INFORMATION SHEET

Nitrogen Use On Dairy Farms

Responsibly getting the best bang for your buck.

Historically, nitrogen fertiliser used to be only applied to boost pasture growth to fill specific feed gaps, but today it is more extensively used on the majority of dairy farms.

BACKGROUND

Highly profitable farmers, supported by extensive research, know that, if used wisely, nitrogen is a valuable, relatively cheap source of additional feed for direct grazing or conservation. The overall effect is the ability to milk more cows or import less feed, in most cases a combination of both.

But, if nitrogen is used incorrectly, any extra feed produced may not actually be that cheap, higher profit may not eventuate and serious environmental damage may occur.

Nitrogen can leach into groundwater and waterways, and contribute to greenhouse emissions rather than go into more feed. Best practice management reduces the risk of these problems.

Nitrogen, feed and profit

Dairy industry data indicates that the most profitable dairy farms are using more nitrogen than those of average performance. In general terms, the rate of applied nitrogen on these farms appears to be 0.8 - 0.9 kg N/ha/day of "observed" pasture growth per year.

For example, in a lower rainfall (700 mm) dryland dairy area, with a 200 day growing season 170 kg/ha N (350 kg/ha urea) may be applied, while in an irrigation area it might be 300 kg/ha N (650 kg/ha urea).

It is not a matter of just adding more. Astute farmers know to use the same logic when applying nitrogen fertiliser as they do when feeding concentrates. There is a point at which, for an extra unit of input, the extra output (if any) does not cover the cost of that extra input.

The effect of nitrogen fertiliser is measured in the amount of extra feed grown and used (kg dry matter) per kilogram of nitrogen applied.

The cost of growing this extra feed, which will vary according to the effectiveness of applications and how well the extra feed is utilised, must be compared to other feed sources.

Table 1
Variation in the Cost of Additional Pasture Consumed When Urea is $690/T ($1.50/kg N)
* Assuming PKS levels are adequate.

Extra Response Kg DM/kg N	Utilisation	Cost of Extra Pasture Consumed
High response 20:1	75%	$100/T DM
	50%	$150/T DM
Average response 10 :1	75%	$200/T DM
	50%	$300/T DM
Low response 5:1	75%	$400/T DM
	50%	$600/T DM

In recent years, the cost of high quality feed delivered on farm has been about $400/T DM consumed ($340/T fresh weight). Nitrogen has cost about $1.50/kg, which equates to $690/T urea. Table 1 provides an indication of the cost of extra pasture consumed.

Depending on the conditions surrounding the decision to apply nitrogen, the extra feed could cost between $100 and $600 per tonne dry matter.

The term "cheap" feed becomes questionable beyond a certain point.

Poorly timed applications, size and frequency of applications and poor use of any extra feed grown mean negative impacts on both the bottom line and the environment.

RESPONSIBLE OPTIMUM NITROGEN USAGE

There is considerable, very clear scientific evidence associated with responsibly using nitrogen fertiliser to maximise pasture grown and consumed, and minimise any negative impacts on the environment.

Type of Nitrogen

- Urea is still the cheapest source of nitrogen.
- There is no difference in yield between nitrogen sources (urea/DAP) if the same rate of nitrogen is applied (as long as there is no deficiency in any other nutrient).

Optimum rates to apply

- For any individual nitrogen application: 25 - 55 kg N/ha (55 -120 kg/ha of Urea).
  - The rate within this range will be affected by the amount of feed required, the time of year, the interval between grazing and factors that strike a balance between cost, response and impact.
  - Generally, rates below and above this range have not been found to be economic and when above, very significantly increase the environmental impacts. Even on fodder paddocks, such as those used for silage, the extra yield obtained has not been economic at higher rates, unless there is an abnormally high plant density to respond.
  - Nitrous oxide release to the atmosphere increases dramatically above rates of 60 kg N/ha in any one application. Annual rates of applied nitrogen above 270 kg N/ha also appear to increase nitrous oxide emissions sharply.
- There is no scientific evidence which suggests that the use of nitrogen fertilisers in the optimum range above will have any long term harmful effect on the soil. The aim is for the maximum amount of nitrogen to be used by plants rather than end up in air or water.
- In theory, nitrogen fertilisers at higher rates will acidify soils. In practice, this is often not observed due to the soil's ability to buffer the impact of the nitrogen fertiliser, but the environmental risks are higher.

