Cropping solutions for Burdekin farming systems

Final economic analysis 2012-2016

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Queensland Government

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1 Introduction

Boasting over 80,000 hectares of irrigated farming land, the Lower Burdekin region is a valuable agricultural resource for the Australian economy. Sugarcane is the most common crop grown in the region with production supporting the operation of four sugarcane mills that produce around one quarter of Australia's sugar (CANEGROWERS, 2016). However, fluctuations in the price of sugar, together with ebbs and flows in the price of other locally grown crops, does have some influence over the amount of land planted with particular crops. For example, a recent spike in the price of mungbeans has seen some growers shift to including mungbeans into their rotations, while rice is starting to gain some popularity in the region.

One particular opportunity available to Burdekin sugarcane growers is the inclusion of fallow crops into their rotations. Past research conducted by the Sugar Yield Decline Joint Venture found that yield decline is caused by a number of factors, one of which is soil degradation resulting from long-term monoculture (Garside et al., 2005). This discovery recognises the importance of fallow cropping for sugarcane growers to support soil health. Fallow cropping also enables growers to diversify their income stream, thus decreasing their reliance on income from a single commodity.

Nevertheless, farmers may be reluctant to include other crops into their rotations without access to locally available agronomic and extension support, suitable processing facilities, supply chain infrastructure and marketing organisations. Another critical aspect is sound understanding of the likely production and economic impacts on their farming businesses. While the agronomic results from this research study have been published in a separate paper, this report complements those results by examining the relative profitability of the different planting times and fallow crop sequences based on the production results generated by the different treatments. The overarching aim of this report is to help farmers, and other stakeholders, to make better informed decisions by providing them with information about the relative profitability and risk of different planting times and fallow crop sequences.

The two experiments examined in this report were established on a commercial farm in Mona Park (Burdekin) during late 2011. Experiment A compares three single crop fallow treatments and two extended fallow crop treatments, while Experiment B compares bare and cowpea fallow treatments at different cane planting times. The trials have benefitted from the technical expertise of a range of project partners including the Department of Agriculture and Fisheries, Sugar Research Australia and the Commonwealth Scientific and Industrial Research Organisation, including strong collaboration with farmers and other stakeholders that have had valuable input into the trials.

2 Methodology and Parameters

The objective of this economic analysis is to compare the profitability and risk of each treatment in the respective trials. In order to quantify the net economic benefit from each treatment, the analysis calculates gross revenue and deducts the variable[1] costs associated with growing and harvesting the crop to attain the gross margin per hectare. Fixed costs are assumed to remain the same between all of the treatments given that most farmers in the region have access to contractors for fallow crop operations (e.g. planting, harvesting and transporting), while variable labour costs have been factored into the gross margins. The gross margin for each treatment is compared for each sugarcane crop class and annual fallow period[2] over the crop cycle. In addition, other fallow crops have been

[1] For example, expenses on irrigation, fertiliser, chemicals, machinery operations and harvesting expenses.
[2] If there are two fallow crops within one year then the gross margins are added together.

substituted for cowpeas in Experiment B to give an indication of the relative profitability of a range of cash crops associated with each planting time[3].

2.1 Land preparation costs

At the end of the sugarcane crop cycle, it is routine for Burdekin growers that furrow irrigate to cultivate and laser level their paddocks before planting. Another common practice on farms within the Burdekin-Haughton Water Supply Scheme area is to apply Gypsum during the fallow period. Table 1 lists the land preparation practices, and their associated costs, that are considered standard practice at the farm site.

Table 1: Land preparation costs, $/ha.

	$/ha
Laser levelling	$396
Gypsum	$750
Cultivation	$311
Bedforming	$41
Total costs ($/ha)	$1,497

2.2 Sugarcane growing costs and gross margin calculation

The Burdekin cane payment formula[4] was used to calculate gross revenue for the sugarcane crops, while subtracting the cost of levies. The standard management practices at the farm site were used to calculate the variable costs for growing sugarcane. Table 2 lists the variable costs for both plant and ratoon sugarcane crops. These costs were used for all the sugarcane gross margin calculations. Irrigation costs were determined by the quantity of irrigation water applied and the number of irrigations over the crop growing period.

Table 2: Variable growing costs for sugarcane, $/ha.

