SRA Grower Group Innovation Project

Understanding the effect of harvester speed on subsequent ratoon performance in the Burdekin: final report 2014/092

SRA Project Code	**2014/092**		
Project Title	Understanding the effect of harvester speed on subsequent ratoon performance in the Burdekin		
Group name	Burdekin Productivity Services Ltd		
Chief Investigator(s)	Rob Milla		
Project Objectives	• Quantify the effect of various harvester speeds on ratoonability and subsequent yield through shoot and stool counts and crop yield • Provide growers and industry with information on the cost benefit or penalty of a range of harvester speeds between 6 and 12 km/hr • Engage with grower groups and harvesting contractors to discuss the implications of a change in speed of harvesters – ensure that growers are present during project activities such as harvesting, shoot and stool counts. • Explore how harvester speed affects the subsequent crop performance on different soil types and varieties		
Milestone Number	8		
Milestone Due Date	30 May 2017	**Date submitted**	30/5/2017
Reason for delay (if relevant)			
Milestone Title	Third year data analysis and final report		
Success in achieving the milestone	☒ Completely Achieved ☐ Partially Achieved ☐ Not Achieved		
Will the project be completed on the current milestone timetable?	☒ YES ☐ NO (If NO, provide an explanation on how the project will be delivered within Section 6)		

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PART A

Section 1: Abstract

In 2014 six harvester speed trials were established in the Burdekin to investigate the effect of harvester speed on crop yields and subsequent ratooning, and the economics associated with harvesting at different speeds. These trials came about after discussions with growers identified harvester damage as a major cause of yield loss in ratoons. The trials compared the recommended best practice harvesting speed of 7-8 km/h to lower speeds (5-6 km/h) and higher speeds (9 km/h or higher).

The trials commenced in plant cane blocks, and concluded with the second ratoon harvest in 2016. Statistical analysis of the crop yields and changes in yield generally found no correlation between harvester speed and yield or the changes in yield from one year to the next. The only significant effects were noted in the change in yield in between the first and second ratoon crops, at sites 1 and 5. However, at both of these sites there were issues with the irrigation management which have affected the overall yield and potentially compromised the results.

The economic analysis showed that harvesting costs initially decrease as speed increases from a very low speed (5-6 km/h) up to around 9 km/h. Above 9 km/h the costs increased in some cases and decreased in others.

At the conclusion of the project there has been no obvious effect of harvester speed on crop yield or ratooning. There are some trends in the economic analyses, but these are not consistent when the harvesting speed is greater than 9 km/h. This suggests that while growers perceive harvesting speed to be the major factor affecting yields and ratooning, other components of the farming system can have as great an, or greater, effect than harvesting. It also demonstrates the difficulty of isolating and testing the influence of one part of the farming system on yield.

Section 2: Milestone Achievement

Collation of data and statistical analyses

The infield data collection has been completed for the five sites that were harvested in 2016. This included harvest data – yield and ccs – economic data, and post-harvest shoot, stool and gap counts at four weeks after harvest.

In the second ratoon harvest the treatment speeds were the same as the first ratoon harvest which will allow direct comparisons to be made, unlike between plant and first ratoon where some treatment changes were made. To account for changes in the treatment speeds between the plant and first ratoon crops the treatments have been grouped as Low (5-6 km/h), BMP (7-8 km/h), Moderate (9-10 km/h) and High (11 km/h). At sites 4 and 5, the lowest speed in the plant crop became the highest speed in the next crop.

Harvester speed had no effect on the crop yield in either the plant or first ratoon crops. In the second ratoon the different harvester speeds again had no obvious impact on crop yield with minimal variation in yields between treatments (Table 1). Where variation is obvious, it is mostly related to infield variability and has been noticed in the previous two harvests. Figure 1 shows the yield for each plot at site 2 over the three years of the project and clearly demonstrates that yields at this site are more related to block variability (in this case changes in soil type) than to the treatment. This trend is repeated at the other sites (Appendix 1).

