Enhanced efficiency nitrogen – economic case study, Burdekin region

Ayr farming

Key findings:

- When applying EEN fertilisers at 40kgs N/ha below conventional rate:
  - *ENTEC* has similar costs and requires no yield improvement to breakeven
  - *CR25%* is ~$70/ha more expensive and needs extra 2 TCH to breakeven
  - *CR50%* is ~$200/ha more expensive and needs extra 6 TCH to breakeven
- 2015 trial harvest results showed little difference in profitability, while a statistical analysis determined no significant effect of treatment.

The NQ Dry Tropics Project Catalyst provides an opportunity for sugarcane growers to work closely with technical specialists to examine innovative and aspirational practices that may enhance profitability, whilst reducing nutrient and pesticide losses from Burdekin farms and improving water quality entering the Great Barrier Reef. Moreover, it facilitates the communication of trial results to other growers, serving as a catalyst to sustainable farming.

Enhanced Efficiency Nitrogen (EEN) fertilisers may improve nitrogen use efficiency and reduce the risk of nitrogen (N) leaving farms and entering Great Barrier Reef catchments. A central question is whether EEN fertilisers can maintain profitability at a lower N application rate (40kg/ha less). This case study examines four key questions including:

1) How do the EEN fertiliser costs compare with conventional fertiliser management?
2) How much extra (or in some cases less) cane needs to be grown to offset the higher (or lower) EEN fertiliser costs?
3) What risk factors influence the relative profitability of the fertilisers and by how much?
4) What is the relative profitability of applying ENTEC® and controlled release fertilisers (at two different rates) on a commercial sugarcane farm in the Burdekin Delta?

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Enhanced efficiency fertilisers

Contemporary research[1] has found that N fertiliser applications to the soil are not being utilised efficiently. N applied in the urea form converts to ammonium after a period of time, which then oxidises rapidly to nitrate. In this form, it can be lost from plant-soil systems easily via numerous pathways including ammonia volatisation, leaching, nitrification and denitrification. A study[2] examining N losses on well drained, friable clay soils at South Johnstone (Prasertsak, et al., 2002) found that first ratoon cane recovered 19 per cent of total applied N when urea was applied to the surface and 29 per cent when applied subsurface. This lost N has not only environmental implications but also affects the profitability of farming businesses.

Two particular forms of EEN fertilisers are being trialled by Ayr Farming; controlled release fertilisers and fertilisers with additives that inhibit nitrification. Controlled release fertilisers are designed to release nutrients when the crop requires them, thus increasing availability and maximising crop uptake, while reducing the probability of losing surplus nutrients. ENTEC® or DMPP[3] is a type of nitrification inhibitor that can be added to granular fertiliser. Nitrification inhibitors slow the rate of nitrification and reduce the risk of

[1] Chen, D., Suter, H., Islam, A., Edis, R., Freney, J. R., & Walker, C. N. (2008). Prospects of improving efficiency of fertiliser nitrogen in Australian agriculture: a review of enhanced efficiency fertilisers. *Australian Journal of Soil Research*, 46, 289-301.

[2] Prasertsak, P., Freney, J. R., Denmead, O. T., Saffigna, P. G., Prove, B. G., & Reghenzani, J. R. (2002). Effect of fertilizer placement on nitrogen loss from sugarcane in tropical Queensland. *Nutrient Cycling in Agroecosystems*, 229-239.

[3] 3,4-Dimethylpyrazole phosphate.

losses from nitrous oxide emissions and the leaching of nitrate.

Soil and climatic conditions are central to the performance of EEN fertilisers[4]. If soil and climatic conditions are not conducive to N losses during periods of crop N uptake then the potential benefits that these products provide may go unexploited. These products could therefore be appreciated as insurance of yield potential in contrast to assurance of higher yields.

While many studies have examined the efficacy of EEN fertilisers to reduce nutrient losses, little emphasis has been placed on comparing the financial implications of using these products with common practice.

