Soils - Pastures – Livestock - Profit

Bangalara Dairies Pty Ltd

ATF J & M Bake Family Trust

Crossmaglen, NSW 2450

2016 Fert$mart – Fertiliser Management Plan

Prepared By Matt Thompson, MNC Agronomy Pty Ltd

30/06/2016
Bangalara Dairies Pty Ltd
Jason & Michele Bake
393 Crossmaglen Road
Bonville NSW 2450

Dear Jason & Michele,

EXECUTIVE SUMMARY - YOUR 2016 FERT$MART FERTILISER MANAGEMENT PLAN

The Fertiliser Management plan herein has been prepared within the guidelines of Dairy Australia's Fert$mart Accredited Advisor Program. This plan aims to assess and record current soil fertility levels across your property and to provide recommendations that focus upon efficient and more profitable use of fertiliser. Important protocols adhered to and/or considered within this process include:

- Accurate soil testing procedure of representative areas (herein known as Farm Management Zones, or FMZ's) using a NASA or ASPAC accredited laboratory
- Historical trends in soil structure and fertility in response to previously implemented pasture improvement plans (including annual fertiliser plans)
- Nutrient balance based upon soil test results vs. actual previous 12-month fertiliser history, as well as estimated utilised pasture yields and nutrient requirements
- The 4R's Fertiliser Program (Right Time, Right Rate, Right Place & Right Product)
- Current visual assessments of your property's pastures, sward composition and grazing utilisation
- Current visual assessment of cow condition, as well as analysis of production and milk components
- Farm management goals and future production targets

Summary of Key Findings & Recommendations

- Baseline Calcium levels are low across the farm.
- Despite excellent soil Organic Matter levels, soil structure is poor.
- High soil Magnesium and Iron levels mean capital and regular lime input is important across all FMZ's.
- Soil Phosphorus levels are high across all FMZ 's. Availability is poor in all FMZ's due to elevated Iron levels.
- FMZ 1 and 2 have excessive soil Potassium levels. This is causing poor palatability and grazing utilisation issues, and potentially grass tetany issues.
- Sulphur needs to be applied regularly in small amounts, although levels are adequate.

- An audit of pasture production and plant nutrition requirements (Appendix 7.1) shows that in 2015, an average of 160kg/ha/N, 17kg/ha/P and 36kg/ha/K was used to grow 7894kg/DM/ha of pasture.
- The audit also shows that the estimated nutrients that will be required for 2016 pasture production (based on the target of 12000kg/DM/ha utilised), will be on average 244kg/ha/N, 26kg/ha/P and 55kg/ha/K.
- Theoretically, based on nutrients from imported feed, grazing recycling factors and nutrients exported as milk, the average nutrient input per hectare to achieve 12000kg/DM/ha should be 130kg/ha/N, 5kg/ha/P and 0kg/ha/K. However, in practice, much of the recycled nutrients is applied in specific, concentrated areas (such as effluent solids being applied to FMZ 4).
- Pasture herbage testing should be utilised periodically to give snapshots of plant nutrient levels and potential deficiencies.
- Continue with your annual soil monitoring program and regular review of soil fertiliser plans and pasture management practices, making adjustments as advised.
- Review the Fert$mart plan again in 2016 with your Fert$mart accredited advisor.
- As always, please consult me as circumstances or conditions change.

I recommend you continue with annual audits of soil health, as well as frequent inspections to make modifications to the fertiliser plan based upon important aspects such as current pasture performance, grazing rotations and utilisation, cow health and weather conditions. One-off sampling is better than nothing, but nothing is better than sampling the same area regularly over multiple years such that more informed fertiliser management can be implemented on the basis of trends in soil fertility.

Ultimately, milk production is a function of management techniques and the ability of management to allow for, and adjust quickly to (if not before) significant events occurring. Pre-empting limits to production, and adopting change in order to maximise production, are skills that a modern dairy farmer must posses to remain viable.

Regards

Matt Thompson
Agronomist
MNC Agronomy Pty Ltd

Table of Contents

1.0 ABOUT THE FERT$MART PLAN

The aim of the Fert$mart Plan is to assist dairy farmers reach higher levels of profitability and sustainability. The key is to use the *Right Source* of fertiliser, at the *Right Rate*, in the *Right Place* and at the *Right Time* (the 4Rs).

The "Fert$mart Tick" can be displayed on a fertiliser management plan when all the following criteria have been met:

- ✓ Farm areas where fertiliser is to be applied have been identified and referenced in the recommendations.
- ✓ Soil constraints and other production limitations have been considered before making recommendations.
- ✓ Soil fertility trends based on current soil tests, previous soil test records (if available), and the Regional Soil Fertility Guidelines have been considered.
- ✓ Basic soil health indicators have been considered.
- ✓ Crop or pasture condition has been considered.
- ✓ Strategic use of on-farm nutrients (e.g. effluent and manure) has been explored and economic options for reuse considered.
- ✓ A nutrient budget has been used to work out the P, K (S if regionally applicable) maintenance requirements.
- ✓ A documented 4Rs fertiliser program has been provided to the farmer (either a soft or hard copy) which describes the products, rates, place/placement, and timing for each paddock or farm management zone.
- ✓ Managing environmental, human, and animal health risks of the fertiliser program have been assessed, documented and conveyed to the farmer.

What is Fert$mart?

Fert$mart is the Australian dairy industry's national nutrient management framework developed by Dairy Australia in collaboration with farm nutrient advisors and farmers. It has been developed to improve the efficiency and profitability of fertiliser use on Australian dairy farms. The Fert$mart framework prescribes the recommended steps, including the knowhow tools, to help dairy farmers and their trusted advisors develop a Fert$mart Plan. A Fert$mart Plan is a nutrient management plan which considers factors affecting the movement of nutrients into, around, and off the farm when formulating the source, rate, timing and placement of fertiliser to most benefit pasture productivity and profitability aspirations.

What is a Fert$mart Plan?

It is an annual fertiliser plan which uses farm management zones (FMZ) to provide site specific recommendations based upon site specific information such as: soil test results undertaken within each FMZ, land characteristics (e.g. soil type, aspect), site limitations and risks (i.e. soil type, proximity to a water course), the usual management undertaken and aspirational fertility targets (based upon yield potential). Recommendations for each FMZ incorporate the types of fertiliser to be used, the application rates, how the fertiliser is to be applied and the timing for each application. A Fert$mart Plan develops these recommendations through following the Fert$mart planning cycle and checklist

The Fert$mart Planning Cycle (Figure 1) consists of seven steps designed to be repeated annually to update and fine-tune fertiliser management.

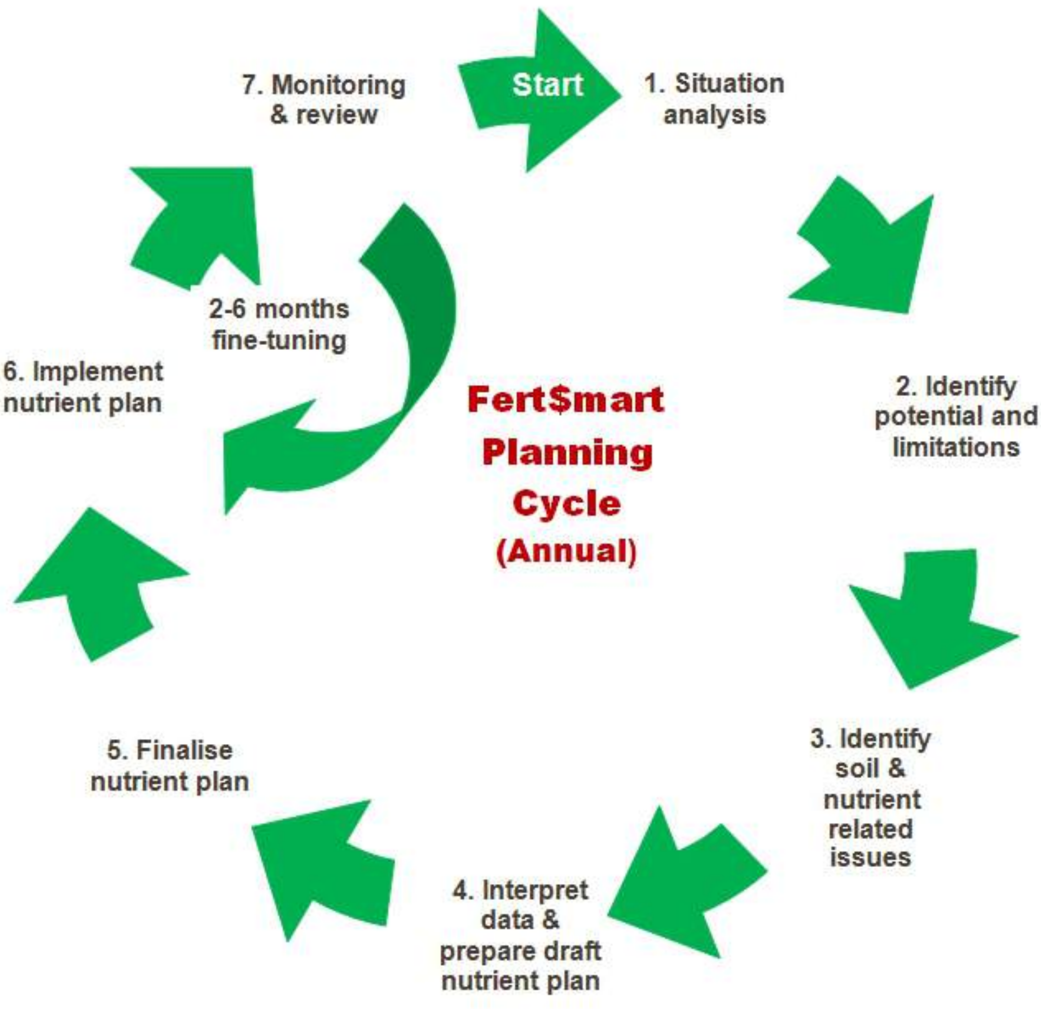


Figure 1. The Fert$mart Planning Cycle

Step 1: Situation analysis - Focuses on understanding the farm business, the current farming system, resources (water, soils, nutrient sources, pastures and crop), infrastructure and management.