In the 2016 harvest some yield variability, that is not related to underlying block variability can be seen at sites 1 and 5. Further investigation shows that this variability can probably be attributed to irrigation management. At site 1, plot 9 had one less irrigation, while at site 5 there were problems with water reaching the end of the field in plots 1, 5, 8 and 9.

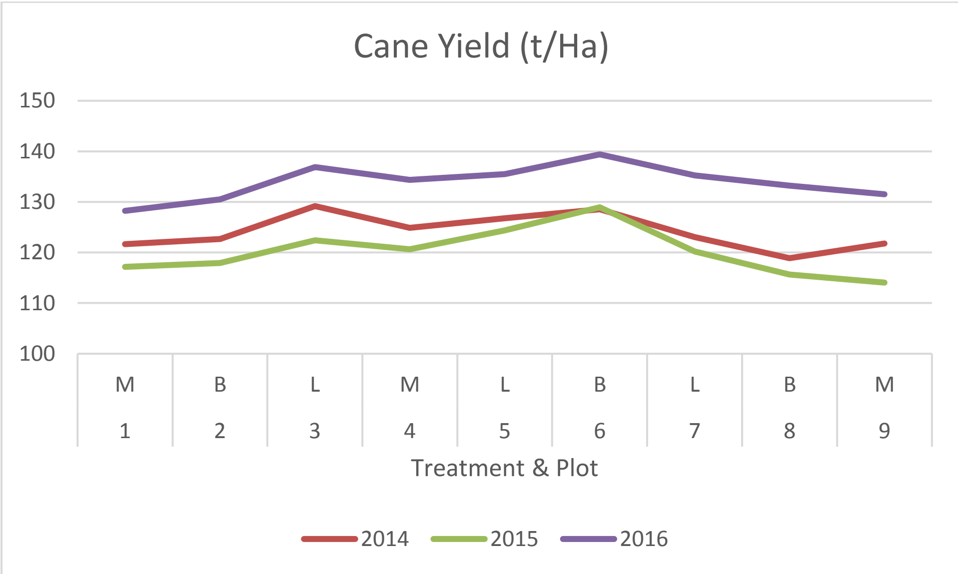


Figure 1. Cane yield per plot at site 2 over the three years of the project

The statistical analyses confirms the initial impression from the raw data (Table 2). That is, that harvester speed has had significant effect on cane yield or CCS. The only significant effects were seen in the change of yield between 2015 and 2016 at sites 1 and 5. At these sites the statistical analyses would suggest that faster harvesting speeds result in higher yields. However it is highly likely that the irrigation issues at these sites have confounded the results. This is especially true at site 5 where all the 7 km/h plots were affected by poor irrigation. At site 1 the analysis of cane yield disregarded the yield from the final plot (where one watering was missed), but this value was included in the analysis of sugar yield and probably explains why there has been a treatment effect for tonnes of sugar at that site but no treatment effect on cane yield or CCS.

This series of trials has found no strong link between harvesting speed and yield in the following crop, but the maximum harvester speeds in the trials could be considered to be reasonably conservative. Anecdotal reports suggest that some machines are regularly operated at much higher speeds, but this is difficult to confirm. Discussions with the drivers who assisted with the trial ascertained that for most of them, an operating speed of around 9-10 km/h, depending on crop size, was the most comfortable. At this speed the machine was relatively stable and there were minimal delays waiting for haulouts. In larger crops and the dual row blocks (sites 1 and 2) speeds would generally be lower because of the volume of material going through the machine. While there could be value in trialling the effect of higher speeds e.g. 15 km/h it is unlikely that suitable co-operators would be found.

