Project Catalyst Trial Report

Groundwater Nitrate Monitoring and Reduced N rate Trial

Grower Information	
Grower Name:	Bryan Langdon
Entity Name:	Langfarm Pty Ltd
Trial Farm No/Name:	BKN-09449A
Mill Area:	Kalamia
Total Farm Area ha:	168
No. Years Farming:	
Trial Subdistrict:	Maidavale
Area under Cane ha:	168

Status: Completed

Background Information

Aim: To develop a site-specific nitrogen reduction rate that the grower can implement on their blocks that are irrigated with underground water high in nitrates.

Background: (Rationale for why this might work)
There are a number of growers in the Burdekin that are irrigating their sugarcane with water that is high in nitrates. This nitrogen is plant available and can be used as part of the farm's fertiliser program. There a number of issues with reducing fertiliser rates according to the amount applied via irrigation water. Firstly, the level of nitrates may vary throughout the season so there is no set amount of nitrogen that is applied to paddock per irrigation. Secondly, the number of irrigation events may be increased or decreased, depending on the annual rainfall volume and pattern. Due to this variability, developing an area wide "nitrogen-reduction-rate" for farms in areas with ground water nitrates is a difficult and inexact process. To compensate for this, monitoring the level of nitrates in irrigation water on a specific block will be conducted for 6-12 months. This data will be used to calculate the total amount of nitrogen applied to the paddock through irrigation over a season. After this, a "safe" reduction rate (or rates) will be developed and implemented in a trial, comparing it to the recommended 6 Easy Steps rate of fertiliser. There will also be a 20m strip of "Zero-N" where no fertiliser will be applied. This will be used to assess how available the irrigation-nitrates are to the crop. The trial will be reimplemented and harvested for a second year.

Potential Water Quality Benefit:
Reducing nitrogen fertiliser rates to compensate for nitrogen applied with the irrigation water, could see (in high nitrate areas) large reductions of fertiliser applied. With less fertiliser applied, there is less risk of the applied nitrogen being lost to run off/deep drainage.

Expected Outcome of Trial:
That a "safe" nitrogen deduction value will be produced for the grower, that he will be able to implement on his farm, without risks to water quality and his productivity.

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Where did this idea come from: There have been a number of ground water nitrate projects conducted in the Burdekin, though the focus has been placed on an area-wide solution. This idea was developed to provide a number of growers will safe nitrogen reduction values that are specific to their farms.

Plan - Project Activities	**Date :** (mth/year to be undertaken)	**Activities** :(breakdown of each activity for each stage)
Stage 1	**September 2016-August 2017**	- A specific block has been selected for monitoring - Regular monitoring of irrigation water samples for nitrates - The grower is keeping a record of irrigation timings and lengths in this period, for that block - A bucket a stopwatch assessment will be conducted to assess flow rate - This data will be used to assess the total amount of nitrogen being applied to the crop over the season - This data will be then used to develop a "safe nitrogen reduction"
Stage 2	**August 2017-October 2018**	- A trial will be implemented on the monitored block - This trial will compare the 6 Easy Steps rate to the reduced rate of fertiliser. There will also be a zero N treatment. - Biomass samples will be taken to assess nitrogen uptake - This trial will be harvested and the data will be analysed for differences in yield between the treatments
Stage 3	**October 2018-March 2021**	- A trial will be re-implemented on the monitored block - This trial will compare the 6 Easy Steps rate to the reduced rate of fertiliser. There will also be a zero N treatment. - Biomass samples will be taken to assess nitrogen uptake - This trial will be harvested and the data will be analysed for differences in yield between the treatments
Stage 4		
Stage 5		
Stage 6		

Project Trial site details

Trial Crop:	Sugarcane
Variety: **Rat/Plt:**	KQ 228
Trial Block No/Name:	3-1
Trial Block Size Ha:	28.73ha
Trial Block Position (GPS):	19˚ 39’ 01.00’’ 147˚ 22’ 00.20’’
Soil Type:	Medium Clay (Sandy?)

Block History, Trial Design:

A trial has not been implemented on the block this year. 12 months of monitoring is being conducted of the irrigation water being applied to the block. A water sample of as many irrigations as possible is being taken and sent to the Hortus Technical Services Laboratory for analysis (current results below). The block is currently a first ratoon crop of KQ228.

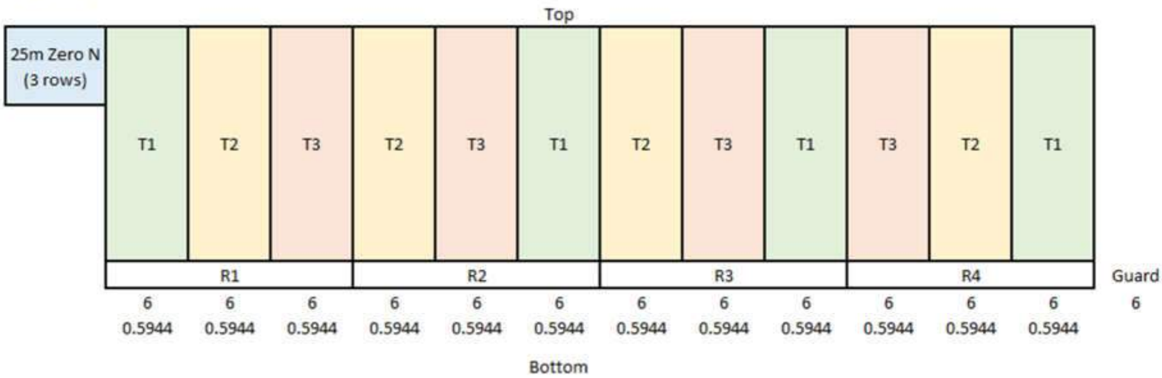
A trial will be established on the block once the current cane has been harvested – it will compare the normal Six Easy Steps nitrogen rate to a fertiliser rate with a “safe” nitrogen reduction. There will also be a section of zero-N – this will help us assess the crop’s ability to uptake the irrigation nitrates. The trial will be implemented on a second ratoon, KQ228 crop.