	Plant crop	Ratoon crops
Cultivation	$94	$63
Planting	$855	$0
Crop nutrition	$599	$473
Weed, pest & disease control	$122	$91
Irrigation	$593	$445
Variable costs - excl. harvesting ($/ha)	$2,263	$1,072

2.3 Fallow crop gross margins

In order to compare the relative profitability of each fallow crop treatment, it is imperative to determine the net benefit generated by each type of fallow crop. The primary function of the fallow crops in the trial was to investigate and compare the subsequent sugarcane production from each of the fallow crop treatments. Because of the limitations imposed by the characteristics of the trial[5], the fallow

[3] Cowpeas were planted as a surrogate for a range of cash crops to mimic soil health benefits, etc.
[4] Burdekin cane payment formula = sugar price x 0.009 x (CCS – 4) + 0.662.
[5] For example, a significant proportion of the cotton crop was ruined by spray drift from a neighbouring paddock. Also, the inter-planting of a variety of different crops influenced the type and frequency of pests that were affecting crop development. The implements used to carry out operations were not of the same standard as those conventionally used for commercial farming operations.

crops did not produce yields that are representative of those produced by Burdekin farmers in a commercial setting. Consequently, the economic analysis used crop production and farm operational data that are representative of commercially grown crops in the Burdekin, specific to the area (e.g. soil type and other characteristics) where possible. This method enables a realistic and equitable comparison to be made between each treatment.

The crop gross margins used for the analysis are shown in Table 3. The on-farm price was determined by taking the mean price for each crop (based on market prices and graded quality) and subtracting freight costs, grading costs, processing costs, drying costs, ginning costs and levies. The yields and variable costs used to calculate the gross margins are based on information provided by a number of technical specialists and farmers operating in the Burdekin region. Prices are based on five-year mean prices. Land preparation costs (see Table 1) have been excluded from the gross margin figures in Table 3, as these are part of the broader evaluation including the sugarcane farming system.

Table 3: Fallow crop gross margins, $/ha.

	Mung beans	Soy beans	Cotton	Maize	Cow peas	Bare	PORP
Yield (t/ha, bales/ha)	1.8	4	8.3	9.5	0	0	0
On-farm price (mean, $/t)	$870	$475	$405	$277	0	0	0
On-farm revenue ($/ha)	$1,566	$1,900	$3,361	$2,633	$0	$0	$0
Planting ($/ha)	$123	$195	$147	$362	$161	$0	$0
Crop nutrition ($/ha)	$0	$0	$614	$639	$0	$0	$0
Weed & pest control ($/ha)	$168	$142	$201	$34	$37	$86	$0
Irrigation ($/ha)	$99	$148	$346	$346	$63	$0	$0
Pre-harvest spray & harvesting ($/ha)	$128	$148	$208	$120	$0	$0	$0
Other[6] ($/ha)	$50	$50	$733	$0	$118	$0	$0
Total variable costs[7] ($/ha)	$568	$683	$2,249	$1,501	$379	$86	$0
Gross margin ($/ha)	**$998**	**$1,217**	**$1,112**	**$1,132**	**-$379**	**-$86**	**$0**

2.4 Other parameters

A number of other parameters need to be estimated to carry out the economic analysis. The economic analysis uses the five-year mean net sugar price (2011-2015), while all input prices (e.g. fertiliser and chemical) have been sourced from local suppliers. Sugarcane production data that was collected for each treatment replicate during the trial was used to calculate sugarcane revenue. The following information outlines some assumptions required for the analysis:

- Sugar price = $424 per tonne of sugar
- Harvesting costs + levies = $8.11 per tonne of cane
- Input prices – sourced from local suppliers (2016)

[6] Includes agronomy fees (mung/soy/cotton), Bollgard licence fees (cotton), growth regulator costs (cotton) and the mulching and bedforming costs necessary to plant the next crop (cotton/cowpeas).
[7] Excluding costs used to calculate the on-farm price (freight and grading costs, and levies).