Step 2: Identify potential and limitations - Checks that farm production goals are realistic, given there may be limitations other than nutrients. This step also identifies any gaps in knowledge and skills, and shortlists management options best suited to the farm and farm business.

Step 3: Identify soil and nutrient related issues - Focuses purely on soil and nutrient related issues. Soil tests and field observations are used to narrow down which factors are limiting production and need to be managed.

Step 4: Interpret data and prepare draft nutrient plan - The information from all previous steps is interpreted and used to prepare a draft soil and nutrient management plan.

Step 5: Finalise nutrient plan – Practical aspects of the draft plan are checked and finalised in agreement with farm management.

Step 6: Implement nutrient plan – Nutrient management plan is implemented.

Step 7: Monitoring and review – Monitoring and review is on-going. Fine-tuning the plan may be required within 2-6 months depending on crop/pasture/milk production performance.

In year 2 the planning cycle begins again, however soil testing may not be required. In year 3 soil tests are carried out across the farm to check soil fertility levels and trends.

Farm Management Zones – What are they?

Farm Management Zones are areas with similar soil, nutrient and management characteristics which may otherwise overlap across traditional farm paddock boundaries. Given that there are normally a large number of paddocks on a dairy farm it is often more practical to soil test in farm management zones (FMZ) than to soil test in every paddock.

Areas on the farm that could form separate FMZs include:

- Different soil types
- Within those different soil types, different nutrient status
- Different management (night paddocks; silage / hay paddocks; effluent paddocks etc.)
- New and old irrigation areas

A farm map is used to identify the FMZs, and to discuss soil and fertiliser management decisions with farm staff and contractors. FMZs can be shown by simply highlighting the area directly onto the farm map using a clear plastic overlay, or by creating a digital shape file using mapping software. Paddocks or FMZs are labelled on the farm map and referred to in the fertiliser program.

For more information see http://fertsmart.dairyingfortomorrow.com.au
This plan was prepared in accordance with the Fert$mart criteria by:

Matt Thompson
MNC Agronomy Pty Ltd
PO Box 964
Taree NSW 2430

Name:

Signed: Date:

Disclaimer *The recommendations made in this report are based only on information available at the time of writing, and the success of implementation is reliant on many management and environmental factors out of the control of MNC Agronomy Pty Ltd. MNC Agronomy Pty Ltd does not have any detail of the current management practices and prevailing pasture status, and as such will not be liable for any damages suffered as a result of implementation of any of these recommendations. If more specific information and/or advice are sort after, MNC Agronomy Pty Ltd recommends engaging its services to carry-out a specific and detailed audit of its current soil, plant and livestock system, thereby allowing for more specific and detailed recommendations.*

2.0 FARM DETAILS

Bangalara Dairies supply approximately 1, 700,000L of milk (123,000kg total milk solids) into the fresh milk market for the processor Parmalat.

Located at 393 Crossmaglen Road, Bonville, NSW, the total farm area is 144ha, comprising of a milking platform area of approximately 100ha, which supports subtropical based pastures and high quality intensively grown crops to support milk production is times of high energy and protein demand. The milking platform is complemented with a feedpad central to the milking platform which enables specific and cutting edge balancing of the herds diet using , predominantly, home grown fodder ensiled both from the milking platform at times of surplus and also lease cropping blocks in the local area.

The herd size is 400 cows in milk in a seasonal calving arrangement that sees calving in early February to mid May targeting a traditional period of increased demand for fresh milk in the northern NSW market (and therefore increased income per kg milk solids). Milk production is predominantly based on home grown forage to keep feed inputs to a minimum, and cow production per cow has increased significantly over the past decade as the system has been refined, with the predominantly crossbred herd producing over 300kg milk solids/cow annually.

The area is segregated into two distinct pasture management areas; one annual forage crops in a 2-3 year cropping and pasture rotation to achieve maximum yield and forage quality (FMZ 1), and the other consisting predominantly of a kikuyu sub-tropical grass base (FMZ 2, 3 and 4). The majority of the farm is oversown annually (in March/April) to highly productive Italian and annual ryegrasses suited to the environment and the pasture sward they are established in. For the purpose of soil fertility management, the milking area has been split into 4 Farm Management Zones (FMZ's) as outlined in Section 3.0 (below). Fertiliser used last year included 11t DAP, 4t SOP, 43t Urea, 12t Entec Urea and approximately 1400t Lime.

During dry periods, or gaps in pasture production, conserved fodder, in the form of harvested ryegrass or kikuyu silage from the milking platform in periods of excess growth, and 650t corn snaplage, 700t Corn Silage and 300t soybean silage harvested from leased cropping areas are used not only to fill feed gaps, but also to manipulate milk components and promote cow health. In 2015, 140t Hominy meal and 180t Canola meal, along with a small amount of vitamin and mineral premix, were purchased from off farm.

The dairy effluent program consists of two trafficable solids traps, which are irrigated onto a 34ha effluent reuse area (FMZ 3) using two travelling irrigators. This area has a permanent pasture base of kikuyu, clover and ryegrass to maximise utilisation of the effluent. The solids traps are cleaned out regularly, with the sludge stockpiled and spread @ 10t/ha predominantly on paddocks of FMZ 3 and 4, where key soil macro levels are lowest.

3.0 FARM MANAGEMENT ZONES (FMZ)

The milking platform has been split into the following four Farm Management Zones based on historic soil testing, pastures grown, typical paddock use, irrigation and paddock aspect. The four FMZ's are illustrated on the farm map (following page).

FMZ 1 – 9ha – (highlighted yellow on farm map) cropping areas used to grow annual crops for either grazing, ensiling or both. History of large amounts of feedpad compost (effluent reuse).

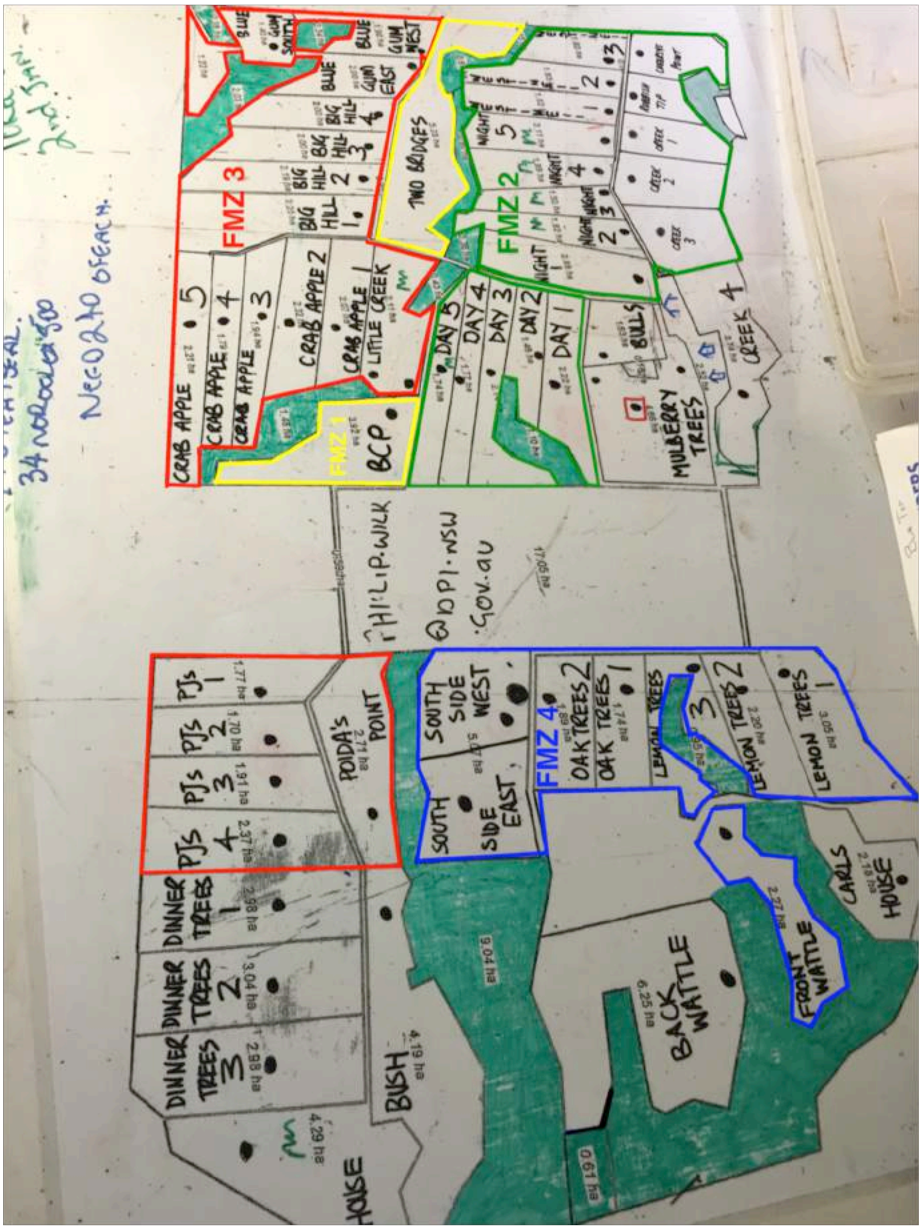
FMZ 2 — 34ha - (highlighted green on farm map) Well established kikuyu stands oversown with annual and italian ryegrass annually. This is the predominant effluent re-use area, where the only inputs (apart from the effluent) are lime, Nitrogen and Sulphur.

