# *Smart blending of Enhanced Efficiency Fertilisers to maximise sugarcane profitability — case study*

## About the research

Sugar's sub-project of the MPfN Program, *Smart blending of Enhanced Efficiency Fertilisers to maximise sugarcane profitability*, conducted its work under Activity 6 of the Program, with the key objective being to generate knowledge and understanding of the interplay of factors to optimise N formulation and N rate . Results include:

- *Sugarcane yields showed no statistically significant differences between N supplied by conventional urea and N supplied by EEFs*, although the highest agronomic efficiency of all N fertiliser products was at the lowest N application rate; and
- *The use of Polymer Coated Urea products can significantly reduce the risk of nitrate leaching during the first 2-3 months.* A decision tree in pre-season planning that accounts for site characteristics, seasonal conditions and farm management practices can aid in reducing N losses.

## Analysis of research — farm level economics of EEFs

A farm level framework was developed to evaluate the economic and environmental potential of optimising N application using EEFs in a blend to match N supply with plant nutrient demand. An analysis undertaken with data from two seasons at Lannercost, Qld used a partial budget model to compare total N applied at the 6 Easy Steps rate (6ES) and the cost differences from nitrogen products including urea, Entec and a Polymer Coated Urea (PCU – 41% N) blend. Table 1 shows the yield response in the form of sugar yields, and cost of N per tonne of sugar yield. Increases in sugar yield were significant on only a few occasions on any of the six sites during the three-year project period. The cost of the PCU was double the cost of standard urea following the[1] 6ES.

**Table 1 — Sugar yield results and per hectare costs of three urea products (urea, Entec and PCU blend) over two seasons at Lannercost, Qld**

| Product | Price ($/t)[1] | Rate (kg N/ha) 6 easy steps rate | Cost ($/ha) | Sugar Yields[2] (t/ha) | Change in yield | Cost N /t sugar/ha |
|---|---|---|---|---|---|---|
| **Urea** | 500 | 145 | $158 | 10.6 | 0 (base) | $14.9 |
| **Entec** | 620 | 145 | $196 | 10.75 | +1.4% | $18.23 (+22%) |
| **PCU 75% Urea 25%** | 963 | 145[2] | $331 | 11.2 | +5.6% | $29.55 (+99%) |

1. Reeves (2020)
2. Lannercost analysis (2016-17)

## Valuing economic and environmental losses from urea fertiliser

Numerous studies have been undertaken on EEF products - finding little yield benefit or improvement in agronomic fertiliser use efficiency[2]. In this study, project authors found the unique release pattern of EEFs would minimise N loss pathways in wet seasons, particularly where N fertiliser is applied directly before heavy rain. If seasonal conditions (in particular, rainfall) can be predicted recommendations on EEF formulation, rate and timing could be delivered specifically for the seasons/years when loss pathways are expected to be significant. Therefore, to quantify losses of generic EEF products with urea the value of N losses to the environment need to be quantified. Table

[1] https://www.qld.gov.au/__data/assets/pdf_file/0032/67937/rwq-np-method.pdf
[2] https://www.publish.csiro.au/sr/pdf/SR15314

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2 draws on industry research to overlay environmental costs associated with N lost to the environment using a 2% emissions factor[3] (EF) and an N rate applied for two products from 6ES for Lannercost (Qld). The latest market value from the Government Emission Reduction Fund reverse auction of $16/tonne $CO_2e$ has been applied, together with a nitrous oxide $CO_2e$ equivalent of 298 per kg $N_2O$. Studies by Wang[4] et al (2012 & 2014) suggest avoided losses for DMPP N products average around 50%. Therefore, the total value of losses to the environment through gasification and product leaching at the case study site was estimated to be $28/ha for urea and $17/ha for Entec treatment. Accounting for a higher priced EEF product still equated to a 41% saving in environmental losses.