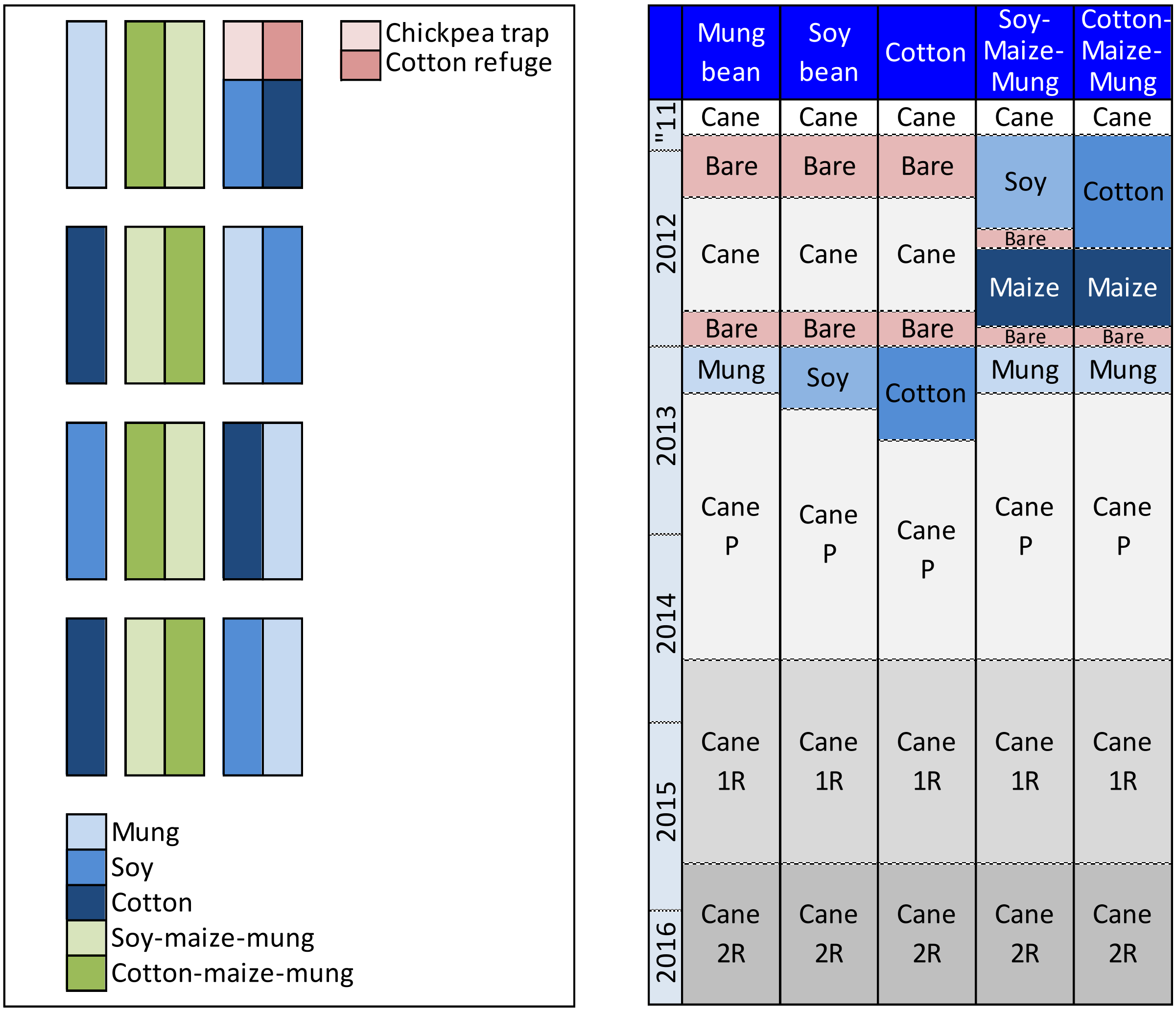
3 Experiment A – a comparison of short and extended fallow crop sequences (single- and multi-crop fallows)

This trial examines five different fallow crop treatments. Three of these have single crop fallows (mungbeans, soybeans and cotton) while two treatments have extended fallows with three consecutive fallow crops (1) Soybeans, maize and then mungbeans, and (2) Cotton, maize and then mungbeans. After the (last) fallow crops were harvested, they were planted with sugarcane to investigate the differences in sugarcane production after the fallow crop sequences.

3.1 Trial design and timeline

See Figure 1 (a) and (b) for the trial layout and timeline, respectively. The trial design consisted of a completely randomised small plot trial with five treatments and four replicates. Sugarcane production data has been collected up to, and including, the second ratoon crop. As specified with the use of genetically modified cotton, the trial site required a chickpea trap and a non-Bacillus Thuringiensis cotton refuge. For the single crop fallow treatments, a cane crop was planted in 2012 to mimic the conditions of a short fallow treatment after earthworks were carried out in order to establish the trial (headlands, plots, etc.).