Site description & trial design

The trial was established in 2014 by Farmacist on a crop entering its second ratoon (2R). Table 1 provides a summary of the characteristics of the trial block. The current crop was planted in 2012 and is the first cane crop to be grown on the block by Ayr farming.

Table 1: Characteristics of trial site

Element	Description
Soil type:	Loam to sandy loam
Location:	McDesme, Burdekin Delta
Variety:	Q183
Crop stage:	Second ratoon (2014-15)

A fundamental question underlying the investigation is whether EEN fertilisers can maintain productivity at relatively lower N application rates to offset the relatively higher product costs. Therefore, to examine the efficiency of the EEN fertilisers, an N rate 40 kilograms per hectare below the conventional rate was selected for each of the comparative treatments, while each treatment applies the same rate of phosphorus, potassium and sulphur[5].

Table 2 displays the N application rate for the five treatments being investigated in the trial. Two controlled release treatments with different proportions of polymer coated[6] urea are explored (1) 25 per cent, and (2) 50 per cent. All treatments were replicated three times using a randomised layout.

Table 2: Application rate of nitrogen (kg N/ha)

Treatments				
Urea*	Urea	ENTEC	CR25%	CR50%
220	180	180	180	180

*Conventional N rate

Methodology

Four key questions are examined in this study. The first question compares the costs of the fertiliser treatments? The main cost difference is the added cost of the EEN fertilisers. However, as these products have been applied at lower rates the study compares their costs relative to conventional fertiliser management.

As some EEN fertilisers have higher costs than conventional fertiliser management (depending on application rates), the second question examines the cane yield improvement necessary for each treatment to breakeven with the conventional N rate (Urea 220N). To calculate revenue, the analysis uses past block production data to estimate second ratoon crop yields; 111 tonnes of cane per hectare (TCH) and 14.2 units of CCS.

While the initial analysis uses some standardised variables, it is important to look at how certain risks may influence the relative profitability of the fertiliser treatments. Consequently, the third question examines two key risks; changes in cane yield and fluctuations in the sugar price. A vital

[4] Ferguson, R., Shapiro, C., Gordon, B., Killorn, R., Motavelli, P., & Norman, R. (2010). Enhanced Efficiency Fertilizers for Nitrogen Management. *Nutrient Management for Water Protection in Highly Productive Systems of the Heartland* (pp. 1-35). Kansas: K-State Research and Extension.

[5] Each treatment had the same quantity of phosphorus (20kg/ha), potassium (80kg/ha) and sulphur (33kg/ha) applied by using custom blends.
[6] Polymer and sulphur coating.

unknown is the influence EEN fertilisers will have on sugarcane crop yields. To examine this uncertainty in further detail, this case study explores how changes in yield influence the profitability of the EEN fertiliser treatments by calculating the difference in gross margin from conventional fertiliser management. Another risk factor that can influence the profitability of EEN fertilisers is the sugar price. Over the past decade, sugar prices have fluctuated between $280 and $520 per tonne. At high sugar prices, growers may be more willing to trial EEN fertilisers if they anticipate potential production benefits. Consequently, the influence of the sugar price on the breakeven yield is explored.

The fourth question investigates how profitable the EEN fertiliser treatments have been so far in the trial? The analysis draws on 2015 harvest data from the trial site to calculate and compare the gross margin for each treatment.

The Farm Economic Analysis Tool (FEAT) was used to evaluate the revenues and costs of each treatment. From these results, the gross margin[7] of each treatment is compared. The analysis uses the five-year average sugar price of $430/t. Input prices were collected from local suppliers and labour has been costed at $30/hour.

Crop nutrition expenses

The prices and application rates of the fertiliser blends for each treatment are outlined in Table 3.

