*Technical Sheet for Solution Implementation*

# Managing Soil pH Through Liming

**Thematic area:** Environmental Sustainability.

**Priority:** How to manage grassland in the face of the future challenges?

**Need:** What solutions to protect soil quality in the long term?

**Solution EU number:** GM-11.

**Content of the solution:** Soil pH correction through liming is a long-term grassland management practice that improves nutrient availability, soil biological activity, and forage quality. Effective liming strategies should always be based on accurate soil diagnosis and carefully calibrated application rates.

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## Reasons for Implementing the Solution

Maintaining an appropriate soil pH improves nutrient availability, soil structure, and biological activity, supporting productive and resilient grasslands. Proper liming also enhances forage quality and helps prevent soil acidity problems such as aluminium toxicity and nutrient imbalances.

## Description of Solution Strategies

Soil pH correction through liming should be considered a structural soil management strategy rather than a simple corrective input. By restoring soil pH to a biologically and agronomically optimal range, liming directly influences nutrient availability, soil biological activity, and pasture botanical composition, with cascading effects on forage quality and equine nutrition. Its effectiveness depends on accurate soil diagnosis, appropriate choice of liming material, and calibrated application rates adapted to soil buffering capacity and management intensity. When properly managed, pH correction contributes to more stable and productive grasslands over the long term. Conversely, excessive or poorly targeted liming may lead to nutrient imbalances, biodiversity loss, or environmental risks, highlighting the importance of progressive, monitored interventions integrated into overall grassland management.

In practice, correcting soil pH improves the growing conditions for desirable grassland species and increases the efficiency with which plants can utilise nutrients already present in the soil or supplied through fertilisation. Over time, this results in denser and more persistent swards, improved forage yield and quality, and reduced establishment of acid-tolerant, less productive plant species. Better root development and soil biological activity also enhance soil structure, water infiltration, and resilience during periods of drought or heavy rainfall, contributing to more productive and sustainable pasture management

Effective soil pH management relies on regular soil analyses and a good understanding of soil properties such as texture, nutrient

already present in the soil or supplied through fertilisation. Over time, this results in denser and more persistent swards, improved forage yield and quality, and reduced establishment of acid-tolerant, less productive plant species. Better root development and soil biological activity also enhance soil structure, water infiltration, and resilience during periods of drought or heavy rainfall, contributing to more productive and sustainable pasture management

Effective soil pH management relies on regular soil analyses and a good understanding of soil properties such as texture, nutrient status, organic matter content, and cation exchange capacity. Therefore, this solution should be implemented alongside site-specific soil monitoring and fertilisation planning to ensure that liming interventions are necessary, well-calibrated, and environmentally sustainable.

For more information, see TS CC-3: Soil Analysis to Reduce Fertilizer Use.

## Implementation Steps

### 1. Measuring actual soil pH

- Before any intervention, laboratory soil analysis is essential. It should include:
  - pH ($H_2O$), measured in a soil–water suspension,
  - pH (KCl), which reflects exchangeable acidity and is typically 0.5 to 1 pH unit lower than pH ($H_2O$).
- Agronomic targets for grasslands:
  - pH ($H_2O$) ≥ ~5.5–6.0 for productive grasslands,
  - pH ($H_2O$) ≥ 6.0 to support legumes such as alfalfa.
- Soils with pH < 5.5 restrict root growth and increase the risk of aluminium toxicity.

### 2. Selecting the appropriate liming material

- Types of liming amendments:
  - Calcitic lime (CaCO3), speed of action moderate.
  - Dolomitic lime (CaMg(CO3)2), speed of action moderate but supplies Mg.
  - Quicklime / Hydrated lime (CaO / Ca(OH)2), speed of action rapid but more expensive.
- The choice depends on soil Ca and Mg status and on how rapidly pH correction is required.

### 3. Determining application rates

- Actual rates must be adjusted according to:
  - soil texture.
  - organic matter content.
  - cation exchange capacity (CEC).
  - buffering capacity.
- Annual applications are generally limited to ≤ 1,500 CaO units/ha to avoid chemical imbalances in the soil.

**4. Optimal timing for implementation**

- After cutting, or early spring before vegetation resumes growth.
- In permanent grasslands, incorporation is not mandatory. Surface application combined with rainfall ensures gradual penetration into the soil profile.
- Adequate soil moisture and close contact between amendment and soil particles are key to effective neutralization.