Figure 1: Trial layout (a) and timeline (b).



In the next sections, the gross margins generated by the fallow crops are evaluated followed by a comparison of the gross margins for each of the plant and ratoon sugarcane crops. After that, the profitability of each treatment is compared over the crop cycle, which is followed by a risk analysis.

3.2 Fallow crop results

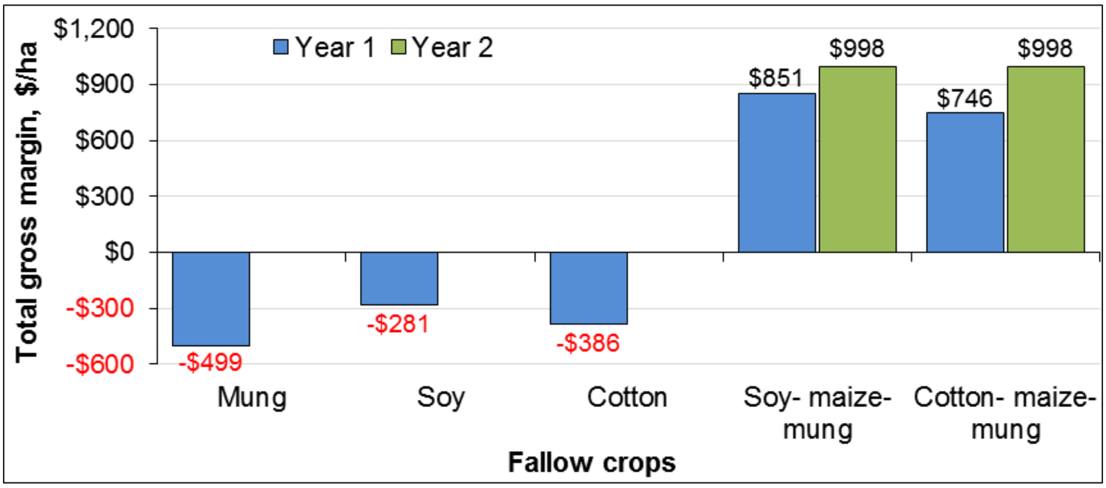
This section examines the gross margin outcomes for each fallow sequence scenario in Experiment A during their short or extended (one- or two-year) fallow periods. The total gross margin values include the land preparation costs that are incurred at the beginning of the crop cycle. For the extended fallow scenarios, gross margins generated within an annual period are added together. For example, the gross margins for the soybean and maize crops have been added together, while subtracting the land preparation costs, to calculate the total gross margin in year 1 for the 'soy-maize-mung' treatment. The year 2 cost for the same treatment is simply the mungbean gross margin.

Table 4 presents the gross margin for each fallow crop scenario. The year one total gross margin results for each single fallow crop scenario show that the crop gross margins are fully depleted by the land preparation costs. However, these costs are only endured once per sugarcane crop cycle (e.g. 5 years) and would be borne by the farmer regardless of whether the paddock was fallowed or not (e.g. bare fallow of plough-out replant). The crop gross margins for the extended fallow scenarios highlight the potential returns that might be available to some Burdekin sugarcane farmers. Figure 2 illustrates the total fallow gross margin for each cropping sequence.

Table 4: Fallow crop – costs and gross margin, $/ha.

Fallow crops	Mung	Soy	Cotton	Soy- maize-mung	Cotton- maize-mung
Fallow length	Short 5 months	Short 6 months	Short 8 months	Extended 16 months	Extended 16 months
Land preparation costs	-$1,497	-$1,497	-$1,497	-$1,497	-$1,497
Crop gross margin, year 1	$998	$1,217	$1,112	(soy) $1,217 (maize) $1,132	(cotton) $1,112 (maize) $1,132
Total gross margin, year 1	-$499	-$281	-$386	$851	$746
Crop gross margin, year 2	n/a	n/a	n/a	$998	$998
Total gross margin, year 2	n/a	n/a	n/a	$998	$998

Figure 2: Fallow crop gross margins.



3.3 Sugarcane crop results

Figures 3, 4 & 5 compare the gross margin results for each treatment in the plant crop, first ratoon, and second ratoon. An analysis of variance (ANOVA) was performed on the plant crop results, which found that the F-test was statistically significant at the 5 per cent significance level indicating a significant effect of treatment. Pairwise comparisons were consequently conducted for the five treatments using the 95 per cent LSD ($1,300). The 'soy-maize-mung' treatment was found to deliver a significantly higher gross margin than all of the single crop fallow treatments. ANOVA analyses were also undertaken on the first and second ratoon results, which found that the F-tests were not statistically significant.