Table 1. 2016 Harvest results

Site 1	Plot	Treatment	Tonnes Cane/Ha	Tonnes Sugar/Ha
Kovacich BRIA Q208	1	7	108	17.5
	2	5	106	17.3
	3	7	105	17.3
	4	5	107	17.3
	5	7	110	17.6
	6	7	113	17.9
	7	7	112	17.8
	8	7	112	18.2
	9	5	104	17.1
Site 2	**Plot**	**Treatment**	**Tonnes Cane/Ha**	**Tonnes Sugar/Ha**
Dal Santo BRIA Q183	1	10	128	21.2
	2	8	131	21.6
	3	6	137	22.7
	4	10	134	22.2
	5	6	136	22.1
	6	8	139	23.3
	7	6	135	22.3
	8	8	133	21.5
	9	10	131	22.2
Site 4	**Plot**	**Treatment**	**Tonnes Cane/Ha**	**Tonnes Sugar/Ha**
Curro BRIA Q183	1	11	106	13.9
	2	9	108	14.8
	3	7	105	14.0
	4	11	105	14.5
	5	9	106	14.5
	6	7	104	14.3
	7	11	107	14.5
	8	9	107	14.7
	9	7	107	14.8
Site 5	**Plot**	**Treatment**	**Tonnes Cane/Ha**	**Tonnes Sugar/Ha**
Farr Delta Q208	1	7	106	15.6
	2	11	117	17.4
	3	9	117	18.5
	4	9	101	15.7
	5	7	99	14.6
	6	11	101	14.7
	7	11	108	16.0
	8	9	91	14.0
	9	7	89	13.9
Site 6	**Plot**	**Treatment**	**Tonnes Cane/Ha**	**Tonnes Sugar/Ha**
Galea BRIA Q208	1	11	124	19.5
	2	7	123	19.1
	3	9	127	19.8
	4	9	121	18.8
	5	11	125	19.3
	6	7	119	18.4
	7	11	123	19.0
	8	9	124	19.2
	9	7	123	19.0

Values in red are plots where irrigation problems have affected yield.

Table 2. Summary of the statistical analyses from the 2016 harvest

Site	Tonnes Cane/Ha	CCS	Change in Yield	Tonnes Sugar/Ha
1 – Kovacich	Not significant	Not significant	Significant 7(a), 5(b)	Significant 7(a), 5(b)
2 – Dal Santo	Not significant	Not significant	Not significant	Not significant
4 – Curro	Not significant	Not significant	Not significant	Not significant
5 – Farr	Not significant	Not significant	Significant 11(a), 9(ab), 7(b)	Not significant
6 - Galea	Not significant	Not significant	Not significant	Not significant

Shoot, stool and gap counts

All of the shoot and gap counts have now been completed (Table 3). These counts were on 10 m plots that had been marked out immediately before the first (2014) harvest. In each replicate there were four count plots, two at the top end of the block and the others at the bottom. At all but site 3, these plots were in rows 2 and 3 of the replicate. At site 3 the replicates were six rows wide and the counts were done in rows 3 and 4.

For the final harvest there was only one count, at one month after harvest; compared to the plant and first ratoon crops where counts were conducted at 1, 3 and 6 months post-harvest. At site 1, most of the trial, except for the last 3 plots, was ploughed out immediately after harvest. At this site the post-harvest counts are an average of 2 plots for the 7 km/h treatment, and the actual count for the 5 km/h treatment. At all the other sites the average is of the 3 replicates in each treatment.

While there has been no statistical analysis conducted there does not appear to be any correlation between the number of shoots or gaps and either harvester speed or crop yield. The most obvious factors affecting the counts are the time of harvest and row configuration. Site 4 was harvested in early August, compared to the others which were harvested in November and December, and the influence of cooler weather on emergence is obvious. The shoot counts for sites 1 and 2 also look low, but these are dual row blocks and the counts were only done on a single row.

Table 3. 2016 Post-harvest shoot, stool and gap counts

Site	Harvester Speed	Average Shoots	Average Stools	Average Gaps
1 – Kovacich Q208	5	171	14	4.5
	7	174	12	5.6
2 – Dal Santo Q183	6	157	13	4.3
	8	131	12	5.0
	10	161	13	4.8
4 – Curro Q183	7	70	14	5.8
	9	79	13	4.6
	11	81	14	5.7
5 – Farr Q208	7	251	14	2.8
	9	259	15	2.3
	11	264	15	3.1
6 – Galea Q208	7	243	14	2.0
	9	244	13	3.4
	11	269	15	1.2

Over the term of the project the stool counts have been considered to be the least accurate because they relied the most on the assessor's interpretation of where one stool ended and the next started. The shoot and gap counts were more quantitative and should be more accurate. The shoot counts are not considered to be particularly useful measure of harvester damage as they appear to be more influenced by variety and time of year than by treatment.