Timing of applications to maximise response

- If the pasture is growing it will respond to N fertiliser. Make sure there is adequate soil moisture and temperature for pasture growth/response. Ensure any other soil deficiencies are addressed to get the most from applications of nitrogen.
- Nitrogen increases the size of ryegrass leaves and grazing interval (rotation length) determines the number of leaves. Within the optimum rate range, linking the rate of nitrogen applied to the optimum grazing interval for the time of year will maximise response. For example:
  - In winter, a long rotation of 40 - 60 days, with nitrogen applied at 40-55 kg N/ha as cows leave a paddock, will collectively grow more leaves and larger leaves; hence there is significantly more dry matter.
  - In spring, assuming the extra feed can be justified, the nitrogen rate will be lower, as will the grazing interval be shorter, a priority being feed quality not quantity. 25 kg N/ha with a rotation length of 18 -25 days is still in the optimum total response range.
- A "whole farm" nitrogen application is 7-10% less efficient than following the cows immediately after grazing. Delaying the application of N fertiliser reduces the potential response by about 1% per day post grazing. There is a risk applying nitrogen close to grazing, it can be applied 2-3 days pre grazing and 7 days post grazing. If it is applied 7-14 days pre grazing, there is a risk of elevated nitrate levels and a low response.

Situations to avoid

- Low ground temperatures (below 4 degrees C): very low responses to N.
- Not enough moisture in the soil for growth.
- In summer months 6 -14% (maximum 25%) of Urea can be lost through volatilization and responses are low. Avoiding high "risk", low response applications will minimise losses to the atmosphere. Summer losses are greatest when urea is applied after rain (or irrigation), than being applied before the rain.
- De-nitrification (increased nitrous oxide) is higher in water logged soils compared to dry soils.
- Waterlogged soils with moving water will have minimal if any response and maximum losses. Nitrogen is highly soluble in water and will move quickly away from the root zone.
- Saturated soils without moving water may see a reasonable response to nitrogen but the response may take longer than usual.
- The 14 days after a nitrogen application coincides with the highest nitrate level in the plant. This can be associated with harmful animal health affects, but is not frequently observed.
- If the soil is deficient in phosphorous, potassium, or sulphur, the response to nitrogen will be reduced, or a higher rate may be needed to achieve the same response, affecting the profitability of the response and increasing environmental risks.

PRACTICAL APPROACHES TO MAXIMISE RESPONSE AND MINIMISE IMPACT

The profitable dairy farmer aims to blend the science with observed practical evidence.

Optimum, profitable use of nitrogen and care of the environment are not in conflict if best practice is followed.

The best operators, considering the economics and the environment:

- Use a strategic and flexible approach to nitrogen fertiliser (not a recipe) based on knowledge of their farm, in terms of areas that are drier, wetter, lower and higher as well as those with different aspects. Responses and losses will vary significantly with soil type, aspect, and topography, all of which vary within one farm.
  - Use different rates on different areas of the farm, keeping within the optimum range unless there is a very good reason not to (e.g. higher plant density).

    Poorer paddocks are either re-sown or don't receive nitrogen.
  - "Read" their seasons extremely well. Some seasons have greater nitrogen deficiencies and lower growth rates than others - rates vary accordingly. In some cases growth rates are actually measured to identify if nitrogen is needed.
  - Alter the rate applied with the grazing interval, time of year, and feed demands at the time. This links the nitrogen to the stage of growth of the plant.
  - Are highly selective as to which areas receive nitrogen in wet conditions. This decision will be carefully evaluated, since they know the physical response is lower, reducing profitability and increasing the environmental impact.
  - Cease nitrogen applications in dry conditions, but, as the pasture starts to dry out, there is often a last rotation of nitrogen, to "push" feed further into summer and delay the feeding of fodder. Nitrogen applications will cease completely when there is no or minimal, observable pasture growth. This will vary within and between farms and also depend on the risk profile of the individual farmer.
- Either purchase suitable spreaders themselves (best results) or have a scale large enough to be able to have a commercial arrangement with a distributor, to enable the correct part of the farm to receive the correct rate at the correct time. At critical times of the year, the window of opportunity is one or two days, after which it is no longer optimum, becomes high risk, and results in a poor response and significant losses.
- Know the fertility levels of farm use/management zones on their farm through regular (every second year) soils testing of each zone.
- Ideally, record the annual rate of nitrogen applied and annual pasture consumption figure, as a method of evaluating the effectiveness of the nitrogen and grazing management interaction.
- Products with nitrification inhibitors, urease inhibitors, or polymer coating- all designed to enhance the efficiency and reduce environmental impacts have not yet been widely adopted as being cost effective on many dairy farms but the better operators are aware of their existence and are ready to use them as cost allows.

