	0.88	2.2	0.11	7.2	102	377	<5	20	116	<40	<70	81	74		
CF S412b	DL	Bt3	85	75	0.75	11	4.6	0.10	0.98	0.74	0.91	2.1	0.13	4.9	101	357	<5	21	127	<40	<70	79	65		
CF S413b	DLB mid	Ap	15	77	0.76	8.2	3.0	0.11	0.62	0.76	0.94	2.0	0.17	3.8	97	372	<5	19	95	<40	<70	84	64		
CF S414b	DLB mid	E/B	40	79	0.77	8.9	3.4	0.13	0.70	0.73	0.92	2.0	0.15	4.3	101	389	<5	22	108	<40	<70	84	58		
CF S415b	DLB mid	Bt1	55	74	0.75	11	4.4	0.10	0.91	0.72	0.86	2.2	0.12	4.7	99	381	<5	22	116	<40	<70	82	60		
CF S416b	DLB mid	Bt2	65	73	0.75	11	4.8	0.09	1.01	0.76	0.88	2.2	0.13	5.4	100	369	<5	21	124	<40	<70	77	62		
CF S417b	DLB mid	Bt3	85	75	0.75	11	4.6	0.09	0.98	0.77	0.90	2.1	0.15												

continued on next page ...

Table S1a continued - Chemical composition of pooled soil samples at central field trials (Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub> fusion).

				Raw data (major oxides)												Raw data (trace elements)							
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	LOI*	Sum	Ba	Cd	Co	Cr	Cu	Pb	Sr	Zn
				(cm)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)
CF 2 (spring barley at flowering 2020)																							
CF S 423b	C luc.	Ap	5	75	0.71	7.2	2.8	0.11	0.52	0.53	0.85	1.8	0.16	7	96	330	<5	14	100	210	<20	74	65
CF S 424b	C luc.	Ap	15	77	0.75	7.6	2.8	0.11	0.55	0.56	0.88	1.9	0.17	6.9	100	341	<5	16	107	<70	<20	77	69
CF S 425b	C luc.	Ap	25	77	0.74	7.5	2.8	0.12	0.56	0.56	0.89	1.9	0.16	7.4	100	340	<5	16	104	<70	<20	77	67
CF S 426b	C luc.	E/B	38	78	0.75	7.2	2.6	0.10	0.50	0.51	0.89	1.9	0.10	5.2	98	333	<5	14	110	83	<20	76	46
CF S 427b	C luc.	Bt1	53	75	0.74	8.1	3.1	0.10	0.61	0.50	0.82	1.9	0.08	5.3	96	341	<5	17	91	<70	<20	75	39
CF S 428b	C luc.	Bt2	70	75	0.76	8.8	3.5	0.10	0.69	0.58	0.81	2.0	0.09	6.3	98	354	<5	18	120	<70	<20	81	45
CF S 429b	C luc.	Bt3	90	74	0.77	9.1	3.6	0.11	0.70	0.56	0.77	2.1	0.08	6.1	98	371	<5	19	97	<70	<20	79	45
CF S 430b	C	Ap	5	75	0.73	7.4	2.8	0.11	0.55	0.55	0.88	1.9	0.16	7	97	336	<5	14	106	<70	<20	76	66
CF S 431b	C	Ap	15	78	0.74	7.6	3.1	0.12	0.57	0.56	0.85	1.9	0.17	7.2	101	341	<5	16	99	<70	<20	76	71
CF S 432b	C	Ap	25	78	0.74	7.5	3.0	0.13	0.56	0.61	0.86	1.9	0.18	8.5	102	344	<5	18	100	<70	<20	77	70
CF S 433b	C	E/B	38	77	0.74	7.8	2.9	0.10	0.57	0.51	0.84	1.9	0.10	5.8	98	340	<5	14	95	<70	<20	76	39
CF S 434b	C	Bt1	53	75	0.76	8.3	3.1	0.10	0.62	0.53	0.84	1.9	0.08	5.9	97	348	<5	16	92	<70	<20	77	37
CF S 435b	C	Bt2	70	73	0.78	9.1	3.5	0.10	0.72	0.57	0.80	2.0	0.09	6.2	97	365	<5	18	150	<70	<20	80	45
CF S 436b	C	Bt3	90	74	0.77	9.0	3.5	0.11	0.73	0.59	0.76	2.0	0.10	5.9	97	361	<5	21	150	<70	<20	83	48
CF S 437b	DLB luc.	Ap	5	75	0.71	7.2	2.8	0.13	0.53	0.55	0.78	1.8	0.16	8	97	340	<5	16	98	<70	<20	78	66
CF S 438b	DLB luc.	Ap	15	80	0.76	7.6	3.0	0.12	0.56	0.57	0.82	1.9	0.16	6.0	101	344	<5	16	95	<70	<20	79	69
CF S 439b	DLB luc.	Ap	25	77	0.74	7.5	3.1	0.14	0.55	0.57	0.81	1.9	0.16	6.9	99	346	<5	17	101	<70	<20	77	68
CF S 440b	DLB luc.	E/B	38	76	0.72	7.6	2.9	0.11	0.57	0.64	0.80	1.9	0.15	8.5	100	350	<5	15	82	<70	<20	79	56
CF S 441b	DLB luc.	Bt1	53	74	0.76	8.1	3.0	0.10	0.63	0.60	0.80	1.9	0.11	7.5	98	367	<5	16	101	<70	<20	83	42
CF S 442b	DLB luc.	Bt2	70	74	0.76	8.8	3.3	0.10	0.68	0.59	0.79	2.0	0.10	6.9	98	360	<5	17	94	<70	<20	80	43
CF S 443b	DLB luc.	Bt3	90	75	0.77	9.1	3.5	0.11	0.72	0.60	0.77	2.0	0.09	4.2	96	369	<5	18	97	<70	<20	86	44
CF S 444b	DLB	Ap	5	77	0.73	7.5	2.9	0.11	0.54	0.57	0.81	1.9	0.18	4.9	97	338	<5	16	96	<70	<20	78	68
CF S 445b	DLB	Ap	15	78	0.73	7.6	2.9	0.12	0.57	0.54	0.80	1.9	0.16	5.1	98	346	<5	16	92	<70	<20	76	67
CF S 446b	DLB	Ap	25	77	0.73	7.6	2.8	0.11	0.56	0.56	0.81	1.9	0.16	4.6	97	345	<5	16	87	<70	<20	77	62
CF S 447b	DLB	E/B	38	76	0.70	7.3	2.6	0.10	0.56	0.81	0.79	1.8	0.15	7.6	98	339	<5	14	79	<70	<20	84	56
CF S 448b	DLB	Bt1	53	76	0.76	8.5	3.2	0.10	0.64	0.59	0.79	2.0	0.10	4.1	97	369	<5	18	94	<70	<20	82	40
CF S 449b	DLB	Bt2	70	76	0.77	9.2	3.8	0.10	0.72	0.60	0.78	2.0	0.09	3.8	98	360	<5	18	95	<70	<20	81	46
CF S 450b	DLB	Bt3	90	74	0.75	9.3	3.8	0.09	0.78	0.59	0.77	2.0	0.08	6.8	98	343	<5	17	93	<70	<20	78	42
International reference material used to determine accuracy and precision of the method																							
SRM 2709a Soil Joaquin Soil (a)				62	0.53	14	4.6	0.07	2.3	2.5	1.6	2.4	0.12	6.9	97	970	<5	18	140	<40	<70	235	100
SRM 2709a Soil Joaquin Soil (b)				62	0.52	13	4.3	0.07	2.3	2.4	1.5	2.3	0.14	3.9	92	925	<5	16	135	<70	<20	219	90
SRM 2709a Soil Joaquin Soil mean				62	0.53	13	4.5	0.07	2.3	2.5	1.6	2.3	0.13	5	95	948	-	17	137	-	-	227	95
SRM 2709a Soil Joaquin Soil 2SD				0.91	0.02	1.3	0.42	0.00	0.12	0.14	0.06	0.10	0.03	4.3		64	-	2.8	7.8	-	-	23	14
SRM 2709a Soil Joaquin Soil RSD (%)				1%	3%	10%	9%	0%	5%	6%	4%	4%	20%	80%		7%	-	17%	6%	-	-	10%	15%
SRM 2709a San Joaquin Soil certified value				n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.		n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	
SRM 2709a San Joaquin Soil certified absolute uncertainty				n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.		n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	

\* calculated as difference from the sum of oxides to 100%; n.r. = not reported; (a)-(b) = full digestion replicates.  
C: control; C luc.: control + lucerne; DL: deep loosening; DLB: deep loosening + biowaste compost; DLG: deep loosening + greenwaste compost;  
DLB luc.: deep loosening + biowaste compost + lucerne.

Table S1b Loss on ignition corrected chemical composition of pooled soil samples at central field trials (Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub> fusion).

				LOI corrected data (major oxides)										LOI corrected data (trace elements)									
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	Sum	Ba	Cd	Co	Cr	Cu	Pb	Sr	Zn	
(cm)				(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	
CF 1-1 (winter wheat at flowering 2018)																							
CF S46b	C	Ap	15	78	0.83	9.1	3.4	0.12	0.68	0.83	1.01	2.2	0.20	96	405	<5	21	124	<40	<70	94	74	
CF S47b	C	E/B	40	77	0.84	11	4.5	0.11	0.86	0.75	0.96	2.4	0.15	98	421	<5	23	125	<40	<70	96	64	
CF S48b	C	Bt1	55	72	0.80	12	5.0	0.12	1.04	0.80	0.93	2.5	0.16	95	413	<5	23	137	<40	<70	89	72	
CF S49b	C	Bt2	65	75	0.80	12	5.1	0.11	1.1	0.81	0.94	2.4	0.16	99	393	<5	24	135	<40	<70	92	67	
CF S50b	C	Bt3	85	75	0.80	11	4.9	0.10	1.02	0.80	0.93	2.3	0.17	97	368	<5	23	133	<40	<70	88	68	
CF S51b	DL	Ap	15	80	0.82	9.2	3.5	0.12	0.70	0.89	1.00	2.2	0.20	99	403	<5	22	124	<40	<70	94	84	
CF S52b	DL	E/B	40	77	0.81	10	4.2	0.11	0.83	0.76	0.94	2.3	0.16	97	405	<5	21	118	<40	<70	94	66	
CF S53b	DL	Bt1	55	77	0.81	11	4.8	0.11	0.98	0.81	0.94	2.4	0.15	99	402	<5	23	130	<40	<70	93	73	
CF S54b	DL	Bt2	65	75	0.78	11	4.7	0.11	0.98	0.80	0.91	2.3	0.16	97	379	<5	22	127	<40	<70	87	68	
CF S55b	DL	Bt3	85	75	0.78	11	5.3	0.11	1.00	0.85	0.92	2.2	0.18	97	374	<5	23	129	<40	<70	90	71	
CF S56b	DLB	Ap	15	81	0.81	8.8	3.3	0.12	0.69	0.95	0.99	2.2	0.22	99	394	<5	21	124	<40	<70	97	71	
CF S57b	DLB	E/B	40	76	0.81	10	4.2	0.12	0.84	0.79	0.92	2.4	0.17	97	411	<5	22	117	<40	<70	93	68	
CF S58b	DLB	Bt1	55	75	0.79	11	4.8	0.10	0.95	0.76	0.89	2.3	0.15	96	394	<5	22	122	<40	<70	94	63	
CF S59b	DLB	Bt2	65	76	0.78	11	4.6	0.09	0.97	0.79	0.93	2.3	0.15	97	376	<5	22	127	<40	<70	88	61	
CF S60b	DLB	Bt3	85	75	0.80	11	4.9	0.10	1.02	0.83	0.94	2.3	0.16	97	380	<5	25	126	<40	<70	95	65	
CF 1-2 (spring barley at flowering 2018)																							
CF S166b	C	Ap	15	73	0.81	8.8	3.2	0.12	0.65	0.77	1.02	2.1	0.16	91	388	<5	20	124	<40	<70	91	64	
CF S167b	C	E/B	40	80	0.84	10	3.9	0.11	0.82	0.70	0.99	2.3	0.12	100	416	<5	22	112	<40	<70	99	68	
CF S168b	C	Bt1	55	80	0.82	11	4.3	0.11	0.92	0.74	0.96	2.5	0.13	101	418	<5	23	116	<40	<70	96	68	
CF S169b	C	Bt2	65	78	0.80	11	4.5	0.11	0.96	0.76	0.93	2.4	0.12	100	408	<5	23	123	<40	<70	97	70	
CF S170b	C	Bt3	85	78	0.81	11	4.8	0.10	1.04	0.80	0.95	2.4	0.14	100	399	<5	22	130	<40	<70	96	65	
CF S171b	DL	Ap	15	82	0.83	8.9	3.3	0.11	0.68	0.74	1.01	2.2	0.15	99	396	<5	21	112	<40	<70	97	73	
CF S172b	DL	E/B	40	81	0.83	9.9	3.8	0.11	0.81	0.75	0.99	2.3	0.13	100	409	<5	21	135	<40	<70	97	62	
CF S173b	DL	Bt1	55	81	0.81	11	4.4	0.10	0.95	0.75	0.97	2.4	0.13	102	409	<5	22	122	<40	<70	99	64	
CF S174b	DL	Bt2	65	77	0.80	11	4.6	0.11	1.00	0.77	0.92	2.4	0.14	98	395	<5	21	126	<40	<70	94	69	
CF S175b	DL	Bt3	85	77	0.79	11	4.9	0.10	1.03	0.77	0.93	2.3	0.13	99	380	<5	24	131	<40	<70	92	74	
CF S176b	DLB	Ap	15	82	0.82	8.8	3.4	0.12	0.68	0.78	1.00	2.2	0.18	99	392	<5	20	120	<40	<70	96	69	
CF S177b	DLB	E/B	40	79	0.80	9.4	3.6	0.10	0.78	0.73	0.97	2.3	0.14	98	398	<5	21	121	<40	<70	94	68	
CF S178b	DLB	Bt1	55	77	0.78	12	5.1	0.09	1.1	0.82	0.93	2.4	0.14	100	378	<5	22	133	<40	<70	91	80	
CF S179b	DLB	Bt2	65	76	0.80	11	4.8	0.10	1.1	0.78	0.95	2.4	0.13	99	398	<5	23	127	<40	<70	94	68	
CF S180b	DLB	Bt3	85	77	0.79	11	4.9	0.11	1.1	0.80	0.97	2.4	0.13	99	387	<5	22	137	<40	<70	96	70	
CF S181b	DLG	Ap	15	81	0.81	8.8	3.3	0.12	0.69	0.79	1.03	2.2	0.17	99	397	<5	20	113	<40	<70	97	73	
CF S182b	DLG	E/B	40	78	0.81	9.9	3.9	0.10	0.84	0.72	0.98	2.3	0.14	98	400	<5	21	120	<40	<70	95	73	
CF S183b	DLG	Bt1	55	75	0.76	10	4.3	0.09	0.95	0.71	0.91	2.3	0.12	95	372	<5	21	114	<40	<70	91	62	
CF S184b	DLG	Bt2	65	77	0.79	11	4.8	0.10	1.02	0.76	0.93	2.3	0.13	99	381	<5	22	127	<40	<70	90	74	
CF S185b	DLG	Bt3	85	79	0.78	11	4.8	0.09	1.03	0.79	0.93	2.2	0.15	101	367	<5	21	126	<40	<70	82	75	
CF 1-2 (winter wheat at maturity stage 2019)																							
CF S403b	C	Ap	15	84	0.81	8.5	3.2	0.11	0.63	0.75	1.03	2.1	0.17	101	389	<5	20	109	<40	<70	90	64	
CF S404b	C	E/B	40	81	0.82	9.6	3.7	0.11	0.75	0.70	0.98	2.2	0.12	100	409	<5	21	110	<40	<70	89	62	
CF S405b	C	Bt1	55	79	0.83	11	4.4	0.11	0.92	0.75	0.93	2.3	0.14	101	414	<5	23	111	<40	<70	88	65	
CF S406b	C	Bt2	65	78	0.81	12	4.8	0.10	1.03	0.79	0.92	2.4	0.14	100	414	<5	23	121	<40	<70	89	69	
CF S407b	C	Bt3	85	77	0.79	12	5.0	0.10	1.1	0.81	0.95	2.3	0.14	100	393	<5	23	133	<40	<70	86	75	
CF S408b	DL	Ap	15	81	0.82	8.8	3.3	0.13	0.66	0.74	1.02	2.2	0.17	99	398	<5	21	111	<40	<70	89	78	
CF S409b	DL	E/B	40	80	0.81	9.5	3.7	0.11	0.74	0.71	0.96	2.2	0.14	99	395	<5	23	114	<40	<70	90	62	
CF S410b	DL	Bt1	55	76	0.79	11	4.4	0.10	0.92	0.73	0.92	2.3	0.13	97	396	<5	20	124	<40	<70	85	67	
CF S411b	DL	Bt2	65	79	0.81	12	4.9	0.10	1.02	0.79	0.95	2.4	0.12	102	406	<5	22	125	<40	<70	87	80	
CF S412b	DL	Bt3	85	79	0.79	11	4.8	0.10	1.03	0.78	0.95	2.3	0.14	101	375	<5	22	133	<40	<70	83	68	
CF S413b	DLB mid	Ap	15	80	0.79	8.5	3.1	0.12	0.64	0.79	0.98	2.1	0.18	97	387	<5	20	99	<40	<70	87	67	
CF S414b	DLB mid	E/B	40	82	0.81	9.3	3.6	0.14	0.73	0.76	0.96	2.1	0.16	101	406	<5	23	113	<40	<70	88	61	
CF S415b	DLB mid	Bt1	55	78	0.79	11	4.6	0.10	0.95	0.76	0.91	2.3	0.13	99	400	<5	23	122	<40	<70	86	63	
CF S416b	DLB mid	Bt2	65	77	0.79	12	5.1	0.10	1.1	0.80	0.93	2.3	0.14	100	390	<5	22	131	<40	<70	81	66	
CF S417b	DLB mid	Bt3	85	79	0.79	11	4.8	0.10	1.03	0.80	0.95	2.2	0.16	101	374	<5	22	128	<40	<70	86	68	
CF S418b	DLG	Ap	15	82	0.82	9.1	3.7	0.12	0.70	0.78	0.99	2.1	0.17	100	395	<5	22	114	<40	<70	96	63	
CF S419b	DLG	E/B	40	80	0.80	10	4.1	0.13	0.84	0.75	0.94	2.3	0.14	100	403	<5	21	122	<40	<70	88	64	
CF S420b	DLG	Bt1	55	75	0.79	11	4.6	0.09	0.98	0.76	0.93	2.2	0.13	97	387	<5	21	126	<40	<70	90	61	
CF S421b	DLG	Bt2	65	74	0.78	12	5.1	0.10	1.03	0.78	0.92	2.2	0.14	97									

continued on next page ...