The gap counts were expected to increase with increasing harvester speed because the feedback from growers is that as the machine speed increases it pulls out more cane, thus increasing the number of gaps and decreasing the yield. The results from the trials showed no strong correlation between harvesting speed and gaps (Table 4). In fact, despite the fact they were considered to be the easiest to accurately measure, the gap counts were highly inconsistent over time. The differences between the one and three month counts are probably because cane will have continued to emerge, possibly reducing the number of gaps. The variations between three and six months could be caused by some stools dying out, the Q183 in particular had a lot of shoot death in that time frame at all sites, or could be count error due to trying to count in large crops that were beginning to lodge.

Table 4. Average number of gaps per treatment over the whole project

Site	Speed	2014 Harvest				2015 Harvest			2016
		Pre	1 mth	3 mth	6 mth	1 mth	3 mth	6 mth	1 mth
Kovacich	Low	4.8	4.7	3.8	3.8	4.0	3.7	3.8	4.5
	BMP	4.5	4.8	3.6	3.6	3.9	3.6	4.6	5.6
Dal Santo	Low	1.7	2.5	1.8	2.8	6.4	2.5	2.9	4.3
	BMP	1.8	3.1	2.3	2.7	7.0	3.0	3.0	5.0
	Moderate	2.3	3.3	2.8	2.9	6.6	3.4	3.2	4.8
Bugeja	Low	0.6	0.4	0.0	0.2	0.3	0.2	0.7	
	BMP	0.3	0.4	0.1	0.3	0.8	0.3	1.2	
	Moderate	1.0	0.6	0.5	0.4	0.6	0.3	0.9	
Curro	BMP	2.2	3.4	2.1	1.9	4.4	2.5	2.5	5.8
	Moderate	0.8	2.5	1.0	1.6	2.8	1.5	1.8	4.6
	Low-High	2.5	3.8	2.3	2.3	3.9	2.5	2.8	5.7
Farr	BMP	0.9	1.6	1.0	1.7	2.2	1.7	2.9	2.8
	Moderate	1.0	1.7	1.0	1.5	1.8	1.5	2.3	2.3
	Low-High	1.4	2.6	1.3	1.7	2.5	2.1	2.4	3.1
Galea	BMP	1.6	2.8	2.5	2.6	3.4	2.0		2.2
	Moderate	1.8	3.0	2.3	2.7	2.9	2.5		2.4
	High	0.8	1.5	1.3	1.3	1.8	1.3		2.1

Economic analysis

As in the previous two seasons a range of numbers were collected and provided to DAF economists for economic modelling and analysis. Not all the required information could be collected and some assumptions have been made regarding fuel use and the cost of fuel. Wages costs have also been assumed to be the same for all groups (Table 5). Engine and elevator hours, the time taken to harvest each plot and to fill and empty haulouts were all recorded at harvest

Table 5. Economic model assumptions

	Fuel use in motion (L/h)							Fuel use idle (L/h)	Wages ($/t)
	5 km/h	6 km/h	7 km/h	8 km/h	9 km/h	10 km/h	11 km/h		
Harvester	58.59	59.85	61.77	64.35	67.59	71.50	76.06	40	0.70
Haulout	30							10	0.50

The economic analysis of harvesting costs for the 2016 season followed a similar trend to the previous two crops. At each site the costs initially decreased with increasing speed. Above 9 km/h there was no consistency in the results. At some sites the costs continued to decrease while at others they increased (Table 6).

The average harvesting costs over the life of the project show a decrease in costs when moving from a low speed of 5-6 km/h to the BMP speed of 7-8 km/h. Beyond this the costs increased at some sites, while decreasing at others (Figure 2).

