SINGLE-IMPACT FICHE
OIL AMENDMENT WITH LIME AND GYPSUM

IMPACT: CROP YIELD

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 CROP YIELD. It is based on 5 synthesis papers[1], including from 19 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 crop yield 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.

- Both liming and gypsum amendments, compared to no-amendment, showed significant positive effect on crop yield. Out of 5 synthesis papers, 4 showed consistently positive effect (increase of crop yield), while 1 paper reported non-statistically-tested results.

Out of the 5 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 crop yield	Crop yield	Gypsum	No gypsum	2	0	0	1 (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 5 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 crop yield. The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref2	Maize	Kenya	19	Lime	No lime	Crop yield	Average observed increase in maize yields was 57% (with 2 t ha −1 lime).	56%
Ref3	Saline-sodic soil types	China	59	Soil amendment using flue gas desulfurization gypsum (FGDG)	No-amendment control under identical experimental conditions	Crop yield, Plant seedling emergence	Soil amendment using flue gas desulfurization gypsum (FGDG) significantly increased crop yield (+91.2%) and plant seedling emergency (+63.2%).	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
Ref4	Arable crops	Brazil and Paraguay	43	Gypsum application	No gypsum	Crop yield	Gypsum application decreases Al toxicity to plants and increases crop grain yields as a result in no-tillage soils with high Al saturation.	81%
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	Yield	Averaged across different crop species, the application of CaO, $CaCO_3$, $Ca(OH)_2$, and $CaMg(CO_3)_2$ significantly increased yield by 13.2, 34.3, 29.2, and 66.5%, respectively.	81%
Ref7	Grain yields in sub-tropical Brazil	Brazil	20	Gypsum application	Specific treatment without gypsum, that induced the highest yield	Crop yield	Irrespective of water deficiency, applying gypsum to soils with high subsurface acidity increased the average yield by 14 % in corn (85 % studied cases) and by 20 % in winter cereals (75 % of cases). Soybean only responded positively to gypsum in the simultaneous presence of high soil subsurface acidity and water deficiency (average increase 23 %, 100 % of cases). However, no proper statistical analysis is available in this work.	44%

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 crop yield	Crop yield	Gypsum	No gypsum	Ref3 and Ref4			Ref7
		Lime	No lime	Ref2 and Ref5			

3. FACTORS INFLUENCING THE EFFECTS ON CROP YIELD

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on crop yield, according to the synthesis papers reviewed.

Factor	Reference number
Al saturation	Ref4
Crop species	Ref5 and Ref4
Incorporation depth	Ref3
Irrigation	Ref3
NA	Ref5, Ref5, Ref5, Ref5, Ref5, Ref4, Ref4, Ref4, Ref4, Ref4, Ref2, Ref2, Ref2, Ref2, Ref2, Ref2, Ref2, Ref7, Ref7, Ref7, Ref7, Ref7, Ref7, Ref7, Ref7, Ref3, Ref3, Ref3, Ref3 and Ref3
Plowing	Ref5
Soil pH	Ref2
Soil texture	Ref5
Water deficiency	Ref4
Water table	Ref3

4. KNOWLEDGE GAPS

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

Ref Num	Gap
Ref2	Further research could investigate liming effects for crops other than maize.
Ref3	Most studies of flue gas desulfurization gypsum application focus on changes in plant productivity and a few soil properties such as soil salinity and pH. There are few studies that have investigated changes in soil physical properties that reflect water retention such as the distribution and stability of soil aggregates, and soil hydraulic conductivity, infiltration, and permeability. The lack of simultaneous measurements for multiple soil properties and plant productivity does not allow the determination of underlying mechanisms regarding how FGDG application can affect soil functions. This makes it difficult to offer practical suggestions to improve the amelioration by FGDG amendment.
Ref4	Long-term experiments under NT are needed also because most existing studies are relatively new (<2yr) and only allow one to evaluate short-term effects of gypsum on soil properties and crop yields.
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.
Ref7	All existing studies involved Oxisols and most (80 %) examined the crop response of soybean or corn. Sixty-one (76 %) of the 73 growing seasons examined in this systematic review corresponded to a period shorter than three years after gypsum was applied.

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
Ref2	R.Hijbeek; M.P.van Loon; W.Ouaret; B.Boekelo; M.K.van Ittersum	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
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
Ref4	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
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
Ref7	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

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