Table S1b continued - Loss on ignition corrected chemical composition of pooled soil samples at central field trials (Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub> fusion).

LOI corrected data (major oxides)														LOI corrected data (trace elements)								
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	Sum	Ba	Cd	Co	Cr	Cu	Pb	Sr	Zn
			(cm)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)
CF 2 (spring barley at flowering 2020)																						
CF S 423b	C luc.	Ap	5	80	0.76	7.7	3.0	0.12	0.56	0.57	0.91	2.0	0.17	96	354	<5	15	107	<40	<70	79	70
CF S 424b	C luc.	Ap	15	83	0.81	8.1	3.1	0.12	0.59	0.60	0.94	2.0	0.18	100	366	<5	17	115	<40	<70	83	74
CF S 425b	C luc.	Ap	25	83	0.80	8.1	3.1	0.12	0.61	0.61	0.96	2.0	0.18	100	367	<5	17	112	<40	<70	83	72
CF S 426b	C luc.	E/B	38	82	0.79	7.6	2.7	0.10	0.53	0.54	0.94	2.0	0.11	98	351	<5	15	116	<40	<70	80	49
CF S 427b	C luc.	Bt1	53	79	0.78	8.6	3.3	0.11	0.65	0.53	0.87	2.0	0.08	96	360	<5	18	96	<40	<70	79	41
CF S 428b	C luc.	Bt2	70	80	0.82	9.4	3.7	0.11	0.74	0.61	0.86	2.1	0.10	98	378	<5	19	128	<40	<70	86	48
CF S 429b	C luc.	Bt3	90	79	0.82	9.7	3.9	0.12	0.75	0.60	0.82	2.2	0.09	98	395	<5	21	103	<40	<70	84	48
CF S 430b	C	Ap	5	81	0.79	8.0	3.0	0.12	0.59	0.59	0.95	2.0	0.17	97	363	<5	15	115	<40	<70	82	71
CF S 431b	C	Ap	15	84	0.80	8.2	3.4	0.13	0.62	0.60	0.91	2.1	0.18	101	367	<5	17	107	<40	<70	82	76
CF S 432b	C	Ap	25	85	0.81	8.2	3.3	0.14	0.62	0.66	0.94	2.1	0.19	102	376	<5	20	109	<40	<70	84	77
CF S 433b	C	E/B	38	81	0.79	8.3	3.0	0.11	0.61	0.54	0.89	2.0	0.10	98	361	<5	15	101	<40	<70	81	41
CF S 434b	C	Bt1	53	80	0.81	8.8	3.3	0.10	0.66	0.57	0.89	2.1	0.09	97	370	<5	16	98	<40	<70	82	39
CF S 435b	C	Bt2	70	78	0.83	9.7	3.8	0.11	0.77	0.61	0.85	2.2	0.10	96	389	<5	19	160	<40	<70	85	48
CF S 436b	C	Bt3	90	78	0.82	9.6	3.8	0.11	0.77	0.62	0.81	2.1	0.10	97	384	<5	22	159	<40	<70	88	51
CF S 437b	DLB luc.	Ap	5	81	0.77	7.8	3.1	0.14	0.58	0.59	0.85	1.9	0.18	97	369	<5	18	106	<40	<70	85	72
CF S 438b	DLB luc.	Ap	15	85	0.81	8.1	3.2	0.12	0.60	0.61	0.88	2.0	0.17	101	366	<5	17	101	<40	<70	84	73
CF S 439b	DLB luc.	Ap	25	83	0.80	8.1	3.3	0.15	0.60	0.61	0.87	2.0	0.17	99	372	<5	18	109	<40	<70	83	73
CF S 440b	DLB luc.	E/B	38	83	0.79	8.3	3.1	0.12	0.63	0.70	0.87	2.1	0.16	100	383	<5	16	90	<40	<70	86	61
CF S 441b	DLB luc.	Bt1	53	80	0.82	8.8	3.3	0.11	0.68	0.64	0.86	2.1	0.12	97	397	<5	17	109	<40	<70	90	45
CF S 442b	DLB luc.	Bt2	70	80	0.82	9.4	3.6	0.11	0.73	0.63	0.84	2.1	0.11	98	387	<5	18	101	<40	<70	86	46
CF S 443b	DLB luc.	Bt3	90	78	0.80	9.5	3.7	0.12	0.75	0.63	0.80	2.1	0.10	96	385	<5	19	101	<40	<70	90	46
CF S 444b	DLB	Ap	5	81	0.76	7.9	3.0	0.11	0.57	0.60	0.85	2.0	0.19	97	355	<5	17	101	<40	<70	82	72
CF S 445b	DLB	Ap	15	82	0.77	8.0	3.1	0.12	0.60	0.57	0.85	2.0	0.17	98	365	<5	17	97	<40	<70	80	71
CF S 446b	DLB	Ap	25	81	0.77	8.0	3.0	0.12	0.59	0.59	0.85	2.0	0.17	97	361	<5	17	91	<40	<70	81	65
CF S 447b	DLB	E/B	38	82	0.76	7.9	2.8	0.11	0.61	0.88	0.85	2.0	0.17	98	367	<5	15	85	<40	<70	90	61
CF S 448b	DLB	Bt1	53	79	0.80	8.8	3.3	0.11	0.66	0.61	0.82	2.1	0.11	97	385	<5	18	98	<40	<70	86	42
CF S 449b	DLB	Bt2	70	79	0.80	9.6	3.9	0.10	0.74	0.63	0.81	2.1	0.09	98	374	<5	19	99	<40	<70	84	48
CF S 450b	DLB	Bt3	90	79	0.80	10.0	4.0	0.10	0.83	0.64	0.82	2.1	0.09	98	368	<5	18	100	<40	<70	84	45
International reference material used to determine accuracy and precision of the method																						
SRM 2709a Soil Joaquin Soil (a)				67	0.57	15	5.0	0.07	2.51	2.74	1.7	2.6	0.13	97	1042	<5	19	150	<40	<70	252	107
SRM 2709a Soil Joaquin Soil (b)				64	0.54	13	4.5	0.07	2.35	2.55	1.6	2.4	0.15	92	962	<5	17	140	<40	<70	228	94
SRM 2709a Soil Joaquin Soil mean				66	0.56	14	4.7	0.07	2.4	2.6	1.6	2.5	0.14	94	1002	-	18	145	-	-	240	101
SRM 2709a Soil Joaquin Soil 2SD				3.9	0.04	1.96	0.66	0.00	0.23	0.27	0.14	0.22	0.02		113	-	3.8	14.8	-	-	35	20
SRM 2709a Soil Joaquin Soil RSD (%)				6%	8%	14%	14%	4%	10%	10%	8%	9%	15%		11%	-	21%	10%	-	-	15%	19%
SRM 2709a San Joaquin Soil certified value				65	0.56	14	4.8	0.07	2.4	2.7	1.6	2.5	0.16		979	0.37	13	130	34	17	239	103
SRM 2709a San Joaquin Soil certified absolute uncertainty				0.9	0.01	0.3	0.1	0.01	0.03	0.13	0.04	0.1	0		28	0.00	0.20	20	0.50	0.10	6.0	4.0
relative difference (measured value/certified value) (%)				1%	0%	0%	-1%	5%	1%	-2%	3%	-1%	-14%		2%	-	41%	12%	-	-	0%	-2%

(a)-(b) = full digestion replicates.

C: control; C luc.: control + lucerne; DL: deep loosening; DLB: deep loosening + biowaste compost; DLG: deep loosening + greenwaste compost;

DLB luc.: deep loosening + biowaste compost + lucerne.

Table S2a Chemical composition of pooled soil samples at central field trials (microwave digestion).

Raw data (major oxides)															Raw data (trace elements)											
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	LOI	B	Ba	Co	Cr	Cu	Ga	Li	Ni	Rb	Sr	Zn	
			(cm)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	
CF 1-1 (winter wheat at flowering 2018)																										
CF S46b	C	Ap	15	n.d.	0.16	4.6	3.1	0.11	0.53	0.54	0.04	0.73	0.28	4.2	18	132	8.3	47	15	7.4	22	27	70	37	66	
CF S47b	C	E/B	40	n.d.	0.16	6.1	4.0	0.09	0.69	0.49	0.04	0.87	0.23	4.7	22	148	8.8	48	14	8.6	25	31	81	36	55	
CF S48b	C	Bt1	55	n.d.	0.17	7.3	4.6	0.09	0.86	0.55	0.04	1.0	0.23	5.6	29	161	9.5	55	14	10	30	38	95	40	59	
CF S49b	C	Bt2	65	n.d.	0.15	7.1	4.5	0.09	0.88	0.56	0.04	0.99	0.25	5.4	29	151	8.9	56	15	10	29	36	94	40	58	
CF S50b	C	Bt3	85	n.d.	0.15	7.1	4.4	0.08	0.86	0.60	0.05	0.99	0.25	4.5	29	150	8.5	55	15	9.9	29	36	92	40	57	
CF S51b	DL	Ap	15	n.d.	0.17	4.9	3.1	0.11	0.57	0.68	0.04	0.78	0.30	4.4	18	144	7.1	57	13	7.6	20	24	71	37	61	
CF S52b	DL	E/B	40	n.d.	0.14	6.4	3.7	0.10	0.69	0.61	0.05	0.99	0.24	4.1	24	166	8.5	65	14	9.6	26	29	92	41	57	
CF S53b	DL	Bt1	55	n.d.	0.15	7.5	4.3	0.09	0.84	0.57	0.05	1.1	0.23	5.5	29	171	9.0	65	15	11	28	36	102	44	57	
CF S54b	DL	Bt2	65	n.d.	0.16	7.3	4.4	0.10	0.83	0.57	0.05	1.0	0.24	4.0	29	161	10	60	15	10	29	37	97	43	56	
CF S55b	DL	Bt3	85	n.d.	0.14	6.8	4.9	0.09	0.84	0.64	0.04	0.96	0.27	4.2	27	147	9.6	54	15	9.8	29	39	90	41	58	
CF S56b	DLB	Ap	15	n.d.	0.15	4.5	2.9	0.10	0.52	0.68	0.04	0.71	0.32	5.6	18	124	7.6	49	15	7.2	20	24	69	39	68	
CF S57b	DLB	E/B	40	n.d.	0.15	6.0	3.9	0.11	0.68	0.54	0.04	0.92	0.26	4.9	22	150	9.5	46	15	8.5	24	32	80	38	59	
CF S58b	DLB	Bt1	55	n.d.	0.16	7.2	4.3	0.09	0.80	0.54	0.06	1.0	0.21	5.0	28	163	9.7	63	15	11	29	33	102	44	60	
CF S59b	DLB	Bt2	65	n.d.	0.16	7.2	4.3	0.08	0.81	0.55	0.06	1.0	0.23	4.6	28	156	8.2	63	14	10	28	33	96	42	56	
CF S60b	DLB	Bt3	85	n.d.	0.15	7.4	4.5	0.09	0.86	0.58	0.05	1.0	0.23	5.6	29	160	9.4	64	16	11	29	37	102	44	60	
CF 1-2 (spring barley at flowering 2018)																										
CF S166b	C	Ap	15	n.d.	0.16	4.7	2.9	0.11	0.51	0.52	0.04	0.73	0.23	3.9	16	135	7.1	52	13	7.4	19	23	69	36	61	
CF S167b	C	E/B	40	n.d.	0.16	6.2	3.7	0.09	0.66	0.49	0.05	0.89	0.16	4.5	22	161	8.7	58	14	9.6	24	28	89	41	57	
CF S168b	C	Bt1	55	n.d.	0.16	6.9	4.0	0.10	0.75	0.53	0.05	0.96	0.17	4.1	25	167	9.6	57	14	10	26	32	93	41	55	
CF S169b	C	Bt2	65	n.d.	0.16	7.0	4.1	0.09	0.77	0.52	0.05	0.99	0.17	4.6	27	164	9.0	58	14	10	27	32	94	42	56	
CF S170b	C	Bt3	85	n.d.	0.15	7.3	4.5	0.09	0.84	0.57	0.05	1.00	0.17	4.0	29	160	8.8	62	15	11	30	35	99	43	56	
CF S171b	DL	Ap	15	n.d.	0.15	4.8	3.0	0.10	0.52	0.49	0.04	0.66	0.22	3.7	17	133	6.6	51	22	7.3	19	22	68	36	57	
CF S172b	DL	E/B	40	n.d.	0.15	5.7	3.4	0.09	0.63	0.51	0.04	0.78	0.18	4.5	20	149	7.9	54	13	8.7	23	26	81	38	53	
CF S173b	DL	Bt1	55	n.d.	0.16	6.8	3.9	0.09	0.75	0.53	0.05	0.96	0.16	4.8	26	159	9.1	59	14	10	27	31	95	42	56	
CF S174b	DL	Bt2	65	n.d.	0.16	7.3	4.3	0.09	0.81	0.55	0.05	1.0	0.18	5.2	29	164	9.2	64	15	11	28	34	102	45	58	
CF S175b	DL	Bt3	85	n.d.	0.15	7.5	4.5	0.09	0.85	0.55	0.05	1.0	0.19	4.9	29	158	9.2	65	16	11	30	36	99	42	60	
CF S176b	DLB	Ap	15	n.d.	0.15	4.8	3.0	0.10	0.52	0.52	0.04	0.74	0.23	4.8	17	131	6.9	49	13	7.4	20	22	69	38	60	
CF S177b	DLB	E/B	40	n.d.	0.16	5.5	3.4	0.09	0.62	0.55	0.04	0.75	0.18	4.6	20	132	7.4	45	13	8.1	22	26	74	36	54	
CF S178b	DLB	Bt1	55	n.d.	0.14	7.4	4.7	0.07	0.87	0.57	0.05	0.98	0.18	5.6	31	154	8.8	59	16	10	30	37	96	40	61	
CF S179b	DLB	Bt2	65	n.d.	0.16	6.9	4.3	0.08	0.82	0.55	0.04	0.92	0.17	5.3	28	150	9.5	56	15	10	28	34	92	40	57	
CF S180b	DLB	Bt3	85	n.d.	0.14	6.9	4.3	0.09	0.83	0.54	0.05	0.89	0.18	5.2	29	144	9.4	56	16	10	30	36	94	42	62	
CF S181b	DLG	Ap	15	n.d.	0.16	4.7	3.0	0.10	0.52	0.52	0.04	0.65	0.23	4.5	17	124	6.8	47	13	7.2	19	23	66	35	59	
CF S182b	DLG	E/B	40	n.d.	0.17	6.3	3.7	0.09	0.68	0.50	0.05	0.89	0.18	4.7	23	155	7.7	59	14	9.4	24	28	88	40	56	
CF S183b	DLG	Bt1	55	n.d.	0.15	7.4	4.3	0.08	0.80	0.53	0.05	1.0	0.17	5.4	28	167	9.5	70	16	11	29	32	102	44	59	
CF S184b	DLG	Bt2	65	n.d.	0.17	7.4	4.3	0.08	0.83	0.54	0.06	1.0	0.18	5.6	30	163	10	73	15	11	31	35	104	45	62	
CF S185b	DLG	Bt3	85	n.d.	0.16	7.6	4.4	0.09	0.85	0.58	0.05	1.0	0.18	4.8	30	164	8.9	68	15	11	30	37	101	44	58	
CF 1-2 (winter wheat at maturity stage 2019)																										
CF S403b	C	Ap	15	n.d.	0.16	4.4	2.7	0.10	0.49	0.61	0.02	0.69	0.25	4.1	16	128	7.0	47	64	6.5	18	21	62	35	55	
CF S404b	C	E/B	40	n.d.	0.14	4.3	2.6	0.07	0.50	0.46	0.02	0.65	0.16	4.1	20	148	7.7	47	48	7.9	22	24	74	36	48	
CF S405b	C	Bt1	55	n.d.	0.17	6.4	3.8	0.09	0.75	0.60	0.03	0.92	0.21	4.9	24	158	8.8	52	68	9.0	26	28	84	38	51	
CF S406b	C	Bt2	65	n.d.	0.15	6.8	4.1	0.08	0.82	0.61	0.03	0.96	0.21	5.2	28	164	8.8	54	68	10	30	32	93	40	59	
CF S407b	C	Bt3	85	n.d.	0.14	7.0	4.3	0.09	0.87	0.63	0.03	0.97	0.22	5.0	29	158	9.8	56	69	9.8	31	35	92	40	56	
CF S408b	DL	Ap	15	n.d.	0.16	4.2	2.6	0.11	0.48	0.00	0.02	0.68	0.23	4.2	15	124	7.8	42	64	6.2	18	22	58	31	52	
CF S409b	DL	E/B	40	n.d.	0.16	5.2	3.2	0.10	0.60	0.56	0.03	0.79	0.20	4.1	19	145	8.5	45	64	7.6	23	26	73	35	53	
CF S410b	DL	Bt1	55	n.d.	0.15	6.4	3.7	0.09	0.76	0.54	0.03	0.93	0.19	1.3	25	167	9.4	53	65	9.4	27	29	87	39	53	
CF S411b	DL	Bt2	65	n.d.	0.14	6.6	4.0	0.08	0.78	0.58	0.03	0.92	0.19	7.2	27	162	9.7	55	66	9.7	29	33	91	39	56	
CF S412b	DL	Bt3	85	n.d.	0.11	5.5	3.3	0.07	0.67	0.51	0.03	0.76	0.16	4.9	28	155	9.0	55	53	9.8	29	33	90	40	55	
CF S413b	DLB mid	Ap	15	n.d.	0.15	4.3	2.8	0.10	0.52	0.76	0.02	0.68	0.24	3.8	14	118	6.4	41	54	5.9	17	19	56	31	50	
CF S414b	DLB mid	E/B	40	n.d.	0.15	5.0	3.2	0.12	0.59	0.67	0.03	0.75	0.23	4.3	19	150	9.2	45								

Table S2a continued - Chemical composition of pooled soil samples at central field trials (microwave digestion).

