# NITROGEN MANAGEMENT IN THE QUEENSLAND SUGARCANE INDUSTRY

THE ECONOMIC RISKS OF POLICIES THAT PRESCRIBE NITROGEN RATES BELOW INDUSTRY GUIDELINES

CANEGROWERS

**JULY 2020**

Prepared by CANEGROWERS with economic modelling conducted by Queensland Economic Advocacy Services and Adept Economics

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# EXECUTIVE SUMMARY

**Background**
Cane farming generates wealth, drives economic growth and supports the jobs, wages and livelihoods of thousands of residents in communities along the Queensland coast. However, there are concerns over the contributions of cane farms to catchment loads of dissolved inorganic nitrogen (DIN) and the possible effects on the health of inshore marine ecosystems within the lagoon of the Great Barrier Reef (GBR).

Nutrient management is a key component of sugarcane agronomy, and the SIX EASY STEPS™ (6ES) Program provides growers with evidence-based, block-specific recommendations for meeting the nitrogen (N) and other nutrient requirements of the crop for each year of the crop cycle. However, there is a persistent belief within parts of the Federal and State governments that 6ES recommendations exceed crop requirements. This belief has permeated the design and justification of voluntary incentive programs, regulations, and the evaluation framework used to measure progress towards practice and water quality targets. For example, the Queensland Government regulations are based on growers moving to what is termed the 'B' risk category for water quality, and this requires growers to apply N rates that are 15 to 30% below 6ES guidelines.

This report quantified the impacts of such blanket reductions in N rates, relative to the 6ES recommendations, on cane farms and mills, and on the economic value of the industry to regional communities and the State as a whole. It used a generalised nitrogen response function for each cane region, derived from N response trials within each region.

**Main findings**
The main finding is that the blanket use of N rates below those recommended by the SIX EASY STEPS program would markedly reduce the production and incomes of farms, the profitability of mills, and the economic and social health of regional economies. For example, a 30% reduction in N rate would cause reductions of 5.0 -7.5 tonne/ha in cane yields and 0.7 to 1.2 tonne/ha in sugar yields, depending on district. This, in turn, would reduce crop partial net returns by $142 to $266/ha, again depending on district.

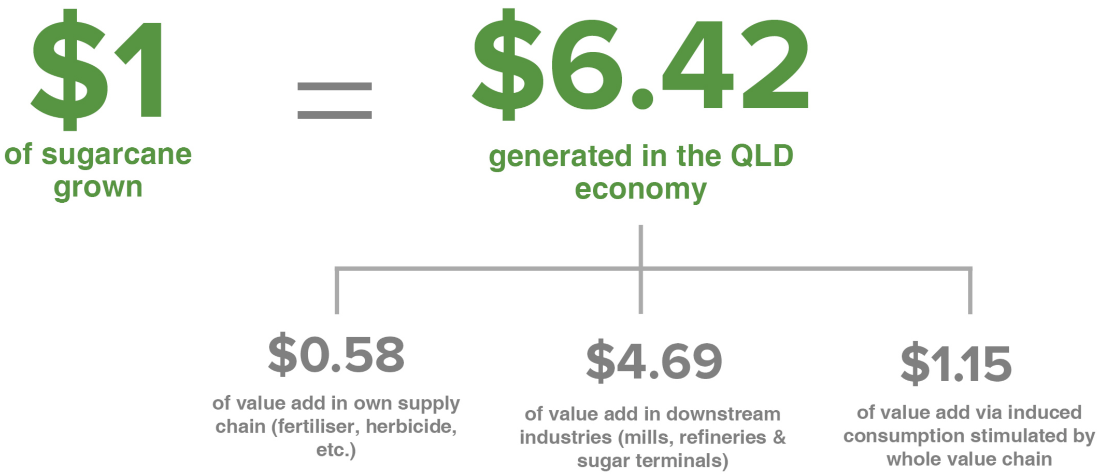
These on-farm impacts would lead to reductions in the industry's direct economic benefits for regional economies, ranging from approximately $11 million per annum in the Wide Bay-Burnett to $44 million per annum in north Queensland. The collective direct regional impacts would penalise the Queensland economy by up to $110 million each year. When the indirect economic impacts of the reduction in cane farming are accounted for, the annual cost to the State's economy is approximately $160 million or nearly $1.3 billion over ten years (in present value terms).

The industry recognises that it should continue efforts to research, develop and implement cost-effective options for improving nitrogen use efficiency and reducing losses of DIN. That ongoing work is important. However, this study has clearly demonstrated the economic risk to industry and regional communities of seeking reduced DIN through widespread reductions in N application rates below those recommended by the 6ES program.

Current reef water quality policies, regulations and programs are based on unrealistic expectations of what growers can afford to do in reducing N application rates. The report also highlights the associated risks from these policies and regulations to the viability of mills and the health of regional economies. All such policies, regulations and programs need urgent review and revision with strong industry input.

# 1. INTRODUCTION

Cane farming generates wealth, drives economic growth and supports the jobs, wages and livelihoods of thousands of residents in communities along the Queensland coast. A recent report (QEAS 2019) quantified its importance to Queensland, including its $4 billion in economic activity, over 22,000 jobs and over 10,000 businesses. Cane farming benefits the community through employment and stimulus across the value chain, with one dollar in economic activity in cane growing supporting an additional $6.42 elsewhere in the Queensland economy.




Cane farming in Queensland occurs predominantly in the lower reaches of catchments that flow into the lagoon of the Great Barrier Reef (GBR). The influence of cane and other agriculture on catchment water quality, and the possible implications of this for the health of inshore marine ecosystems, has led to Federal and State governments setting targets for improved water quality and implementing various interventions to achieve these. For cane farming, the primary focus has been on anthropogenic dissolved inorganic nitrogen (DIN) in catchment discharge. The current target for DIN is a 60% reduction in catchment loads by 2025 (relative to modelled 2009 loads) (Queensland Government 2018).

Nutrient management is a key component of sugarcane agronomy, and the SIX EASY STEPS™ (6ES) program provides growers with evidence-based and reliable recommendations for rates of nitrogen (N) and other essential nutrients for each cane block (Wood *et al*. 2003, Schroeder *et al*. 2009, Skocaj *et al*. 2012). These recommendations are based on soil tests taken at the end of each crop cycle and, for nitrogen recommendations, account for potentially mineralisable N and for other sources of available N such as fallow legume crops and mill by-products. The recommendations are district and block specific, tailored to the plant and subsequent ratoon crops, and include any ameliorants required to manage soil constraints such as sodicity and acidity. In effect, the 6ES recommendations provide a complete nutrient management plan for each cane block for the crop cycle.

The 6ES recommendations are guidelines – they are the best estimate of the optimal rates of N and other nutrient based on each block's soil types, soil testing and management history. Field trials and demonstration sites have shown these recommendations to be reliable and robust. For N recommendations, this reflects the particularly strong data sets on which they are based, which includes multi-site, long-term field trials in various production regions (see Appendix A for a description of the data sources under-pinning the 6ES program).

In addition to providing nutrient recommendations, the program includes steps for reviewing the adequacy of nutrient supply during the crop cycle (e.g. through leaf analysis, on-farm trials). However, growers using the 6ES program typically follow the recommendations closely throughout the crop cycle. Some growers may deviate from the recommendations for specific situations, such as final-year ratoons or late-harvested crops, that they consider may be less responsive to nutrients. However, there is limited data to support such situation-specific refinements. The recent launch of the SIX EASY STEPS Toolbox by Sugar Research Australia (SRA 2020) provides guidance to growers and their advisors for possible refinements to N rates for specific circumstances.

Increasing scrutiny of nutrient management by Federal and State governments has led to interventions including a sequence of voluntary programs (e.g. Reef Rescue and Reef Trust) and increasing levels of regulation (e.g. the *Environmental Protection (Great Barrier Reef Protection Measures) and Other Legislation Amendment Act 2019*). While early interventions generally focused on increasing adoption of the 6ES recommendations, especially for N, more recent programs and regulations seek the use of even lower N rates.

This arises from a persistent belief, within parts of the Federal and State governments, that crop productivity is generally too low to justify use of the 6ES recommendations and that the latter rates are only needed when and where yields are exceptionally high.