FMZ 3 – 38ha - (highlighted red on farm map) Consists of well established kikuyu and/or prairie grass areas with perennial white clover throughout. Sown in autumn to annual ryegrass. Generally adequate Phosphorus and Potassium, main soil nutrient inputs are Calcium, Sulphur and Nitrogen. Feedpad solids are applied in sections of this zone on a rotational basis.

FMZ 4 – 19ha – (highlighted blue on farm map) Newer pasture improvement areas where improved species are being integrated as soil fertility increases. Recent Phosphorus applications have increased plant available P levels significantly, and Calcium and Sulphur are the major limiting nutrients. Feedpad solids have a place here to improve soil OM levels.

3.1 FARM MAP

The following farm map illustrates the above Farm Management Zones (FMZ's).



3.2 FMZ 1

Area:	9 ha
Background:	Cropping areas used to grow annual crops for either grazing, ensiling or both. History of large amounts of feedpad compost (effluent reuse).
Soil structure:	High OM and Mg, low CEC and Ca.
Soil health:	Poor root development due to poor soil structure and excessive K levels
Past history:	See below "Soil Health Summary"
Past inputs:	Feedpad solids, effluent, Urea

Desired soil fertility levels		
Phosphorus	> 25.0 mg/kg	All P levels high to very high
Potassium	> 220.0 mg/kg	K levels high
Calcium	> 65% of ECEC	Low

- Fertiliser inputs (particularly N) are based on high pasture yields and utilisation.
- Irrigation infrastructure on reliable water course increases potential yields.
- High rainfall pasture production under best practice management indicates pasture production should be in the vicinity of 15tDM/ha/year utilised (20tDM/ha grown).
- Soil tests now, and historically, highlight the importance of soil Calcium and Magnesium in maintaining soil structural integrity and nutrient availability, particularly P availability and N utilisation.

Managing Risk

- All Urea blends should only be applied when adequate soil moisture is available.
- Maintain >70% groundcover at all times to maximise water and fertiliser utilisation.
- Mulching excess residual (predominantly Dec-Feb) improves surface water penetration into the soil profile and reduces N losses to leaching during heavy rainfall events.
- Using Sulphate of Potash as the preferred K source ensures greater consistency of plant available K throughout the year, with limited peaks and troughs in plant K levels compared to MOP.
- Although good plant available P levels are present, placing DAP directly adjacent to the seed at sowing (via direct drilling) ensures high plant available P as seedling develop, and minimises potential environmental P losses, or tie-up with cations such as Iron (Fe) which are naturally high in this soil type.

3.3 FMZ 2

Area:	34 ha
Background:	Main milking platform area and effluent reuse area (liquids)
Soil structure:	Higher flats to undulating ridge country.. Kikuyu dominant perennial grass providing year-round growth and improving topsoil health. High OM, P and K, low Ca.
Soil health:	High K causing plant and animal health issues
Past history:	See below "Soil Health Summary"
Past inputs:	Effluent and urea

Desired soil fertility levels		
Phosphorus	> 25.0 mg/kg	Very high
Potassium	> 220.0 mg/kg	High
Calcium	> 65% of ECEC	Low and requires maintenance

- High rainfall pasture production under best practice management indicates pasture production should be in the vicinity of 15tDM/ha/year utilised.
- Soil tests now, and historically, highlight the importance of soil Calcium and Magnesium in maintaining soil structural integrity and nutrient availability, particularly P availability and N utilisation.

Managing Risk on Effluent Re-use Areas

- Use of Calcium (Lime) and Sulphur (as gypsum and SOA) will help pasture palatability and utilisation of pasture.
- Consider exporting nutrients to other sections of the farm to prevent further build-up of K.
- Effluent should not be applied to young seedlings or to irrigate a crop up due to the risk of burning. Run effluent in a separate line through your travellers or flush with fresh water at the end of the season to prevent corrosion of irrigation equipment.
- Total potassium per application should be no more than **60 kg K/ha**, and no more than **120 kg K/ha** per year. This applies for both liquid effluent and sludge. Soil K levels in paddocks that have been repeatedly used for effluent disposal often have very high K levels and will not require application of potassium fertiliser (subject to a soil test). Effluent paddocks can be cut for hay or silage to remove excess potassium and prevent overloading.
- Avoid applying effluent to paddocks used to calve down the herd as the excess potassium can lead to grass tetany with cows going down due to induced magnesium deficiency.
- For liquid effluent, the total nitrogen application should be no more than **50 kg N/ha**.

Strategies to reduce problems

Any effluent or sludge applied to land should not leave the farm boundary or pollute any surface waterway or ground water. In addition, steps should be taken to reduce the risk of odours.

Strategies to minimise these risks include:

- Where possible, effluent should be applied to land during the drier months. Applications in the wetter months increase the risk of runoff to streams or leaching to ground water when soils are saturated. Nitrous oxide greenhouse gas emissions are also higher under anaerobic conditions.
- Apply effluent or sludge on areas well away from watercourses or drainage lines.
- Apply effluent at such a rate that the liquid does not remain ponded for more than one hour after application.
- For all spray applications, use sprinkler nozzles that produce large droplets rather than a fine

spray. Note, the lower the nozzle height, the lower the odour potential.

- Consider the wind direction and velocity on days when applying effluent or spreading sludge or manure. Adjust application times to suit.

Use Dairy Effluent Safely

Effluent ponds are dangerous

- Please ensure your pond is safe for yourself and contractors working on your farm.
- Ponds must be fenced from people and stock: - be especially careful that small children can't access effluent ponds.
- Must have signage stating:
    - a) Dangerous areas
    - b) Location of flotation devices at the pond in case someone falls in.
    - c) Procedures for "What if" something goes wrong: e.g. person fell in, tractor fell in.

Safe pumping from ponds

Typically, contractors will come with a tractor and slurry tanker and they will request the farmer to set up a second tractor on the edge of the pond with a PTO driven stirrer.

- Ensure there is safe and easy access to the pond for all large machinery
- Ensure all earthworks around the pond are stable under heavy loads.
- All tractors have PTOs guarded, and are in good condition

Please keep in mind:

- It may be difficult to identify the pond surface area if ponds are heavily overgrown.
- The water line should be carefully marked before backing any machinery up to the pond.
- Floating debris may cause blockages or be flung into the stirrer.
- External batter slopes on ponds are steep when accessing machinery.
- Ideally, there should be bump stops for tractors – even a heavy timber chock is better than nothing.
- People driving tractors in the vicinity of effluent ponds need to be very experienced. People have died when tractors and stirrers have fallen into deep ponds.
- There needs to be a clear line of sight between all people working around an effluent pond.
- Wear Personal Protective Equipment (PPE) and be highly visible.
- Establish clear procedures for immediate communication.

Contractor management - You need to:

- Check contractor registration includes current public liability insurances and "professional indemnity" insurance.
- Undertake contractor induction for your farm (map, with routes to be used and hazards in the area / en-route).
- Ensure contractor's tractor / equipment are safe to operate e.g. PTO guards are in place.
- Check equipment is in good operating order (may need to sight their maintenance records)
- Sight their safe operating procedures for performing this task.

Animal health considerations when using dairy effluent or sludge as fertiliser

Bacteria that cause diseases can be found in manure, urine and milk. These include

- Johne's disease
- Salmonellosis
- Leptospirosis
- Mastitis
- Enzootic bovine leucosis,
- Worm eggs, coccidial eggs, clostridium organisms and tetanus spores are also passed in manure.

- In most cases, the period of time before application to pasture and the dilution effect of the washdown water tend to reduce the risk to stock that graze paddocks that have been treated with waste water.

Effluent Testing should be carried out periodically
Testing of effluent is important to give an accurate indication of actual nutrients applied to the effluent re-use area. Steps should be:
1. Collect an effluent sample for analysis. *This must be as applied to the paddock via the irrigator.* It is pointless to take a sample from top of the pond. A good way is to put out buckets while irrigator is going. Measure the amount that irrigator is applying (mm), remembering that 100 mm/ha is equivalent to 1 ML per ha.
2. Keep effluent sample cold and get to lab for analysis asap.
3. Look at the analysis for nutrients in ppm and convert to kg nutrient per ML. For example:
ammonium 8.58 ppm = 8.58 kg in 1ML
phosphorus 18.71 ppm = 18.71 kg in 1 ML
potassium 58.43ppm = 58.43 kg in 1ML
4. Convert kg per ML to total annual application based on total effluent irrigation for the year.

For example:
Effluent irrigator applies 4 mm/ha each application, with 30 applications per year to same paddock. 4 mm x 30 = 120 mm/ha/year = 1.2 ML/ha per year.
Effluent analysis shows potassium (K) at 58.43 ppm = 58.43 kg in 1 ML, which is 70.11 kg in 1.2 ML. Therefore effluent paddock is receiving 70.11 kg K/ha per year.

