**ACTIVITY: Liming paddocks**

**Activity idea**

In this activity, students measure the pH of soil collected from a paddock. This will be used to estimate the amount of agricultural lime needed to promote good grass growth.

By the end of this activity, students should be able to:

* apply a simple, but standard, sampling technique
* collect and appropriately process soil samples
* recall the meaning of pH and its relationship to acidity/basicity
* estimate soil type from a given set of guidelines
* use a given formula to calculate the amount of agricultural lime needed
* explain how agricultural lime helps to neutralise acid soils
* understand the meaning of the term ‘tonne/hectare’.

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**Introduction/background**

In this activity, students collect soil samples from a measured area of school playing field or paddock. After mixing, drying and crushing, the pH of the soil is measured. Along with a classification of the soil type, this pH value will be placed into an industry-standard agricultural lime requirement formula, and from this, the tonnes per hectare of lime needed to promote good grass growth can be calculated.

The farming industry of New Zealand uses close to 1.9 million tonnes of agricultural lime each year. With 32.6 million sheep, 5.9 million dairy cattle and 3.9 million beef cattle, the health and production rates of pasture are critical to maintaining this heavy grazing load. It is the presence of large amounts of calcium carbonate-rich limestone in regional New Zealand that underpins this hugely important industry.

Spreading agricultural lime onto the paddocks that house and feed this huge number of herbivorous animals has several benefits:

* It neutralises soil acidity.
* It is a direct source of plant nutrients.
* By raising soil pH, it increases the supply of other nutrients from the soil.
* By raising soil pH, it promotes the growth of beneficial soil bacteria and other organisms.

Successful pasture management involves assessing the correct amount of lime to spread. One way of doing this is to use a formula developed by New Zealand soil scientists in 1984:

 lime required (tonnes/hectare) = 26.2 – (4.4 x pH) + (0.007 x CEC)

The pH of the soil needs to be determined, and to find the CEC (cation exchange capacity), the simplest way is to assess the soil type and to read off an appropriate value from the table below. (The exchange capacity of a soil is a measure of its ability to hold and release various elements and compounds.)

|  |  |  |
| --- | --- | --- |
| **Level** | **CEC** | **Soil description** |
| Low | 5–12 | Sandy or low in organic matter |
| Medium | 12–25 | Average, silty or clay soils with medium to low organic matter  |
| High | 25–40 | High fertility silt or clay soils with high or medium organic matter  |
| Very high | >40 | Clay soils with high organic matter or peat soils |

For example, if the soil pH is 5.8 and the soil type is an average clay soil whose estimated CEC is 15, the lime required is calculated as:

lime required (tonnes/hectare) = 26.2 – (4.4 x pH) + (0.007 x CEC)

= 26.2 – (4.4 x 5.8) + (0.007 x 15)

 = 26.2 – 25.52 + 0.105

 = 0.785 tonne/hectare

So 785 kg of lime needs to be evenly spread on each hectare of pasture.

Note: 1 hectare (ha) is 10,000 m2. A paddock 100 x 100 m has an area of 1 ha. A 100 x 50 m rugby field is 0.5 ha.

Applying a suitable sampling method to gain an overall picture of the soil status of the paddock is of critical importance. One commonly applied method is to run a zigzag line through the paddock and take 16–20 samples at equally spaced distances down the line.

**What you need**

* Copies of the student handout [Calculating pH](#handout)
* Tape measure (30 m)
* Sports cones x 20
* Soil core sampler (plastic tube 25 mm diameter and 75 mm depth)
* Plastic bags to hold each group’s core samples (x 5)
* Shallow plastic trays to house 20 core samples (x 2)
* Suitable area to dry the soil samples before mixing, crushing and sieving
* Rolling pin to crush the soil
* 2 mm mesh sieve
* Plastic beakers – 250 mL and 50 mL
* Measuring cylinder 100 mL
* pH meter or pH papers accurate in the range 4.0–6.0
* Distilled water

**What to do**

1. Hand out copies of the student handout [Calculating pH](#handout) and discuss.
2. As a class, measure out a 100 x 100 m area on the school playing field or a suitable pasture paddock. Place cones at the corners. (Smaller areas can be used depending on the size of the school grounds, but seeing what 1 ha looks like gives a better feel for ‘agricultural’ area.)
3. Map out a zigzag pattern across this area with the remaining cones. Start at one corner and trace out an ‘M’ shape, placing cones at equally spaced distances down the four arms of the zigzag.
4. At each cone placement, take a soil sample using the plastic tube corer. Place the soil sample in a plastic bag. If the class is divided into 5 large groups, each group will be responsible for taking 4 cores, each from a different site.
5. Empty the contents of each group’s bag onto a large tray and spread out. Note the appearance of the soil and estimate a CEC value for it using the table above.
6. Set the tray aside until the soil samples are dry.
7. Crush the dried soil samples with a rolling pin and thoroughly mix the soil.
8. Carefully sieve the dried, crushed and mixed soil onto a separate tray.
9. Fill a 50 mL beaker with the processed soil. Place in a 250 mL beaker and add 100 mL of distilled water.
10. Stir the soil water mix for 5 minutes and set aside for 1 hour.
11. Determine the pH of the soil water mix.
12. Calculate the tonnes per hectare of lime required using the formula above.

**Student handout: Calculating pH**

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1. The pH of soil samples taken from a dairy farm was found to be 5.5. This farm is located in an area where the soil type was described as being a sandy soil low in organic matter with a CEC of about 10. Calculate the amount of lime needed to lift the pH of this soil up into a range more supportive of good pasture growth.
2. If the size of the farm in Q1 is 120 ha and the price of agricultural lime is $30 per tonne, calculate the cost of the lime needed.
3. Agricultural lime is ground limestone rock with a calcium carbonate content of at least 85%. Chemical lime is calcium oxide and slaked lime is calcium hydroxide. Write the chemical formulas for these important three calcium compounds.



1. The ideal pH range for pasture is 5.8– 6.2. As the soil pH falls below 5.5, list any three nutrients on the chart above whose availability to plants drops off substantially.
2. A high level of manganese makes pasture less palatable to stock, and an excess of it can be poisonous to young stock. What does the chart show about the availability of manganese as the pH falls from 6.0 to 5.0?

**Calculating pH answers**

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*Lime required (tonnes/hectare) = 26.2 – (4.4 x pH) + (0.007 x CEC)*

 *= 26.2 – (4.4 x 5.5) + (0.007 x 10)*

 *= 2.07 tonnes per hectare*

1. If the size of the farm in Q1 is 120 ha and the price of agricultural lime is $30 per tonne calculate the cost of the lime needed.

*Cost = 2.07 x 120 x $30*

 *= $7452*

1. Agricultural lime is ground limestone rock with a calcium carbonate content of at least 85%. Chemical lime is calcium oxide and slaked lime is calcium hydroxide. Write the chemical formulas for these important three calcium compounds.
* *Agricultural lime – CaCO3*
* *Chemical lime – CaO*
* *Slaked lime – Ca(OH)2*



1. The ideal pH range for pasture is 5.8– 6.2. As the soil pH falls below 5.5, list any three nutrients on the chart above whose availability to plants drops off substantially.

*Nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, molybdenum.*

1. A high level of manganese makes pasture less palatable to stock and an excess of it can be poisonous to young stock. What does the chart show about the availability of manganese as the pH falls from 6.0 to 5.0?

*The level of manganese rises, increasing its availability.*