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:	Airville
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.

To install a real time ground water nitrate sensor in a bore to monitor nitrate levels throughout the year.

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.

A real time nitrate sensor has been developed by the University of Lincoln (NZ) to minotir ground water nitrates. This sensor has been installed in monitoring bores in the Canterbury Plains where they have a severe groundwater nitrate issue.

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.

Real time monitoring of groundwater nitrates can help growers build confidence in utilising irrigation nitrates as part of their fertiliser budgets by allowing them to observe fluctuation patterns and make more informed decisions.

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.

Service provider contact: Billie White (0409 477 359, billiew@farmacist.com.au)

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 2019-Dec 2019**	- Implement reduced N rate trial with zero N plot - Collect grab samples to test for nitrate throughout the season - Investigate the real time nitrate sensor
Stage 2	**December 19 to June 2020**	- Biomass sample the Nitrogen rate trial - Purchase and install a real time nitrate sensor - Collect grab samples to compare to the nitrate sensor
Stage 3	**June 2020 to December 2020**	- Harvest the nitrogen rate trial and reimplement - Monitoring sensor data and compare to grab sample data
Stage 4	**December 2020 – March 2021**	- Collate and analyse results - Biomass trial for nitrogen uptake data
Stage 5		
Stage 6		

Project Trial site details

Trial Crop:	Sugarcane
Variety: **Rat/Plt:**	2R KQ 228
Trial Block No/Name:	2-3
Trial Block Size Ha:	10.46
Soil Type:	Medium Clay (Shallow sand layers)

Block History, Trial Design:

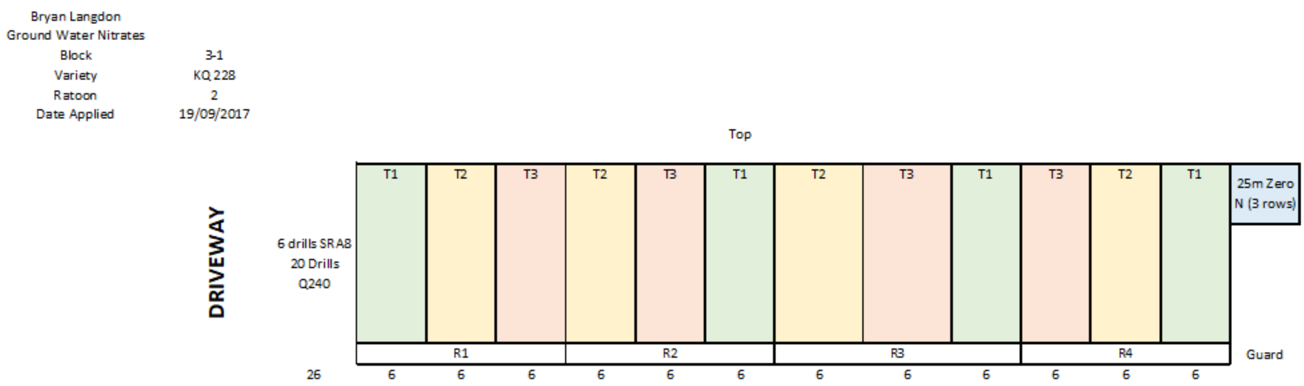
The farm hosting this trial has a history of high nitrate levels in the aquifers accessed by their irrigation bores. As a fully irrigated system, irrigating with high-nitrate water has both benefits and significant issues. The primary issue with irrigating with high-nitrate water is that each irrigation applies a small amount of plant available nitrogen. This can cause issues with CCS and sugar yields in sugarcane. Small, regular applications of nitrogen can lead to increased cane yields which is beneficial to the grower; however, on the same note, small, regular applications of nitrogen encourage the crop to continue growing and producing vegetative growth. Because the crop is growing vegetatively, it does not put it's energy into ripening and producing sugar. This leads to poor CCS results.

This trial is another element in a push to support growers to utilise the nitrates contained in their irrigation water as part of their fertiliser budgets.

Results:

This trial is a continuation of the trial that has been established on Bryan's farm since 2017. The ongoing trial (2017 – 2020) has investigated reduced nitrogen rates on a block that is irrigated with groundwater that is high in nitrate. This trial has been harvested in 2018 and 2019 (reimplemented for a 2020 harvest), and has found no significant yield differenced between 185N, 155N and 125N. The exact same trial layout has been established on a neighbouring block and the grower has been collecting grab samples of the irrigation water that is being applied to the block, and keeping irrigation records to help calculate the total amount of nitrogen being applied to the paddock through irrigation water.