				Raw data (major oxides)											Raw data (trace elements)												
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	LOI	B	Ba	Co	Cr	Cu	Ga	Li	Ni	Rb	Sr	Zn		
				(cm)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	
CF 2 (spring barley at flowering 2020)																											
CF S 423b	C luc.	Ap	5	n.d.	0.12	3.8	2.3	0.10	0.39	0.31	0.04	0.61	0.22	7	16	116	8.5	48	18	6.3	17	16	63	31	72		
CF S 424b	C luc.	Ap	15	n.d.	0.12	3.7	2.4	0.09	0.40	0.32	0.04	0.62	0.22	6.9	17	115	8.2	48	18	6.4	17	14	65	33	76		
CF S 425b	C luc.	Ap	25	n.d.	0.13	3.7	2.4	0.09	0.42	0.30	0.04	0.58	0.21	7.4	18	115	8.6	47	19	6.5	17	15	63	31	76		
CF S 426b	C luc.	E/B	38	n.d.	0.12	4.0	2.5	0.08	0.39	0.30	0.03	0.56	0.12	5.2	17	111	8.0	40	13	6.2	16	14	59	30	53		
CF S 427b	C luc.	Bt1	53	n.d.	0.11	4.7	2.8	0.09	0.49	0.29	0.04	0.71	0.08	5.3	19	125	11	45	13	7.4	21	18	70	33	47		
CF S 428b	C luc.	Bt2	70	n.d.	0.12	5.2	3.0	0.08	0.55	0.33	0.05	0.73	0.10	6.3	23	139	10	50	14	8.5	24	20	79	37	54		
CF S 429b	C luc.	Bt3	90	n.d.	0.12	5.3	3.0	0.09	0.54	0.34	0.05	0.75	0.10	6.1	23	152	12	51	15	9.2	24	22	85	39	56		
CF S 430b	C	Ap	5	n.d.	0.13	4.1	2.5	0.09	0.43	0.33	0.04	0.62	0.22	7	19	121	8.3	48	19	6.7	18	17	66	32	84		
CF S 431b	C	Ap	15	n.d.	0.11	4.0	2.6	0.10	0.43	0.32	0.04	0.65	0.22	7.2	18	119	10	46	20	6.9	19	18	68	32	83		
CF S 432b	C	Ap	25	n.d.	0.12	3.9	2.7	0.11	0.43	0.38	0.04	0.66	0.25	8.5	19	123	11	46	20	6.8	18	18	66	32	82		
CF S 433b	C	E/B	38	n.d.	0.10	3.9	2.4	0.08	0.42	0.27	0.04	0.62	0.11	5.8	19	117	9.0	45	13	7.0	19	16	67	31	50		
CF S 434b	C	Bt1	53	n.d.	0.11	4.4	2.5	0.07	0.46	0.31	0.04	0.62	0.10	5.9	19	126	9.1	46	13	7.6	22	17	72	34	50		
CF S 435b	C	Bt2	70	n.d.	0.12	4.9	2.8	0.08	0.52	0.32	0.05	0.71	0.10	6.2	20	141	10	50	14	8.8	24	22	86	38	56		
CF S 436b	C	Bt3	90	n.d.	0.11	4.9	2.8	0.08	0.54	0.34	0.05	0.72	0.09	5.9	20	134	10	50	14	8.7	24	20	83	39	54		
CF S 437b	DLB luc.	Ap	5	n.d.	0.11	3.6	2.5	0.11	0.40	0.32	0.03	0.61	0.22	8	14	121	9.3	42	18	6.1	17	15	62	31	75		
CF S 438b	DLB luc.	Ap	15	n.d.	0.11	3.3	2.2	0.08	0.35	0.30	0.03	0.53	0.21	6.0	14	110	8.2	43	19	6.3	17	15	64	31	77		
CF S 439b	DLB luc.	Ap	25	n.d.	0.12	3.7	2.5	0.11	0.39	0.30	0.03	0.55	0.21	6.9	14	117	10	46	20	6.2	17	17	64	31	73		
CF S 440b	DLB luc.	E/B	38	n.d.	0.11	3.8	2.3	0.08	0.40	0.37	0.04	0.60	0.18	8.5	14	117	8.3	43	16	6.3	17	15	67	34	63		
CF S 441b	DLB luc.	Bt1	53	n.d.	0.12	4.4	2.5	0.08	0.47	0.32	0.05	0.74	0.12	7.5	17	131	8.7	51	13	7.4	19	16	79	38	53		
CF S 442b	DLB luc.	Bt2	70	n.d.	0.21	2.2	1.2	0.03	0.22	0.46	0.05	1.2	0.19	6.9	18	234	9.2	58	13	8.2	22	32	85	39	50		
CF S 443b	DLB luc.	Bt3	90	n.d.	0.23	3.3	1.8	0.05	0.33	0.55	0.05	1.4	0.21	4.2	20	261	10	61	13	8.8	23	37	89	40	53		
CF S 444b	DLB	Ap	5	n.d.	0.12	3.9	2.4	0.09	0.41	0.31	0.04	0.65	0.23	4.9	14	120	7.7	57	19	6.4	17	14	68	33	73		
CF S 445b	DLB	Ap	15	n.d.	0.10	3.8	2.5	0.10	0.41	0.29	0.03	0.62	0.21	5.1	19	115	8.9	49	21	6.6	17	15	66	31	79		
CF S 446b	DLB	Ap	25	n.d.	0.10	3.6	2.3	0.09	0.40	0.30	0.03	0.64	0.20	4.6	18	106	8.3	45	18	6.4	17	13	62	30	72		
CF S 447b	DLB	E/B	38	n.d.	0.10	3.6	2.1	0.07	0.40	0.49	0.04	0.59	0.20	7.6	18	111	8.3	40	17	6.3	17	14	60	36	68		
CF S 448b	DLB	Bt1	53	n.d.	0.13	4.7	2.7	0.08	0.49	0.32	0.05	0.75	0.11	4.1	19	141	9.9	58	13	8.1	20	16	77	38	53		
CF S 449b	DLB	Bt2	70	n.d.	0.11	5.0	3.0	0.07	0.49	0.32	0.05	0.64	0.08	3.8	22	130	9.7	58	14	8.8	22	18	84	39	55		
CF S 450b	DLB	Bt3	90	n.d.	0.11	4.9	2.8	0.06	0.52	0.30	0.05	0.64	0.08	6.8	23	125	9.5	61	14	9.2	23	18	88	40	54		
International reference material used to determine accuracy and precision of the method																											
SRM 2709a Soil Joaquin Soil (a)				n.d.	0.18	9.0	5.2	0.06	2.1	1.6	0.09	1.2	0.17	n.d.	52	453	8.6	96	27	11	44	68	75	106	91		
SRM 2709a Soil Joaquin Soil (b)				n.d.	0.15	7.6	4.6	0.06	2.2	1.7	0.09	1.0	0.19	n.d.	51	439	9.1	91	27	11	43	70	76	106	91		
SRM 2709a Soil Joaquin Soil (c)				n.d.	0.16	5.1	3.2	0.06	2.2	1.6	0.09	0.75	0.17	n.d.	53	433	9.0	95	27	11	43	73	77	104	92		
SRM 2709a Soil Joaquin Soil (d)				n.d.	0.14	7.0	4.2	0.06	2.0	1.8	0.08	0.62	0.20	n.d.	51	451	9.2	90	96	10	44	67	74	104	89		
SRM 2709a Soil Joaquin Soil (e)				n.d.	0.15	7.0	4.1	0.06	2.1	1.9	0.09	0.68	0.21	n.d.	52	448	9.2	93	86	11	45	67	77	104	88		
SRM 2709a Soil Joaquin Soil (f)				n.d.	0.12	6.7	3.9	0.05	2.0	1.4	0.09	0.60	0.19	n.d.	49	438	10	95	29	10	40	60	76	105	107		
SRM 2709a Soil Joaquin Soil (g)				n.d.	0.12	6.4	3.7	0.05	1.9	1.4	0.09	0.66	0.18	n.d.	49	410	11	101	29	11	40	56	78	106	109		
SRM 2709a Soil Joaquin Soil (h)				n.d.	0.12	6.3	3.5	0.05	1.7	1.3	0.09	0.49	0.17	n.d.	49	382	11	94	29	10	40	55	77	105	106		
SRM 2709a Soil Joaquin Soil mean				-	0.14	6.9	4.1	0.05	2.0	1.6	0.09	0.75	0.18	5.4	51	432	9.6	94	43	11	43	65	76	105	97		
SRM 2709a Soil Joaquin Soil 2SE				-	0.01	0.79	0.45	0.00	0.10	0.14	0.00	0.17	0.01	-	1.2	17	0.59	2.4	21	0.10	1.6	4.6	0.92	0.57	6.4		
SRM 2709a Soil Joaquin Soil RSE				-	10%	11%	11%	6%	5%	9%	5%	22%	5%	-	2%	4%	6%	3%	48%	1%	4%	7%	1%	1%	7%		

(a)-(h) = full digestion replicates; n.d. = not determined.  
C: control; C luc.: control + lucerne; DL: deep loosening; DLB: deep loosening + biowaste compost; DLG: deep loosening + greenwaste compost; DLB luc.: deep loosening + biowaste compost + lucerne.

Table S2b Loss on ignition corrected chemical composition and magnesium and strontium isotope composition of pooled soil samples at central field trials (microwave digestion).

				LOI corrected data (major oxides)										LOI corrected data (trace elements)										MC-ICP-MS analyses									
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	B	Ba	Co	Cr	Cu	Ga	Li	Ni	Rb	Sr	Zn	δ <sup>26</sup> Mg <sub>DSM-3</sub>	2SD	δ <sup>25</sup> Mg <sub>DSM-3</sub>	2SD	n	Δ <sup>25</sup> Mg <sup>* </sup>	<sup>87</sup> Sr/ <sup>86</sup> Sr	2SE	
			(cm)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(‰)	(‰)	(‰)	(‰)	(‰)				
CF 1-1 (winter wheat at flowering 2018)																																	
CF S46b	C	Ap	15	n.d.	0.17	4.8	3.2	0.11	0.55	0.57	0.04	0.76	0.29	19	138	8.7	49	16	7.8	23	28	73	38	69	-0.02	0.08	-0.01	0.02	2	0.00	n.d.	n.d.	
CF S47b	C	E/B	40	n.d.	0.16	6.4	4.2	0.10	0.72	0.51	0.04	0.92	0.24	23	155	9.3	51	15	9.0	26	32	85	38	57	0.00	0.07	-0.01	0.04	4	-0.01	n.d.	n.d.	
CF S48b	C	Bt1	55	n.d.	0.18	7.7	4.8	0.10	0.92	0.59	0.05	1.1	0.25	30	170	10.0	59	15	10.6	32	40	100	43	62	0.03	0.04	0.01	0.04	4	-0.01	n.d.	n.d.	
CF S49b	C	Bt2	65	n.d.	0.16	7.5	4.7	0.10	0.93	0.59	0.05	1.05	0.26	30	160	9.4	59	16	10.6	30	38	99	42	61	0.03	0.03	0.00	0.00	4	-0.01	n.d.	n.d.	
CF S50b	C	Bt3	85	n.d.	0.16	7.4	4.6	0.09	0.90	0.63	0.05	1.03	0.26	30	157	8.9	58	16	10.3	31	37	97	42	60	0.05	0.06	0.01	0.04	4	-0.01	n.d.	n.d.	
CF S51b	DL	Ap	15	n.d.	0.17	5.2	3.2	0.11	0.59	0.71	0.04	0.82	0.31	19	151	7.4	60	14	7.9	21	25	74	39	64	-0.08	0.09	-0.07	0.06	4	-0.03	n.d.	n.d.	
CF S52b	DL	E/B	40	n.d.	0.15	6.6	3.9	0.11	0.72	0.64	0.05	1.03	0.25	25	174	8.9	68	15	10.0	27	30	96	43	60	0.08	0.03	0.02	0.03	3	-0.02	n.d.	n.d.	
CF S53b	DL	Bt1	55	n.d.	0.16	7.9	4.6	0.10	0.89	0.60	0.06	1.2	0.24	31	182	9.5	69	16	11.2	30	38	107	46	61	0.08	0.03	0.04	0.04	4	0.00	n.d.	n.d.	
CF S54b	DL	Bt2	65	n.d.	0.16	7.6	4.6	0.10	0.86	0.60	0.05	1.1	0.25	31	168	10.7	62	15	10.7	31	39	101	44	59	0.08	0.07	0.04	0.03	4	-0.01	n.d.	n.d.	
CF S55b	DL	Bt3	85	n.d.	0.14	7.1	5.1	0.10	0.87	0.67	0.05	1.00	0.28	28	154	10.0	57	16	10.2	31	41	94	43	61	0.03	0.03	0.00	0.03	4	-0.02	n.d.	n.d.	
CF S56b	DLB	Ap	15	n.d.	0.15	4.7	3.1	0.11	0.56	0.72	0.04	0.75	0.34	19	132	8.0	52	16	7.7	21	25	73	41	72	-0.04	0.01	-0.01	0.02	4	0.01	n.d.	n.d.	
CF S57b	DLB	E/B	40	n.d.	0.16	6.3	4.1	0.11	0.71	0.57	0.04	0.97	0.27	23	158	10.0	49	15	9.0	25	33	84	40	63	0.06	0.04	0.03	0.04	4	0.00	n.d.	n.d.	
CF S58b	DLB	Bt1	55	n.d.	0.17	7.6	4.6	0.09	0.84	0.57	0.06	1.1	0.22	29	172	10.2	66	16	11.1	30	35	107	46	63	0.06	0.06	0.02	0.02	4	-0.01	n.d.	n.d.	
CF S59b	DLB	Bt2	65	n.d.	0.16	7.5	4.5	0.09	0.85	0.57	0.06	1.1	0.24	29	163	8.6	66	15	10.6	29	35	101	44	59	0.10	0.05	0.03	0.02	3	-0.02	n.d.	n.d.	
CF S60b	DLB	Bt3	85	n.d.	0.16	7.8	4.7	0.09	0.91	0.61	0.06	1.1	0.24	30	170	10.0	68	17	11.4	31	39	108	47	64	0.08	0.03	0.03	0.05	4	-0.01	n.d.	n.d.	
CF 1-2 (spring barley at flowering 2018)																																	
CF S166b	C	Ap	15	n.d.	0.16	4.9	3.0	0.11	0.53	0.54	0.04	0.76	0.24	17	140	7.4	54	13	7.7	20	24	72	37	63	-0.03	0.03	-0.03	0.02	4	-0.02	n.d.	n.d.	
CF S167b	C	E/B	40	n.d.	0.16	6.5	3.8	0.10	0.69	0.51	0.05	0.93	0.17	23	169	9.1	61	15	10.0	25	30	93	43	59	-0.04	0.06	-0.03	0.03	4	-0.01	n.d.	n.d.	
CF S168b	C	Bt1	55	n.d.	0.17	7.2	4.2	0.10	0.78	0.55	0.05	1.00	0.18	26	174	10.0	59	15	10.4	27	34	97	43	57	0.07	0.03	0.03	0.03	4	-0.01	n.d.	n.d.	
CF S169b	C	Bt2	65	n.d.	0.16	7.3	4.3	0.10	0.80	0.55	0.05	1.04	0.18	28	171	9.5	61	15	10.6	28	34	99	44	58	0.06	0.02	0.03	0.02	4	0.00	n.d.	n.d.	
CF S170b	C	Bt3	85	n.d.	0.16	7.6	4.7	0.09	0.87	0.60	0.05	1.04	0.18	30	167	9.2	65	15	11.1	31	36	103	45	59	0.06	0.04	0.01	0.02	4	-0.02	n.d.	n.d.	
CF S171b	DL	Ap	15	n.d.	0.16	5.0	3.1	0.10	0.54	0.51	0.04	0.69	0.23	17	138	6.8	53	23	7.6	20	23	71	37	59	0.02	0.07	0.00	0.04	4	-0.01	n.d.	n.d.	
CF S172b	DL	E/B	40	n.d.	0.16	6.0	3.5	0.10	0.66	0.54	0.05	0.82	0.19	21	157	8.2	57	14	9.1	24	27	85	40	55	0.04	0.09	0.01	0.04	4	-0.01	n.d.	n.d.	
CF S173b	DL	Bt1	55	n.d.	0.16	7.2	4.1	0.09	0.79	0.55	0.05	1.01	0.17	28	167	9.5	62	15	10.9	29	32	100	44	58	0.04	0.03	0.01	0.02	4	-0.01	n.d.	n.d.	
CF S174b	DL	Bt2	65	n.d.	0.17	7.7	4.5	0.10	0.85	0.58	0.05	1.1	0.19	30	173	9.7	67	16	11.5	29	36	107	47	62	0.09	0.03	0.05	0.01	4	0.00	n.d.	n.d.	
CF S175b	DL	Bt3	85	n.d.	0.15	7.9	4.8	0.09	0.90	0.57	0.05	1.1	0.20	30	166	9.7	68	16	11.1	31	38	104	44	63	0.12	0.03	0.07	0.01	2	0.01	n.d.	n.d.	
CF S176b	DLB	Ap	15	n.d.	0.15	5.0	3.2	0.10	0.55	0.55	0.04	0.77	0.25	18	137	7.2	52	13	7.7	21	24	72	40	63	0.00	0.06	-0.01	0.03	4	-0.01	n.d.	n.d.	
CF S177b	DLB	E/B	40	n.d.	0.17	5.8	3.6	0.09	0.65	0.57	0.04	0.79	0.19	21	138	7.8	47	13	8.4	23	27	78	38	57	0.05	0.03	0.01	0.03	4	-0.01	n.d.	n.d.	
CF S178b	DLB	Bt1	55	n.d.	0.15	7.8	5.0	0.08	0.92	0.60	0.05	1.03	0.19	32	163	9.3	63	17	11.1	32	40	102	42	65	0.13	0.03	0.07	0.04	3	0.01	n.d.	n.d.	
CF S179b	DLB	Bt2	65	n.d.	0.17	7.3	4.5	0.09	0.87	0.58	0.05	0.97	0.18	30	158	10.1	59	16	10.8	30	36	97	43	60	0.17	0.04	0.09	0.03	8	0.00	n.d.	n.d.	
CF S180b	DLB	Bt3	85	n.d.	0.15	7.3	4.5	0.09	0.87	0.57	0.05	0.93	0.19	31	152	10.0	59	16	10.9	32	38	100	44	66	0.16	0.06	0.09	0.05	8	0.01	n.d.	n.d.	
CF S181b	DLG	Ap	15	n.d.	0.17	4.9	3.2	0.10	0.54	0.55	0.04	0.68	0.24	18	130	7.2	49	13	7.5	19	24	69	36	62	0.03	0.05	0.02	0.03	4	0.00	n.d.	n.d.	
CF S182b	DLG	E/B	40	n.d.	0.18	6.6	3.9	0.09	0.71	0.52	0.05	0.94	0.19	24	162	8.1	62	15	9.8	26	30	93	42	58	0.08	0.02	0.03	0.02	3	-0.01	n.d.	n.d.	
CF S183b	DLG	Bt1	55	n.d.	0.16	7.8	4.6	0.08	0.85	0.56	0.06	1.1	0.18	30	177	10.1	74	17	11.6	31	34	108	46	62	0.16	0.02	0.09	0.04	8	0.01	n.d.	n.d.	
CF S184b	DLG	Bt2	65	n.d.	0.18	7.8	4.6	0.09	0.88	0.57	0.06	1.1	0.19	32	173	10.6	77	16	12.1	33	37	110	48	66	0.16	0.06	0.08	0.04	8	0.00	n.d.	n.d.	
CF S185b	DLG	Bt3	85	n.d.	0.16	8.0	4.6	0.09	0.90	0.61	0.06	1.1	0.19	31	173	9.4	72																

