The 'Dairy Nitrogen Fertiliser Advisor' - a tool to predict optimal N application rates in grazed dairy pastures

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Abstract

Nitrogen (N) is the most limiting nutrient in intensive pasture-based dairy systems in Australia. To-date, decisions regarding N have relied mostly on generalised rules based on average pasture responses to applied N.

In this paper, a new web-based application called the ‘Dairy Nitrogen Fertiliser Advisor’ (the ‘N-Advisor’) is presented. Marginal analysis and profit-maximising principles are used to assist dairy farmers and their advisors when they are considering how much N to apply to a particular paddock for a particular grazing rotation.

The tool embodies rigorously defined response functions for pasture dry matter consumption that can be expected from the range of possible applications of N. These are based on dry matter yield responses of pasture to N fertiliser derived from 65 N fertiliser experiments undertaken across Australia over the past 40 years (which equate to nearly 6,000 data sets for N fertiliser - pasture yield response). A response function for the relevant region and season is calibrated by the decision-maker to the area of pasture to which the N fertiliser is to be applied.

Nitrogen fertiliser recommendations developed using the N-Advisor incorporate the marginal product derived from the calibrated response function, the costs of the fertiliser (as applied) and the value of the extra pasture consumed.

The N-Advisor allows users to perform what-if analyses, such as exploring the effect on the profit maximising level of N of changing the cost of N fertiliser applied, or changing the value of the dry matter consumed. The N-Advisor also enables risk associated with production outcomes to be taken into account.

The aim of the N-advisor is to provide production and profitability information that has the rigour and relevance to add value to farmer decision-making about their application of N.

Keywords

Nitrogen, dairy pastures, nutrient decision, economics, risk

Introduction

A ‘Generalised Model of N Fertiliser Responses’ for the Australian dairy industry (Chia and Hannah, 2013) that exhibits diminishing returns has been incorporated into an economic framework and embedded in a web based decision support tool. The tool, called the ‘Dairy Nitrogen Fertiliser Advisor’ (N-Advisor), aims to help dairy farmers decide how much nitrogen to apply to a particular paddock for a particular grazing rotation.

Current advice to industry on N fertiliser application rates is based on linear relationships, such as ‘an additional 10 kg extra DM for each kg N applied’ (Jacobs and Hargreaves, 2002), or (implicitly) on average responses whereby growers are advised to utilise additional feed “cost effectively” by comparing the cost of pasture with the cost of purchased feed (Dairy Australia, 2011(b)). However, if the assumed production function is linear, then the marginal product is constant, and the average product equals the marginal product; “under such conditions, if the value of the marginal product is greater than the price of the input, it pays to add the input in an infinite amount” (Bishop and Toussaint 1958, p48). Furthermore, if recommendations are based on average responses, then higher N application rates are applied than are warranted on profit maximisation grounds.

The N-Advisor takes into account the same factors as the current decision making approaches: i.e. the pasture response to additional N, the ‘as spread’ cost of N fertiliser, and the opportunity cost of pasture consumed as represented by the cost of bought-in substitutes. Where we differ is in the use of marginal analysis to assist dairy farmers and their advisors when they are considering how much N to apply to a particular paddock for a particular grazing rotation.

The N-Advisor is an output of the ‘Dairy Nitrogen for Greater Profit’ project funded by the Gardiner Foundation in response to the increasing challenges being faced by dairy farmers to use N fertiliser efficiently and to reduce potentially adverse environmental impacts through over-application of N fertiliser. The beta-version of the N-Advisor is accessible at http://vro.depi.vic.gov.au/dpi/vro/vrosite.nsf/pages/nitrogen-advisor.

Method

Response functions

The ‘Generalised Model of N Fertiliser Responses’ for the Australian dairy industry was developed using data compiled from fertiliser trials carried out in Australia between 1955 and 2009; the majority being conducted during the 1960s and 1970s. This work involved gathering and standardising data and meta data (such as location, dates, soil type etc.) from 65 identified N fertiliser experiments, which contributed to approximately 6000 N fertiliser – pasture response data sets.