ASSESSING THE IMPACT: YOUR BOTTOM LINE AND THE ENVIRONMENT

Two neighbours could apply 240 kg N/ha with dramatically different outcomes:

Wally Waste: Wally has 6 X 40 kg N/ha applications monthly over the "whole farm" between April and December. The rotation length varies between 15-25 days throughout the year. Some pastures are a bit open and lack density.

Simone Sharp: Simone won't have a fixed number of applications. The first will depend on the summer and the suspected nitrogen levels in the soil at the autumn break. She will continually "read" the season in regard to nitrogen responses. Rates will vary from 45 kg N/ha to 25 kg N/ha, depending upon growth rate and rotation length. Open and thin pastures are either re-sown or topped up in autumn. If the season extends, she will have more applications and feed less expensive feed.

The only way of identifying any differences in the outcome for Wally and Simone is in calculating the pasture consumed for the nitrogen applied in each case.

In the same way, on an annual basis, that dairy farmers assess per cow production relative to the level of concentrate fed (e.g. 550 kg of milk solids and 1.6 tonne of concentrate would generally be regarded as very acceptable) there needs to be an evaluation of pasture consumed relative to nitrogen applied.

A high nitrogen usage dairy farm has both an economic and environmental obligation to evaluate the practice, since, if nitrogen is being used excessively in relation to the response gained in pasture consumed then, it is very likely that the environmental impacts are significantly worse.

	Low Rainfall (600 – 700 mm)	Moderate Rainfall (700 – 900 mm)	High Rainfall (900+ mm)
Days of Observed Growth	190	235	280
Annual Applied N (kg/ha)	160 kg	200 kg	250+ kg
Urea equivalent (kg/ha)	348 kg	435 kg	544 kg
Pasture consumed T DM/ha	6	8	10

Table 2
The following table provides a guide to good pasture consumption figures at a range of annual rates of applied nitrogen for different rainfall areas.

What do your figures tell you?

For example, if your farm is situated in a high rainfall area, and the annual result is 8 TDM/ha pasture consumed at your nitrogen usage of 250 kg Nß/ha, then this is not optimum and all factors contributing to pasture consumption require investigation, especially the timing, the rate, and the site of applied nitrogen.

Equally, if you are in the 250+ kg N/ha group hopefully you are consuming more than 10 tonne, otherwise it needs to be reviewed to achieve >10 tonne, or reduce the nitrogen rate.

POSSIBLE FUTURE

Some countries beyond Australia have already started to introduce regulations to limit either the annual use of nitrogen or the rate which can be applied in any one application.

In the Netherlands, levels on grasslands (pasture) have been set at 250 kg N/ha, with lower rates on some sandy soil types. In New Zealand, negotiations are currently occurring with some regional authorities who intend introducing limits of 30 kg N/ha as the upper limit in any one application.

It is a much better situation if a dairy farmer firstly knows the annual rate used on their farm and, secondly, can indicate that they use a strategic and controlled approach, to optimise the economic response with due consideration for the environment.

The alternative “recipe approach” and general ignorance about annual rates does not help profit, the environment, or avoiding regulatory intervention.

The references used in this nitrogen usage summary provide useful sources of more detailed information

Guidelines for the use of nitrogen fertiliser on rain fed pasture in South Eastern Australia, Dr Richard Eckard University of Melbourne http://www.greenhouse.unimelb.edu.au/nitrogen/. This link contains:

- Competitive challenges - environmental rules are changing the rules of the game. Rabobank “Agriculture in focus” June 2014
- Dairy Farm Monitor Report 2013/2014 DEPI/Dairy Australia. www.depi.vic.gov.au/dairyfarmmonitor
- Greener Pastures project Western Australia jlucey@agric.wa.gov.au
- Historical client data OMJ Agricultural Consulting omj@dcsi.net.au
- Nitrogen Management presentation by Dr. Richard Eckard, Ellinbank 2014
- Using Nitrogen Confidently Seminar Proceedings April 1999, edited by Frank Mckenzie.

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Written by John Mulvany for GippsDairy. Funded by Dairy Australia and the Australian Government.