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

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### 2. Citation

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## 3. Data Description

The data herein were used to evaluate the success of subsoil management practices conducted from 2018 to 2020 at the central field sites (CF1 and CF2) of "Campus Klein Altendorf" (Rheinsberg, Germany). Subsoil management practices include deep loosening with and without the incorporation of biowaste compost and green waste compost, as well as using lucerne as deep rooting pre-crop. Subsoil managements are complemented by a control.

Presented are element concentrations of macronutrients (Ca, K, Mg, P), micronutrients (B, Cu, Fe, Mn, Zn), plant beneficial elements (Al, Co, Na, Ni, Si) and elements of non-nutritional character (Ba, Cd, Cr, Ga, Li, Pb, Rb, Sr, Ti) along with soil pH data, magnesium isotope compositions ( $\delta^{26}$ Mg), and radiogenic strontium isotope ratios ( $\delta^{87}$ Sr/ $\delta^{86}$ Sr) of samples covering the soil-plant system of the agrosphere. Soil compartments include depth profiles of Luvisol of the easily exchangeable fraction of the soil (1M NH<sub>4</sub>OAc extraction), and bulk soil (Li<sub>2</sub>B<sub>4</sub>O<sub>7</sub> fusion digests and microwave assisted sample digests). Plant compartments include bulk ear, bulk stem, and bulk leaf of winter wheat (*Triticum aestivum L.*) and spring barley (*Hordeum vulgare L.*) sampled at flowering and maturity stage. Chemical and isotope composition of bulk aboveground crop (shoot) are also presented. Finally, chemical and isotope compositions of compost and converter lime are provided.

Tables supplementary to the article, including data quality control, are provided in .pdf and .xlsx formats. In addition, data measured in the course of the study are also provided as machine readable ASCII files.

## 4. File description

Supplementary tables to Uhlig et al. (2022) are provided in .pdf and .xlsx formats. In addition, analytical data are provided as tab separated ASCII files. The first three rows in the ASCII files begin with "#" and contain licence and citation. In In all files, values that were not measured are marked with "n.d." and concentrations below limit of quantification are marked with "<LOQ".

### 4.1. File inventory

- **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).
- **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).
- **Table S2a** Chemical composition of pooled soil samples at central field trials (microwave digestion).
- **Table S2b** Loss on ignition corrected chemical composition and magnesium and strontium isotope composition of pooled soil samples at central field trials (microwave digestion).
- **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.

## 4.2.Soil samples

# 4.2.1. 2022-003\_Uhlig 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)

Column header	unit	Description
sample ID	dimensionless	Sample identifier used in this study
field site	dimensionless	Name of central field trial
crop species	dimensionless	Description of crop type
growing stage	dimensionless	Description of growing stage
year	dimensionless	Year of sampling
treatment	dimensionless	<sup>a</sup> Subsoil management practice
soil horizon	dimensionless	Type of soil horizon
mean depth	cm	Mean sampling depth
SiO2	wt%	<sup>b</sup> Oxide concentration of silicon
TiO2	wt%	<sup>b</sup> Oxide concentration of titanium
Al2O3	wt%	<sup>b</sup> Oxide concentration of aluminium
Fe2O3	wt%	<sup>b</sup> Oxide concentration of iron
MnO	wt%	<sup>b</sup> Oxide concentration of manganese
MgO	wt%	<sup>b</sup> Oxide concentration of magnesium
CaO	wt%	<sup>b</sup> Oxide concentration of calcium
Na2O	wt%	<sup>b</sup> Oxide concentration of sodium
K2O	wt%	<sup>b</sup> Oxide concentration of potassium
P2O5	wt%	<sup>b</sup> Oxide concentration of phosphorus
LOI	wt%	Loss on ignition
Sum	wt%	Sum of oxide concentrations and LOI
Ва	ppm	<sup>c</sup> Barium concentration
Cd	ppm	<sup>c</sup> Cadmium concentration
Со	ppm	<sup>c</sup> Cobalt concentration
Cr	ppm	<sup>c</sup> Cadmium concentration
Pb	ppm	<sup>c</sup> Lead concentration
Sr	ppm	<sup>c</sup> Strontium concentration
Zn	ppm	<sup>c</sup> Zinc concentration

<sup>&</sup>lt;sup>a</sup> C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

<sup>&</sup>lt;sup>b</sup> Raw data (major elements, measured with ICP-OES).

<sup>&</sup>lt;sup>c</sup> Raw data (trace elements, measured with ICP-OES).

