Liming Dairy Pastures

In dairy pastures, the acidification of soil is a naturally occurring as well as a management induced process which can be a limiting factor in pasture production if the acidity is not treated. If acidity is left untreated, over time the acidity can move down the profile into the subsoil which can be more difficult and expensive to neutralise.

Treatment of acid soils can be overcome with the application of liming materials. Using soil tests to monitor soil acidity (pH) and the selection of cost effective liming materials is essential to economically keep on top of soil acidity and maintain healthy productive pastures.

What is the optimum range for pastures and what should the target be when liming?
The optimum pH range for pasture is between $pH_{(water)}$ 5.6 to 7. If the pH is below the optimum range and requires increasing, generally a target of around 5.8 to 6 is good.

How to neutralise acid soils
Liming materials such as crushed limestone (lime or agricultural limestone) or crushed dolomite are the two most common products that are applied to neutralise acid soils. Other liming materials such as burnt and slaked lime are quicker to neutralise acid soils but are often very expensive compared to agricultural lime or dolomite.

Liming material applied to the surface will slowly work its way down the profile with the movement quicker in sandier textured soils. When carrying out pasture renovation, incorporating the liming material when cultivating will speed up pH change.

When applying a liming material, the pH change varies between soil types with sandier textured soils (low pH buffered soils) requiring less lime to change the pH compared to heavier textured clay soils (high pH buffered soil) or soils with high organic carbon levels. To get a more accurate assessment of the pH buffering of your soil a pH buffer test can be done by most soil testing laboratories.

Soil Type	Estimated Increase in pH
Sand	0.5 – 0.7
Loam	0.3 – 0.5
Clay	0.2 – 0.3
Red clay loam (basalt	0.04 – 0.1

The estimated pH increases over the upper 10 cm of soil due to the addition of 1 t/ha (1 kg/10 sq metres) of 100 % NV product to different soil types. From soilquality.org.au

It is best to apply at least 2.5 t/ha to get a good response. The upper limit for one application is 7.5 t/ha. Lime has to be physically in contact with moist acidic soil in order to neutralise acidity. Lime dissolves slowly in the soil, therefore, incorporation in the top 10 cm of soil (or deeper if possible) is best to increase the rate of reaction and leaching of lime to a greater depth. Incorporating lime will increase soil pH in the 0 – 10 cm soil depth within 1 – 3 years.

How to select a liming material
Agricultural lime and dolomite are the two most common liming materials for agricultural purposes. Agricultural lime contains calcium carbonate and dolomite contains both calcium carbonate and magnesium carbonate. It is the carbonate component of these liming materials which is required to neutralise acid soils.

If the soil is magnesium deficient, dolomite lime is an option to supply magnesium.

The effectiveness of the liming material is determined by two factors:

- Neutralising value of the product. The neutralising value (NV) is the chemical capability of the liming material to neutralise acids soils with pure calcium carbonate having a NV of 100%. The higher the NV the more pure the product.
- Particle size of the crushed product. Lime with a finer particle size is more effective than lime with courser particles.

The Effective Neutralising Value (ENV) test of a liming material takes into consideration the NV (purity of the lime) and also the particle size distribution to indicate how effective the lime will be to neutralise acid soils. The higher the ENV% the more effective it will be.

On the soilquality.org.au website there is a lime comparison calculator which is a handy tool to compare limes based on their quality and price.

When lime has been recommended by an agronomist, it is essential to know whether the application rate is based on an ENV of 100% or based on the actual ENV of the lime source.

When purchasing lime the supplier should be able to supply the lime quality specifications that should include the NV and ENV.

There are a number of laboratories that can test for lime quality. Some laboratories will report the calculated NV by calculating the estimated carbonate component based on how much calcium and magnesium is present in the lime.

A more direct test for NV is to measure how much acid the liming material will neutralise. This test is particularly good if there are quantities of non-neutralising calcium forms like calcium sulphate.

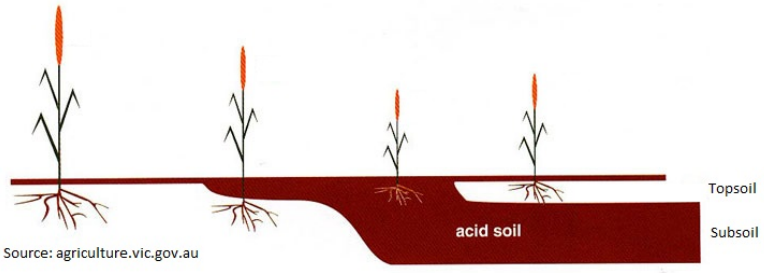
Lime samples analysed for Tasmanian Fert$mart plans in 2015 showed differences between samples. Agricultural limestone NV's ranged between 74% and 84% and the ENV's ranged from 37% to 50%. The dolomite NVs ranged from 18% to 32% and the ENV's ranged from 8% to 23%. If you are embarking on a significant liming program, it pays to do an independent test for lime quality so that you can best target your lime spend. Generally a lime test will be under $150.

SOIL ACIDITY 101

What is soil acidity and how is it measured?

Soil acidification is the accumulation of hydrogen ions (H^+) in the soil. To measure acidity, a pH test which has a scale that ranges from 0 to 14 is required as an indicator of how acid (low pH) or alkaline (high pH) the soil is. There are two types of laboratory pH tests available: $pH_{(water)}$ (1:5 water) and $pH_{(caCl2)}$ (1:5 Calcium Chloride). In Tasmania, $pH_{(water)}$ is the most common test.

When soil testing for pH, typically the topsoil (0 to 7.5 or 10cm) is tested, however, as shown in the picture to the right, the subsoil, where there is also pasture root activity, may also be acidic and should also be monitored.



Source: agriculture.vic.gov.au

Over liming soils can have negative effects on pasture production so it is wise to always soil test prior to liming to determine whether lime is necessary, and at what rate?

What causes acidity?

The main processes which cause acidity (drop in pH) in agricultural soils are: the removal of alkaline plant material; the addition and leaching of nitrogen from legumes and fertiliser; the accumulation of organic matter; and the leaching of nutrients like calcium, magnesium and potassium. The rate of pH decline is quicker in light textured (sandier) soils compared to soils with higher clay content. As rainfall increases the rate of pH decline also increases. Soil acidification is a natural process that is accelerated by agricultural production and needs to be monitored over time.

What are the effects of acidity on pasture production?

As the soil pH falls below the optimum range, pasture production starts to become affected due to plant nutrients (nitrogen, phosphorus, potassium, sulphur, calcium, manganese and also the trace element molybdenum) becoming unavailable or limited, regardless of the levels in the soil and previous fertiliser history.

Microbial activity in the soil is slowed or stopped as the soil pH drops. The reduction in fixation of nitrogen in legumes caused by low pH is one activity that can have a big impact on pasture production. As the pH drops to very low levels, the solubility of aluminium and manganese in the soil solution increases to toxic levels, which inhibits root development and can severely limit or stop plant growth.

As soil becomes more acid, productive pasture species disappear and are replaced by species of low agricultural value.