

SUPPORT OF CANE FARMER TRIALS OF **ENHANCED EFFICIENCY FERTILISER** IN THE CATCHMENTS OF THE GREAT BARRIER REEF (EEF60)



Great Barrier
Reef Foundation



QUEENSLAND SUGARCANE INDUSTRY PIONEERS ENHANCED EFFICIENCY FERTILISER (EEF) RESEARCH

INTRODUCTION

The Queensland sugarcane industry is a pioneer in Enhanced Efficiency Fertiliser (EEF) research. With support from project partners over three seasons, Queensland growers tested EEFs on 74 sugarcane farms located between Mossman and Bundaberg.

The project was a collaborative partnership between sugarcane growers, CANEGROWERS, Sugar Research Australia (SRA), regional productivity services, the Australian Department of Agriculture, Water and the Environment (DAWE), and the Queensland governments' Department of Agriculture and Fisheries (DAF) and Environment and Science (DES).

A technical management group made up of representatives from CANEGROWERS, SRA, DAWE, DAF, DES, University of Queensland (UQ) and CSIRO was responsible for ensuring the research was scientifically robust.

The large number of trials and consistency in trial design enabled the collection and analysis of a wealth of data to determine:

- what types, blends and rates of EEF perform better
- where EEFs get optimal results – soil types, rainfall conditions and regions
- when EEFs work best – application time.

The project evaluated the production and profitability implications for commercial farms from applying EEFs in place of conventional urea fertiliser.

Given EEFs are reported to reduce nitrogen (N) losses (from the crop root zone) by better matching N supply to crop demand over the growing season, the EEFs were tested at N rates 20% below the SIX EASY STEPS (6ES) guidelines (Step 4).

HOW EEFs CAN HELP

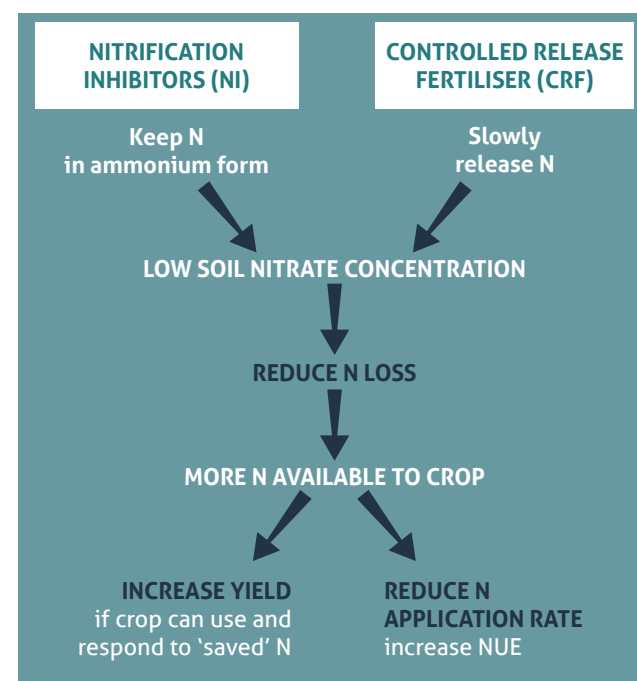


Diagram 1: Benefits of EEFs.

THE TREATMENTS APPLIED TO TRIAL SITES

Two main types of EEFs were tested in the project:

- controlled release fertilisers (CRFs), which release N slowly through a polymer coating
- nitrification inhibitors (NIs) such as 3,4-Dimethylpyrazole (DMPP), which are added to urea to stabilise the N in ammonium form.

Treatments included:

- nitrogen at the 6ES rate applied as urea (Urea 6ES)
- nitrogen at 20% less than the 6ES rate applied as urea (Urea -20%)
- nitrogen at 20% less than the 6ES rate applied as a blended product which consisted of 33% DMPP treated urea and 67% controlled release fertiliser (DMPP/CRF -20%)
- nitrogen at 20% less than the 6ES rate applied as either a CRF blended with urea (at a ratio of 20% CRF and 80% urea), or DMPP treated urea, or other EEF product. **Note:** These treatments were collectively referred to as the 'Wildcard'.