As of September 2017, a randomised, replicated strip trial (3 treatments, 4 replications) has been implemented on Bryan’s farm. This trial is comparing 3 different N rates (125N v. 155N v. 185N). 185N is the grower’s current N rate, compared to two reduced rates. The bore is still being monitored through regular water samples. A sensor has been placed at the top of the block to assist the grower in recording his irrigations.

Trial Layout and Treatments:

Bryan Langdon
Ground Water Nitrates

Block	3-1
Variety	KQ 228
Ratoon	2
Date Applied	19/09/2017



Treatment	Description	Product	Rate (kg/ha)	N Rate (kgN/ha)	K Rate (kgK/ha)
1	Grower Rate (6ES-20)	CK 135 S	640	185	89
2	6ES rate - 50kgN/ha	CK 135 S	540	155	75
3	6ES rate - 80kgN/ha	Nitra King S	460	125	75
Zero N		Sulphate of Potash	200	0	83

The trial was reimplemented and harvested for the 2019 season.

The trial has been reimplemented to be harvested in the 2020 season.

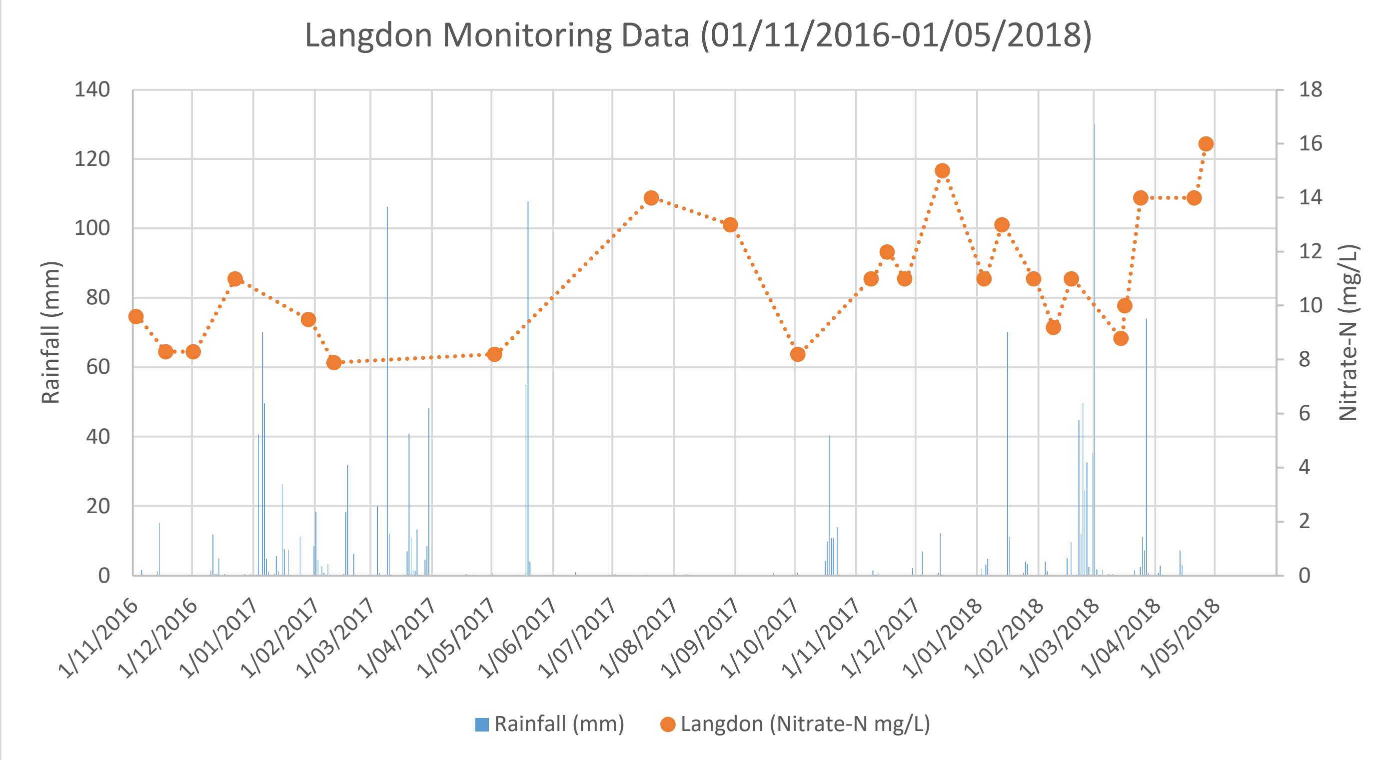
Results:

2016-2017 Results:

Monitoring Data:

Date	Nitrate-N Level (mg NO3-N/L)	kgN/ha applied per irrigation (using a ML/ha value of 0.8ML/ha)
2/10/2017	8.2	6.56
8/11/2017	11	8.8
16/11/2017	12	9.6
25/11/2017	11	8.8
13/12/2017	15	12
18/12/2017	11	8.8
26/12/2017	11	8.8
4/01/2018	11	8.8
13/01/2018	13	10.4
29/01/2018	11	8.8
8/02/2018	9.2	7.36
17/02/2018	11	8.8
14/03/2018	8.8	7.04
16/03/2018	10	8
24/03/2018	14	11.2
20/04/2018	14	11.2
26/04/2018	16	12.8
14/05/2018	9.8	7.84
Approximate kgN/ha applied through irrigation water		165kgN/ha

Approximate volume of water applied per irrigation:
0.86ML/ha



HARVEST DATA (2017-2018)

Cane Yield

There was a 11.21tC/ha difference between the highest yielding treatment (T2 155N, 178.52) and the lowest yielding treatment (T3 125N, 167.31). At P=0.05, there was no significant difference between the cane yield results of year treatment. When the probability value is increase to 0.15, there was a significant difference between the results. T2 (178.52) yielded significantly higher than T3 (167.31). There was no significant difference between T1 (174.81) and either of the other treatments.

The significant difference at P=0.15 and not at P=0.05, indicates that we can be 85% sure that the cane yield results are due to the treatments, but we cannot be 95% sure (P=0.05).

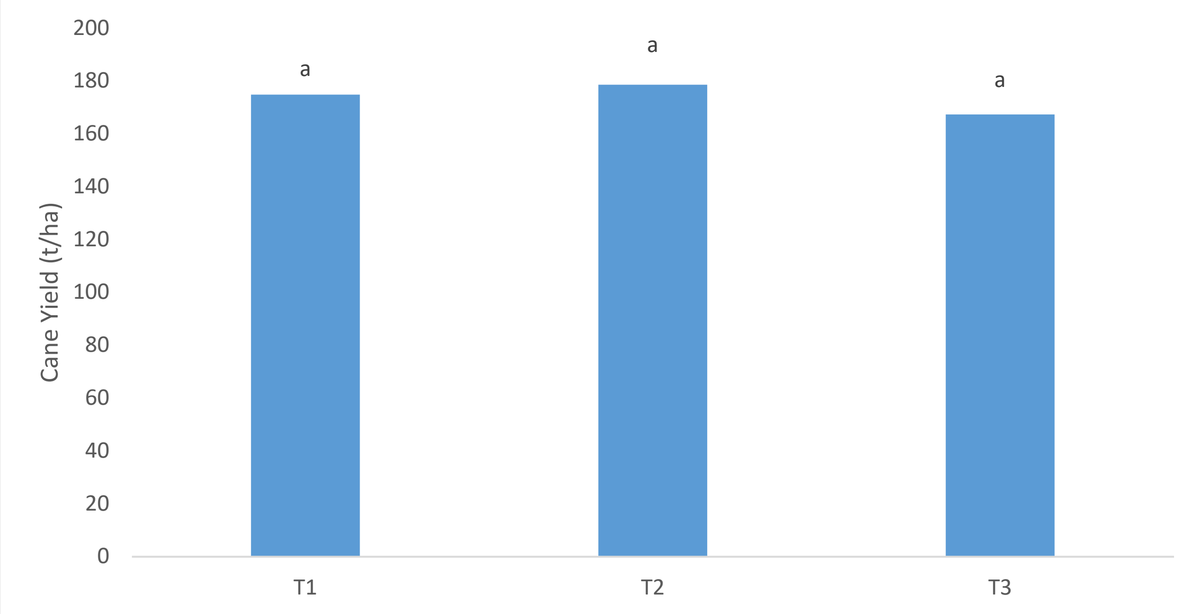


Figure 1 Treatment Cane Yield Results (tC/ha) (P=0.05)

Table 1 Treatment Cane Yield Results (tC/ha)

Treatment	tC/ha	P=0.05	P=0.15
T1 (185N)	174.81	a	ab
T2 (155N)	178.52	a	a
T3 (125N)	167.31	a	b
Prob (F)		0.1227	0.1227

CCS

There was a 0.25-unit difference between the highest CCS treatment (T2 155N, 13.89) and the lowest CCS treatment (T1 185N, 13.64). At P=0.05, there was no significant difference between the cane yield results of year treatment. When the probability value is increase to 0.15, there was a significant difference between the results. There was no significant difference between T2 and T3 (13.89 and 13.86 respectively); however, both treatments were significantly higher than T1 (13.64).

The significant difference at P=0.15 and not at P=0.05, indicates that we can be 85% sure that the CCS results are due to the treatments, but we cannot be 95% sure (P=0.05).

