Project Catalyst Trial Report

Sub Surface Ameliorants

Grower Information	
Grower Name:	John and Phil Deguara
Entity Name:	MAPP Farming
Trial Farm No/Name:	MKY-03082A
Mill Area:	Mackay Sugar
Total Farm Area ha:	240
No. Years Farming:	>40 years – 3rd and 4th generation
Trial Subdistrict:	Brightley
Area under Cane ha:	350 (combined total of operation)

Trial Status

Completed

Author: John Turner (Farmacist). For further information contact John on Mb No. 0437 581 921.

Background Information

Aim: To demonstrate and measure soil health and sugarcane yield benefits from deep placement of soil ameliorants including mill mud and mill ash.

Background:
There are several soil properties that have shown to constrain yield, in particular soils with inflated sodium levels and soils that are subject to water logging, such as deep clay soils.

Sodic soils result in poor soil structure that effects infiltration, percolation and availability of water. High sodicity causes clay particles to swell excessively when wet to the point they separate and disperse. This results in structural collapse of the soil profile and closure of soil pores, severely restricting water and air movement throughout the soil. Water logging is also common in sodic soils. Typical impacts of sodic soils on sugarcane crops include reduced plant populations, poorer growth within those populations, and reduced root growth and distribution. Poor yield outcomes reduce nitrogen use efficiency (NUE) as well as overall profitability of the site.

For soils with poor subsurface drainage characteristics, or low-lying areas, heavy rainfall inundation over the three-month wet season significantly impacts the productivity of water-logged areas and is considered a major contributor to within block yield variability in the Central region.

The sub-soil ameliorant application trial of John and Phil Deguara is the first of its kind in the Mackay sugarcane growing region. The trial site was established to assess and provide confidence to growers that burying ameliorants below the surface of the soil has potential to improve soil qualities deeper down the soil profile, increasing top-soil depth and expanding the volume of the rooting zone. Under consideration also is that deep placement will reduce the risk of nutrient runoff and has potentially to improve soil structure in the crop root zone. Both contribute to improved NUE and profitability.

Results from a small trial, commenced in 2015, was assessed by hand harvest in maturing cane crop in 2016. As shown in figure 1, the highest crop yield was achieved in treated cane, however, this was not consistent across repetitions. Heavy lodging had occurred in the treated treatments, which is likely to have restricted crop growth and final yield in that treatment

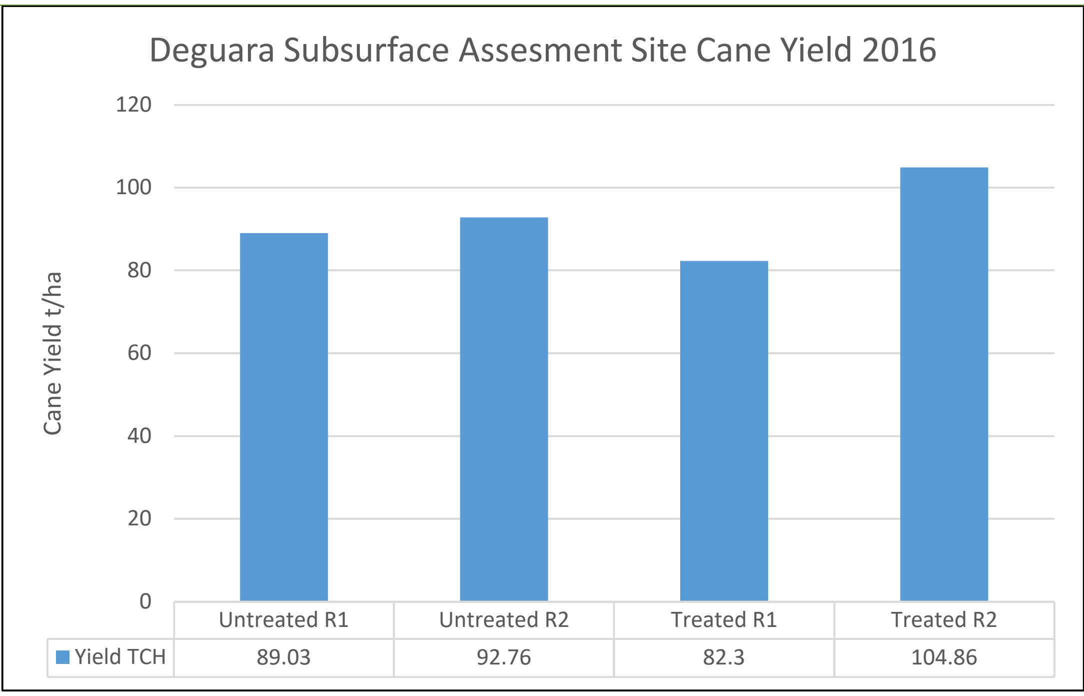


Figure 1 - 2016 Cane yield following 2015 ameliorant application

Potential Water Quality Benefit:
Reduced risk of nutrient movement off site with improved yields and reduced exposure of applied nutrients to run-off potential.

Expected Outcome of Trial:
Improved soil structure and increased yield where sub-soil ameliorant application has been used.

Service provider contact: Farmacist Pty Ltd

Where did this idea come from: John and Phil Deguara

Plan - Project Activities		
	Dates:	**Activities:**
Stage 1	July 2016	Bury ameliorants into fallow paddock, followed by mung bean and soybean crop (Site 1)
Stage 2	August 2016	Plant cane (Site 1)
Stage 3	September 2017	Harvest Production (Site 1) - Plant cane
Stage 4	July 2017	Identify new trial site and conduct soil analysis (Site 2)
Stage 5	October 2017	Apply treatments to trial site (Site 2)
Stage 6	December 2017	Plant soybeans (Site 2)
Stage 7	August 2018	Harvest Site 1 – 1st Ratoon Plant cane (Site 2)
Stage 8	August 2019	Harvest Production (Site 2) - Plant cane
Stage 9	December 2019	Continue project for site 2
Stage 10	September 2020	Harvest Site 2 – 1st Ratoon

Project Trial site details

Trial Crop:	Sugar cane
Variety: **Rat/Plt:**	Q252
Trial Block No/Name:	5-1 and 17-2
Trial Block Size Ha:	6.8ha
Trial Block Position (GPS):	148.944298, -21.251684
Soil Type:	Victoria Plains - Deep Cracking Clay and Calen – Brown Chromosol

Block History, Trial Design

The trial site (Site 1) was Electromagnetic (EM) surveyed to determine the location of soil boundaries (Figure 2). A yield map of the site (Figure 3) demonstrates the lowest yielding areas of the paddock are located where the highest EC readings were taken. High EC is often associated with soils that are heavier in texture and can have drainage issues. The yield map also indicates the locations of the highest yielding are regions of low EC values, indicating lighter textured soils with good drainage properties.