The treatments were replicated (three replicates) and randomised at each site.

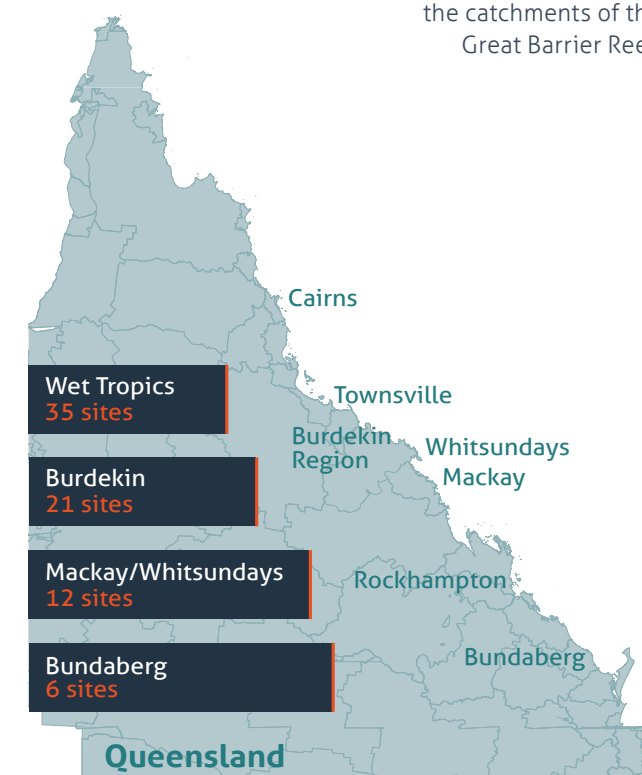
Over the period of the project, factors such as crop establishment, irrigation management, and pests and disease management were monitored.

A total of 54 trial sites had at least one Wildcard treatment with 128 crops harvested during the 2018, 2019 and 2020 harvest seasons.

Table 1: A breakdown of crops harvested by type of Wildcard and region.

REGION	DMPP UREA	CRF BLENDED WITH UREA	OTHER	TOTAL
Wet Tropics	35	17	5	57
Burdekin	12	21	8	41
Mackay-Whitsundays	12	16	2	30
Total number of harvests	59	54	15	128

Map 1: EEF trial sites within the catchments of the Great Barrier Reef.



DATA COLLECTION

Cane yield and CCS data were supplied by local sugar mills and used to calculate sugar yield and grower profitability.

Results were then analysed to identify differences in cane yield, sugar yield and profitability attributed to EEFs.

NITROGEN USE EFFICIENCY (NUE)

To compare the nitrogen use efficiency of EEFs vs urea, several measures were employed.

These included calculating the total amount of N captured by crops grown with EEFs compared to those grown with urea and the proportion of N supplied by these products.

POST-HARVEST SOIL NITROGEN

Soil mineral nitrogen was assessed within one to two days following harvest to calculate kilograms of nitrogen per hectare (kg N/ha) remaining in the top 20cm of the soil profile and then compared across treatments.



Image 3: Collecting and processing biomass samples in the Burdekin.

RESULTS

UREA APPLIED AT N RATES 20% LESS THAN 6ES

Compared to applying urea at the 6ES recommended rate, the lower rate of urea reduced cane yields in medium and high rainfall conditions. However, under low rainfall conditions CCS improved and higher grower profitability was achieved.

Nevertheless, the current accuracy of seasonal climate forecasts makes targeting low rainfall conditions risky – which highlights the opportunity for applying EEFs to protect N from rainfall induced losses.