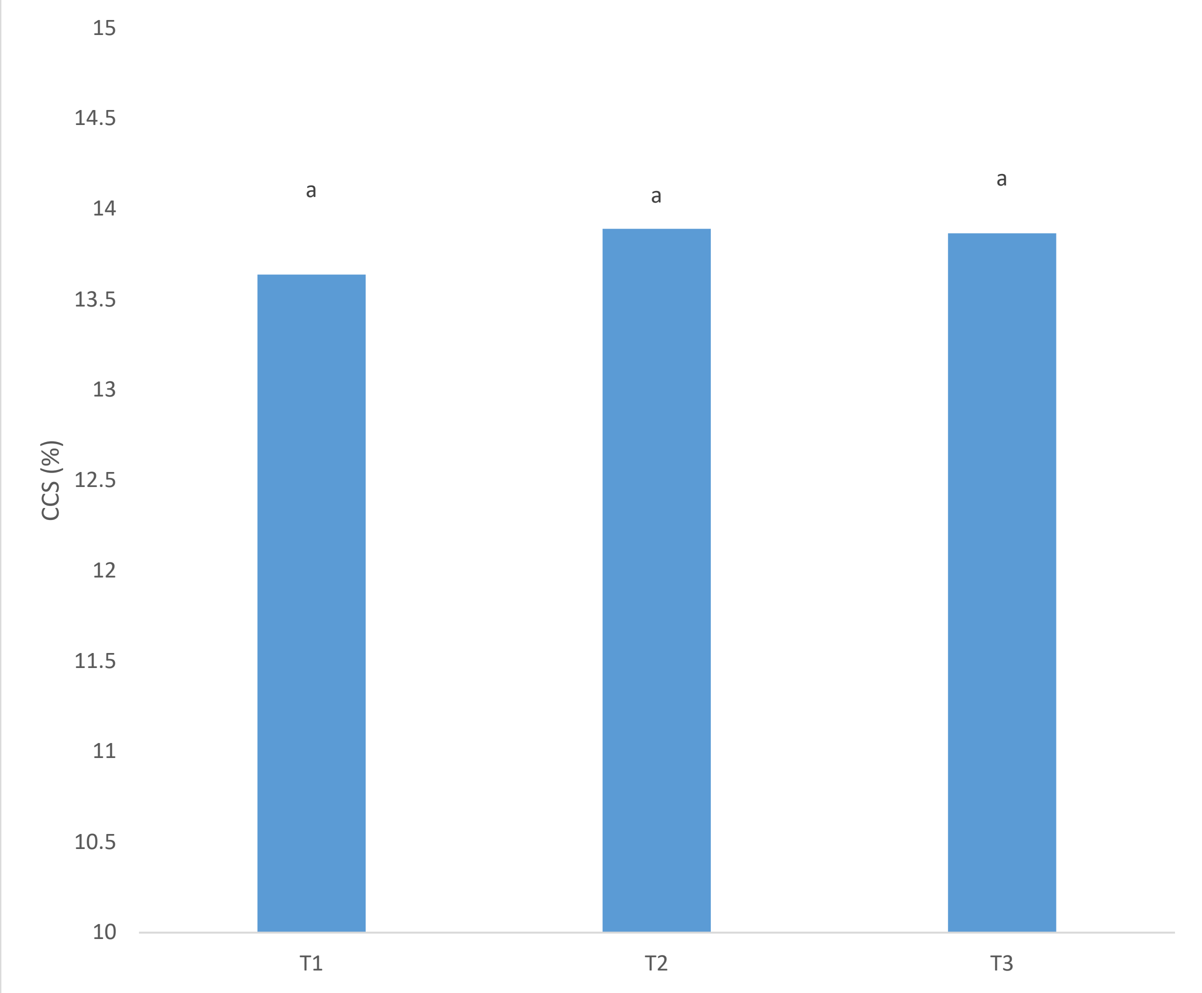


Figure 2 Treatment CCS results (P=0.05)

Table 2 Treatment CCS Results

Treatment	CCS	P=0.05	P=0.15
T1 (185N)	13.64	a	b
T2 (155N)	13.89	a	a
T3 (125N)	13.86	a	a
Prob (F)		0.1191	0.1191

Sugar Yield

There was a 1.59tS/ha difference between the highest yielding treatment (T2 155N, 24.79) and the lowest yielding treatment (T3 125N, 23.20). At P=0.05, there was no significant difference between the cane yield results of year treatment. When the probability value is increase to 0.15, there was a significant difference between the results. T2 (24.79) yielded significantly higher than T3 (23.20). There was no significant difference between T1 (23.84) and either of the other treatments.

The significant difference at P=0.15 and not at P=0.05, indicates that we can be 85% sure that the sugar yield results are due to the treatments, but we cannot be 95% sure (P=0.05)

