Project Catalyst Trial Report

Dynamic Nutrient Planning - Getting Nitrogen Right in Time and Place

Grower Information	
Grower Name:	RACECOURSE PROJECTS PTY LTD
Entity Name:	RACECOURSE PROJECTS PTY LTD
Trial Farm No/Name:	MKY- 04301A
Mill Area:	Racecourse Mill
Total Farm Area ha:	260
No. Years Farming: (Grower Experience)	N/A
Trial Subdistrict:	Dawlish

Trial Status

Completed

Background Information

Aim:

1. To evaluate the *1622WhatIf?*™ tool as a robust scientific method for determining crop nitrogen (N) fertiliser requirements within field.
2. To determine potential N fertiliser input reductions by better understanding soil/crop/seasonal dynamics in application decision making.

Background:

When it comes to altering fertiliser rates on sugarcane crops, there is no single decision-making support tool. A team at CSIRO has developed the *1622WhatIf?*™ App that is promoted as allowing farmers to evaluate the risks and benefits of changing N fertiliser applications. The App takes a scenario approach, for example a grower may ask "*What if I change my fertiliser rate, harvest date and/or fertilising date? How would that affect my crop yield and N losses?*'

The trial uses the CSIRO *1622WhatIf?*™ App to model crop N fertiliser requirements for a large sugarcane block at Dawlish. Soil cores, field productivity history, irrigation practices and soil type were collected and provided as inputs to the *1622WhatIf?*™ App. Based on the outputs of the model, a replicated field trial was established where N fertiliser inputs were varied annually according to the App's predicted requirements.

Crop N uptake, yield and sugar content measurements were collected in 2019 from four baseline N rates. Based upon crop performance data generated, *1622WhatIf?*™ parameter inputs were refined, and new targeted treatments were applied.

Catchment Solutions is collecting water samples from each treatment to measure potential nutrient run off for the life of the trial.

Potential Water Quality Benefit:

A more robust decision support methodology is required to assist growers and their advisers in making more informed decisions about N fertiliser applications in sugarcane, particularly identifying scenarios (soil type constraints, seasonal constraints) which may result in reduced yield and determining an appropriate N rate reduction to support that yield potential. The trial supports N rate determination that responds to seasonal conditions and N loss risk potential. This approach mitigates against losses to the environment through increased N use efficiency (NUE) and maximising crop yield potential.

Expected Outcome of Trial:

Validation of the *1622WhatIf?*™ model by evaluating the yield and water quality outcomes of adopting the model's recommended annual N fertiliser application rates. A decision support tool that provides greater confidence to growers and advisors that N application rate recommendations are reflective of potential crop yield and seasonal conditions.

Service provider contact: Steven Norman, Farmacist (0432 680 532).

Where did this idea come from: Grower/Farmacist

Plan - Project Activities

	Date:	Activities:
Stage 1	October 2019	• Assess trial site soil characteristics • EM map the paddock • Soil samples and cores for nutrient analysis
Stage 2	December 2019	Develop trial plan and apply fertiliser treatments.
Stage 3	January 2020	Water Quality Sampling by Catchment Solutions ▪ KP water samplers installed ▪ Samples captured during 2020 wet season Analysis completed
Stage 4	October 2020	• Crop N uptake assessments • Trial harvest - yield performance assessments • *1622WhatIf?*™ model re-runs with trial data input • New treatments determined in response to year 1 results
Stage 5	November 2020	• New fertiliser applied for 2021 season • Catchment Solutions installed KP water samplers for 2021 season
Stage 6	October 2021	• 2021 Wet Season water sampling and analysis by Catchment Solutions • Removal of KP water samplers in readiness for harvest Crop analysis and grower engagement
Stage 7	December 2021	• Crop Biomass sampling day • Trial harvest • Crop N uptake assessments Fertilisers applied
Stage 8	January 2022	• Crop and tissue data analysis of 2021 season complete Reset trial layout and begin 2022 crop observations

Project Trial site details

Trial Crop:	Sugarcane
Q240 1st ratoon	Q240 1st ratoon
Trial Block No/Name:	2-1
Trial Block Size Ha:	11.2 ha
Trial Block Position (GPS):	149° 9'43.65"E, -21°22'1.70"S
Soil Type:	Sunnyside class A sodosol, silty clay loam over grey heavy clay subsoils.

Block History, Trial Design

Trial Layout

The trial was located in Dawlish, QLD. The soil type at this site is a Sunnyside soil which is a grey duplex soil, characterised by often acidic topsoils that have a high cation exchange capacity, low organic carbon values, and grey well drained clay with many yellow mottles at depth.

The trial was established with four treatments, each with four 0.7ha replicates, and a control (Figure 1). The initial treatment rates were determined by using the industry's nutrient guidelines, the SIX EASY STEPS (6ES), and +/- the recommended rates.

The application rates of N were varied annually for each treatment dependent on the *1622WhatIf?*™ recommended rate.