This belief has spawned alternative mechanisms for calculating optimal N rate, using calculations based on growers' yield expectations or yield history (e.g. Anon 2013, Rust *et al*. 2017, Bramley *et al*. 2019). Such yield-based calculations have been the basis for the Paddock to Reef (P2R) practice framework used to assess growers' practices in terms of the P2R perception of 'best management'. For example, the 2013 version states that best practice is a calculation of N based on applying certain multipliers to 'grower's own yield expectations' (Queensland Government 2013). The most recent version (Queensland Government 2019) states that best practice is the 'optimal amount' calculated from yield history.

A simple inspection of the field data that underpins the 6ES program shows these approaches can be spurious. Examples provided in Appendix A show that 6ES recommendations for N are derived from numerous field experiments with different sites and years covering a wide range in yields. This depth of investigation has resulted in guidelines that enable decisions on when or where yield responses to applied fertiliser N are likely. In contrast, the alternative approaches generally rely on crop response to N being related to crop size. However, Thorburn *et al*. (2018) analysed data from all such field experiments in Queensland and found there was little correlation between cane yield and optimal N rate. Despite this, the belief that 6ES recommendations are excessive has permeated the design and justification of voluntary programs, regulations, and the P2R framework used to measure growers' progress towards practice and water quality targets (e.g. Qld Gov 2013, Alluvium 2016, Office of Great Barrier Reef 2017).

Consequently, policies and programs are based on unrealistic expectations of what growers can afford to do in reducing N application rates. For example, the current Queensland Government regulations are based on growers moving to what is termed the 'best practice', or 'B', risk category for water quality (Office of Great Barrier Reef 2017), which assumes optimal N rates are generally 15 to 30% below the 6ES recommendations.

To highlight the economic risk of this approach, this report quantifies the impacts of blanket reductions in N rates, relative to the 6ES guidelines, on the profits of cane farms and mills, and on the economic value of the industry to regional communities and the State as a whole. A whole supply chain analysis provides a real world understanding of the consequences of the scenarios for surrounding communities.

# 2. METHODOLOGY

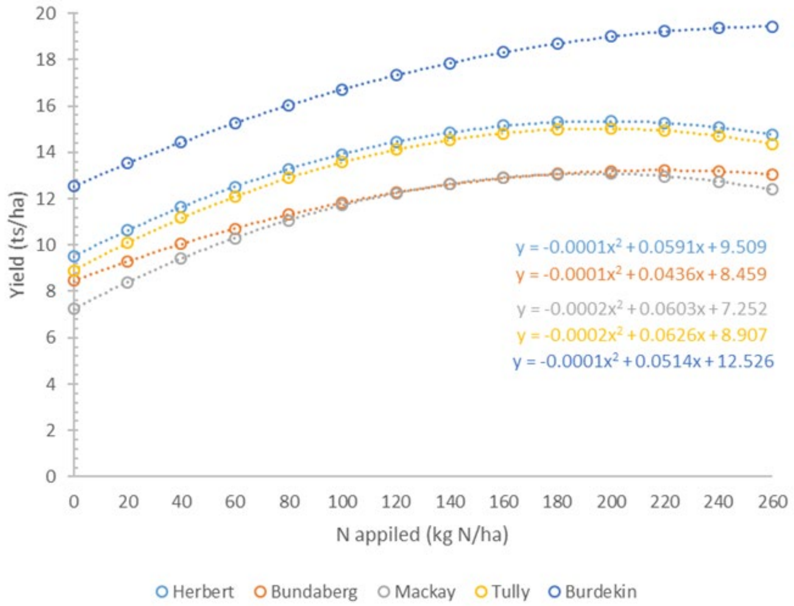
There were three main steps in quantifying the economic impacts of reductions in N rates on cane farms, mills and regional economies:

1. Development and utilisation of representative N response functions for ratoon cane for each of five districts, based on field data. The method is described in Appendix A. Based on the availability of relevant field data and the need to be representative of each economic region of interest, the districts selected were Tully, Herbert River, Burdekin, Mackay and Bundaberg.
2. The generalised N response function for each district was used to estimate impacts on farm production (cane and sugar tonnes per ha) and partial net return ($/per ha) from various reductions in N rates (10%, 15%, 20%, 25%, and 30%) relative to an appropriate generalised estimate of the 6ES recommended rate (taken to be the N rate that produced 95% of maximum yield).
3. The enterprise impacts were scaled up for each of five regional economies and to the Queensland economy as a whole. The five regional economies, and the representative response functions used for each, were:
   i. Far north Queensland, from Mossman in the north to Tully in the south, but excluding the Tableland (impacts derived from Tully district response function)
   ii. North Queensland (weighted impact from the individual Herbert and Burdekin response functions)
   iii. Mackay region, including Mackay, Proserpine, and Plane Creek districts (Mackay response function)
   iv. Bundaberg and Wide Bay Burnett (WBB) region, including Bundaberg, Isis, and Maryborough districts (Bundaberg response function)
   v. Remainder of Qld (indirect economic impacts only)

## 2.1 NITROGEN-YIELD RESPONSE FUNCTIONS

These relationships were derived from numerous replicated and randomised N field trials located in the different districts (indicated above). In each case, yield [tonnes of cane harvested per hectare (TCH)] and the commercial cane sugar (CCS) values were determined relative to increasing rates of N applied as urea. Cane yield and CCS were used to estimate the tonnes of sugar harvested per hectare (TSH). The relationship between TSH and N applied (kg N/ha) are presented in Figure 1. See Appendix A for the methods used to derive the generalised district functions.

**Figure 1. Relationship between yield (tonnes of sugar harvested per hectare (ts/ha)) and N applied (kg N/ha) for each representative district.**




## 2.2 IMPACTS OF REDUCED N RATES ON PARTIAL NET RETURNS OF FARMS AND MILLS

The reductions in TSH (relative to TSH at the 6ES rate) as a result of reduced N rates are shown in Table 1. For the purpose of this study, the reference 6ES rate for each region was derived from the corresponding regional response curve, and was defined as the N rate at which 95% of maximum yield was achieved.

The reference 6ES rate for each district was close to 140 kg N/ha except for the Burdekin, where it was 170 kg N/ha. In each district, except for the Burdekin, these reference rates approximated the economic optimum (see Figure 4). The optimum rate for the Burdekin was somewhat higher than 170 kg N/ha. However, the latter rate was used for the Burdekin to maintain consistency of approach in the analysis.

**Table 1. Reductions (% relative to TSH at 6ES rate) in TSH from reduced rates of N for each district.**

| *N rate relative to 6ES* | *Bundaberg* | *Burdekin* | *Herbert* | *Mackay* | *Tully* |
|---|---|---|---|---|---|
| -10% | -1.9% | -1.9% | -1.8% | -2.1% | -1.9% |
| -15% | -3.0% | -3.0% | -2.9% | -3.3% | -3.0% |
| -20% | -4.1% | -4.1% | -4.1% | -4.7% | -4.2% |
| -25% | -5.4% | -5.3% | -5.4% | -6.2% | -5.6% |
| -30% | -6.7% | -6.6% | -6.7% | -7.8% | -7.0% |

*Farm partial net returns*

The partial net return at each level of N, as per the yield response functions (Appendix A), was calculated using the cane price formula with the CCS at each level of N application multiplied by the tonnes of cane/ha less the costs of the N applied per ha and the harvesting and levies costs per ha. This gave the partial net return per ha. The difference between the partial net return per ha for the change in N application rate provided a marginal analysis.

The formula for calculating the farm partial net return per hectare of cane is as follows:

$$PNR_{Farm}/ha = [\ \{\ P_s \times 0.009\ (CCS - 4)\ \} + C - H\ ] \times TCH - P_N\ N$$

PNR stands for partial net return, $P_s$ stands for the sugar price per tonne, C is the constant in the cane price ($/tonne cane), H stands for harvesting and levies costs ($/tonne cane), $P_N$ stands for the price of nitrogen ($/kg), and N stands for nitrogen (kg) applied per hectare. Parameters used in the equation, based on district consultations and desktop review, are as follows:

- $P_s$ of $450;
- $P_N$ of $1.52/kg;
- C of $0.60/tonne; and
- H of $9.00/tonne.

CCS and TCH are calculated using the response functions provided for each region relating CCS and TCH to nitrogen applied (Appendix A). Note these functions are for ratoon cane, and the calculation of PNR accounts only for the variable nitrogen fertiliser and harvesting costs associated with this cane. All other costs are fixed.