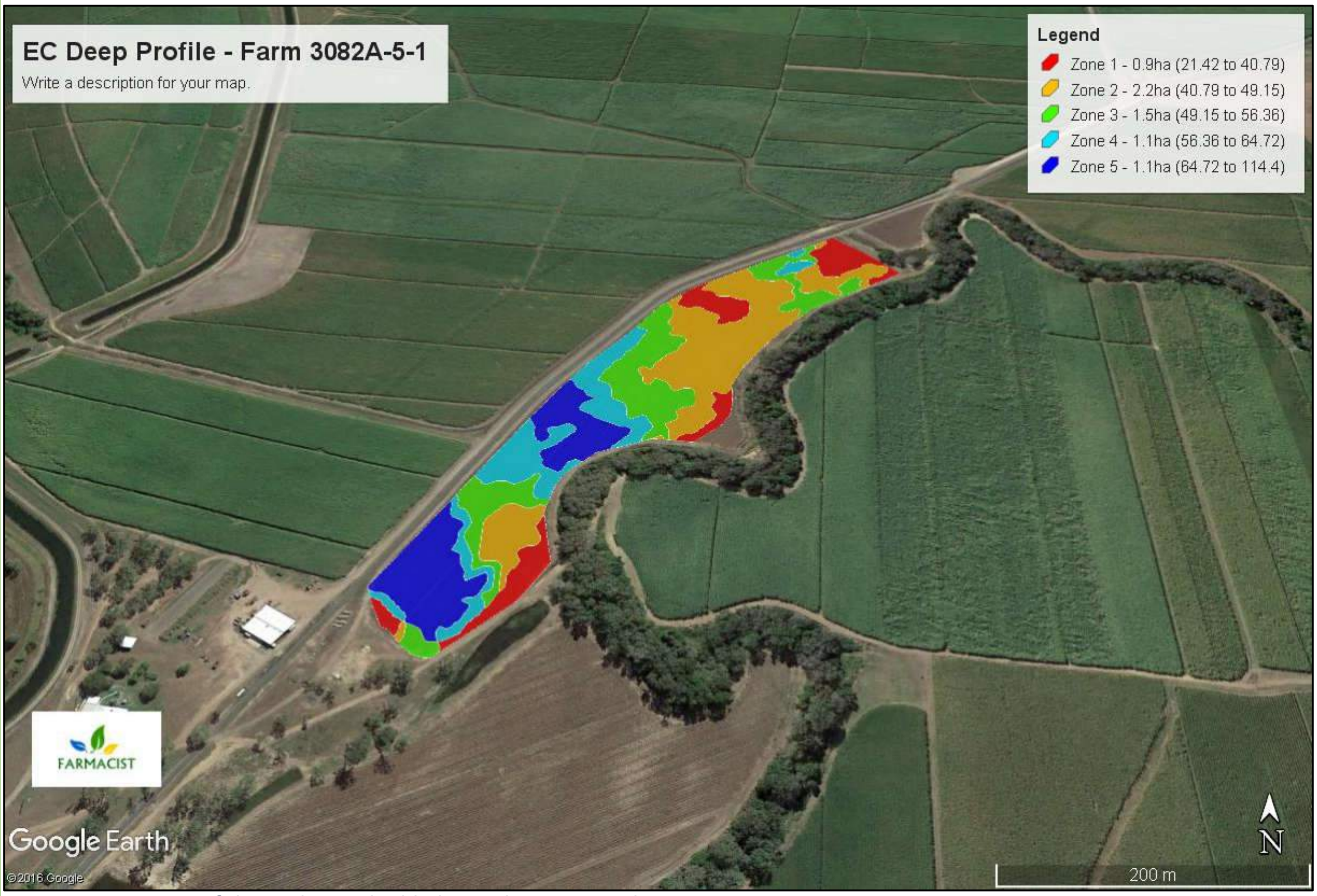


Figure 2 - EM map of the trial site 1 highlighting changes in soil properties

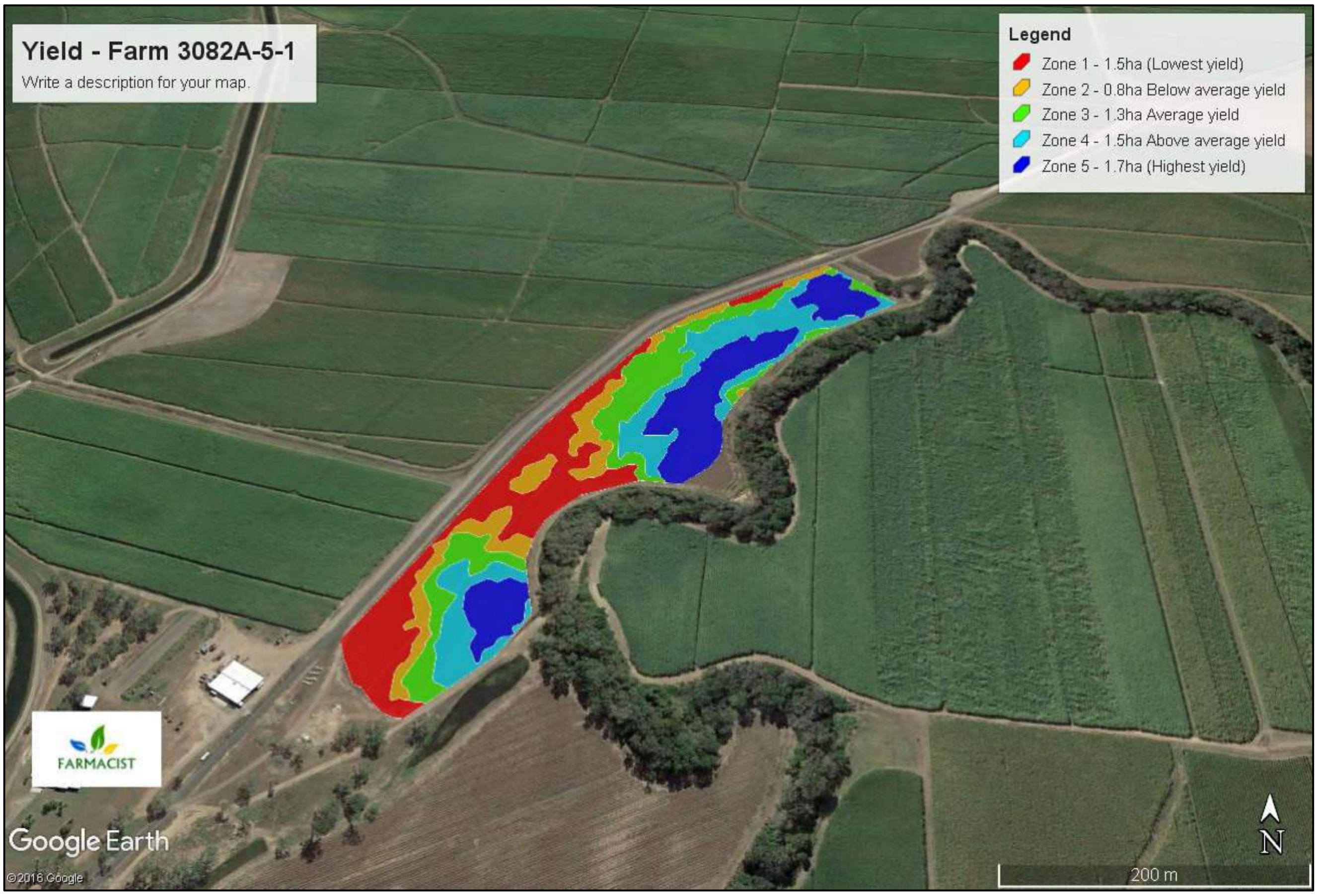


Figure 3 - Yield variation map of site 1

Figure 4 provides and outline of the trial design for Site 1. Table 1 highlights the different application of products for each of the treatments for Site 1.