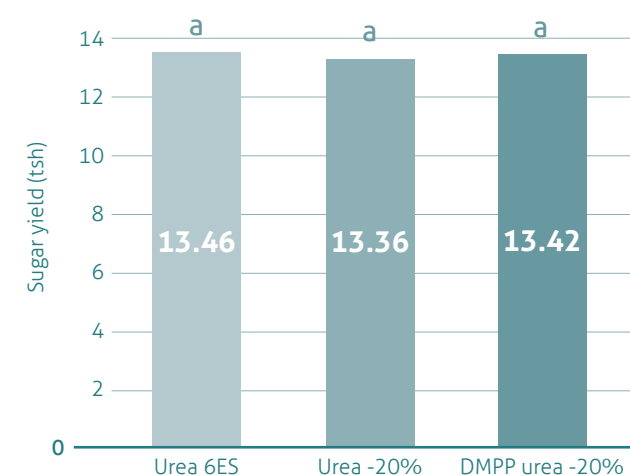


Figure 1: Mean sugar yield (tsh) and net revenue (\$/ha) for 59 trials where urea (at 6ES and 20% less) was compared to DMPP treated urea applied at 20% less. $P < 0.05$, means followed by a common letter are not significantly different at the 5% level.

PERFORMANCE OF DMPP TREATED UREA COMPARED TO UREA APPLIED AT 6ES

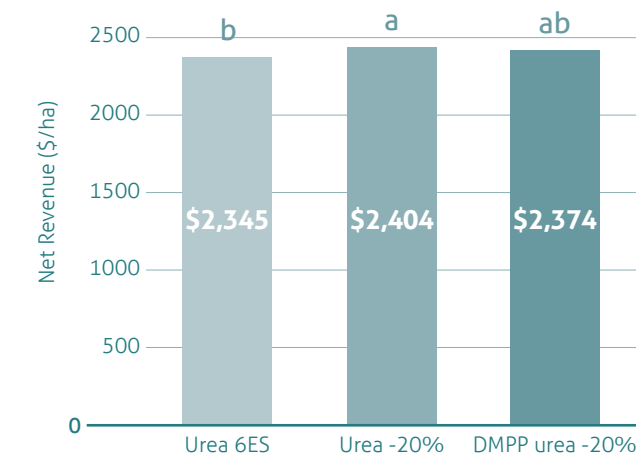
The project tested DMPP treated urea in 59 trials on 25 sites over three seasons. Mean sugar yield in tonnes of sugar per hectare (tsh) and net revenue in dollars per hectare (\$/ha) results are presented in Figure 1.

The sites were located on commercial sugarcane farms and spread across the Wet Tropics (15), Burdekin (6) and Mackay-Whitsundays (4) regions.

The DMPP treated urea was applied at an N rate 20% lower than 6ES guidelines, referred to as 'DMPP urea -20%'.

Compared to urea applied at the 6ES N rate DMPP urea -20% produced:

- ✓ Similar fertiliser cost
- ✓ Similar cane yield and sugar yield
- ✓ Higher CCS (on average by 0.14 units)
- ✓ Similar profitability
- ✓ No difference in crop N content due to similar availability of fertiliser N
- ✓ No difference in post-harvest soil N (top 20cm of profile)
- ✓ More cane per kg of applied N due primarily to lower N rate and limited yield response when using urea applied at the 6ES rate.



PERFORMANCE OF CRF BLENDED WITH UREA COMPARED TO UREA APPLIED AT 6ES

The project tested a blend of 20% controlled release fertiliser and 80% urea in 54 trials on 25 sites over three seasons.

Mean sugar yield (tsh) and net revenue (\$/ha) results are presented in Figure 2.

The sites were located on commercial sugarcane farms and spread across the Wet Tropics (8), Burdekin (10) and Mackay-Whitsundays (7) regions.

The blend of 80% urea with 20% controlled release fertiliser was applied at an N rate 20% lower than 6ES guidelines referred to as 'CRF urea blend -20%'.