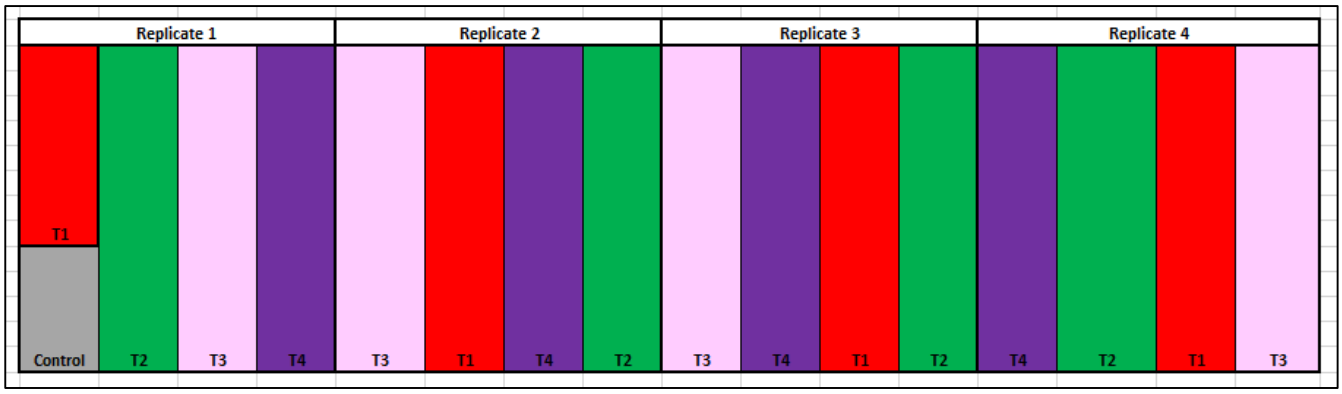

Figure 1: Trial layout of treatments and replicates

The N application rates applied are outlined in Figure 2. These rates where determined as the baseline and 2021 applacations are replicated rates from 2020 season;

- **Treatment 1-** -30% 6ES rate
- **Treatment 2-** -15% 6ES rate
- **Treatment 3-** 6ES rate
- **Treatment 4-** Typical grower practice

Control – 0kg N/ha
Treatment 1 – 110 kg
Treatment 2- 130 kg
Treatment 3 – 6ES 150kg
Treatment 4- 170 kg

Figure 2: Treatments of 2020 and 2021 season

The *1622WhatIf?* ™ App was used to alter the rates applied after the 2019 season. The new 2020 fertilsers rates were replicated for the 2021 season. Two dunder brews where used in order to maintain the same phosphorus, potassium and sulfur quantity across the four treatments, with N being the only variable.

Table 1 outlines the 2020 applications determined by the *1622WhatIf?* ™ App model, with consideration for forecasted local climate conditions and crop performance.

Table 1: Rationale for 2020 post-harvest N application rate

Treatment	N rate (kgN/ha)	Rational
1	110	*WhatIf?*™ App determined minimal yield risk between 80 kg/ha and 110 kg/ha.
2	80	No yield impact previous season between lowest and highest treatment. Given the crop was cut late, fertilised late and low yielding (60 t/ha average) the rate was reduced to 80 kg/ha
3	150	150 kg/ha is the Six Easy Steps rates, this will stay constant throughout the trial
4	180	Annual forecast predicts higher than average rainfall. Typical grower practice is to increase N rates to mitigate against potential N losses (denitrification & run-off) and increased potential yield.

Catchment Solutions water quality sampling

KP samplers, developed by BBIFMAC, were used to collect end of furrow run-off. The KP sampler is considered cheaper and simpler to run, as well as provide data more accepted as representing farm paddock run-off from rainfall events. The water quality assessment involved the use of KP samplers to collect end of paddock run-off following extensive rainfall events.

Samples were collected over the 2020 wet season on the:
- 28th January 2020
- 17th February 2020
- 27th February 2020
- 5th March 2020

Samples were collected over the 2021 wet season on the:
- 12th December 2020
- 4th January 2021
- 18th January 2021
- 18th February 2021

Water quality analysis included:
- Suspended solids
- Nutrients: N and phosphorus (dissolved and total)

Figure 3 KP water sampler on the trial site

Results

Yield results 2020

2020 yield results indicated no significant difference in tonnes of cane or tonnes of sugar per hectare (tC/ha, tS/ha) between the four treatments (Figures 4 &5). The paddock was cut and fertilised late in 2019, restricting the crop's potential growth.