Table S2b continued - Loss on ignition corrected chemical composition and magnesium and strontium isotope composition of pooled soil samples at central field trials (microwave digestion).

				LOI corrected data (major oxides)									LOI corrected data (trace elements)										MC-ICP-MS analyses														
sample ID	treatment	soil horizon	mean depth	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	B	Ba	Co	Cr	Cu	Ga	Li	Ni	Rb	Sr	Zn	δ <sup>26</sup> Mg <sub>DSM-3</sub>	2SD	δ <sup>25</sup> Mg <sub>DSM-3</sub>	2SD	n	Δ <sup>25</sup> Mg <sup>+</sup> *	<sup>87</sup> Sr/ <sup>86</sup> Sr	2SE					
			(cm)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(wt.%)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(‰)	(‰)	(‰)	(‰)	(‰)								
CF 2 (spring barley at flowering 2020)																																					
CF S 423b	C luc.	Ap	5	n.d.	0.13	4.1	2.4	0.10	0.42	0.34	0.04	0.65	0.23	17	125	9.1	52	19	6.8	19	17	68	34	78	0.09	0.02	0.05	0.02	4	0.01	0.72202	5.0E-06					
CF S 424b	C luc.	Ap	15	n.d.	0.13	3.9	2.6	0.10	0.43	0.34	0.04	0.67	0.24	19	124	8.8	51	20	6.9	19	15	70	35	81	0.06	0.03	0.04	0.01	4	0.01	0.72161	4.5E-06					
CF S 425b	C luc.	Ap	25	n.d.	0.14	4.0	2.6	0.10	0.45	0.33	0.04	0.63	0.23	20	124	9.3	51	20	7.0	19	16	68	33	82	0.08	0.06	0.05	0.04	4	0.00	0.72195	5.2E-06					
CF S 426b	C luc.	E/B	38	n.d.	0.13	4.2	2.6	0.09	0.42	0.32	0.04	0.59	0.13	18	117	8.4	42	14	6.5	17	15	62	31	56	0.12	0.05	0.07	0.02	4	0.01	0.72186	5.7E-06					
CF S 427b	C luc.	Bt1	53	n.d.	0.11	4.9	3.0	0.09	0.52	0.30	0.04	0.75	0.09	20	132	11.1	47	14	7.8	22	19	73	35	50	0.12	0.04	0.08	0.04	4	0.02	0.72300	4.9E-06					
CF S 428b	C luc.	Bt2	70	n.d.	0.13	5.5	3.2	0.08	0.58	0.36	0.05	0.78	0.11	25	149	11.1	54	15	9.1	26	22	84	39	57	0.13	0.02	0.08	0.03	4	0.02	0.72288	5.1E-06					
CF S 429b	C luc.	Bt3	90	n.d.	0.12	5.6	3.2	0.09	0.57	0.36	0.05	0.80	0.11	25	162	12.3	54	16	9.8	26	23	91	42	60	0.14	0.04	0.07	0.03	4	0.00	0.72424	5.3E-06					
CF S 430b	C	Ap	5	n.d.	0.14	4.4	2.7	0.10	0.46	0.36	0.04	0.67	0.24	21	130	9.0	52	21	7.3	19	18	71	35	91	0.08	0.03	0.06	0.00	4	0.02	0.72178	5.2E-06					
CF S 431b	C	Ap	15	n.d.	0.12	4.3	2.9	0.10	0.46	0.35	0.04	0.70	0.23	20	128	11.2	50	22	7.4	20	19	74	35	89	0.10	0.03	0.07	0.03	4	0.02	0.72257	5.2E-06					
CF S 432b	C	Ap	25	n.d.	0.13	4.3	2.9	0.12	0.47	0.42	0.04	0.72	0.27	21	134	12.0	51	21	7.5	20	19	72	35	89	0.10	0.04	0.05	0.04	4	0.00	0.72200	4.6E-06					
CF S 433b	C	E/B	38	n.d.	0.11	4.2	2.5	0.08	0.44	0.29	0.04	0.66	0.12	20	124	9.5	48	14	7.4	21	17	71	33	53	0.15	0.04	0.09	0.02	4	0.01	0.72296	5.3E-06					
CF S 434b	C	Bt1	53	n.d.	0.11	4.7	2.7	0.08	0.49	0.33	0.04	0.66	0.11	20	134	9.7	48	14	8.1	23	19	77	36	53	0.16	0.04	0.09	0.02	4	0.01	0.72270	4.4E-06					
CF S 435b	C	Bt2	70	n.d.	0.13	5.3	3.0	0.08	0.55	0.34	0.05	0.76	0.10	22	151	11.0	53	15	9.4	26	23	92	41	60	0.14	0.04	0.07	0.03	4	0.00	0.72326	4.8E-06					
CF S 436b	C	Bt3	90	n.d.	0.11	5.2	3.0	0.08	0.58	0.36	0.05	0.77	0.10	21	142	11.0	53	15	9.2	26	22	88	41	57	0.10	0.04	0.07	0.02	4	0.02	0.72316	4.9E-06					
CF S 437b	DLB luc.	Ap	5	n.d.	0.12	3.9	2.7	0.12	0.43	0.35	0.04	0.66	0.23	15	132	10.1	46	20	6.6	19	16	68	34	82	0.06	0.05	0.05	0.01	3	0.01	0.72138	4.5E-06					
CF S 438b	DLB luc.	Ap	15	n.d.	0.12	3.5	2.3	0.08	0.37	0.31	0.04	0.57	0.23	15	117	8.8	46	20	6.7	18	16	68	33	82	0.12	0.02	0.10	0.01	3	0.04	0.72161	5.0E-06					
CF S 439b	DLB luc.	Ap	25	n.d.	0.13	4.0	2.7	0.11	0.42	0.33	0.04	0.59	0.23	15	125	10.8	50	22	6.7	18	19	69	33	79	0.11	0.04	0.07	0.03	4	0.01	0.72190	4.9E-06					
CF S 440b	DLB luc.	E/B	38	n.d.	0.12	4.1	2.5	0.09	0.44	0.40	0.04	0.66	0.20	16	127	9.0	47	17	6.9	19	16	74	37	68	0.09	0.02	0.04	0.03	4	0.00	0.72176	5.3E-06					
CF S 441b	DLB luc.	Bt1	53	n.d.	0.13	4.8	2.7	0.08	0.51	0.34	0.06	0.80	0.13	18	142	9.4	55	14	8.0	21	17	85	41	57	0.11	0.02	0.05	0.05	4	0.00	0.72293	5.4E-06					
CF S 442b	DLB luc.	Bt2	70	n.d.	0.22	2.4	1.3	0.04	0.24	0.49	0.05	1.3	0.21	19	252	9.9	63	14	8.8	23	34	91	42	54	0.13	0.03	0.06	0.04	3	0.00	0.72378	5.3E-06					
CF S 443b	DLB luc.	Bt3	90	n.d.	0.24	3.5	1.9	0.05	0.34	0.57	0.05	1.5	0.22	21	273	10.4	63	14	9.2	24	38	93	42	55	0.14	0.02	0.10	0.02	4	0.02	0.72416	4.9E-06					
CF S 444b	DLB	Ap	5	n.d.	0.13	4.1	2.5	0.09	0.43	0.33	0.04	0.68	0.24	15	126	8.1	60	20	6.8	18	15	71	35	77	0.10	0.01	0.06	0.01	4	0.01	0.72198	4.9E-06					
CF S 445b	DLB	Ap	15	n.d.	0.11	4.0	2.6	0.10	0.43	0.31	0.04	0.65	0.22	20	121	9.4	51	22	7.0	18	16	69	32	84	0.08	0.01	0.05	0.05	4	0.01	0.72242	5.1E-06					
CF S 446b	DLB	Ap	25	n.d.	0.10	3.8	2.4	0.09	0.42	0.31	0.03	0.67	0.21	19	111	8.7	47	19	6.7	18	14	65	31	75	0.10	0.02	0.05	0.04	4	0.00	0.72182	4.5E-06					
CF S 447b	DLB	E/B	38	n.d.	0.10	3.9	2.3	0.08	0.44	0.54	0.04	0.63	0.21	20	120	8.9	43	18	6.8	18	15	65	38	73	0.08	0.03	0.04	0.02	4	0.00	0.71979	6.3E-06					
CF S 448b	DLB	Bt1	53	n.d.	0.13	4.9	2.8	0.08	0.51	0.33	0.06	0.78	0.12	20	147	10.3	60	14	8.5	21	17	80	40	55	0.12	0.04	0.08	0.03	4	0.01	0.72368	5.2E-06					
CF S 449b	DLB	Bt2	70	n.d.	0.12	5.2	3.1	0.07	0.51	0.34	0.05	0.67	0.08	23	135	10.1	61	15	9.2	23	19	87	41	57	0.14	0.07	0.09	0.05	4	0.02	0.72360	4.9E-06					
CF S 450b	DLB	Bt3	90	n.d.	0.12	5.2	3.0	0.06	0.55	0.32	0.06	0.69	0.08	25	134	10.2	65	15	9.8	25	19	94	43	58	0.14	0.06	0.08	0.01	4	0.00	0.72401	5.5E-06					
Converter lime																																					
CF S 451	converter lime		n.d.	n.d.	<LOQ	2.3	27	<LOQ	4.9	43	<LOQ	<LOQ	0.83	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	-1.38	0.07	-0.69	0.03	4	0.03	0.70913	5.5E-06					
International reference material used to determine the precision and extraction recovery of the method																																					
SRM 2709a Soil Joaquin Soil (a)				n.d.	0.19	9.5	5.5	0.06	2.3	1.7	0.10	1.3	0.18	55	479	9	101	28	11	47	72	79	112	96	-0.15	0.02	-0.05	0.02	1	0.02	0.70856	5.7E-06					
SRM 2709a Soil Joaquin Soil (b)				n.d.	0.16	8.0	4.8	0.06	2.3	1.8	0.10	1.1	0.20	54	464	10	96	28	11	46	74	80	112	96	-0.10	0.03	-0.09	0.01	4	-0.03	0.70864	5.3E-06					
SRM 2709a Soil Joaquin Soil (c)				n.d.	0.17	5.4	3.4	0.06	2.3	1.7	0.10	0.80	0.18	56	457	10	101	28	11	46																	

**Table S3** Soil pH of pooled soil samples.

sample ID	treatment	soil horizon	mean depth (cm)	soil pH (CaCl <sub>2</sub> )
<b><i>CF 1-1 (winter wheat at flowering 2018)</i></b>				
CF S46b	C	Ap	15	8.0
CF S47b	C	E/B	40	7.7
CF S48b	C	Bt1	55	7.4
CF S49b	C	Bt2	65	7.6
CF S50b	C	Bt3	85	7.6
CF S51b	DL	Ap	15	7.6
CF S52b	DL	E/B	40	7.6
CF S53b	DL	Bt1	55	7.6
CF S54b	DL	Bt2	65	7.6
CF S55b	DL	Bt3	85	7.6
CF S56b	DLB	Ap	15	7.7
CF S57b	DLB	E/B	40	7.7
CF S58b	DLB	Bt1	55	7.7
CF S59b	DLB	Bt2	65	7.7
CF S60b	DLB	Bt3	85	7.6
<b><i>CF 1-2 (spring barley at flowering 2018)</i></b>				
CF S166b	C	Ap	15	7.5
CF S167b	C	E/B	40	7.6
CF S168b	C	Bt1	55	7.6
CF S169b	C	Bt2	65	7.6
CF S170b	C	Bt3	85	7.6
CF S171b	DL	Ap	15	7.3
CF S172b	DL	E/B	40	7.4
CF S173b	DL	Bt1	55	7.4
CF S174b	DL	Bt2	65	7.4
CF S175b	DL	Bt3	85	7.5
CF S176b	DLB	Ap	15	7.1
CF S177b	DLB	E/B	40	7.3
CF S178b	DLB	Bt1	55	n.d.
CF S179b	DLB	Bt2	65	7.4
CF S180b	DLB	Bt3	85	7.5
CF S181b	DLG	Ap	15	7.2
CF S182b	DLG	E/B	40	7.3
CF S183b	DLG	Bt1	55	7.4
CF S184b	DLG	Bt2	65	7.5
CF S185b	DLG	Bt3	85	7.5
<b><i>CF 1-2 (winter wheat at maturity stage 2019)</i></b>				
CF S403b	C	Ap	15	8.1
CF S404b	C	E/B	40	8.0
CF S405b	C	Bt1	55	8.0
CF S406b	C	Bt2	65	7.9
CF S407b	C	Bt3	85	7.9
CF S408b	DL	Ap	15	7.8
CF S409b	DL	E/B	40	7.7
CF S410b	DL	Bt1	55	7.7
CF S411b	DL	Bt2	65	7.8
CF S412b	DL	Bt3	85	7.8
CF S413b	DLB mid	Ap	15	7.7
CF S414b	DLB mid	E/B	40	7.8
CF S415b	DLB mid	Bt1	55	7.8
CF S416b	DLB mid	Bt2	65	7.8
CF S417b	DLB mid	Bt3	85	7.8
CF S418b	DLG	Ap	15	7.7
CF S419b	DLG	E/B	40	7.7
CF S420b	DLG	Bt1	55	7.7
CF S421b	DLG	Bt2	65	7.7
CF S422b	DLG	Bt3	85	7.7

continued on next page ...