# 4.2.2. 2022-003\_Uhlig Table S1b Loss on ignition corrected chemical composition of pooled soil samples at central field trials ( $Li_2B_4O_7$ fusion)

Column header	unit	Description
sample ID	dimensionless	Sample identifier used in this study
field site	dimensionless	Name of central field trial
crop species	dimensionless	Description of crop type
growing stage	dimensionless	Description of growing stage
year	dimensionless	Year of sampling
treatment	dimensionless	<sup>a</sup> Subsoil management practice
soil horizon	dimensionless	Type of soil horizon
mean depth	cm	Mean sampling depth
SiO2	wt%	<sup>b</sup> Oxide concentration of silicon
TiO2	wt%	<sup>b</sup> Oxide concentration of titanium
Al2O3	wt%	<sup>b</sup> Oxide concentration of aluminium
Fe2O3	wt%	<sup>b</sup> Oxide concentration of iron
MnO	wt%	<sup>b</sup> Oxide concentration of manganese
MgO	wt%	<sup>b</sup> Oxide concentration of magnesium
CaO	wt%	<sup>b</sup> Oxide concentration of calcium
Na2O	wt%	<sup>b</sup> Oxide concentration of sodium
K2O	wt%	<sup>b</sup> Oxide concentration of potassium
P2O5	wt%	<sup>b</sup> Oxide concentration of phosphorus
Sum	wt%	Sum of oxide concentrations and LOI
Ва	ppm	<sup>c</sup> Barium concentration
Cd	ppm	<sup>c</sup> Cadmium concentration
Со	ppm	<sup>c</sup> Cobalt concentration
Cr	ppm	<sup>c</sup> Chromium concentration
Pb	ppm	<sup>c</sup> Lead concentration
Sr	ppm	<sup>c</sup> Strontium concentration
Zn	ppm	<sup>c</sup> Zinc concentration

 $<sup>^</sup>a$  C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

<sup>&</sup>lt;sup>b</sup> LOI corrected data (major elements, measured with ICP-OES).

<sup>&</sup>lt;sup>c</sup> LOI corrected data (trace elements, measured with ICP-OES).

# 4.2.3. 2022-003\_Uhlig Table S2a Chemical composition of pooled soil samples at central field trials (microwave digestion)

sample ID dimensionless Sample identifier used in this study field site dimensionless Name of central field trial crop species dimensionless Description of crop type growing stage dimensionless Description of growing stage year dimensionless Year of sampling treatment dimensionless Type of soil horizon mean depth cm Mean sampling depth SiO2 wt% bOxide concentration of silicon TiO2 wt% bOxide concentration of titanium Al2O3 wt% bOxide concentration of aluminium Fe2O3 wt% bOxide concentration of manganese	
crop species dimensionless Description of crop type growing stage dimensionless Description of growing stage year dimensionless Year of sampling treatment dimensionless as Subsoil management practice soil horizon dimensionless Type of soil horizon mean depth cm Mean sampling depth SiO2 wt% boxide concentration of silicon TiO2 wt% boxide concentration of titanium Al2O3 wt% boxide concentration of aluminium Fe2O3 wt% boxide concentration of iron	
growing stage dimensionless Description of growing stage  year dimensionless Year of sampling  treatment dimensionless a Subsoil management practice  soil horizon dimensionless Type of soil horizon  mean depth cm Mean sampling depth  SiO2 wt% b Oxide concentration of silicon  TiO2 wt% b Oxide concentration of titanium  Al2O3 wt% b Oxide concentration of aluminium  Fe2O3 wt% b Oxide concentration of iron	
year dimensionless Year of sampling treatment dimensionless a Subsoil management practice soil horizon dimensionless Type of soil horizon mean depth cm Mean sampling depth SiO2 wt% b Oxide concentration of silicon TiO2 wt% b Oxide concentration of titanium Al2O3 wt% b Oxide concentration of aluminium Fe2O3 wt% b Oxide concentration of iron	
treatment dimensionless a Subsoil management practice soil horizon dimensionless Type of soil horizon mean depth cm Mean sampling depth SiO2 wt% b Oxide concentration of silicon TiO2 wt% b Oxide concentration of titanium Al2O3 wt% b Oxide concentration of aluminium Fe2O3 wt% b Oxide concentration of iron	
soil horizon dimensionless Type of soil horizon  mean depth cm Mean sampling depth  SiO2 wt% bOxide concentration of silicon  TiO2 wt% bOxide concentration of titanium  Al2O3 wt% bOxide concentration of aluminium  Fe2O3 wt% bOxide concentration of iron	
mean depth cm Mean sampling depth  SiO2 wt% bOxide concentration of silicon  TiO2 wt% bOxide concentration of titanium  Al2O3 wt% bOxide concentration of aluminium  Fe2O3 wt% bOxide concentration of iron	
SiO2 wt% b Oxide concentration of silicon TiO2 wt% b Oxide concentration of titanium Al2O3 wt% b Oxide concentration of aluminium Fe2O3 wt% b Oxide concentration of iron	
TiO2 wt% b Oxide concentration of titanium  Al2O3 wt% b Oxide concentration of aluminium  Fe2O3 wt% b Oxide concentration of iron	
Al2O3 wt% b Oxide concentration of aluminium Fe2O3 wt% b Oxide concentration of iron	
Fe2O3 wt% b Oxide concentration of iron	
MnO wt% b Oxide concentration of manganese	
MgO wt% b Oxide concentration of magnesium	
CaO wt% b Oxide concentration of calcium	
Na2O wt% b Oxide concentration of sodium	
K2O wt% b Oxide concentration of potassium	
P2O5 wt% b Oxide concentration of phosphorus	
LOI wt% Loss on ignition	
B ppm <sup>c</sup> Boron concentration	
Ba ppm <sup>c</sup> Barium concentration	
Co ppm <sup>c</sup> Cobalt concentration	
Cr ppm <sup>c</sup> Chromium concentration	
Cu ppm <sup>c</sup> Copper concentration	
Ga ppm <sup>c</sup> Gallium concentration	
Li ppm <sup>c</sup> Lithium concentration	
Ni ppm <sup>c</sup> Nickel concentration	
Rb ppm <sup>c</sup> Rubidium concentration	
Sr ppm <sup>c</sup> Strontium concentration	
Zn ppm <sup>c</sup> Zinc concentration	

