Fertiliser and lime calculator

User manual

Version 1

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Disclaimer

This user manual and Excel calculator was prepared by Cam Nicholson, Nicon Rural Services for use by participants in soils and fertiliser workshops. It is not to be copied or distributed beyond these workshops without the permission of Nicon Rural Services.

The output from using the fertiliser and lime calculator is intended as a source of information only. While all care has been taken, Nicon Rural Services does not guarantee the calculator is without flaw of any kind or is wholly appropriate for your purposes and therefore disclaim all liability for any error, loss or other consequence which may arise from you relying on any information generated.

Background

Calculating the type and rate of fertiliser and/or lime to apply that suits an individual paddock can be challenging. This simple spreadsheet enables users to progress through the steps to inform a decision around fertiliser and/or lime application that is appropriate to their circumstances. The calculator has 4 coloured tabs, with several steps combined in some tabs (figure 1).

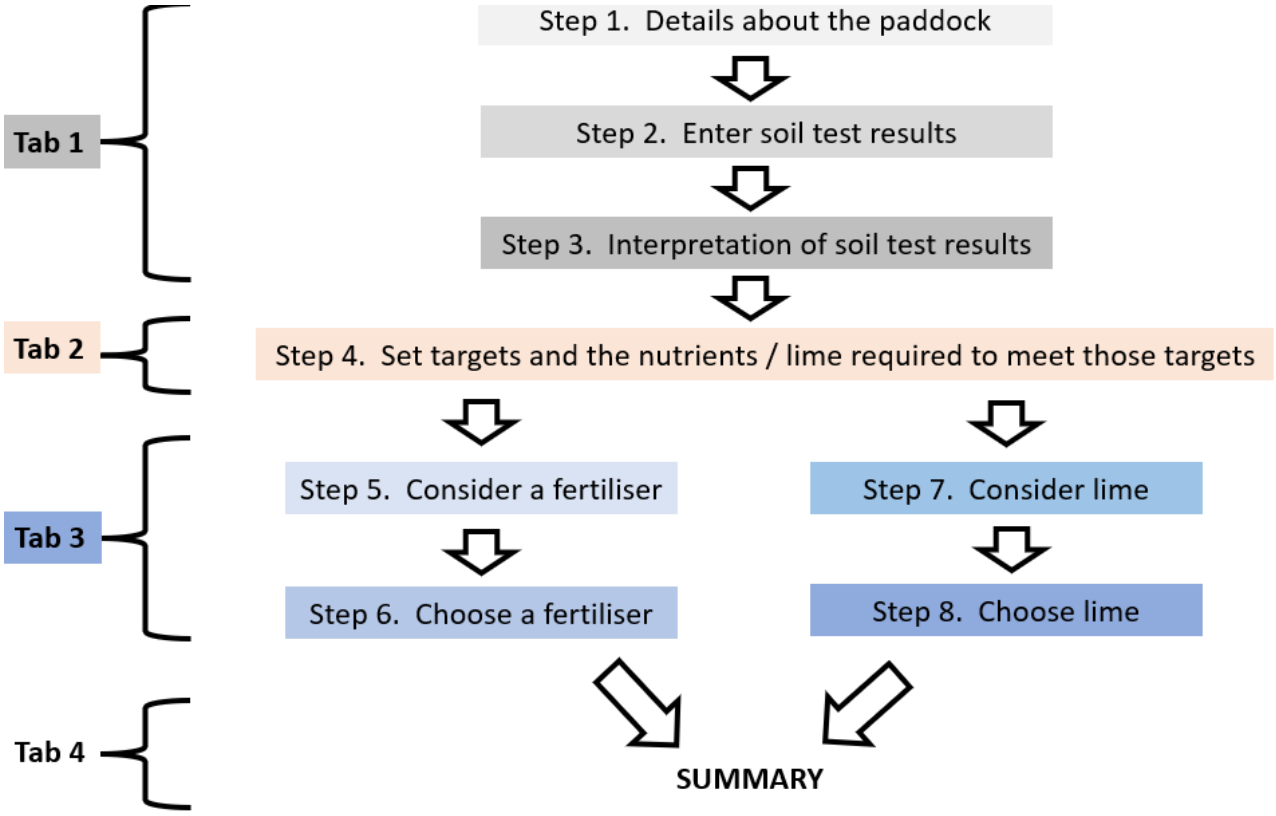

Figure 1. Steps and corresponding tabs in the fertiliser and lime calculator.

Users can only enter information in the **white** cells and can only make choices from the **green** drop down lists (click on the cell and an arrow will appear). Select from the list.

The calculations are underpinned by three basic principles and one requirement:

- The ***Law of the Minimum*** (Leibig's Law), where growth is limited by the scarcest or most limited resource, not the total or most abundant resource. This limitation may not be soil conditions and could be the pasture species present or the grazing method.
- The ***Law of Diminishing Returns***, where additional growth to extra fertiliser or lime diminishes as sufficiency is approached.