**Table S3** continued - Soil pH of pooled soil samples.

sample ID	treatment	soil horizon	mean depth	soil pH (CaCl <sub>2</sub> )
(cm)				
<b>CF 2 (spring barley at flowering 2020)</b>				
CF S 423b	C luc.	Ap	5	6.7
CF S 424b	C luc.	Ap	15	6.7
CF S 425b	C luc.	Ap	25	6.6
CF S 426b	C luc.	E/B	38	6.8
CF S 427b	C luc.	Bt1	53	6.9
CF S 428b	C luc.	Bt2	70	7.1
CF S 429b	C luc.	Bt3	90	7.2
CF S 430b	C	Ap	5	6.7
CF S 431b	C	Ap	15	6.8
CF S 432b	C	Ap	25	6.8
CF S 433b	C	E/B	38	6.9
CF S 434b	C	Bt1	53	7.0
CF S 435b	C	Bt2	70	7.2
CF S 436b	C	Bt3	90	6.9
CF S 437b	DLB luc.	Ap	5	7.0
CF S 438b	DLB luc.	Ap	15	6.7
CF S 439b	DLB luc.	Ap	25	6.7
CF S 440b	DLB luc.	E/B	38	7.2
CF S 441b	DLB luc.	Bt1	53	7.3
CF S 442b	DLB luc.	Bt2	70	7.3
CF S 443b	DLB luc.	Bt3	90	7.4
CF S 444b	DLB	Ap	5	6.9
CF S 445b	DLB	Ap	15	6.8
CF S 446b	DLB	Ap	25	6.9
CF S 447b	DLB	E/B	38	7.5
CF S 448b	DLB	Bt1	53	7.7
CF S 449b	DLB	Bt2	70	7.6
CF S 450b	DLB	Bt3	90	7.6
<b>International reference material used to determine the precision of the method</b>				
SRM 2709a Soil Joaquin Soil (a1)				7.9
SRM 2709a Soil Joaquin Soil (a2)				7.8
SRM 2709a Soil Joaquin Soil (a3)				8.0
<b>SRM 2709a Soil Joaquin Soil (a) mean</b>				<b>7.9</b>
SRM 2709a Soil Joaquin Soil (a) 2SD				0.2
SRM 2709a Soil Joaquin Soil (b1)				8.3
SRM 2709a Soil Joaquin Soil (b2)				7.8
SRM 2709a Soil Joaquin Soil (b3)				8.1
<b>SRM 2709a Soil Joaquin Soil (b) mean</b>				<b>8.1</b>
SRM 2709a Soil Joaquin Soil (b) 2SD				0.5
SRM 2709a Soil Joaquin Soil (c1)				8.4
SRM 2709a Soil Joaquin Soil (c2)				8.2
SRM 2709a Soil Joaquin Soil (c3)				8.2
<b>SRM 2709a Soil Joaquin Soil (c) mean</b>				<b>8.3</b>
SRM 2709a Soil Joaquin Soil (c) 2SD				0.3
<b>SRM 2709a Soil Joaquin Soil mean</b>				<b>8.1</b>
<b>SRM 2709a Soil Joaquin Soil 2SD</b>				<b>0.4</b>

(a1, b1, c1)-(a3, b3, c3) = replicate analyses of soil pH.

C: control; C luc.: control + lucerne;

DL: deep loosening;

DLB: deep loosening + biowaste compost;

DLG: deep loosening + greenwaste compost;

DLB luc.: deep loosening + biowaste compost + lucerne.

Table S4 Chemical and magnesium and strontium isotope ccomposition of the exchangeable fraction (1M NH<sub>4</sub>OAc) of pooled soil samples at central field trials.

ICP-MS analyses															MC-ICP-MS analyses								
sample ID	treatment	soil horizon	mean depth	Ba	Ca	Fe	K	Li	Mg	Mn	Na	P	Rb	Sr	Zn	δ <sup>26</sup> Mg <sub>DSM-3</sub>	2SD	δ <sup>25</sup> Mg <sub>DSM-3</sub>	2SD	n	Δ <sup>25</sup> Mg <sup>+</sup>	<sup>87</sup> Sr/ <sup>86</sup> Sr	2SE
			(cm)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(ng/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(‰)	(‰)	(‰)	(‰)		(‰)		
CF 1-1 (winter wheat at flowering 2018)																							
CF S46e	C	Ap	15	14	1592	3.0	173	88	88	6.8	12	14	0.32	4.2	1.8	-1.41	0.02	-0.73	0.02	3	0.01	0.70938	4.1E-06
CF S47e	C	E/B	40	21	1812	3.7	113	82	94	2.7	16	3.0	0.80	5.8	1.7	-1.35	0.08	-0.70	0.08	3	0.01	0.70997	5.2E-06
CF S48e	C	Bt1	55	26	2168	4.5	121	61	107	1.3	20	1.4	1.8	7.5	2.0	-1.30	0.04	-0.69	0.03	3	-0.02	0.71079	4.8E-06
CF S49e	C	Bt2	65	24	2252	4.6	129	59	97	1.1	20	1.4	1.6	7.7	1.7	-1.32	0.08	-0.67	0.01	3	0.02	0.71157	4.0E-06
CF S50e	C	Bt3	85	23	2153	4.6	122	59	101	1.0	22	1.5	1.5	7.5	1.7	-1.41	0.04	-0.72	0.03	3	0.01	0.71202	4.2E-06
CF S51e	DL	Ap	15	14	1741	3.8	213	90	94	5.9	14	18	0.24	4.5	1.5	-1.43	0.06	-0.73	0.04	3	0.01	0.70938	4.3E-06
CF S52e	DL	E/B	40	18	1790	3.9	130	85	96	3.0	18	3.6	0.74	5.6	1.5	-1.39	0.06	-0.70	0.05	3	0.02	0.70993	4.9E-06
CF S53e	DL	Bt1	55	21	2048	4.5	119	75	103	1.6	24	1.9	1.8	7.4	1.6	-1.34	0.07	-0.69	0.05	3	0.01	0.71080	3.9E-06
CF S54e	DL	Bt2	65	21	2105	4.7	115	69	94	0.92	22	1.8	1.8	7.8	1.8	-1.36	0.09	-0.71	0.03	4	0.00	0.71151	4.5E-06
CF S55e	DL	Bt3	85	20	2251	5.1	115	70	97	1.1	20	2.3	1.5	8.0	1.7	-1.44	0.02	-0.75	0.06	3	0.00	0.71186	4.3E-06
CF S56e	DLB	Ap	15	11	2051	4.7	383	88	136	8.4	16	39	0.25	5.3	1.7	-1.29	0.05	-0.66	0.02	3	0.01	0.70941	4.9E-06
CF S57e	DLB	E/B	40	17	1837	4.3	384	80	141	3.3	29	7.5	0.27	5.8	1.7	-1.16	0.07	-0.59	0.04	3	0.02	0.70979	4.9E-06
CF S58e	DLB	Bt1	55	22	2007	4.6	130	61	105	1.7	58	1.9	1.3	7.3	2.0	-1.32	0.03	-0.69	0.02	3	0.00	0.71060	5.2E-06
CF S59e	DLB	Bt2	65	21	2104	4.8	116	58	90	0.98	58	1.7	1.6	7.4	1.7	-1.38	0.03	-0.72	0.04	3	0.00	0.71133	4.5E-06
CF S60e	DLB	Bt3	85	22	2238	5.0	120	57	97	0.97	36	1.7	1.7	7.9	1.8	-1.45	0.03	-0.75	0.00	2	0.00	0.71179	4.9E-06
CF 1-2 (spring barley at flowering 2018)																							
CF S166e	C	Ap	15	14	1493	3.2	155	94	76	6.5	13	14	0.27	3.6	2.1	-1.45	0.05	-0.75	0.03	3	0.01	n.d.	n.d.
CF S167e	C	E/B	40	22	1694	3.8	108	82	89	2.5	16	2.3	0.83	5.3	1.8	-1.38	0.04	-0.70	0.03	3	0.02	n.d.	n.d.
CF S168e	C	Bt1	55	24	1937	4.5	106	64	94	1.4	17	1.6	1.6	6.8	1.7	-1.35	0.03	-0.69	0.02	3	0.01	n.d.	n.d.
CF S169e	C	Bt2	65	24	2018	5.0	107	60	88	1.4	17	1.7	1.6	7.2	1.8	-1.36	0.06	-0.71	0.04	3	0.00	n.d.	n.d.
CF S170e	C	Bt3	85	26	2199	5.2	117	63	98	0.9	19	1.5	1.6	7.5	1.8	-1.45	0.06	-0.76	0.06	3	0.00	n.d.	n.d.
CF S171e	DL	Ap	15	16	1603	3.8	163	88	83	6.1	14	11	0.25	4.1	1.7	-1.43	0.03	-0.74	0.04	3	0.00	n.d.	n.d.
CF S172e	DL	E/B	40	22	1685	4.3	117	79	90	3.6	16	2.8	0.79	5.5	1.7	-1.41	0.03	-0.73	0.03	3	0.00	n.d.	n.d.
CF S173e	DL	Bt1	55	25	1929	5.0	110	63	93	1.9	19	1.7	1.5	6.7	2.1	-1.38	0.02	-0.71	0.04	3	0.01	n.d.	n.d.
CF S174e	DL	Bt2	65	26	2105	5.4	112	60	90	1.2	18	1.5	1.8	7.5	2.0	-1.38	0.02	-0.72	0.04	3	0.00	n.d.	n.d.
CF S175e	DL	Bt3	85	26	2077	5.6	114	61	100	0.95	20	1.5	1.7	7.8	1.8	-1.46	0.08	-0.76	0.03	3	0.00	n.d.	n.d.
CF S176e	DLB	Ap	15	14	1664	4.2	224	89	98	6.2	22	17	0.19	4.2	1.9	-1.34	0.07	-0.70	0.01	3	0.00	n.d.	n.d.
CF S177e	DLB	E/B	40	20	1843	4.8	161	85	106	3.4	33	5.3	0.50	5.5	1.7	-1.31	0.03	-0.68	0.03	3	0.00	n.d.	n.d.
CF S178e	DLB	Bt1	55	31	2325	6.2	126	66	114	1.00	32	1.7	1.9	7.8	2.1	-1.31	0.04	-0.69	0.00	3	-0.01	n.d.	n.d.
CF S179e	DLB	Bt2	65	28	2279	6.1	123	65	104	0.93	23	1.6	1.9	7.7	2.3	-1.37	0.04	-0.70	0.04	3	0.01	n.d.	n.d.
CF S180e	DLB	Bt3	85	29	2300	6.1	125	64	113	0.94	22	1.6	1.7	7.8	2.3	-1.44	0.02	-0.76	0.01	3	-0.01	n.d.	n.d.
CF S181e	DLG	Ap	15	15	1713	4.6	209	95	100	7.8	15	16	0.26	4.2	2.2	-1.38	0.00	-0.71	0.01	3	0.01	n.d.	n.d.
CF S182e	DLG	E/B	40	22	1791	4.9	132	89	105	3.2	19	3.3	0.76	5.5	2.3	-1.35	0.05	-0.70	0.04	3	0.00	n.d.	n.d.
CF S183e	DLG	Bt1	55	27	2039	5.6	114	67	102	2.0	20	1.8	1.7	6.8	2.1	-1.32	0.03	-0.69	0.05	3	0.00	n.d.	n.d.
CF S184e	DLG	Bt2	65	28	2213	6.0	119	64	100	1.4	19	1.8	1.8	7.4	2.0	-1.33	0.02	-0.70	0.05	3	-0.01	n.d.	n.d.
CF S185e	DLG	Bt3	85	27	2247	6.0	122	61	107	0.88	20	1.5	1.7	7.4	2.4	-1.37	0.01	-0.72	0.04	3	0.00	n.d.	n.d.
CF 1-2 (winter wheat at maturity stage 2019)																							
CF S403e	C	Ap	15	14	1466	n.d.	173	102	81	2.5	6.7	12	0.31	4.4	0.06	-1.39	0.02	-0.71	0.04	2	0.02	0.70930	5.5E-06
CF S404e	C	E/B	40	22	1584	n.d.	110	87	90	1.0	13	2.2	0.87	5.8	0.04	-1.34	0.04	-0.69	0.03	5	0.01	0.70975	5.2E-06
CF S405e	C	Bt1	55	26	1880	n.d.	113	64	100	0.66	13	1.5	1.8	7.6	0.03	-1.30	0.00	-0.67	0.01	2	0.01	0.71057	5.3E-06
CF S406e	C	Bt2	65	27	2128	n.d.	135	63	102	0.49	14	1.4	1.6	8.5	0.02	-1.34	0.01	-0.70	0.07	2	0.00	0.71119	5.1E-06
CF S407e	C	Bt3	85	27	2165	n.d.	131	70	120	0.26	17	1.3	1.6	8.7	0.02	-1.39	0.04	-0.72	0.04	5	0.01	0.71160	5.5E-06
CF S408e	DL	Ap	15	15	1517	n.d.	183	112	85	2.8	7.5	11	0.29	4.5	0.07	-1.39	0.00	-0.70	0.01	2	0.02	0.70937	5.8E-06
CF S409e	DL	E/B	40	20	1508	n.d.	127	102	91	1.4	14	3.3	0.61	5.5	0.04	-1.32	0.05	-0.70	0.00	2	-0.01	0.70972	5.7E-06
CF S410e	DL	Bt1	55	26	1868	n.d.	120	80	105	0.67	16	1.5	1.6	7.8	0.03	-1.32	0.03	-0.69	0.04	3	0.00	0.71060	4.4E-06
CF S411e	DL	Bt2	65	27	2046	n.d.	133	71	104	0.48	16	1.5	1.7	8.4	0.02	-1.28	0.06	-0.68	0.04	2	-0.02	0.71120	4.9E-06
CF S412e	DL	Bt3	85	26	2032	n.d.	129	67	115	0.30	18	1.3	1.9	8.5	0.02	-1.40	0.02	-0.73	0.05	6	0.00	0.71170	5.6E-06
CF S413e	DLB mid	Ap	15	15	1525	n.d.	201	102	91	2.6	9.1	14	0.24	4.6	0.07	-1.32	0.06	-0.71	0.04	5	-0.02	0.70937	4.8E-06
CF S414e	DLB mid	E/B	40	17	1706	n.d.	170	96	102	1.6	21	6.3	0.40	5.8	0.05	-1.29	0.05	-0.69	0.03	3	-0.02	0.70970	5.2E-06
CF S415e	DLB mid	Bt1	55	24	1992	n.d.	124	75	111	0.59	28	1.8	1.6	8.1	0.02	-1.29	0.05	-0.67	0.02	3	0.00	0.71075	5.1E-06
CF S416e	DLB mid	Bt2	65	26	2141	n.d.	133	74	110	0.32	22	1.4	1.9	8.8	0.02	-1.32	0.05	-0.69	0.07	3	0.00	0.71143	4.7E-06
CF S417e	DLB mid	Bt3	85	24	2102	n.d.	131	79	114	0.19	17	1.3	1.8	8.6	0.02	-1.42	0.05	-0.74	0.03	3	0.00	0.71188	5.3E-06
CF S418e	DLG	Ap	15	15	1550	n.d.	199	115	99	3.0	7.1	11	0.31	4.8	0.06	-1.29	0.04	-0.68	0.04	4	-0.01	n.d.	n.d.



Table S4 continued - Chemical and magnesium and strontium isotope ccomposition of the exchangeable fraction (1M NH4OAc) of pooled soil samples at central field trials.

