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

Kerry Stott, Bill Malcolm, Cameron Gourley

Contributed presentation at the 60th AARES Annual Conference,
Canberra, ACT, 2-5 February 2016

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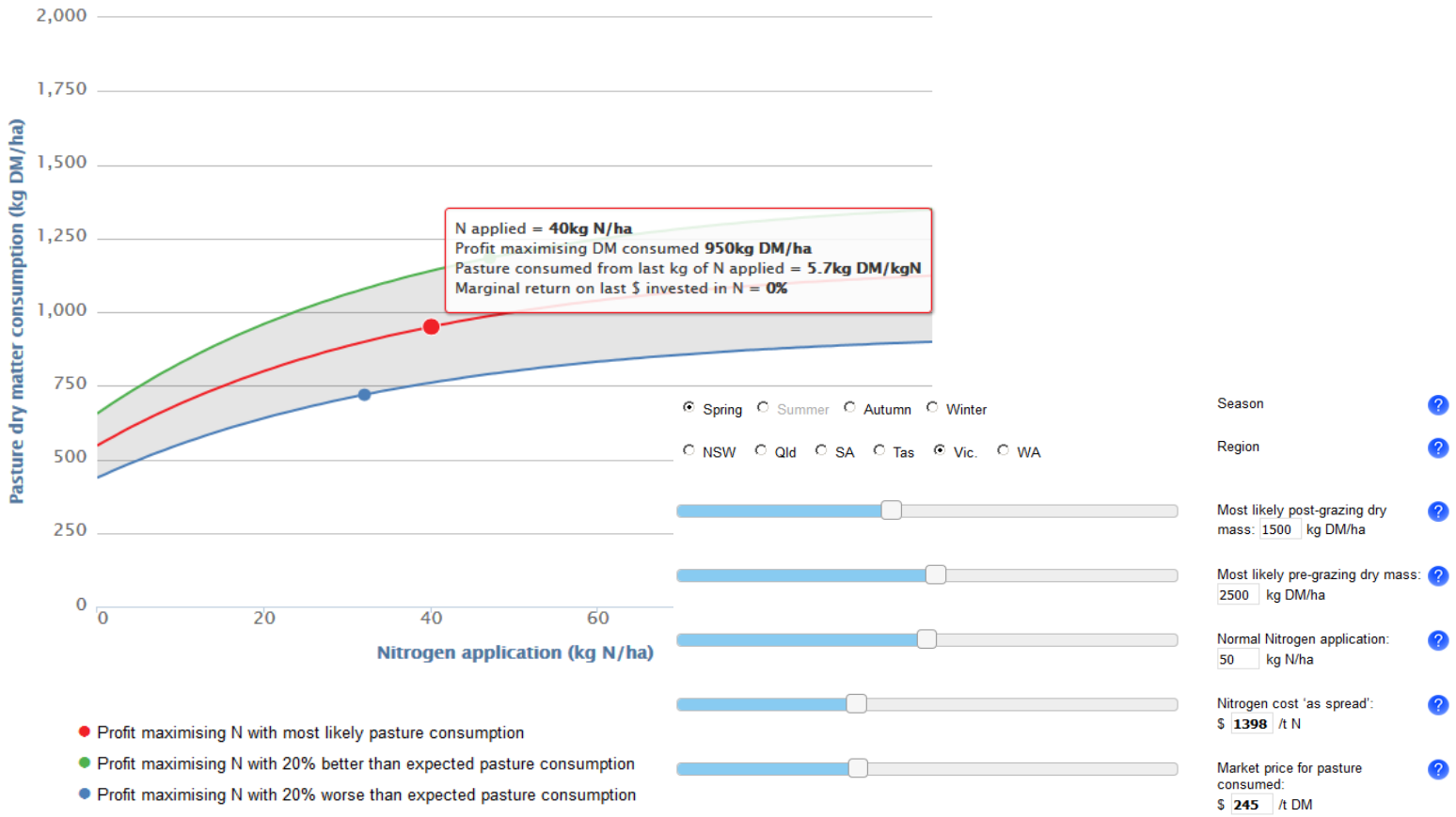
Dairy N Fertiliser Advisor Interface……

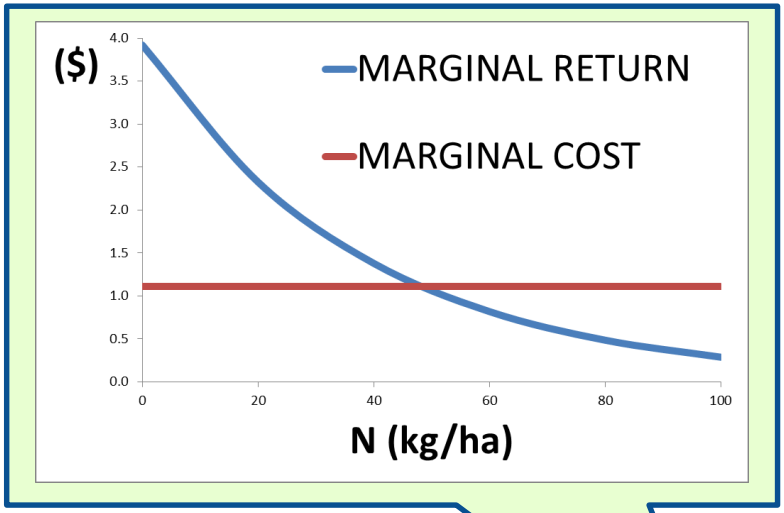
Select your season and region

Select the most likely pre and post-grazing DM for the current rotation, and the amount of Nitrogen you would normally use (if any) to achieve these outcomes