Compared to urea applied at the 6ES N rate, the CRF urea blend-20% produced:

- ✓ Similar fertiliser cost
- ✓ Similar cane yield, CCS and sugar yield
- ✓ Similar profitability
- ✓ No difference in crop N content due to similar availability of fertiliser N
- ✓ No difference in post-harvest soil N (top 20cm of profile)
- ✓ More cane per kg of applied N, due primarily to lower N rate and limited yield response when using urea applied at the 6ES rate.

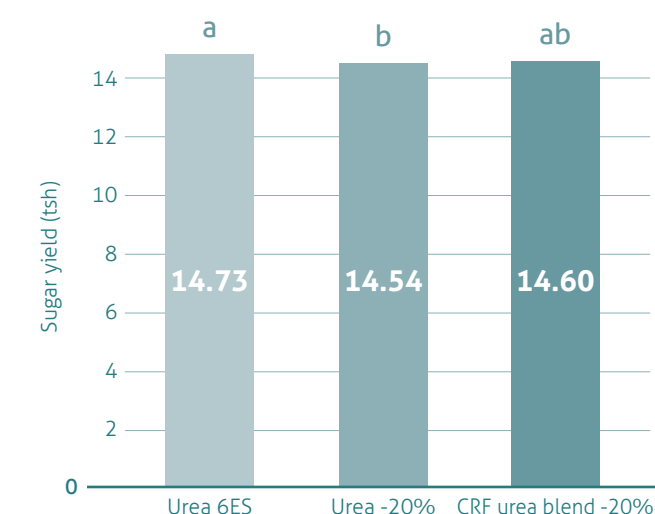
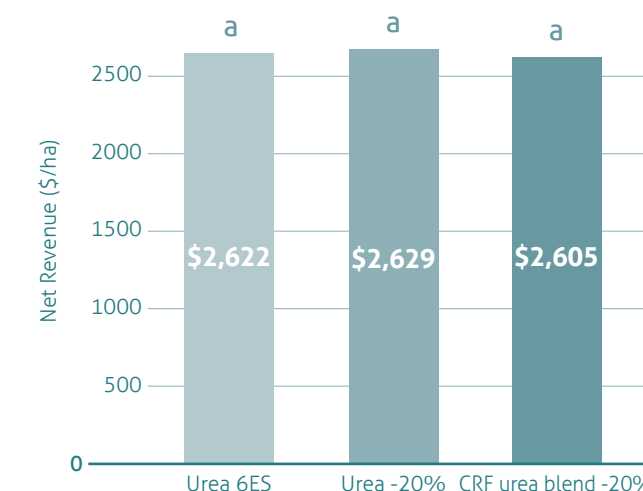


Figure 2: Mean sugar yield (tsh) and net revenue (\$/ha) for 54 trials where urea (at 6ES and 20% less) was compared to a blend of CRF and urea applied at 20% less. $P < 0.05$, means followed by a common letter are not significantly different at the 5% level.



Image 4: Post-harvest soil sampling.



PERFORMANCE OF WILDCARDS AT 20% LESS COMPARED TO UREA APPLIED AT 6ES

The Wildcards were tested in 128 trials on 54 sites over three seasons.

Wildcard EEFs consisted mostly of DMPP treated urea or CRF blended with urea (at a ratio of 20% CRF and 80% urea), while the few others were either Nitrapyrin (a nitrification inhibitor) or pure CRF.

All Wildcard EEFs were applied at N rates 20% less than the 6ES recommendation.

Findings identified that EEF performance was influenced by soil type, rainfall and fertiliser application time. Mean sugar yield (tsh) and net revenue (\$/ha) results are presented in Figure 3.

Compared to urea applied at the 6ES N rate, the Wildcard EEFs (-20% N) produced:

- ✓ Similar cane yield to Urea 6ES in nearly all situations
- ✓ Higher CCS in low and medium rainfall conditions
- ✓ Similar profitability to Urea 6ES across all soil, rainfall and application time combinations
- ✓ Appeared more profitable in sandy soils with high rainfall after late fertiliser application, which was consistent with previous research.