<sup>&</sup>lt;sup>a</sup> C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

<sup>&</sup>lt;sup>b</sup> Raw data (major oxides, measured with ICP-MS).

<sup>&</sup>lt;sup>c</sup> Raw data (trace elements, measured with ICP-MS).

# 4.2.4. 2022-003\_Uhlig Table S2b Loss on ignition corrected chemical composition and magnesium and strontium isotope composition of pooled soil samples at central field trials (microwave digestion)

sample ID         dimensionless         Sample identifier used in this study           field site         dimensionless         Name of central field trial           crop species         dimensionless         Description of crop type           growing stage         dimensionless         Description of growing stage           year         dimensionless         Year of sampling           treatment         dimensionless         Type of soil horizon           mean depth         Mean sampling depth           SIO2         wt%         b Oxide concentration of silicon           TIO2         wt%         b Oxide concentration of silicon           TIO2         wt%         b Oxide concentration of silicon           TIO2         wt%         b Oxide concentration of trianium           AI2O3         wt%         b Oxide concentration of iron           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of manganesium           CaO         wt%         b Oxide concentration of manganesium           K2O         wt%         b Oxide concentration of potassium           R2O         wt%         b Oxide concentration of potassium           R2O         wt%         b Oxide concentration of phosphorus	Column header	unit	Description
field site dimensionless dimensionless crop species dimensionless dimensionless dimensionless prowing stage dimensionless dimensionless year dimensionless year dimensionless year dimensionless year dimensionless year of sampling treatment dimensionless soil horizon dimensionless discorptantion of candial province concentration of manganese dimensionless dimensionless dimensionless dimensionless dimensionless dimensionless dimensionless dimension dimensionless dimensionless dimension dimensionless distribution of propertico dimensionless dimensionless dimensionless dimensionless di Strontium isotope ratio of radiogenic 875r to stable 865r dimensionless di Strontium isotope ratio of radiogenic 875r to stable 865r dimensionless di Strontium isotope ratio of radiogenic 875r to stable 865r dimensionless di Strontium isotope ratio of of radiogenic 875r to stable 865r dimensionless di Strontium isotope ratio of of radiogenic 875r to stable 865r dimensionless dimensionless di Strontium isotope ratio of of radiogenic 875r to stable 865r dimensionless dimensionless dimensio	sample ID	dimensionless	·
crop species         dimensionless         Description of growing stage           year         dimensionless         Description of growing stage           year         dimensionless         Year of sampling           treatment         dimensionless         "Subsoil management practice           soil horizon         dimensionless         Type of soil horizon           mean depth         cm         Mean sampling depth           SiO2         wt%         b Oxide concentration of silicon           TiO2         wt%         b Oxide concentration of itanium           Al2O3         wt%         b Oxide concentration of aluminium           Fe2O3         wt%         b Oxide concentration of iron           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of magnesium           CaO         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration           Barium concentration         concentration           Co		dimensionless	
growing stage         dimensionless         Description of growing stage           year         dimensionless         Year of sampling           treatment         dimensionless         *Subsoil management practice           soil horizon         dimensionless         Type of soil horizon           mean depth         Cm         Mean sampling depth           SiO2         wt%         b Oxide concentration of silicon           TiO2         wt%         b Oxide concentration of itanium           Al2O3         wt%         b Oxide concentration of tanium           Al2O3         wt%         b Oxide concentration of managanese           MnO         wt%         b Oxide concentration of managanese           MgO         wt%         b Oxide concentration of godisum           K2O         wt%         b Oxide concentration of podassium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration           B         ppm         c Boron concentration	crop species	dimensionless	Description of crop type
year         dimensionless         Year of sampling           treatment         dimensionless         Subsoil management practice           soil horizon         dimensionless         Type of soil horizon           mean depth         cm         Mean sampling depth           SiO2         wt%         b Oxide concentration of silicon           TiO2         wt%         b Oxide concentration of silicon           Al2O3         wt%         b Oxide concentration of ititanium           Fe2O3         wt%         b Oxide concentration of ititanium           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration           B         ppm         c Barium concentration           Co         ppm         c Cobalt concentration           Cr         ppm			