Provide your estimate of the 'as spread' cost of Nitrogen and the market value of the extra pasture consumed (based on the market price for substitute ME)

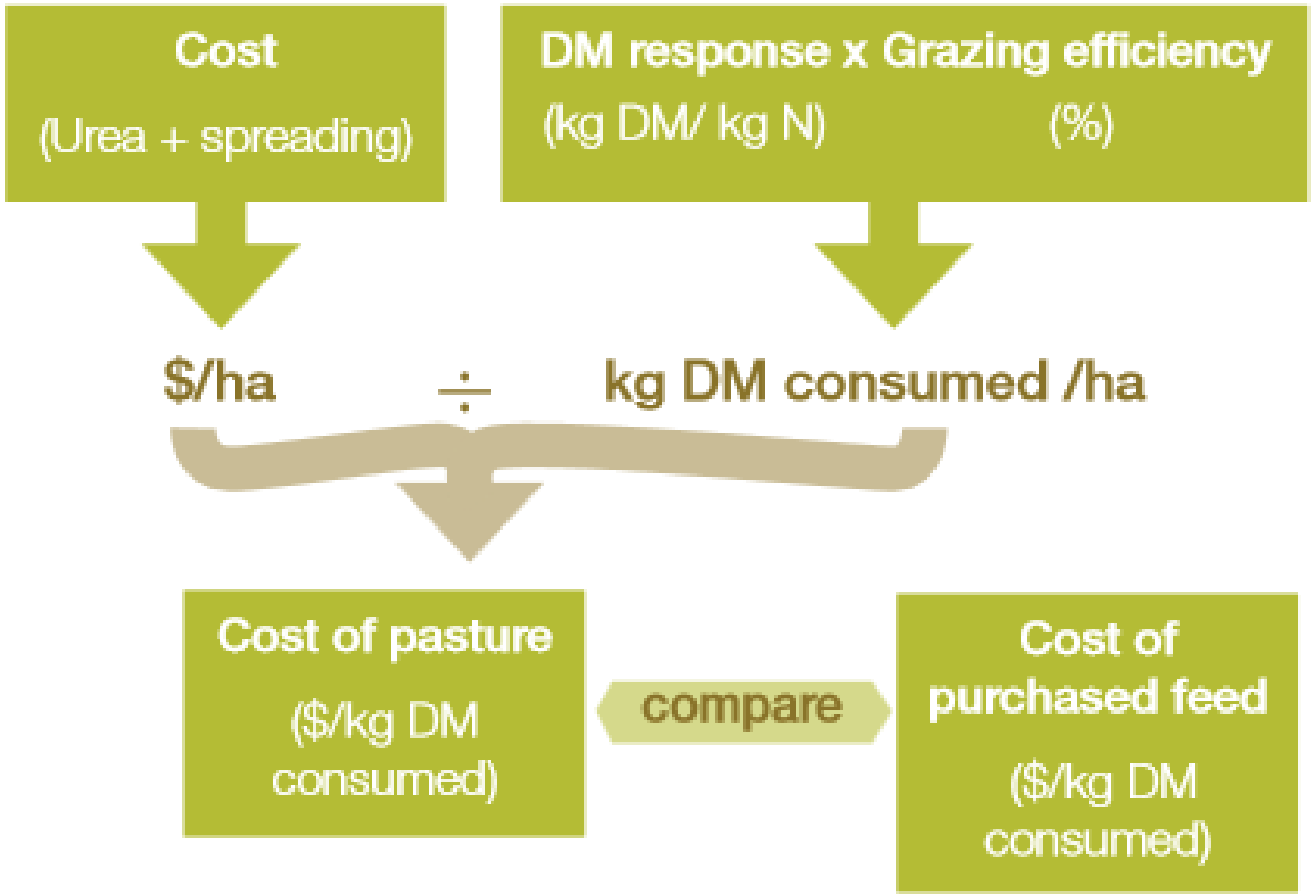


Economic approach



With their advisors dairy farmers will be able to test their intuition about how much N to apply to a particular paddock, for the particular time of the year, so that the last kilogram adds to profit.

Current approach …….



Outline

- Some simple maths
  - The generalised N response function
  - The profit maximising N rate
- Model calibration
- Market data
- A scenario
- Results
- Conclusions

Some simple maths

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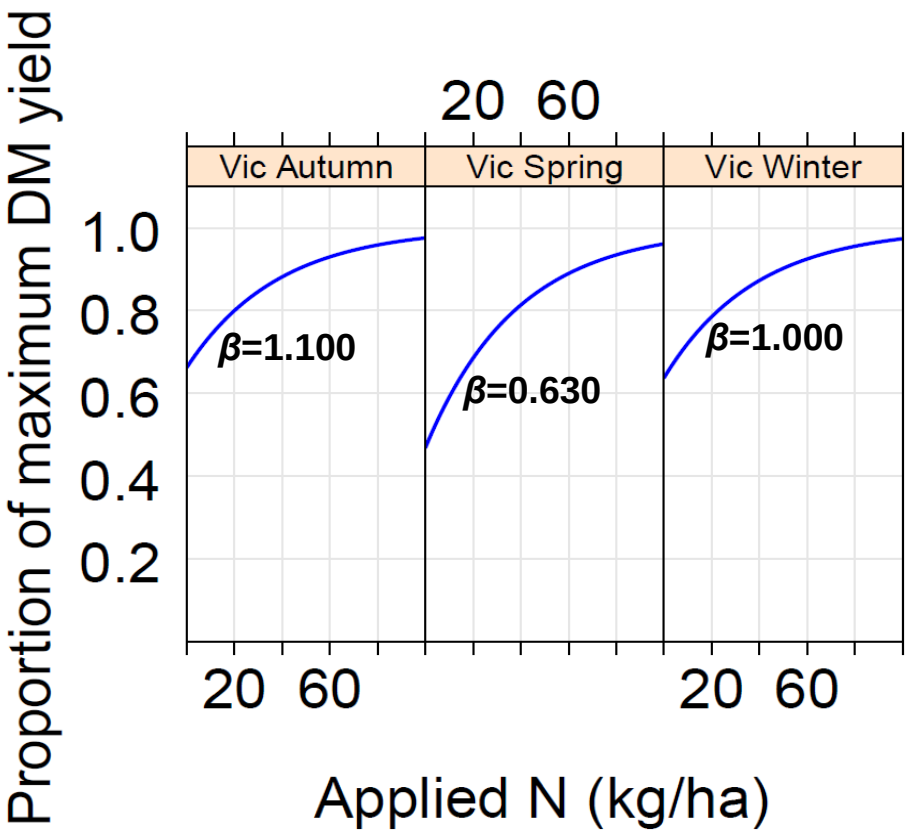
Model of N fertiliser responses