Table 1 design

Figure 4 -Trial Site 1 - Applications and Treatments

Deguara Farm 3082A Block 5-1 - Sub surface ameliorant applications - Row Numbers

Row Numbers	Treatment Numbers	N↑ ***Creek - Eastern edge of paddock***
34 35 36 37 38 39 40 41	Remainder of rows in paddock	Remainder of paddock same as Guard
31 32 33	11	No furrow opening, no product applied and speed tilled
28 29 30	10	Furrow opened to 350mm, no product applied and speed tilled
25 26 27	Guard	Furrow opened to 350mm and mud buried @ 50 t/ha and speed tilled
		Headland
22 23 24	Guard	Furrow opened to 350mm and mud buried @ 50 t/ha and speed tilled
19 20 21	6	Mud and Ash both @ 50 t/ha - surface applied and speed tilled
16 17 18	5	Ash @ 100 t/ha - surface applied and speed tilled
13 14 15	4	Mud @ 50 t/ha - surface applied and speed tilled
10 11 12	3	Furrow opened to 350mm, mud and Ash buried both @ 50 t/ha and speed tilled
7 8 9	2	Furrow opened to 350mm and Ash buried @ 100 t/ha and speed tilled
4 5 6	1	Furrow opened to 350mm and mud buried @ 50 t/ha and speed tilled
1 2 3	Guard	Furrow opened to 350mm and mud buried @ 50 t/ha and speed tilled
	W↓	***Cane rail line - western edge of paddock***

		Application Contributions (kg/ha)			
Treatment	**Applications**	N	P	K	S
Mud buried @ 50 t/ha	**Soybean**	40			
	At Plant APP @45l/ha	7	10		
	Mud	30	100	30	8
	Top dress: MKY 50/50 @2600m3	72	0	70	10
	Total	149	110	100	18
Ash buried @ 100 t/ha	**Soybean**	40			
	At Plant APP @45l/ha	7	10		
	Top dress: Lucerne @3.8m3	86	25	100	29
	Ash	10	80	100	15
	Top dress 2: Urea @ 45 kg/ha	20			
	Total	163	115	200	44
Mud & Ash buried both @50 t/ha	**Soybean**	40			
	At Plant APP @45l/ha	7	10		
	Mud and Ash	35	140	80	15
	Top dress: MKY 50/50 @2600m3	72	0	70	10
	Total	154	150	150	25
Control	**Soybean**	40			
	At Plant APP @45l/ha	7	10		
	Top dress: Lucerne @3.8m3	86	25	100	29
	Top dress 2: Urea @ 45 kg/ha	20			
	Total	153	35	100	29
Whole of paddock has been deep ripped to 600mm					
Whole of paddock has had mung bean followed by soybean (both taken to harvest) and then planted with cane early August 2016					
APP liquid starter @ 45 l/ha applied at planting					

Application equipment

Figures 5 to 9 provide a sequence of events that occur when applying ameliorants sub-surface from the opening of the furrow, application of product and closing of furrow ready for planting.

Figure 5 - Furrows are opened with modified tillage equipment

Figure 6 ***- Ameliorants including mill mud and ash are banded into the furrow***

Figure 7 - High tech depth gauge is used (Patent Pending)

Figure 8 - Ameliorants including mill mud and ash are banded into the furrow

Figure 9 – Furrow closed over ready for planting

Results

Results from the 2017 Harvest (Site 1)