An issue that needs mentioning is the cane yield production during the first ratoon crop. Biomass sample data showed that the extended fallow 'soy-maize-mung was yielding approximately 150 tonnes of cane per hectare (TCH) at 6-months of age and only grew another 20TCH over the following 6-month period because it was so heavily lodged. In contrast, the shorter fallow treatments were not yielding so highly at that age and gained significantly more tonnage over the following 6 months without being lodged. In conclusion, it is likely that lodging had an adverse impact on the quantity of cane yield harvested.

Figure 3: Plant crop gross margins. Error bars represent the 95% LSD.

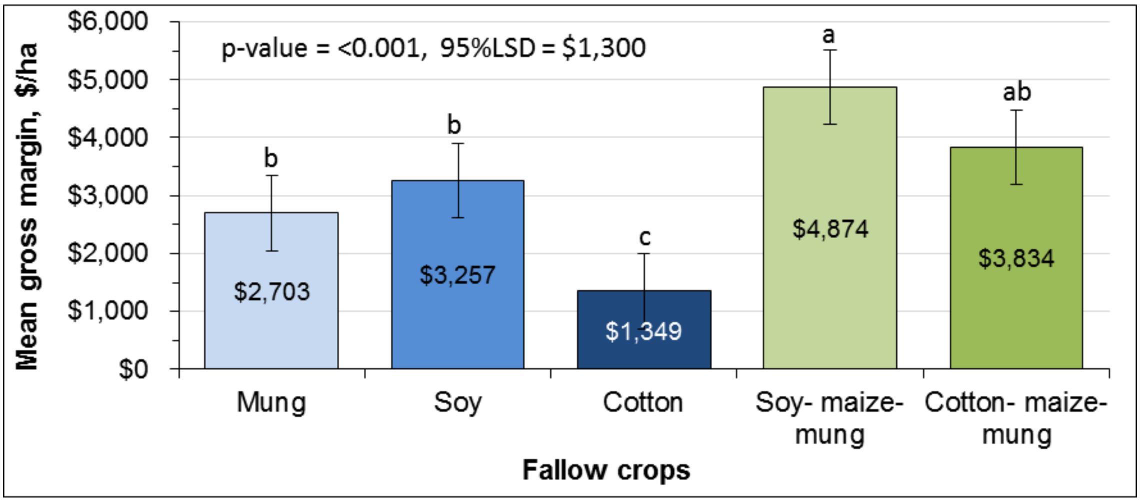


Figure 4: 1st ratoon crop gross margins. Error bars represent the 95% LSD.