- $Y = \alpha*(1-\exp(-\beta-\lambda*N))$

3 parameters….

- Maximum attainable yield when N applied is large and has had sufficient time to express itself ($\alpha = 1$)
- Implicit measure of existing soil nitrogen (β, varies with season and State)
- Measure of curvature (λ, constant)



Profit maximising N rate (N^*)

N* was obtained by equating the slope of the production function to the ratio of the cost of the input (P_n) to the value of the output (P_{dm}).

$$\alpha*\lambda*\exp(-\beta-\lambda*N) = P_n/P_{dm}$$

$$=> N^* = (1/-\lambda)*((\ln((P_n/P_{dm})/(\alpha*\lambda)))+\beta)$$

Calibration

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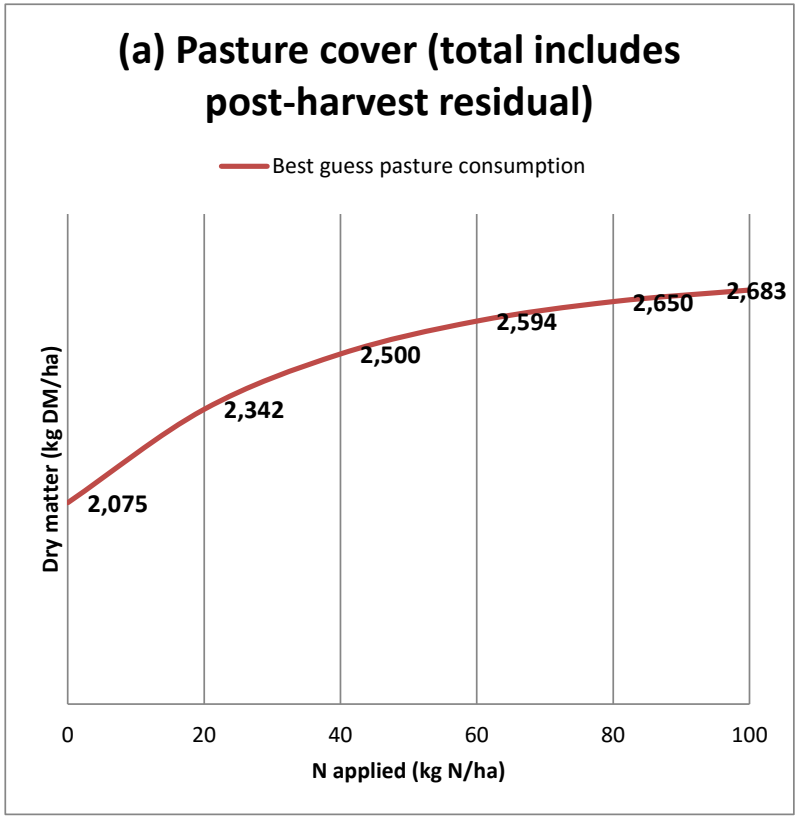
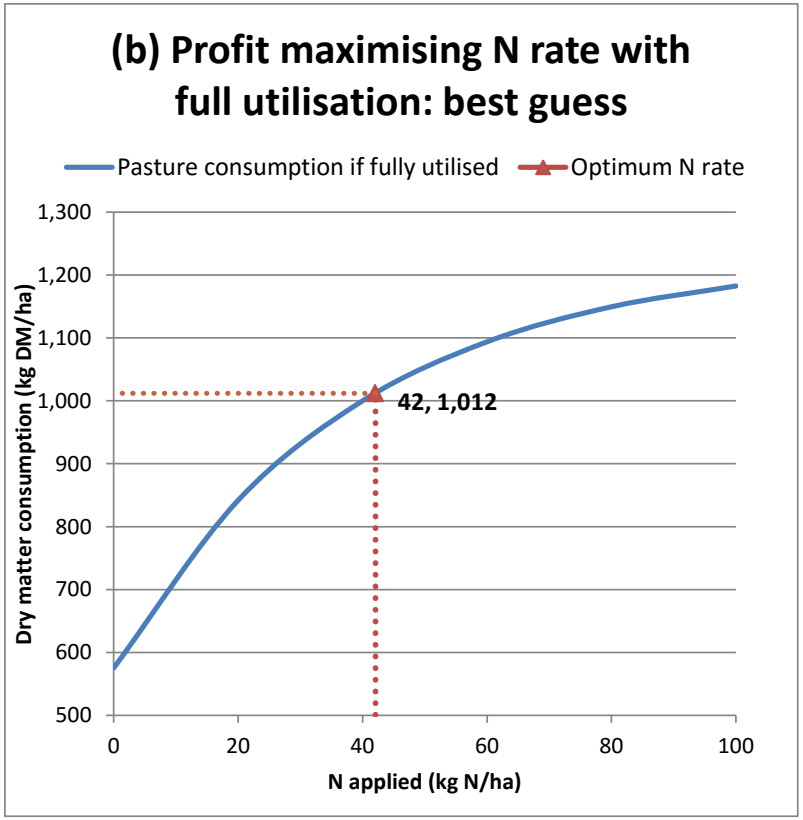
Pre-and post grazing dry-mass:

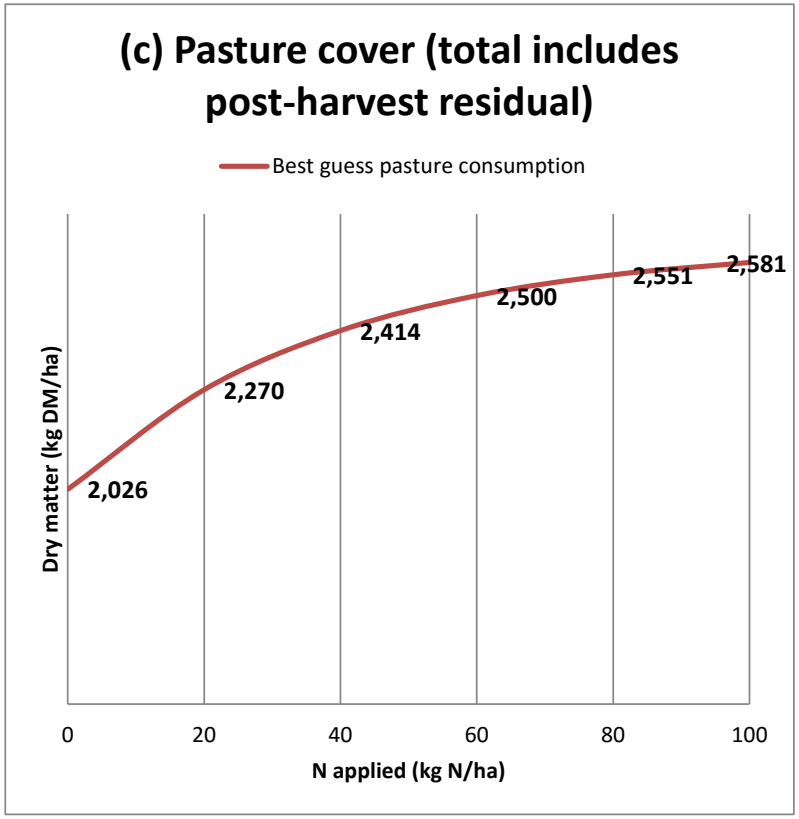
Picture showing post-grazing residual of 4-6 cm, equivalent to 1,500-1,600 kg dry matter (DM) per ha. Source: http://www.dairyaustralia.com.au/~/media/Documents/Animal%20management/Feed%20and%20nutrition/thirtythirty/3030%20-%20PRG%20I%20-%20Max%20growth%20and%20nutritive%20value%201.pdf

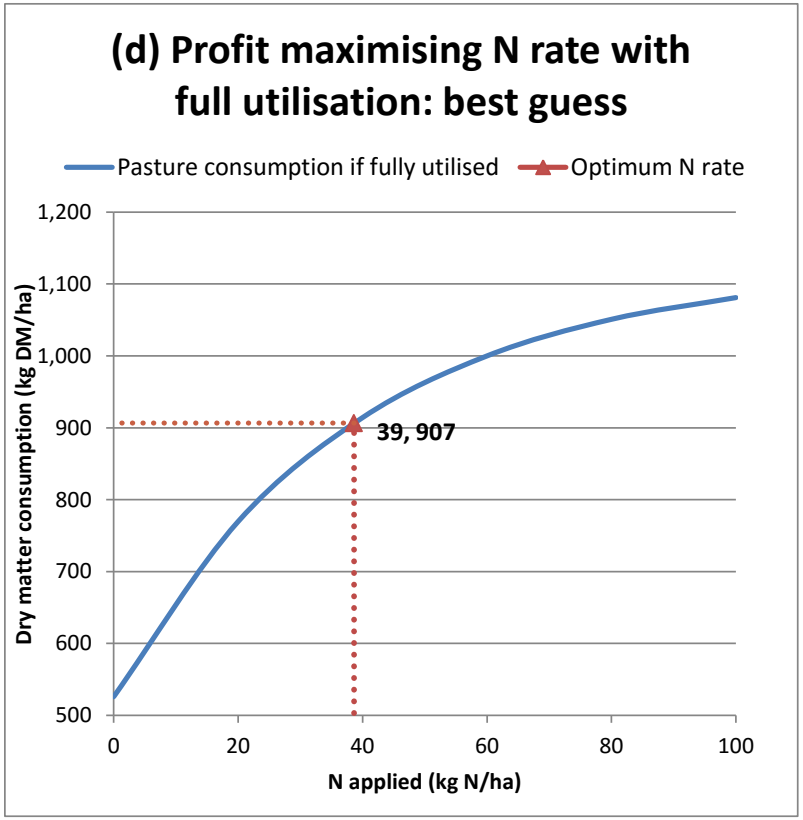
More productive pasture: pre-grazing dry mass of 2,500 kg DM/ha achieved with 40kg N/ha





