

# CQ nitrogen update – February 2026

## Enhanced Efficiency Fertiliser (EEF) experiment

**EEFs are simply fertilisers that have a mechanism for delaying nutrient release into the soil environment.** Mostly nitrogen based, they rely on either polymer coated granules that degrade over time or chemical additives that prevent the conversion of urea to ammonium (through hydrolysis) or ammonium to nitrite (by suppressing *Nitrosomonus* spp. bacteria within the soil), ultimately delaying post application conversion to nitrate.

Nitrate is available for plant use, but is also susceptible to loss due to leaching or denitrification. For pre-plant fertiliser application, delaying the urea–nitrate conversion improves efficiency by better coinciding nitrate release with a crop development stage that enables more rapid crop uptake, reducing the opportunity for environmental loss. From late squaring onwards, cotton can take up 3-4 kg N/ha per day.

### Objective

The experiment aims to compare the efficiency of applied urea via enhanced efficiency fertiliser (Incitec's eNpower®) or timely in-crop only use of regular urea and with a regular pre-plant urea application strategy to see whether EEFs can be used to enable reduced nitrogen usage without compromising productivity. The treatments are:

- 1. Grower reference (regular practice)** – Base application of regular urea (400 kg/ha) pre-plant with in-crop application of regular urea (200 kg/ha) prior to flowering [Total urea 600 kg/ha].
- 2. Base only** – Base application of eNpower (400 kg/ha), with no additional in-crop urea [Total urea 400 kg/ha = 30% less].
- 3. In-crop only** – No base application. Regular urea (400 kg/ha) applied in-crop between first and second irrigation and prior to first flower [Total urea 400 kg/ha = 30% less].

Measurement of crop nitrogen uptake and yield along with soil sampling before and after harvest will assess changes to available soil nitrogen. The emissions intensity of each treatment will be calculated against lint yield as an additional measure of production efficiency.

It's likely that different nitrogen strategies will produce similar yields albeit with altered crop emissions intensity. A saving of 100 kg of applied nitrogen in-field could reduce nitrous oxide emissions by 0.5-1.5 kg/ha. N<sub>2</sub>O is a potent GHG with roughly 298 times the global warming potential of CO<sub>2</sub> therefore improved efficiencies in nitrogen can significantly reduce the emissions intensity of cotton produced. When considering nitrogen associated emissions (manufacturing & in-field) a 200 kg/ha reduction of urea can reduce emissions by 1000–1500 kg CO<sub>2</sub>e.

### Why does this matter?

New emissions reporting legislation is increasing the compliance requirements for companies to calculate and report emissions across their businesses **and** supply chains. Brands will increasingly be interested in the emissions associated with commodity production, and cotton with a lower emissions profile may, in time, become more attractive. Finance companies are also increasingly interested in the emissions intensity of business activities that they finance. Current legislation does not extend to most Australian farming businesses, but other parts of the supply chain will be increasingly compelled to consider emissions factors.

In response, CRDC have funded the Low Emissions Intensity Farming Systems in cotton (Cotton LEIFS) initiative. Developed by Grains Research and Development Corporation (GRDC), a national program of LEIFs programs is supporting work like this to help growers explore options to lower the emissions intensity of their production systems without sacrificing productivity.



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# Nitrogen fertiliser uptake by 'grown on' cotton in CQ

$^{15}\text{N}$  atom nitrogen ( $^{15}\text{N}$ ) is exceedingly rare in the natural environment and urea laced with this isotope can be used as a 'label' to track the fate of applied fertiliser. Two experiments in grown on cotton used  $^{15}\text{N}$  to understand plant uptake and potentially track remnant nitrogen over future seasons.

The two key treatments of interest were:

1. Base-applied  $^{15}\text{N}$ -enriched urea (250 kg N/ha) at planting followed by regular urea applied in-crop at cut-out (95 kg N/ha).
2. Base-applied regular urea (250 kg N/ha) at planting followed by  $^{15}\text{N}$ -enriched urea applied in-crop at cut-out (95 kg N/ha).

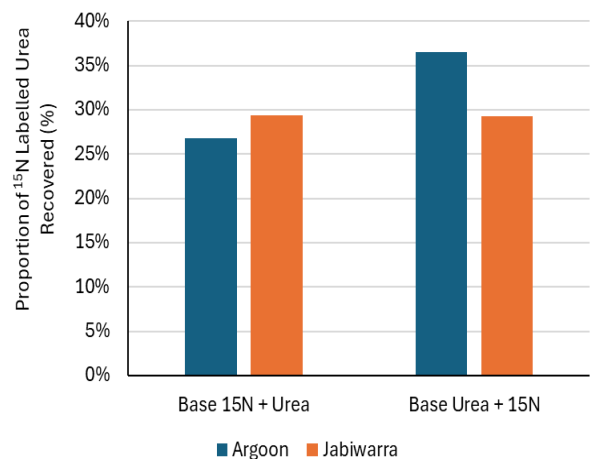
This experiment was done during the 2024/25 season at two irrigated cotton sites (Jabiwarra, Cowal Ag and Argoon, Morawitz Family) that had been planted late August/early September, grown on and picked in May. Partitioned biomass assessments were taken at cut-out and at final maturity.