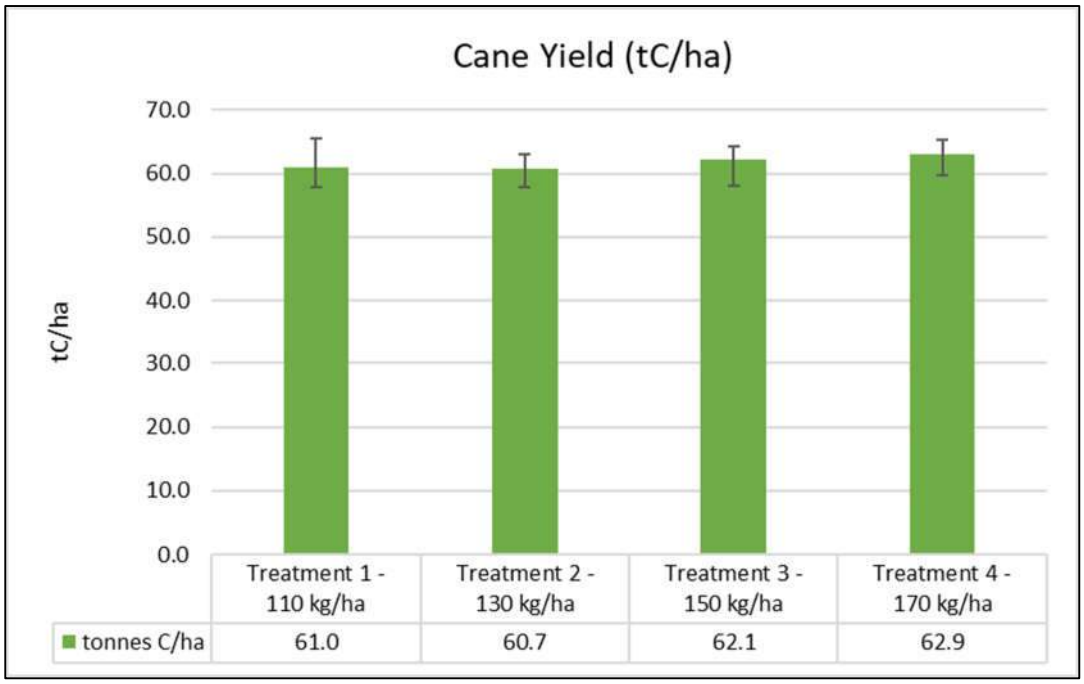

Figure 4 Cane Yield (tC/ha) of 2020 treatments.

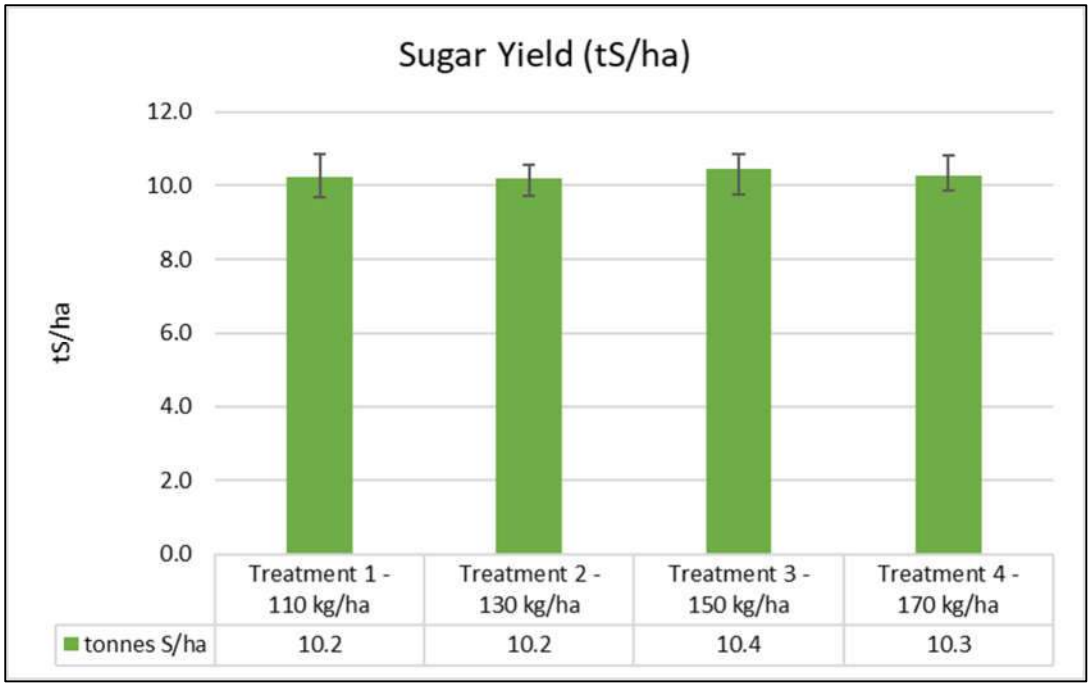

Figure 5 Sugar Yield (tS/ha) of 2020 treatment

NUE results indicated that Treatment 1 (110 kgN/ha) resulted in the highest efficiency (Figure 6). The grower saved 60 kgN/ha but yielded 1.9 tC/ha and 0.1 tS/ha higher than Treatment 4 (170kgN/ha), equating to 67% improvement in NUE by using the lower N rate. However, the extent of this result must be considered with some caution because the reduced growing period. The significance of this result cannot be determined until the 2021 harvest results are collected and can be statistically compared on a daily growth rate in a determined period.