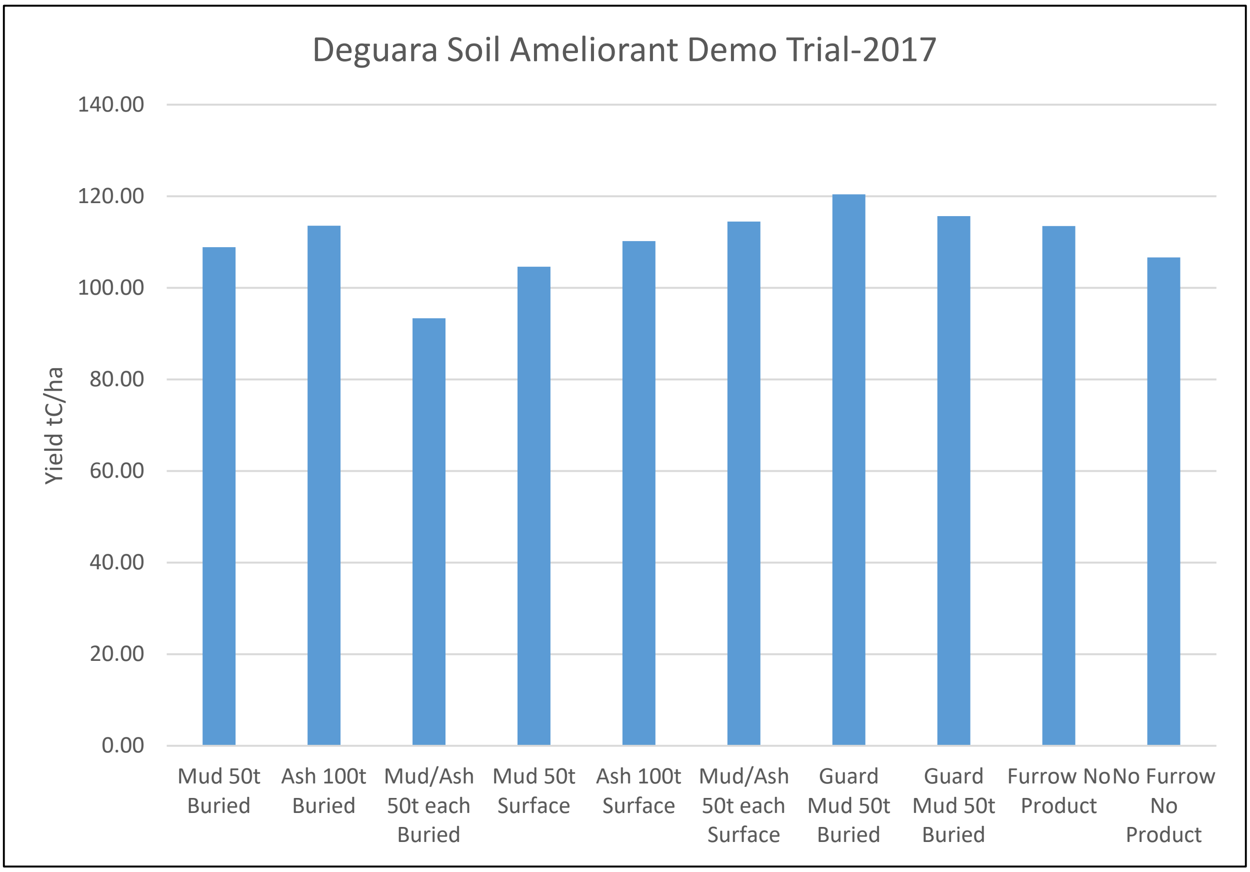


Figure 10 - Cane yields per treatment (Site 1) 2017 harvest

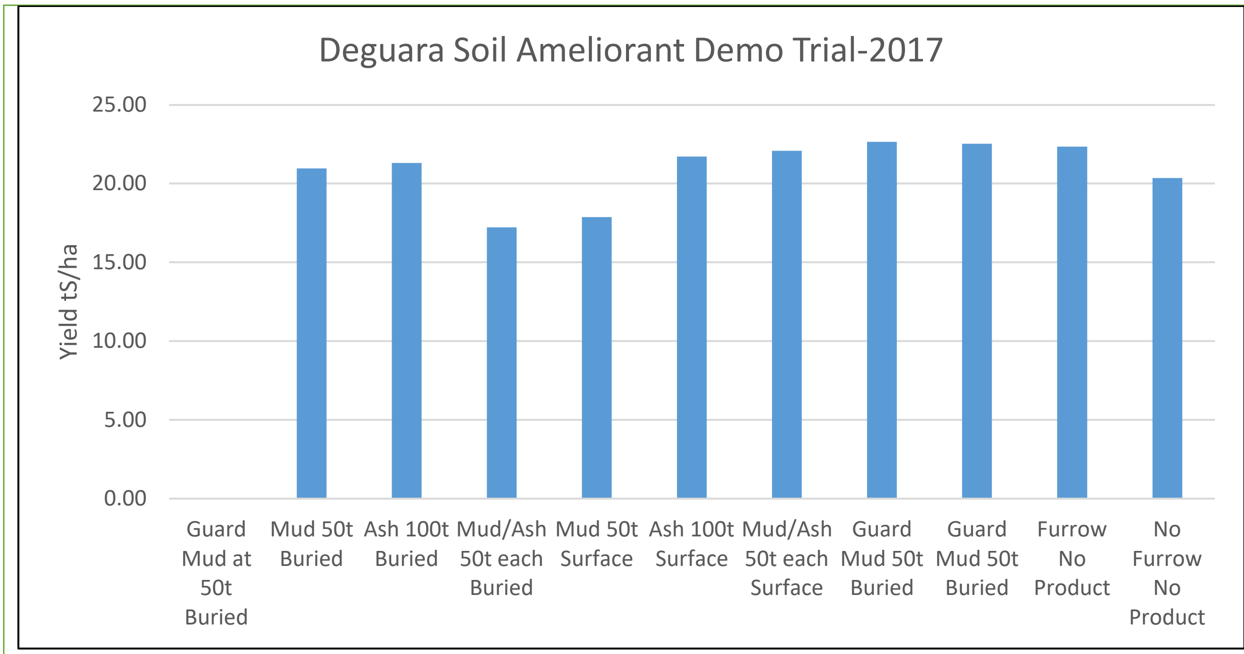


Figure 11 - Sugar yields by treatments (Site 1) 2017 harvest

The 2017 results did not present a clear relationship between treatment and yield as shown in Figures 10 and 11. This cane block suffered from flood damage during February and March of 2017, likely compromising the treatments.

A new trial (Site 2) was established in 2018. The trial design is provided in Figures 12 and 13. The design focused on two main treatments:

1. Ash only (Figure 12); and
2. A mixture of mud and ash (Figure 13).

The variable applied was sub-surface applied or surface applied.

Ash Trial										
								Head land		
			30m	**20**	**30m**	**20m**	**30m**	**20m**	**30m**	**20m**
	81 rows				3082 13-06					
Treatment 3	6 rows		**R1**		R2		R3		R4	
Treatment 2	6 rows		R1		R2		R3		R4	
Treatment 1	6 rows		R1		R2		R3		R4	
	6 rows									

Treatment 1 = Control
Treatment 2 = Surface applied Ash 100 t/ha
Treatment 3 = Sub-surface applied Ash 100 t/ha

Figure 12 - trial design of ash only treatment (Site 2)

Mud/Ash Trial

					Head Land					
			30m	**20**	**30m**	**20m**	**30m**	**20m**	**30m**	**20m**
	81 rows				3082 13-05					
Treatment 3	6 rows		**R1**		R2		R3		R4	
Treatment 2	6 rows		R1		R2		R3		R4	
Treatment 1	6 rows		R1		R2		R3		R4	
	6 rows									

Treatment 1 = Control
Treatment 2 = Surface applied Mud-Ash 50 t/ha
Treatment 3 = Sub-surface applied Mud-Ash 50 t/ha

Figure 13 - trial design of mud/ash combination treatment (Site 2)