Trial Layout:



Trial Treatments:

Treatment	Description	Product	Rate (kg/ha)	N Rate (kgN/ha)	P Rate (kgP/ha)	K Rate (kgK/ha)	S Rate (kgS/ha)
1	Grower Rate (6ES-20)	CK 135 S	640	185	0	84	22
2	6ES rate - 50kgN/ha	CK 135 S	540	155	0	70	18
3	6ES rate - 80kgN/ha	Nitra King S	460	125	0	75	15
Zero N		Sulphate of Potash	200	0	0	83	34

In the previous trial, grab samples of irrigation water have been collected to assess the nitrate levels throughout the year. This will be continued, and the data will be compared to a real time nitrate sensor that will be installed in a bore on the farm. The real time nitrate sensor was developed by the University of Lincoln (NZ), and is specifically designed to monitor groundwater nitrates through observation bores.

SENSOR UPDATE 12/6/2020

Farmacist has been in discussion with Aquamonix (Australian distributors of the GW50 sensor) about the purchase and installation of a sensor. One of their technical officers has visited the site to assess it for suitability. With some modifications to the site, they are comfortable installing a sensor in the bore and have provided a quote for a GW50 sensor and the associated data logging equipment. There is potential to intall a second sensor in the bore which will measure water table height, EC and temperature; however, this required further investigation.

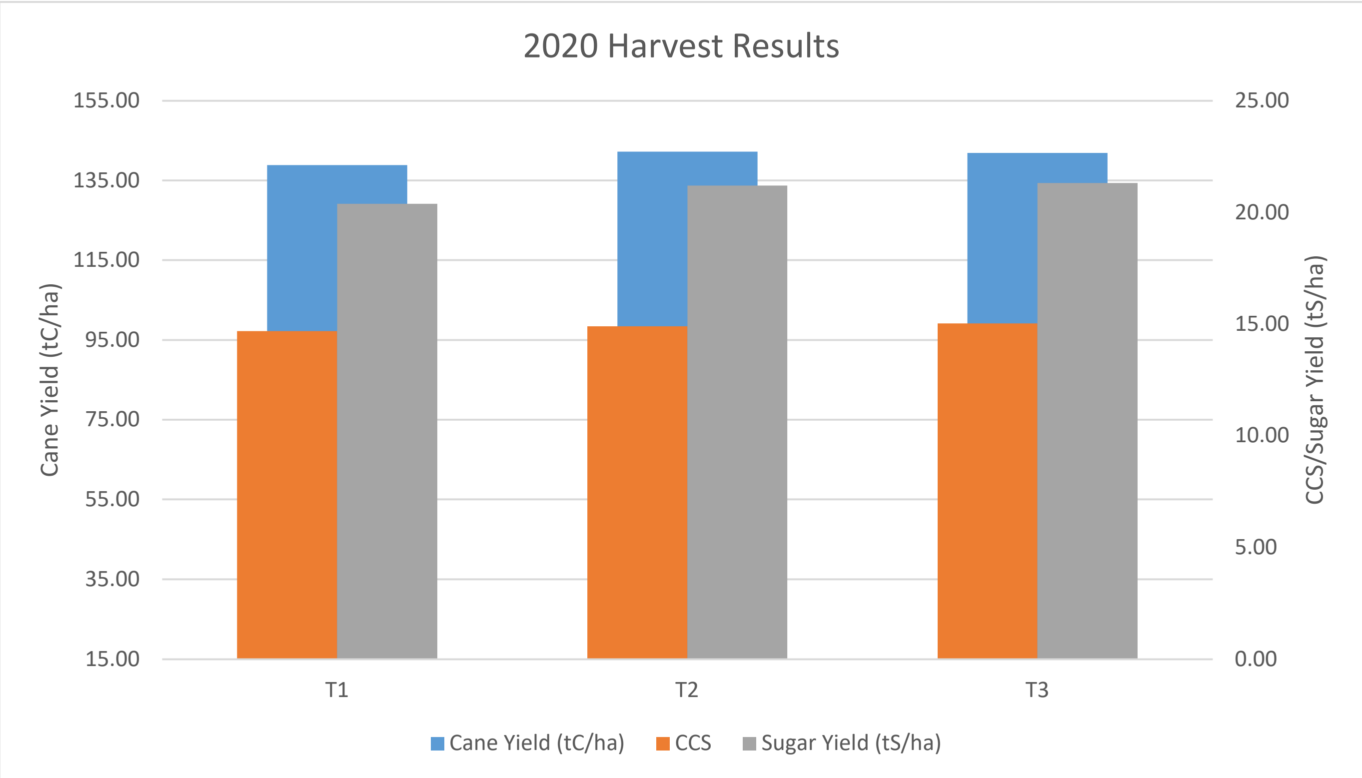
The trial site will be biomass sampled in July 2020 to assess the treatments for nitrogen uptake.

