Managing soil acidity

Understanding the problem and the practical options for your farm

Soil acidity is one of the most significant and widespread constraints to agricultural productivity in Australia. It is a slow, cumulative process — easy to overlook until the damage is already limiting production. Monitoring soil pH and applying lime strategically should be treated as non-negotiable elements of routine farm management.

Critical threshold

When soil pH drops below 5.0 (CaCl2) in a pasture system, productivity begins to decline. At this point, nutrient availability, biological activity, and plant persistence are all compromised. The most cost-effective time to act is before this threshold is reached.

Why soil acidity matters

The consequences of unchecked soil acidification extend well beyond reduced pasture growth. The impacts are agronomic, biological, and structural — and some are irreversible.

Agronomic impacts

As pH falls, the availability of essential plant nutrients changes significantly. Some nutrients become less accessible; others — particularly aluminium and manganese — become toxic at low pH. Aluminium solubility increases sharply below pH 5.0, directly inhibiting root elongation and restricting plant access to water and nutrients at depth.

Biological impacts

Soil microbial activity is sensitive to pH. As acidity increases, the populations of beneficial bacteria and fungi that drive nutrient cycling and organic matter decomposition decline. Rhizobia bacteria — which form the nitrogen-fixing nodules on legume roots — are particularly sensitive. Legume persistence and productivity often fail in acid soils not because the plant cannot grow, but because it can no longer fix nitrogen effectively.

Structural impacts

Leaching of nutrients combined with increased availability of aluminium and iron at low pH can cause irreversible soil structure decline. In clay soils this is particularly damaging — the plastic, cohesive characteristics of a healthy clay are lost, and the soil begins to crumble and disperse. This cannot be restored by liming alone.

Off-site impacts

Reduced plant growth from soil acidity means less water use by the pasture, which increases the risk of recharge and salinity. Increased runoff removes water-soluble nutrients and risks both erosion and stream contamination. Nutrient leaching below the root zone can pollute groundwater. Managing soil acidity is not only a farm productivity issue — it is an environmental responsibility.

Recognising the symptoms

Soil acidity rarely presents as a single dramatic event. It typically shows as a gradual, uneven decline that is easy to attribute to other causes. Key indicators to watch for include:

Symptoms of soil acidity in pasture systems
• Poor plant vigour, reduced growth rates, and lower yields
• Uneven pasture growth across a paddock, particularly in acid-sensitive species
• Poor establishment and persistence of sown pasture species
• Failure of legume nodulation -- clover and lucerne thin out or disappear
• Stunted root growth -- plants are shallow-rooted and drought-sensitive
• Persistence and spread of acid-tolerant weeds such as sorrel
• Increased incidence of fungal and other pasture diseases

If any of these symptoms appear across a paddock or a specific zone, soil pH testing should be the first diagnostic step. Test both the surface (0-10 cm) and subsurface (10-20 cm) layers -- subsoil acidity is often more advanced than surface readings suggest and is harder to correct.

What drives soil acidification

Soil acidification is a natural process, but agricultural practices significantly accelerate its rate. Understanding the main drivers allows producers to slow the process as well as correct it.

Nitrogen use

Nitrogen fertilisers have an acidifying effect on soil. The greatest contributor, however, is not the nitrogen itself but the unused feed it generates. Additional pasture growth that is not consumed by livestock becomes organic matter, which breaks down to humic acids over time — acidifying the soil in the process. Matching nitrogen application to genuine plant demand and ensuring that additional growth is utilised is the most practical way to reduce this effect.

Export of alkalinity in produce

Most plant material is slightly alkaline. Every time hay or silage is removed from a farm, it takes calcium, magnesium, and potassium with it — alkaline cations that are not returned. Lucerne hay and legume crops are among the highest contributors to acidification through export. Grazing has a considerably lower impact because the majority of nutrients consumed are recycled back to the paddock via urine and dung.

Feeding hay or silage back onto the paddocks from which it was cut is one of the simplest ways to slow acidification — it returns the alkalinity and nutrients to the soil system rather than exporting them permanently.

Organic matter accumulation

Improving soil organic matter has many well-documented benefits for soil health, water-holding capacity, and biological activity. However, as microbial activity breaks organic matter down to

humus and humic acids over time, there is also a gradual acidifying effect. This does not mean avoiding organic matter improvement — it means accounting for it in your liming program.