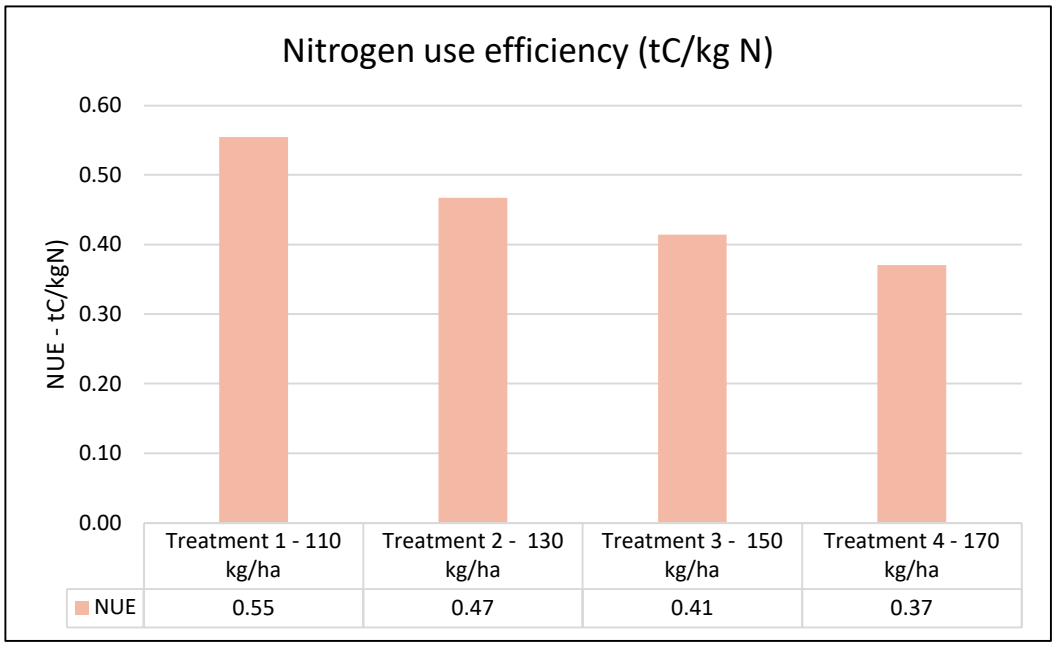

Figure 6 Nitrogen use efficiency (tC/kg N) for 2020 harvest.

Leaf samples 2020

Leaf sampling results show little difference between N, phosphorus, and sulphur percentage in the leaf, however, potassium levels increased as N levels decreased (Figure 7). The control had similar, if not higher, nutrient content compared to the fertilised treatments.

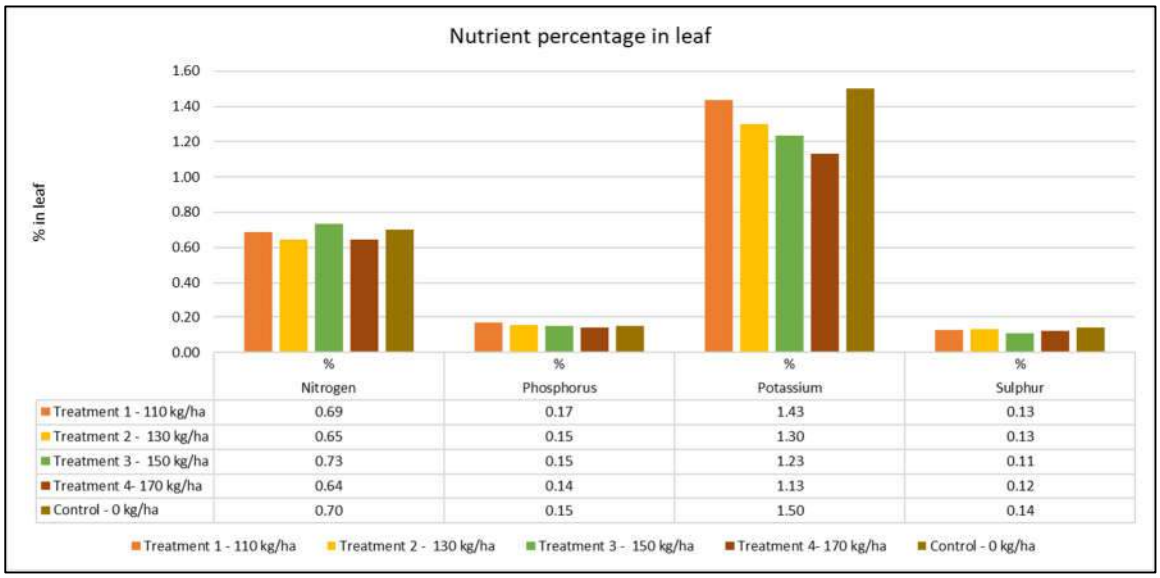

Figure 7 Leaf sample nutrient results 2020

2020 Catchment Solutions water sample results

The initial assessment determined that the Dissolved Inorganic Nitrogen (DIN) estimate run-off loads increased in line with the increasing N Treatments, with Treatment 4 (170 kgN/ha) having the highest paddock run-off at 0.228 kg N/ha). There were no changes in mass loads for the paddock run-off for both the DIN and Particulate N. There were no changes in mass loads for the paddock run-off for Total Phosphorous, while Particulate Phosphorous had a more elevated mass load in the replicates of Treatment 3 (150kgN/ha), although this may be associated with factors outside of the trial assessment.