*Mill partial net returns*

The partial net return per ha to milling is the total value of sugar per ha at each level N applied based on CCS less the payment made to growers in the CCS formula, less the marginal milling costs per tonne of cane. This was calculated using the formula:

$$PNR_{Mill}/ha = [\ P_s \times (CCS/100) - \{\ P_s \times 0.009\ (CCS - 4)\ \} + C\ ] \times TCH - MC \times TCH$$

In this formula, MC stands for milling costs per tonne of cane which were assumed to be $5/tonne across the industry.

## 2.3 SCALING FARM IMPACTS TO REGIONAL ECONOMIES

Estimates of hectares of cane harvested by region (Table 2) were sourced from the CANEGROWERS 2019 Annual Report. The estimated impacts on TCH/ha for each region were converted into regional level impacts, using the economic model developed in QEAS's (2019) study of the economic contribution of the sugarcane industry, and which was partly based on the model used by Lawrence Consulting (2019). The economic contributions estimated in the QEAS (2019) study are summarised in Appendix B.

**Table 2. Hectares of cane harvested by region, Queensland**

| *Region* | *2017* | *2018* | *Average* |
|---|---|---|---|
| Bundaberg & rest of WBB | 42,834 | 44,388 | 43,611 |
| Far North Queensland | 77,574 | 76,146 | 76,860 |
| Mackay | 106,200 | 108,001 | 107,101 |
| North Queensland | 125,765 | 125,908 | 125,837 |
| Rest of Queensland* | 7,754 | 8,062 | 7,908 |
| **Queensland** | **360,127** | **362,505** | **361,316** |

**Rest of Queensland in this table includes the Tableland and the area around Rocky Point. Note that direct economic impacts are not calculated for the Rest of Queensland in this report.*

The correspondence between the economic regions used in the QEAS (2019) report and the representative districts for which nitrogen-response functions were derived, is shown in Table 3.

**Table 3. Correspondence between economic regions in the QEAS (2019) report and districts for which nitrogen-response functions were derived.**

| *QEAS (2019) regions* | *District with generalised nitrogen-response function* |
|---|---|
| Wide-Bay Burnett (WBB) | Bundaberg |
| Mackay | Mackay |
| North Queensland | Burdekin, Herbert |
| Far North Queensland (FNQ) | Tully |

Note that for the North Queensland economic region there were two N-response functions available: Burdekin and Herbert. For this region, the outputs were a combination of the individual nitrogen-response functions for Burdekin and Herbert using respective weightings of 0.6 and 0.4, the latter based on their relative tonnes of cane crushed (CANEGROWERS 2019).

To estimate the economic impacts of reduced N rates beyond the farm gate, specific shocks were formulated that corresponded to reductions in N rate of 10%, 15%, 20%, 25%, and 30% (relative to the reference 6ES recommendation). The logic underlying the economics is set out in Figure 3. The estimated reduction in TSH was assumed to have the same proportional impact on gross value added (GVA) by cane growers and sugar mills.

**Figure 3. Economic model for scaling up farm impacts**

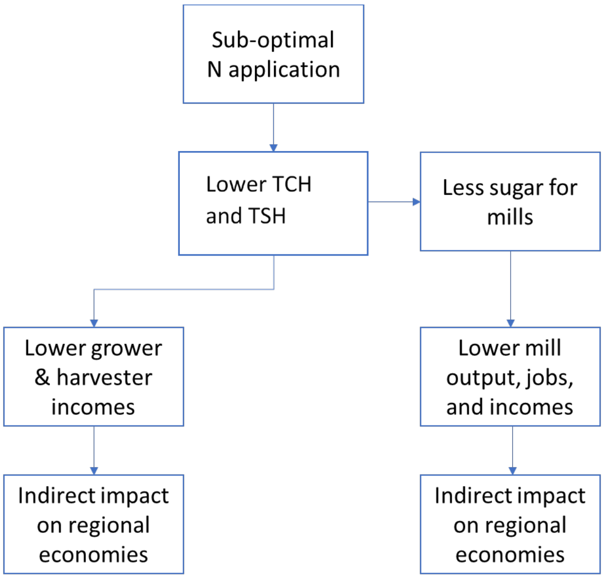



Table 4 shows the impacts of reduced N rates on regional cane tonnages, which seeded the estimates of regional economic impacts.

**Table 4. Reduction in the annual tonnes of cane crushed in each region as a result of reduced N rates.**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -65,451 | -101,703 | -140,305 | -181,258 | -224,562 |
| Far North Queensland | -142,037 | -224,919 | -315,710 | -414,410 | -521,019 |
| Mackay | -187,156 | -294,588 | -411,257 | -537,163 | -672,304 |
| North Queensland | -253,688 | -396,076 | -548,825 | -711,937 | -885,412 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | -648,333 | -1,017,286 | -1,416,098 | -1,844,768 | -2,303,296 |

The estimates of indirect impacts from this study should be taken as upper bounds of potential economic impacts - cautious interpretation of indirect/multiplier effects is required when these are generated by Input-Output models (Gretton 2013).

# 3. RESULTS

## 3.1 EFFECTS ON CROP PARTIAL NET RETURN

The translation of the N-yield response functions for each district into impacts of changing N rates on partial net return per ha for ratoon cane is shown in Figure 4.