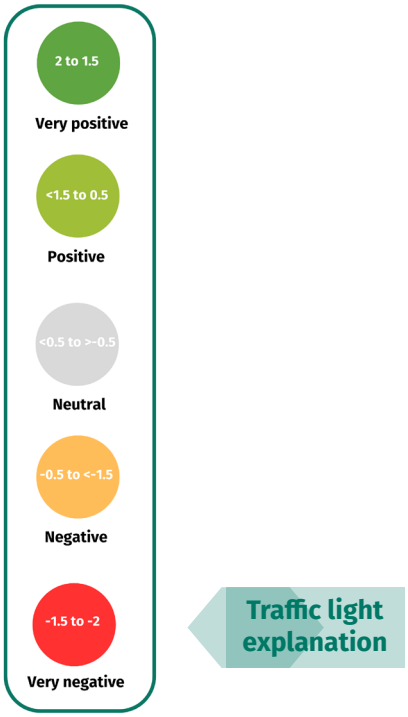
**5. Monitoring and adjustment**

- Soil analyses should be repeated every 3-5 years, or after major liming operations, to monitor pH evolution and refine future applications.

# Managing Soil pH Through Liming

## How Will this Solution Impact the Performance of your Farm?

| TOPIC | SCORE |
|---|---|
| Social | -0.25 |
| Economics | 1.00 |
| Welfare | 0.50 |
| Health | 0 |
| Environmental | 0.17 |
| Pasture access and management | 1.00 |
| Global | 0.33 |




**Socioeconomics:** This solution will not have effect on the social performance of the farm because soil pH management mainly concerns technical grassland management. It may slightly increase workload, although liming can be delegated to external contractors. Spreaders may also have a negative public image, but appropriate communication about the environmental and agronomic benefits of liming can improve acceptance among horse owners.

This solution will support the economic performance of the farm because healthier soils can increase grass productivity and make otherwise poorly productive land more viable. Although soil analysis, liming, and application involve significant initial costs, these can be offset over time by higher forage production and improved pasture quality. Better soil condition and documented soil analyses may also increase the value of agricultural land.

**Health & Welfare:** This solution will have no direct effect on the farm's health performance, as it does not directly contribute to maintaining low levels of pain or reducing the need for veterinary treatment. Monitoring soil pH is more closely related to soil productivity than to equine health. However, by supporting a more balanced mineral composition of forage produced on the farm, it may indirectly contribute to better overall equine health.

This solution supports the farm's equine welfare performance by promoting positive emotional states associated with an appropriate body condition through the

availability of high-quality green fodder produced on the farm. If it concerns also the pastures, the access to good pasture and unrestricted locomotor activity further contribute to positive welfare outcomes. It may also contribute to better physical fitness by improving the mineral composition of the forage and, potentially, by reducing the occurrence of muddy soil. These opportunities contribute to positive welfare and an optimal mental state.

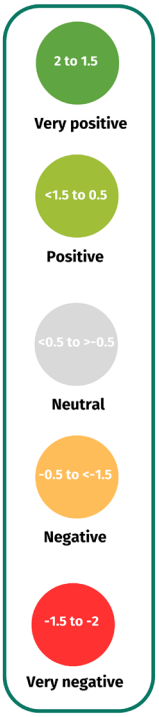
**Environmental sustainability:** This solution will not have effect on the environmental performance of the farm because liming is generally not included in carbon footprint calculations, although maintaining soil pH above 6.5 may reduce $N_2O$ emissions. The solution can increase carbon storage and improve soil life, root growth, and water retention. Liming, especially with quicklime, may reduce biodiversity by favouring certain species, but its effects are nuanced and context-dependent. Soil disturbance may increase the risk of heavy metal leaks to water.

This solution will support on the land access or management performance of the farm becauseis improving soil health and grassland productivity. Liming corrects soil acidity, increases nutrient availability, promotes beneficial soil microbes, reduces soil compaction, and supports healthier root growth. These improvements enhance grassland productivity and resilience while helping to maintain balanced soil conditions.