3.4 FMZ 3

Area:	38 ha
Background:	Mainly ridges and supporting kikuyu, praire grass, paspalum and annual ryegrass.
Soil structure:	High organic matter and high Magnesium topsoil requiring regular Calcium (lime) applications to ensure good water infiltration and to reduce waterlogging.
Soil health:	Marginal P and K. Ca, N and S require input.
Past history:	See below "Soil Health Summary"
Past inputs:	Feedpad solids, DAP, urea

Desired soil fertility levels		
Phosphorus	> 25.0 mg/kg	high with Olsen P above 40mg/kg
Potassium	> 220.0 mg/kg	Generally high.
Calcium	> 65% of ECEC	Marginal but high Mg dictates Ca requirements

- Fertiliser inputs (particularly N) are based on high pasture yields and utilisation.
- Irrigation infrastructure on reliable water course increases potential yields.
- High rainfall pasture production under best practice management indicates pasture production should be in the vicinity of 15tDM/ha/year utilised (20tDM/ha grown).
- Soil tests now, and historically, highlight the importance of soil Calcium and Magnesium in maintaining soil structural integrity and nutrient availability, particularly P availability and N utilisation.

Managing Risk

- All Urea blends should only be applied when adequate soil moisture is available.
- Maintain >70% groundcover at all times to maximise water and fertiliser utilisation.
- Mulching excess residual (predominantly Dec-Feb) improves surface water penetration into the soil profile and reduces N losses to leaching during heavy rainfall events.
- Using Sulphate of Potash as the preferred K source ensures greater consistency of plant available K throughout the year, with limited peaks and troughs in plant K levels compared to MOP.
- Although good plant available P levels are present, placing DAP directly adjacent to the seed at sowing (via direct drilling) ensures high plant available P as seedling develop, and minimises potential environmental P losses, or tie-up with cations such as Iron (Fe) which are naturally high in this soil type.

3.5 FMZ 4

Area:	19 ha
Background:	Relatively new paddocks to the milking platform (and often used by dry stock).
Soil structure:	High OM but low CEC indicating poor microbial activity.
Soil health:	Lower P availability due to high Iron. Lime needed
Past history:	See below "Soil Health Summary"
Past inputs:	Some SOA/DAP

Desired soil fertility levels		
Phosphorus	> 25.0 mg/kg	High but poor availability due to high Fe
Potassium	> 220.0 mg/kg	Adequate
Calcium	> 65% of ECEC	Marginal but high Mg

- Fertiliser inputs (particularly N) are based on high pasture yields and utilisation.
- Irrigation infrastructure on reliable water course increases potential yields.
- High rainfall pasture production under best practice management indicates pasture production should be in the vicinity of 15tDM/ha/year utilised (20tDM/ha grown).
- Soil tests now, and historically, highlight the importance of soil Calcium and Magnesium in maintaining soil structural integrity and nutrient availability, particularly P availability and N utilisation.

Managing Risk

- All Urea blends should only be applied when adequate soil moisture is available.
- Maintain >70% groundcover at all times to maximise water and fertiliser utilisation.
- Mulching excess residual (predominantly Dec-Feb) improves surface water penetration into the soil profile and reduces N losses to leaching during heavy rainfall events.
- Using Sulphate of Potash as the preferred K source ensures greater consistency of plant available K throughout the year, with limited peaks and troughs in plant K levels compared to MOP.
- Although good plant available P levels are present, placing DAP directly adjacent to the seed at sowing (via direct drilling) ensures high plant available P as seedling develop, and minimises potential environmental P losses, or tie-up with cations such as Iron (Fe) which are naturally high in this soil type.

4.0 SOIL HEALTH SUMMARY

The Soil Health Summary summarises the key deficiencies or major limitations to production for each of the FMZ's. The purpose of the soil health summary is to not only identifying the areas that still require improvement, but to also highlight the improvements that have been made in the past.

17 nutrients are necessary for plant growth. These nutrients, often referred to as "essential nutrients", play different roles and are required for a number of tasks associated with plant growth. The essential nutrients can be divided into two categories: Macronutrients and Micronutrients (or trace elements), A deficiency in any one of the 17 essential nutrients may reduce pasture growth and therefore animal production.

Fertilisers are required to overcome nutrient deficiencies and to replace the nutrients that are lost or removed from the soil and pasture. Although grazing animals receive most of their essential nutrients from pasture; plants and animals have different requirements for essential nutrients. Various trace elements are deficient in some dairying areas. However, it is sometimes simpler and more economical to treat animal nutrient deficiencies directly rather than by trying to supply the nutrient indirectly through the pasture.

To simplify this process, the three areas of soil health that MNC Agronomy focus's on, in order of importance, are Soil Structure, Key Soil Macro Nutrients and Key Soil Micro Nutrients.

4.1 SOIL STRUCTURE

Calcium

Calcium (Ca) is a major contributor to soil structure and the plant availability of all 16 other essential nutrients. It is also involved in the proper functioning of growing points (especially root tips), maintaining strong cell walls, and legume growth. In a high rainfall subtropical environment, such as this, Calcium levels are continually being depleted and replacement of soil calcium is a major contributor to the profitability of pasture based milk production.

Calcium levels in all FMZ's are low in terms of soil structure and plant availability. Lime applications across all FMZ's, and specific rates, followed by annual soil monitoring is advised.

Magnesium

Magnesium (Mg), along with Calcium, is a major contributor to soil structure. Magnesium levels need to be in adequate proportions in relation to Calcium to ensure a friable soil structure with good water holding capacity and a low propensity to waterlogging and Sodium retention. It is also an essential component of chlorophyll and is required for the transport of phosphorus around the plant.

Magnesium levels are high across all FMZ’s, and lime input is required periodically to offset this.

Organic Matter

Soil organic matter is the other key factor in soil structure. Organic matter (dead or decaying plant or animal material) is essential to improve several soil functions; surface water penetration, water holding capacity, nutrient holding capacity, humus production, nitrogen utilization, microbial activity; the list goes on.

All FMZ’s have moderate to high soil organic matter levels, so the main emphasis in these areas is ensuring microbial activity is supported via regular lime input and maintaining soil N reserves. Although soil OM levels in FMZ 1 are good, the high N inputs and nutrient removal from these areas means OM levels need to be monitored.

Salinity

Salinity (EC 1:5) levels in all FMZ’s have all been historically been low. Salinity in FMZ 2 needs to be monitored (effluent re-use area) to ensure build-up doesn’t occur in the future

pH

Soil pH is a function of total cations and the ratios in which they exist. Although ultimately only an indicator, soil pH gives us a good insight into the availability of many nutrients. In particular in your soil type, pH is critical to the availability of Phosphorus due to slightly elevated Iron (Fe) and Aluminium (Al) levels.

A good liming and dolomite history in FMZ 1 has been essential to maintain an adequate pH. FMZ 2, 3 and 4, given some lime history and high soil Mg levels, have slightly acidic pH, and further lime applications will be required in the future to maintain this.

4.2 KEY MACRO NUTRIENTS

Soil structure lays the foundation allowing for pasture growth through the increased availability of water and nutrients. The remaining macronutrients, Nitrogen (N), Phosphorus (P), Potassium (K), and Sulphur (S) are required in relatively large quantities by plants; measured by either a percentage or mg/kg. Plant growth may be retarded because:

- These nutrients are lacking in the soil.
- They become available too slowly.
- They are not adequately balanced.

Nitrogen

Nitrogen (N) is needed for all growth processes, as it is the major component of amino acids, which are the building blocks of proteins, enzymes and the green pigment chlorophyll. Chlorophyll converts sunlight energy into plant energy in the form of sugars and carbohydrates.

Soil N levels are highly variable due to several factors such as crop/pasture growth stage, soil moisture, recent rainfall, soil organic matter etc etc. Although many of your soil tests did indicate low soil Nitrogen levels, applications did occur not long after the time of sampling to coincide with rainfall events. Small but regular applications of N are important across the property, and particularly in the heavy kikuyu areas where high levels of soil OM restrict plant uptake of applied N.

Phosphorus

Phosphorus (P) helps run the 'power station' inside every plant cell and has a key role in energy storage and transfer. Phosphorus is necessary for all growth processes and for the nodulation of rhizobia bacteria and nitrogen fixation.

Phosphorus levels in FMZ 1, 2 and 3 are high to very high and input is only required in very small amounts at planting to ensure plant available P in the root zone of establishing pastures. FMZ 4 does required higher inputs of P due to limited fertiliser history.

Potassium

Potassium (K) is needed for a wide range of important processes within the plant, including cell wall development, flowering and seed set. Potassium has a key role in regulating water uptake and the flow of nutrients in the sap stream of the plant. It helps legumes fix nitrogen and also helps the plant to resist stress from weather, insects and diseases. Excessive plant Potassium is undesirable to grazing livestock; reducing palatability as well as nutritional value, and will cause animal health issues in severe cases.

K levels require regular input in FMZ 4 to ensure plant available K . The use of SOP as a K source is recommended due to its more sustained release and also as soil S levels are marginal. K levels are adequate to high across the other FMZ's; FMZ 2 may require gypsum in the future to reduce soil K and Na levels, but ideally the effluent re-use area will be expanded to alleviate this need.

Sulphur

Sulphur (S) is required for the formation of several amino acids, proteins, and vitamins and for chlorophyll production. It also helps the plant to resist stress from weather, insects and diseases. Sulphur is highly leachable and tends to be depleted in wet years or following waterlogged conditions.

Soil S levels are adequate but need to be maintained to drive pasture quality.

4.3 TRACE ELEMENTS

The micronutrients or trace elements, include Molybdenum (Mo), Copper (Cu), Zinc (Zn), Manganese (Mn), Iron (Fe), and Boron (B). Although only required in small amounts, minor nutrients (micronutrients, or trace elements) are essential for plant growth and livestock health. These nutrients often act as catalysts in chemical reactions. It is possible to have toxicities of trace elements, as well as deficiencies.