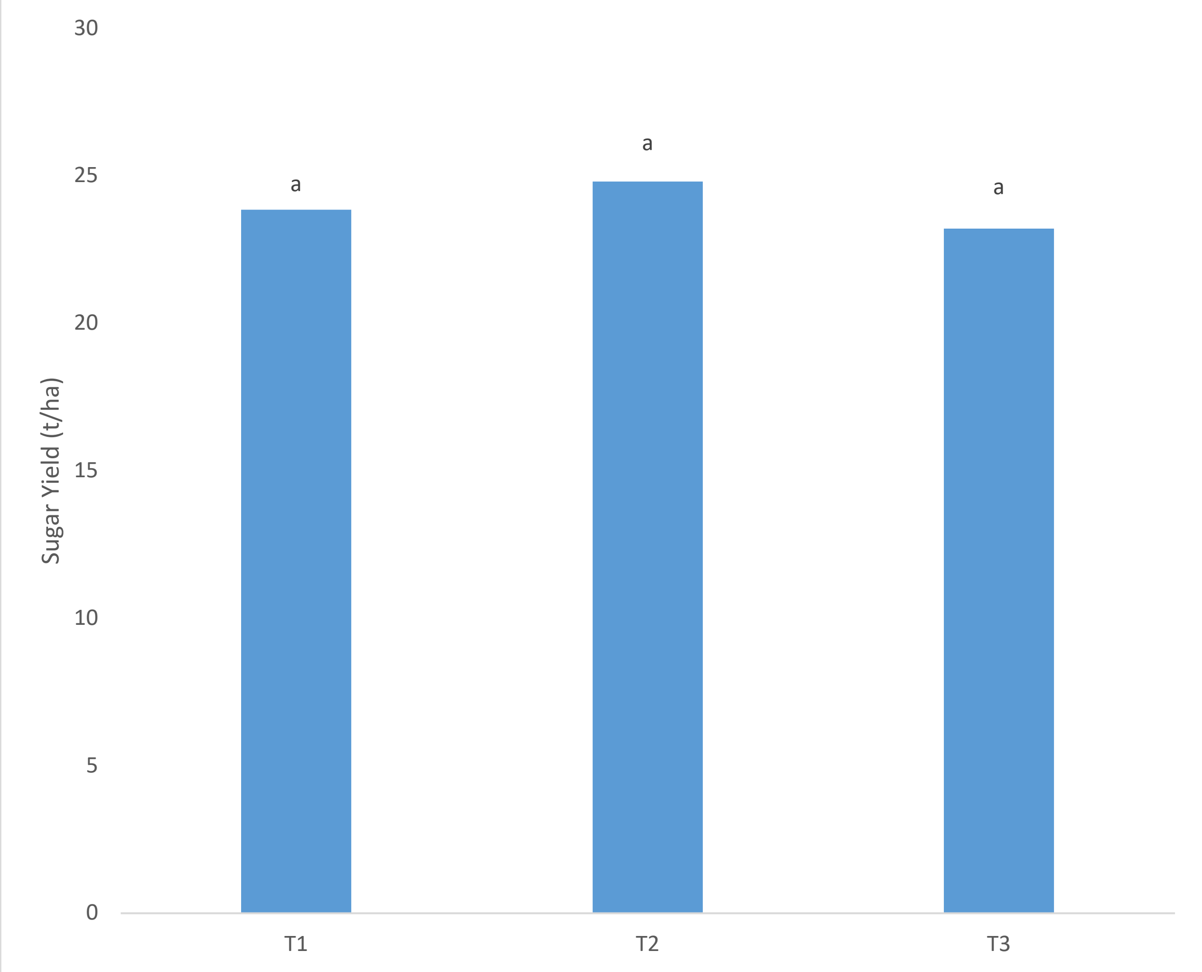


Figure 3 Treatment Sugar Yield results (tS/ha) (P=0.05)

Table 3 Treatment Sugar Yield Results (tS/ha)

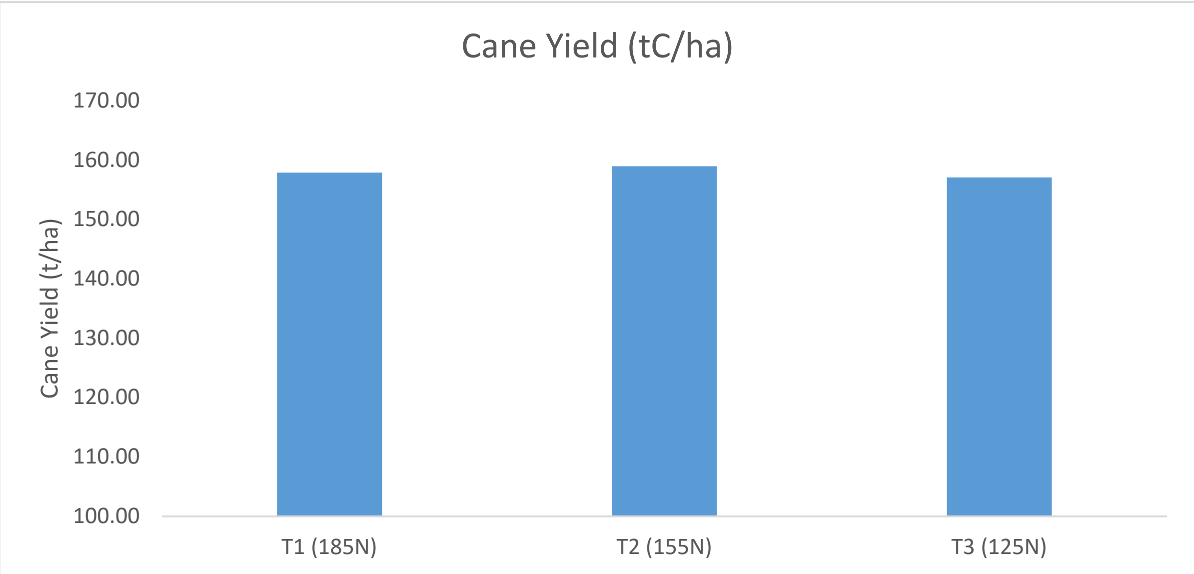
Treatment	Sugar Yield (tS/ha)	P=0.05	P=0.15
T1 (185N)	23.84	a	ab
T2 (155N)	24.79	a	a
T3 (125N)	23.20	a	b
Prob (F)		0.1012	0.1012