Figure 8 2020 trial harvest

Figure 9 Day of 2020 trial harvest

2020 *1622WhatIf?™* Analysis

The results of the 1622WhatIf?TM better informed the N application decisions of 2020. The low risk of yield loss between nitrogen rates was consistent with the minimal yield differences between harvested treatments.

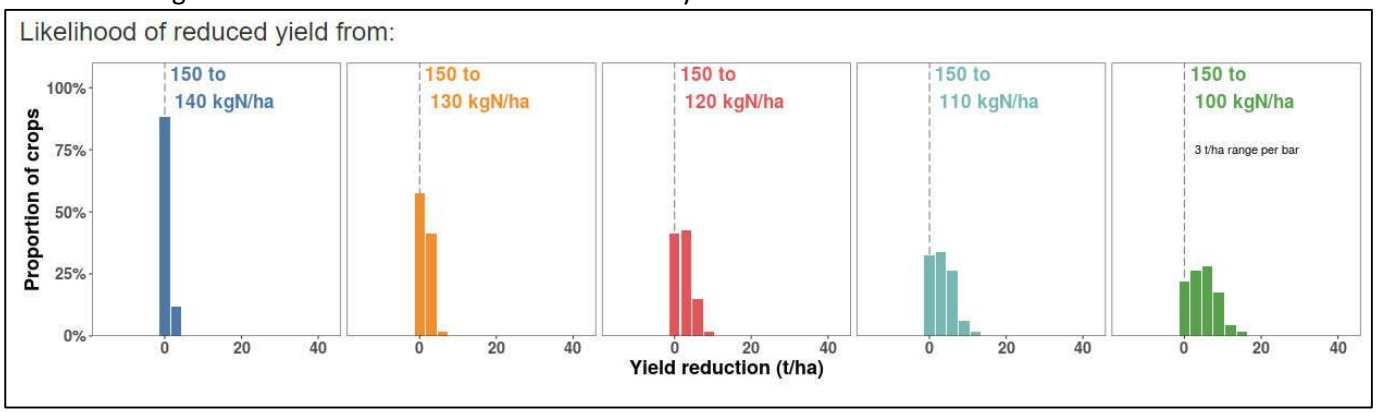

Figure 10 2020 1622whatIF? Yield reduction graph

Yield results 2021

2021 yield results indicated no significant difference in tonnes of cane or tonnes of sugar per hectare (tC/ha, tS/ha) between the four treatments (Figures 11 & 12). The paddock was cut and fertilised late in 2020, restricting the crop's potential growth. The control expresses a significant reduction in cane and subsequent sugar yield. This was as expected as control was unfertilised (0 kg N/ha).

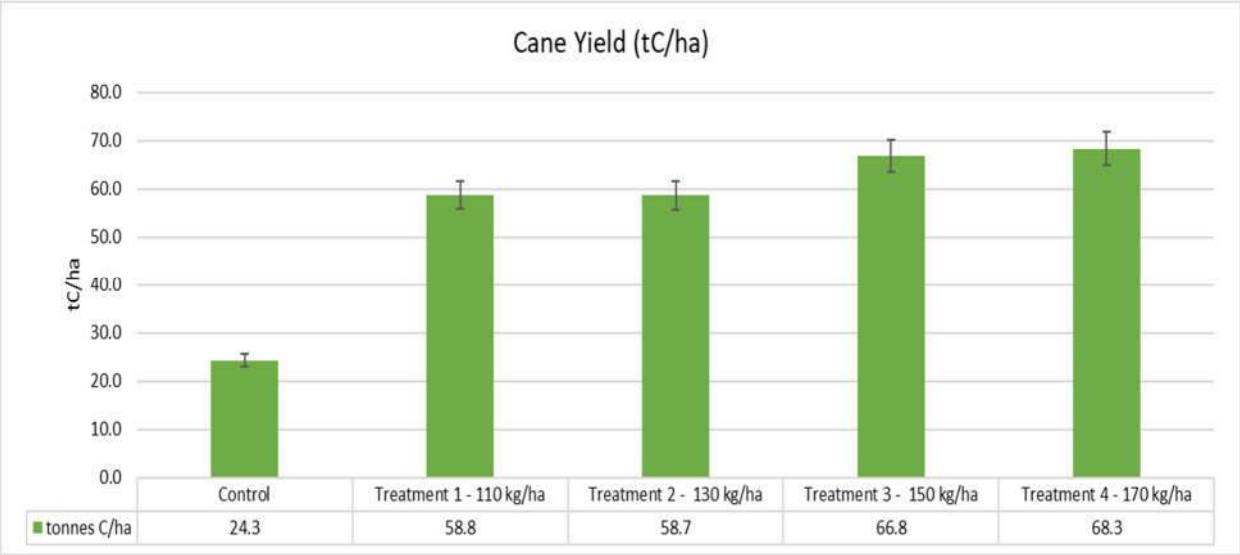

Figure 11 Cane Yield (tC/ha) of 2021 treatments.