Table 6. Harvesting costs ($/Ha) 2016

Harvester Speed	1 – Kovacich	2 – Dal Santo	4 – Curro	5 – Farr	6 - Galea
5	$482.72				
6		$429.37			
7	$479.25		$371.81	$344.25	$402.41
8		$427.23			
9			$367.08	$331.44	$384.82
10		$428.03			
11			$379.74	$325.44	$375.76

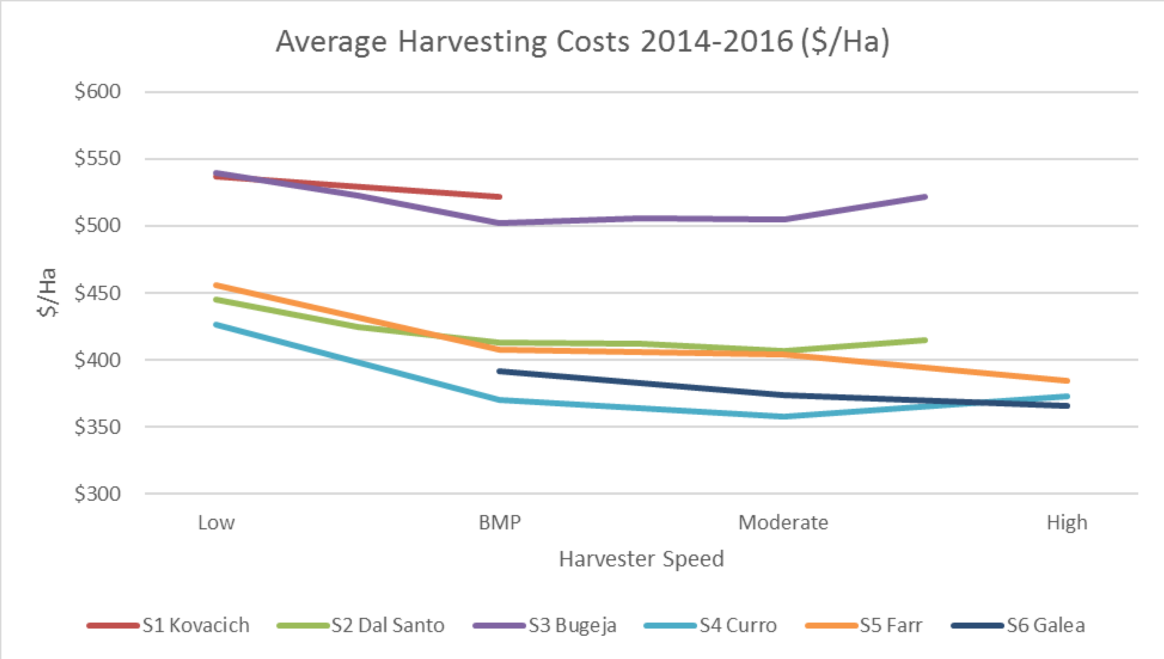


Figure 2. Average harvesting costs 2014-2016 ($/Ha)

Section 3: Intellectual Property (IP) and Confidentiality

Not applicable.

Section 4: Communication and Adoption of Outputs

The second year results and analyses were included in the June 2016 edition of the BPS newsletter which is distributed to all growers and a number of industry personnel (Attachment 1). A summary of the final year's results and the overall project outcomes will be included in the June 2017 newsletter.

The project results were due to be discussed at the shed meetings held in February and March 2017, however other topics were prioritised. BPS is currently collating the results of all trials into a trial booklet that will be distributed as a hard copy to growers (Attachment 2). It is planned that this will be delivered to growers before the BPS AGM in August.

The trial results have not confirmed the original hypothesis, i.e. that harvester damage is the main cause of yield decline. This makes it difficult to make recommendations on what is the appropriate harvester speed. It is recognised that harvester speed is only one component of the puzzle. Other factors that are known to affect harvesting performance are: operator experience, sharpness of basecutter blades, crop presentation, and basecutter depth.

Section 5: Environmental Impact

Not applicable.