Table 3: Fertiliser price and application rate (kg/ha)

Urea 220	Urea 180	ENTEC 180	CR25% 180	CR50% 180
$695/t	$700/t	$779/t	$903/t	$1,108/t
773	685	685	673	661

* 2015 fertiliser prices

Figure 1 examines the crop nutrition expenses for each treatment in the trial during 2R. Fertiliser application costs were calculated systematically from fuel and oil consumption, repairs and maintenance, labour costs and the work rate when side-dressing. Comparing each of the treatments finds that the urea treatment with 180kg/ha of N has the lowest cost, while the controlled release treatment with a 50 per cent blend has the highest cost. Interestingly, the 220kg/ha of N treatment and the *ENTEC®* treatment, which delivers 40kg/ha less N, both have similar costs. As no other management practices were different amongst the treatments, all other growing expenses (e.g. weed control and cultivation) were the same.

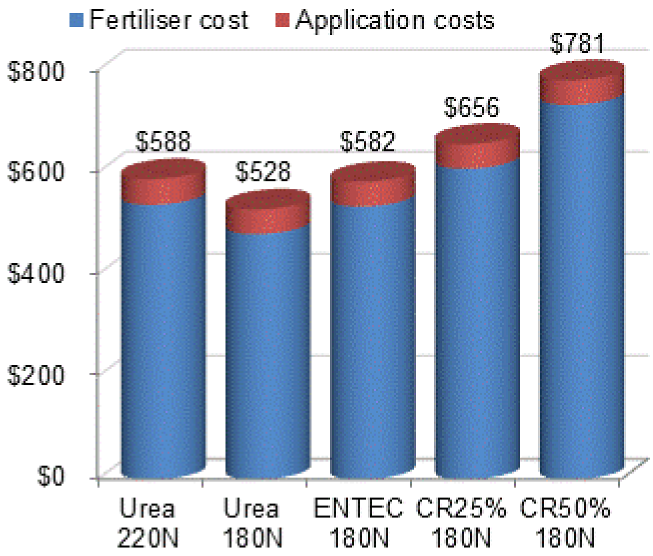

Figure 1: Crop nutrition expenses ($/ha)

Breakeven yield analysis

To put these cost differences into context, Figure 2 examines the yield change required for each treatment to maintain the same profitability as conventional fertiliser management (220kg N/ha), assuming a constant CCS level. As the urea treatment with 180kg/ha of N has the lowest cost, it can afford to lose yield of almost two TCH before it becomes less profitable than conventional management. On the other hand, the controlled release treatment with a 50 per cent blend would require a yield increase of 6 TCH to maintain profitability.

[7] The gross margin is a measure of profitability and is calculated by subtracting variable growing expenses (e.g. fertiliser and harvesting costs) from revenue.

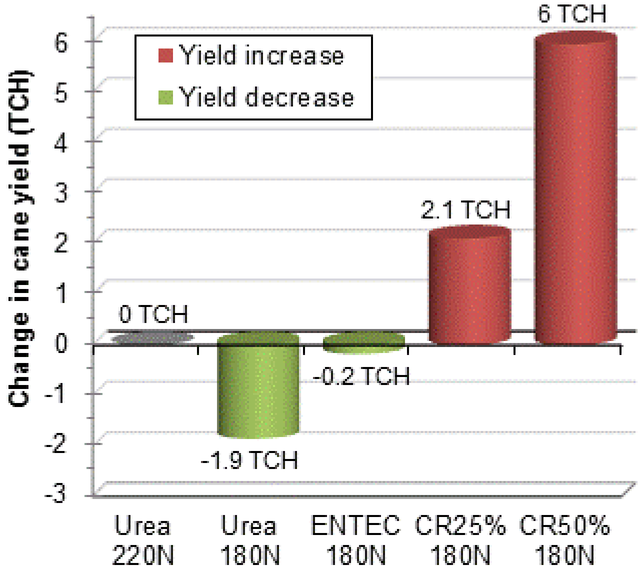

Figure 2: Breakeven yield analysis

Risk analysis

Figure 3 builds on the preceding chart by enabling readers to examine the comparative profitability of each treatment, based on expected changes in cane yield, relative to conventional management. For example, if a grower perceives that the *ENTEC®* treatment will produce 5 TCH more than the *Urea 220N* treatment, then they could expect an improvement in profit by around $165/ha.