**Figure 4. Impacts of N application rates on farm partial net return for each representative district**

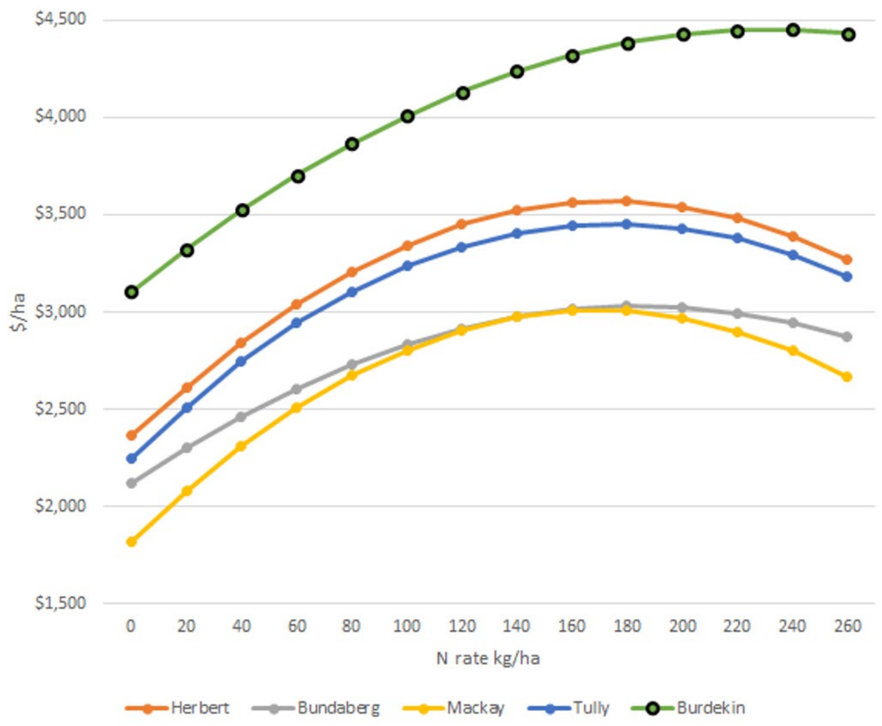


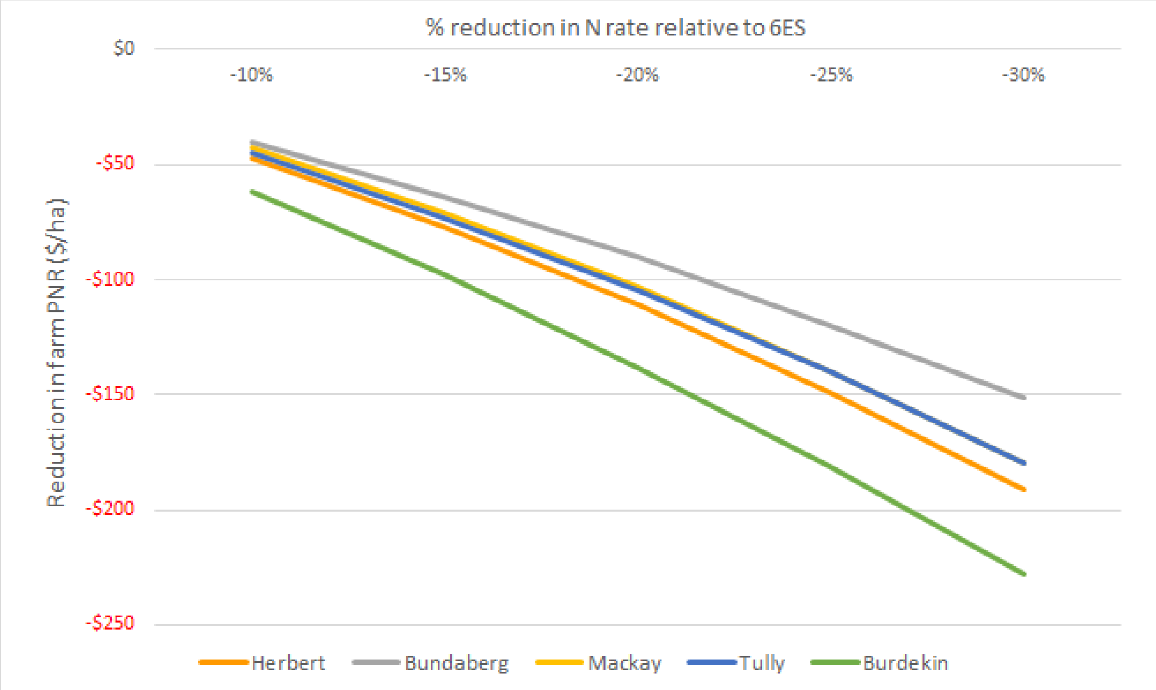

Table 5 shows the impacts of reduced N rates on partial net return of ratoon cane for each district. The impact on PNR of a 30% reduction in N rate ranged from $151 per ha for Bundaberg to $228 per ha for Burdekin (Figure 5).

For a Herbert River grower with 130 ha under cane each year, a 15% reduction in N rate would create a loss in net revenue of approximately $10,000 per year, while a 30% reduction in N rate would mean a loss of $24,830 per year. For all growers in the Herbert, this would be a total loss of $4.4 M (15% less N) or $10.9 M (30% less N), given the area harvested is around 57,000 ha. For a Burdekin grower with the same area of cane, 15% and 30% less N would result in annual losses of $12,250 and $28,500, respectively. The corresponding losses for all Burdekin growers would be $6.7 M and $15.7 M, respectively.

**Table 5. Impacts of reduced N rates on partial net returns ($/ha) for farms in each representative district**

| *N application* | *Bundaberg* | *Burdekin* | *Herbert* | *Mackay* | *Tully* |
|---|---|---|---|---|---|
| 6ES rate | $2,975 | $4,356 | $3,521 | $2,973 | $3,404 |
| -10% (below 6ES) | $2,935 | $4,294 | $3,474 | $2,930 | $3,359 |
| -15% | $2,911 | $4,258 | $3,444 | $2,902 | $3,331 |
| -20% | $2,885 | $4,218 | $3,410 | $2,870 | $3,299 |
| -25% | $2,855 | $4,175 | $3,372 | $2,833 | $3,264 |
| -30% | $2,824 | $4,128 | $3,330 | $2,793 | $3,224 |

**Figure 5. Reductions in farm partial net returns from reduced N rates, for each representative district**




## 3.2 EFFECTS ON PARTIAL NET RETURN OF MILLS

Table 6 shows the impacts of reduced N rates on partial net returns per ha for sugar mills in each district. Reductions in partial net returns from a 30% reduction in N rate range from $92 to $136/ha, which is a 7 to 8% reduction for each mill. For the Burdekin mills, this would be a total annual loss of $9.4 M (68,800 ha harvested) while for the Tully mill, this would be an annual loss of $3.4 M (29,700 ha harvested).

**Table 6. Impacts of reduced N rates on mill partial net return ($/ha) for mills in each representative district**

| *N application* | *Bundaberg* | *Burdekin* | *Herbert* | *Mackay* | *Tully* |
|---|---|---|---|---|---|
| 6ES rate | $1,395 | $2,075 | $1,653 | $1,403 | $1,630 |
| -10% (below optimal) | $1,368 | $2,035 | $1,622 | $1,372 | $1,598 |
| -15% | $1,354 | $2,013 | $1,605 | $1,355 | $1,579 |
| -20% | $1,338 | $1,990 | $1,586 | $1,335 | $1,559 |
| -25% | $1,321 | $1,965 | $1,565 | $1,314 | $1,537 |
| -30% | $1,303 | $1,939 | $1,543 | $1,292 | $1,513 |

## 3.3 EFFECTS ON INDUSTRY (FARM PLUS MILLS) PARTIAL NET RETURN

Adding the estimated impacts for cane farms in (Table 5) with the corresponding mill impacts (Table 6) produces industry impacts of reduced N rates (Table 7). Reductions in partial net returns, from a 30% reduction in N rate, range from $244 to $363/ha, which is a 5.6 to 6.6 % reduction in industry partial net return for each district. For the Tully district, this means a loss of $8.8 M per year while the Burdekin district would lose $25 M per year.

**Table 7 Impacts of reduced N management on partial net return ($/ha) for the industry (farms and mills) in each representative district**

| *N application* | *Bundaberg* | *Burdekin* | *Herbert* | *Mackay* | *Tully* |
|---|---|---|---|---|---|
| 6ES rate | $4,370 | $6,430 | $5,174 | $4,376 | $5,034 |
| -10% (below optimal) | $4,304 | $6,330 | $5,096 | $4,302 | $4,957 |
| -15% | $4,265 | $6,272 | $5,049 | $4,256 | $4,911 |
| -20% | $4,222 | $6,208 | $4,996 | $4,205 | $4,858 |
| -25% | $4,176 | $6,140 | $4,937 | $4,148 | $4,800 |
| -30% | $4,126 | $6,067 | $4,873 | $4,085 | $4,737 |

## 3.4 DIRECT IMPACTS OF REDUCED N RATES ON REGIONAL ECONOMIES

*Direct impacts from effects on farm incomes*

Table 8 shows the estimated reduction in regional farm income from sugarcane production under the different nitrogen scenarios. State-wide, the annual impacts range from a reduction in farm incomes of $16.9 million for a 10% reduction in N rates relative to 6ES, to $66.5 million for a 30% reduction in N rate.

There would also be direct negative effects via lower expenditure on harvesting (Table 9) and fertiliser (Table 10). The state-wide impact of these would be lost economic value of close to $45 million for a 30% reduction in N application rates.

**Table 8. Reductions in regional farm incomes, $ million, per annum.**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -1.7 | -2.8 | -3.9 | -5.2 | -6.6 |
| Far North Queensland | -3.5 | -5.6 | -8.1 | -10.8 | -13.9 |
| Mackay | -4.6 | -7.6 | -11.1 | -14.9 | -19.3 |
| North Queensland | -7.0 | -11.3 | -16.0 | -21.2 | -26.8 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | **-16.9** | **-27.3** | **-39.1** | **-52.1** | **-66.5** |

**Table 9. Reduction in purchases of harvesting services, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -0.6 | -0.9 | -1.3 | -1.6 | -2.0 |
| Far North Queensland | -1.3 | -2.0 | -2.8 | -3.7 | -4.7 |
| Mackay | -1.7 | -2.7 | -3.7 | -4.8 | -6.1 |
| North Queensland | -2.3 | -3.6 | -4.9 | -6.4 | -8.0 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | **-5.8** | **-9.2** | **-12.7** | **-16.6** | **-20.7** |

**Table 10. Reduction in purchases of fertiliser, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -0.9 | -1.4 | -1.9 | -2.3 | -2.8 |
| Far North Queensland | -1.6 | -2.5 | -3.3 | -4.1 | -4.9 |
| Mackay | -2.3 | -3.4 | -4.6 | -5.7 | -6.8 |
| North Queensland | -3.0 | -4.5 | -6.0 | -7.6 | -9.1 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | **-7.9** | **-11.8** | **-15.7** | **-19.7** | **-23.6** |

*Direct impacts from effects on mill incomes*
Table 11 shows the estimated reduction in regional mill incomes under the different nitrogen scenarios. State wide, the annual impacts to mills range from a reduction in gross income of $11.4 million for 10% less N applied, to $40.7 million for 30% less N.