treatment dimensionless soil horizon dimensionless Type of soil horizon mean depth cm Mean sampling depth SiO2 wt% b Oxide concentration of silicon TiO2 wt% b Oxide concentration of titanium Al2O3 wt% b Oxide concentration of aluminium Fe2O3 wt% b Oxide concentration of aluminium Fe2O3 wt% b Oxide concentration of manganese MgO wt% b Oxide concentration of manganese MgO wt% b Oxide concentration of manganese MgO wt% b Oxide concentration of sodium Na2O wt% b Oxide concentration of sodium Na2O wt% b Oxide concentration of sodium N2O wt% b Oxide concentration of potassium P2O5 wt% b Oxide concentration of phosphorus B ppm c Boron concentration Co ppm c Cobalt concentration Cr ppm c Cobalt concentration Cr ppm c Cobper concentration Ui ppm c Cithium concentration Ui ppm c Cithium concentration Rb ppm c Rubidium concentration Pr Cr ppm c Strontium concentration Pr Cr ppm c Strontium concentration Pr Cr ppm c Strontium concentration Pr Cr ppm c Concentration Ui ppm			
soil horizon         dimensionless         Type of soil horizon           mean depth         cm         Mean sampling depth           SiO2         wt%         b Oxide concentration of silicon           TiO2         wt%         b Oxide concentration of titanium           Al2O3         wt%         b Oxide concentration of aluminium           Fe2O3         wt%         b Oxide concentration of iron           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of calcium           Na2O         wt%         b Oxide concentration of sodium           R2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of phosphorus           B         ppm         c Berour concentration           Co         ppm         c Barium concentration           Co         ppm         c Cobalt concentration           Li         ppm			, ,
mean depth         cm         Mean sampling depth           SiO2         wt%         b Oxide concentration of silicon           TiO2         wt%         b Oxide concentration of titanium           Al2O3         wt%         b Oxide concentration of aluminium           Fe2O3         wt%         b Oxide concentration of iron           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of alcium           Na2O         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of phosphorus           B         ppm         c Born concentration           Co         wt%         b Oxide concentration           Co         ppm         c Cobalt concentration           Cr         ppm         c Cobalt concentration           Cr         ppm         c Copper concentration           Cr         ppm         c Copper concentration           Ga         ppm         c Stontium concentration           Ii         ppm         c Nickel concentration           Rb         ppm         c Strontium concentration           Ga <td></td> <td></td> <td></td>			
SiO2         wt%         b Oxide concentration of silicon           TiO2         wt%         b Oxide concentration of titanium           Al2O3         wt%         b Oxide concentration of aluminium           Fe2O3         wt%         b Oxide concentration of iron           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of manganesium           CaO         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of phosphorus           B         ppm         c Boron concentration           Ba         ppm         c Boron concentration           Co         ppm         c Cobalt concentration           Cr         ppm         c Copper concentration           Cu         ppm         c Gallium concentration           Li         ppm         c Sillium concentration           Sr         ppm         c Strontium concentration           Sr         ppm         c Strontium concentration <td></td> <td></td> <td></td>			
TiO2 wt% b Oxide concentration of titanium  Al2O3 wt% b Oxide concentration of aluminium  Fe2O3 wt% b Oxide concentration of iron  MnO wt% b Oxide concentration of manganese  MgO wt% b Oxide concentration of manganese  MgO wt% b Oxide concentration of manganese  MgO wt% b Oxide concentration of calcium  Na2O wt% b Oxide concentration of sodium  K2O wt% b Oxide concentration of potassium  P2O5 wt% b Oxide concentration of phosphorus  B ppm G Boron concentration  Co ppm G Cobalt concentration  Co ppm G Cobalt concentration  Co ppm G Cobalt concentration  Cu ppm G Copper concentration  Li ppm G Callium concentration  Li ppm G Callium concentration  Rb ppm G Rubidium concentration  Sr ppm G Strontium concentration  Sr ppm G Strontium concentration  Sr ppm G Cobalt concentration  Sr ppm G Cobalt concentration  Sr ppm G Callium concentration  Sr Oxide Concentration  Sr Oxide Concentration  Ali ppm G Callium concentration  Sr Oxide Concentration  Sr Oxide Concentration  Sr Oxide Concentration  Ali ppm G Callium concentration  Sr Oxide Concentration  Sr	-	wt%	
Al2O3       wt%       b Oxide concentration of aluminium         Fe2O3       wt%       b Oxide concentration of iron         MnO       wt%       b Oxide concentration of manganese         MgO       wt%       b Oxide concentration of manganesium         CaO       wt%       b Oxide concentration of sodium         Na2O       wt%       b Oxide concentration of sodium         K2O       wt%       b Oxide concentration of potassium         P2O5       wt%       b Oxide concentration of phosphorus         B       ppm       c Boron concentration         Co       ppm       c Cobalt concentration         Co       ppm       c Cobalt concentration         Cr       ppm       c Cobalt concentration         Cr       ppm       c Cobalt concentration         Cu       ppm       c Cobalt concentration         Cu       ppm       c Cobalt concentration         Ga       ppm       c Cobalt concentration         Li       ppm       c Gallium concentration         Li       ppm       c Rubidium concentration         Sr       ppm       c Strontium concentration         Sr       ppm       c Strontium concentration         Sr       ppm <td></td> <td></td> <td></td>			
