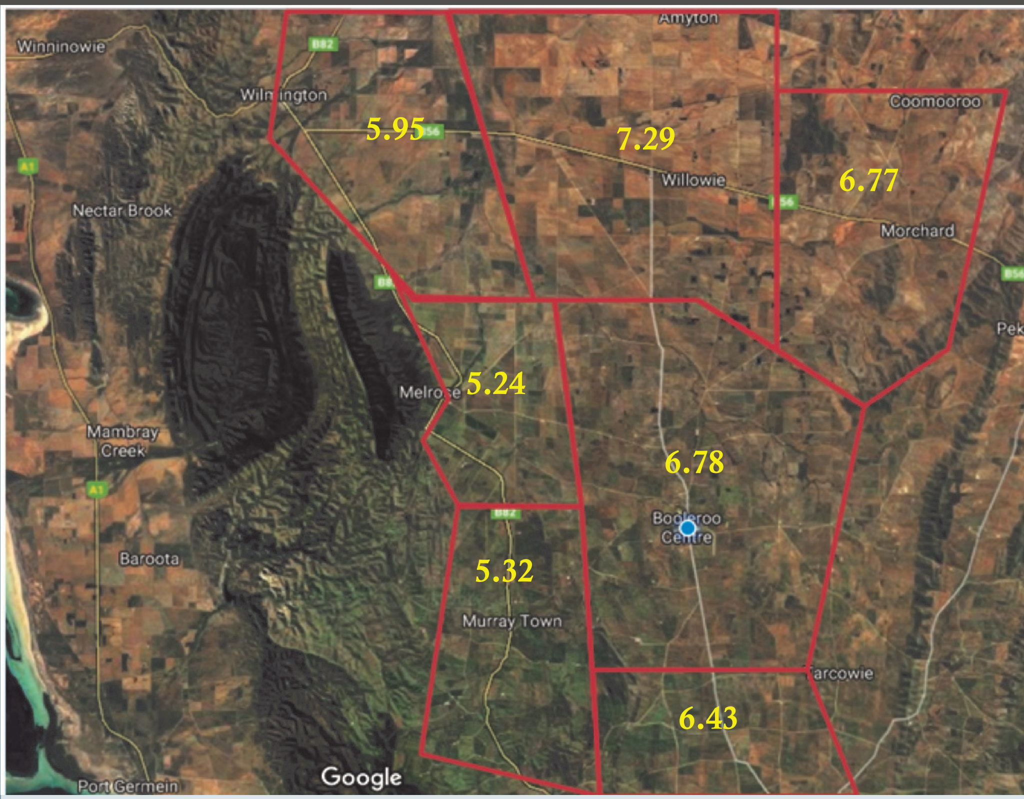
SOIL ACIDIFICATION IN THE UPPER NORTH



Google Maps image of the Upper North district split into seven geographical regions. The average pH (measured in calcium chloride) in the top 10cm has been displayed for each region. The higher rainfall regions are clearly the more acidic. Map developed by Matt Foulis, Northern Ag.

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What is happening – prevalence of declining soil pH

Soil acidification is emerging as an issue in South Australia's Upper North. Although acid soils have not traditionally been a widespread problem in region, some local farmers have recently noticed the pH in some of their paddocks is dropping. NYNRM estimates that around 35 per cent of soils in the Northern and Yorke region, which encompasses the Upper North, are considered to have a moderate to high risk of acidification. While soil acidification is a naturally occurring process, it is being accelerated by more intensive and productive farming systems. Acid soils may also be becoming more noticeable due to farmers growing more acid-sensitive crops, such as lentils.

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Upper North Farming Systems

What is soil acidity?

Soils become acidic when they have excess levels of hydrogen ions. Acidity often starts in the topsoil, but if left untreated can also affect the subsoil.

Acidity and alkalinity are expressed using the logarithmic pH scale, which ranges from 0 to 14. A pH reading of 7 is considered to be neutral, while everything below 7 is acidic, and everything above is alkaline.

The optimum pH range for most plants is 6-8, when measured in calcium chloride. The lower the pH reading, the more acidic the soil. While mildly acidic soils can cause problems for sensitive crops, soil acidity become a much more serious threat when the pH falls below 5. At this level, even tolerant crops and pastures are affected.

Soil pH is either measured in water or calcium chloride. Using calcium chloride generally gives more accurate results, and so is the preferred method.

Canola is particularly sensitive to acid soils.
Photo: Ruth Sommerville.

Why is it happening – causes of acidification

Areas with lower rainfall, such as the Upper North, tend to have alkaline soils. Soil acidification is, however, a naturally occurring process and is quickly accelerated by certain agricultural practices. Systems with higher inputs and higher production are most susceptible. Major contributors to soil acidification in the Upper North include;

- **Addition of nitrogen**: inefficient use of nitrogen fertilisers is the main cause of soil acidification. Ammonium-based fertilisers in particular lower soil pH because once in the soil ammonium is easily converted to nitrate and hydrogen ions. If not quickly taken up by plants, nitrate leaches down through the soil profile, leaving behind a high concentration of hydrogen ions in the plant root zone. Nitrogen added to the soil by legume crops can also lead to this problem.