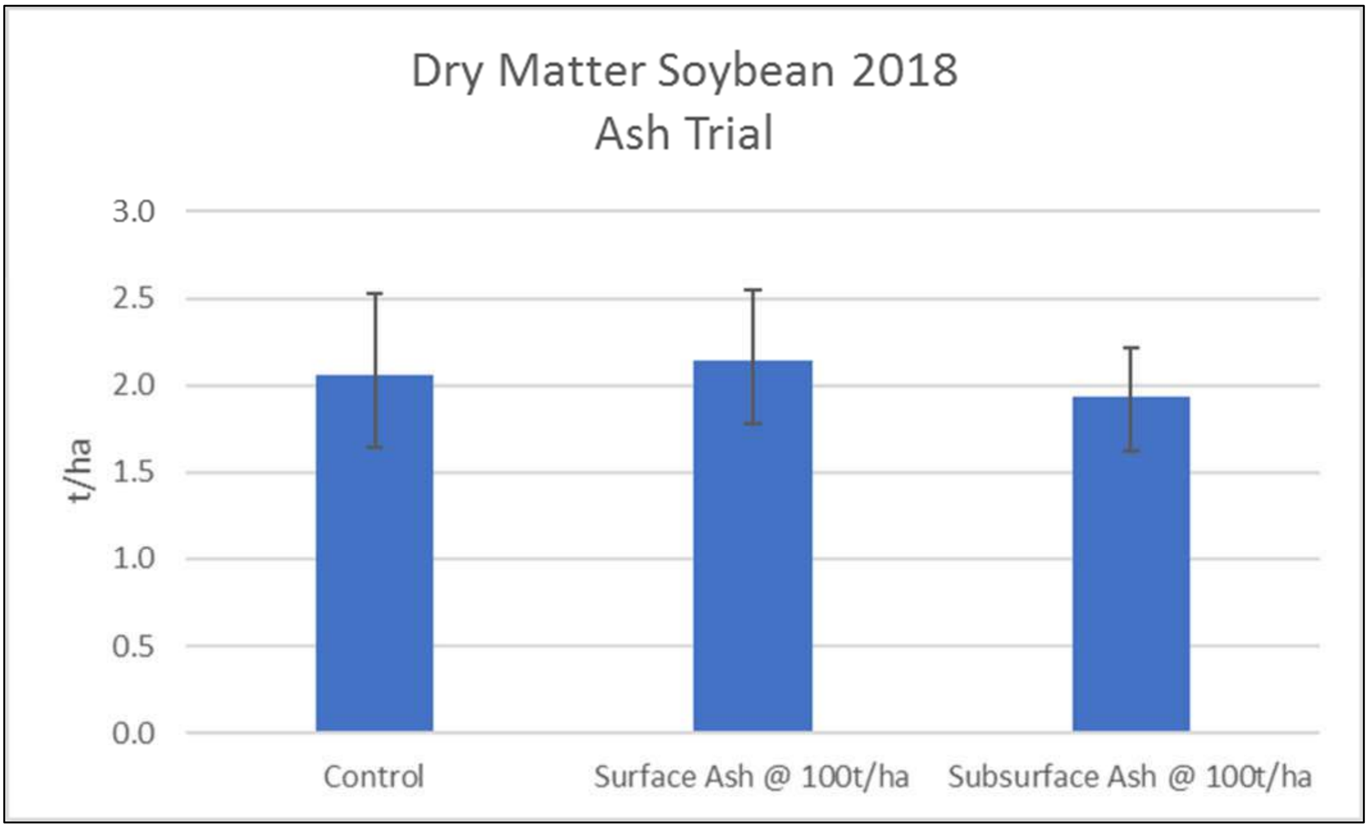


Figure 14 - soybean yields - ash only treatments

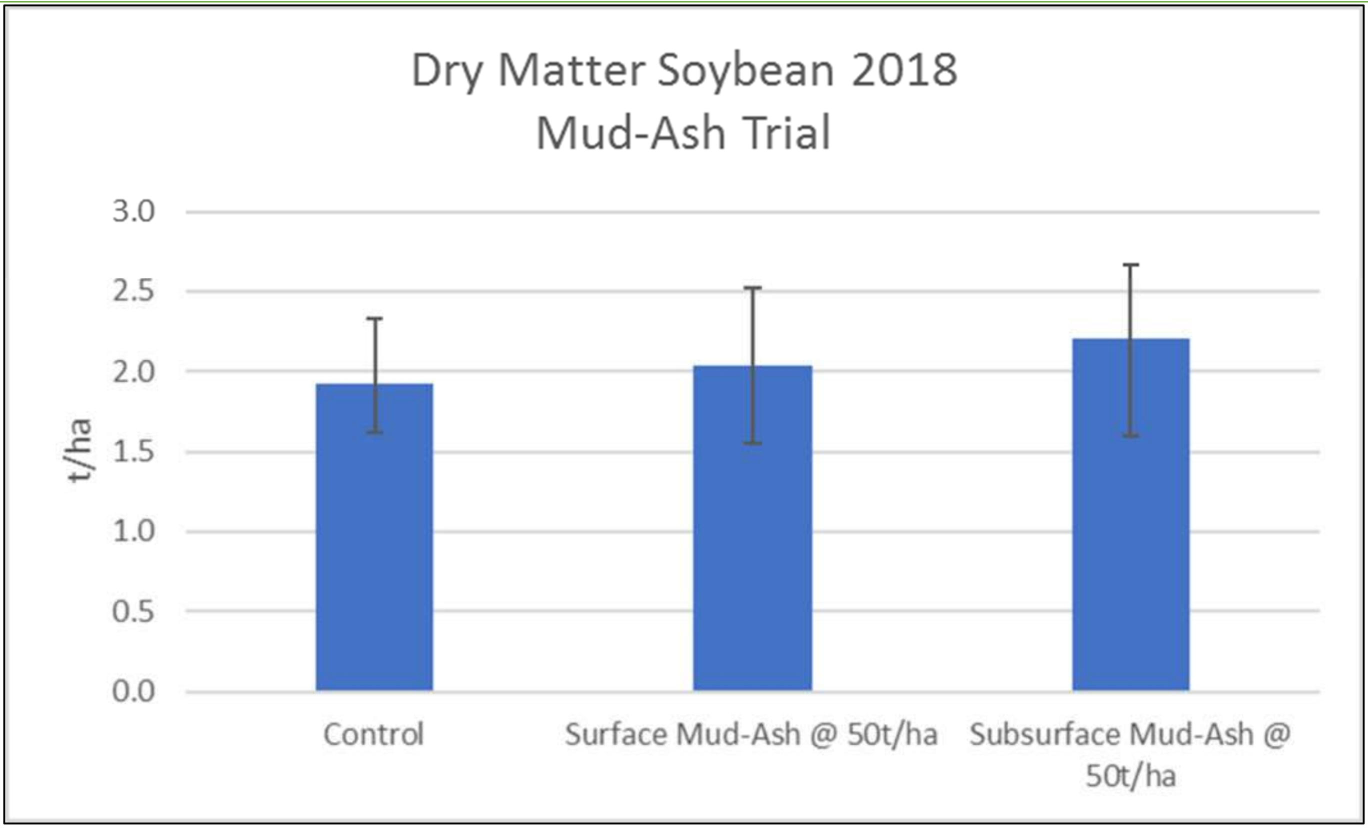
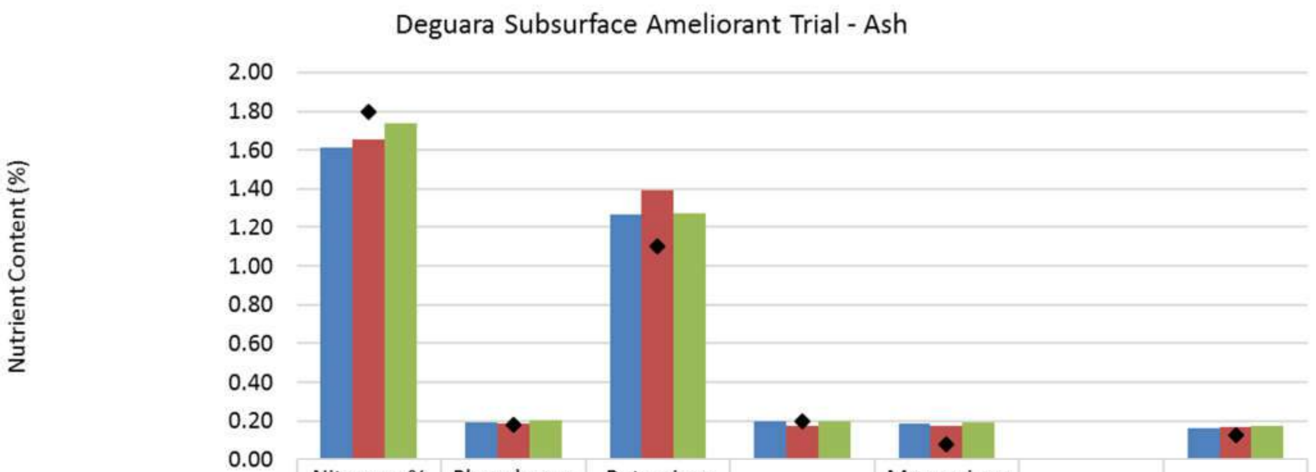


Figure 15 - soybean yields - mud/ash treatments

Prior to planting of Site 2 in 2018, a soybean crop was grown in summer 2017-2018 and assessed for any variances. No major differences were noted between the treatments in the ash (Figure 14) or the mud/ash treatments (Figure 15).