The grower has the irrigation record app installed on his phone to help calculate his water use and associated application of nitrogen through the irrigation water.

TRIAL UPDATE 19/02/2021

The trial was harvested 16-17th of September 2020. This was a second ratoon crop of KQ228.

Harvest Data:



	Cane Yield (tC/ha)	CCS	Sugar Yield (tS/ha)
T1 (185N)	138.83 -	14.68 -	20.38 -
T2 (155N)	142.20 -	14.90 -	21.19 -
T3 (125N)	141.85 -	15.03 -	21.32 -
Prob F (95%)	*0.6269*	*0.2143*	*0.4460*

There was no significant difference between the yields (Cane, CCS and Sugar) of the treatments. This is inline with the results of the previous trial which also showed no significant difference in yield responses over 3 years.

Though the trial yielded well, the paddock ratooned poorly (grub damage). The trial was re-implemented, but wont be cut in the 2021 season due to concerns about poor ratooning.

Sensor Installation and Readings:

The GW50 nitrate sensor has been installed in an irrigation cylinder and has being recording readings. The original plan for the installation was to put the sensor down a working bore; however, there were concerns about the sensor becoming entangled with the bore shaft and issues with cleaning the sensor. To combat these issues, the sensor was installed in an irrigation cylinder – it will collect nitrate-nitrogen data while the pump is running, but no data when the pump is off. There has been some issues with turbulence causing fluctuation in the nitrate-nitrogen readings; however, the median and average of the readings appears to be an appropriate measure of the nitrate-nitrogen levels.

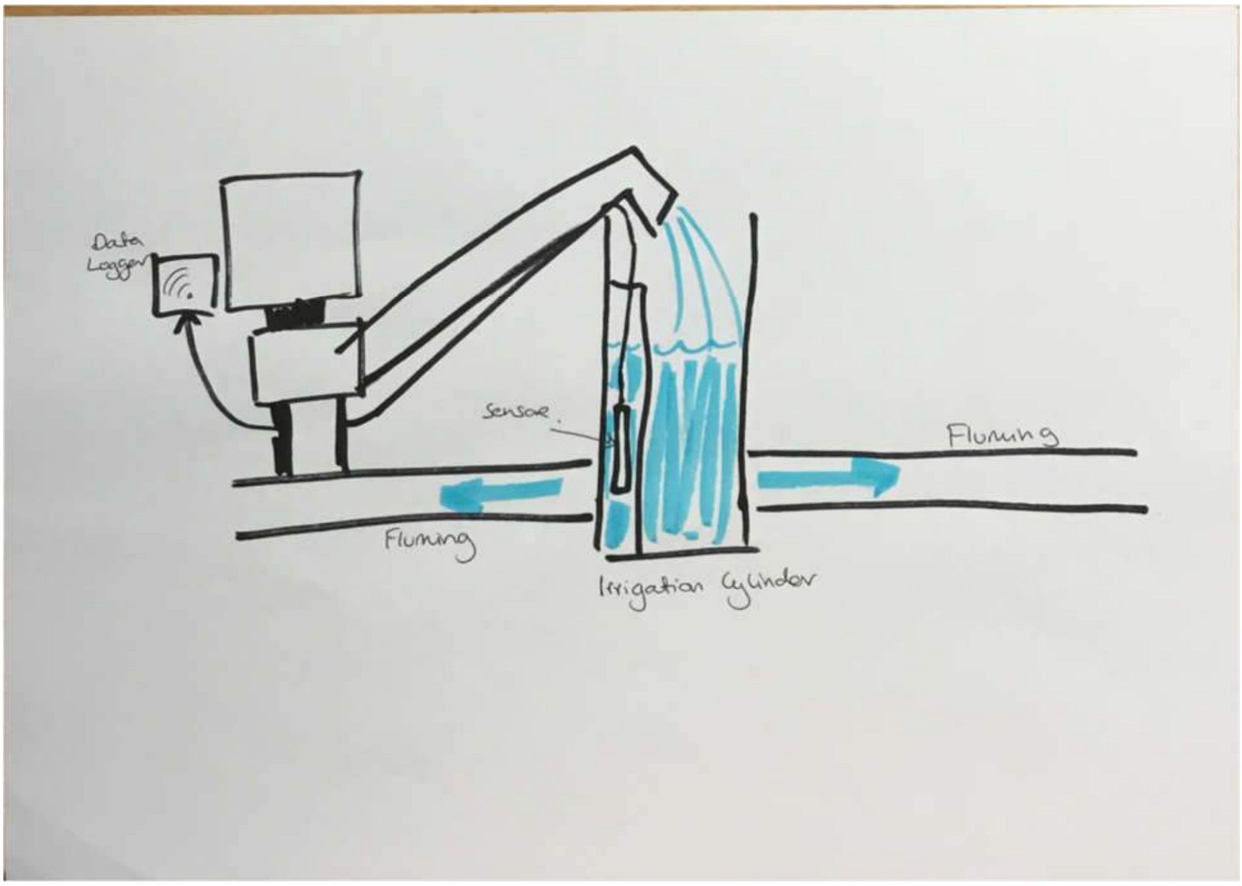
The sensor is also working well as a form of irrigation records, as the nitrate sensor only reads data when the paddock is being irrigated. Combining the hours of irrigation with a known flowrate and the nitrate-nitrogen data will be a useful way to assess the amount of nitrate-nitrogen being applied to the paddock per irrigation.