Fe2O3         wt%         b Oxide concentration of iron           MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of magnesium           CaO         wt%         b Oxide concentration of sodium           Na2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of phosphorus           B         ppm         c Boron concentration           Ba         ppm         c Barium concentration           Co         ppm         c Cobalt concentration           Cr         ppm         c Chromium concentration           Cu         ppm         c Gallium concentration           Ga         ppm         c Gallium concentration           Ni         ppm         c Nickel concentration           Rb         ppm         c Strontium concentration           Sr         ppm         c Strontium concentration           Zn         ppm         c Strontium concentration           δ26Mg         %         d Magnesium isotope ratio of <sup>26</sup> Mg to <sup>24</sup> Mg expressed in common delta notation           2SD         %         d Uncertainty of δ <sup>25</sup> Mg           δ25Mg         %         d Uncertainty of δ <sup>25</sup> Mg			
MnO         wt%         b Oxide concentration of manganese           MgO         wt%         b Oxide concentration of manganesium           CaO         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of phosphorus           B         ppm         c Boron concentration           Co         ppm         c Cobalt concentration           Co         ppm         c Cobalt concentration           Cr         ppm         c Chromium concentration           Cu         ppm         c Copper concentration           Ga         ppm         c Gallium concentration           Li         ppm         c Stickel concentration           Ni         ppm         c Nickel concentration           Sr         ppm         c Strontium concentration           δ26Mg         %         d Magnesium isotope ratio of 26Mg to 24Mg expressed in common delta notation           2SD         %         d Magnesium isotope ratio of 25Mg to 24Mg expre		<b>†</b>	
MgO         wt%         b Oxide concentration of magnesium           CaO         wt%         b Oxide concentration of calcium           Na2O         wt%         b Oxide concentration of sodium           K2O         wt%         b Oxide concentration of potassium           P2O5         wt%         b Oxide concentration of phosphorus           B         ppm         c Boron concentration           B         ppm         c Barium concentration           Co         ppm         c Cobalt concentration           Cr         ppm         c Chromium concentration           Cu         ppm         c Copper concentration           Ga         ppm         c Gallium concentration           Li         ppm         c Stickel concentration           Ni         ppm         c Rubidium concentration           Sr         ppm         c Strontium concentration           G         d Magnesium isotope			
CaO       wt%       b Oxide concentration of calcium         Na2O       wt%       b Oxide concentration of sodium         K2O       wt%       b Oxide concentration of potassium         P2O5       wt%       b Oxide concentration of phosphorus         B       ppm       c Boron concentration         Ba       ppm       c Barium concentration         Co       ppm       c Cobalt concentration         Cr       ppm       c Chromium concentration         Cu       ppm       c Copper concentration         Ga       ppm       c Gallium concentration         Li       ppm       c Nickel concentration         Ni       ppm       c Rubidium concentration         Sr       ppm       c Strontium concentration         Sr       ppm       d Uncertainty of δ26			
Na2O       wt%       b Oxide concentration of sodium         K2O       wt%       b Oxide concentration of potassium         P2O5       wt%       b Oxide concentration of phosphorus         B       ppm       c Boron concentration         Ba       ppm       c Barium concentration         Co       ppm       c Cobalt concentration         Cr       ppm       c Chromium concentration         Cu       ppm       c Copper concentration         Ga       ppm       c Gallium concentration         Li       ppm       c Nickel concentration         Ni       ppm       c Nickel concentration         Sr       ppm       c Strontium concentration         Sr       ppm       c Strontium concentration         Sr       ppm       c Zinc concentration         δ26Mg       d Magnesium isotope ratio of 26Mg to 24Mg expressed in common delta notation         2SD       %o       d Uncertainty of δ26Mg         δ25Mg       d Uncertainty of δ25Mg         Δ25Mg       d Uncertainty of δ25Mg         A25Mg       d Deviation of δ25Mg from the equilibrium isotope fractionation line in the three-isotope space calculated following (Young and Galy (2004)         n       d dimensionless       d Number of Mg isotope mass s		<u> </u>	-