Plant tissue tests are far more reliable than soil tests for assessing what was available for plant uptake, but even these are not always correct and must be taken at the appropriate times of the year to increase their accuracy and reliability.

Some of the micronutrient deficiencies in plants can cause nutrient deficiencies in the animals that graze those plants. In some cases (for example, copper and manganese), these micronutrients are also essential for plant growth. In other cases (for example, selenium), they are not required by the plant. Thus, in many cases of animal nutrient deficiency, it may be better to treat the animal rather than to apply fertilisers to pastures to overcome the problem. It is therefore important to discuss trace element issues with your local veterinarian.

Though plant testing is the recommended method for testing for trace element disorders in plants, it is usually unreliable for trace element requirements for animal nutrition. Testing body fluids (blood, urine, saliva) and tissues (liver, bone) is often required to determine whether animals have a trace element disorder. Seeking veterinary advice in addition to, or instead of, plant tissue testing is recommended.

Molybdenum

Molybdenum (Mo) is essential for the health of the rhizobia bacteria associated with the legume root nodules that are responsible for atmospheric nitrogen fixation. Molybdenum is also directly involved in nitrogen metabolism and specifically implicated in the electron-transfer system (for example, nitrate reductase and enzyme nitrogenous reactions). Molybdenum is the least abundant of the trace elements in the soil and the least required by plants with the exception of nickel.

Mo levels are good across the farm.

Copper

Copper (Cu) is required for the formation of enzymes for chlorophyll production, nutrient processing and the plant's exchange of water and oxygen for carbon dioxide. It is also required for seed setting of legumes. Plant responses (in other words, additional growth) due to copper are rare. Like most trace elements excessive quantities of copper can interfere with the uptake of other trace elements like iron; therefore producing iron deficiency symptoms.

Cu is marginal across all FMZ’s, and high soil P levels are likely to reduce uptake. Some area of FMZ 2 and 3 that are high in Zinc have very low plant available Cu levels. Animal supplementation occurs daily here, and as soil levels are not very low, application via fertiliser is only advised during periods of likely plant leaf disease, such as humid weather in late spring on ryegrass.

Zinc

Zinc (Zn) is associated with the formation of chlorophyll and of several enzyme systems required for protein synthesis. It also has a regulatory role in the intake and efficient use of water by plants.

Zn levels are slightly high across the farm, particularly the FMZ 1 and 2. No input required.

Manganese

Manganese (Mn) has several plant-growth functions. It is closely associated with iron, copper and zinc as a catalyst in plant-growth processes; is essential for rapid germination; and plays a role in enzyme systems in seed and new tissues.

Manganese levels are adequate to slightly high across the property. This can exacerbate Boron deficiency.

Iron

Iron (Fe) is associated with the production of chlorophyll and helps to carry oxygen around the plant cells. Iron is also involved in reactions that convert nitrates to ammonia in the plant.

Soil Iron levels are moderate to high across all FMZ’s, which is common for the region. Maintaining higher soil pH through liming will ensure the high Fe levels have minimal effect on P, Zn and Cu availability.

Boron

Boron (B) is mainly involved in the movement of sugars throughout the plant and in seed production in legumes. It is also an important nutrient in the metabolism of nitrogen, carbohydrates, and hormones and is involved in the uptake and efficient use of calcium in the plant. Boron may induce both toxicities and deficiencies in Australia.

B is slightly low across all FMZ’s. Application of B should only occur via foliar applications if visual deficiency symptoms are evident in susceptible crops such as summer legumes, maize and brassicas.

5.0 FERTILISER PROGRAM 2016

Fertiliser products top-dressed unless otherwise indicated using DairySAT BMP (best management practices). Please note rates are kg/ha and details of key recommendations can be found in section 6 (Key Recommendations) and 4 (Soil Health Summary).

5.1 FMZ 1 – FERTILISER PLAN

Proposed Fertiliser Program 2016	FMZ 1		Area (ha):	9

BAKE

Product	*N*	*P*	*K*	*S*
Map-Star	11	18	0	12
SOA	23	0	0	21
21:3:0:17 Custom Blend	21	3	0	17
Urea:SOA Blend	33	0	0	12
Urea	46	0	0	0
Lime	0	0	0	0

Apply in	Rate	Product	N	P	K	S
January	200	21:3:0:17 Custom Blend	42.0	6.0	0.0	34.0
February	3500	Lime	0.0	0.0	0.0	0.0
March	0	0	0.0	0.0	0.0	0.0
April	50	Map-Star	5.5	9.0	0.0	6.0
May	100	Urea	46.0	0.0	0.0	0.0
June	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
July	80	Urea	36.8	0.0	0.0	0.0
August	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
September	100	SOA	23.0	0.0	0.0	21.0
October	100	SOA	23.0	0.0	0.0	21.0
November	80	Urea:SOA Blend	26.4	0.0	0.0	9.6
December	0	0	0.0	0.0	0.0	0.0
Total Nutrient applied Per Ha			**268.70**	**15.00**	**0.00**	**115.60**

5.2 FMZ 2 - FERTILISER PLAN

Proposed Fertiliser Program 2016	FMZ 2		Area (ha): 34

BAKE

Product	*N*	*P*	*K*	*S*
Map-Star	11	18	0	12
SOA	23	0	0	21
UREA	46	0	0	0
Urea:SOA Blend	33	0	0	12
Feedpad Solids Compost	1.65	0.56	0.66	0.3
Lime	0	0	0	0

Apply in..	Rate..	Product	N	P	K	S
January	0	0	0.0	0.0	0.0	0.0
February	80	UREA	36.8	0.0	0.0	0.0
March	50	Map-Star	5.5	9.0	0.0	6.0
April	100	UREA	46.0	0.0	0.0	0.0
May	100	UREA	46.0	0.0	0.0	0.0
June	80	UREA	36.8	0.0	0.0	0.0
July	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
August	2500	Lime	0.0	0.0	0.0	0.0
September	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
October	100	SOA	23.0	0.0	0.0	21.0
November	80	UREA	36.8	0.0	0.0	0.0
December	0	0	0.0	0.0	0.0	0.0
Total Nutrient applied Per Ha			**296.90**	**9.00**	**0.00**	**51.00**

5.3 FMZ 3 - FERTILISER PLAN

Proposed Fertiliser Program 2016	FMZ 3		Area (ha): 38

BAKE

Product	*N*	*P*	*K*	*S*
Map-Star	11	18	0	12
SOA	23	0	0	21
UREA	46	0	0	0
Urea:SOA Blend	33	0	0	12
Feedpad Solids Compost	1.65	0.56	0.66	0.3
Lime	0	0	0	0

Apply in	Rate	Product	N	P	K	S
January	0	0	0.0	0.0	0.0	0.0
February	80	UREA	36.8	0.0	0.0	0.0
March	0	0	0.0	0.0	0.0	0.0
April	50	Map-Star	5.5	9.0	0.0	6.0
May	100	UREA	46.0	0.0	0.0	0.0
June	80	UREA	36.8	0.0	0.0	0.0
July	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
August	80	UREA	36.8	0.0	0.0	0.0
September	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
October	100	SOA	23.0	0.0	0.0	21.0
November	80	UREA	36.8	0.0	0.0	0.0
December	2000	Lime	0.0	0.0	0.0	0.0
Total Nutrient applied Per Ha			**287.70**	**9.00**	**0.00**	**51.00**

5.4 FMZ 4 – FERTILISER PLAN

Proposed Fertiliser Program 2016	FMZ 4		Area (ha): 19

BAKE

Product	*N*	*P*	*K*	*S*
Map-Star	11	18	0	12
SOA	23	0	0	21
UREA	46	0	0	0
Urea:SOA Blend	33	0	0	12
Feedpad Solids Compost	1.65	0.56	0.66	0.3
Lime	0	0	0	0

Apply in	Rate	Product	N	P	K	S
January	0	0	0.0	0.0	0.0	0.0
February	0	0	0.0	0.0	0.0	0.0
March	0	0	0.0	0.0	0.0	0.0
April	0	0	0.0	0.0	0.0	0.0
May	100	UREA	46.0	0.0	0.0	0.0
June	80	UREA	36.8	0.0	0.0	0.0
July	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
August	80	UREA	36.8	0.0	0.0	0.0
September	100	Urea:SOA Blend	33.0	0.0	0.0	12.0
October	100	SOA	23.0	0.0	0.0	21.0
November	1500	Lime	0.0	0.0	0.0	0.0
December	10000	Feedpad Solids Compost	165.0	56.0	66.0	30.0
Total Nutrient applied Per Ha			**373.60**	**56.00**	**66.00**	**75.00**

6.0 KEY RECOMMENDATIONS

- Baseline Calcium levels are low across the farm.
- Despite excellent soil Organic Matter levels, soil structure is poor.
- High soil Magnesium and Iron levels mean capital and regular lime input is important across all FMZ's.
- Soil Phosphorus levels are high across all FMZ 's. Availability is poor in all FMZ's due to elevated Iron levels.
- FMZ 1 and 2 have excessive soil Potassium levels. This is causing poor palatability and grazing utilisation issues, and potentially grass tetany issues.
- Sulphur needs to be applied regularly in small amounts, although levels are adequate.
- An audit of pasture production and plant nutrition requirements (Appendix 7.1) shows that in 2015, an average of 160kg/ha/N, 17kg/ha/P and 36kg/ha/K was used to grow 7894kg/DM/ha of pasture.
- The audit also shows that the estimated nutrients that will be required for 2016 pasture production (based on the target of 12000kg/DM/ha utilised), will be on average 244kg/ha/N, 26kg/ha/P and 55kg/ha/K.
- Theoretically, based on nutrients from imported feed, grazing recycling factors and nutrients exported as milk, the average nutrient input per hectare to achieve 12000kg/DM/ha should be 130kg/ha/N, 5kg/ha/P and 0kg/ha/K. However, in practice, much of the recycled nutrients is applied in specific, concentrated areas (such as effluent solids being applied to FMZ 4).
- Pasture herbage testing should be utilised periodically to give snapshots of plant nutrient levels and potential deficiencies.
- Continue with your annual soil monitoring program and regular review of soil fertiliser plans and pasture management practices, making adjustments as advised.
- Review the Fert$mart plan again in 2016 with your Fert$mart accredited advisor.
- As always, please consult me as circumstances or conditions change.