**Table 2 — Valuing urea product lost to the environment under normal conditions using 6ES at Lannercost, Qld**

| Product | Applied rate (145 kg N/ha) | Emissions[5] (kg $N_2O$-N/ha/yr$^{-1}$) | $CO_2e$ Emissions (kg/ha/yr$^{-1}$) | Emissions value[6] ($/ha) | Deep drainage losses[7] (kg N/ha) | Total value of losses ($/ha) |
|---|---|---|---|---|---|---|
| Urea | 315 | 2.9 | 864.2 | 13.82 | 14.5 | 28.33 |
| Entec | 315 | 1.45 | 432.1 | 6.91 | 9.76 | 16.68 |

**Sensitivity testing N emissions factor and deep drainage losses**.

Sensitivity analysis, broadly defined, is the investigation of these potential changes and errors and their impacts on conclusions to be drawn from the model. Analysis was undertaken to test the sensitivity of emissions factor and deep-drainage losses from a range of soils and climate scenarios. Under extremely wet scenarios, denitrification and leaching of N products is more likely to occur[8]. Under these circumstances, EEF products become more competitive with urea when environmental benefits are accounted for. Production and hence economic benefits may not necessarily be realised in very wet scenarios depending on the crop's response to N (which depends on N rate and crop growth potential-with the latter potentially negatively affected by low radiation and waterlogging). The results of sensitivity in Table 3 show when the N emissions factor is high and quantities of N leaching exceeds 10%, per hectare environmental and economic costs of urea are substantial. Using a base cost of $158 / ha cost of urea from the 6ES, the losses under the extreme scenario (20% EF and 25% leaching) provide an indication of future price-points for EEF products to match urea. The economic cost of N lost to the environment through deep drainage is the percentage value of the fertiliser only. Methods are currently underway to incentivise practices that result in avoided nitrate leaching using 'paddock to reef modelling' undertaken in Great Barrier Reef catchments[9]. When all environmental costs associated with nitrous oxide and leaching are market-based, the true economic value of EFFs in comparison with urea will be made clearer.

**Table 3 sensitivity test results of combined per hectare economic and environmental cost ($/ha) of N losses for urea fertiliser (N emissions factor v deep soil nitrate losses) using rate assumptions from 6ES at Lannercost, Qld.**

| | | Nitrous oxide emissions factor (%) | | | |
|---|---|---|---|---|---|
| | | **2%** | **5%** | **10%** | **20%** |
| Deep soil nitrate losses % | **10%** | $29.6 | $50.3 | $84.9 | $154.0 |
| | **15%** | $37.5 | $58.2 | $92.8 | $161.9 |
| | **20%** | $45.5 | $66.1 | $100.7 | $169.8 |
| | **25%** | $53.2 | $74.0 | $108.6 | $177.7 |

[3] https://www.industry.gov.au/sites/default/files/2020-05/nga-national-inventory-report-2018-volume-1.pdf
[4] ASSCT published papers on nitrogen fertiliser management 2012, 2014
[5] https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg3-chapter8-1.pdf
[6] http://www.cleanenergyregulator.gov.au/ERF/Auctions-results/march-2020
[7] https://www.cottoninfo.com.au/sites/default/files/documents/Irrigation%20and%20N%20tour%20booklet%20-%20FINAL.pdf
[8] https://www.sciencedirect.com/science/article/abs/pii/S0167880911002829
[9] https://www.reefcredit.org/approved-methodologies/

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**Potential value for EEFs in sugarcane systems using seasonal forecasts**

As demonstrated by the sensitivity analysis, under certain climatic conditions, the environmental and economic costs associated with per hectare N losses can be substantial. Using seasonal forecasting simultaneously with nutrient budgets can present opportunities to better match fertiliser product with plant demand, particularly in years of high precipitation. It might be only every two or three years there is a clear or strong climate signal, but it is worth tuning in to, given the timing, intensity and amounts of rainfall and solar radiation during different climate phases. The charts in Figure 1 show how various climate phases in the Indian and Pacific Ocean can help determine in-crop rainfall at Ingham (adjacent to the study area at Lannercost, Qld). The outlook shows a high probability (71%) of *greater* than median rainfall for the next six months with "medium" skill level. Climate decision support such as the www.climateapp.net.au can provide guidance on choice of fertiliser product. In periods of higher than normal rainfall such as La Niña years, the probability of a wet growing season and higher N losses increases. To the contrary, drier El Niño and years result in a reduced probability of high rainfall events leading to denitrification and leaching. More research is required to better quantify the economic costs and benefits of applying EEFs at various locations using seasonal forecasts in cane growing regions.