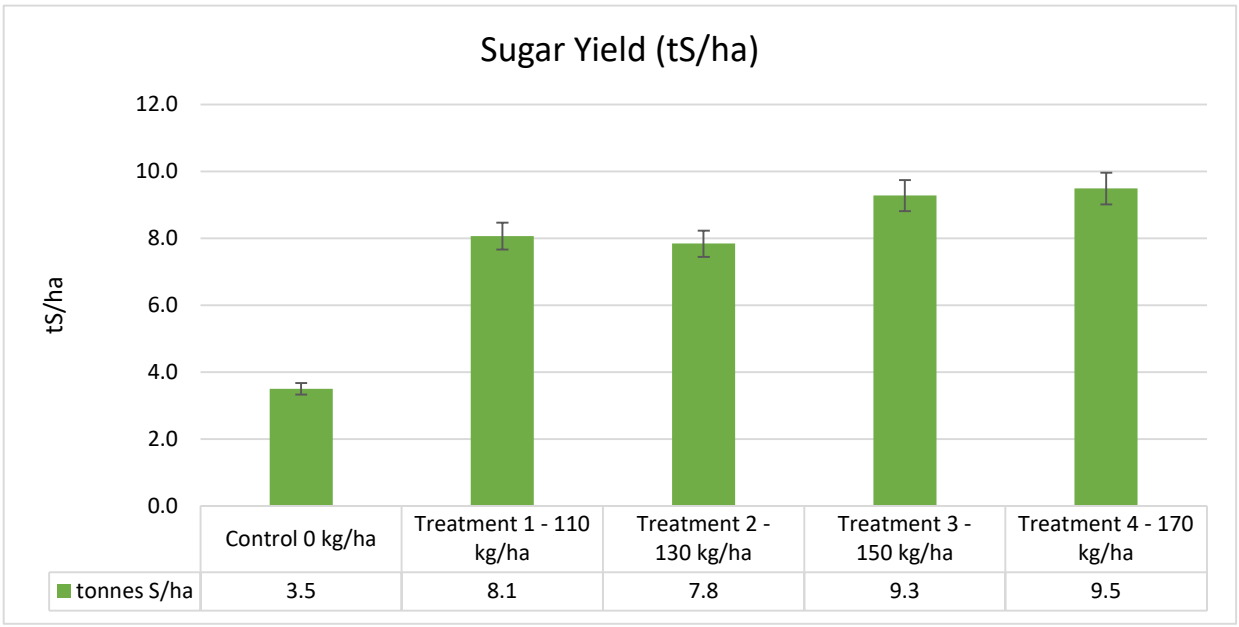

Figure 12 Sugar Yield (tS/ha) of 2021 treatments.

Similarly to the 2020 season, NUE results indicated that Treatment 1 (110 kg N/ha) resulted in the highest NUE (Figure 13). In treatment 1 the grower saved 60 kg N/ha however, on average, treatment 4 yielded 9.5 tC/ha and 1.4 tS/ha lower (170 kg N/ha). Treatment 2 and 3 express the same NUE. The control was not added to Figure 13 as it is insignificant to data interpretation.