Chia and Hannah (2013) analysed the fertiliser – pasture response data sets and developed a non-linear mixed effects model to describe the production response. The model was based upon the exponential Mitscherlich function and comprised fixed effects for Australian State and season (spring, summer, autumn, winter), soil phosphorus status (limiting or non-limiting) and harvest type (initial or residual), and random effects for location and partition (where ‘partition’ refers to a single trial or sub-section of a trial). The analysis was hampered by the extent of the data, patchy availability of meta data, only two nitrogen rates applied in the majority of trials, skewed representation of states, regions and times, and selection biases arising from trial protocols. Despite these limitations, the generalised model usefully predicts pasture response to applied N as a proportion of maximum obtainable yield when applied *N* is unlimiting and has had sufficient time to express itself.

The response functions for each Australian state and season embedded in the N-Advisor and are scaled to equal 1. Parameter values used are for non-residual (initial) yields and non-limiting soil phosphorus. Mathematically, the N response functions are as follows:

$$y = \alpha(1 - e^{-\beta-\lambda N}) + \epsilon \qquad (1)$$

where

y is output from the added input N scaled as a proportion of maximum obtainable yield,

α is the maximum attainable yield set at 1,

β is an implicit measure of existing soil N,

λ is a constant and it is a measure of the curvature of the response function, and

ϵ is the error term.

The values for β vary with the fixed effects of Australian state and season, as illustrated for Victoria in Figure 1. A full set of values for β are shown in Appendix 1. The value of λ is 0.026 for all locations and seasons.

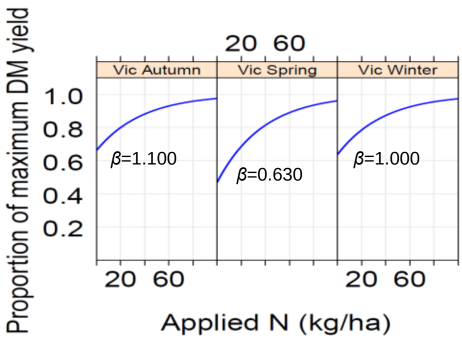

Fig. 1. Seasonal N response curves for proportional DM yield for Victoria

As modelled, α is a proportional response and must be calibrated to the farm paddock by a farmer and/or advisor using their judgement to form a subjective estimate of yield at a defined level of N application. According to Chia and Hannah (2013, p16), absolute values for α (α^*), for purposes of real-time, on-site prediction may be estimated from an estimated DM yield with zero applied N (y_0)”, as follows:

$$\boldsymbol{\alpha^* = y_0/(1 - e^{-\beta})} \qquad (2)$$

where

$\boldsymbol{\alpha}^*$ the absolute value for the maximum attainable yield

y_0 is the expected pasture consumption (kg DM/ha) at 0 applied *N.”*

This method is generalised in the N-Advisor. To determine α^* farmers and/or their advisors are asked to estimate the level of DM/ha that would be produced and consumed in the paddock that is about to be fertilised for any defined quantity of extra N/ha applied. Specifically, farmers and/or their advisors are asked to provide:

1. the most likely post-grazing dry matter mass in the area to be fertilised
2. the most likely pre-grazing dry matter mass in the area to be fertilised
3. the N rate (zero or non-zero) judged most likely to achieve these outcomes

Expected pasture consumption (or ‘utilisation’) is determined by subtracting the expected post-grazing dry matter mass from the pre-grazing dry matter mass.

The profit maximising N

The decision rule to maximise profit from using a variable input, such as N, is to apply the input up until the point where the return from an extra kilogram of N applied (marginal revenue, MR_n) just exceeds the marginal cost (MC). This rule assumes full information, no constraints on capital and all other inputs are held constant.