Factors that affect the rate of acidification

Factor	Effect on acidification rate
Soil texture	Sandy soils have lower cation exchange capacity and water-holding capacity -- they buffer poorly and acidify faster. Clay soils acidify more slowly but subsoil acidification can be severe and harder to address.
Rainfall	Higher rainfall zones acidify faster. Greater rainfall intensity increases leaching of alkaline cations (calcium, magnesium, potassium, nitrate-nitrogen) through the profile.
Nitrogen fertiliser use	Higher nitrogen inputs increase the acidifying load, particularly where additional pasture growth is not fully utilised.
Produce removal	Removal of grain, hay, and silage exports alkalinity. Higher removal rates accelerate acidification.
Pasture type	Annual pastures acidify soils faster than deep-rooted perennial species, which capture and cycle nutrients more efficiently through the profile.

Management options

There are three main approaches to managing soil acidity. They are not mutually exclusive -- an effective long-term strategy will combine all three.

The three options at a glance
• Liming -- the primary corrective tool; addresses existing acidity and restores pH to productive levels
• Tolerant species and varieties -- a short-term adaptive strategy; does not stop acidification
• Reducing the rate of acidification -- the long-term preventive strategy; slows the process across the whole farm

Option 1 — Liming

Liming is the most economical and effective method of correcting soil acidification. It neutralises soil acidity, improves nutrient availability, supports biological activity, and restores conditions for legume nodulation. It should be viewed as a routine input, not a one-off treatment.

Calculating your lime requirement

The standard formula for calculating lime requirement is:

Lime required (t/ha) = (Target pH - Soil test pH) / Conversion factor
Note: rates assume a product with a neutralising value (NV) of 100% (pure calcium carbonate).
If NV is less than 100%: Lime to spread (t/ha) = (Lime required x 100) / NV
If soil organic matter exceeds 2%: add an additional 0.4 t/ha to the calculated rate.

Select the conversion factor that matches your soil type:

Soil type	Conversion factor	Notes
Clay	**0.26**	High buffering capacity; = more lime per pH unit change.
Clay loam	**0.37**	Moderate buffering.
Sandy clay loam	**0.47**	Lower buffering.
Sandy loam	**0.57**	Least buffering; pH drops fastest — prioritise monitoring.

Neutralising value and particle size

Neutralising value (NV) is expressed as a percentage of pure calcium carbonate, which is assigned a value of 100%. A higher NV means less lime is needed to achieve the target pH. Particle size also matters: lime with a higher proportion of fine particles reacts more quickly in the soil and delivers faster pH correction. When comparing lime products, assess both NV and fineness together.

Option 2 — Using tolerant species and varieties

Selecting acid-tolerant pasture species provides a short-term production benefit on paddocks where pH has already declined. However, it does not address the underlying acidification process -- the soil will continue to acidify, and eventually even tolerant species will be affected.

Use tolerant species as a bridge strategy while a liming program brings pH back to productive levels, not as a substitute for it.

Preferred pH range for common pasture species

Species	pH range (water)	pH range (CaCl2)	Acid tolerance
Lucerne	6.0 – 8.0	5.3 – 7.3	**Low**
White clover	6.0 – 7.0	5.3 – 6.3	**Low**
Phalaris	5.7 – 7.5	5.0 – 7.8	**Moderate**
Perennial ryegrass	5.3 – 7.0	4.6 – 6.3	**Moderate**
Annual ryegrass	5.3 – 7.0	4.6 – 6.3	**Moderate**
Sub clover	5.2 – 7.0	4.5 – 6.3	**Moderate–High**
Cocksfoot	5.0 – 7.5	4.3 – 6.8	**High**

Option 3 — Reducing the rate of acidification

Slowing the rate at which soils acidify reduces the frequency and quantity of lime applications required over time. The following practices, applied consistently, make a meaningful difference:

Practices that reduce the rate of acidification

- Sow deep-rooted perennial pastures: perennial species capture and cycle nutrients through the profile more efficiently, reducing nitrogen leaching and humic acid accumulation.
- Apply fertiliser at rates matched to plant demand: avoid building nutrients above what plants can use -- excess nutrients are more vulnerable to leaching.
- Monitor soil fertility regularly: keep nutrient levels within the productive range, neither excessive nor deficient. Soil test at least every 2-3 years.
- Feed hay and silage back onto the paddock it was cut from: this recycles the alkalinity and minerals removed at cutting back to where they were extracted.
- Rotate grazing across paddocks: distributes dung and urine more evenly, returns alkaline nutrients more uniformly, and supports stronger pasture growth across the whole farm.
- Utilise additional pasture growth generated by fertiliser inputs: don't let it accumulate as ungrazed organic matter -- this maximises the productive return and minimises humic acid loading.

How Highlands Ag Solutions can help

- Soil pH testing and interpretation across paddock zones
- Lime requirement calculations and product comparison
- Whole-farm acidification management planning
- Pasture species selection for acid-affected paddocks
- Fertiliser program design to minimise acidification load
- Soil organic matter and biological health assessment