Less productive pasture: pre-grazing dry mass of 2,500 kg DM/ha achieved with 60kg N/ha





Market data

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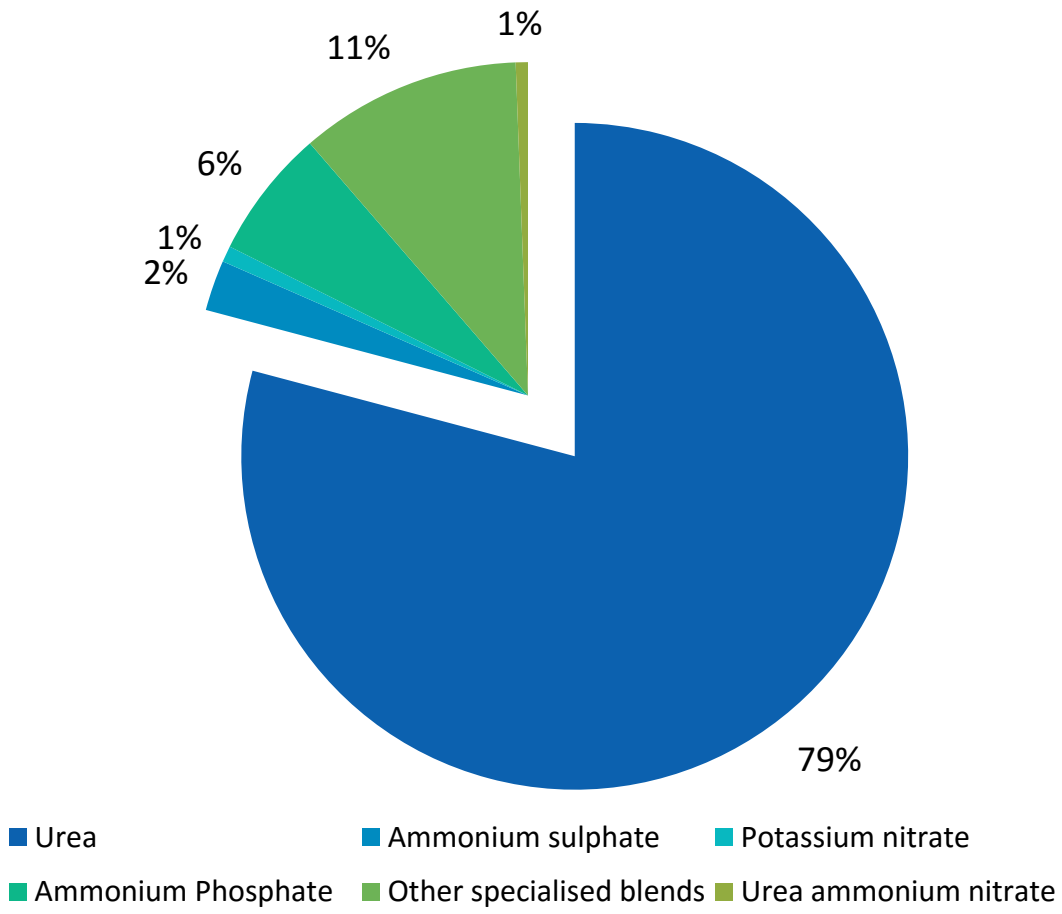
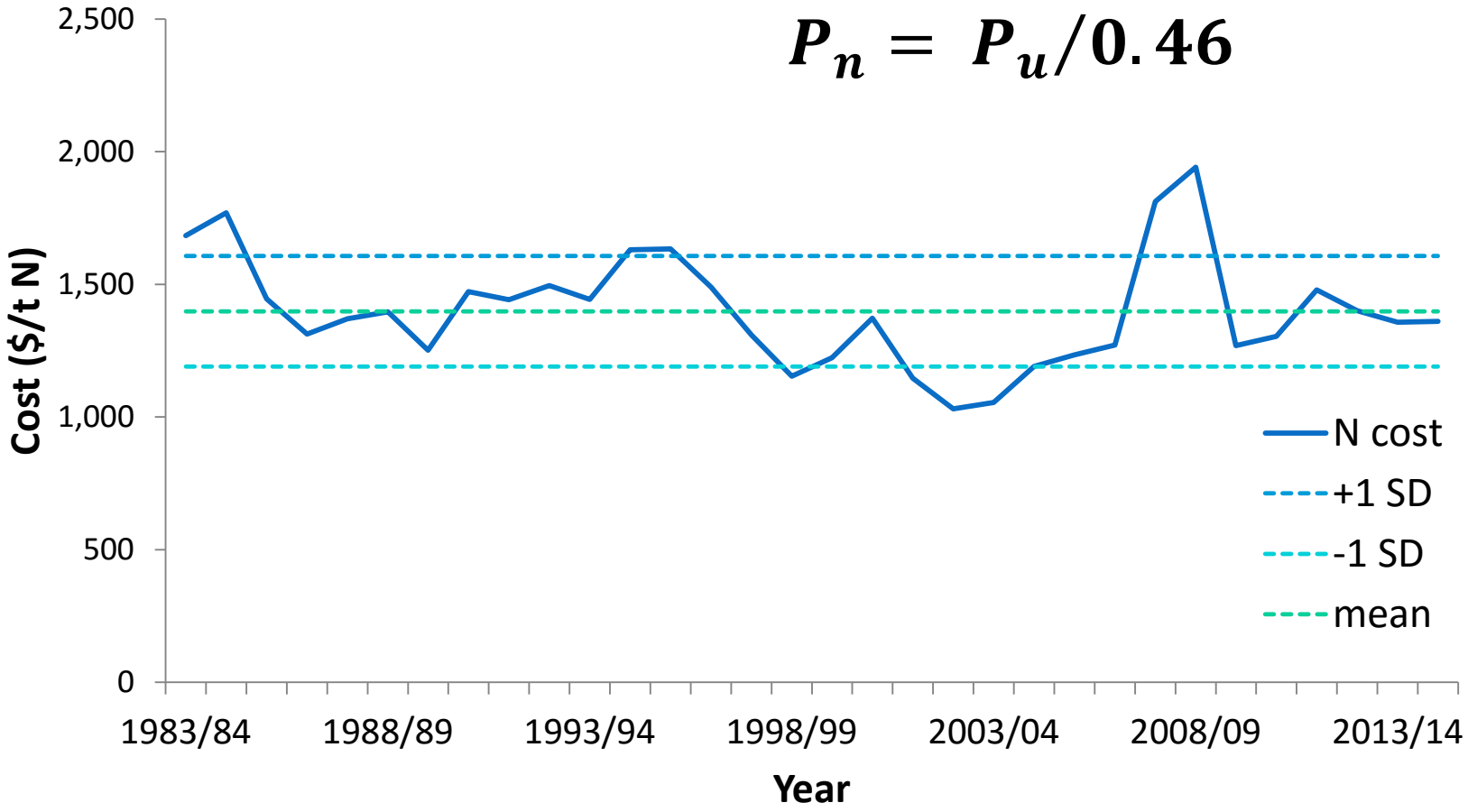
Major N-type fertilisers used in the dairy industry