# Managing Soil pH Through Liming

## How Will this Solution Impact the Resilience of your Farm?

| TOPIC | SCORE |
|---|---|
| Social | -0.17 |
| Economics | 0.54 |
| Welfare | 0.67 |
| Health | 0.08 |
| Environmental | 0.86 |
| Pasture access and management | 0 |
| Global | 0.40 |




**Socioeconomics:** This solution will not impact social performance of the farm facing external chalThis solution will not impact social performance of the farm facing external challenges assessed because its main effects are technical and environmental rather than social. Liming may slightly increase workload, although application can be outsourced, and its public image may require appropriate communication. Nevertheless, it indirectly supports resilience by securing local forage availability, improving soil health and water management, and maintaining horse welfare during pandemics, disease outbreaks, extreme weather, or reduced grassland access.

This solution will support economic performance of the farm facing external challenges assessed because improved soil pH increases grassland productivity, allowing farms to produce more forage on the same or even a smaller land area. This reduces dependence on external feed supplies, limits hay purchases during droughts or supply disruptions, can generate income from surplus forage, and increases land value. More resilient soils and pastures also reduce losses from extreme weather. However, liming and application costs can increase significantly with inflation because amendment prices depend on global markets.

**Health & Welfare:** This solution does not directly support the farm's health performance, as appropriate soil pH does not directly reduce pain, mortality, or the need for medication when the farm is exposed to external pressures. Nevertheless, prolonged access to high-quality pasture may help maintain horses in good health and appropriate body condition, thereby supporting their ability to cope with external challenges.

# Managing Soil pH Through Liming

When the farm is exposed to challenges such as staff shortages, reduced income, water scarcity, or limited access to maintenance and technical services, this solution may help maintain welfare performance by supporting the production of high-quality forage. Such forage can contribute to appropriate body condition and physical fitness, as well as potentially supporting horses' positive mental states. Therefore, this solution is expected to positively affect welfare performance only when monitoring and maintaining appropriate soil pH result in improved pasture quality and, consequently, higher-quality forage.

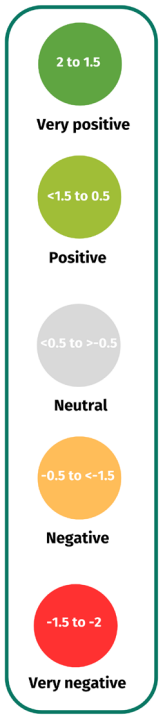
**Environmental sustainability:** This solution will support environmental performance of the farm facing external challenges assessed because this solution It increases soil carbon storage, soil biodiversity and improves water management in presented scenarios. improved soil structure helps retain water and nutrients, increasing the resilience and productivity of grasslands.

This solution will not impact land access or management performance of the farm facing external challenges assessed because effects are mixed and generally limited. Improved grassland productivity can help maintain yields with fewer inputs under inflation and increase resilience during extreme weather events. Pandemics and high welfare standards may make implementation more difficult if there is a shortage of labour or contractors available to carry out liming and other field operations. Where access to grassland is lost or limited, healthier and more productive grasslands can partially compensate for the reduced area, but they cannot fully replace lost land.

# Managing Soil pH Through Liming

## How can this solution help your farm to face specific external challenges to be more resilient?

| CHALLENGES | SCORE |
|---|---|
| Inflation | 0.25 |
| Pandemic | 0.29 |
| High welfare standard | 0.50 |
| High infectious diseases | 0.25 |
| Extreme weather event | 0.54 |
| Loss/limited access to grassland | 0.58 |




**Inflation & Social Crises:** Social challenge: This solution will not impact the global performance of the farm facing pandemics because its benefits are mainly related to soil and forage productivity and do not directly address the major disruptions caused by a pandemic. Although it can secure local fodder availability, support horse maintenance and welfare, and improve soil life and carbon storage, these benefits are largely independent of the pandemic itself. Moreover, implementation still requires labour or access to an external service provider, which may be constrained during a pandemic.

Economic challenge: This solution will not impact the global performance of the farm facing inflation because its positive effects on forage production, soil health, carbon storage, land productivity and horse maintenance are counterbalanced by the increased cost of lime and application services. As amendment prices are themselves dependent on world market prices, inflation can make implementation more expensive. Higher grassland yields and land value provide resilience benefits, but they do not eliminate the farm's exposure to rising input costs.

**Welfare & Diseases:** Health challenge: This solution is expected to have a neutral effect on the farm's global performance across the three sustainability dimensions when facing an infectious disease outbreak. A sudden outbreak may compromise the achievement of socioeconomic, environmental, and animal health and welfare objectives. While well-managed pastures and fields can contribute to good nutritional status and support horses' general health, they are unlikely to substantially reduce the impact of an infectious disease outbreak.

