GENERAL FICHE
SOIL AMENDMENT WITH LIME OR GYPSUM

Data extracted in April 2021

Note to the reader: This general fiche summarises all the environmental and climate impacts of SOIL AMENDMENT WITH LIME OR GYPSUM found in a systematic review of 7 synthesis research papers[1].

The general fiche provides the highest level of synthesis – symbolised by the top of the pyramid  . As each synthesis research paper involves a number of individual papers ranging from 19 to 175, the assessment of impacts relies on a large number of results obtained mainly in field experiments (carried out in situations close to real farming environment), and sometimes in lab experiments or from model simulations. In addition to this general fiche, single-impact fiches provide a deeper insight in each individual impact of SOIL AMENDMENT WITH LIME OR GYPSUM (bioavailability and plant uptake of toxic compounds, crop yield, greenhouse gas emission, soil biological quality, soil nutrients, soil organic carbon and soil physical-chemical quality), with more detailed information – medium part of the pyramid  . Finally, individual reports provide fuller information about the results reported in each synthesis paper, in particular about the modulation of effects by factors related to soil, climate and management practices – base of the pyramid  .

This general fiche on SOIL AMENDMENT WITH LIME OR GYPSUM is part of a set of similar fiches providing a comprehensive picture of the impacts of farming practices on climate and the environment.

1. DESCRIPTION OF THE FARMING PRACTICE

Description	• Soil amendments are the practices used to improve the soil quality in terms of its structure and biochemical function. Most amendments use calcium-containing minerals, such as lime or gypsum. Both types of amendment have different chemical properties, as explained in Key descriptors.
Key descriptors	• Different types of calcium-containing minerals are used in practice, in particular[2] – Lime refers to a material that can come in different forms, especially calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$). It is used to reduce soil acidity and to add calcium or magnesium to the soil. – Gypsum, or calcium sulfate dihydrate, ($CaSO_4 \cdot 2H_2O$), is a neutral salt. It can be used to improve soil calcium and sulphur levels. Gypsum is about 200 times more soluble than agricultural lime, allowing it to move readily down the soil profile where it can help to alleviate a range of subsoil problems. In some acid soils, gypsum can be used to ameliorate subsoil aluminium toxicity, while in saline alkaline soils to alleviate sodium toxicity and to regulate soil pH, bulk density and water infiltration

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results.

[2] References used:

- https://agbmps.osu.edu/bmp/amending-soils-lime-or-gypsum-nrcs-333
- https://www.kzndard.gov.za/images/Documents/researchandtechnologydevelopment/publications/researchreports/2015_13_Agricultural_uses_of_lime_and_gypsum.pdf
- http://www.gypsoil.com/news-and-events/gypsum-and-lime

2. DESCRIPTION OF THE IMPACTS OF THE FARMING PRACTICE ON CLIMATE AND THE ENVIRONMENT

We reviewed the impacts of soil amendment with lime or gypsum vs. no amendment.

The table below shows the number of synthesis papers reporting positive, negative, no effect, or uncertain effects. For each impact, the effect with the higher score is marked in bold and the cell coloured. The numbers between parenthesis indicate the number of synthesis papers with a quality score of at least 50%. Details on quality criteria can be found in this document .

Among the 7 synthesis papers, 2 included experiments conducted in Europe and 6 have a quality score higher than 50%. Some synthesis papers reported more than one impact.

Impact	Intervention	Control	Positive	Negative	No effect	Uncertain
Decrease GHG emissions	Lime	No lime	0	0	0	**1 (1)**
Improve soil physical-chemical quality	Gypsum	No gypsum	**1 (1)**	0	0	0
	Lime	No lime	**2 (2)**	0	0	0
Increase soil organic carbon	Gypsum	No gypsum	**1 (1)**	0	0	0
	Lime	No lime	0	0	**1 (1)**	0
Increase soil nutrients	Gypsum	No gypsum	0	0	**1 (1)**	0
Increase soil biological quality	Gypsum	No gypsum	**1 (1)**	0	0	0
Decrease bioavailability and plant uptake of toxic compounds	Gypsum	No gypsum	0	**1 (1)**	**1 (1)**	0
	Lime	No lime	**1 (1)**	0	0	0
Increase crop yield	Lime	No lime	**2 (2)**	0	0	0
	Gypsum	No gypsum	**2 (2)**	0	0	1 (0)

3. DESCRIPTION OF THE KEY FACTORS INFLUENCING THE SIZE OF THE EFFECT

Only the factors explicitly studied in the reviewed synthesis papers with a significant effect are reported below. Details regarding the factors can be found in the *individual reports* following the hyperlinks (or ref X).