MR is the value of the output (P_y), which in this case is the equivalent market value of the dry matter (DM) consumed by the dairy herd, multiplied by the marginal product (MP_n). *MC* is the N cost ‘as applied’ (P_n). So $P_y * MP_n = P_n$.

Alternatively, $MP_n = P_n/P_y$. This is the same as saying the profit maximising N use is where the slope of the response function (MP_n) equals the ratio of the cost of the input to the value of the output. The profit maximising amount of N applied decreases with the increasing cost of fertiliser and increases with the increasing value of the DM produced and consumed.

Using this latter representation of the profit maximising rule a number of measures are derived and reported to users. These being:

- The pasture consumed from the last unit (kg) of N applied is obtained from the derivative or slope of the calibrated response function.

$$MP_n = \alpha^* \lambda e^{(-\beta - \lambda N)} \quad (3)$$

- The profit maximising N (*N**) application rate is obtained by equating equation 3 to the ratio of the cost of the input to the value of the output and solving for N (equation 5).

$$\alpha^* \lambda e^{(-\beta - \lambda N)} = P_n/P_y \quad (4)$$

$$\Rightarrow N^* = (1/-\lambda)\big(\ln((P_n/P_y)\,/(\alpha^* \lambda)\big) + \beta) \quad (5)$$

- Pasture consumption at the profit maximising N rate is calculated by substituting $N*$ for N in the response function.

$$y = \alpha^{*}(1 - e^{-\beta-\lambda N^{*}}) \quad (6)$$

- The Marginal Revenue (MR_n) on the money invested in the last unit of N applied (expressed as a decimal) is calculated as shown in equation 7.

$$MR_n = \left(\left(\alpha^{*}\lambda e^{(-\beta-\lambda N)}P_y\right) - P_n\right) / P_n \quad (7)$$

'As spread' cost of N

The cost of the nutrient N is derived from the price for urea. There are many N-type fertilisers, however, urea was chosen as it is a single-nutrient fertiliser with a high N content of 46%. Hence urea is usually the cheapest source of N for pasture-based dairies in southern Australia, and the most commonly used (comprising about 80% of the total).

The cost of the nutrient N (P_n) is derived from the price for urea fertiliser (P_f) according to the following formula:

$$P_n = P_f / Pct_n \quad (8)$$

where,

P_f is the price of urea fertiliser delivered and spread.

Pct_n is the percentage of elemental N in urea (46%).

Data on the annual average price of urea (delivered) for the past 30 years, were obtained from ABARES (2015). An additional $65/tN was allowed for spreading, based on published contract rates for fertiliser spreading (The Weekly Times, 2013).

Equivalent market value of the nutrition supplied by pasture

A simple, robust way of valuing the extra pasture consumed by the grazing animals as a result of the added N is to use market opportunity costs and the replacement value of an equivalent quantity of metabolisable energy (ME). This is the approach used in the N-Advisor.

Johnson and Hardin (1955) identified three different values of pasture – the replacement or acquisition value, the salvage value, and the use value on individual farms (MVP or MR_n). The replacement value that we recommend using in the N-Advisor may or may not coincide with the use value, and is typically much higher than the salvage value due to high handling and transportation costs plus imperfections in the market (Figure 2).