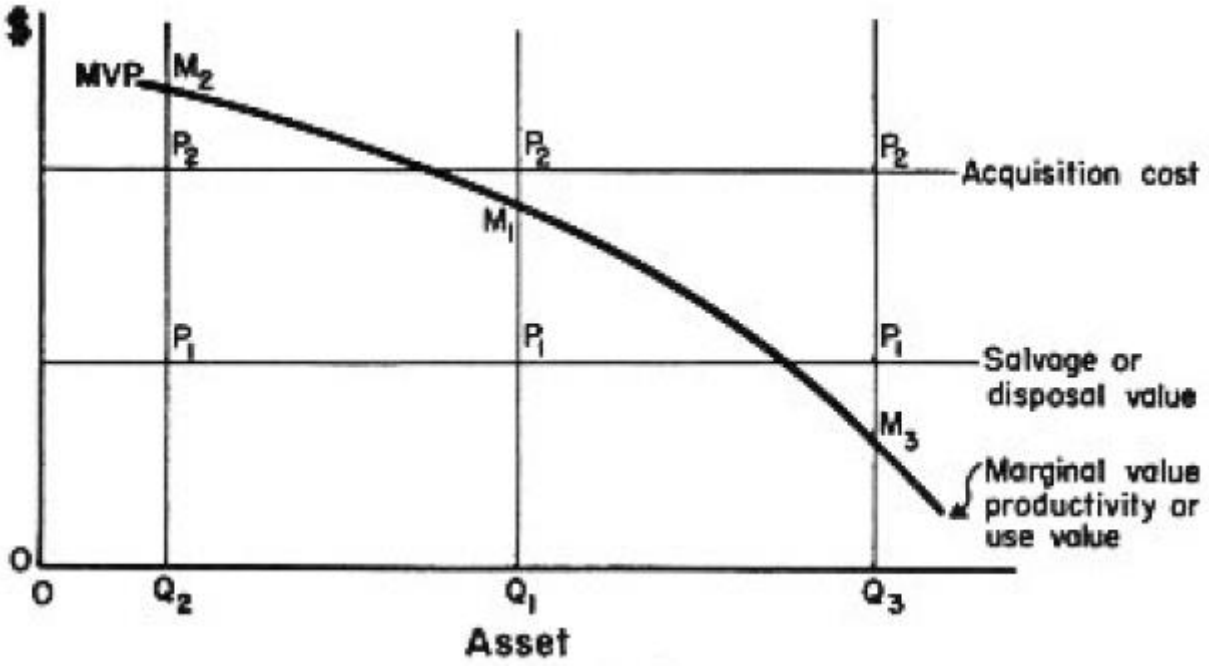


N cost ‘as spread’ (real)