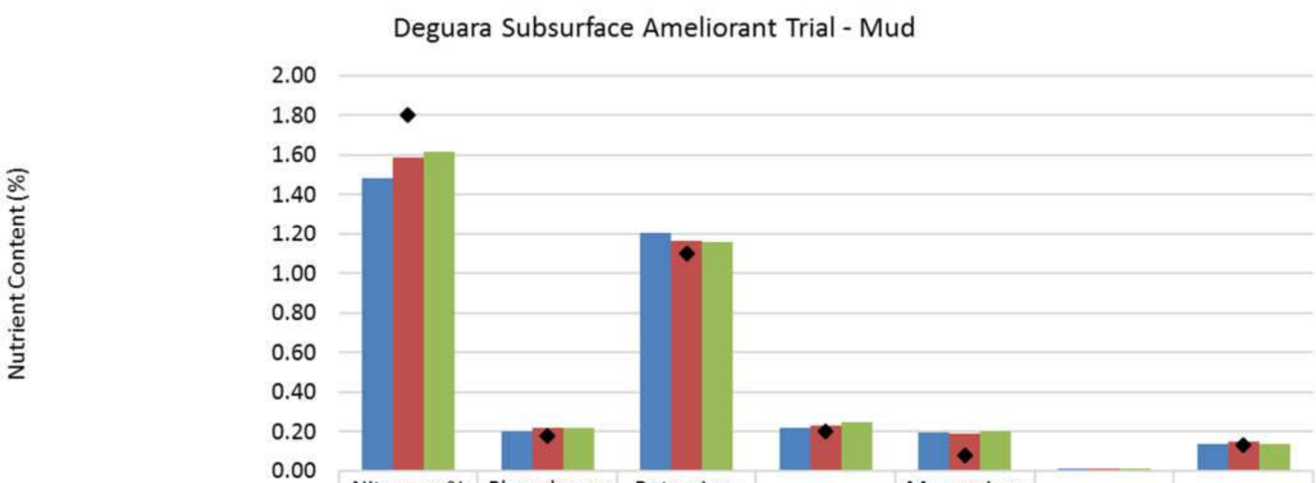
Leaf Samples 2019

Leaf samples were taken in March 2019 to assess for variations in nutrient content of each treatment on Site 2. N contents were higher in the treatments with ash or mud-ash applied, however this difference was minimal. All other nutrients showed no clear trends to indicate a superior treatment with results demonstrating at or above critical value, indicating a sufficient supply of nutrients.



	Nitrogen % Dumas	Phosphorus %	Potassium %	Calcium %	Magnesium %	Sodium %	Sulfur %
Control	1.61	0.19	1.27	0.20	0.19	0.01	0.16
Surface Ash 100t/ha	1.65	0.19	1.40	0.17	0.17	0.01	0.17
Sub-surface Ash 100t/ha	1.74	0.21	1.28	0.20	0.19	0.01	0.18
◆ Critical Value	1.8	0.18	1.1	0.2	0.08		0.13

Figure 16 Leaf sample results 2019 - Ash Trial



	Nitrogen % Dumas	Phosphorus %	Potassium %	Calcium %	Magnesium %	Sodium %	Sulfur %
Control	1.49	0.20	1.20	0.22	0.20	0.01	0.14
Surface Mud-Ash 50t/ha	1.59	0.22	1.16	0.23	0.19	0.01	0.15
Sub-surface Mud-Ash 50t/ha	1.62	0.22	1.16	0.25	0.20	0.01	0.14
◆ Critical Value	1.8	0.18	1.1	0.2	0.08		0.13

Figure 17 Leaf sample results 2019 - Mud-Ash Trial

Harvest Results – 2019

Trials were harvested on the same day in mid-September as plant cane.

On average the mud/ash treatment outperformed the ash only treatment by 1.0 ts/ha, the lowest mud/ash result was 0.1 ts/ha below the highest ash treatment result.

The ash trial performed as expected (Figure 18) with the highest yield coming from the sub-surface treatment (12.8 ts/ha), followed by the surface applied treatment (12.0 ts/ha) and then the control (11.6 ts/ha). The mud/ash trial results (Figure 19) demonstrated that the highest yield resulted from the surface applied treatment (13.7 ts/ha), followed by sub-surface (13.1 ts/ha) and then the control (12.7 ts/ha).