# Managing Soil pH Through Liming

Welfare challenge: This solution can positively contribute to the farm's global performance when adapting to higher animal welfare standards. Maintaining an appropriate body condition is an essential component of equine welfare, and producing high-quality forage on the farm can help ensure that this requirement is met. However, forage provision should be carefully monitored to prevent overnutrition and obesity. When properly managed, this solution can therefore strengthen farm resilience while supporting compliance with increasingly demanding welfare standards.

**Climate Change & Access to Land:** Environmental challenge: this solution will support the global performance of the farm facing abnormally high or low temperatures, drought, excessive raining, windstorms and/or flood because it improves the resilience of grasslands. The farm can maintain more consistent forage production, reducing the need to purchase additional hay and ensuring horses have enough feed throughout the year. Healthier soils are better able to absorb and retain water and nutrients, which helps pastures stay productive during dry periods and recover more quickly after heavy rain. This leads to less pasture damage, a longer grazing season, improved access to forage, and reduced workload for farm staff. More productive grasslands can increase yields and profitability, while enhanced soil health supports biodiversity, stores more carbon, and strengthens the farm's long-term ability to manage land sustainably under changing climate conditions.

Land access/management challenge: this solution will support the global performance of the farm facing loss or limited access to agricultural land because it improves grassland productivity and quality. Healthier, more productive pastures provide more forage from a smaller area, helping to maintain grazing opportunities for horses, reduce workload, and support profitability. Improved soil health also enhances carbon storage, supports biodiversity, and strengthens the farm's long-term ability to manage land sustainably when access to agricultural land is limited or lost.

# Managing Soil pH Through Liming

## Cost-benefit Analysis

### Costs

#### Socioeconomics:

- Initial investment in lime, soil analyses, and, if needed, external advisory services or contractors.
- Time required for planning, monitoring, and implementing liming operations.
- Training costs if farmers carry out soil interpretation and application planning themselves.
- Economic efficiency depends on correct calibration and may be affected by fluctuations in lime prices.
- Poorly targeted applications can result in unnecessary costs and limited benefits.

#### Health & Welfare:

- Excessively productive or nutrient-rich pastures may increase the risk of overfeeding in some horses.
- Over-liming can create mineral imbalances, particularly by reducing magnesium availability through excessive calcium levels.
- Changes in pasture composition may require adjustments to grazing and feeding management.

#### Environmental Sustainability:

- Production, transport, and application of liming materials generate a carbon footprint.
- Tractor use and field operations increase energy consumption and emissions.
- Excessive or poorly managed liming may reduce botanical diversity.

### Benefits

- Improved forage productivity and more stable grass yields over time.
- Better forage quality, which can increase the overall profitability of grassland-based systems.
- More consistent forage availability throughout the year, reducing dependence on external feed sources.
- Enhanced long-term soil health and more efficient use of grassland resources.
- Potential increase in land value through improved soil fertility and pasture performance.
- Opportunities to market surplus forage in productive years.

- Improved mineral composition and overall quality of forage.
- Reduced abundance of acid-tolerant or low-value plant species in pastures.
- Better soil structure and bearing capacity, improving pasture accessibility and reducing muddy conditions.
- Access to higher-quality, more nutritious forage supports equine health and welfare.
- More balanced nutrition may contribute to improved body condition and overall well-being.

- Increased soil biological activity and healthier soil ecosystems.
- Improved soil carbon storage and water retention capacity.
- Greater resilience of grasslands to climatic variability and environmental stress.
- More stable pasture botanical

# Managing Soil pH Through Liming

**Costs**

- Risk of nutrient leaching under unsuitable weather conditions or inappropriate application rates.
- Some industrial liming by-products may contain heavy metals and therefore require careful selection.

**Benefits**

composition over the long term.
- Reduced prevalence of acid-indicator plant species.
- Enhanced forage quality and productivity through healthier soils.
- Better overall soil functioning supports sustainable grassland management.

**Cooperation between Farms:**

- No significant direct costs identified.

- Sharing spreading equipment or machinery can reduce individual investment costs.
- Joint soil analyses or advisory services may improve cost efficiency.
- Exchange of practical experiences and management strategies can support better liming decisions among neighbouring farms.

