Soil acidification

Soil acidification is a process by which soil pH decreases over time. There are no visible signs of the problem, apart from a decline in yields.

Soils can acidify under natural conditions over thousands of years, with high rainfall areas most affected. However, they can also acidify rapidly over a few years under intensive agricultural practices. Acidification can affect either the surface soil only, or the subsoil as well.

Farmers in areas at greatest risk need to identify the problem as early as possible. Treating surface acidity can be relatively simple, and brings considerable benefits in plant growth and yield. Sub-surface acidity is difficult and costly to correct.

Areas at risk

Queensland has more than 500 000 hectares of agricultural and pastoral land that has acidified or is at risk of acidification. The higher rainfall coastal areas used for intensive agriculture are most susceptible.

Soils most at risk are lighter-textured sands and loams with low organic matter levels, and the naturally acidic red clay loam soils commonly found in areas such as the South Burnett and Atherton Tableland.

Soils least at risk are the neutral to alkaline clay soils (e.g. the black clay soils of the Darling Downs and Central Queensland, and brigalow soils).

Farming and acidification

Some farming methods accelerate soil acidification. Table 1 shows the results of a comparison of pH levels from an area under native vegetation and an adjacent cultivated area. The tests were conducted on a soil that was susceptible to soil acidification in the Burnett district.

Factors that accelerate acidification include:

- the application of ammonium-based nitrogen fertilisers to naturally acid soils at rates in excess of plant requirements
- leaching of nitrate nitrogen, originally applied as ammonium-based fertilizers, out of the root zone
- continued removal of alkaline plant and animal produce and waste products from the paddock.

Growing plants remove alkalinity from the soil. When harvested products are removed, the soil becomes more acidic. The impact is greatest where a large quantity of material is removed, as in the production of silage, hay and sugarcane.

Table 1. Effect of cropping practices on soil ph (in water) at a site in the Burnett district.

Depth (cm)	Soil pH of native vegetation area	Soil pH of adjacent cultivated area
0-10	5.5	4.5
10-20	5.2	4.5
20-30	5.0	4.5
30-50	4.9	4.7
50-70	4.6	4.6

Impacts

There are no visible symptoms of soil acidification other than declines in crop and pasture production which may be dramatic in serious cases. As soils become more acid some nutrients may become less available while other elements in the soil may reach toxic levels.

Acidic soils may have some or all of the following problems:

- helpful soil micro-organisms may be prevented from recycling nutrients (e.g. nitrogen supply may be reduced)
- phosphorus in the soil may become less available to plants
- deficiencies of calcium, magnesium and molybdenum may occur
- the ability of plants to use subsoil moisture may be limited
- aluminium, which is toxic to plants and micro-organisms, may be released from the soil
- levels of manganese may reach toxic levels
- uptake by crops and pastures of the heavy metal contaminant, cadmium, may increase.

Managing acid soils

It is most important that soil acidity be treated at an early stage. If acidity spreads into the sub-soil, serious yield reduction may occur. Sub-soil acidity is difficult and costly to control.

The first step in managing soil acidity is to diagnose any increase in acidity. This involves reliable soil tests of pH, aluminium and manganese levels for the plough layer (0 to 10 centimeters) and for the sub-surface to 50 or 60 centimeters.

Farming practices recommended for minimising acidification include:

- matching nitrogen fertiliser inputs to crop demand
- using forms of nitrogen fertilizer that cause less acidification
- efficient irrigation management to minimise leaching
- early sowing after fallow to ensure more rapid utilisation of available nitrogen
- growing deep-rooting perennial species to take up nitrogen from greater depths
- regular applications of lime to counter the acidification inherent in the agricultural system
- growing acid tolerant crops or crop varieties more tolerant of acid soils. Sugar cane and bananas are examples of acid tolerant crops.

Fertiliser use

Soil testing should be carried out to ensure that fertiliser rates match plant requirements. Application of a crop's entire fertiliser needs at planting time may contribute to soil acidification by allowing the leaching of nitrate nitrogen before the crop roots have developed. If practical, a split application of fertiliser will help to overcome this problem.

Table 2 summarises the acidifying effect of different nitrogen fertilisers. Nitrate-based fertilizers such as calcium nitrate and potassium nitrate are the least acidifying but their higher cost limits their use to high-value horticultural crops.

Table 2. Acidification potential of nitrogen fertilizers assuming that some leaching loss of applied nitrogen occurs.

Fertiliser	Acidification potential
Calcium nitrate, Potassium nitrate	Low
Nitram, urea, animal manure	Medium
Ammonium sulfate, MAP, DAP	High

Lime or dolomite application

When soils are too acidic for a particular crop, lime or dolomite can be used to increase the pH to the desired level. The amount of lime or dolomite required to correct an acidic pH will depend on the soil and the crop grown. Soils with high organic matter and clay content will be more resistant to changes in pH and will require larger application rates. Therefore soil pH, while indicating the need for lime, is not a reliable guide as to how much lime is required.

To obtain an estimate of the amount of lime required to correct an existing soil acidity problem, a soil test called 'Lime Requirement' or 'Buffer pH' should be requested. Most commercial soil testing laboratories offer this soil test. The test is used to give a lime recommendation to raise the soil pH of the surface 10 centimeters of 1 hectare of soil to a target pH that will not limit crop yield. In general, a target pH (in water) of 5.5 is suggested.

Once the target soil pH is reached, additional lime or dolomite may be required depending on the crop grown. Some cropping systems have an acidifying effect on soils that is related to the amount of material removed at harvest, the amount and type of fertilisers normally used and the amount of leaching that occurs. Table 3 indicates the amount of lime required to counter the inherent acidification associated with the growth of a particular crop. There are opportunities to decrease fertiliser rates in some cropping systems without affecting yields.

Table 3. Lime required to counter the acidification inherent in some cropping systems

Cropping system	Lime required (tonnes/ha/year)
Summer crop-winter fallow	0.1
Crop-pasture rotation	0.1
Table grapes	0.1
Sugarcane	0.2
Grass pasture for hay production	0.3
Bananas	1.7

It is uneconomic to apply small amounts of lime on an annual basis. A paddock's lime requirements may be met by applying larger amounts at less frequent intervals e.g. a requirement of 0.1 tonne of lime per hectare per year, could be met by applying one tonne every 10 years.

Further information

This and other science notes are available from the Queensland Government website www.qld.gov.au – search 'science notes'. For further information about this science notes series phone **13 QGOV** (13 74 68) – ask for science notes – Land series L45. Other science notes related to this topic include:

- L47—Understanding soil pH

- L60—Acid sulfate soil in Queensland (the process of soil acidification is not related to acid sulfate soils)

For further information visit <http://www.qld.gov.au/environment/land/soil/soil-health/acidification/>, or email soils@qld.gov.au.