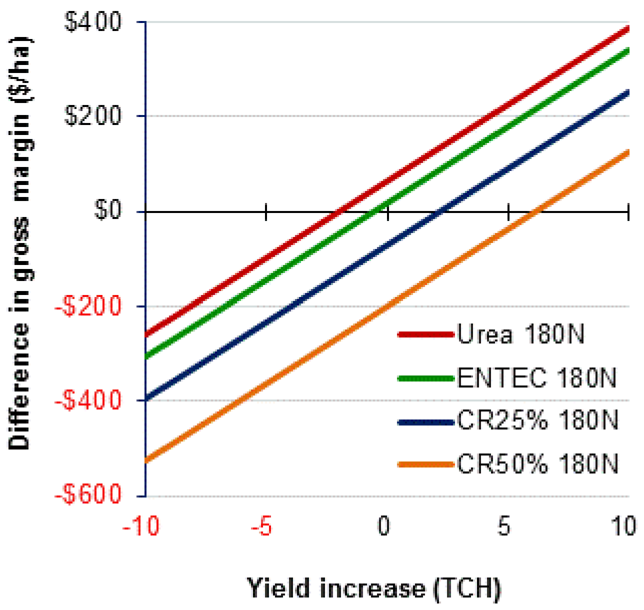

Figure 3: Sensitivity of the gross margin to changes in cane yield

While Figure 2 ascertained the breakeven yield at a sugar price of $430, Figure 4 extends on these findings to examine the sensitivity of the economic outcome to variations in the price of sugar. The results identify that at low sugar prices the controlled release treatments require a larger yield increase to breakeven, while the sugar price has little influence on the *ENTEC®* treatment.

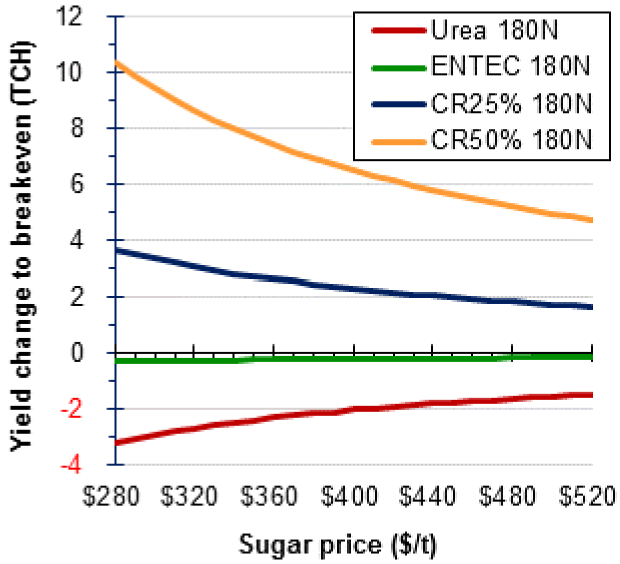

Figure 4: Sensitivity of the breakeven yield to fluctuations in the price of sugar

2015 production analysis

Table 4 examines the trial block's production results from the 2015 harvest; TCH, CCS and tonnes of sugar per hectare (TSH). While the controlled release fertiliser treatments have higher average cane yields, and the *ENTEC®* treatment higher average CCS, the statistical analysis identified no significant effect of treatment for any of the production results.

Table 4: Production results from 2015 harvest

	TCH	CCS	TSH
Urea 220N	122.7 a	16.5 a	20.3 a
Urea 180N	123.0 a	16.2 a	19.9 a
ENTEC	122.0 a	16.7 a	20.4 a
CR25%	125.6 a	16.4 a	20.6 a
CR50%	126.7 a	16.5 a	20.9 a
Prob. (F)	*0.91*	*0.29*	*0.73*

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Figure 5 (bottom of page) presents the average gross margin for each fertiliser treatment during the second ratoon crop. Comparing the treatments shows that even though the controlled release treatments had the highest TSH, their higher fertiliser costs made them relatively less profitable than the *Urea 220N* and *ENTEC®* treatments. Nevertheless, a statistical analysis of the economic results determined no significant effect of treatment; Prob. (F) = 0.92 > 0.05.