2018-2019

The information below is a summary of the data collected for Bryan Langdon's Groundwater Nitrate Trial for the 2018-2019 period. This is the second year that the trial has been harvested (as third ratoon, KQ228) and the trial has been re-implemented for harvest in 2020. This data has not been statistically analysed at this stage.

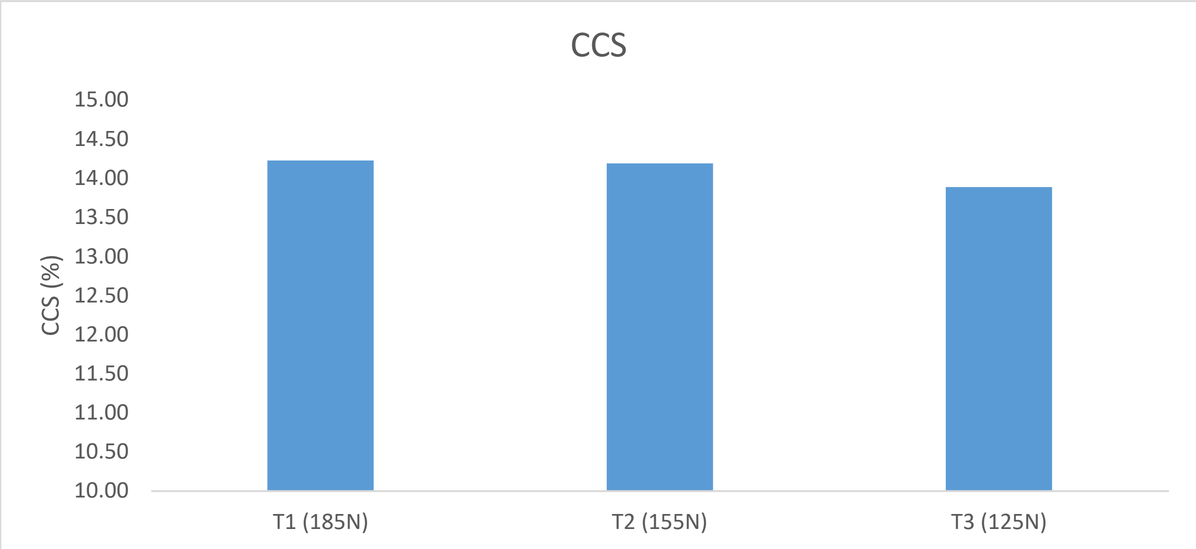
Harvest Data:

There was little difference between the cane yields of each treatment (tC/ha). Treatment 2 (155N) yielded slightly higher than Treatments 1 & 3 (185N and 125N, respectively) at 158.96tC/ha, compared to 157.88 and 157.08tC/ha.

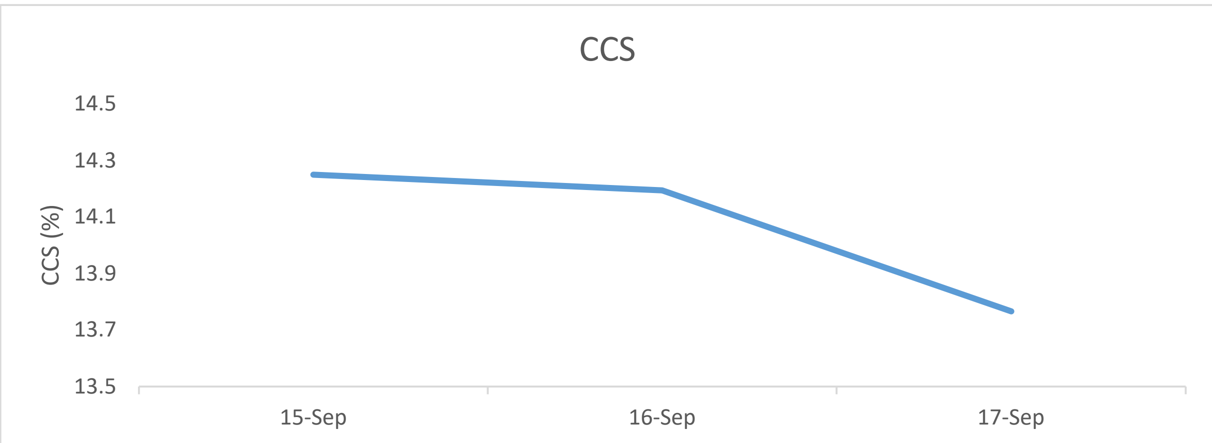


	Cane Yield (tC/ha)
T1 (185N)	157.88 -
T2 (155N)	158.96 -
T3 (125N)	157.08 -
Prob (F) = 0.05	0.8009

Unlike the previous year's data, in 2019, there was a downward trend in CCS when compared to the reduced nitrogen rates. This may have been due to the treatments; however, is it likely that issues with harvest had a greater impact on these results. The entire trial was burnt on the 14th of September. Harvest of the trial began on the 15th of September, however, a harvester break-down and reduced bin allocations for those days lead to the trial harvest continuing to the 17th of September. As a result, the cane that was harvested on the 17th had been burnt for 3 days and this may have had an impact on the crop CCS. The graph below shows the average CCS for the treatments over the three days of harvest.

