European Commission

FARMING PRACTICE
SOIL AMENDMENT WITH LIME AND GYPSUM

IMPACT: GHG EMISSIONS

Reference 2

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

Background and objective

Liming is a long-term investment with benefits becoming apparent over multiple years. Long-term economic strategies can be problematic for farmers who lack investment capital and who may have short-term decision time frames, such as most smallholder farmers in sub-Saharan Africa. In addition, application of lime causes substantial greenhouse gas (GHG) emissions (especially CO_2). It is currently unclear how liming affects GHG emissions per tonne of maize, in cases where liming increases crop yields. Assess if liming acid soils is economically and environmentally viable at different levels of intensification for maize cultivation in Western Kenya.

Search strategy and selection criteria

A literature search was conducted using Google Scholar and Web of Science to find suitable field experiments. Our study interests were fourfold: 1) to quantify the effect of lime application on soil pH in the first year after lime application; 2) to quantify the change in soil pH in the second to fifth year after lime application; 3) to quantify the effect of lime application on maize yields; 4) to quantify the effect of soil pH on maize yields. If data from a field experiment could provide insight into at least one of these four interests, it was included in our database. 1)maize was included as a crop; 2) the experiment was conducted in East Africa; 3) at least two of the following variables were reported: maize yields, initial soil pH and/or - if applied - the amount of liming.

Data and analysis

Data was considered an outlier if reported values on maize yields and change in soil pH were above or below the mean plus or minus three times the standard deviation. Three statistical models were constructed to link liming, soil pH and maize yields through time using the nls function (R v3.6.1) of the 'stats package. For each model, relevant co-variables such as fertiliser application, liming rate and initial pH were included. Uncertainty in maize yield was estimated using the predictNLS function of the 'propagate' package in R. Uncertainties on profit estimates and GHG emissions were assessed using a replicated Latin hypercube design and drawing 625 (25 × 25) samples from the parameter space. GHG emissions from lime application were estimated based on the IPCC tier 1 approach. The amount of lime applied was multiplied by the emission factor of lime application (i.e., 0.12 CO_2-C t lime−1 for $CaCO_3$ (IPCC, 2006, IPCC, 2019), as this type of lime was the most common type used in the experiments and in Western Kenya). GHG emissions from the production of lime were estimated as the amount of lime applied multiplied by the emission factor (i.e., 0.06).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
19	Maize	Lime	No lime	Metric: GHG emissions per yield unit; Effect size: Difference of of the considered metrics between intervention and control	0.5625

Results

- For most fertiliser schemes and soil pH levels, liming does not alter GHG emissions per tonne maize because the increase in maize yield compensates for the additional emissions from liming.
- At a soil pH of 4.5 and low fertiliser use, adding lime decreases GHG emissions per tonne of maize.

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Liming does not significantly alter GHG emissions per tonne maize. At low-fertilisation rates, it significantly decreases GHG emissions per tonne of maize.