7.0 APPENDIX

7.1 MNC Agronomy Audit of Pasture Production and Plant Nutrient Requirements

MNC Agronomy Soil Nutrient Audit

Client	**BAKE**					
Year	**2016**					
Cow numbers (in milk, average)	400					
Area (milking platform - ha)	100					
In bale supplementation (av. kg/DM/day)	2.29					
2015 estimated imported supplementry feed budget (kg/DM/cow/day)	11.30					
2015 Milk Production (L)	1673785			***kg/nutrient/ha/year***		
	kg total/year	**kg/ha/year**	**Supplement type**	**N**	**P**	**K**
In Bale Supplements	180000	1800	**Canola meal**	115.0	20.8	24.7
	14600	146	**Average concentrate**	5.7	0.9	1.1
	140000	1400	**Brewers grain**	60.6	10.5	10.4
Other Supplements	300000	3000	**Lucerne silage**	79.1	13.6	68.7
	1350000	13500	**Maize silage**	162.4	34.5	151.2

	N	P	K
TOTAL kg/nutrient imported/ha/year	423	80	256
Total kg/nutrient exported as milk/ha/year	54	17	23
Total kg/nutrient/ha returning to paddock	***113***	***20***	***115***

Estimated Nutrient Removal (av. kg/ha/year)

	Av. kgDM/ha/year utilised	**N**	**P**	**K**
2015 Actual pasture production	7894	160	17	36
2016 Pasture production TARGET	12000	244	26	55

	N	P	K
Total kg/nutrient/ha returning to paddock (from above)	113	20	115

	N	**P**	**K**
2016 Av. Estimated Nutrient Deficit (i.e. Nutrients Required kg/ha maintenance)	***130***	***5***	***0***

** nutrient figures taken from NSW DPI industry standards, 2007, "Mineral content of common ruminant stockfeed, crops and pastures" by Ian Blackwood*

8.2 Soil Test Reports

Premium Soil Analysis

MNC Agronomy

Apal

Customer: BANGALARA DAIRIES

Agent: MNC AGRONOMY

Sample Name: BCP 2BF

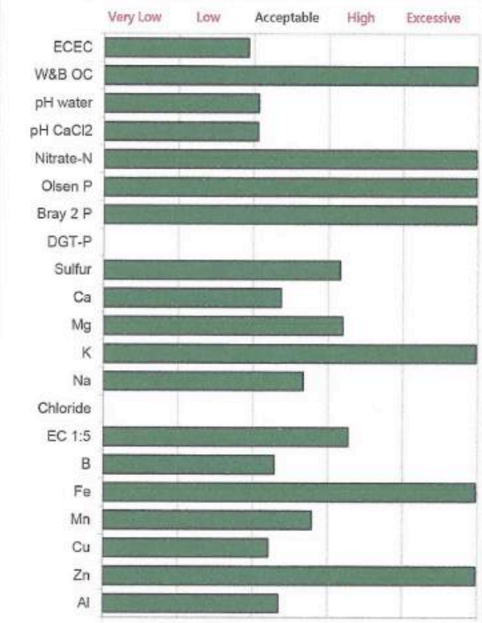
Crop: Soybeans

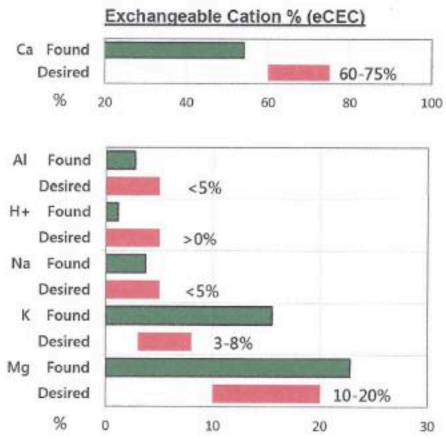
Control 15765

Lab No.: D089

Date: 21-Oct-15

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	10.87
	Organic Carbon (W&B)	%	>0.7	7.13
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.35
	pH 1:5 (CaCl2)		5.5 - 6.5	4.84
Exchangeable N-P-S	Nitrate - N	ppm	10 - 50	122.1
	Ammonium - N	ppm	-	8.7
	Olsen Phosphorus	ppm	20 - 30	87
	Bray 2 Phosphorus	ppm	50 - 80	210
	PBI unadjusted		<100	347
	MCP Sulfur (S)	ppm	10 - 20	37.6
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1100	1179
	Magnesium (Mg)	ppm	150 - 175	302
	Potassium (K)	ppm	> 100	660
	Sodium (Na)	ppm	< 70	93
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	0.29
	Exch. Hydrogen	c.mol/kg	-	0.12
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	< 0.15	0.34
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.00
	DTPA Iron (Fe)	ppm	10 - 70	169
	DTPA Manganese (Mn)	ppm	4 - 50	45
	DTPA Copper (Cu)	ppm	0.5 - 5.0	1.09
	DTPA Zinc (Zn)	ppm	1.0 - 5.0	10.7
Ratios	Ca:Mg RATIO		2 - 8	2.37
Exchangeable cation %	Calcium	% Ca	60 - 75	54.1
	Magnesium	% Mg	10 - 20	22.8
	Potassium	% K	3 - 8	15.5
	Sodium	% Na	<5	3.7
	Exch. Aluminium	% Al	<5	2.7
	Exch. Hydrogen	% H	>0	1.1





Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel.: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

Premium Soil Analysis

MNC Agronomy

Apal

Customer: BANGALARA DAIRIES

Agent: MNC AGRONOMY

Sample Name: NIGHT WESTINEII

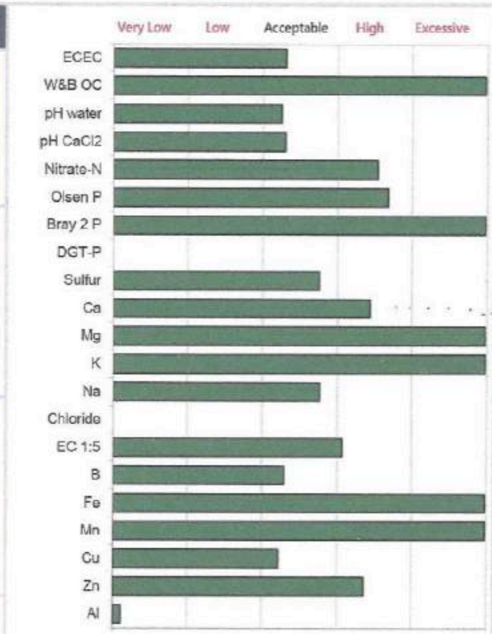
Crop: Kikuyu

Control 15765

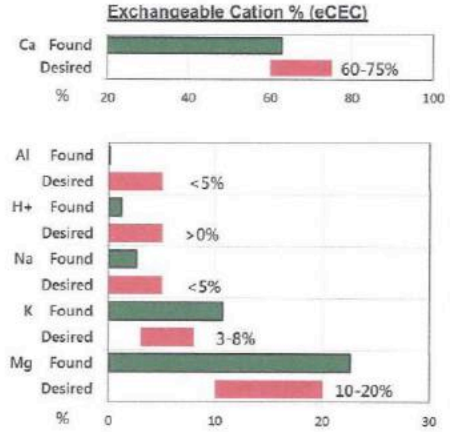
Lab No.: D083

Date: 21-Oct-15

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	15.17
	Organic Carbon (W&B)	%	>1.8	10.82
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.74
	pH 1:5 (CaCl2)		5.5 - 6.5	5.35
Exchangeable N-P-S	Nitrate - N	ppm	20 - 50	113.9
	Ammonium - N	ppm	-	15.9
	Olsen Phosphorus	ppm	30 - 40	77
	Bray 2 Phosphorus	ppm	50 - 70	183
	PBI unadjusted		<100	229
	MCP Sulfur (S)	ppm	10 - 20	26.9
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1200	1912
	Magnesium (Mg)	ppm	50 - 100	417
	Potassium (K)	ppm	60 - 100	635
	Sodium (Na)	ppm	< 30	89
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	<0.02
	Exch. Hydrogen	c.mol/kg	-	0.18
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	<0.25	0.35
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.03
	DTPA Iron (Fe)	ppm	10 - 70	190
	DTPA Manganese (Mn)	ppm	2 - 50	99
	DTPA Copper (Cu)	ppm	2.0 - 4.0	2.37
	DTPA Zinc (Zn)	ppm	2.0 - 10.0	18.4
Ratios	Ca:Mg RATIO		2 - 8	2.78
	K:Mg Ratio		< 0.5	0.47
Exchangeable cation %	Calcium	% Ca	60 - 75	62.9
	Magnesium	% Mg	10 - 20	22.6
	Potassium	% K	3 - 8	10.7
	Sodium	% Na	<5	2.6
	Exch. Aluminium	% Al	<5	0.0
	Exch. Hydrogen	% H	>0	1.2