- The **Conservation of Matter**, which means if nutrients contained in products sold off the farm or 'tied up' by the soil are not replaced, the pool of nutrients in the soil will be depleted.
- A recent ***soil test*** that accurately represents the nutrient and other characteristics of the soil to a depth of 10 cm.

Further explanations that underpin the calculations in each step is provided.

And another thing!

Soil testing, soil laboratory analysis and plant response to nutrients applied is not an exact science. There is variability associated with each step, meaning the predicted result may not perfectly align with the next measured soil test. However the available science and advisor experience used in this calculator does provide a reasonable guide as to the likely result.

Details on each tab

Tab 1 – Soil test results & paddock details (steps 1, 2, 3).

This tab is used to enter paddock information (step 1), soil test results (step 2) and to provide an interpretation of the estimated pasture growth or pasture limitations based on the soil test results (step 3). Where yield response curves are available (P, K, S, pH), their % of maximum production is represented by a 'barrel' with each measure shown as a 'stave' in the barrel. This visual representation enables the most limiting factor to be easily identified along with an estimation of the 'gap' before a different measure becomes limiting (figure 2).

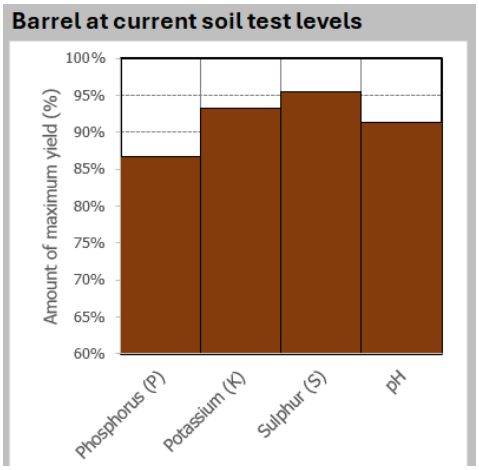

Figure 2. Representation of estimated yield compared to maximum for phosphorus (P), potassium (K), sulphur (S) and acidity (pH).

If yield responses curves are not available, thresholds have been set, with alerts appearing if any results exceed these threshold levels (figure 3).

Alerts about other indicators	Comment
Aluminium	High aluminium for species
Electrical conductivity	No issue
Exchangeable sodium %	No issue
Calcium:Magnesium ratio	No issue
Current stocking rate (DSE/ha)	Stocking rate likely to match current fertility

Figure 3. Example of alerts to threshold measurements

There can be multiple analysis methods to test for a specific nutrient. Some common analysis methods are provided but these are not exhaustive. Users need to select the matching analysis method for the nutrient reported.

If some values are not on the soil test leave blank e.g. PBI value. Default values will be applied based on other soil characteristics.

The information collected in this step is used for the following:

- The summary output sheet.
- Calculations on the total amount and cost of any products chosen.
- Calculation of the maintenance nutrient requirements (to maintain current nutrient levels) or estimate decline in growth / stocking rate if no nutrients are applied.
- To estimate if the current stocking rate broadly matches the potential pasture grown based on annual average rainfall and current nutrient levels (questionable value in growing more pasture if the current pasture is not being adequately utilised).
- To describe the desirable species you want to support in the pasture (as different species have different optimum nutrient and pH levels).
- To estimate the % of maximum production for major macronutrients (P, K, S) and acidity (pH).
- If potential production of other soil parameters may be limiting yield (threshold values for salinity, soil structure)
- To inform the calculation of rate and type of fertiliser / lime that may be applied.

Tab 2 – Nutrient and lime considered (step 4).

This tab enables target nutrient and pH levels to be set. Historically these targets have been recommended to reach 95% of maximum production, however if starting with a large deficiency or with limited finances, a target of 95% may not be appropriate. Users are encouraged to set their own targets (see below).

The nutrients to apply are split into two components - **capital** and **maintenance**.

- **Capital** refers to the quantity of a specific nutrient (in kg/ha) required to raise the soil test value by 1 unit. This amount will vary depending on the analysis method used along with other soil characteristics (entered in tab 1).
- **Maintenance** refers to the quantity of nutrient required to replace what is 'lost' annually in animal products and nutrient 'tie up' in the soil. It is estimated based on the number of DSE carried over the application period (entered in tab 1).

The calculator enables users to chose one of three application scenarios. These are:

- **No fertiliser or lime** scenario. This is chosen to estimate the ***decline*** in pasture growth and stocking rate over time as nutrients are 'exported' through loss in products e.g. meat, milk, wool, etc and tied up by the soil. It indicates the impact if no nutrients are applied and usually shows a shortening in the 'staves' of the barrel. If some nutrients or pH is sufficient to achieve 100% of maximum growth, the staves may not appear to decline as there is excess amount of nutrient that can be used.
- **Maintenance only** scenario. This is chosen if the user wished to ***maintain*** current fertility levels. The calculation only includes the nutrients required to replace what is lost annually in animal products and nutrient 'tie up' in the soil. The 'staves' in the barrel should remain the same.
- **Capital + maintenance** scenario. This is chosen if the user wishes to ***increase*** pasture growth (and possibly stocking rate) from current levels. This is illustrated by increasing one or more 'stave' in the barrel. It requires nutrients to *maintain* current and possibly additional annual livestock demand (keep the current 'staves' where they are) plus *additional* nutrients to increase the length of one or more of the 'staves'.