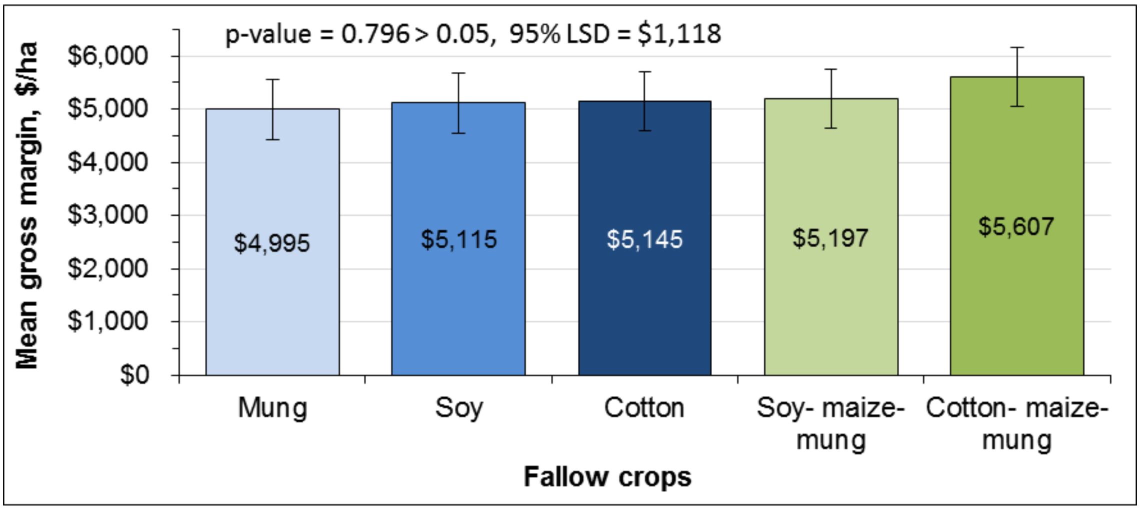
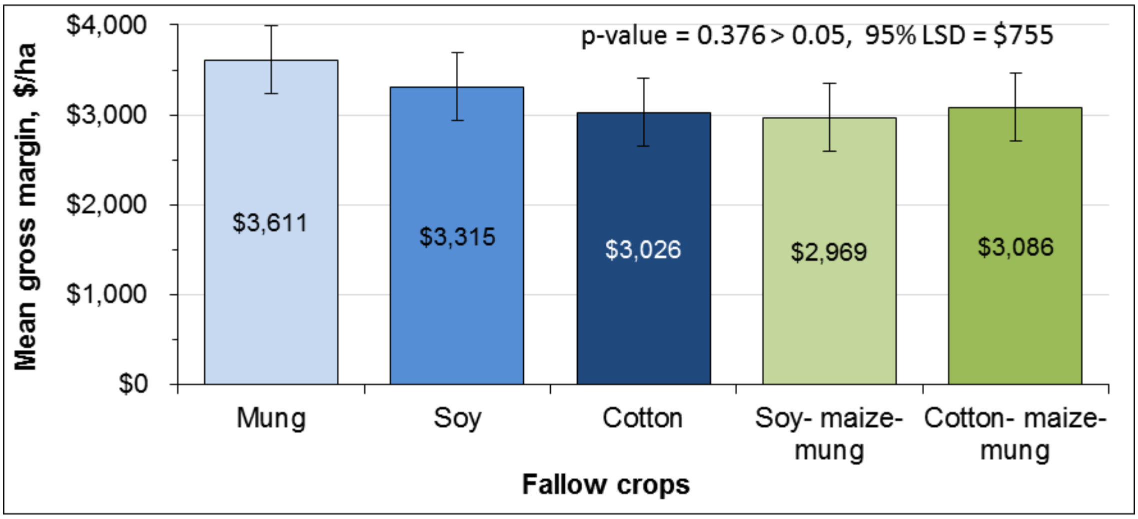


Figure 5: 2nd ratoon crop gross margins. Error bars represent the 95% LSD.



3.4 Performance over the crop cycle (including fallow crop GM)

Table 5 summarises the results from each crop to show the relative performance of each treatment over the crop cycle. The values in the row labelled 'Crop GMs – Fallow year 1' show the cumulative gross margin for each of the fallow crops produced (see Table 3) minus the land preparation costs that accrued before the fallow crops were planted (see Table 1). The values in the row below ('Crop GMs – Fallow year 2') show the gross margin for a mungbean crop, which was the last crop grown in the extended fallow treatments.

The bottom line of Table 5, as well as Figure 6, shows the mean gross margin produced by each treatment over the full crop cycle, which includes the fallow crops (two years for the extended fallow scenarios) and the sugarcane crops[8]. The ANOVA on the mean annual gross margin found a significant difference between the treatments (p=0.047). Pairwise comparisons using Fisher's unprotected 95% LSD suggest the mean annual gross margin for cotton is significantly less than all other treatments except 'mung'.