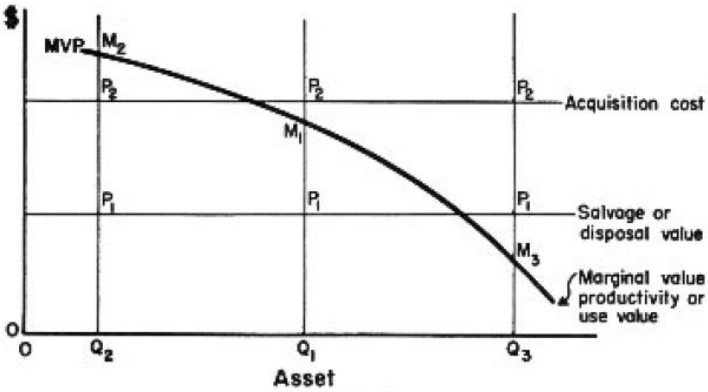

Fig. 2. Upper and lower limit for the market value of pasture forage

It is assumed that inputs are purchased or sold in perfectly competitive markets and the farm can get all it wants or sell all it wants without affecting prices. Hence the supply curve for the substitute input is horizontal at the prevailing price (P_2 in Figure 2), which is influenced by the season and the supply of sources of ME at this time. The MVP of forage as a feed falls as more forage is used. It is peculiar to the technology employed and the circumstances of individual farms and the value of the product for which the ME is to be used to produce at this time, i.e. the milk price at the time of year the decision to add N is being made. In contrast to the easy access to current market prices for hay and grain (DA, 2016) computation of the VMP is not practical for the current purpose.

From a profit maximising perspective, where pasture is produced and used in a farm system its value must be greater than what it would return if it was sold for agistment or fodder conservation (P_1 in Figure 2) and less than the value of an equivalent substitute input to the system (P_2). If the pasture was worth more than the substitute input (say M_2), then the substitute input would be used and the pasture would not be used in the farm system. If the pasture was worth less than the salvage value (say M_3), then logically the pasture would be baled up and sold or agisted out. At M_1, there would be no reason to acquire more of the asset or dispose of it. In time, however, the introduction of a technology or a change in milk prices could easily shift the MVP curve to the right or left, thus increasing or decreasing Q_1M_1 in Figure 2.

Recent Australian research has shown that a feed grain or concentrate (such as feed barley) is the appropriate reference feed to use (as opposed to pasture hay), and that the most important value determining attribute of the feed is metabolisable energy (ME) (as opposed to crude protein) (Lewis *et al.*, 2015). Hence, after Doyle and Elliot (1983), the replacement value (P_y) is estimated according to the following (though no utilisation rate was included for simplicity):

$$P_y = P_b * ME_y/ME_b * U \qquad (9)$$

where,

P_b is the barley price (delivered) at the time of year the N fertiliser decision is being made

ME_p is the ME concentration in pasture on a dry weight basis

ME_b is the ME concentration in barley on a dry weight basis, and

U is the utilisation rate.

Data on annual average prices for feed barley for the past 30 years, were obtained from ABARES (2015). The ME concentration of barley is estimated at 12.3 MJ/kg DM (Agriculture Victoria, 2015a). The nutritive characteristics of perennial ryegrass pasture varies with the region and season in which it is grown (Agriculture Victoria, 2015b), we used a figure of 11.5 MJ/kg DM.

Accommodating risk in expected pasture consumption

To account for risk and uncertainty in production outcomes, the N-Advisor allows for variation around the ‘best bet’ level of extra pasture consumed.

In practice the actual DM consumed that will result from an application of N will differ from the best estimate that is made at the time of the decision. Actual pasture DM consumed cannot be predicted with precision, except by chance. Even if the response function that is applied to the paddock was accurately predicted, the resulting output that is consumed will depend on the extent and timing of the subsequent rainfall and temperature events that will occur during the grazing season, as well as the management of the animals at the time of grazing. This situation applies of course to N fertiliser decisions made with or without using the N-Advisor.

Thus an important part of the process of using the N-Advisor to inform the decisions farmers make about applying N is for them to consider a reasonable range of the possible eventual DM consumed as a result of the decision to apply a particular quantity of N. Then, the decision-maker is in a position to make a well informed ‘bet’. To this end, the N-Advisor also identifies the most profitable N application for the cases where the actual DM available to be consumed is 20% above or below the most likely level of pasture consumption.

Data

The optimum N application rate was determined for the scenario described in Table 1. A sensitivity analysis was undertaken to accommodate the historical range of fertiliser and pasture values.