Exchangeable Cation % (eCEC)



Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

F (CR)-003 Version 1 Page 1 of 2

MNCAgronomy

Fert$mart
Making fertiliser profitable
Fert$mart Plan

Premium Soil Analysis

MNCAgronomy

Apal

Customer: BANGALARA DAIRIES

Sample Name: NIGHT WESTINEII

Lab No.: D083

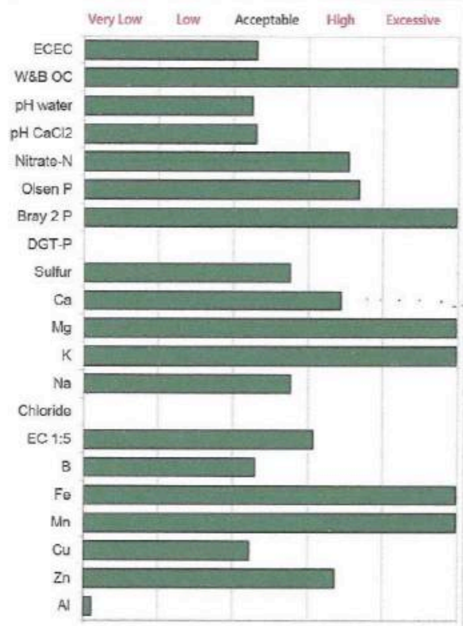
Agent: MNC AGRONOMY

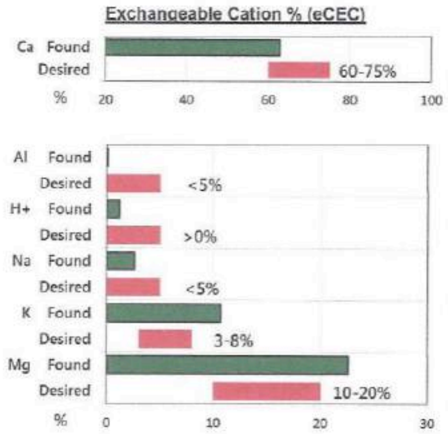
Crop: Kikuyu

Date: 21-Oct-15

Control 15765

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	15.17
	Organic Carbon (W&B)	%	>1.8	10.82
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.74
	pH 1:5 (CaCl2)		5.5 - 6.5	5.35
Exchangeable N-P-S	Nitrate - N	ppm	20 - 50	113.9
	Ammonium - N	ppm	-	15.9
	Olsen Phosphorus	ppm	30 - 40	77
	Bray 2 Phosphorus	ppm	50 - 70	183
	PBI unadjusted		<100	229
	MCP Sulfur (S)	ppm	10 - 20	26.9
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1200	1912
	Magnesium (Mg)	ppm	50 - 100	417
	Potassium (K)	ppm	60 - 100	635
	Sodium (Na)	ppm	< 30	89
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	<0.02
	Exch. Hydrogen	c.mol/kg	-	0.18
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	<0.25	0.38
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.03
	DTPA Iron (Fe)	ppm	10 - 70	190
	DTPA Manganese (Mn)	ppm	2 - 50	99
	DTPA Copper (Cu)	ppm	2.0 - 4.0	2.37
	DTPA Zinc (Zn)	ppm	2.0 - 10.0	18.4
Ratios	Ca:Mg RATIO		2 - 8	2.78
	K:Mg Ratio		< 0.5	0.47
Exchangeable cation %	Calcium	% Ca	60 - 75	62.9
	Magnesium	% Mg	10 - 20	22.6
	Potassium	% K	3 - 8	10.7
	Sodium	% Na	<5	2.6
	Exch. Aluminium	% Al	<5	0.0
	Exch. Hydrogen	% H	>0	1.2





Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel.: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

F (CR)-003 Version 1 Page 1 of 2

MNCAgronomy

Fert$mart
Making fertiliser profitable
Fert$mart Plan

Premium Soil Analysis

MNCAgronomy

Apal

Customer: BANGALARA DAIRIES

Agent: MNC AGRONOMY

Sample Name: NIGHT WESTINEII

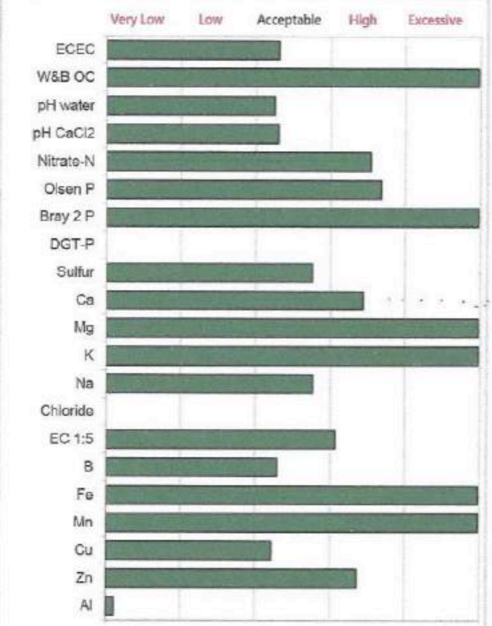
Crop: Kikuyu

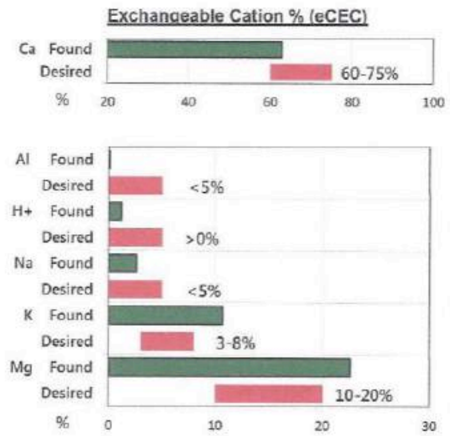
Control 15765

Lab No.: D083

Date: 21-Oct-15

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	15.17
	Organic Carbon (W&B)	%	>1.8	10.82
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.74
	pH 1:5 (CaCl2)		5.5 - 6.5	5.35
Exchangeable N-P-S	Nitrate - N	ppm	20 - 50	113.9
	Ammonium - N	ppm	-	15.9
	Olsen Phosphorus	ppm	30 - 40	77
	Bray 2 Phosphorus	ppm	50 - 70	183
	PBI unadjusted		<100	229
	MCP Sulfur (S)	ppm	10 - 20	26.9
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1200	1912
	Magnesium (Mg)	ppm	50 - 100	417
	Potassium (K)	ppm	60 - 100	635
	Sodium (Na)	ppm	< 30	89
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	<0.02
	Exch. Hydrogen	c.mol/kg	-	0.18
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	<0.25	0.35
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.03
	DTPA Iron (Fe)	ppm	10 - 70	190
	DTPA Manganese (Mn)	ppm	2 - 50	99
	DTPA Copper (Cu)	ppm	2.0 - 4.0	2.37
	DTPA Zinc (Zn)	ppm	2.0 - 10.0	18.4
Ratios	Ca:Mg RATIO		2 - 8	2.78
	K:Mg Ratio		< 0.5	0.47
Exchangeable cation %	Calcium	% Ca	60 - 75	62.9
	Magnesium	% Mg	10 - 20	22.6
	Potassium	% K	3 - 8	10.7
	Sodium	% Na	<5	2.6
	Exch. Aluminium	% Al	<5	0.0
	Exch. Hydrogen	% H	>0	1.2





Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel.: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