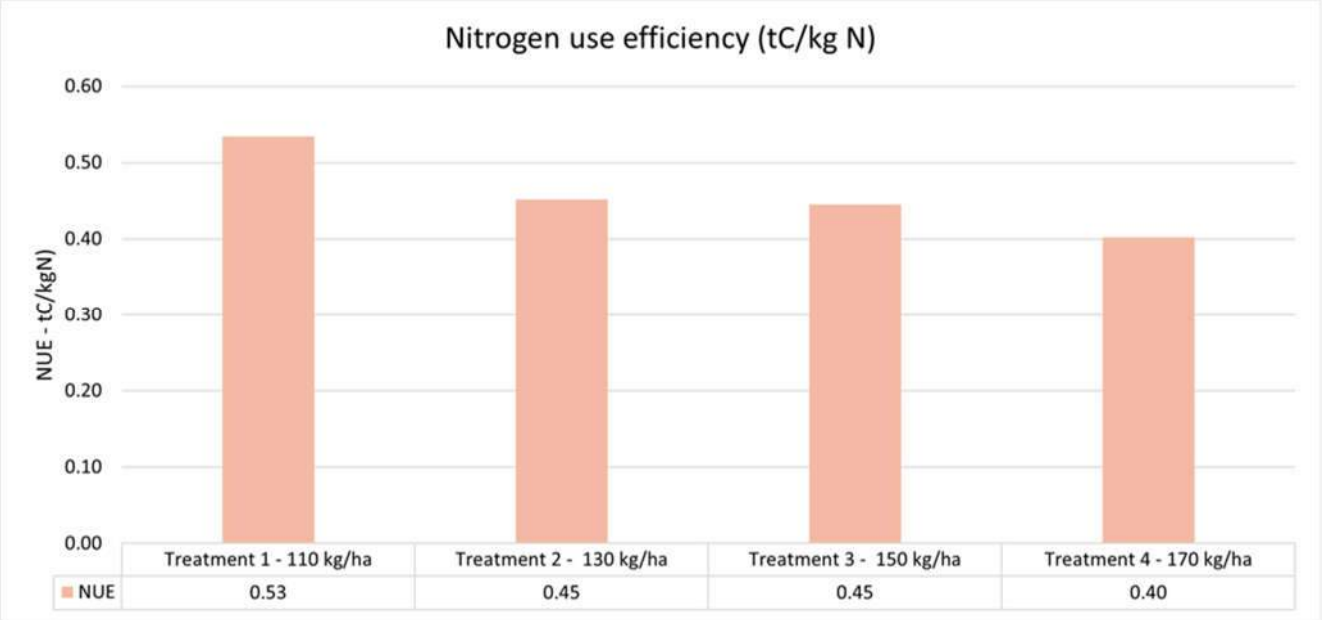

Figure 13 Nitrogen use efficiency (tC/kg N) for 2021 harvest.

Leaf samples 2021

Leaf sampling results show little difference between N, phosphorus, and sulphur percentage in the leaf, however, potassium levels increased as N levels decreased (Figure 14). The control had similar, if not higher, nutrient content compared to the fertilised treatments.

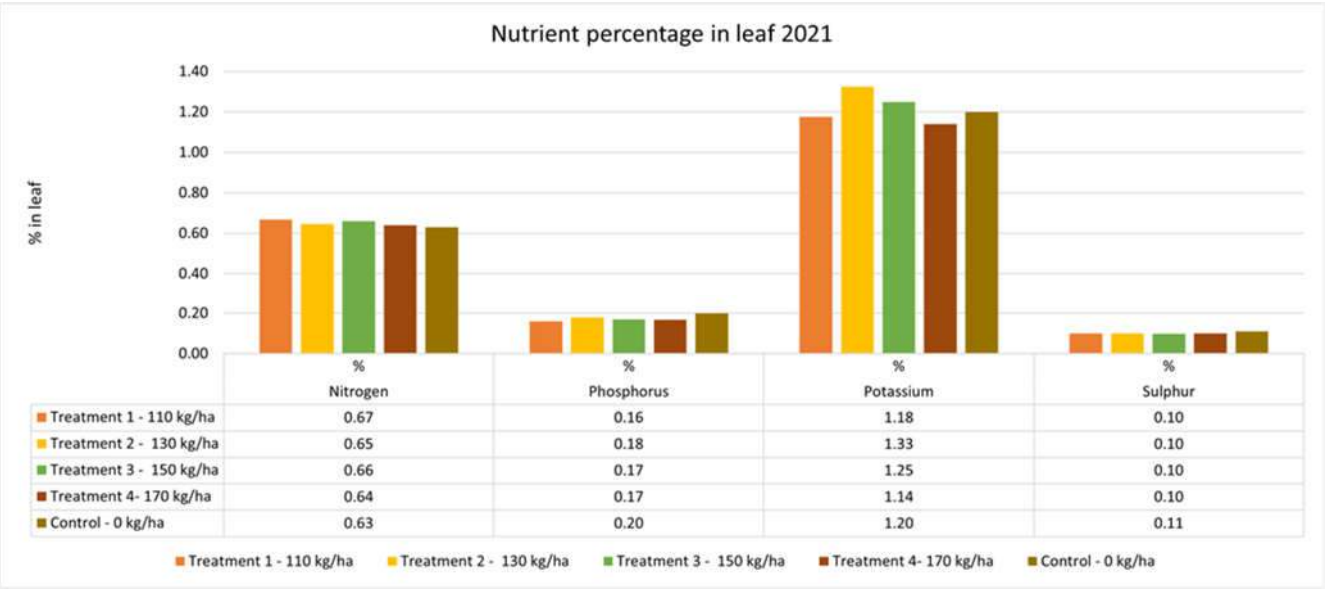

Figure 14 Leaf sample nutrient results 2021

2020 and 2021 Catchment Solutions water sample results (combined)

Results show Total Nitrogen (TN) and Dissolved Inorganic Nitrogen (DIN) run-off load rates increase as a response to the increased rates to Urea in the different treatments. However, Treatment 2 (130 kg N/ha) showed the highest run-off load rate average of DIN at 0.46 kg N/ha over 2020 and 2021 seasons. Comparably Treatment 4 (170 kg N/ha) DIN average expressed a lower rate of 0.34 kg N/ha. Total Nitrogen of Treatment 2 was 1.83 kg N/ha, which is higher than Treatment 4 at 1.67 kg N/ha. Treatment 2 Dissolved Organic Nitrogen (DON) and Particulate Nitrogen (PN) rates expressed DON of 0.99 kg N/ha and a PN of 0.46 kg N/kg. Comparably treatment 4 expressed slightly lower rates of DON at 0.84 kg N/ha and PN at 0.27 kg N/ha. According to Catchment solutions, the elevated run-off concentration may have been influenced by factors outside the trial assessment.

Figure 15: 2021 Biomass sampling – Farmacist team

2021 *1622WhatIf?* ™ Analysis

The results of the 1622WhatIf? better informed the N application decisions of 2020. 2021 replicated the treatment application rates of the 2020 season. The low risk of yield loss between nitrogen rates was consistent with the minimal yield differences between harvested treatments.