The scenario is for a Victorian perennial ryegrass pasture growing relatively rapidly during spring. The pre-grazing dry mass is about 2,500 kg DM/ha and the N rate a grower would normally use to achieve this outcome is 50 kgN/ha (Dairy Australia, 2011(a)). The post-grazing dry mass of 1,500kg DM/ha is consistent with recommended pasture management strategies (Dairy Australia, *op.cit.*).

Prices shown in the table are the annual averages in real terms for the past 32 years. Data on annual average estimates of the equivalent market value of pasture and the ‘as spread’ cost of N are shown in Appendix 2. Also shown in the appendix is the price ratio. Prices adjusted for inflation (using the PPI) are graphed below.

Table 1. Input data and values used in the scenario

Variable	Description	Value
Season	Pasture response to N varies throughout the growing season. Select from spring, summer, autumn or winter.	spring
Region	Pasture response to N varies from location to location. Select from NSW, Queensland, South Australia, Tasmania, Victoria or Western Australia	Victoria
Most likely post-grazing dry mass (kg DM/ha)	The most likely residual mass following grazing for the current rotation. ..based on expected weather condition over the next few weeks	1,500
Most likely pre-grazing dry mass (kg DM/ha)	The most likely pre-grazing mass for the prevailing conditions (soil temperature and moisture) over the current rotation for your nominated N application.	2,500
Usual Nitrogen application (kg N/ha)	The amount of urea (say 100kg/ha) applied multiplied by 0.46. to achieve the above outcomes.	50
Nitrogen cost 'as spread' ($/t)	The 'as spread' cost of urea divided by 0.46.	1398
Equivalent market value of pasture ($/t DM)	The current barley price multiplied by the ME concentration in pasture divided by the ME concentration in barley.	245

The real N cost 'as spread' has declined by -0.7% p.a. over the past 32 years. It has averaged $1,398/t N, with a range of one standard deviation (SD) around the mean of $1,190/t N to $1,607/t N (figure 3). The real N cost 'as spread' fell to a minimum of 1,031 in 2002/03 and reached a maximum of 1,942 in 2008/09, when the global oil price crisis caused the cost of natural gas (a key component in the fertiliser manufacturing process) spiked.

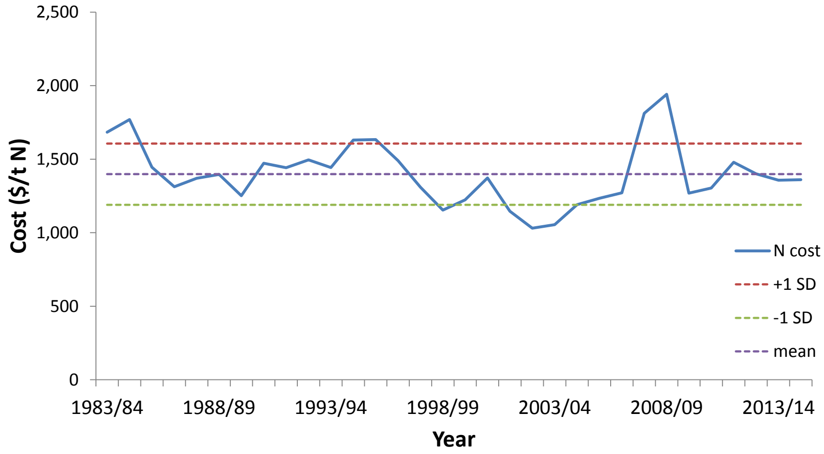

Fig. 3. N cost 'as spread' (real)

In real terms the equivalent market value of pasture 'delivered' averaged $245/t DM, with a range of one SD around the mean of $200/t DM to $289/t N (figure 4). The minimum was $187/t in 1998/99 and the maximum was $352/t in 2002/03 when there were drought-induced shortages in Australia, and hence extremely high prices for grain, fodder and alternative feedstuffs.