K2O       wt%       b Oxide concentration of potassium         P2O5       wt%       b Oxide concentration of phosphorus         B       ppm       c Boron concentration         Ba       ppm       c Barium concentration         Co       ppm       c Cobalt concentration         Cr       ppm       c Chromium concentration         Cu       ppm       c Gallium concentration         Ga       ppm       c Gallium concentration         Li       ppm       c Nickel concentration         Ni       ppm       c Rubidium concentration         Sr       ppm       c Strontium concentration         Zn       ppm       c Strontium concentration         Zn       ppm       c Strontium concentration         δ26Mg       d Magnesium isotope ratio of 26Mg to 24Mg expressed in common delta notation         2SD       %       d Uncertainty of δ26Mg         δ25Mg       d Magnesium isotope ratio of 25Mg to 24Mg expressed in common delta notation         2SD       %       d Uncertainty of δ25Mg         Δ25Mg       d Uncertainty of δ25Mg         Magnesium isotope ratio of 25Mg to 24Mg expressed in common delta notation         2SD       d Uncertainty of δ25Mg         A25Mg       d Deviation of δ2		<b>\</b>	
P2O5       wt%       b Oxide concentration of phosphorus         B       ppm       c Boron concentration         Ba       ppm       c Barium concentration         Co       ppm       c Cobalt concentration         Cr       ppm       c Chromium concentration         Cu       ppm       c Gallium concentration         Ga       ppm       c Gallium concentration         Li       ppm       c Nickel concentration         Ni       ppm       c Rubidium concentration         Sr       ppm       c Strontium concentration         Sr       ppm       c Strontium concentration         Zn       ppm       c Strontium concentration         δ26Mg       d Magnesium isotope ratio of 26Mg to 24Mg expressed in common delta notation         2SD       d Uncertainty of δ26Mg         δ25Mg       d Magnesium isotope ratio of 25Mg to 24Mg expressed in common delta notation         2SD       d Uncertainty of δ25Mg         Δ25Mg       d Uncertainty of δ25Mg         Δ25Mg       d Deviation of δ25Mg from the equilibrium isotope fractionation line in the three-isotope space calculated following (Young and Galy (2004)         n       d dimensionless       d Number of Mg isotope mass spectrometry analyses         87Sr/86Sr       d dimensionl			
B ppm		<u> </u>	•
Ba       ppm       c Barium concentration         Co       ppm       c Cobalt concentration         Cr       ppm       c Chromium concentration         Cu       ppm       c Copper concentration         Ga       ppm       c Gallium concentration         Li       ppm       c Lithium concentration         Ni       ppm       c Rubidium concentration         Sr       ppm       c Strontium concentration         Sr       ppm       c Strontium concentration         Zn       ppm       c Zinc concentration         δ26Mg       d Magnesium isotope ratio of 26Mg to 24Mg expressed in common delta notation         2SD       d Uncertainty of δ26Mg         δ25Mg       d Magnesium isotope ratio of 25Mg to 24Mg expressed in common delta notation         2SD       d Uncertainty of δ25Mg         Δ25Mg       d Deviation of δ25Mg from the equilibrium isotope fractionation line in the three-isotope space calculated following (Young and Galy (2004)         n       d imensionless       d Number of Mg isotope mass spectrometry analyses         87Sr/86Sr       d imensionless       d Strontium isotope ratio of radiogenic 87Sr to stable 86Sr			
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Zn       ppm       c Zinc concentration         δ26Mg       %       d Magnesium isotope ratio of <sup>26</sup> Mg to <sup>24</sup> Mg expressed in common delta notation         2SD       %       d Uncertainty of δ <sup>26</sup> Mg         δ25Mg       %       d Magnesium isotope ratio of <sup>25</sup> Mg to <sup>24</sup> Mg expressed in common delta notation         2SD       %       d Uncertainty of δ <sup>25</sup> Mg         Δ25Mg       %       d Deviation of δ <sup>25</sup> Mg from the equilibrium isotope fractionation line in the three-isotope space calculated following (Young and Galy (2004)         n       dimensionless       d Number of Mg isotope mass spectrometry analyses         87Sr/86Sr       d Strontium isotope ratio of radiogenic <sup>87</sup> Sr to stable <sup>86</sup> Sr	Sr		
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$	δ26Mg		<sup>d</sup> Magnesium isotope ratio of <sup>26</sup> Mg to <sup>24</sup> Mg expressed in
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			
$ \begin{array}{c} \text{common delta notation} \\ \text{2SD} & \% & \text{d Uncertainty of $\delta^{25}Mg} \\ \Delta 25Mg & \% & \text{d Deviation of $\delta^{25}Mg from the equilibrium isotope} \\ \text{fractionation line in the three-isotope space calculated} \\ \text{following (Young and Galy (2004)} \\ \text{n} & \text{dimensionless} & \text{d Number of Mg isotope mass spectrometry analyses} \\ 87Sr/86Sr & \text{dimensionless} & \text{d Strontium isotope ratio of radiogenic $^{87}$Sr to stable $^{86}$Sr} \\ \end{array} $	2SD	‰	<sup>d</sup> Uncertainty of δ <sup>26</sup> Mg
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	δ25Mg	%	<sup>d</sup> Magnesium isotope ratio of <sup>25</sup> Mg to <sup>24</sup> Mg expressed in
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			common delta notation
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· · · · · · · · · · · · · · · · · · ·	87Sr/86Sr	dimensionless	<sup>d</sup> Strontium isotope ratio of radiogenic <sup>87</sup> Sr to stable <sup>86</sup> Sr
		dimensionless	