ICP-MS analyses															MC-ICP-MS analyses									
sample ID	treatment	soil horizon	mean depth	Ba	Ca	Fe	K	Li	Mg	Mn	Na	P	Rb	Sr	Zn	δ <sup>26</sup> Mg <sub>BDSM-3</sub>	2SD	δ <sup>25</sup> Mg <sub>BDSM-3</sub>	2SD	n	Δ <sup>25</sup> Mg <sup>+</sup> *	<sup>87</sup> Sr/ <sup>86</sup> Sr	2SE	
			(cm)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(ng/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(‰)	(‰)	(‰)	(‰)		(‰)			
CF 2 (spring barley at flowering 2020)																								
CF S 423e	C luc.	Ap	5	15	1091	2.2	253	89	124	3.5	11	13	0.25	3.5	1.1	-1.01	0.07	-0.50	0.04	4	0.02	0.70942	5.1E-06	
CF S 424e	C luc.	Ap	15	15	1013	2.1	192	100	128	2.1	10	12	0.33	3.0	1.1	-1.03	0.03	-0.52	0.04	4	0.02	0.71012	5.0E-06	
CF S 425e	C luc.	Ap	25	15	1067	2.2	208	103	126	2.1	12	15	0.32	3.1	1.1	-1.03	0.04	-0.51	0.02	3	0.03	0.71009	5.4E-06	
CF S 426e	C luc.	E/B	38	16	962	2.1	140	81	85	0.96	16	2.7	0.21	2.8	0.78	-1.08	0.08	-0.55	0.04	4	0.02	0.71065	4.3E-06	
CF S 427e	C luc.	Bt1	53	20	1325	2.7	124	62	82	0.43	24	n.d.	0.63	4.6	0.83	-1.07	0.03	-0.54	0.04	4	0.02	0.71131	4.6E-06	
CF S 428e	C luc.	Bt2	70	24	1672	3.7	106	58	91	0.17	35	n.d.	0.90	7.0	0.94	-1.13	0.04	-0.57	0.02	4	0.02	0.71200	6.0E-06	
CF S 429e	C luc.	Bt3	90	27	1688	3.8	96	48	107	0.16	37	n.d.	1.2	7.3	1.1	-1.18	0.10	-0.59	0.06	4	0.02	0.71269	5.9E-06	
CF S 430e	C	Ap	5	16	1140	2.6	244	111	127	3.6	8.7	12	0.28	3.9	1.3	-1.07	0.09	-0.54	0.07	4	0.01	0.70937	6.2E-06	
CF S 431e	C	Ap	15	15	1080	2.6	201	110	126	1.9	10	13	0.33	3.4	2.0	-1.08	0.03	-0.54	0.05	3	0.02	0.71027	4.7E-06	
CF S 432e	C	Ap	25	15	1086	2.6	219	109	125	1.5	12	16	0.30	3.4	1.2	-1.05	0.06	-0.54	0.06	3	0.00	0.71034	4.7E-06	
CF S 433e	C	E/B	38	18	1096	2.7	137	100	92	0.62	18	2.5	0.23	3.3	1.7	-1.08	0.04	-0.56	0.00	3	0.01	0.71103	5.8E-06	
CF S 434e	C	Bt1	53	21	1382	3.3	101	77	79	0.32	30	1.7	0.80	5.2	0.87	-1.12	0.01	-0.56	0.03	3	0.03	0.71177	5.4E-06	
CF S 435e	C	Bt2	70	24	1646	3.9	99	67	94	0.17	35	1.2	1.4	7.2	1.1	-1.14	0.07	-0.58	0.05	4	0.02	0.71230	6.0E-06	
CF S 436e	C	Bt3	90	23	1618	3.9	94	62	133	0.08	34	1.5	1.4	7.2	1.2	-1.21	0.03	-0.62	0.06	3	0.01	0.71258	5.2E-06	
CF S 437e	DLB luc.	Ap	5	15	1080	2.9	206	114	127	4.1	18	15	0.25	3.7	1.2	-1.06	0.02	-0.53	0.01	3	0.02	0.70976	5.6E-06	
CF S 438e	DLB luc.	Ap	15	15	1041	2.4	172	112	124	2.5	12	14	0.29	3.2	1.2	-1.10	0.05	-0.56	0.02	4	0.01	0.71008	5.7E-06	
CF S 439e	DLB luc.	Ap	25	15	1065	2.6	184	120	121	2.3	14	14	0.29	3.2	1.1	-1.09	0.03	-0.57	0.03	4	0.00	0.71023	5.7E-06	
CF S 440e	DLB luc.	E/B	38	13	1469	3.6	326	102	166	3.2	39	16	0.30	4.4	0.80	-1.00	0.03	-0.50	0.05	4	0.02	0.71022	4.7E-06	
CF S 441e	DLB luc.	Bt1	53	18	1439	3.6	163	87	112	1.3	72	4.8	0.46	5.6	0.97	-1.04	0.03	-0.53	0.01	4	0.02	0.71120	5.6E-06	
CF S 442e	DLB luc.	Bt2	70	22	1562	4.0	88	86	87	0.25	37	1.8	1.2	6.8	0.93	-1.23	0.03	-0.62	0.04	4	0.02	0.71209	4.0E-06	
CF S 443e	DLB luc.	Bt3	90	22	1677	4.2	77	64	113	0.12	33	2.5	1.3	7.3	0.96	-1.29	0.05	-0.65	0.05	4	0.02	0.71223	4.5E-06	
CF S 444e	DLB	Ap	5	14	1081	3.0	243	106	124	3.4	15	20	0.25	4.3	1.4	-1.10	0.07	-0.56	0.04	4	0.01	0.70896	4.6E-06	
CF S 445e	DLB	Ap	15	15	1027	2.8	183	106	125	1.9	12	19	0.29	3.5	1.3	-1.05	0.02	-0.53	0.04	3	0.02	0.71007	5.1E-06	
CF S 446e	DLB	Ap	25	14	1146	3.0	226	106	128	1.3	12	18	0.26	3.6	1.1	-1.07	0.07	-0.54	0.07	4	0.02	0.71028	4.0E-06	
CF S 447e	DLB	E/B	38	10	1833	4.3	403	74	205	4.0	59	n.d.	0.45	5.7	0.32	-0.95	0.06	-0.49	0.03	4	0.00	0.71014	5.0E-06	
CF S 448e	DLB	Bt1	53	19	1412	4.1	156	59	104	1.1	77	4.1	0.37	5.7	0.88	-1.04	0.03	-0.55	0.02	4	-0.01	0.71124	4.3E-06	
CF S 449e	DLB	Bt2	70	23	1669	4.7	86	59	92	0.23	39	3.2	1.3	7.4	1.1	-1.18	0.04	-0.60	0.04	4	0.01	0.71219	4.0E-06	
CF S 450e	DLB	Bt3	90	24	1738	5.0	81	48	134	0.13	41	2.7	1.5	7.9	1.1	-1.23	0.03	-0.63	0.03	4	0.01	0.71260	5.0E-06	
International reference material used to determine the precision of the extraction method																								
SRM 2709a Soil Joaquin Soil exch. (a)				60	4756	12	600	978	865	5.0	253	8.6	4.5	36	4.9	-0.64	0.08	-0.34	0.05	3	-0.01	0.70774	5.0E-06	
SRM 2709a Soil Joaquin Soil exch. (b)				73	6423	18	602	1096	902	10	207	21	5.2	50	4.0	-0.69	0.03	-0.36	0.04	3	0.00	0.70769	5.2E-06	
SRM 2709a Soil Joaquin Soil exch. (c)				n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-0.75	0.08	-0.39	0.05	4	0.00	0.70768	6.0E-06	
SRM 2709a Soil Joaquin Soil exch. mean				66	5589	15	601	1037	884	7.5	230	15	4.9	43	4.4	-0.69	0.10	-0.36	0.04	3	0.00	0.70771	0.00006	
SRM 2709a Soil Joaquin Soil exch. 2SD				18	2358	8.3	1.9	167	52	7.1	65	18	1.0	19	1.3									
SRM 2709a Soil Joaquin Soil exch. RSD				27%	42%	55%	0%	16%	6%	0.94	28%	119%	21%	45%	30%									
International reference material used to determine the accuracy and precision of concentration and Mg isotope analyses																								
SRM 1640a natural water (a)				0.15	5.0	0.05	0.56	<LOQ	1.0	0.04	3.1	<LOQ	<LOQ	0.12	0.05	-0.70	0.02	-0.36	0.02	1	0.00	0.70897	4.5E-06	
SRM 1640a natural water (b)				0.15	4.8	0.04	0.60	<LOQ	1.0	0.04	3.1	<LOQ	<LOQ	0.12	0.06	-0.62	0.03	-0.33	0.03	7	0.00	n.d.	n.d.	
SRM 1640a natural water (c)				0.16	4.8	0.06	0.65	<LOQ	1.0	0.04	3.1	<LOQ	<LOQ	0.12	0.08	-0.63	0.04	-0.36	0.04	6	-0.03	n.d.	n.d.	
SRM 1640a natural water (d)				n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-0.61	0.04	-0.32	0.05	7	0.00	n.d.	n.d.	
SRM 1640a natural water (e)				n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-0.64	0.04	-0.32	0.07	4	0.01	n.d.	n.d.	
SRM 1640a natural water mean				0.15	4.9	0.05	0.60	-	1.0	0.04	3.1	-	-	0.12	0.06	-0.64	0.07	-0.34	0.04	5	0.00	0.70897	0.00000	
SRM 1640a natural water 2SD				0.01	0.27	0.02	0.08	-	0.01	0.00	0.05	-	-	0.01	0.03									
SRM 1640a natural water RSD				6%	6%	39%	14%	-	1%	0.03	2%	-	-	5%	53%									
SRM 1640a natural water certified value**				0.15	5.6	0.0365	0.58	0.0004	1.1	0.0407	3.1	n.r.	0.001	0.13	0.06	-0.73	0.08	-0.38	0.08		0.00			
SRM 1640a natural water certified absolute uncertainty**				0.001	0.02	0.0017	0.002	0.00001	0.003	0.00035	0.03	n.r.	0.000001	0.001	0.0003									
relative difference (measured value/certified value) (%)				1%	-13%	40%	5%	-	-2%	-0.09	0%	-	-	-4%	17%									

\* calculated following Young and Galy (2004); \*\* Isotope data taken from GeoReM (<http://georem.mpch-mainz.gwdg.de> (accessed 22. January 2021)).

<LOQ = below limit of quantification; n.d.: not determined; n.r.: not reported; 2SD: two-fold standard deviation; 2SE: two-fold standard error, n: number of Mg isotope mass spectrometry analyses.

C: control; C luc.: control + lucerne; DL: deep loosening; DLB: deep loosening + biowaste compost; DLG: deep loosening + greenwaste compost;

DLB luc.: deep loosening + biowaste compost + lucerne.

Table S5 Chemical and magnesium and strontium isotope composition of plant samples at central field trials.

sample ID	crop organ	field repetition - treatment	biomass	Macronutrients				Micronutrients					Beneficial elements			Non-nutritive elements					MC-ICP-MS analyses								
				K	Ca	Mg	P	Fe	Mn	Zn	Cu	B	Na	Al	Co	Ba	Sr	Ti	Cr	Li	$\delta^{26}\text{Mg}_{\text{DSM-3}}$	2SD	$\delta^{25}\text{Mg}_{\text{DSM-3}}$	2SD	n	$\Delta^{25}\text{Mg}^*$	$^{87}\text{Sr}/^{86}\text{Sr}$	2SE	
				(g)	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	(‰)	(‰)	(‰)	(‰)	(‰)				
CF 1-1 (winter wheat at flowering 2018)																													
CF V 1e	ear	1 - C	0.54	8643	667	808	2866	25	18	21	2.7	4.3	21	13	5.1	3.5	1.8	2.4	67	12	-0.39	0.06	-0.22	0.06	6	-0.01	0.71046	4.2E-06	
CF V 4e	ear	2 - C	0.96	9771	820	898	3033	52	23	25	3.2	5.0	25	52	6.8	3.4	1.9	3.7	113	42	-0.56	0.06	-0.28	0.05	3	0.01	0.71075	4.9E-06	
CF V 7e	ear	3 - C	0.80	8704	616	729	2659	28	20	17	2.3	4.1	19	21	15	2.5	1.5	2.5	146	32	-0.41	0.09	-0.22	0.04	3	-0.01	0.71099	4.6E-06	
CF V 1l	leaf	1 - C	0.98	19467	4398	975	2294	119	55	10	2.4	3.1	29	137	12	12	8.8	5.0	422	102	-0.85	0.06	-0.43	0.05	3	0.01	n.d.	n.d.	
CF V 4l	leaf	2 - C	1.63	18867	4521	1075	1805	221	58	13	2.6	3.5	76	262	7.8	11	7.9	6.8	544	183	-0.95	0.06	-0.50	0.04	3	0.00	n.d.	n.d.	
CF V 7l	leaf	3 - C	1.30	15266	3395	762	1355	83	65	9.8	1.6	2.4	36	85	3.1	9.4	6.9	2.5	328	69	-0.94	0.06	-0.48	0.04	4	0.01	n.d.	n.d.	
CF V 1s	stem	1 - C	1.03	9786	549	311	1507	10	25	8.1	1.3	0.52	47	5.7	1.4	3.2	2.3	0.73	89	9.5	-0.72	0.08	-0.37	0.04	6	0.00	n.d.	n.d.	
CF V 4s	stem	2 - C	1.71	10936	606	352	1357	15	24	9.2	1.6	0.55	132	12	3.2	3.1	2.2	0.67	103	12	-0.87	0.09	-0.44	0.06	5	0.02	n.d.	n.d.	
CF V 7s	stem	3 - C	1.53	11602	595	320	1212	n.d.	32	n.d.	1.3	n.d.	n.d.	n.d.	n.d.	3.6	n.d.	2.3	n.d.	n.d.	n.d.	-0.86	0.02	-0.47	0.01	2	-0.02	n.d.	n.d.
CF V 2e	ear	1 - DL	0.74	10573	895	908	3091	36	23	24	2.8	4.4	16	28	6.8	4.6	2.0	2.6	88	24	-0.56	0.06	-0.29	0.07	5	0.01	0.71024	4.7E-06	
CF V 5e	ear	2 - DL	0.69	10716	780	814	2907	36	21	22	3.8	4.1	20	26	8.3	3.0	2.3	4.3	120	23	-0.46	0.04	-0.23	0.05	3	0.00	0.71061	5.0E-06	
CF V 8e	ear	3 - DL	0.70	10212	717	883	2947	30	21	20	2.1	4.5	18	24	9.9	3.5	1.5	2.9	116	19	-0.42	0.09	-0.22	0.04	3	0.00	0.70974	4.3E-06	
CF V 2l	leaf	1 - DL	1.36	20007	4192	1122	2299	141	57	17	2.6	3.5	38	151	5.9	14	8.0	5.3	363	120	-0.96	0.08	-0.48	0.04	4	0.01	n.d.	n.d.	
CF V 5l	leaf	2 - DL	1.09	17730	4085	889	1840	103	56	12	2.5	2.8	22	96	4.4	11	7.9	3.0	288	82	-0.95	0.06	-0.48	0.04	3	0.02	n.d.	n.d.	
CF V 8l	leaf	3 - DL	1.17	18340	3130	718	1845	168	53	8.8	2.8	3.2	26	209	4.5	9.6	8.1	10	470	147	-0.94	0.06	-0.47	0.03	2	0.02	n.d.	n.d.	
CF V 2s	stem	1 - DL	1.29	13215	701	406	1777	23	27	13	2.0	1.0	59	19	2.3	4.9	2.4	1.6	141	25	-0.83	0.08	-0.43	0.04	5	0.01	n.d.	n.d.	
CF V 5s	stem	2 - DL	1.00	12554	603	320	1309	14	26	8.2	1.5	0.53	55	9.1	1.6	3.2	2.2	1.0	76	12	-0.84	0.08	-0.44	0.04	5	0.00	n.d.	n.d.	
CF V 8s	stem	3 - DL	1.14	11635	558	317	1474	13	25	11	1.3	0.70	29	9.0	4.3	3.7	1.8	0.80	91	13	-0.82	0.05	-0.40	0.03	3	0.02	n.d.	n.d.	
CF V 3e	ear	1 - DLB	0.82	11069	856	862	3182	40	22	22	2.7	4.2	22	29	4.4	5.1	1.9	2.9	80	25	-0.34	0.06	-0.18	0.06	6	0.00	0.71049	4.6E-06	
CF V 6e	ear	2 - DLB	0.86	10348	920	861	2803	88	22	21	3.5	4.2	31	112	3.0	4.1	2.0	4.8	214	88	-0.70	0.08	-0.35	0.05	8	0.01	0.71159	4.7E-06	
CF V 9e	ear	3 - DLB	0.61	11092	980	883	3237	46	21	43	2.6	3.8	27	45	6.9	4.5	2.0	3.2	118	36	-0.42	0.05	-0.21	0.04	3	0.01	0.71073	4.1E-06	
CF V 3l	leaf	1 - DLB	1.54	29325	4532	995	2508	230	59	15	2.7	3.2	270	296	11	20	9.6	7.8	606	228	-0.83	0.08	-0.43	0.06	3	0.01	n.d.	n.d.	
CF V 6l	leaf	2 - DLB	1.41	20453	4969	1361	1853	122	44	14	2.9	3.5	165	119	4.1	12	9.4	3.6	316	96	-0.98	0.07	-0.49	0.03	3	0.02	n.d.	n.d.	
CF V 9l	leaf	3 - DLB	1.36	18217	3027	845	1998	64	35	9.0	1.9	2.7	87	52	0.39	10	6.4	3.0	200	58	-0.85	0.08	-0.43	0.04	4	0.01	n.d.	n.d.	
CF V 3s	stem	1 - DLB	1.30	17183	739	436	1972	19	22	20	1.9	0.71	431	11	3.2	4.7	2.4	1.5	102	17	-0.80	0.07	-0.40	0.05	4	0.01	n.d.	n.d.	
CF V 6s	stem	2 - DLB	1.33	12911	712	445	1485	18	20	14	2.1	0.71	343	15	2.4	3.6	2.3	1.1	78	12	-0.89	0.06	-0.47	0.05	4	-0.01	n.d.	n.d.	
CF V 9s	stem	3 - DLB	1.11	13526	635	390	1895	14	20	9.1	1.7	0.66	255	3.8	0.37	4.5	2.3	1.4	79	14	-0.75	0.05	-0.38	0.08	4	0.01	n.d.	n.d.	
CF 1-2 (spring barley at flowering 2018)																													
CF V 22e	ear	1 - C	0.64	9230	804	867	2845	34	17	23	3.4	1.3	47	8.4	2.1	1.8	1.9	2.5	34	15	-0.82	0.06	-0.40	0.04	3	0.02	n.d.	n.d.	
CF V 26e	ear	2 - C	0.58	9844	833	811	2654	33	19	21	3.6	0.90	51	7.7	33	3.0	2.0	2.1	78	13	-0.76	0.05	-0.38	0.06	3	0.02	n.d.	n.d.	
CF V 22l	leaf	1 - C	0.50	26390	6331	657	1191	116	39	24	3.4	2.6	138	129	5.6	6.8	9.2	3.5	362	104	-1.29	0.05	-0.65	0.03	4	0.02	n.d.	n.d.	
CF V 26l	leaf	2 - C	0.41	26088	6066	710	1105	114	44	18	3.9	2.5	161	142	44	7.8	9.6	3.5	369	102	-1.26	0.06	-0.65	0.07	4	0.01	n.d.	n.d.	
CF V 22s	stem	1 - C	0.46	16378	836	236	1104	66	8.2	12	1.4	0.64	232	94	5.4	4.0	2.8	2.1	565	60	-1.29	0.04	-0.67	0.07	2	0.01	n.d.	n.d.	
CF V 26s	stem	2 - C	0.36	26290	1006	213	1544	18	7.7	25	1.9	0.74	352	7.9	46	6.2	3.8	1.8	236	21	-1.36	0.05	-0.67	0.04	1	0.04	n.d.	n.d.	
CF V 19e	ear	1 - DL	0.56	10109	908	879	2697	48	21	26	4.5	1.4	99	33	3.5	3.5	2.9	4.3	94	25	-0.75	0.08	-0.37	0.03	4	0.02	n.d.	n.d.	
CF V 23e	ear	2 - DL	0.42	10643	772	838	2848	39	17	23	3.5	1.0	51	8.7	14	1.8	1.5	2.9	90	15	-0.74	0.05	-0.36	0.03	4	0.02	n.d.	n.d.	
CF V 27e	ear	3 - DL	0.61	8878	784	828	2551	35	17	21	3.2	0.86	54	9.9	11	1.8	1.6	2.0	92	16	-0.75	0.04	-0.38	0.04	3	0.01	n.d.	n.d.	
CF V 19l	leaf	1 - DL	0.40	22589	6603	844	1130	225	61	12	4.3	3.0	399	295	11	14	16	8.6	667	195	-1.09	0.05	-0.56	0.04	3	0.01	n.d.	n.d.	
CF V 23l	leaf	2 - DL	0.40	23578	5874	758	1282	122	42	17	5.4	2.9	168	134	41	7.3	13	5.5	459	112	-1.11	0.09	-0.56	0.04	3	0.02	n.d.	n.d.	
CF V 27l	leaf	3 - DL	0.43	29710	6752	734	1231	110	42	17	7.8	2.6	161	135	48	9.7	17	5.9	405	101	-1.34	0.05	-0.69	0.07	4	0.01	n.d.	n.d.	
CF V 19s	stem	1 - DL	0.33	23134	919	180	844	25	6.4	13	2.7	0.88	652	24	13	4.9	4.1	1.1	292	28	-1.31	0.08	-0.67	0.07	5	0.01	n.d.	n.d.	
CF V 23s	stem	2 - DL	0.35	17501	947	227	1276	33	8.7	16	2.0	0.61	344	18	30	3.7	2.8	0.89	419	24	-1.38	0.10	-0.71	0.04	5	0.01	n.d.	n.d.	
CF V 27s	stem	3 - DL	0.39	16161	1029	198	683	21	7.3	11	1.6	0.63	243	13	12	3.4	3.3	1.8	162	18	-1.37	0.09	-0.72	0.06	4	0.00	n.d.	n.d.	
CF V 20e	ear	1 - DLB	0.68	10559	750	831	2826	40	19	27	3.5	1.3	58	14	6.8	3.2	1.6	2.9	74	17	-0.72	0.07	-0.35	0.06	4	0.03	n.d.	n.d.	
CF V 24e	ear	2 - DLB	0.66	8777	739	827	2726	34	18	23	3.6	1.1	58	6.7	13	1.8	1.5	2.2	71	14	-0.73	0.09	-0.39	0.03	3	0.00	n.d.	n.d.	
CF V 28e	ear	3 - DLB	0.61	8407	749	814	2524	36	19	22	3.5	0.92	48																