These findings indicate that the benefits of EEFs are more evident in high rainfall conditions when the likelihood of N losses are greatest.

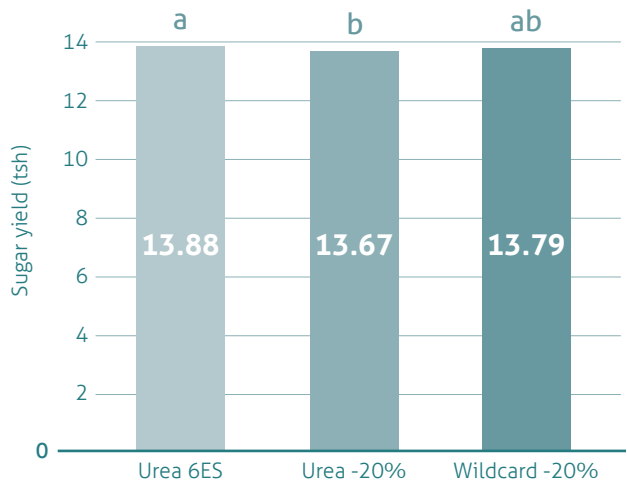


Figure 3: Mean sugar yield (tsh) and net revenue (\$/ha) for 128 trials where urea (at 6ES and 20% less) was compared to all Wildcards applied at 20% less. P<0.05, means followed by a common letter are not significantly different at the 5% level.

OTHER EEF STRATEGIES

The project also examined other EEF strategies involving blends of EEFs and different N rates.

The most tested of these was a blend of 67% controlled release fertiliser and 33% DMPP treated urea applied at 20% less N. This product appeared to perform as well as DMPP treated urea and the CRF urea blend in terms of cane and sugar yield and nitrogen use efficiency. However, the product is not currently commercially available, and due to its high cost (50-60% higher than Urea 6ES), was significantly less profitable to apply except for a few situations (e.g. sandy soils with high rainfall after late fertiliser application).

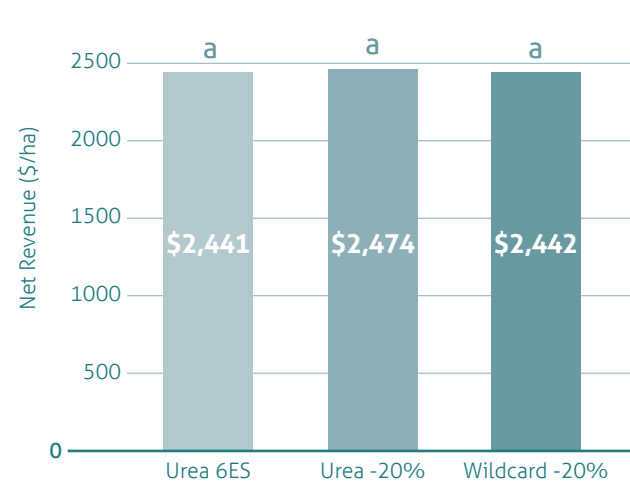
Another EEF strategy tested in six trials was the same EEF blend (67% CRF and 33% DMPP) but applied at the 6ES recommended N rate.

It did not increase yield relative to the same EEF blend at the lower rate, which made it even less profitable due to the additional fertiliser costs.

Also, this option did not result in any additional N being captured by the crop and consequently had lower NUE.

MEASUREMENT OF N LOSSES VIA LEACHING

At four sites in the Wet Tropics and two in the Burdekin the movement of dissolved inorganic N (DIN) through the soil profile in leachate was monitored by ceramic pore water samplers.



These were positioned directly below the crop row at a depth of 1 metre and monitored over the wet season for three years to provide an understanding of how EEFs applied at N rates 20% less than 6ES performed relative to urea applied at 6ES recommended rates.