Conclusion

EEN fertilisers may improve the nitrogen use efficiency of urea based fertilisers under certain soil and climatic conditions. This case study examined the nutrient expenses and yield changes necessary to compensate for the higher/lower costs associated with the use of these products on a sugarcane farm in the Burdekin Delta. When applying EEN fertilisers at rates 40kgs N/ha less than applied conventionally; *ENTEC®* has about the same cost, *CR25%* is ~$70/ha more expensive, and *CR50%* is ~$200/ha more expensive.

The results indicate that to breakeven; the *ENTEC®* treatment does not need a cane yield improvement, the *CR25%* treatment needs to improve cane yields by two TCH and the *CR50%* treatment needs to improve cane yields by six TCH. However, the breakeven yield is sensitive to the sugar price with a low sugar price increasing the yield improvement needed, and vice versa.

The 2015 harvest results showed that while the controlled release fertilisers had slightly higher average production, their higher fertiliser costs made them slightly less profitable than the *Urea 220N* and *ENTEC®* treatments. However, the differences between the treatments were marginal and the statistical analysis determined no significant effects of treatment.

Acknowledgements

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Citation

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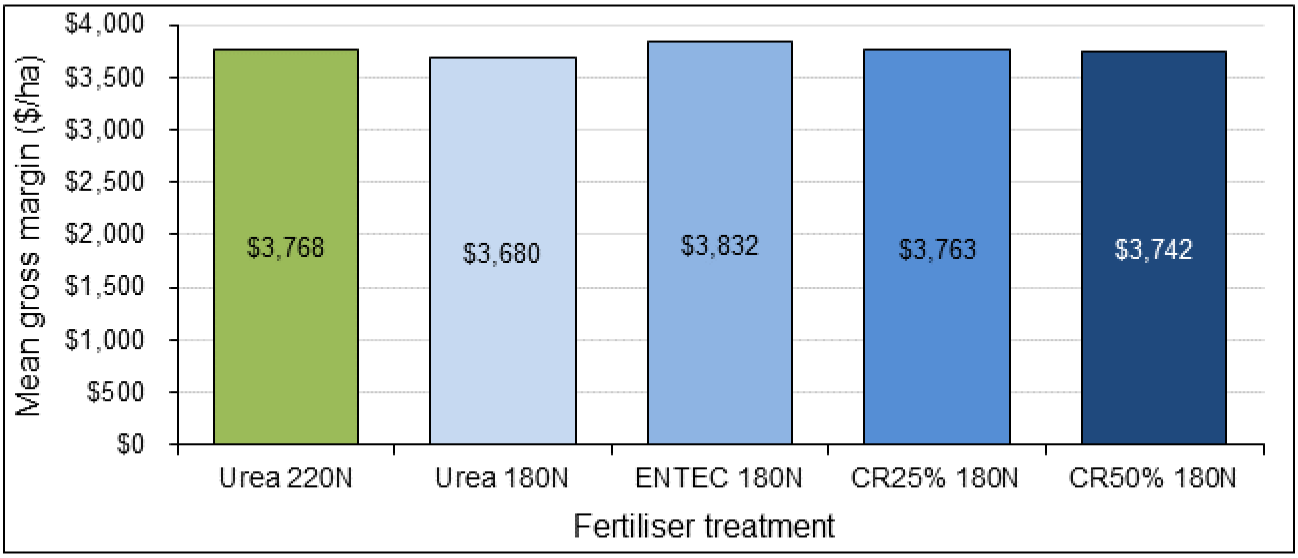

Figure 5: Gross margin analysis