- **Product removal**: most plant products are alkaline, and removing them from the paddock leaves behind a higher residual concentration hydrogen ions. Product removal includes the harvest of grain and hay, as well as grazing by stock. Removal of animal products can also acidify soil. While this usually occurs at a slower rate, the effects can build up over time. Uneven deposition of animal waste in set stocking systems can also contribute.

- **Leaching**: when nitrate is leached it is accompanied by other positively charged ions, including calcium, magnesium, sodium and potassium. In the process, hydrogen ions are left behind, acidifying the root zone. Because of their low cation exchange capacity (CEC) and low water holding capacity, sandy soils are particularly susceptible to acidification. Water does not drain as quickly through clay soils, which also have a greater ability to buffer acidification by releasing other ions.

- **Organic matter accumulation**: organic matter is inherently acidic, so its accumulation in soil will acidify it.

Consequences of soil acidification

Acid soils have a range of negative outcomes for productivity and sustainability. Primary effects of acid soils include;

- Greater nutrient leaching,
- Tie-up of phosphorus, magnesium, molybdenum and calcium,
- Release of toxic levels of aluminium and manganese into the soil solution,
- A decline in microbial activity,
- Degradation of clay soil structure.

Further consequences of these effects include;

- Declining production,
- Poor and uneven plant establishment,
- Stunted root growth and declining water-use efficiency,
- Poor plant vigour and competitiveness,
- Inhibition of legume nodulation,
- Grass tetany (hypomagnesaemia) and milk fever (hypocalcaemia) in livestock.

Remember that symptoms associated with acid soils can also be characteristic of various other problems. Soil pH should be tested before remedial actions are taken.

Monitoring and checking soil pH

Soil pH can be checked using field pH kits, available from most agricultural suppliers. Ideally, soil samples should also be sent to an accredited laboratory every 5-10 years. The best time to collect samples is during summer, when the soil is dry.

When sending soil to a laboratory for testing;

- Try to sample from uniform areas of the paddock to ensure consistency in the results. Avoid sheep camps, headlands, tracks etc.
- Use a soil corer to take 10cm deep samples from along a fixed transect.
- Collect at least 30 cores, then thoroughly mix them together. Remove a smaller-sub sample from the bulked soil to send for testing.

Make sure to keep records of where samples were collected and the pH measurements so that any changes over time can be identified.

Lime is costly and pH can vary greatly across a paddock. Precision soil pH mapping, for example using Veris machines, can significantly reduce input costs by allowing more targeted lime applications.

Table 1. Crops grown in the Upper North region and their sensitivity to acid soils.

Crop type	Tolerance to acidity
Faba beans, canola, annual medics, lucerne	Very sensitive
Some wheat varieties, barley, field pea, phalaris	Sensitive
Some wheat varieties, sub-clover, cocksfoot, vetch, fescue, perennial ryegrass	Tolerant
Oats, triticale, serradella	Very tolerant

How to manage decreasing soil pH

Soil pH is raised by adding lime or other liming materials. How much lime needs to be applied will depend on a range of factors, including the current pH, the desired pH, the soil texture and the lime source being used. Lime's effectiveness at improving soil pH will also depend on its quality, defined by its 'neutralising value, and its particle size. The neutralizing value is determined by the lime's calcium carbonate content. Good lime or liming material should have a neutralizing value of 80 per cent or greater. Finer material with a smaller particle size will neutralize the acid in soils much faster than coarser material, but is harder to spread and can block up spreaders. For this reason, it may be better to have a mixture of fine and coarse liming material. Ideally, 60 per cent of the lime will also pass though a 0.3 mm sieve. Incorporating lime into the soil will have the quickest results. Lime moves very slowly down the soil profile, so if just spreading on the soil surface, it is better to do so well before sowing.

Equation for working out lime requirement:

Lime requirement (t/ha) = (target pH – current pH) x soil texture factor

Texture factor and lime required to raise the soil pH by 1 unit:

Loam to clay loam: 4
Sandy loam: 3
Sand: 2

Example: to raise the pH of a clay loam with a pH of 4.9 to pH 5.5;

(5.5 – 4.9) x 4 = 2.4 t/ha lime required

Cautions:

- Be careful not to over-apply lime, as this can result in trace-element deficiencies in plants and stock, and may increase the risk of some plant diseases such as take-all.
- Do not try to raise the pH level by more than one unit per lime application.
- If organic matter levels are low, reduce the lime rate by 25 per cent.

Many farmers in the Upper north have traditionally relied on Nutrilime®, a byproduct from the soda ash manufacturing plant in Adelaide, however the plant has now closed. Alternative forms of lime for the region include Clare Quarry lime, Kulpara dolomite, and Angaston Penlime®.

Other resources:

Soil Quality Pty Ltd (2018) 'Soil pH fact sheet,' http://soilquality.org.au/factsheets/soil-ph-south-austral

Ag Excellence Alliance (2018) 'Soil acidity,' https://agex.org.au/project/soil-acidity/