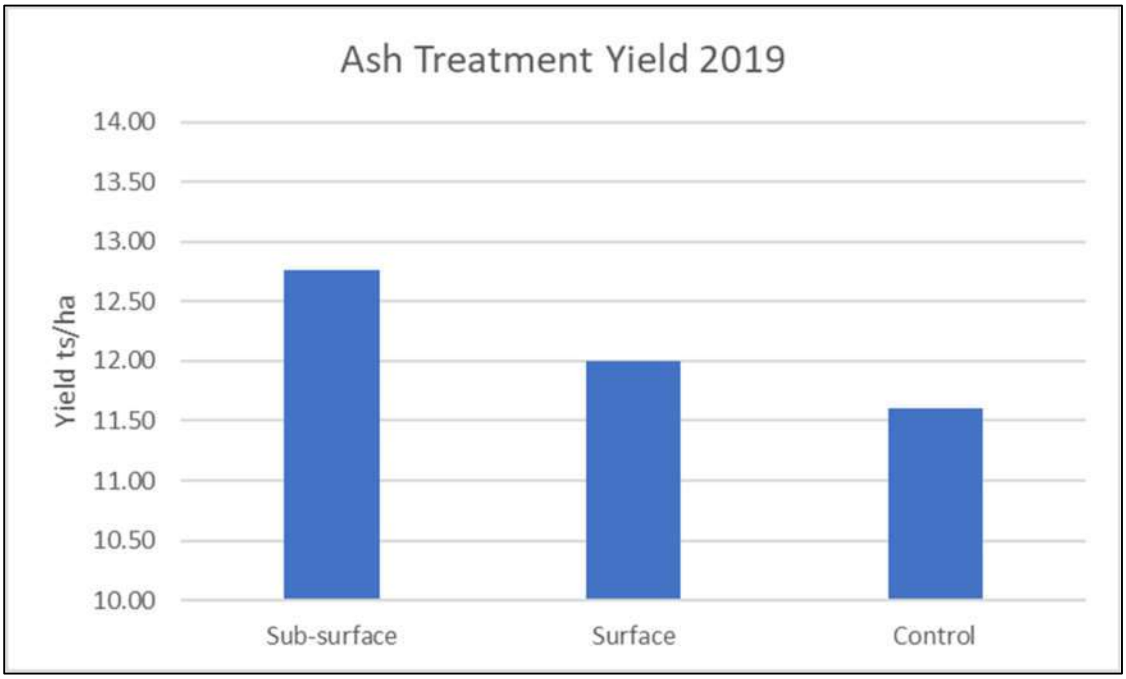


Figure 18 Ash trial sugarcane yield 2019

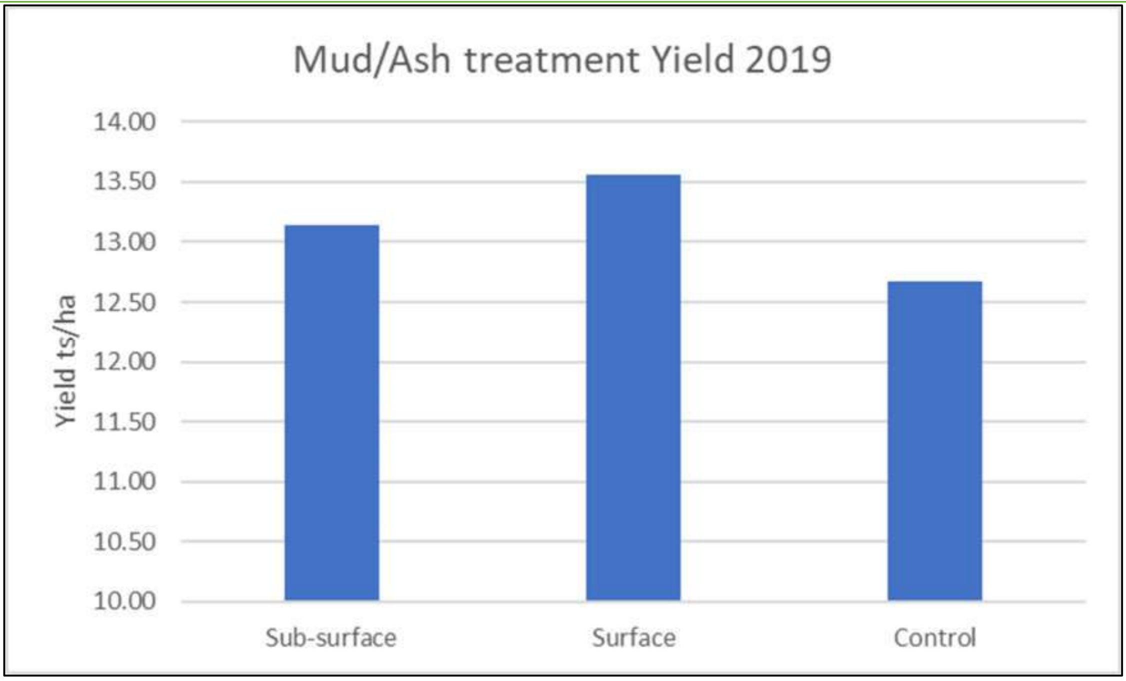


Figure 19 Mud/Ash trial sugarcane yield 2019

Biomass Analysis - 2020

Biomass samples collected at harvest (Figures 20 & 21) indicate the mud/ash treatment was able to access more Potassium than the ash only treatment, all other nutrient uptake was very similar.