**Table 11. Reductions in regional mill incomes, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -1.2 | -1.8 | -2.5 | -3.3 | -4.0 |
| Far North Queensland | -2.5 | -3.9 | -5.5 | -7.2 | -9.0 |
| Mackay | -3.3 | -5.2 | -7.2 | -9.5 | -11.9 |
| North Queensland | -4.5 | -7.0 | -9.8 | -12.7 | -15.8 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | **-11.4** | **-17.9** | **-25.0** | **-32.6** | **-40.7** |

This in turn has a direct impact on wages of mill workers (Table 12), assuming 20% of the variable cost estimate of $5/tonne is related to labour, which is broadly consistent with IBISWorld (2019) estimates of the industry cost structure. The state-wide impact of reduced N rates ranges from an annual loss of wages of $0.6 million for 10% sub-optimal application to $2.3 million for 30% sub-optimal application.

**Table 12. Reductions in sugar mill wages, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -0.1 | -0.1 | -0.1 | -0.2 | -0.2 |
| Far North Queensland | -0.1 | -0.2 | -0.3 | -0.4 | -0.5 |
| Mackay | -0.2 | -0.3 | -0.4 | -0.5 | -0.7 |
| North Queensland | -0.3 | -0.4 | -0.5 | -0.7 | -0.9 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | **-0.6** | **-1.0** | **-1.4** | **-1.8** | **-2.3** |

There are also direct effects on purchases of intermediate goods and services used by mills, with the state-wide impact ranging from -$2.6 million per annum for 10% reduction in N rates, to -$9.2 million per annum for 30% reduced N (Table 13).

**Table 13. Reductions in purchases of intermediate goods and services by sugar mills, $ million, per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -0.3 | -0.4 | -0.6 | -0.7 | -0.9 |
| Far North Queensland | -0.6 | -0.9 | -1.3 | -1.7 | -2.1 |
| Mackay | -0.7 | -1.2 | -1.6 | -2.1 | -2.7 |
| North Queensland | -1.0 | -1.6 | -2.2 | -2.8 | -3.5 |
| Rest of Queensland | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Queensland** | **-2.6** | **-4.1** | **-5.7** | **-7.4** | **-9.2** |

*Total direct impacts*
Table 14 shows the estimates for total direct impacts, being the sum of tables 8 (Farm incomes), 11 (Mill incomes), and 12 (Wages). The reductions in the industry's direct economic benefits to the State ranges from $29 million per annum for 10% sub-optimal application to $110 million for 30% sub-optimal application.

Note that it does not include impacts on harvesting services, fertiliser, or intermediate goods and services because these are inputs. The value added associated with these inputs is picked up in the indirect impacts (see next section).

**Table 14. Total direct economic losses from reduced N rates, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Wide-Bay Burnett | -3.0 | -4.7 | -6.6 | -8.6 | -10.9 |
| FNQ | -6.1 | -9.7 | -13.9 | -18.4 | -23.4 |
| Mackay | -8.1 | -13.1 | -18.7 | -24.9 | -31.8 |
| North Queensland | -11.8 | -18.7 | -26.3 | -34.6 | -43.5 |
| Rest of Queensland | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Queensland** | **-28.9** | **-46.2** | **-65.4** | **-86.6** | **-109.6** |

## 3.5 INDIRECT IMPACTS OF REDUCED N MANAGEMENT

Using QEAS's (2019) economic contributions model, the potential indirect economic impacts of reduced farm incomes, as a result of blanket reductions in N rates, are provided in Table 15. Indirect impacts are up to $40.5 million state-wide. Note that the pattern of the indirect impacts across the state reflects the high leakage of expenditure from regional economies that typically occurs due to purchases of goods and services from other parts of the State, such as South East Queensland.

**Table 15. Estimates of indirect economic impacts via reduced supply-chain purchases and lower incomes on cane farms, $ million, per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Bundaberg & rest of WBB | -0.7 | -1.1 | -1.6 | -2.0 | -2.6 |
| Far North Queensland | -1.5 | -2.4 | -3.4 | -4.5 | -5.7 |
| Mackay | -2.0 | -3.2 | -4.5 | -6.0 | -7.6 |
| North Queensland | -2.8 | -4.5 | -6.2 | -8.2 | -10.2 |
| Rest of Queensland | -3.8 | -6.1 | -8.6 | -11.4 | -14.4 |
| **Queensland** | **-10.9** | **-17.3** | **-24.4** | **-32.1** | **-40.5** |

*NB. In calculating indirect impacts it is assumed that direct regional gross value added is 50% of regional purchases of harvesting services, which appears a reasonable assumption in the absence of specific data. Indirect impacts via fertiliser purchases are excluded as regional value added impacts are small.*

We have calculated the potential indirect economic impacts due to lower production at sugar mills (Table 16). The indirect impacts range from -$2.7 million through to -$9.7 million.

Aggregating these estimates shows the indirect economic penalties to the State range from -$13.6 million for 10% sub-optimal application to -$50.2 million for 30% sub-optimal application (Table 17).

**Table 16. Estimates of indirect economic impacts via reduced supply chain purchases and lower labour incomes at sugar mills, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Bundaberg & rest of WBB | -0.2 | -0.4 | -0.5 | -0.7 | -0.9 |
| Far North Queensland | -0.5 | -0.9 | -1.2 | -1.6 | -2.0 |
| Mackay | -0.7 | -1.1 | -1.6 | -2.0 | -2.6 |
| North Queensland | -1.0 | -1.5 | -2.1 | -2.7 | -3.4 |
| Rest of Queensland | -0.3 | -0.4 | -0.6 | -0.7 | -0.9 |
| **Queensland** | **-2.7** | **-4.3** | **-5.9** | **-7.7** | **-9.7** |

**Table 17. Total indirect impacts from reduced N application rates, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Bundaberg & rest of WBB | -1.0 | -1.5 | -2.1 | -2.7 | -3.4 |
| Far North Queensland | -2.1 | -3.3 | -4.6 | -6.1 | -7.7 |
| Mackay | -2.7 | -4.3 | -6.1 | -8.0 | -10.1 |
| North Queensland | -3.8 | -6.0 | -8.3 | -10.9 | -13.6 |
| Rest of Queensland | -4.0 | -6.5 | -9.1 | -12.1 | -15.3 |
| **Queensland** | **-13.6** | **-21.5** | **-30.3** | **-39.8** | **-50.2** |

## 3.6 TOTAL IMPACTS OF REDUCED NITROGEN APPLICATION

The combined direct and indirect impacts of blanket reductions in nitrogen application of up to 30% are presented in Table 18. The adverse impacts on the State economy from reduced yields are up to $160 million per annum. The total impacts, including indirect impacts, can be considered conservative, bearing in mind the finding of the QEAS (2019) report which demonstrated $1 in cane farming generates over $6 in value elsewhere in the value chain. The findings in this report are consistent with that finding and are based on the same economic model. A specific shock to the production process is modelled, and we have used evidence on the expected impacts on specific purchases from the supply-chain, rather than assuming reductions in the purchases of all inputs by cane growers and mills.

**Table 18. Estimated total economic impacts of sub-optimal nitrogen application, $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Bundaberg & WBB | -3.9 | -6.2 | -8.7 | -11.4 | -14.3 |
| FNQ | -8.1 | -13.0 | -18.5 | -24.5 | -31.1 |
| Mackay | -10.8 | -17.4 | -24.8 | -33.0 | -41.9 |
| North Queensland | -15.6 | -24.7 | -34.6 | -45.4 | -57.1 |
| Rest of Queensland | -4.0 | -6.5 | -9.1 | -12.1 | -15.3 |
| **Queensland** | **-42.5** | **-67.8** | **-95.7** | **-126.4** | **-159.7** |

Over a ten-year period, the loss of value added to the Queensland economy would amount to nearly $1.3 billion (Table 19).

