SINGLE-IMPACT FICHE
SOIL AMENDMENT WITH LIME AND GYPSUM

IMPACT: SOIL PHYSICO-CHEMICAL QUALITY

Data extracted in February 2021
Fiche created in May 2024

Note to the reader: This fiche summarises the effects of Soil amendment with lime and gypsum on SOIL PHYSICO-CHEMICAL QUALITY. It is based on 3 synthesis papers[1], including from 39 to 175 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effects of soil amendment with lime and gypsum, as compared to no-amendment, on soil physico-chemical quality are reported in **Table 1**.

The table below shows the number of synthesis papers with statistical tests reporting i) a significant difference between the Intervention and the Comparator, that is to say, a significant statistical effect, which can be positive or negative; or ii) a non-statistically significant difference between the Intervention and the Comparator. In addition, we include, if any, the number of synthesis papers reporting relevant results but without statistical test of the effects. Details on the quality assessment of the synthesis papers can be found in the methodology section of this WIKI.

- Soil amendment with both gypsum and lime, compared to no amendment, showed significant positive effect on soil physical-chemical quality (soil pH, soil exchangeable sodium, cation exchange capacity, soil available nutrients) in the 3 synthesis papers reviewed.

Out of the 3 selected synthesis papers, one included studies conducted in Europe (see **Table 2**).

Table 1: Summary of effects. Number of synthesis papers reporting positive, negative or non-statistically significant effects on environmental and climate impacts. The number of synthesis papers reporting relevant results but without statistical test of the effects are also provided. When not all the synthesis papers reporting an effect are of high quality, the number of synthesis papers with a quality score of at least 50% is indicated in parentheses. The reference numbers of the synthesis papers reporting each of the effects are provided in **Table 3**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase soil physico-chemical quality	Soil physical-chemical quality	Gypsum	No gypsum	1	0	0	0
		Lime	No lime	2	0	0	0

QUALITY OF THE SYNTHESIS PAPERS

The quality of each synthesis paper was assessed based on 16 criteria regarding three main aspects: 1) the literature search strategy and primary studies selection; 2) the statistical analysis conducted; and 3) the evaluation of potential bias. We assessed whether authors addressed and reported these criteria. Then, a quality score was calculated as the percentage of these 16 criteria properly addressed and reported in each synthesis paper. Details on quality criteria can be found in the methodology section of this WIKI.

2. IMPACTS

The main characteristics and results of the 3 synthesis papers are reported in **Table 2** with the terminology used in those papers, while **Table 3** shows the reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**. Comprehensive 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, are provided in the **summaries of the synthesis papers** available in this WIKI.

Table 2: Main characteristics of the synthesis papers reporting effects on soil physico-chemical quality. The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref1	Rice cultivation	Asia	39	Liming treatment, including $CaCO_3$, $Ca(OH)_2$, and CaO	No-liming control under identical experimental conditions	Soil pH	Liming significantly increases soil pH in rice cultivation.	94%
Ref3	Saline-sodic soil types	China	59	Soil amendment using flue gas desulfurization gypsum (FGDG)	No-amendment control under	Soil pH, Soil exchangeable	Soil amendment using flue gas desulfurization gypsum (FGDG) significantly reduced soil pH (−8.1%) and soil exchangeable sodium	62%

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results. Details can be found in the methodology section of the WIKI.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
					identical experimental conditions	sodium percentage	percentage (−37.4%).	
Ref5	Field-studies, laboratory incubation or greenhouse pot studies	Global (including Europe)	175	Liming treatment, including dolomite ($CaMg(CO_3)_2$), calcium hydroxide ($Ca(OH)_2$), calcium carbonate ($CaCO_3$), and calcium oxide (CaO)	No-liming control under identical experimental conditions	Soil pH, Cation exchange capacity (CEC), soil nutrients	To effectively neutralize soil acidity, the optimum liming duration, rate, and material type were < 3 years, 3–6 Mg ha−1, and $Ca(OH)_2$, respectively. Liming significantly ameliorated soil Al^{3+}, increased basic cations (Ca^{2+} and Mg^{2+}), neutralized soil pH across different cropping systems, and improved the soil nutrient status (increasing exchangeable nitrogen, potassium, and phosphorous).	81%

Table 3: Reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase soil physico-chemical quality	Soil physical-chemical quality	Gypsum	No gypsum	Ref3			
		Lime	No lime	Ref1 and Ref5			

3. FACTORS INFLUENCING THE EFFECTS ON SOIL PHYSICO-CHEMICAL QUALITY

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on soil physico-chemical quality, according to the synthesis papers reviewed.

Factor	Reference number
Incorporation depth	Ref3
Liming rate	Ref1 and Ref5
NA	Ref1, Ref1, Ref1, Ref1, Ref1, Ref1, Ref5, Ref5, Ref5, Ref3, Ref3, Ref3, Ref3, Ref3 and Ref3
Scale of experiment	Ref1 and Ref5
Soil organic matter	Ref5
Soil salinity	Ref3
Soil texture	Ref5
Time scale	Ref5

4. KNOWLEDGE GAPS

Table 5: Knowledge gap(s) reported by the authors of the synthesis papers included in this review.

Ref Num	Gap
Ref5	The complexity of responses identified in this study emphasizes the need for adopting more advanced data-science algorithms coupled with high-dimensional data sets in the future that could enhance our understanding of the underlying mechanisms of liming on an agroecosystem basis.

5. SYNTHESIS PAPERS INCLUDED IN THE REVIEW

Table 6: List of synthesis papers included in this review. More details can be found in the summaries of the meta-analyses.

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref1	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
Ref3	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
Ref5	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

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