F (CR)-003 Version 1 Page 1 of 2

Premium Soil Analysis

MNCAgronomy

Apal

Customer: BANGALARA DAIRIES

Sample Name: NIGHT WESTINEII

Lab No.: D083

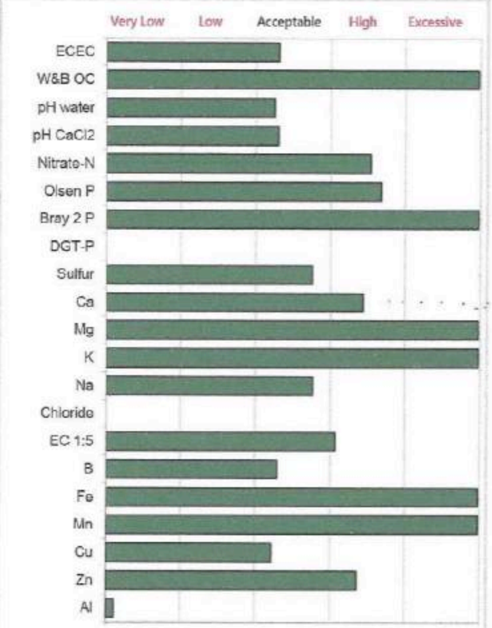
Agent: MNC AGRONOMY

Crop: Kikuyu

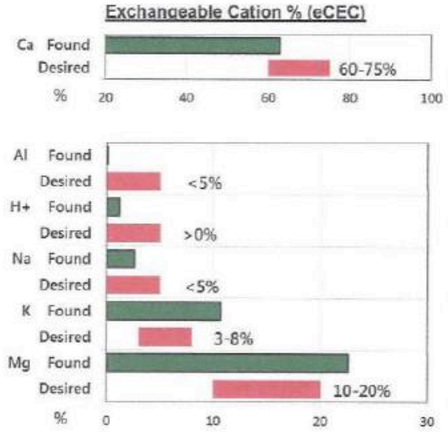
Date: 21-Oct-15

Control 15765

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	15.17
	Organic Carbon (W&B)	%	>1.8	10.82
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.74
	pH 1:5 (CaCl2)		5.5 - 6.5	5.35
Exchangeable N-P-S	Nitrate - N	ppm	20 - 50	113.9
	Ammonium - N	ppm	-	15.9
	Olsen Phosphorus	ppm	30 - 40	77
	Bray 2 Phosphorus	ppm	50 - 70	183
	PBI unadjusted		<100	229
	MCP Sulfur (S)	ppm	10 - 20	26.9
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1200	1912
	Magnesium (Mg)	ppm	50 - 100	417
	Potassium (K)	ppm	60 - 100	635
	Sodium (Na)	ppm	< 30	89
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	<0.02
	Exch. Hydrogen	c.mol/kg	-	0.18
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	<0.25	0.35
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.03
	DTPA Iron (Fe)	ppm	10 - 70	190
	DTPA Manganese (Mn)	ppm	2 - 50	99
	DTPA Copper (Cu)	ppm	2.0 - 4.0	2.37
	DTPA Zinc (Zn)	ppm	2.0 - 10.0	18.4
Ratios	Ca:Mg RATIO		2 - 8	2.78
	K:Mg Ratio		< 0.5	0.47
Exchangeable cation %	Calcium	% Ca	60 - 75	62.9
	Magnesium	% Mg	10 - 20	22.6
	Potassium	% K	3 - 8	10.7
	Sodium	% Na	<5	2.6
	Exch. Aluminium	% Al	<5	0.0
	Exch. Hydrogen	% H	>0	1.2



Exchangeable Cation % (eCEC)



Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel.: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

F (CR)-003 Version 1 Page 1 of 2

Premium Soil Analysis

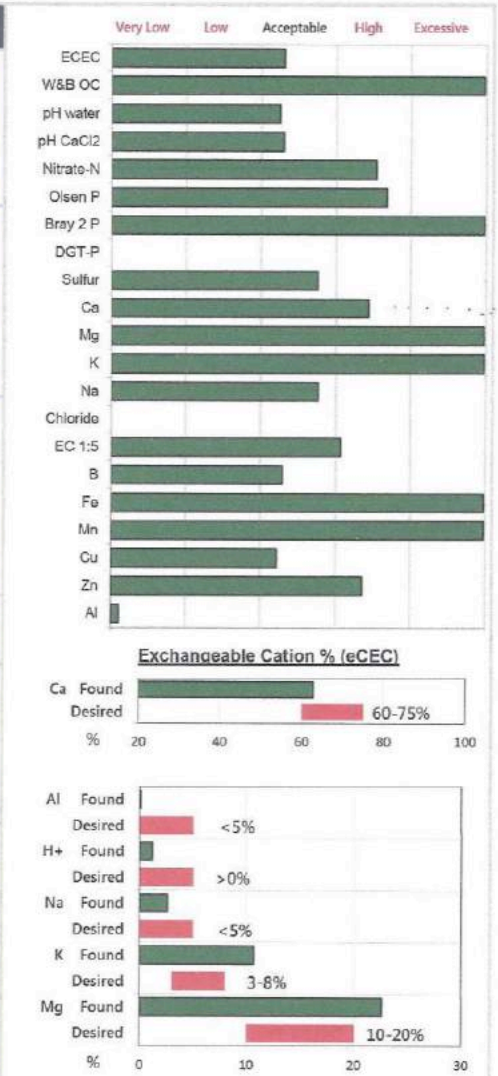
Apal

Customer: BANGALARA DAIRIES
Sample Name: NIGHT WESTINEII
Lab No.: D083

Agent: MNC AGRONOMY
Crop: Kikuyu
Date: 21-Oct-15

Control 15765

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	15.17
	Organic Carbon (W&B)	%	>1.8	10.82
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.74
	pH 1:5 (CaCl2)		5.5 - 6.5	5.35
Exchangeable N-P-S	Nitrate - N	ppm	20 - 50	113.9
	Ammonium - N	ppm	-	15.9
	Olsen Phosphorus	ppm	30 - 40	77
	Bray 2 Phosphorus	ppm	50 - 70	183
	PBI unadjusted		<100	229
	MCP Sulfur (S)	ppm	10 - 20	26.9
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1200	1912
	Magnesium (Mg)	ppm	50 - 100	417
	Potassium (K)	ppm	60 - 100	635
	Sodium (Na)	ppm	< 30	89
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	<0.02
	Exch. Hydrogen	c.mol/kg	-	0.18
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	<0.25	0.35
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.03
	DTPA Iron (Fe)	ppm	10 - 70	190
	DTPA Manganese (Mn)	ppm	2 - 50	99
	DTPA Copper (Cu)	ppm	2.0 - 4.0	2.37
	DTPA Zinc (Zn)	ppm	2.0 - 10.0	18.4
Ratios	Ca:Mg RATIO		2 - 8	2.78
	K:Mg Ratio		< 0.5	0.47
Exchangeable cation %	Calcium	% Ca	60 - 75	62.9
	Magnesium	% Mg	10 - 20	22.6
	Potassium	% K	3 - 8	10.7
	Sodium	% Na	<5	2.6
	Exch. Aluminium	% Al	<5	0.0
	Exch. Hydrogen	% H	>0	1.2



Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel.: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

F (CR)-003 Version 1 Page 1 of 2

Premium Soil Analysis

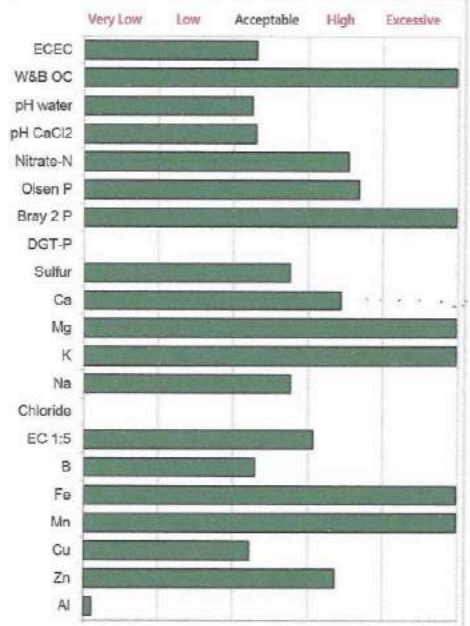
MNCAgronomy

Apal

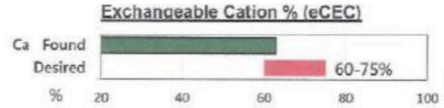
Customer: BANGALARA DAIRIES
Sample Name: NIGHT WESTINEII
Lab No.: D083
Agent: MNC AGRONOMY
Crop: Kikuyu
Date: 21-Oct-15

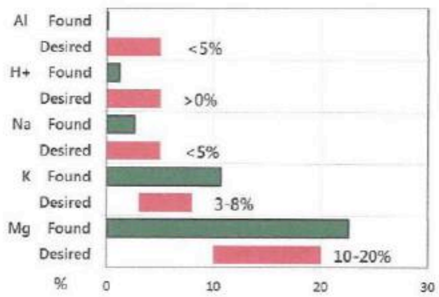
Control 15765

		Unit	Desired Level	Level Found
	ECEC	c.mol/kg	12 - 25	15.17
	Organic Carbon (W&B)	%	>1.8	10.82
	Total Nitrogen (Dumas)	%	-	NR
	pH 1:5 (Water)		6.0 - 7.0	5.74
	pH 1:5 (CaCl2)		5.5 - 6.5	5.35
Exchangeable N-P-S	Nitrate - N	ppm	20 - 50	113.9
	Ammonium - N	ppm	-	15.9
	Olsen Phosphorus	ppm	30 - 40	77
	Bray 2 Phosphorus	ppm	50 - 70	183
	PBI unadjusted		<100	229
	MCP Sulfur (S)	ppm	10 - 20	26.9
Exchangeable cations	Calcium (Ca)	ppm	1000 - 1200	1912
	Magnesium (Mg)	ppm	50 - 100	417
	Potassium (K)	ppm	60 - 100	635
	Sodium (Na)	ppm	< 30	89
	Exch. Aluminium (Al)	c.mol/kg	< 0.5	<0.02
	Exch. Hydrogen	c.mol/kg	-	0.18
Salt	Chlorides (Cl)	ppm	<180	NR
	Salinity EC 1:5	dS/m	<0.25	0.35
Trace Elements	Boron (B)	ppm	0.5 - 2.0	1.03
	DTPA Iron (Fe)	ppm	10 - 70	190
	DTPA Manganese (Mn)	ppm	2 - 50	99
	DTPA Copper (Cu)	ppm	2.0 - 4.0	2.37
	DTPA Zinc (Zn)	ppm	2.0 - 10.0	18.4
Ratios	Ca:Mg RATIO		2 - 8	2.78
	K:Mg Ratio		< 0.5	0.47
Exchangeable cation %	Calcium	% Ca	60 - 75	62.9
	Magnesium	% Mg	10 - 20	22.6
	Potassium	% K	3 - 8	10.7
	Sodium	% Na	<5	2.6
	Exch. Aluminium	% Al	<5	0.0
	Exch. Hydrogen	% H	>0	1.2



Exchangeable Cation % (eCEC)





Analysis by APAL, PO Box 327, 489 The Parade, Magill SA 5072
Tel.: 08 8332 0199 Fax: 08 83612715 Email: info@apal.com.au Website: www.apal.com.au

ASPAC

NR Test not requested

DGT-P desired ranges & critical levels exist for limited crop types.

F (CR)-003 Version 1 Page 1 of 2