## Additional Resources

### Publications


- Ellis, A. D., Longland, A. C., Coenen, M., & Miraglia, N. (2010). Grass composition and management in relation to equine metabolic disorders. Animal Feed Science and Technology, 158, 1–12.
- Fageria, N. K., & Baligar, V. C. (2008): Ameliorating soil acidity of tropical Oxisols by liming for sustainable crop production. Advances in Agronomy, 99, 345–399.
- Goulding, K. W. T. (2016): Soil acidification and the importance of liming agricultural soils. Soil Use and Management, 32, 390–399.
- Haynes, R. J., & Naidu, R. (1998): Influence of lime, fertilizer and manure applications on soil organic matter content and soil physical conditions: a review. Nutrient Cycling in Agroecosystems, 51, 123–137.
- Serrano, J., Shahidian, S., Costa, F., Carreira, E., Pereira, A., & Carvalho, M. (2021): Can Soil pH Correction Reduce the Animal Supplementation Needs in the Critical Autumn Period in Mediterranean Montado Ecosystem? Agronomy , 11(3), 514. https://doi.org/10.3390/agronomy11030514
- Whitehead, D. C. (2000): Nutrient Elements in Grassland: Soil–Plant–Animal Relationships. CABI Publishing.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*Technical Sheet for Solution Implementation*

# Managing Soil pH Through Liming

***Annex***

## Ideas to Animate a Workshop About the Solution

- Ask an agricultural advisor, soil specialist, liming company, or grassland management consultant to sponsor or support the workshop.
- Find a model farm where soil pH correction and liming practices have been successfully implemented and documented.
- Carry out practical demonstrations such as soil sampling, pH testing, and lime spreading calculations, allowing participants to actively take part in the different steps.

## Proposed Struct.ure for the Workshop on Soil pH Correction through Liming in Equine Farms

**1. Introduction to Soil pH Correction through Liming**

- What is soil pH correction and why is it important for equine grasslands?
- The role of soil pH in nutrient availability, soil biology, and forage production.
- Different liming materials available on the market (e.g., calcitic lime, dolomitic lime, quicklime, hydrated lime).

**2. Benefits of Soil pH Correction in Equine Farms**

- Improved forage quality and more stable pasture productivity.
- Better nutrient availability and healthier soils.
- Reduced long-term pasture degradation and improved land value.
- Enhanced resilience of grasslands to environmental stress.

**3. Practical Applications on Equine Farms**

- Soil sampling and interpretation of laboratory analyses.
- Integrating liming into pasture and grazing management plans.
- Adapting liming strategies to different soil types and horse production systems.
- Combining liming with broader grassland improvement measures.

**4. How to Choose the Most Suitable Liming Approach**

- Evaluating the needs and objectives of the farm.
- Assessing soil characteristics, pH levels, and nutrient status.
- Selecting the appropriate liming material based on calcium and magnesium requirements.
- Comparing application methods, service providers, and costs.

**5. Hands-On Demonstration**

- Demonstration of proper soil sampling techniques.
- Interpretation of real soil analysis reports.
- Calculation of liming requirements for different scenarios.
- Demonstration of spreading equipment and application practices, if available.

**6. Monitoring and Troubleshooting**

- How often to repeat soil analyses and monitor pH development.
- Recognising signs of over-liming or nutrient imbalances.
- Adjusting liming strategies according to pasture performance.
- Integrating liming into long-term grassland management plans.

**7. Case Studies and Real-World Examples**
- Examples of equine farms that have implemented regular soil pH management.
- Discussion of improvements in forage production and pasture condition.
- Lessons learned regarding planning, costs, and practical implementation.
- Farmer experiences with different liming materials and strategies.

**8. Cost Analysis and Return on Investment (ROI)**
- Initial costs for soil analyses, lime, and application.
- Comparison between self-application and contractor services.
- Long-term economic benefits through improved forage productivity and reduced feed purchases.
- Estimating ROI based on pasture size and management intensity.

**9. Q&A Session**
- Open discussion on specific soil and pasture challenges.
- Questions regarding liming materials, timing, and application rates.
- Exchange of experiences among participants.

**10. Wrap-Up and Resources**
- Summary of key principles of soil pH management.
- Information on advisory services, soil laboratories, and technical guidelines.
- Additional resources for sustainable grassland management in equine systems.
- Information on possible support schemes or group purchasing opportunities for liming materials and services.