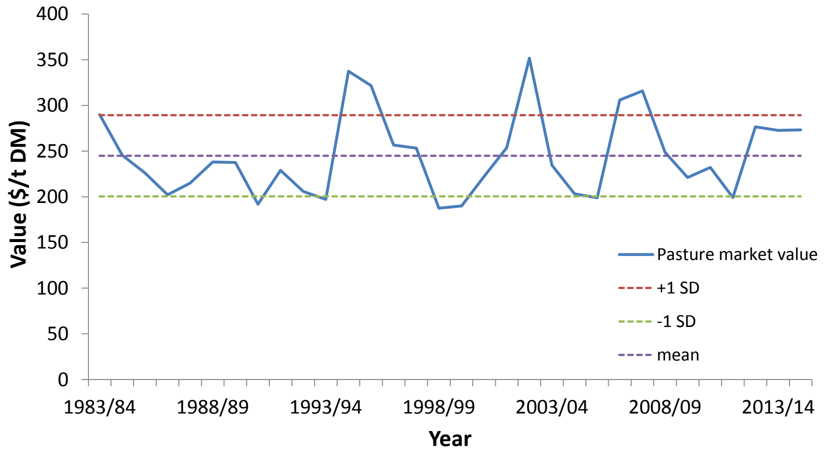

Fig. 4. Equivalent market value of pasture value 'delivered' (real)

The price ratio of N cost to pasture value has been relatively stationary at about 5.5 (Figure 5). However, there have been a number of peaks and troughs over this 32-year period; notably the peak in the price ratio of 7.6 in 2008/09 due to historically high fertiliser prices, and the trough of 2.7 in 2002/03 when low fertiliser prices coincided with the historical peak in feed grain prices.

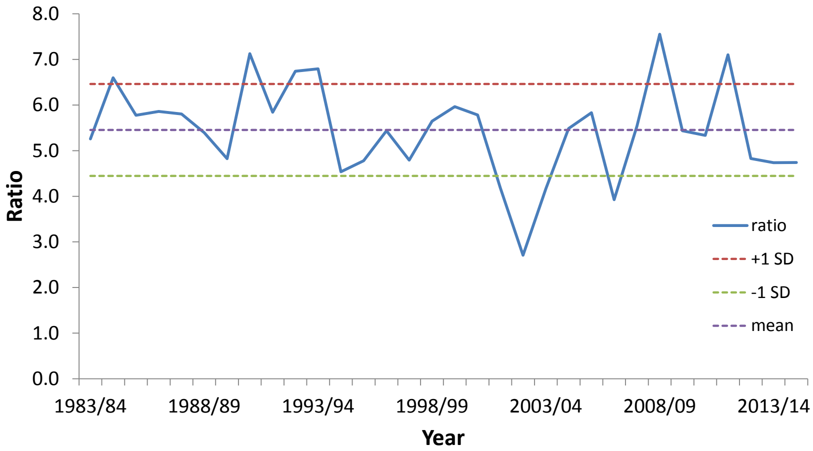

Fig. 5. Ratio of N cost to pasture value

Results & Discussion

For the scenario under investigation, Table 2 shows the total DM consumed, average pasture consumed per kg N applied (sometimes called the "N response efficiency"), pasture consumed for the last kilogram of N applied (the marginal product), and the marginal return on the last dollar invested in N over a range N application rates (0 to 100 kg N/ha). Similar results are displayed in the N-Advisor (Figure 6)

Fig. 6. Dairy N Fertiliser Advisor Interface

The ‘best guess’ profit maximising N is 40 kg N/ha (equivalent to 87 kg urea). At 40 kg N/ha, the marginal return on the last dollar invested in N expresses as a percentage is 0%. The idea that maximum profit is earned when the last unit of input makes a profit of zero percent sometimes confuses, causing people to wonder how is it that profit can be maximised when only a tiny return is made on the last unit of input. The point is that by using other units previously up to this last unit, the producer has earned bigger profits on all the earlier units. Adding all the profits from each unit gives total profit from all units used. To accommodate borrowings, the grower might want to compare the rate of return on the last dollar invested in N with the opportunity cost of capital to determine the optimum rate of N.