<sup>&</sup>lt;sup>a</sup> C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

<sup>&</sup>lt;sup>b</sup> LOI corrected data (major oxides, measured with ICP-MS).

<sup>&</sup>lt;sup>c</sup> LOI corrected data (trace elements, measured with ICP-MS).

<sup>&</sup>lt;sup>d</sup> MC-ICP-MS analyses.

# 4.2.5. 2022-003\_Uhlig Table S3 Soil pH of pooled soil samples at central field trials

Column header	unit	Description
sample ID	dimensionless	Sample identifier used in this study
field site	dimensionless	Name of central field trial
crop species	dimensionless	Description of crop type
growing stage	dimensionless	Description of growing stage
year	dimensionless	Year of sampling
treatment	dimensionless	<sup>a</sup> Subsoil management practice
soil horizon	dimensionless	Type of soil horizon
mean depth	cm	Mean sampling depth
soil pH (CaCl2)	dimensionless	Soil pH measured in a suspension of 0.01M CaCl <sub>2</sub> and soil

<sup>&</sup>lt;sup>a</sup> C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

# 4.2.6. 2022-003\_Uhlig 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

Column header	unit	Description
sample ID	dimensionless	Sample identifier used in this study
field site	dimensionless	Name of central field trial
crop species	dimensionless	Description of crop type
growing stage	dimensionless	Description of growing stage
year	dimensionless	Year of sampling
treatment	dimensionless	<sup>a</sup> Subsoil management practice
soil horizon	dimensionless	Type of soil horizon
mean depth	cm	Mean sampling depth
Ва	ppm	<sup>b</sup> Barium concentration
Ca	ppm	<sup>b</sup> Calcium concentration
Fe	ppm	<sup>b</sup> Iron concentration
К	ppm	<sup>b</sup> Potassium concentration
Li	ppb	<sup>b</sup> Lithium concentration
Mg	ppm	<sup>b</sup> Magnesium concentration
Mn	ppm	<sup>b</sup> Manganese concentration
Na	ppm	<sup>b</sup> Sodium concentration
Р	ppm	<sup>b</sup> Phosphorus concentration
Rb	ppm	<sup>b</sup> Rubidium concentration