The sensor was installed on the 22nd of December 2020, and the first nitrate-nitrogen readings were recorded on the 24th of December 2020.

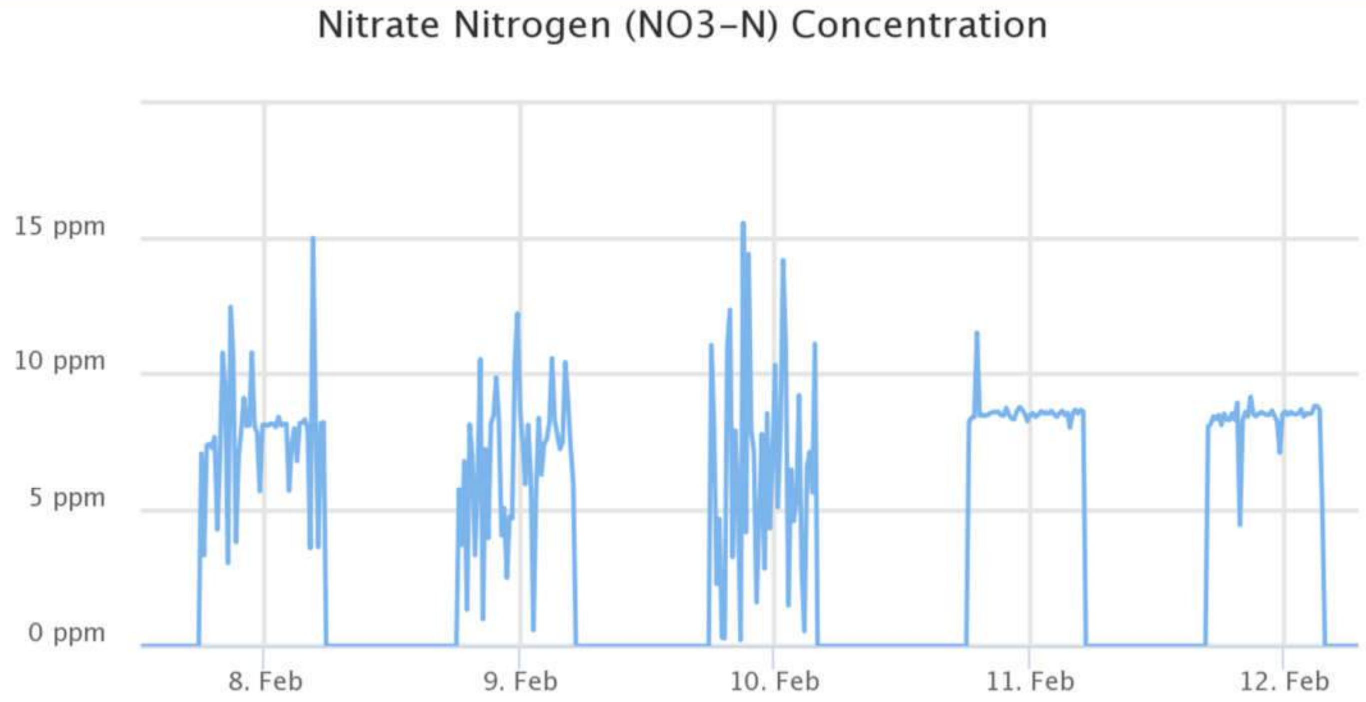
GW50 Nitrate Sensor:

Sensor installation:

Sketch of the sensor installation:



Readings from the sensor:

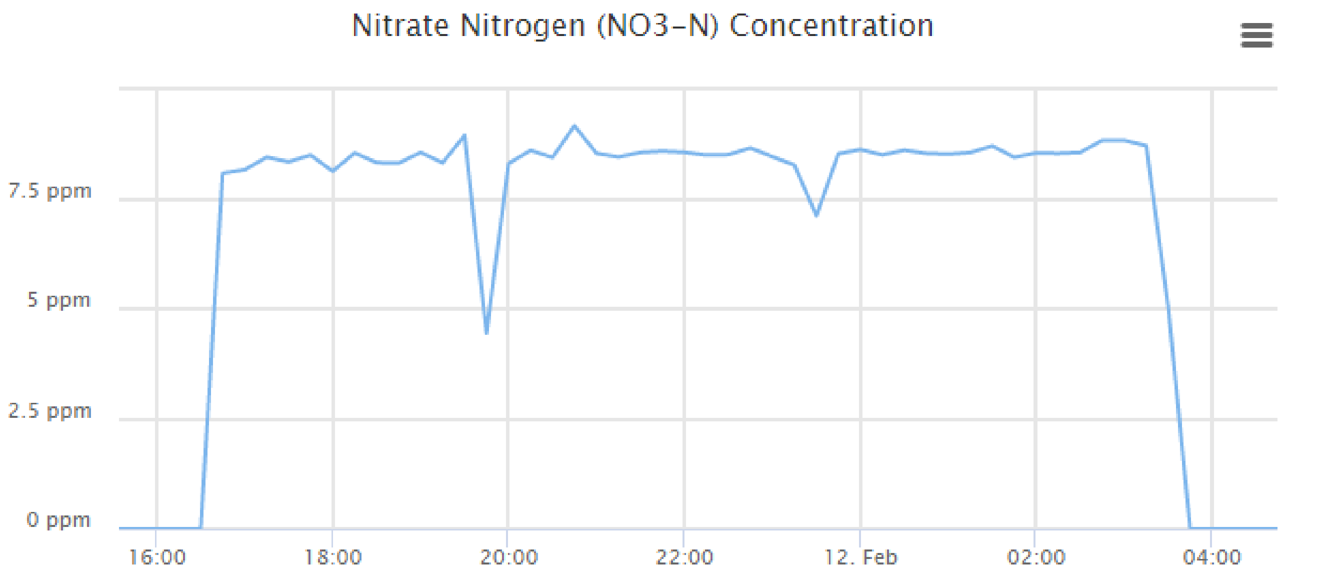


The above data shows a number of irrigation events that have occurred following the sensor installation. The block is split into 5 sets which is the reason for 5 separate readings. As can be seen in the first 3 irrigations, there is significant turbulence in the readings (0-16mgNO3-N/L); however when the raw data is exported, the mean and the median value are very similar to the second two events where the readings are far more stable (approx. 8mgNO3-N/L).

Work has been conducted in an attempt to minimise the variation in the readings including adding fluming to the end of the delivery pipe to minimise the impact of the falling water. The next two options to be trialled will be adding foam around the sensor and inserting the sensor into a piece of slotted PVC (slightly larger diameter to the sensor) to minimise water disturbance.

There is significant potential for the sensor to provide more accurate data concerning the amount of nitrogen applied to the paddock through irrigation water. Taking the sample data below for example:

PROJECT CATALYST



Average Nitrate-nitrogen (mg/L)	8.31
Pump Flow Rate (L/s)	51
Hours of Irrigation (hrs)	10.75 (10hrs, 45mins)
Irrigation Volume (ML/ha)	0.86
Set Area (ha)	2.3
Approximate kgN/ha applied in this irrigation:	**7.11**

Being able to calculate the total amount nitrogen applied to the paddock over the season will be another element of increasing grower's confidence in using irrigation-nitrates as part of their budget. Furthermore, with the sensor providing consistent readings over the irrigation period, it shows that the values are steady numbers that remain constant – further building on that confidence.

The grower has agreed to run the pump for a period of time following rainfall events to measure changes in the nitrate levels.

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:

- Implementing a real time nitrate sensor has provided more data that can be used in decision making. Not only does the sensor record nitrate levels and variation over time, but it also records irrigations – an essential element in utilising irrigation-nitrates in fertiliser budgets.
- 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:

- **Implementing a GW50 nitrate sensor is an expensive exercise and a practice that growers are unlikely to uptake without support.**
- 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.

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.
- Growers are unlikely to install a GW50 nitrate sensor on their own; however, they may utilise the findings from a sensor installed elsewhere.

% 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.