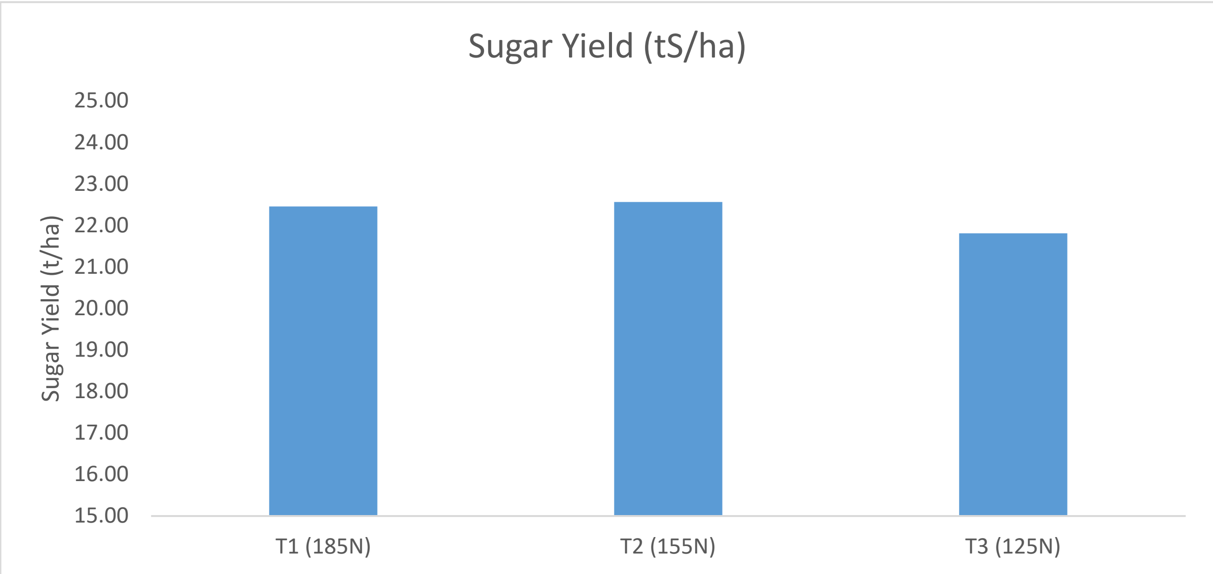


	CCS
T1 (185N)	14.23
T2 (155N)	14.19
T3 (125N)	13.89



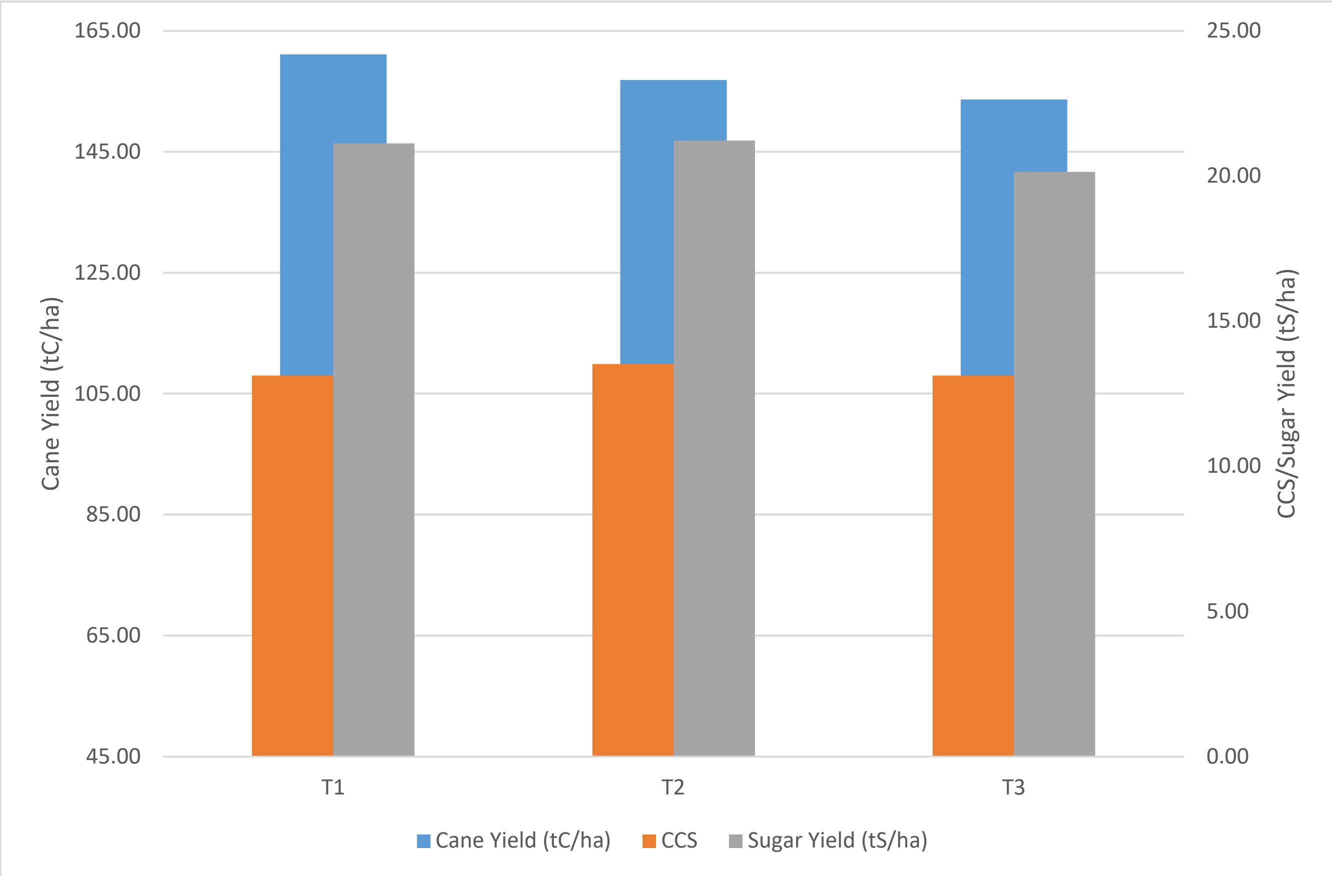
Date	Average CCS of the plots harvested on that date:
15-Sep	14.3
16-Sep	14.2
17-Sep	13.8