Section 6: Project Variations

Personnel Changes

Not applicable

Proposed variations

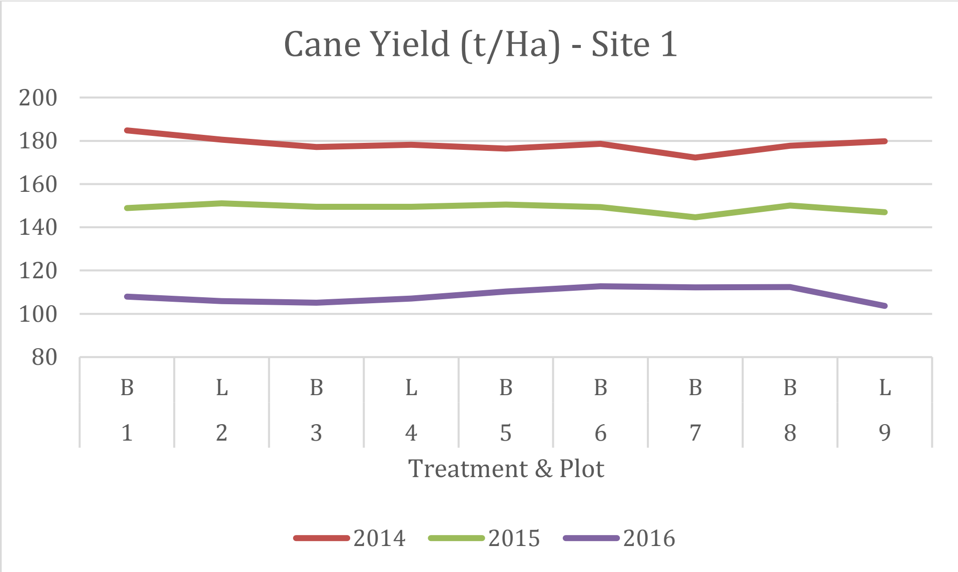
Not applicable

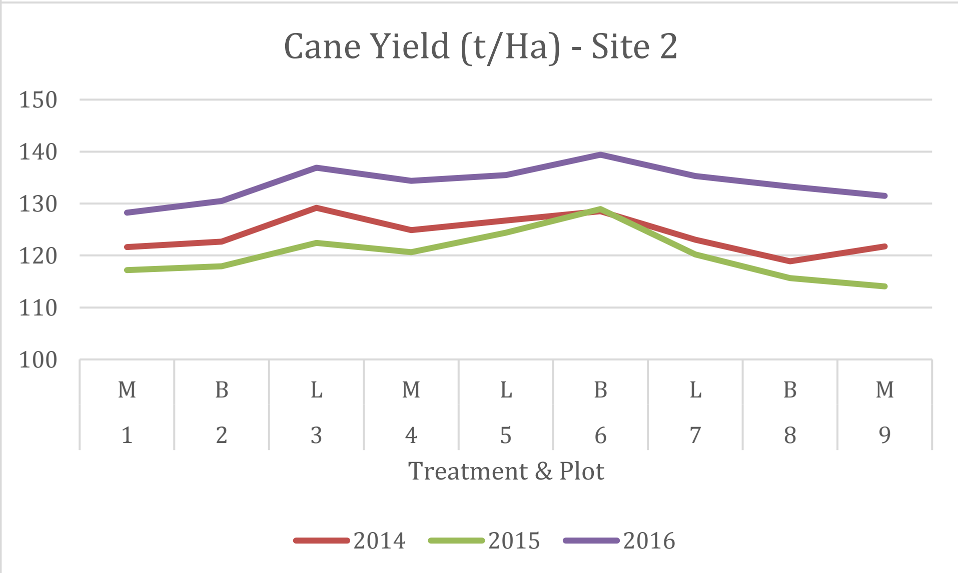