At 40 kg N/ha, the pasture consumed for the last kilogram of N applied (the marginal product) is 5.7, equivalent to the price ratio. The average pasture consumed per kg N applied is 10 kg N/ha. This latter figure is consistent with current advice to industry to assume that additional 10 kg extra DM for each kg N applied (Jacobs and Hargreaves, 2002). If growers were to estimate their N usage by comparing the average cost of pasture consumed (N cost ‘as spread’ divided by average pasture consumed) to the cost of purchased feed (as described in Dairy Australia, 2011(b)), then there is effectively no upper limit to the amount of N to apply; and for applications above 40 kg N/ha, growers would be losing money.

The N-Advisor allows users to perform ‘what-if’ analysis, such as exploring the effect of pasture underutilisation (by changing the estimated post-harvest mass), changing the cost of N fertiliser, or the value of the DM consumed. Quite large annual changes in the cost of N fertiliser are also possible, as discussed earlier.

The value of the DM consumed can vary according to the time of the year, be influenced by the cost of alternative sources of ME which in turn are influenced by the seasonal supply of ME and the value of the end product for which it is used (i.e. the milk price). In the data section we presented annual average prices for feed barley, that we used in estimating replacement values. In practice, growers can readily source current prices for feed stuffs delivered on-farm from Dairy Australia’s “Hay and Grain Market Report” (Dairy Australia, 2016).

Reflecting seasonal pasture growth patterns, Chapman and Kenny (2005) have shown (using biophysical models of pasture growth, farm system models and financial analysis tools) that the use value of dairy pasture in southwest Victoria is at the higher end of the historical estimates presented in late autumn /winter, but at the lower end in spring.

Table 2 Scenario results

N applied	Urea equivalent	Pasture DM consumption	Additional consumption compared with no N	Additional consumption compared with no N	Average pasture consumption per kg N applied	Pasture consumption from last kg of N applied	Value of pasture consumed from last kg of N applied	Cost of last kg of N applied	Return from last kg of N applied	Rate of return on last $ invested in N
(kg N/ha)	(kg Urea/ha)	(kg DM/ha)	(kg DM/ha)	(%)	(kg DM/kg N)	(kg DM/kg N)	($/kg N)	($/kg N)	($/kgN)	(%)
0	0	546	-	-	-	-	-	-	-	-
10	22	689	143	26%	14.3	12.5	3.07	1.40	1.67	119%
20	43	799	253	46%	12.7	9.6	2.36	1.40	0.96	69%
30	65	884	338	62%	11.3	7.4	1.82	1.40	0.42	30%
40	87	950	403	74%	10.1	5.7	1.40	1.40	0.00	0%
50	109	1,000	454	83%	9.1	4.4	1.08	1.40	-0.32	-23%
60	130	1,039	492	90%	8.2	3.4	0.83	1.40	-0.57	-41%
70	152	1,069	522	96%	7.5	2.6	0.64	1.40	-0.76	-54%
80	174	1,092	545	100%	6.8	2.0	0.49	1.40	-0.90	-65%
90	196	1,109	563	103%	6.3	1.6	0.38	1.40	-1.02	-73%
100	217	1,123	577	106%	5.8	1.2	0.29	1.40	-1.11	-79%

The baseline results for the profit maximising N rate in Table 2 are highlighted in Table 3. Also shown in this Table are the profit maximising N application rates and pasture consumption for a change in expected pasture consumption (20% worse or 20% better than expected in brackets), and high and low values for the fertiliser cost and the value of pasture consumed (based on the one standard deviation about the historical mean in real prices). The Table shows that the profit maximising amount of N applied increases not only as the expected pasture consumption increases, but also as the cost of fertiliser decreases in relation to the value of pasture (as reflected in the price ratio shown).