Table S5 continued - Chemical and magnesium and strontium isotope composition of plant samples at central field trials.

sample ID	crop organ	field repetition - treatment	biomass	Macronutrients				Micronutrients					Beneficial elements			Non-nutritive elements					MC-ICP-MS analyses							
				K	Ca	Mg	P	Fe	Mn	Zn	Cu	B	Na	Al	Co	Ba	Sr	Ti	Cr	Li	δ <sup>26</sup> Mg <sub>DSM-3</sub>	2SD	δ <sup>25</sup> Mg <sub>DSM-3</sub>	2SD	n	Δ <sup>25</sup> Mg*	<sup>87</sup> Sr/ <sup>86</sup> Sr	2SE
				(g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(‰)	(‰)	(‰)	(‰)	(‰)		
CF 1-2 (spring barley at maturity stage 2018)																												
CF V 41e	ear	1 - C	0.69	6430	599	719	2568	40	14	21	3.1	0.82	59	11	11	1.5	1.5	1.7	108	13	-0.80	0.10	-0.42	0.07	4	0.00	n.d.	n.d.
CF V 41l	leaf	1 - C	0.07	13749	5844	535	473	72	37	8.9	1.5	0.84	152	73	9.9	9.1	3.4	1.3	152	12	-1.34	0.07	-0.69	0.03	3	0.01	n.d.	n.d.
CF V 41s	stem	1 - C	0.03	16051	865	166	175	16	5.3	12	3.0	4.8	240	3.9	19	3.9	9.9	0.73	406	64	-1.26	0.08	-0.64	0.06	4	0.01	n.d.	n.d.
CF V 42e	ear	1 - DL (strip)	0.47	7266	700	815	2937	48	17	22	3.1	0.93	72	13	3.1	3.2	2.0	2.2	125	16	-0.88	0.09	-0.44	0.05	7	0.02	n.d.	n.d.
CF V 42l	leaf	1 - DL (strip)	0.10	15960	6260	602	444	80	54	9.1	1.5	0.88	257	80	16	15	4.2	1.6	267	13	-1.34	0.08	-0.68	0.04	4	0.02	n.d.	n.d.
CF V 42s	stem	1 - DL (strip)	0.04	18546	927	189	98	15	6.1	7.5	3.2	4.2	477	8.2	42	6.0	13	<LOQ	480	67	-1.18	0.08	-0.59	0.04	3	0.03	n.d.	n.d.
CF V 43e	ear	1 - DL (side)	0.79	7217	742	829	2850	43	16	22	3.6	0.93	67	11	0.6	2.2	1.9	2.6	146	14	-0.83	0.05	-0.43	0.07	4	0.00	n.d.	n.d.
CF V 43l	leaf	1 - DL (side)	0.09	12522	6555	774	760	122	40	13	1.8	0.89	176	120	5.7	7.9	3.4	2.9	311	16	-1.24	0.05	-0.64	0.05	4	0.01	n.d.	n.d.
CF V 43s	stem	1 - DL (side)	0.23	19408	971	307	328	15	7.8	11	3.4	4.5	367	10	15	4.5	11	2.9	609	100	-1.16	0.04	-0.58	0.06	3	0.03	n.d.	n.d.
CF V 44e	ear	1 - DLB low (strip)	0.55	7223	761	760	2644	41	17	22	3.1	0.94	68	11	2.2	3.4	2.1	2.2	83	15	-0.84	0.08	-0.39	0.03	6	0.05	n.d.	n.d.
CF V 44l	leaf	1 - DLB low (strip)	0.04	16170	6076	527	446	92	48	9.9	1.4	0.98	258	94	18	16	3.8	1.7	224	14	-1.28	0.09	-0.66	0.03	5	0.01	n.d.	n.d.
CF V 44s	stem	1 - DLB low (strip)	0.06	20257	923	193	174	17	6.0	6.6	3.1	3.9	478	5.8	21	7.5	12	<LOD	502	76	-1.19	0.06	-0.64	0.04	3	-0.02	n.d.	n.d.
CF V 45e	ear	1 - DLB low (side)	0.49	6454	639	779	2482	43	14	20	3.2	0.85	63	12	10	1.8	1.6	2.0	95	14	-0.85	0.10	-0.44	0.05	5	0.01	n.d.	n.d.
CF V 45l	leaf	1 - DLB low (side)	0.14	13758	5882	558	411	92	37	9.3	1.6	0.93	187	85	11	9.2	3.3	1.8	156	12	-1.35	0.08	-0.69	0.04	6	0.02	n.d.	n.d.
CF V 45s	stem	1 - DLB low (side)	0.06	16058	861	208	97	15	4.4	13	3.1	5.2	300	8.6	10	4.5	10	1.8	436	68	-1.22	0.08	-0.63	0.06	5	0.01	n.d.	n.d.
CF V 46e	ear	1 - DLB mid (strip)	0.65	7127	775	888	3028	38	16	22	3.3	0.99	150	11	2.4	2.9	1.8	2.3	81	15	-0.66	0.07	-0.33	0.04	5	0.02	n.d.	n.d.
CF V 46l	leaf	1 - DLB mid (strip)	0.15	18050	5550	545	500	80	34	9.0	1.6	0.99	827	80	13	14	4.0	1.9	259	18	-1.21	0.10	-0.60	0.04	4	0.04	n.d.	n.d.
CF V 46s	stem	1 - DLB mid (strip)	0.05	25237	1094	196	233	14	4.1	11	2.8	4.0	1716	5.5	49	5.8	11	1.9	508	73	-1.14	0.06	-0.58	0.03	2	0.01	n.d.	n.d.
CF V 47e	ear	1 - DLB mid (side)	0.83	6359	683	875	2902	37	14	24	3.9	0.72	68	9.3	7.3	1.4	1.4	2.8	121	15	-0.87	0.05	-0.42	0.04	2	0.04	n.d.	n.d.
CF V 47l	leaf	1 - DLB mid (side)	0.15	13850	5941	636	639	80	36	15	1.6	0.94	235	68	6.0	9.0	3.4	1.9	237	18	-1.35	0.09	-0.68	0.04	5	0.02	n.d.	n.d.
CF V 47s	stem	1 - DLB mid (side)	0.17	20995	1194	293	214	17	5.5	14	3.6	3.7	494	12	27	3.3	9.7	1.9	394	61	-1.24	0.06	-0.64	0.06	4	0.01	n.d.	n.d.
CF V 48e	ear	1 - DLB high (strip)	0.61	6320	758	830	2947	42	18	23	3.4	0.79	87	11	2.1	2.9	1.7	2.1	78	15	-0.84	0.06	-0.41	0.03	3	0.03	n.d.	n.d.
CF V 48l	leaf	1 - DLB high (strip)	0.07	17447	6205	520	586	121	44	15	1.5	1.0	367	127	7.8	14	3.7	2.5	253	21	-1.24	0.09	-0.61	0.05	5	0.03	n.d.	n.d.
CF V 48s	stem	1 - DLB high (strip)	0.04	27870	1112	247	127	16	5.8	7.0	3.4	4.9	666	6.2	16	5.8	11	2.5	567	98	-1.17	0.07	-0.59	0.06	6	0.02	n.d.	n.d.
CF V 49e	ear	1 - DLB high (side)	0.55	6440	704	844	2907	44	16	23	3.6	0.98	61	11	7.1	2.2	1.6	2.3	80	14	-0.84	0.04	-0.44	0.06	3	0.00	n.d.	n.d.
CF V 49l	leaf	1 - DLB high (side)	0.14	14948	5797	548	619	91	39	11	2.7	1.1	252	80	17	11	6.1	1.7	305	18	-1.35	0.09	-0.68	0.04	3	0.02	n.d.	n.d.
CF V 49s	stem	1 - DLB high (side)	0.11	23150	1140	225	197	15	6.4	14	4.0	5.6	537	4.9	43	5.2	11	1.7	458	72	-1.22	0.04	-0.64	0.04	5	0.00	n.d.	n.d.
CF 1-2 (winter wheat at harvest 2019)																												
CF V 62e	ear	1 - C	1.85	3649	351	594	1973	35	31	9.7	1.5	0.66	19	21	3.0	1.9	1.4	3.3	72	13	-0.58	0.08	-0.29	0.04	7	0.02	0.71065	5.9E-06
CF V 63e	ear	2 - C	2.26	3445	415	692	2059	37	31	13	1.9	0.79	20	21	3.8	1.9	1.4	4.5	80	17	-0.62	0.05	-0.30	0.05	5	0.02	0.71018	4.4E-06
CF V 64e	ear	3 - C	2.12	3606	411	772	2302	35	32	12	1.9	0.84	19	18	1.8	2.2	1.6	8.4	66	13	-0.65	0.05	-0.33	0.05	4	0.01	0.71019	5.1E-06
CF V 62l	leaf	1 - C	0.54	7117	3335	533	391	86	64	3.5	0.92	2.7	31	137	36	17	9.8	1.9	478	93	-1.15	0.01	-0.57	0.01	3	0.03	n.d.	n.d.
CF V 63l	leaf	2 - C	0.63	5824	4429	690	661	191	94	9.2	1.0	2.7	40	290	48	18	11	6.0	836	182	-1.09	0.08	-0.57	0.04	2	0.00	n.d.	n.d.
CF V 64l	leaf	3 - C	0.65	6442	4233	748	739	226	83	4.9	1.1	2.6	61	352	40	24	13	6.4	972	224	-1.08	0.07	-0.55	0.03	4	0.01	n.d.	n.d.
CF V 62s	stem	1 - C	0.85	5099	941	164	100	11	20	2.1	0.90	0.81	42	10	17	13	6.1	0.88	176	15	-1.17	0.03	-0.59	0.05	3	0.02	n.d.	n.d.
CF V 63s	stem	2 - C	1.02	5248	844	163	101	11	18	4.0	1.7	0.63	46	11	10	13	9.3	0.27	185	15	-1.19	0.02	-0.59	0.07	4	0.03	n.d.	n.d.
CF V 64s	stem	3 - C	1.03	6517	768	176	175	8.7	19	4.2	0.91	0.65	49	8	16	15	5.1	<LOQ	202	13	-1.10	0.07	-0.58	0.01	3	0.00	n.d.	n.d.
CF V 50e	ear	1 - DL	1.67	4246	392	666	2367	36	33	11	1.8	1.1	22	24	47	2.1	1.8	2.6	76	15	-0.55	0.02	-0.29	0.03	6	0.00	0.71031	5.3E-06
CF V 50l	leaf	1 - DL	0.69	6607	4647	713	753	197	115	5.1	1.8	3.8	71	279	133	24	13	6.5	711	204	-1.05	0.06	-0.52	0.05	4	0.03	n.d.	n.d.
CF V 50s	stem	1 - DL	0.92	7265	795	141	113	10	20	2.3	2.3	0.87	60	8.0	99	12	12	0.49	154	14	-1.07	0.02	-0.55	0.00	2	0.00	n.d.	n.d.
CF V 51e	ear	1 - DLB min	1.59	3882	400	751	2552	35	31	17	1.9	1.1	21	21	24	2.2	1.7	2.3	77	14	-0.60	0.10	-0.31	0.06	5	0.01	n.d.	n.d.
CF V 51l	leaf	1 - DLB min	0.62	6898	4525	749	1144	156	82	4.6	1.4	4.0	40	226	117	20	13	5.6	631	157	-1.03	0.03	-0.53	0.04	4	0.01	n.d.	n.d.
CF V 51s	stem	1 - DLB min	0.87	6433	748	160	81	9.6	16	3.2	1.1	0.93	111	9.1	95	11	5.3	0.06	155	12	-1.05	0.01	-0.53	0.02	2			

Table S5 continued - Chemical and magnesium and strontium isotope composition of plant samples at central field trials.