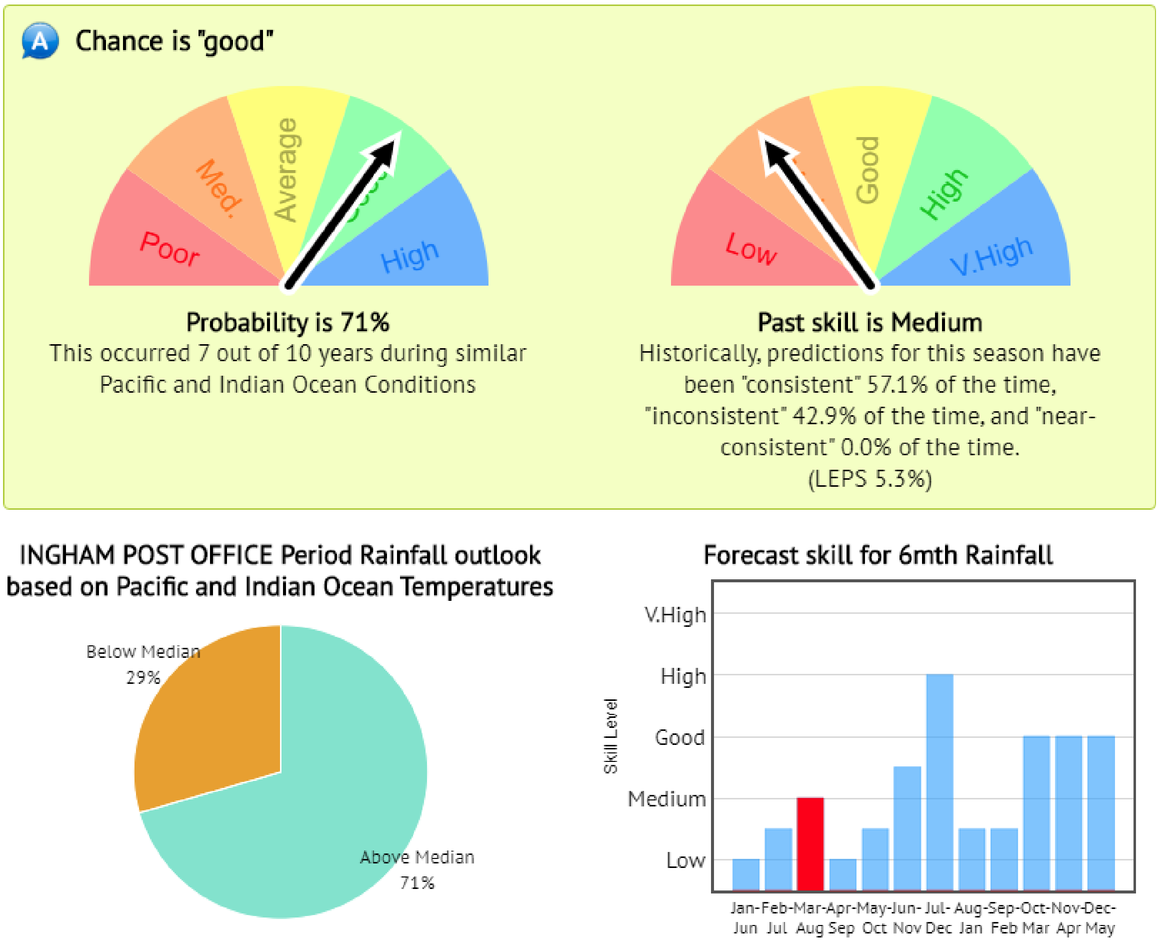


**Figure 1 — Six-month seasonal precipitation outlook for Ingham Qld using www.climateapp.net.au Using EEF blends in La Niña years can offer benefits through avoided losses of fertiliser.**

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While this research found sugarcane yields showed no statistically significant differences between soil mineral N supplied by conventional urea and N supplied by EEFs, knowledge has increased with the following key findings:

- Soil mineral N contents declined to very low levels early in-season after the application of urea following high rainfall events;
- Polymer Coated Urea (PCU) products consistently sustained higher mineral N contents; however, analysis found the usefulness of PCU benefits are limited to mitigating N losses rather than increased supply of N to the crop;
- The lack of yield benefit is specific to the N rates used, which appear to have been above the agronomic optimum N for the seasonal conditions; and
- Yield responses to EEFs were found to be significant in only a small portion of trial sites throughout the 3-year trial period for blended urea/PCU products. Potential exists to better understand profitability under a range of management scenarios, changes in yield and N lost to the environment.

*For information on the MPfN research visit https://www.crdc.com.au/more-profit-nitrogen or contact Sugar Research Australia.*

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*For more information on this economic analysis, please contact Jon Welsh jon@agecon.com.au.*

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