**Table 19. Estimated total economic impacts over ten years (assuming 4% real discount rate), $ million per annum**

| | *Reduction in N (% decrease relative to 6ES rate)* | | | | |
|---|---|---|---|---|---|
| | *-10%* | *-15%* | *-20%* | *-25%* | *-30%* |
| Bundaberg & WBB | -31.9 | -50.4 | -70.5 | -92.3 | -115.7 |
| FNQ | -65.8 | -105.5 | -149.9 | -198.8 | -252.4 |
| Mackay | -87.7 | -141.2 | -201.1 | -267.5 | -340.2 |
| North Queensland | -126.4 | -200.2 | -280.8 | -368.4 | -462.9 |
| Rest of Queensland | -32.7 | -52.4 | -74.2 | -98.2 | -124.3 |
| **Queensland** | **-344.6** | **-549.6** | **-776.5** | **-1025.2** | **-1295.5** |

# 4. DISCUSSION

This study has demonstrated the economic risk to industry and regional economies of seeking reduced losses of DIN through blanket use of N rates below the 6ES recommendations. Such reductions would clearly reduce the production and incomes of farms, the profitability of mills, and the economic and social health of regional economies. A 30% reduction in N rate would cause a 0.7 to 1.2 tonne/ha reduction in sugar yields, depending on district. This, in turn, would reduce crop partial net returns by $142 to $266/ha, again depending on district. These impacts would lead to reductions in the industry's direct economic benefits for regional economies, ranging from approximately $11 million per annum in the Wide-Bay Burnett to $44 million per annum in North Queensland. The collective regional impacts would penalise the Queensland economy by approximately $110 million each year. When we account for impacts on both the direct and indirect economic benefits of cane farming, the annual penalty to the State would be $160 million.

The report demonstrates that current reef water quality policies, regulations and programs are based on unrealistic expectations of what growers can afford to do in reducing N application rates, and also highlights the risk to the viability of mills and regional economies. All such policies, regulations and programs should therefore be urgently reviewed and revised with input from industry.

Confidence that the estimates of economic impacts are realistic is based on:

1. The considerable field data that underpin both the 6ES program and the generalised district relationships between crop production and nitrogen rate used in this study.
2. The availability of a proven model for scaling up farm and mill impacts to the regional scale, including the implications for both direct and indirect economic benefits.

Two aspects of the analysis may have led to a slight overestimate of the economic impacts. Plant crops were not considered in the analysis due to the relatively small data set. Plant crops that follow a fallow period can be less responsive to N than ratoon crops, although this is reflected in the recommendations from the 6ES program. Also, CCS values from field plots were used in the analysis, and these values are typically higher than that from commercial harvests as the latter includes extraneous matter. The CCS levels in commercial harvests may also be affected by higher rates of N if this leads to the crop lodging, so that the optimal N rate under commercial conditions may, at times, be a little lower than that from trial work.

On the other hand, the medium to long-term economic impacts of reduced N rates may be higher than estimated, due to:

1. The potential for the effects of reduced N rates to amplify over time, due to mining of soil nitrogen reserves.
2. The conservative approach to measuring indirect impacts. The QEAS (2019) report found $1 in cane farming generates over $6 in value elsewhere in the value chain but, rather than assuming reductions in the purchases of all inputs by cane growers and mills, only the impacts on specific purchases from the supply-chain were included.
3. Reduced farm profits increasing the likelihood of some cane land being abandoned or being used for less productive purposes.
4. Reduced tonnages leading to fewer harvest contractors, which would extend the harvest season.
5. Reduced tonnages through mills, compromising the viability of at least some mills.

On balance, the estimated impacts of reduced N rates are likely to be a reasonable approximation of the real economic risks to farms, districts and regional economies.

Industry should continue to research and adopt cost-effective options for improving nitrogen use efficiency and reducing losses of DIN. That ongoing work is important for both productivity and reducing risk of possible downstream impacts. However, any blanket reductions of N rates below the 6ES recommendations will damage the industry and the State. Therefore, all parties interested in reducing DIN losses from cane farms should focus on:

- Better adoption of existing cost-effective options, including use of the complete set of nutrient and ameliorant recommendations from 6ES, and better placement and timing of fertiliser applications.
- Research to identify new cost-effective technologies - one current example is the use of fertiliser coatings or other formulations to achieve better synchrony between crop demand and soil availability. This may overcome some of the inefficiencies associated with the use of highly soluble forms of N such as urea. Some products show promise but adoption will require their use to be cost-effective.
- Research to guide further refinement of current nutrient management guidelines, including identification of situations (soil properties × seasonal conditions × management factors) which are likely to be less, or more, responsive to nutrients.

# 5. CONCLUSIONS

This report has identified the potential economic losses from any blanket reductions of N rates below those recommended by the SIX EASY STEPS$^{TM}$ (6ES) Program.  The collective regional impacts would penalise the Queensland economy by up to $160 million each year.  Current reef water quality policies and programs, including the Queensland Government regulations, are based on unrealistic expectations of what growers can afford to do in reducing N application rates.  All such policies, regulations and programs need urgent review and revision with strong input from industry.

Industry should continue to research, develop and implement cost-effective options for improving nitrogen use efficiency and reducing losses of DIN. That ongoing work is important.  However, this report highlights the economic risk to industry and regional communities of seeking reduced DIN through widespread use of N application rates below industry guidelines.

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## Appendix A. Mean regional nitrogen (N) response curves for sugarcane ratoon crops in Queensland

Prepared by Bernard Schroeder (University of Southern Queensland, Toowoomba) for CANEGROWERS, 100 Edward Street, Brisbane

Sustainable sugarcane production is dependent on planting productive and disease-resistant sugarcane cultivars (Cox *et al*. 2005) and using appropriate farming systems (Garside and Bell 2006, Schroeder *et al*. 2013). The latter includes sustainable nutrient management practices based on well-considered and scientifically derived guidelines (Schroeder *et al*. 2006, 2008). In Australia, this is provided by the SIX EASY STEPS™ program that is recognised as current best nutrient management practice (Schroeder *et al*. 2018a) in all cane-growing areas in Queensland and New South Wales. In particular, the N management guidelines are based on results of numerous field trials conducted across the industry over several decades (e.g. Chapman 1968, 1971; Schroeder *et al*. 1998, 2005, 2010a, 2018a).

The appropriate N application rates for agricultural crops are traditionally determined from response curves based on yield data from field trials that include different rates of the applied N. In sugarcane, we have done this by fitting quadratic functions to the mean yield (tc/ha) data points plotted against N applied for each crop in each trial. An example is shown in Figure 1. The most appropriate agronomic rate of applied N (optimum N rate) corresponds to 95% of the maximum yield predicted by the quadratic function (shown by the downward pointing arrows in Figure 1).

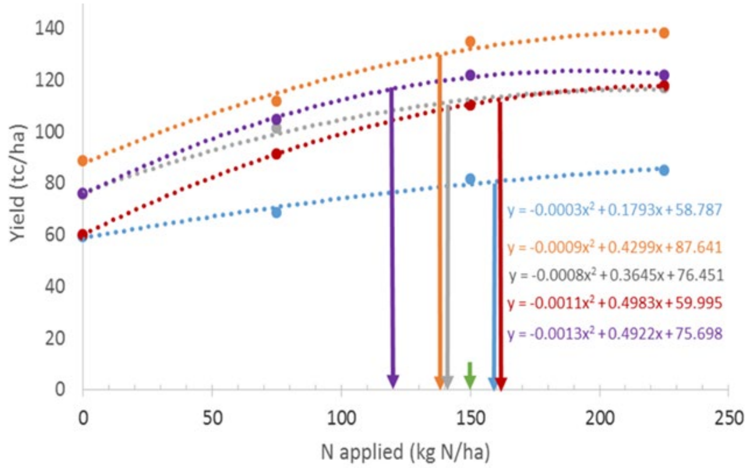


**Figure 1**. Yield response curves resulting from N applied to a trial conducted in the Herbert district over a crop cycle (after Schroeder et al., 2005) consisting of a plant crop (blue), first ratoon (orange), second ratoon (grey), third ratoon (red) and fourth ratoon (purple). The downward pointing arrows indicate the Optimum N application rate (corresponding to 95% of the maximum yield predicted by the quadratic functions fitted to the data points). The small green arrow shows the SIX EASY STEPS™ N rate for this soil.

The availability of data from N trials conducted at various sites across the industry provided the opportunity to determine mean N response curves for the different sugarcane regions in Queensland – Herbert, Bundaberg (Southern), Mackay (Central), Tully (Wet Tropics) and Burdekin. These data were obtained from various sources and included published papers (e.g. Hurney and Schroeder 2012; Salter *et al*. 2010; Schroeder *et al*. 2005, 2009; Skocaj *et al*. 2012, 2019), project milestone and final reports (Schroeder *et al*. 2003, 2010b, 2018b) , BSES technical (Chapman, 1976) and SRA research (Schroeder *et al*. 2015) reports, and some unpublished (Anon 1979) or yet to be published sources (Skocaj 2015).