Column header	unit	Description
Sr	ppm	<sup>b</sup> Strontium concentration
Zn	ppm	<sup>b</sup> Zinc concentration
δ26Mg	%	<sup>c</sup> Magnesium isotope ratio of <sup>26</sup> Mg to <sup>24</sup> Mg expressed in common delta notation
2SD	‰	$^{\rm c}$ Uncertainty of $\delta^{26}$ Mg
δ25Mg	%	<sup>c</sup> Magnesium isotope ratio of <sup>25</sup> Mg to <sup>24</sup> Mg expressed in common delta notation
2SD	‰	$^{\text{c}}$ Uncertainty of $\delta^{25}\text{Mg}$
Δ25Mg	%0	$^{\rm c}$ Deviation of $\delta^{25} Mg$ from the equilibrium isotope fractionation line in the three-isotope space calculated following (Young and Galy (2004)
n	dimensionless	<sup>c</sup> Number of Mg isotope mass spectrometry analyses
87Sr/86Sr	dimensionless	<sup>c</sup> Strontium isotope ratio of radiogenic <sup>87</sup> Sr to stable <sup>86</sup> Sr
2SE	dimensionless	<sup>c</sup> Uncertainty of <sup>87</sup> Sr/ <sup>86</sup> Sr

<sup>&</sup>lt;sup>a</sup> C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

## 4.3. Plant samples

# 4.3.1. 2022-003\_Uhlig Table S5 Chemical and magnesium and strontium isotope composition of plant samples at central field trials

Column header	unit	Description
sample ID	dimensionless	Sample identifier used in this study
field site	dimensionless	Name of central field trial
crop species	dimensionless	Description of crop type
growing stage	dimensionless	Description of growing stage
year	dimensionless	Year of sampling
plant organ	dimensionless	Description of plant organ
field repetition - treatment	dimensionless	<sup>a</sup> Field replicate and subsoil management practice
biomass	g	Total mass of plant organ
К	ppm	<sup>b</sup> Potassium concentration
Ca	ppm	<sup>b</sup> Calcium concentration

<sup>&</sup>lt;sup>b</sup> ICP-MS analyses.

<sup>&</sup>lt;sup>c</sup> MC-ICP-MS analyses.

Column header	unit	Description
Mg	ppm	<sup>b</sup> Magnesium concentration
Р	ppm	<sup>b</sup> Phosphorus concentration
Fe	ppm	<sup>c</sup> Iron concentration
Mn	ppm	<sup>c</sup> Manganese concentration
Zn	ppm	<sup>c</sup> Zinc concentration
Cu	ppm	<sup>c</sup> Copper concentration
В	ppm	<sup>c</sup> Boron concentration
Na	ppm	<sup>d</sup> Sodium concentration
Al	ppm	<sup>d</sup> Aluminium concentration
Со	ppm	<sup>d</sup> Cobalt concentration
Ва	ppm	<sup>e</sup> Barium concentration
Sr	ppm	<sup>e</sup> Strontium concentration
Ti	ppm	<sup>e</sup> Titanium concentration
Cr	ppb	<sup>e</sup> Chromium concentration
Li	ppb	<sup>e</sup> Lithium concentration
δ26Mg	<b>%</b> 0	f Magnesium isotope ratio of <sup>26</sup> Mg to <sup>24</sup> Mg expressed in common delta notation
2SD	‰	$^{\rm f}$ Uncertainty of $\delta^{26}{ m Mg}$
δ25Mg	<b>%</b> o	f Magnesium isotope ratio of <sup>25</sup> Mg to <sup>24</sup> Mg expressed in common delta notation
2SD	‰	$^{\rm f}$ Uncertainty of $\delta^{25}{\rm Mg}$
Δ25Mg	%0	$^{\rm f}$ Deviation of $\delta^{\rm 25} Mg$ from the equilibrium isotope fractionation line in the three-isotope space calculated following (Young and Galy (2004)
n	dimensionless	f Number of Mg isotope mass spectrometry analyses
87Sr/86Sr	dimensionless	<sup>f</sup> Strontium isotope ratio of radiogenic <sup>87</sup> Sr to stable <sup>86</sup> Sr
2SE	dimensionless	f Uncertainty of <sup>87</sup> Sr/ <sup>86</sup> Sr

<sup>&</sup>lt;sup>a</sup> C=control, DL=deep loosening, DLB=deep loosening with incorporation of biowaste compost, DLG=deep loosening with incorporation of green waste compost, C luc.=control with lucerne as pre-crop, DLB luc.=deep loosening with incorporation of biowaste compost and lucerne as pre-crop.

<sup>&</sup>lt;sup>b</sup> Macronutrients (measured with ICP-OES).

<sup>&</sup>lt;sup>c</sup> Micronutrients (Fe, Mn, Zn measured with ICP-OES; Cu, B measured with ICP-MS).

<sup>&</sup>lt;sup>d</sup> Beneficial elements (measured with ICP-OES).

 $<sup>^{\</sup>it e}$  Non-nutritive elements (measured with ICP-MS).

<sup>&</sup>lt;sup>f</sup> MC-ICP-MS analyses.

### 5. References

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