## What did we find?

### Overall dynamics

Total above-ground nitrogen uptake was between 254–308 kg N/ha over the full life of the crop.

- ▶ 27–29% (67–74 kg N/ha) of the nitrogen uptake was derived from the base 250 kg/ha of  $^{15}\text{N}$  applied at planting (Figure 1).
- ▶ The 95 kg/ha of  $^{15}\text{N}$  application of fertiliser made at cut-out had a higher uptake efficiency of 29–37% (28–35 kg N/ha).
- ▶ The remainder was derived from the soil pool. Pre-plant soil testing indicated 60–75 kg N/ha was present, suggesting that a proportion of the total crop uptake was derived from mineralising organic sources during the growing period.



**Figure 1.** Proportion of applied  $^{15}\text{N}$  urea recovered from plant biomass samples (N/ha recovered vs N/ha applied) at final maturity for the base (250 kg N/ha at planting) and side dress (95 kg N/ha at cut-out) treatments in 2024/25.

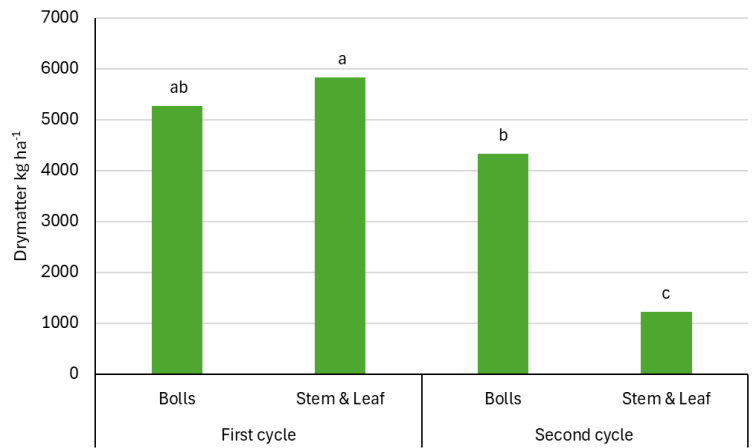


Plants were partitioned into leaves, stems and bolls that had been produced during the first versus second cycles of growth to understand uptake patterns and within-plant distribution of nitrogen.

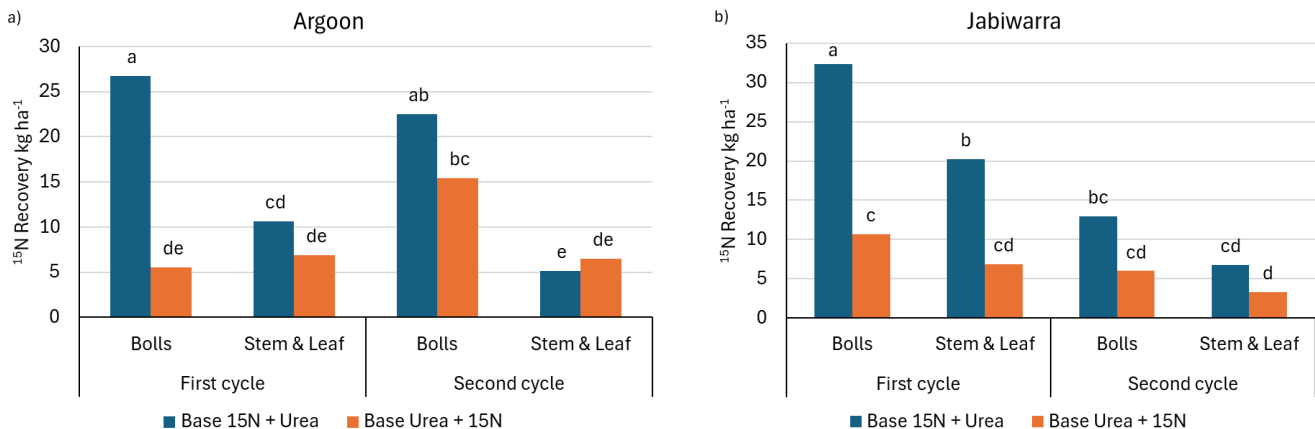
## How did the crop utilise nitrogen from each fertiliser application?