At two Burdekin sites the CRF urea blend was compared to urea Figure 4. DIN concentrations in leachate from crops grown with urea were three times higher than those grown with the EEF.

At four sites across the Wet Tropics applications of DMPP-treated urea was compared to urea. DIN concentrations in leachate from crops grown with urea were 1.5 times higher than those grown with the EEF.



Image 5: Collecting water samples from leaching. Image 6: (back cover): Calibrating a fertiliser box.

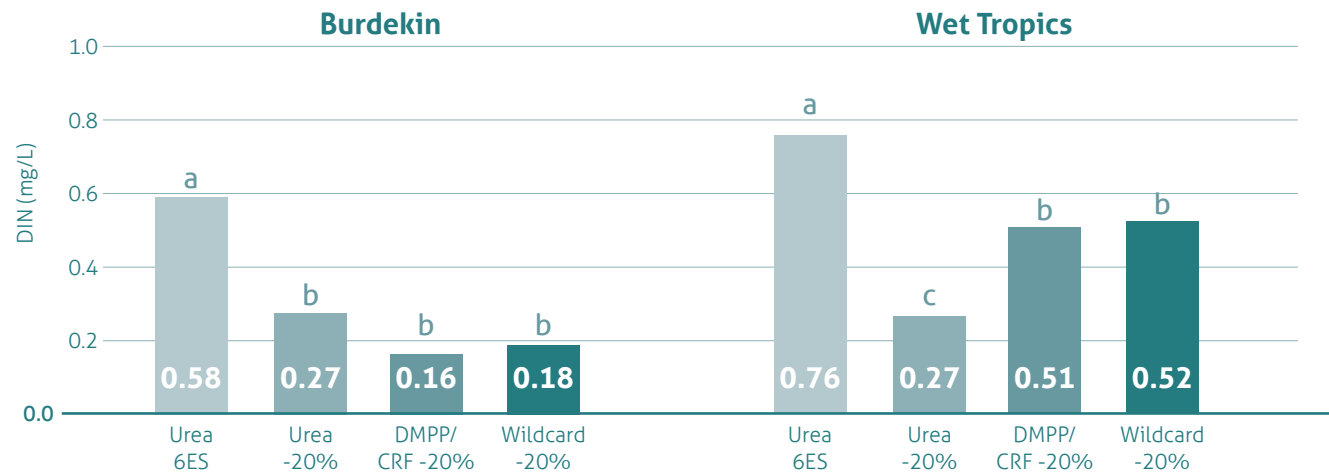


Figure 4: Mean DIN (mg/L) in soil water measured 1 meter below the crop row in each region over three ratoons. P<0.05, means followed by a common letter are not significantly different at the 5% level.

KEY MESSAGES

- ✓ Applying Urea at -20% results in lost cane yield
- ✓ Applying DMPP Urea at -20 % maintains yield and profitability but also improves NUE
- ✓ Applying a CRF urea blend (20% CRF & 80% urea) at -20% maintains yield and profitability but also improves NUE

- ✓ EEF blends with high proportions of CRF cost more, which made them less profitable to apply
- ✓ Evidence suggests that EEFs were more effective when high loss conditions were experienced (sandy soil, high rainfall, late in season)
- ✓ Trying these products when high losses are likely is a good starting point.



ACKNOWLEDGEMENTS

The EEF60 project partners would like to acknowledge the valuable contribution from the growers involved in the project over the past four years. A big thank you also to the harvesting operators and mill personnel involved, project partners and the technical working group.

FOR MORE INFORMATION REFER TO:

Connellan J, Thompson M, Salter B, Olayemi M. (2022) *An evaluation of enhanced efficiency fertilisers in Queensland sugarcane*. Proceedings of the Australian Society of Sugar Cane Technologists: 43.

Read the full report on the Sugar Research Australia website.



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