SUPER-G
SUSTAINABLE PERMANENT GRASSLAND

MEDITERRANEAN
BOREAL
ALPINE
PANNONIAN
CONTINENTAL
ATLANTIC

Liming grassland soils

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- **DESCRIPTION:** Apply a liming material (e.g., ground limestone or chalk) on a regular basis to maintain grassland soils at a neutral to slightly acidic pH (soil pH 5.3 to 6.0 depending on the soil type) to optimise productivity, nutrient use efficiency and plant species diversity.

- **RATIONALE:** Liming grassland soils grassland reduces soil acidity by increasing soil pH, and thereby optimises grass productivity, improves nitrogen use efficiency, and enhances species richness (i.e., the number of different species present in an ecological community, landscape, or region) and biodiversity (variety of life) (Fig. 1). It can also, indirectly, reduce the need for animal supplementary feeding and improve grazing livestock production. Although liming can increase net CO2 emissions, the impact of liming acidic grasslands on total net GHG emissions from grasslands is negligible, as liming either decreases or has no effect on the emissions of two potent greenhouse gases (i.e., nitrous oxide and methane). Liming is a common practice on acid grasslands to correct the soil pH, optimise nutrient availability and plant growth conditions, and thereby provide the right environment for grassland to reach its growth potential. It can improve farm sustainability and help to fulfil the environmental targets proposed in the EU Green Deal and the Farm to Fork and Biodiversity strategies.

Fig.1: Aerial picture of the Park Grass Experiment at Rothamsted Research (Harpenden, southern England) in 2005, showing plot boundaries due to differences in fertiliser and lime treatment combinations producing different vegetation (top left); differences in the type and number of plant species (top right and bottom right; e.g., Anthoxanthum odoratum – sweet vernal grass) due to the different N fertiliser and lime combinations. Plots with lime show more plant species and higher growth rates. The bottom left picture shows sub-plots a, b, c and d. Ground chalk has been applied as necessary to maintain soil pH (at 0-23 cm depth) at pH 7.0 on sub-plots a; pH 6 on sub-plots b; and pH 5 on sub-plots c. Sub-plot d received no ground chalk. For more details see Silvertown et al. (2006).

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MECHANISM OF ACTION: Soils in moist climates are naturally acidic (soil with a pH below 5.3 has strong acidity) unless they have developed in a calcareous parent material such as chalk or limestone. High rainfall and the use of nitrogen fertilisers result in the leaching of calcium, magnesium, potassium, and other ions, which counteract the hydrogen ions that produce acidity. For agricultural systems to operate efficiently, these lost ions need to be replaced on a regular basis through the addition (spreading) of lime (e.g., calcium carbonate in ground dolomitic limestone or chalk). Non-calcareous grassland soils that have been allowed to acidify (or have never received lime) can result in a nutrient-poor habitat, characterised by grassy tussocks and bare ground (Fig. 2). The low soil pH increases solubility of metals such as aluminium (Al), iron (Fe) and manganese (Mn), which, at high concentration, are toxic to grass and have negative effects on grass growth, grass vigour and its potential to mitigate climate change. Soil acidification influences both top- and sub-soils, and negatively impacts grass biomass production and the thriving of desirable species. To neutralise and control soil acidification, and thereby increase the availability of major nutrients such as nitrogen (N), phosphorus (P) and potassium (K), and improve soil physical condition, acid soils should be regularly limed. However, the application rate should be optimised according to the starting soil pH, the target soil pH, and the soil type (topsoil clay content).

Fig.2: Acid grassland with grassy tussocks (a) and bare ground (b).
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Potential for liming acid grasslands

Application of lime on acid grasslands can be used in any biogeographical region in situations where grass productivity is low due to high soil acidity. Liming practices are applicable to all types of grasslands or grass mixtures (monoculture and multi-species). Limed soils are less prone to compaction and have a better structure (e.g., higher earthworm numbers and better water infiltration). Also, liming to optimum soil pH benefits legumes and thereby nitrogen supply.

Support

External incentives may not be available. However, the costs associated with applying lime-materials should be more than covered by the improved nutrient and water use efficiency, grass productivity and grass quality. Additionally, from an environmental point of view, liming has negligible impact on net greenhouse gas emissions.

Example of good practice

Application of lime is a common practice to neutralise and control soil acidification in acid grasslands on many farms. The Park Grass experiment, which began in 1856 at Rothamsted Research in Harpenden, southern England, has shown that regular application of N fertiliser as ammonium sulphate progressively made the soil acidic. However, application of a combination of nitrogen fertiliser and ground chalk showed clear differences in vegetation and number of species (Fig. 1). As soon as grass is cut or grazed and soil conditions are appropriate (i.e., not too wet, to avoid soil compaction), lime can be applied. The lime is usually washed by rainfall into the soil. However, application of lime on high grass cover can reduce its efficiency and give poor results. Application of lime on high grass covers could also increase lime residue, which can negatively impact grazing animals. On permanent grassland, lime is spread on the soil surface and washed in by rainfall (Fig. 3).

Naturally acidic grasslands should be moderately limed within the context of specific climates, soil types and management, as excess liming can decrease grass productivity due to reduced nutrient availability in alkaline conditions, loss of nitrate after rapid SOM mineralisation and changes in microbial community.

Fig. 3: Spread of lime on grassland soils surface using machinery

On fields with contrasting soil types, a soil pH map can be produced using zone sampling (by pre-determined soil type) or grid sampling methods. Global positioning system technology can then be used to variably apply lime according to the soil pH map to avoid under- or over-application of lime. However, the soil pH map will only be meaningful if an adequate number of representative soil samples are taken in each zone or at each grid point.

For further reading:

Silvertown, J., Poulton, P., Johnston, E., Edwards, G., Heard, M., Biss, P.M., 2006. The Park grass experiment 1856-2006: its contribution to ecology. J. Ecol. 94, 801-814.

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