It is useful to consider how the grown on crops produced biomass in terms of bolls vs vegetation in the first and second cycles of growth and then look at how the  $^{15}\text{N}$  fertiliser from the base and cut-out applications were utilised.

- ▶ Boll biomass trended lower for the second cycle but was not statistically different from the first. Both cycles had a high boll load (Figure 2).
- ▶ Supporting foliage differed between the two cycles. Second cycle foliage was smaller, meaning second cycle bolls were partly supported by first cycle leaves (Figure 2), which is time and resource efficient.
- ▶ Base applied  $^{15}\text{N}$  at planting made a significant contribution to BOTH flowering and boll formation cycles (Figures 3a&b)
- ▶  $^{15}\text{N}$  from the application at cut-out made a relatively minor contribution to the first cycle of bolls and a more substantial contribution to the second cycle (Figures 3a&b).
- ▶ Nitrogen recovered from the second cycle bolls was partly remobilised from older first cycle foliage that aged and was progressively shed during the grow-on.



**Figure 2.** Dry matter components (reproductive and vegetative biomass) grown during the first and second cycles of growth for both sites combined (letters denote significant differences ( $P < 0.05$ ) between components and growth cycles).



**Figure 3.**  $^{15}\text{N}$  fertiliser recovery from reproductive (bolls) and vegetative (stem and leaf) biomass components grown during the first and second growth cycles (Letters denote significant differences ( $P < 0.05$ ) between treatments, growth cycle and components).

## What happened to the remaining 70% of applied $^{15}\text{N}$ fertiliser?

Soil sampling at the end of the trial failed to recover significant quantities of  $^{15}\text{N}$ , possibly due to:

- ▶ Soil sampling technique (missed or did not fully intersect with applied bands).
- ▶ Temporary biological tie up – a proportion of  $^{15}\text{N}$  is likely to be contained within the yet to decay crop's root system and soil microbes.
- ▶ Environmental loss due to irrigation tail water, denitrification and leaching.

Subsequent crops grown on the plots will be sampled and processed for  $^{15}\text{N}$  to see whether biologically tied up sources become available again in the following season.

## Take home messages

The results in these experiments were similar to other labelled fertiliser studies in cotton that reported 25-30% uptake efficiency. Some key messages for grown on cotton are:

1. **Base-applied nitrogen was a significant contributor to the crop's nitrogen needs**, accounting for more than half of the fertiliser-derived nitrogen utilised by second cycle bolls.
2. **Growing on cotton improved the nitrogen uptake efficiency of the base-applied nitrogen** due to prolongment of root uptake and remobilisation of nitrogen from older leaves into second cycle bolls.
3. **Applied nitrogen at cut-out contributed to the second cycle of bolls**. The higher uptake efficiency was likely due to the established root system allowing rapid uptake, which reduced potential loss.
4. **The unfertilised controls had the same growing on initiation response timing** (data not shown). Nitrogen availability was not the trigger for the second cycle of growth. The grow on trigger was changes to internal energy balance as bottom bolls matured and opened.
5. **Nitrogen applied at cut-out only made a minor contribution to the first cycle**. This concurs with other studies (the window for nitrogen uptake for regularly grown crops is prior to cut-out).
6. **Soil nitrogen uptake re-commenced during the growing on period** making use of base and cut-out nitrogen applications, thus increasing the efficiency of nitrogen use.
7. **Nitrogen application at cut-out does not need to be large** as the crop will also make use of remaining N in the soil from the base application and mineralising sources.

The contribution of fertiliser applied to the following cotton crop will be studied at Argoon (the Jabbarra field is currently fallow) to determine longer term cycles and impact.

## Acknowledgements

We thank Neek Morawitz and Greg Kauter for their hosting of and collaboration with the <sup>15</sup>N trial work, and Jon Baird (formerly NSW DPI) for sharing the appropriate methodology for conducting this work and assisting with data interpretation.

We also thank Cowal Ag for hosting and Incitec Pivot for supporting the EEF experiment.

If you'd like to be involved or learn more, contact **Paul Grundy: 0427 929 172**.

The Low Emissions Intensity Farming Systems (LEIFS) project is a greenhouse gas (GHG) emissions reduction research, development and extension project, developed by the Grains Research and Development Corporation (GRDC). In collaboration with GRDC, CRDC has adapted this project for the cotton industry via the Cotton LEIFS project, which focuses on field level accounting and emissions reduction strategies delivered in NSW and Qld by NSW DPIRD and Qld DPI.



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