Other Matters

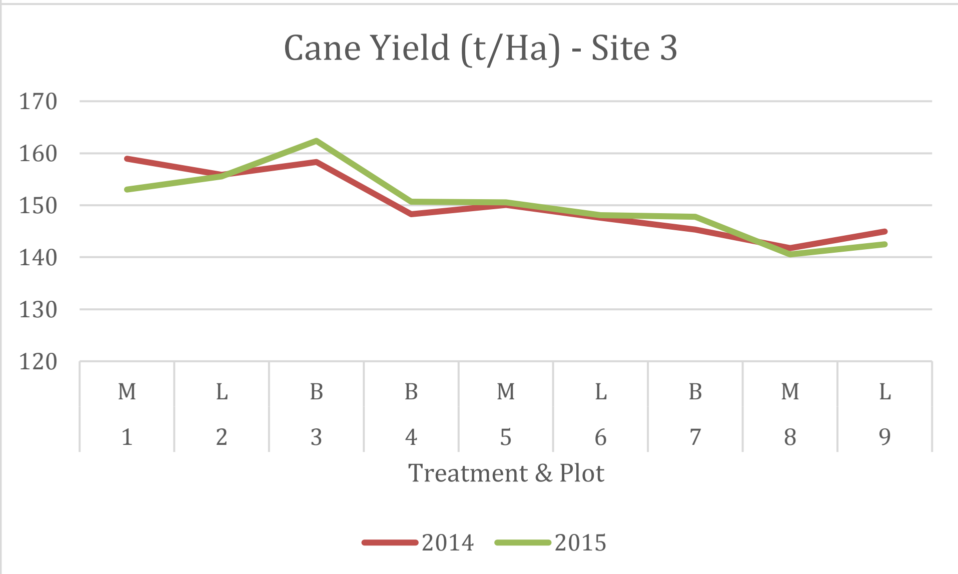
Not applicable

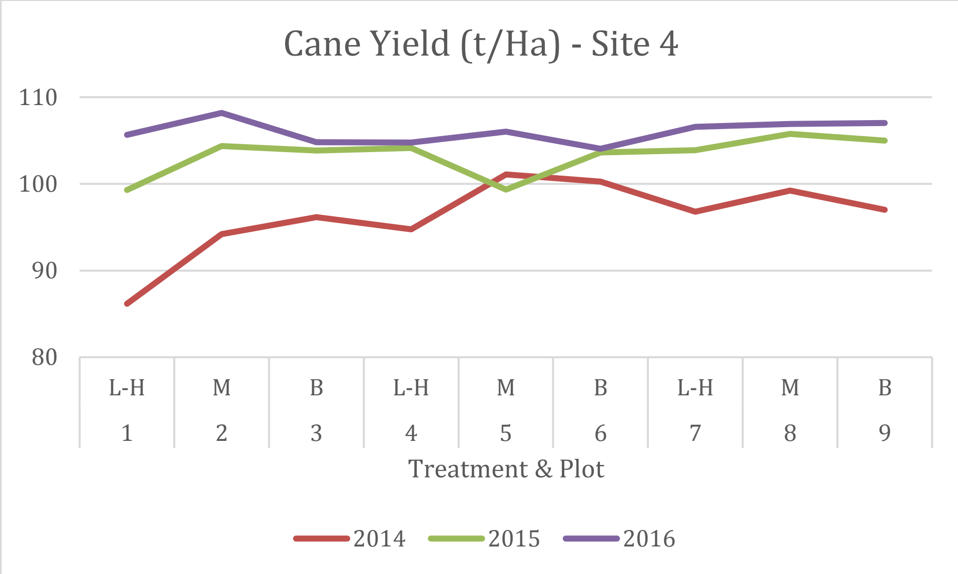
Appendix 1 Cane yield per plot at each site for each year of the project