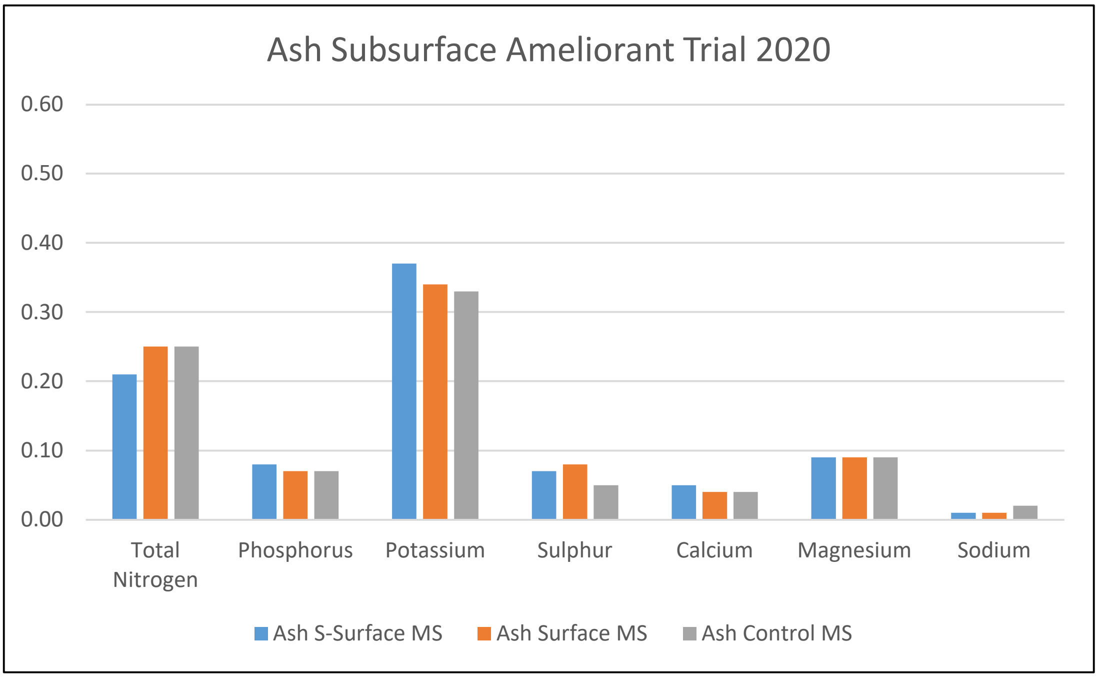


Figure 20 Ash Millable stick biomass percent nutrient analysis 2020

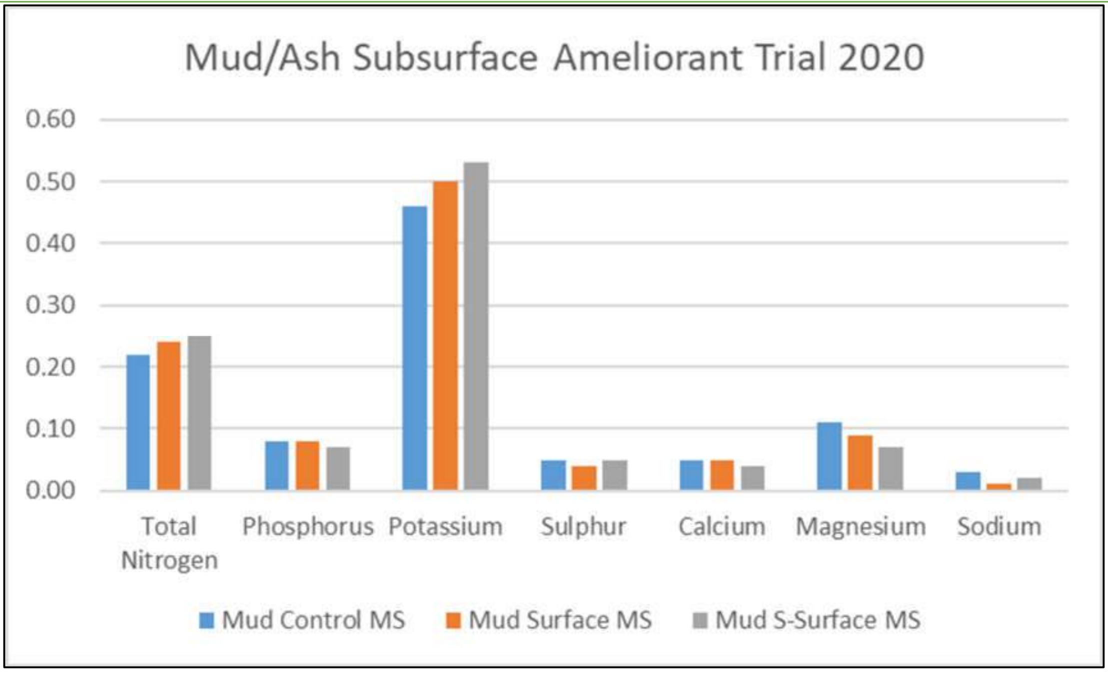


Figure 21 Mud/Ash Millable stick biomass percent nutrient analysis 2020

Harvest Results – 2020

Trials were harvested same day in mid-October as first ratoon SP80.

Both trials yielded the same average of 11.5 ts/ha, with ash treatments varying by 0.3 ts/ha and mud/ash treatments by 0.9 ts/ha (Figure 22).

The subsurface ash treatment was the highest yielding for the ash trial; however, the control and surface treatments of the mud/ash trial were better performing, with the mud/ash subsurface treatment effecting the average yield of this treatment with the lowest yield of 11 ts/ha.

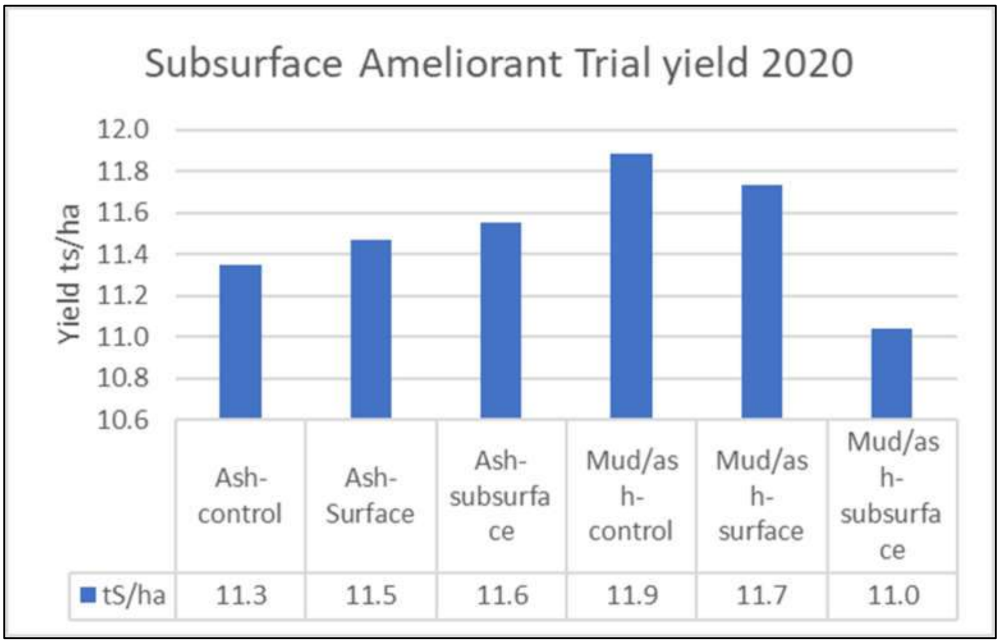


Figure 22 Sugarcane yield for both Ash and Mud/Ash treatments 2020

Conclusions and comments

Ash Trial

The year one (plant cane) results of ash application to sodic soils clearly demonstrates a benefit. Treated sites yielded higher than non-treated sites, with deeper application of sub-surface ash yielding higher than the surface applied treatment (Figure 18).

The results of the second year (1st ratoon) did not demonstrate a significant yield difference between treatments (Figure 22), though the subsurface application was the highest yielding. These results seem to justify the additional resources required to apply subsurface ash for yield and nutrient loss risk reduction benefits.

Sodic soils often respond well to cultivation and produce reasonable yields in plant cane, as demonstrated in this trial by an average of 12.1 ts/ha (Figure 18), though will likely produce lower yields in first ratoons when the benefits of cultivation pass (i.e., aeration), as demonstrated by a reduced average yield of 11.5 ts/ha (Figure 22) in year two of the trial. Ash is generally a long-term ameliorant meaning that soil structure will often improve with time. It is expected that as soil structure of the treated areas improves (i.e., tilth & friability), yield will be increased in later ratoons.

Mud/Ash Trial

The additional nutrients in the mud/ash mix treatment over the control assisted the plant cane to increase yield in year one. This initial benefit has diminished with time and the control was the better yielding treatment in the second year (1st ratoon, Figures 19 & 22). The yield difference between treatments is minimal at this stage of the trial. Continuation of this trend in subsequent ratoons is needed before drawing a definitive conclusion, however the grower understands the long-term benefits to the crop and water quality of subsurface placement of nutrients.

The grower is surprised in the mud/ash result of the first ratoon, however, the minor difference between yield will not result in any changes to current management practice. The small reduction in yield from plant to first ratoon of 0.6 ts/ha is consider by the grower to be within normal yield variation. The grower does expect the subsurface applied products to gradually improve soil health and is taking a long-term view towards soil health.

Advantages of this Practice Change:

Good soil structure helps provide aeration, water infiltration, moisture management (especially irrigation) and nutrient cycling and supply. It minimises pests and diseases, reduces surface run-off into catchments and provides for greater resilience in extreme weather. Nitrogen (N) loss from denitrification is decreased when these types of soils are optimised to increase populations and diversity of soil biology that convert “free” soil N into a form readily available to the sugarcane crop. This is the process of mineralisation.

Disadvantages of this Practice Change:

Sub-surface application does require additional labour and equipment. Cost benefit analysis should include savings of reduced N inputs for the life of the crop and regulatory compliance.

Will you be using this practice in the future:

This practice has demonstratable yield benefits as well as practical advantages in improved nutrient management. Where practical, it is the future intention of John and Phil to continue this program across the whole farm.

% of farm you would be confident to use this practice: 100%