Impact	Factors
Soil physical-chemical quality	Incorporation depth (ref 2), Liming rate (ref 3, 5), Lab/field scale (ref 3, 5), Soil salinity (ref 2), Soil organic matter (ref 5), Soil texture (ref 5), Time scale (ref 5),
Soil organic carbon	Application season (ref 2), Climate (ref 6), Liming duration (ref 6), Soil salinity (ref 2), Soil depth (ref 2)
Bioavailability and plant uptake of toxic compounds	Liming rate (ref 3), Rice cultivar (ref 3), Lab/field scale (ref 3), Soil Cd concentration (ref 3), Soil texture (ref 3), Soil Zn concentration (ref 3), Type of lime (ref 3)
Crop yield	Aluminium saturation (ref 4), Crop species (ref 4, 5), Incorporation depth (ref 2), Irrigation (ref 2), Ploughing (ref 5), Soil texture (ref 5), Soil pH (ref 1), Water table (ref 2), Water deficiency (ref 4)

4. IMPLEMENTATION IN THE PERIOD 2014-2020

GAEC Cross compliance	

Greening	
Rural development measure – submeasure	

5. PICTURES

Pictures are not relevant in this case.

6. LINKS TO OTHER RELEVANT COMPLEMENTARY INFORMATION

We include in this section the links to other complementary sources of information (not peer-reviewed meta-analyses or systematic reviews), provided by AGRI or other stakeholders

7. LIST OF SYNTHESIS PAPERS INCLUDED IN THE REVIEW OF THE FARMING PRACTICE IMPACTS

Number	Author	Year	Title	Reference	doi
1	Hijbeek R, van Loon MP, Ouaret W, Boekelo B, van Ittersum MK	2021	Liming agricultural soils in Western Kenya: Can long-term economic and environmental benefits pay off short term investments?	Agricultural Systems 190, 103095	10.1016/j.agsy.2021.103095
2	Wang Y, Wang Z, Liang F, Jing X, Feng W	2021	Application of flue gas desulfurization gypsum improves multiple functions of saline-sodic soils across China.	Chemosphere. 277:130345	10.1016/j.chemosphere.2021.130345
3	Kong L, Guo Z, Peng C, Xiao X, He Y	2021	Factors influencing the effectiveness of liming on cadmium reduction in rice: A meta-analysis and decision tree analysis	Sci Total Environ. 779:146477	10.1016/j.scitotenv.2021.146477
4	Pias, OHD; Tiecher, T; Cherubin, MR; Silva, AGB; Bayer, C	2020	Does gypsum increase crop grain yield on no-tilled acid soils? A meta-analysis	Agronomy Journal 112, 675–692.	10.1002/agj2.20125
5	Li Y.; Cui S.; Chang S.X., Zhang Q.	2019	Liming effects on soil pH and crop yield depend on lime material type, application method and rate, and crop species: a global meta-analysis. Journal of Soils and Sediments 19(4)	J Soils Sediments 19:1393–406	10.1007/s11368-018-2120-2
6	Eze, S; Palmer, SM; Chapman, PJ.	2018	Soil organic carbon stock in grasslands: Effects of inorganic fertilizers, liming and grazing in different climate settings	Journal of Environmental Management 223, 74-84	10.1016/j.jenvman.2018.06.013
7	Tiecher, T; Pias, OHD; Bayer, C; Martins, AP; Denardin, LGD; Anghinoni, I	2018	Crop Response to Gypsum Application to Subtropical Soils Under No-Till in Brazil: a Systematic Review	Revista Brasileira de Ciencia do Solo 42:170025	10.1590/18069657rbcs20170025