The time period is entered to enable any capital application to be spread over multiple years and ensure annual maintenance is accounted for.

Setting target levels

A table and two 'barrels' are provided to compare current levels with possible future target levels. Further detail below the barrel indicates the current nutrient limitation (which should be addressed first) and the current stocking rate.

As the target levels are changed, the staves in the barrel to the right will change. Ideally the users should set targets to 'even up' the shorter staves. Comments in the table will help guide the numbers to enter.

If **No fertiliser or lime** is chosen then:

- Leave all target values as blank or 0.
- The staves in the right hand barrel may decline, depending on their starting levels.
- The *future most limiting nutrient level* will appear (this may change depending on the decline of each nutrient).
- The *anticipated stocking rate* decline will be calculated. This represents an indicative 'cost' of not applying nutrients.
- The *nutrients / lime required to meet target over the time period* will all be 0 as no nutrients are required.

If **maintenance only** is chosen then:

- Target values should be the same as the current soil test values. Transfer these from the right hand values. If a value is wrong, then an alert will appear.
- Stocking rate should be the same, so the change in stocking rate should be 0.
- The two 'barrels' should appear the same.
- The *nutrients / lime required to meet target over the time period* will be calculated.
- If the quantity of each nutrient is applied over the time period, then theoretically the next soil test should result in similar nutrient levels as the previous soil test.

If **Capital + maintenance** is chosen then:

- Adjust the nutrient (and pH) levels and change in stocking rate to reflect your desired target levels. Use the staves in the right hand barrel as a guide to the target levels to set.
- The *nutrients / lime required to meet target over the time period* will be calculated.
- If the quantity of each nutrient is applied over the time period, then theoretically the next soil test should result in nutrient levels that match the new target levels.

Tab 3 – Products chosen (steps 5, 6, 7, 8).

This tab enables the required nutrient levels calculated in tab 2 to inform the fertiliser choice.

The key information from tab 2 is presented at the top of tab 3. The quantity of nutrients is presented over the time period and per year. If multiple years are selected, different quantities of nutrients can be applied in different years, *if the total nutrient applied adds up over the designated period*. The pie graph provides an indication of the proportion of P, K and S required.

Consider a fertiliser (step 5)

There is a limited range of 'off the shelf' fertilisers available that contain a fixed amount of different nutrients. The % nutrients contained in the fertiliser are shown with the fertiliser selected as % P:K:S. A * on some products indicates indicative nutrient values only.

Rarely do nutrient ratios in fertilisers match the calculated nutrients required. In getting one nutrient to the desired quantity, other nutrients in the fertiliser may be over or under supplied.

Once a fertiliser is chosen from the drop down list and the price entered, a calculation will occur *to ensure the most limiting nutrient achieves the target nutrient level*. This may result in an oversupply or undersupply of other nutrients. If the amount of over or undersupply is significant (greater or less than 15% of what is required) the cells will highlight in red. A 'barrel to the right of the calculation indicates the change in the 'staves' if the chosen fertiliser was applied at the calculated rate.

Alternative fertilisers (and associated cost) can be selected to find the least cost option.

Note: The calculator does not consider other 'benefits' that may occur from using certain fertilisers e.g. extra nitrogen, extra organic matter applied, less prone to leaching, philosophical beliefs etc. Users need to factor this into the cost calculation.

Choose a fertiliser (step 6)

Users may decide to apply the fertiliser type and rate indicated in step 5. If so then the fertiliser type, rate and cost is transferred to the appropriate cells.

However users may wish to apply a different rate or type of fertiliser than indicated in step 5. This can be done by changing the fertiliser choice and rate instead of transferring the product and rate calculated previously.

Whichever values are entered a new 'barrel' will be drawn indicating the length of the 'stave' with the choice made. If the fertiliser and application rate chosen is the same as step 5, the two barrels will be the same (or similar if default values are used in the

absence of some soil test results). If the rate and or type of fertiliser chosen is different, the two barrels will be different.

Consider lime (step 7)

Soil acidity rather than nutrients may be the lowest 'stave' in the barrel.

If a target pH has been set, either because Maintenance only or Capital + maintenance has been selected, then a quantity of lime to achieve the target soil pH level will be calculated. The amount calculated assumes 100% purity and no moisture.

Natural limestone commonly contains moisture and is rarely 100% pure. This needs to be considered when calculating the amount of lime to apply. Enter the purity (often referred to as the neutralising value or NV) and the moisture content to calculate the amount as supplied.

Choose lime (step 8)

Lime is often applied in large quantities (unlike fertiliser) because of the practicalities of spreading and transport. Large applications will raise the soil pH (lengthen the 'stave') to levels that slowly declines (acidifies) over many years. The calculator will estimate the annual rate of acidification.

Tab 4 – Summary.

The summary page indicates the change and costs based on the fertiliser and lime the user has chosen in steps 6 and 8.