Quadratic functions were fitted to the ratoon yield data [tonnes cane per ha (TCH)] from each of the rates of N trials included in the study [Herbert (n=16), Bundaberg (n=15), Mackay (n=16), Tully (n=16) and the Burdekin (n=7)]. The resulting quadratic coefficients (a, b and c) were used to calculate mean quadratic coefficient values for each region/district. These were then used to construct mean regional response curves (Figures 2). Variability is represented in Figure 2 by the quadratic functions obtained from the mean values, plus and minus the standard errors of the means (SEMs). Quadratic functions fitted to the commercial cane sugar (CCS) values plotted against N applied for each trial were used to determine mean regional response curves for CCS values (Figure 3). The resulting quadratic coefficients were used to calculate mean CCS for assumed N rates (0 – 260 kg N/ha) for each region (Table 1). Sugar yield [tonnes sugar per ha (TSH)] were determined from the mean TCH and CCS values and plotted against N applied (Figure 4). As the trials often had different sets of N rate treatments, the N rates shown in Table 1 and Figure 4 are not the actual N rates applied, but rather provided a means of constructing the response curves from the calculated quadratic coefficients.

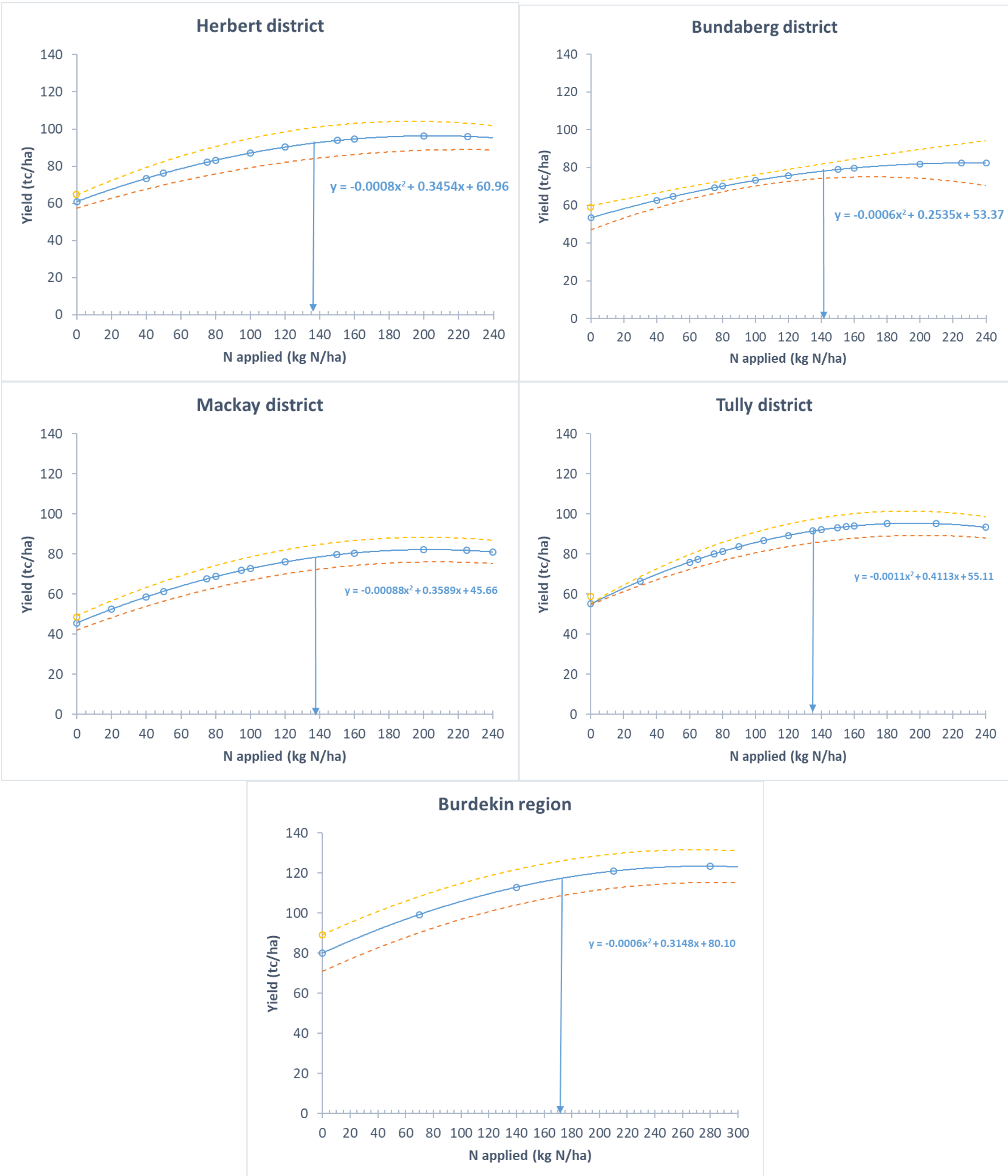


**Figure 2.** Mean district/regional N response curves (TCH plotted against N applied) predicted by the quadratic functions fitted to the data points for ratoon crops in each of the districts/regions (Herbert, Bundaberg, Mackay, Tully and Burdekin). The dotted lines in each graph represent the standard errors of the means (SEMs) above and below each of the response curves. The downward pointing arrows indicate the Optimum N application rate (corresponding to 95% of the maximum yield predicted by the quadratic functions).