Table 3. Sensitivity analysis for profit maximising N application rates

N cost 'as spread' ($/t N)	Equivalent market value of pasture ($/t DM)	Ratio of N cost to pasture value	Profit maximising N	Pasture consumption (kg DM/ha)
1607 (high)	200 (low)	8.0	27 (18*-34)	861 (624-1095)
1398 (average)	245 (average)	5.7	40 (32-47)	950 (719-1184)
1190 (low)	289 (high)	4.1	53 (44-60)	1013 (777-1247)

Total pasture consumption at the profit maximising N rate is 950 kg DM/ha. Assuming a daily pasture intake of 15 kg DM/cow/day, this level of pasture production will support a grazing pressure of 63 cows/ha/d. If the number of cows grazing is not enough to harvest the DM produced, then the post-harvest residual entered in the N-Advisor should be increased; and the profit maximising amount of N and total pasture production will adjust downwards accordingly.

Conclusions

In this paper, a new web-based application called the Dairy Nitrogen Fertiliser Advisor (the ‘N-Advisor’) was presented. The tool embodies marginal analysis and profit-maximising principles to assist dairy farmers and their advisors when they are considering how much N to apply to a particular paddock for a particular grazing rotation.

The N-Advisor allows users to perform what-if analyses, such as exploring the effect on the profit maximising level of N of changing the cost of N fertiliser applied, or changing the value of the dry matter consumed. The N-Advisor also enables risk associated with production outcomes to be taken into account.

The N-advisor provides production and profitability information that has the rigour and relevance to add value to farmer decision-making about their application of N.

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Appendix 1: β values for the generalised experimental response function

Region	Season	β value
New South Wales	Autumn	1.200
	Spring	0.680
	Winter	0.400
Queensland	Summer	0.250
South Australia	Autumn	0.440
Tasmania	Autumn	0.880
	Spring	0.740
	Winter	0.990
Victoria	Autumn	1.100
	Spring	0.630
	Winter	1.000
Western Australia	Autumn	1.100
	Winter	1.400

Source: Chia and Hannah (2013).

Appendix 2: Historical pasture and fertiliser values (nominal)

Year	Feed barley 'delivered' ($/t)[a.]	Equivalent market value of pasture ($/t DM)	Urea 'delivered' ($/t)[a.]	N cost 'as spread' ($/t)	Ratio of N cost to pasture value
1983/84	123	118	286	687	5.3
1984/85	110	106	322	765	6.6
1985/86	109	105	280	674	5.8
1986/87	106	102	276	665	5.9
1987/88	118	114	303	724	5.8
1988/89	142	137	340	804	5.4
1989/90	152	146	324	770	4.8
1990/91	124	119	390	913	7.1
1991/92	147	142	381	893	5.8
1992/93	131	126	390	913	6.7
1993/94	127	123	383	898	6.8
1994/95	227	219	456	1057	4.5
1995/96	227	218	480	1109	4.8
1996/97	181	174	435	1011	5.4
1997/98	179	173	381	893	4.8
1998/99	134	129	334	791	5.6
1999/00	141	136	372	874	6.0
2000/01	173	167	444	1030	5.8
2001/02	203	195	376	883	4.2

2002/03	303	292	363	854	2.7
2003/04	204	197	377	885	4.2
2004/05	182	175	442	1026	5.5
2005/06	182	176	471	1089	5.8
2006/07	295	284	512	1178	3.9
2007/08	347	334	852	1917	5.5
2008/09	263	253	878	1974	7.6
2009/10	221	212	531	1220	5.4
2010/11	238	229	563	1289	5.3
2011/12	208	200	653	1485	7.1
2012/13	284	274	608	1387	4.8
2013/14	281	271	590	1348	4.7
2014/15	284	273	596	1360	4.7
CAGR[b]	2.7%	2.7%	2.4%	2.2%	-0.3

[a] Source: ABARES (2015)
[b] Compound Annual Growth Rate