sample ID	crop organ	field repetition - treatment	biomass	Macronutrients				Micronutrients					Beneficial elements			Non-nutritive elements					MC-ICP-MS analyses								
				K	Ca	Mg	P	Fe	Mn	Zn	Cu	B	Na	Al	Co	Ba	Sr	Ti	Cr	Li	δ <sup>26</sup> Mg <sub>D5M-3</sub>	2SD	δ <sup>25</sup> Mg <sub>D5M-3</sub>	2SD	n	Δ <sup>25</sup> Mg*	<sup>87</sup> Sr/ <sup>86</sup> Sr	2SE	
				(g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(ng/g)	(ng/g)	(‰)	(‰)	(‰)	(‰)	(‰)			
CF 2 (spring barley at flowering 2020)																													
CF V 65e	ear	1 - C luc.	0.92	8954	1824	1205	2341	29	19	23	3.5	2.1	98	5.6	25	4.0	3.2	3.2	89	22	-0.65	0.04	-0.33	0.02	4	0.01	0.71041	5.0E-06	
CF V 66e	ear	2 - C luc.	0.74	7999	1741	1234	2478	31	19	26	4.0	2.5	89	5.9	27	4.3	2.9	3.4	115	14	-0.68	0.01	-0.35	0.01	3	0.00	0.71022	5.4E-06	
CF V 67e	ear	3 - C luc.	0.74	6790	1212	1226	2355	28	16	24	3.4	1.8	72	5.4	23	3.2	2.4	3.5	74	n.d.	-0.65	0.07	-0.31	0.02	3	0.03	0.71020	4.2E-06	
CF V 68e	ear	4 - C luc.	0.75	8033	1349	1219	2482	31	20	27	4.1	2.2	59	3.1	18	4.0	2.3	3.4	51	n.d.	-0.61	0.13	-0.28	0.05	3	0.04	0.71037	5.5E-06	
CF V 65l	leaf	1 - C luc.	0.78	22626	10515	964	1299	64	41	13	3.6	4.2	661	53	17	17	18	3.5	236	214	-1.21	0.04	-0.62	0.05	4	0.01	0.71043	5.0E-06	
CF V 66l	leaf	2 - C luc.	0.69	20976	8362	1033	2046	52	30	13	3.7	4.2	507	27	18	16	13	3.6	192	145	-1.08	0.04	-0.55	0.02	4	0.01	0.71020	5.2E-06	
CF V 67l	leaf	3 - C luc.	0.53	21093	8583	1078	1335	84	30	13	3.4	4.7	479	69	20	16	14	4.5	260	203	-1.04	0.05	-0.53	0.02	4	0.01	0.71030	5.9E-06	
CF V 68l	leaf	4 - C luc.	0.57	23793	7482	804	1310	42	36	15	4.0	5.3	359	21	16	16	12	2.7	209	161	-1.19	0.03	-0.61	0.03	4	0.01	0.71027	4.5E-06	
CF V 65s	stem	1 - C luc.	0.74	15956	1229	397	884	12	3.6	12	1.5	0.47	711	8.3	13	1.9	3.2	1.1	67	31	-0.93	0.03	-0.46	0.03	3	0.03	0.71033	4.1E-06	
CF V 66s	stem	2 - C luc.	0.67	12670	1013	322	905	12	2.5	8.8	1.4	0.44	764	11	24	2.1	2.4	1.1	116	18	-0.95	0.03	-0.47	0.03	4	0.03	0.71025	4.8E-06	
CF V 67s	stem	3 - C luc.	0.52	13886	969	379	589	8.5	2.1	9.6	1.3	0.51	774	7.3	18	2.9	2.7	0.65	87	23	-0.89	0.06	-0.45	0.01	4	0.01	0.71031	4.9E-06	
CF V 68s	stem	4 - C luc.	0.59	14071	826	363	643	8.8	4.1	12	1.4	0.44	535	4.5	16	2.8	2.3	0.60	77	19	-0.90	0.01	-0.44	0.03	4	0.03	0.71037	4.7E-06	
CF V 69e	ear	1 - C	0.75	8924	1196	1163	2807	29	17	25	3.8	2.0	80	4.7	26	4.0	2.4	3.8	96	n.d.	-0.55	0.06	-0.27	0.06	3	0.02	0.71090	5.6E-06	
CF V 70e	ear	2 - C	0.74	7253	1018	1141	2657	31	15	20	3.6	2.0	63	5.1	17	5.1	2.1	3.7	45	n.d.	-0.53	0.02	-0.26	0.03	3	0.01	0.71083	5.8E-06	
CF V 71e	ear	3 - C	0.75	8095	1381	1314	3049	37	16	25	4.0	2.4	77	13	31	4.5	2.9	4.4	103	n.d.	-0.60	0.09	-0.29	0.06	4	0.03	0.71086	4.3E-06	
CF V 72e	ear	4 - C	0.99	7581	1462	1186	2555	30	17	22	4.5	4.3	92	4.3	38	4.8	2.9	4.2	494	51	-0.61	0.05	-0.32	0.02	3	0.00	0.71094	4.9E-06	
CF V 69l	leaf	1 - C	0.48	22744	8867	955	1792	67	29	12	3.3	5.0	494	54	16	20	15	4.7	340	210	-1.15	0.04	-0.59	0.05	4	0.01	0.71065	5.5E-06	
CF V 70l	leaf	2 - C	0.50	17574	8043	753	1697	43	28	7	2.4	5.1	204	27	25	26	13	3.8	204	129	-1.10	0.03	-0.56	0.03	4	0.02	0.71060	5.8E-06	
CF V 71l	leaf	3 - C	0.50	22224	8353	1103	2130	92	21	11	3.4	5.6	390	78	53	22	14	6.2	348	164	-1.03	0.05	-0.53	0.03	4	0.01	0.71079	4.9E-06	
CF V 72l	leaf	4 - C	0.81	22739	4627	932	3247	87	19	18	4.5	3.5	352	88	27	11	9.5	7.3	374	155	-0.82	0.05	-0.42	0.05	4	0.01	0.71099	5.4E-06	
CF V 69s	stem	1 - C	0.47	13948	1153	294	782	8.5	3.1	8.8	1.4	0.51	698	4.0	20	4.5	3.5	0.83	105	26	-0.95	0.02	-0.48	0.04	4	0.02	0.71083	4.3E-06	
CF V 70s	stem	2 - C	0.55	10886	1139	277	815	12	3.2	9.2	1.4	0.51	358	6.7	16	7.2	3.1	0.92	65	15	-0.90	0.04	-0.44	0.02	4	0.03	0.71084	4.6E-06	
CF V 71s	stem	3 - C	0.51	12158	1350	339	690	9.8	2.2	8.9	1.3	0.51	588	6.3	17	4.2	3.4	0.79	137	15	-0.93	0.05	-0.46	0.04	4	0.02	0.71079	4.1E-06	
CF V 72s	stem	4 - C	0.76	8218	1166	333	656	13	3.0	7.8	1.2	0.47	613	12	19	4.0	3.1	0.91	105	16	-0.98	0.05	-0.49	0.05	4	0.02	0.71098	4.9E-06	
CF V 73e	ear	1 - DLB luc.	0.81	7468	1161	1201	2558	35	19	21	3.8	2.3	141	11	19	4.0	2.4	4.3	96	58	-0.61	0.06	-0.29	0.03	3	0.03	0.71061	5.1E-06	
CF V 74e	ear	2 - DLB luc.	0.78	7472	1387	1194	2667	38	18	25	4.7	2.9	87	13	16	5.7	2.6	4.7	95	52	-0.57	0.04	-0.29	0.04	3	0.01	0.71079	5.8E-06	
CF V 75e	ear	3 - DLB luc.	0.76	7353	1362	1155	2471	38	28	25	4.0	2.9	100	5.5	16	4.2	2.6	3.8	57	43	-0.56	0.08	-0.27	0.09	4	0.02	0.71078	5.2E-06	
CF V 76e	ear	4 - DLB luc.	0.77	7404	1293	1274	2536	44	27	28	4.2	2.3	86	6.2	22	4.0	2.2	3.6	58	42	-0.56	0.03	-0.26	0.03	3	0.03	0.71095	6.4E-06	
CF V 73l	leaf	1 - DLB luc.	0.50	25116	8722	1072	1633	68	36	15	3.1	4.2	814	63	34	21	16	4.3	401	213	-1.15	0.03	-0.60	0.05	4	0.00	0.71040	7.2E-06	
CF V 74l	leaf	2 - DLB luc.	0.58	23967	8073	1049	1791	63	54	16	3.2	4.4	1300	57	22	17	14	4.2	391	144	-1.06	0.07	-0.55	0.04	4	0.00	0.71084	4.6E-06	
CF V 75l	leaf	3 - DLB luc.	0.60	23040	8231	975	1235	87	35	12	3.3	3.9	627	67	25	17	13	4.5	319	147	-1.06	0.02	-0.55	0.03	4	0.01	0.71059	4.6E-06	
CF V 76l	leaf	4 - DLB luc.	0.50	22246	7629	836	1529	62	51	81	3.6	4.0	1115	50	11	16	14	4.4	303	168	-1.05	0.03	-0.54	0.06	4	0.00	0.71062	4.1E-06	
CF V 73s	stem	1 - DLB luc.	0.57	12649	1079	264	600	14	3.0	6.0	1.2	0.47	1748	12	20	3.7	3.1	0.86	236	28	-1.00	0.04	-0.51	0.05	4	0.01	0.71053	4.1E-06	
CF V 74s	stem	2 - DLB luc.	0.55	15969	1017	408	996	23	4.8	13	1.5	0.56	1915	18	30	3.6	2.8	1.6	165	25	-0.94	0.02	-0.47	0.03	4	0.02	0.71100	4.6E-06	
CF V 75s	stem	3 - DLB luc.	0.63	10993	1057	306	461	15	3.2	8.0	1.3	0.43	996	17	16	4.0	3.0	0.86	109	20	-0.96	0.05	-0.49	0.03	4	0.01	0.71070	4.4E-06	
CF V 76s	stem	4 - DLB luc.	0.54	13123	1049	453	853	18	5.6	11	1.4	0.47	1421	15	20	3.7	2.9	1.3	136	27	-0.90	0.05	-0.44	0.02	4	0.03	0.71086	4.8E-06	
CF V 77e	ear	1 - DLB	0.80	7480	1221	1095	2520	34	20	23	2.8	2.2	129	4.3	20	3.1	2.0	3.1	253	37	-0.53	0.04	-0.26	0.03	3	0.02	0.71075	6.3E-0E	

Table S5 continued - Chemical and magnesium and strontium isotope composition of plant samples at central field trials.

sample ID	Macronutrients				Micronutrients					Beneficial elements			Non-nutritive elements					MC-ICP-MS analyses									
	K	Ca	Mg	P	Fe	Mn	Zn	Cu	B	Na	Al	Co	Ba	Sr	Ti	Cr	Li	$\delta^{26}\text{Mg}_{\text{DSM-3}}$	2SD	$\delta^{25}\text{Mg}_{\text{DSM-3}}$	2SD	n	$\Delta^{25}\text{Mg}^*$	$^{87}\text{Sr}/^{86}\text{Sr}$	2SE		
	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	( $\mu\text{g/g}$ )	(‰)	(‰)	(‰)	(‰)	(‰)					
SRM 1573a Tomato leaves (a1)	29793	52147	11600	2398	364	260	35	4.2	36	<LOQ	602	<LOQ	65	88	<LOQ	<LOQ	<LOQ	-1.46	0.10	-0.75	0.05	4	0.01	0.71008	5.0E-06		
SRM 1573a Tomato leaves (a2)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-1.43	0.03	-0.71	0.03	3	0.04	0.71009	4.0E-06		
SRM 1573a Tomato leaves (a3)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-1.44	0.05	-0.74	0.03	4	0.01	0.71006	5.2E-06		
SRM 1573a Tomato leaves (b)	23344	50833	11150	2311	379	219	29	3.8	28	94	596	<LOQ	62	88	37	1580	430	-1.39	0.01	-0.72	0.04	4	0.01	n.d.	n.d.		
SRM 1573a Tomato leaves mean	26568	51490	11375	2354	371	240	32	4.0	32	94	599	-	63	88	37	1580	430	-1.43	0.06	-0.73	0.04	4	0.02	0.71008	0.00003		
SRM 1573a Tomato leaves 2SE	6449	1314	450	87	15	41	5	0	8	-	6	-	3	0	-	-	-										
SRM 1573a Tomato leaves RSE	24%	3%	4%	4%	4%	17%	17%	10%	24%	-	1%	-	5%	0%	-	-	-										
SRM 1573a Tomato leaves certified value	26760	50450	12000	2161	368	246	31	4.7	33	136	598	0.58	63	85	n.r.	1988	n.r.										
SRM 1573a Tomato leaves certified uncertainty	480	550	n.r.	28	4.3	7.1	0.55	0.14	0.42	3.7	7.1	0.01	n.r.	n.r.	n.r.	34	n.r.										
relative difference (measured value/certified value)	-1%	2%	-5%	9%	1%	-3%	4%	-15%	-4%	-31%	0%	-	1%	4%	-	-21%	-										
SRM 1575a Pine needles (a1)	4698	2658	1039	1158	45	489	40	2.6	<LOQ	<LOQ	606	<LOQ	6.5	7.1	<LOQ	<LOQ	<LOQ	-0.72	0.02	-0.39	0.01	4	-0.02				
SRM 1575a Pine needles (a2)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-0.77	0.05	-0.37	0.03	3	0.03				
SRM 1575a Pine needles (a3)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	-0.75	0.03	-0.40	0.04	3	-0.01				
SRM 1575a Pine needles mean																		-0.75	0.05	-0.39	0.03	3	0.00				
SRM 1575a Pine leaves certified value***	4170	2500	1060	1070	46	488	38	2.8	9.6	63	580	0.06	6.0	n.r.	n.r.	300-500	n.r.	-0.76	0.04	n.r.	n.r.						
SRM 1575a Pine leaves certified uncertainty	70	100	170	80	2.0	12	2.0	0.20	0.20	1.0	30	0.00	0.20	n.r.	n.r.	n.r.	n.r.										
relative difference (measured value/certified value)	13%	6%	-2%	8%	-1%	0%	6%	-6%	-	-	4%	-	8%	-	-	-	-										
ERM-CD281 Rye grass (a)	37074	6881	1647	2699.2	181	88	34	9.6	<LOQ	2808	43	<LOQ	13	24	<LOQ	29644	<LOQ	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.				
ERM-CD281 Rye grass (b)	38678.2	6937	1656	2728.3	185	89	33	9.2	<LOQ	2030	43	<LOQ	13	23	<LOQ	35755	<LOQ	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.				
ERM-CD281 Rye grass (c)	30917.6	6589	1423	2614.6	210	76	32	9.2	5	3955	42	<LOQ	10	25	7.6	22258	<LOQ	-0.91	0.03	-0.46	0.04	4	0.02				
ERM-CD281 Rye grass mean	35556.6	6802	1575	2681	192	85	33	9.4	-	2931	43	-	12	24	-	29219	-										
ERM-CD281 Rye grasss 2SD	8194	374	264	118	31	15	1.6	0.46	-	1936	2.1	-	2.5	1.8	-	13517	-										
ERM-CD281 Rye grass RSD	23%	5%	17%	4%	16%	17%	5%	5%	-	66%	5%	-	21%	8%	-	46%	-										
ERM-CD281 Rye grass certified value	34000	6300	1600	2800	180	82	31	10	5.5	4000	n.r.	n.r.	n.r.	n.r.	n.r.	24800	n.r.										
ERM-CD281 Rye grass certified uncertainty	n.r.	n.r.	n.r.	n.r.	n.r.	4.0	1.1	0.5	0.5	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	1300	n.r.										
relative difference (measured value/certified value)	5%	8%	-2%	-4%	7%	3%	8%	-8%	-	-27%	-	-	-	-	-	18%	-										
International reference material used to determine the accuracy and precision of Mg isotope analyses																											
ERM-AE143 (1) / SRM987 (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.30	0.04	-1.70	0.01	2	0.02	0.71032	3.7E-06		
ERM-AE143 (2) / SRM987 (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.27		-1.69		1	0.01	0.71031	4.8E-06		
ERM-AE143 (3) / SRM987 (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.22	0.10	-1.66	0.05	3	0.02	0.71029	5.2E-06		
ERM-AE143 (4) / SRM987 (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.22	0.04	-1.64	0.03	4	0.04	0.71027	4.1E-06		
ERM-AE143 (5) / SRM987 (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.28	0.05	-1.70	0.02	4	0.01	0.71030	5.4E-06		
ERM-AE143 (6) / SRM987 (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.27	0.04	-1.69	0.08	4	0.02	0.71028	5.2E-06		
ERM-AE143 (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.20	0.04	-1.65	0.04	4	0.02				
ERM-AE143 (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.24	0.07	-1.66	0.04	3	0.03				
ERM-AE143 (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.28	0.05	-1.69	0.06	3	0.02				
ERM-AE143 (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.20	0.04	-1.67	0.04	7	0.00				
ERM-AE143 (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.27	0.06	-1.68	0.05	2	0.02				
ERM-AE143 (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.25	0.03	-1.68	0.03	4	0.01				
ERM-AE143 (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.27	0.07	-1.66	0.03	4	0.04				
ERM-AE143 (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.29	0.03	-1.70	0.03	4	0.02				
ERM-AE143 (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.32	0.05	-1.70	0.06	4	0.03				
ERM-AE143 (16)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.31	0.01	-1.69	0.03	4	0.04				
ERM-AE143 (17)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.29	0.02	-1.69	0.02	4	0.03				
ERM-AE143 (18)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.29	0.04	-1.69	0.03	4	0.03				
ERM-AE143 (19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-3.24	0.03	-1.66	0.03	4	0.03				
ERM-AE143 / SRM987 mean																		-3.26	0.07	-1.68	0.04	19	0.02				
ERM-AE143 literature value on inter-laboatory comparison****																		-3.28	0.04	-1.68	0.04		0.03				

Elements measured by ICP-OES: K, Ca, Mg, P, Fe, Mn, Zn, Na, Al, Co. Elements measured by ICP-MS: Cu, B, Ba, Sr, Ti, Cr, Li.

(a)-(q) = full digestion replicates; (1)-(18) = Bracketing standard passed through cation-exchange chromatographic method with each sample batch; (a1-a3) repeat cation-exchange chromatography runs on the same sample digestion.

\* calculated following Young and Galy (2004); \*\* isotope data taken from GeoReM (<http://georem.mpch-mainz.gwdg.de> (accessed 22. January 2021)); \*\*\*  $\delta^{26}\text{Mg}$  from Wang et al. (2020);\*\*\*\* from Vogl et al. (2020).

n.r. = not reported; n.d.: not determined; <LOQ = below limit of quantification; 2SD: two-fold standard deviation; 2SE: two-fold standard error, n: number of Mg isotope mass spectrometry analyses.

C: control; C luc.: control + lucerne; DL: deep loosening; DLB: deep loosening + biowaste compost; DLG: deep loosening + greenwaste compost; DLB luc.: deep loosening + biowaste compost + lucerne.