FARMING PRACTICE
IL AMENDMENT WITH LIME AND GYPSUM

IMPACT: CARBON SEQUESTRATION

Reference 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

Background and objective

The interactive effects of non-management factors (e.g. climate and soil) and fertilizer or lime application rates have not been synthesized for global grasslands. Determine the effect size (relative size of change in SOC stock) attributable to grazing-related management (liming and fertilizer addition) and grazing regime in different climatic settings, using a global meta-analysis approach.

Search strategy and selection criteria

The data used for this study were extracted from peer-reviewed journal articles published before January 2017. A search for the articles was conducted in Web of Science between June and December 2016, using all combinations of the following groups of search terms: 1) management, liming, lime addition, fertilizer, nitrogen addition, nitrogen fertilizer application or grazing, 2) soil carbon, soil carbon stock, soil carbon storage or carbon sequestration, 3) grassland, pasture or meadow. 1)they were grassland field studies in which SOC data were recorded in response to either liming, fertilizer application or grazing regime, 2) SOC data were recorded for both the managed field and a well-defined control field, and measurements were made at the same temporal and spatial scales, 3) only one of the target management practices such as grazing regime or nitrogen fertilizer varied while other management activities were absent or remained constant, 4) the depth of soil samples used for SOC determination were clearly specified, 5) the mean, sample sizes, measures of variability such as standard deviation, standard error or coefficient of variation can be extracted from the study, 6) experimental and control plots were established within the same ecosystem and had similar environmental characteristics at the beginning of the study, 7) management activities such as grazing intensity were clearly described quantitatively and/or qualitatively, and 8) experimental duration was clearly specified and was at least one entire growing season in order to avoid the effect of short term noise.

Data and analysis

The meta-analysis was conducted based on the response-ratio approach described by Hedges et al. (1999) using the mixed-effect model of MetaWin software. The total heterogeneity (QT) in each type of management practice was calculated and partitioned into within group heterogeneity (QW) and between group heterogeneity (QB). A significant QB (at 5% probability level) meant that management categories within that management type differed in their effects, and the exact effect of any management category was considered significantly different from that of another category when their 95% confidence intervals did not overlap. The effect size of management activities was further categorised according to duration of management, extent of sampling depth, clay content, climatic zone, MAT and MAP, using the categorical meta-analytic model of MetaWin software. Publication bias (i.e. the tendency for only statistically significant results to be published by journals) was assessed by running a fail-safe test in MetaWin software.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
20	Grasslands	Liming intensity categorised into three rates: low lime, < 3 t/ha lime; moderate lime, 3–5 t/ha lime; and high lime, > 5 t/ha lime.	No-liming under same ecosystem and simiar environmental characteristics.	Metric: Soil organic carbon stock; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	1

Results

- Liming, fertilizer application and grazing resulted in an overall significant reduction (–8.5%) in SOC stock.
- The three management activities differed significantly ($p < 0.05$) in their separate effects on SOC stock. Grazing significantly reduced SOC stock by –15%, liming resulted in a non-significant increase (+5.8%) whereas fertilizer application significantly increased SOC stock by +6.7%.
- There were non-significant increases in SOC stock at both low (+6.8%) and high (+2.8%) lime rates, whereas moderate lime rate led to a significant increase (+14.1%) in soil C stock.
- Generally, an increase in the duration of liming addition was associated with a greater decline in SOC stock.

Factors influencing effect sizes

- Climate : In the temperate zone: the negative effect of liming decreased with increasing Mean Annual Temperature and increased with increasing Mean Annual Precipitation.
- Liming duration : Generally, an increase in the duration of liming and fertilizer addition was associated with a greater decline in SOC stock.

Conclusion

Liming results in a marginal non significant increase in soil C stocks of global grasslands.