There was a slight difference in sugar yield when the treatments were compared. Treatments 1 (185N) and 2 (155N) had a slightly higher sugar yield when compared to Treatment 3 (125N) – this difference is due to the CCS difference and the difference may have not been as clear, had the trial harvested gone as planned.



	Sugar Yield (tS/ha)
T1 (185N)	22.46
T2 (155N)	22.57
T3 (125N)	21.81

2019-2020 Harvest Data:



	Cane Yield (tC/ha)	CCS	Sugar Yield (tS/ha)
T1 (185N)	161.11	13.13	21.12
T2 (155N)	156.87	13.53	21.22
T3 (125N)	153.62	13.13	20.14

The trial harvest data from 2020 showed no significant difference between the treatment yields for tonnes of cane, CCS or tonnes of sugar. This is very encouraging data as this is the third year in a row where there has been no significant difference in yield data over the three different nitrogen rates. The trial was harvested over second, third and fourth ratoon.

Conclusions and comments

Regarding the nitrate levels in the underground:

- The nitrate levels remain fairly stready throughout the year; however, they do spike following significant rainfall events (>80mm) that occur during fertilising periods (planting/ratooning). If large rainfall events occur when fertiliser is not being applied, the nitrate levels tend to remain steady.
- Multiple samples should be taken over the year (minimum, 1 during the "wet season/slack," before and after a large rainfall event, during a significant dry period) to assess the acutal nitrate level in the underground stream that the grower is accessing as a one off sample is not enough data to assess the nitrate level accurately.

Regarding using Ground Water Nitrates as part of a fertiliser budget:

- From the first harvest of the trial, it appears **that ground water nitrates can be used as part of a fertiliser budget.** There was no significant difference between the treatment yields (tC/ha, CCS & tS/ha) at 95% confidence. This **suggests that a significant amount of the nitrate applied through the irrigation water is avaliable to the plant.**
- The **amount the nitrate rates can be reduced is still unknown** (plant uptake still needs to be more thoroughly investigated.
- **The amount of nitrogen that rates can be reduced needs to take climatic conditions into consideration**. The amount of nitrate applied through irrigation water will vary significantly depending on rainfall – if there is a large amount of rain, the grower does not need to irrigate; therefore, the nitrate will not be applied in large amounts.
- It is essential to calculate the annual volume of water being applied in order to more accurately assess the amount of nitrogen being applied through irrigation.

Advantages of this Practice Change:

- Reduced amount of synthetic nitrogen fertiliser being applied.
- Economic savings can be made when using irrigation nitrates (applying less synthetic fertiliser = spending less money)

Disadvantages of this Practice Change:

- Reducing nitrogen rates to account for nitrate in the irrigation water can be risky depending on rainfall. If the grower reduces his nitrogen rates significantly, then rain falls over a long period of time and as a result the grower does not irrigate, he may suffer significant productivity losses due to not applying enough fertiliser in the first place.
- Calculating the amount of nitrogen to reduce fertiliser rates by is difficult at this stage. Not enough research has been conducted into plant uptake of irrigation nitrates to make a "safe" recommendation. Additionally, many Burdekin growers do not know their annual water use (ML/ha/year). This is another important element in calculating nitrogen rate reductions.
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Will you be using this practice in the future:

- The grower already reduces his nitrogen rates to account for irrigation nitrates (from 210N to 180N). He is open to further reducing his nitrogen rates; however, more trials need to be conducted before he has confidence in the practice.

% of farm you would be confident to use this practice :

The grower already reduces his N rate over the area of the farm effected by nitrates (approximately 80%); however, he requires a bit more confidence to reduce his nitrogen rate further.