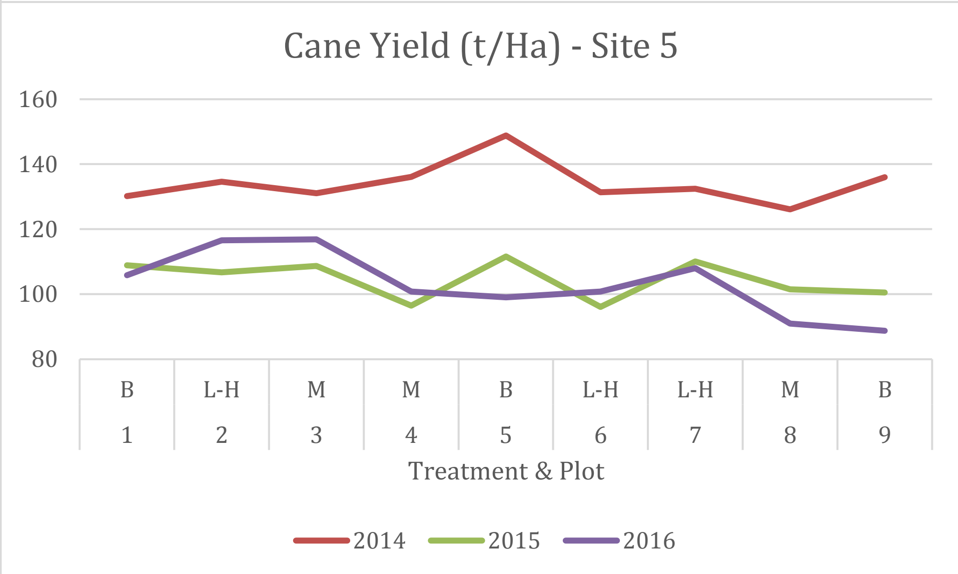
Yield variations follow the same trends over time, suggesting that block variability is the main cause of yield variation, not the treatment

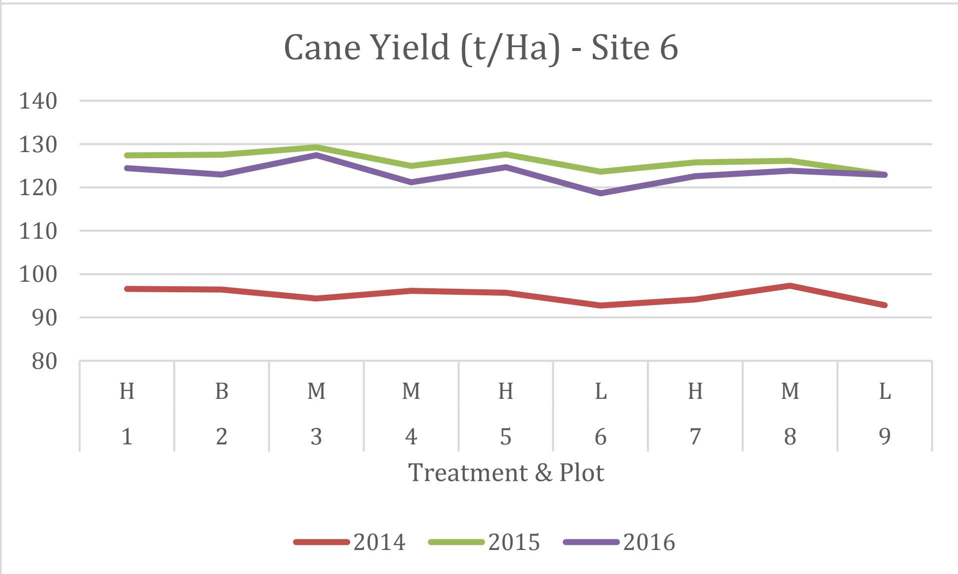







Cane Yield (t/Ha) - Site 4
110
100
90
80
L-H M B L-H M B L-H M B
1 2 3 4 5 6 7 8 9
Treatment & Plot
2014 2015 2016


Cane Yield (t/Ha) - Site 5
160
140
120
100
80
B L-H M M B L-H L-H M B
1 2 3 4 5 6 7 8 9
Treatment & Plot
2014 2015 2016


Cane Yield (t/Ha) - Site 6
140
130
120
110
100
90
80
H B M M H L H M L
1 2 3 4 5 6 7 8 9
Treatment & Plot
2014 2015 2016