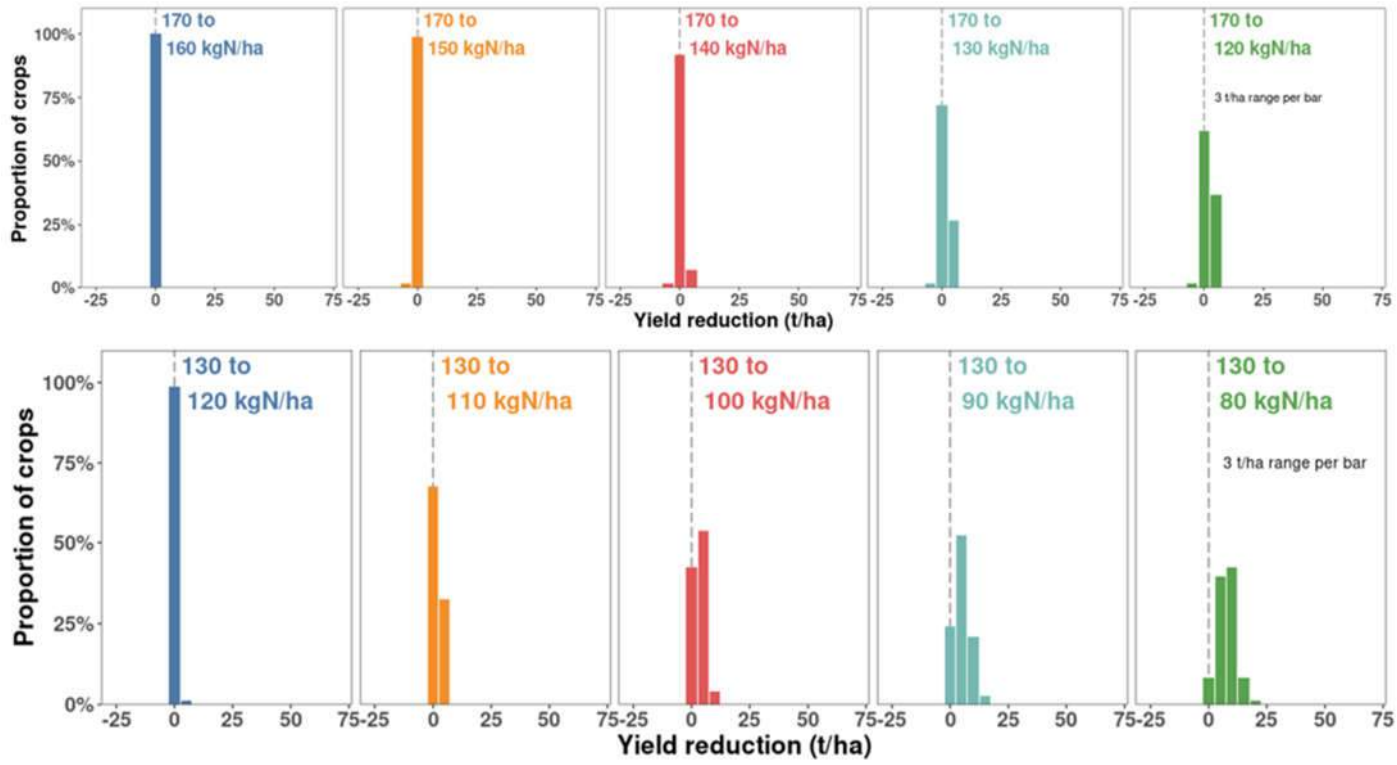

Figure 16: 2021 1622whatIF? yield reduction graph

Conclusions and comments

This project in now complete under this round of funding, however the trial will be continued pending additional funding.

This trial will be harvested in 2022 with new treatment rates that were applied in December 2021. Farmacist is driven to continue the work to promote the new tool. This will assist us to continue the work of extension and increase data set for further investigation.

Advantages of this Practice Change:

Overall, the trial showed the NUE was greatest at 110 kg N/ha compared to the higher rates of treatment. This is an advantage to the grower by reducing cost of fertiliser without diminishing yield significantly. Another advantage is the reduction of environment contamination of the unutilised Nitrogen fertiliser products used in typical application rates.

Disadvantages of this Practice Change:

A small chance of yield reduction over several seasons even though insignificant, can provide uncertainty within grower community. The Adoption rate of growers is likely to be slow. Barriers of adoption include lack of confidence surrounding the reduction N. The use of a technical tool that may not be easily understood and is in an early stage of adoption.

Will you be using this practice in the future:

Overall, yes Farmacist will be promoting confidence in the use of the 1622whatIF app and the data that it represents. The reduction of fertiliser application and NUE show clear evidence that yields are not determined by standard, high N application rates.

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

20% of total farm for initial practice change per individual grower. This is a good start for both grower and advisor as the current trial was on 1 soil type, over a few seasons. The increased use of the WhatIF tool will increase in line with clear outcomes, cost benefit achievements and larger farm yield data sets.