$$P_n = P_u / 0.46$$

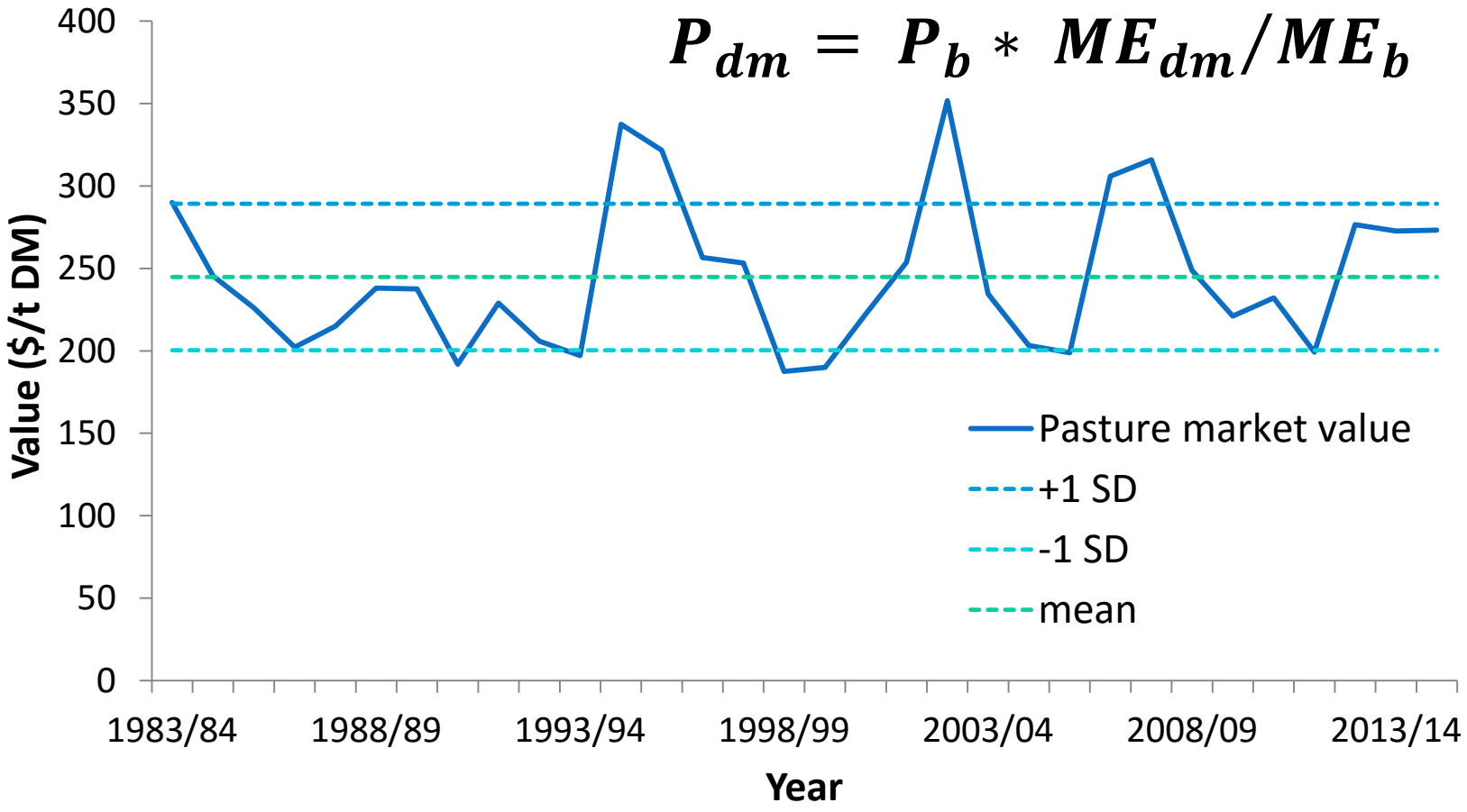


Market value of pasture forage

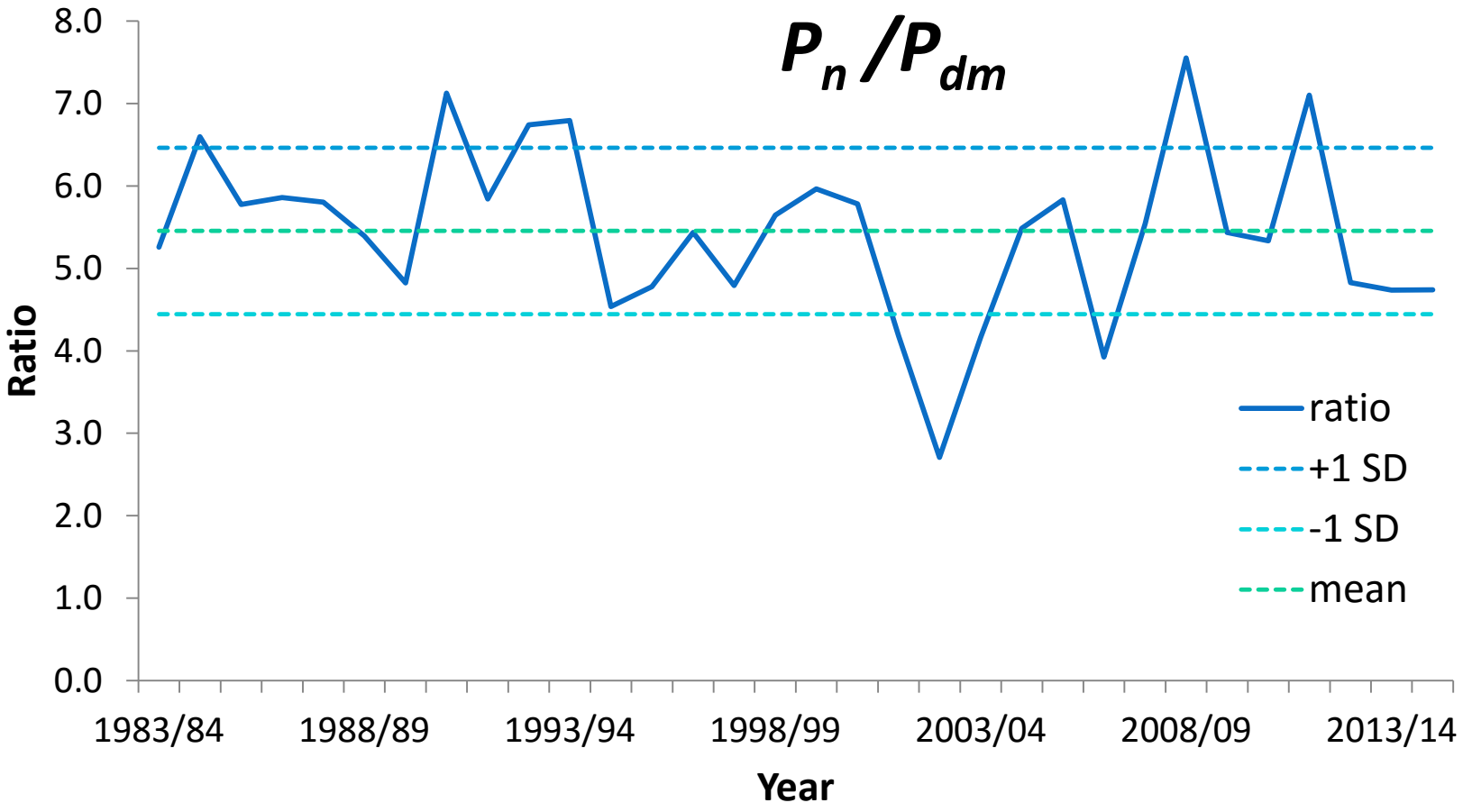


Equivalent market value of pasture ‘delivered’ (real)

$$P_{dm} = P_b * ME_{dm}/ME_b$$



Ratio of N cost to pasture value



Scenario

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Dairy N-Advisor inputs

Variable	Description	Value
Season	Spring, summer, autumn or winter.	spring
Region	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.	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 barley price multiplied by the ME