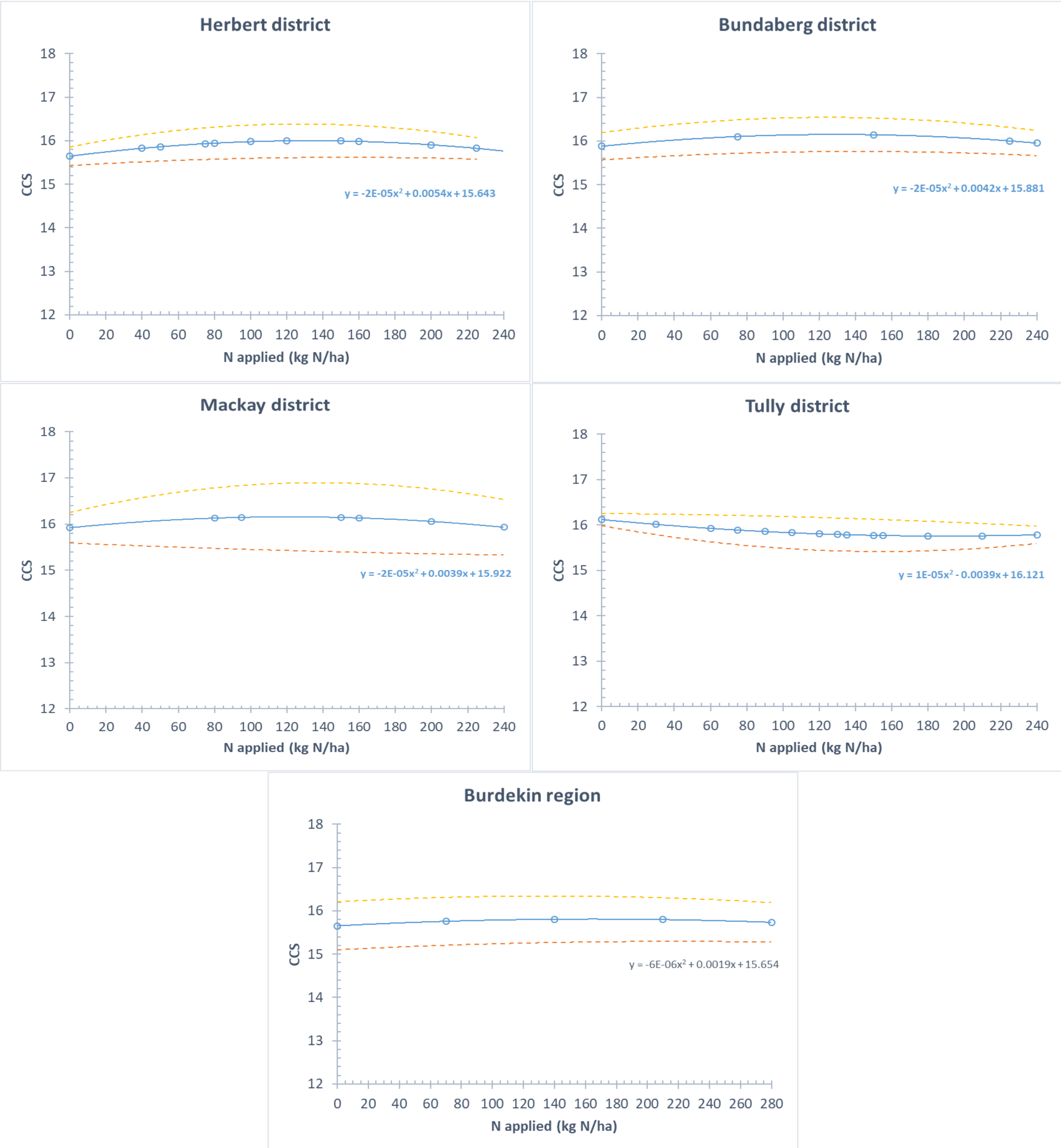


**Figure 3.** Mean district/regional CCS curves (CCS plotted against N applied) predicted by the quadratic functions fitted to the data points for ratoon crops in each of the districts/regions (Herbert, Bundaberg, Mackay, Tully and Burdekin). The dotted lines in each graph represent the standard errors of the means (SEMs) above and below each of the response curves.

Table 1 – Calculated mean regional CCS values for ratoon crops corresponding to the range of the assumed N application rates.

| N application rate (kg N/ha) | Region/district | | | | |
|---|---|---|---|---|---|
| | Herbert | Bundaberg | Mackay | Tully | Burdekin |
| | Calculated CCS (%) | | | | |
| 0 | 15.64 | 15.88 | 15.92 | 16.12 | 15.65 |
| 20 | 15.74 | 15.96 | 15.99 | 16.05 | 15.69 |
| 40 | 15.82 | 16.02 | 16.04 | 15.98 | 15.72 |
| 60 | 15.89 | 16.07 | 16.08 | 15.92 | 15.74 |
| 80 | 15.94 | 16.11 | 16.10 | 15.87 | 15.76 |
| 100 | 15.98 | 16.14 | 16.11 | 15.83 | 15.78 |
| 120 | 16.00 | 16.15 | 16.10 | 15.80 | 15.79 |
| 140 | 16.00 | 16.15 | 16.07 | 15.77 | 15.80 |
| 160 | 15.99 | 16.14 | 16.03 | 15.75 | 15.80 |
| 180 | 15.96 | 16.12 | 15.97 | 15.74 | 15.80 |
| 200 | 15.92 | 16.08 | 15.90 | 15.74 | 15.79 |
| 220 | 15.86 | 16.03 | 15.81 | 15.75 | 15.78 |
| 240 | 15.78 | 15.97 | 15.70 | 15.76 | 15.76 |
| 260 | 15.69 | 15.89 | 15.58 | 15.78 | 15.74 |

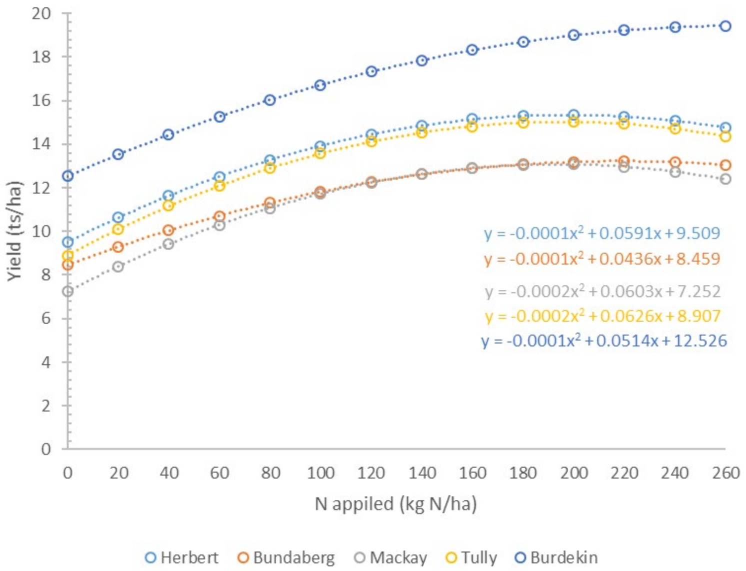


**Figure 4.** Mean regional N response curves (TSH plotted against N applied) for ratoon crops as determined from the relevant TCH and CCS values.

The overall trends indicated that regional mean response curves (TCH and TSH) were similar for the Herbert and Tully districts, and for Mackay and Bundaberg (Figures 2 and 3). As expected, the Burdekin was different from the other regions.

The methodology associated with the study and results provided above is being developed into a scientific paper to be published in an appropriate journal. This intended paper, with the probable title of 'Mean regional nitrogen response curves for sugarcane production in Australia' (BL Schroeder, AW Wood, DM Skocaj, B Salter, JH Panitz G Park, ED Kok), will provide a summary of available data, document the process used to compile the data and information, and report on the development of the mean N response curves for the various districts/regions. This will provide a record of the mechanism that was used to develop appropriate mean response curves based on a relatively large number of trials. The process will also serve as an example for similar uses in other circumstances. It will also enable the SIX EASY STEPS™ to expand the process of capturing and processing additional trial data (past, present and future).

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## Appendix B. Economic contributions estimated in QEAS (2019)

**Contribution to Queensland GSP of sugarcane growing and manufacturing, 2017-18**

| | *Sugarcane growing $M* | *Whole sugar value chain $M* | *Sugarcane growing % of GSP* | *Whole sugar value chain % of GSP* |
|---|---|---|---|---|
| Total Sales | 1,204.7 | 3196.8 | 0.35% | 0.92% |
| *Value added* | | | | |
| Direct | 544.4 | 2,243.6 | 0.16% | 0.64% |
| Indirect–supply chain | 317.6 | 1,174.6 | 0.09% | 0.34% |
| Indirect–consumption induced | 249.5 | 631.3 | 0.07% | 0.18% |
| Indirect–total | 567.1 | 1,805.9 | 0.16% | 0.52% |
| **Total value added** | **1,111.5** | **4,049.5** | **0.32%** | **1.16%** |

*Source: QEAS, 2019*

**Contribution to Queensland employment of sugarcane growing and manufacturing, 2017-18**

| | *Sugarcane growing FTEs* | *Whole sugar value chain FTEs* | *Sugarcane growing % of total FTEs* | *Whole sugar value chain % of total FTEs* |
|---|---|---|---|---|
| Direct | 4,554 | 9,145 | 0.22% | 0.44% |
| Indirect–supply chain | 3,154 | 8,174 | 0.15% | 0.39% |
| Indirect–consumption induced | 2,126 | 5,337 | 0.10% | 0.26% |
| Indirect–total | 5,280 | 13,511 | 0.25% | 0.65% |
| **Total** | **9,834** | **22,657** | **0.47%** | **1.09%** |

*Source: QEAS, 2019*

**Contribution to wages and salaries of sugarcane growing and manufacturing, 2017-18**

| | *Sugarcane growing $ millions* | *Whole sugar value chain $ millions* | *Sugarcane growing $ millions* | *Whole sugar value chain $ millions* |
|---|---|---|---|---|
| Direct | 175.6 | 352.7 | 0.11% | 0.22% |
| Indirect–supply chain | 121.6 | 632.4 | 0.07% | 0.39% |
| Indirect–consumption induced | 82.0 | 375.5 | 0.05% | 0.23% |
| Indirect–total | 203.6 | 1,007.9 | 0.12% | 0.62% |
| **Total** | **379.3** | **1,360.6** | **0.23%** | **0.83%** |

*Source: QEAS, 2019*

**Queensland sugar's contribution to Commonwealth and state taxes and local government rates, 2017-18**

| *Level of government* | *Sugarcane growing $M* | *Whole sugar value chain $M* |
|---|---|---|
| Commonwealth | 226.0 | 823.5 |
| State | 42.2 | 153.7 |
| Local | 103.7 | 103.7* |
| **Total** | **371.9** | **1,080.9** |

*Source: QEAS, 2019*