concentration in pasture (11.5 MJ/kg DM) divided by the ME concentration in barley (12.3 MJ/kg DM).	245

N-Advisor Outputs & Discussion

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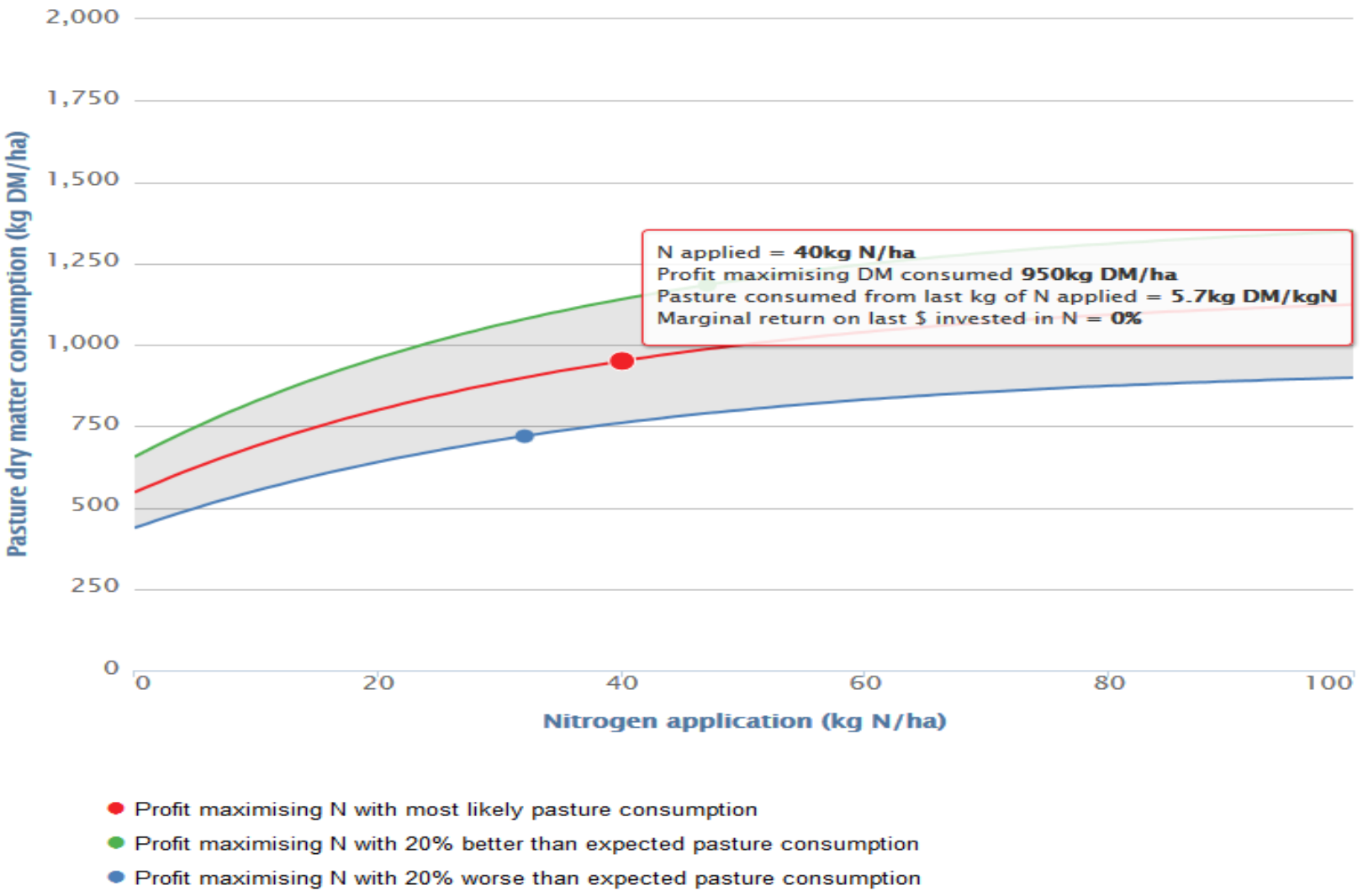
Dairy N Fertiliser Advisor Interface



Conclusions

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.

- 40 years of experimental data on N fertiliser responses.
- profit maximising principles
- what-if analysis on risky variables

Spares

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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%