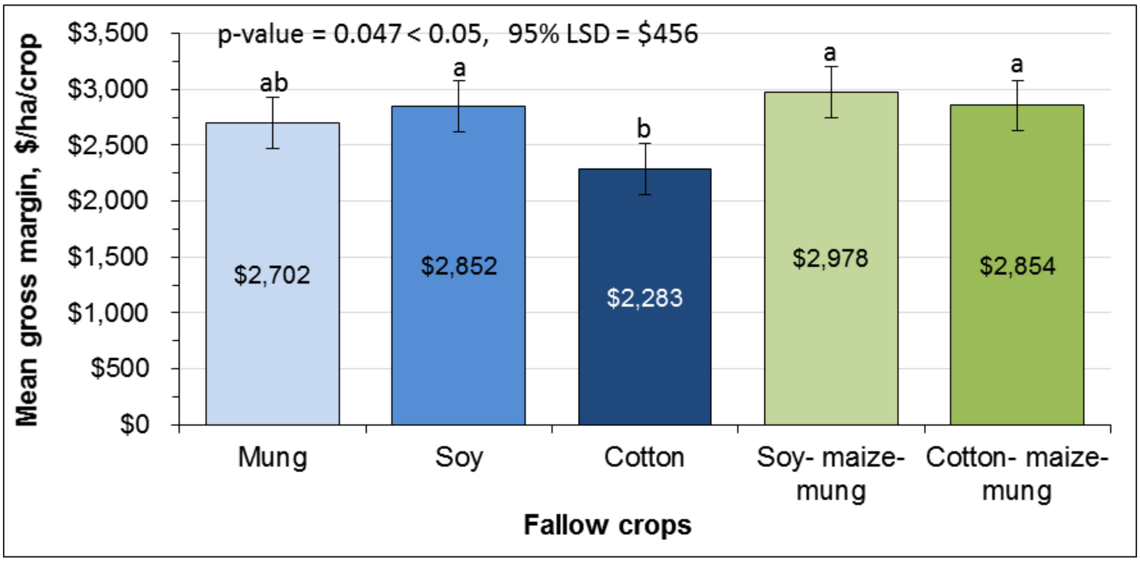
Table 5: Summary of results over the crop cycle, $/ha/crop.

Fallow crops	Mung	Soy	Cotton	Soy- maize- mung	Cotton- maize- mung
Fallow length Crop cycle (years)	Short 4 years	Short 4 years	Short 4 years	Extended 5 years	Extended 5 years
Land preparation	-$1,497	-$1,497	-$1,497	-$1,497	-$1,497
Crop GMs – Fallow year 1	$998	$1,217	$1,112	$2349	$2,244
Crop GMs – Fallow year 2	-	-	-	$998	$998
Plant cane	$2,703 b	$3,257 b	$1,349 c	$4,874 a	$3,834 ab
1st ratoon*	$4,995	$5,115	$5,145	$5,197	$5,607
2nd ratoon*	$3,611	$3,315	$3,026	$2,969	$3,086
Mean (cane P – 2R)**	**$3,769 ab**	**$3,896 a**	**$3,173 b**	**$4,347 a**	**$4,176 a**
Mean (fallow – 2R)***	**$2,702 ab**	**$2,852 a**	**$2,283 b**	**$2,978 a**	**$2,854 a**

* not significantly different ** p-value = 0.029, 95% LSD = $704 *** p-value = 0.047, 95% LSD = $456

[8] Because the crop cycle for the extended fallow treatments are one year longer, the cumulative gross margin for the extended fallow crop treatments were divided by five years to get the mean per year. This is in contrast to the single fallow crop treatments, for which the cumulative gross margin was divided by four years.

Figure 6: Mean gross margin over the crop cycle (including fallow crops). Error bars represent the 95% LSD.



3.5 Short versus extended fallow

A factorial analysis was also undertaken to examine differences between fallow lengths. The fallow length for each treatment was classified as short (5-8 months) or extended (16 months). Table 6 shows that the comparison of short and extended fallow lengths was significant for the plant crop ($p<0.001$). A negative effect suggests the mean of the short fallow length treatments is lower than the mean of the extended fallow length. For the plant crop, the results suggest the short fallow length treatments had a significantly lower mean gross margin than the extended fallow length. There was no significant effect of fallow length for the ratoon crops. An analysis was also completed using the mean gross margins for each crop over the crop cycle including the fallow crops (consistent with the evaluation in Table 5). The result was significant ($p=0.046 < 0.05$), indicating that the extended fallow length scenarios included in this trial had a positive effect on the gross margin. However, the poor performance of the 'cotton' treatment may have influenced this result.

Table 6: Short versus extended fallow

	Plant	1st ratoon	2nd ratoon	Crop cycle – mean (including fallow)
p-value	<0.001	0.358	0.220	0.046
Effect	-$1,918/ha	-$317/ha	$290/ha	-$301/ha/crop
Standard error	$385	$331	$224	$135

3.6 Risk analysis

One key factor that has not been integrated into the preceding analysis is risk. Just like the sugar price, the price that growers receive for their fallow crops fluctuates over time. Risk analysis is a technique that can be used to examine the relative profitability of different treatments when incorporating risk from price movements as well as yield outcomes (e.g. dependent on many factors such as weather conditions). For example, Burdekin farmers harvesting mung bean crops in the summer are at a higher risk of losing their crop due to rain.

3.6.1 Parameters

Unfortunately, analysing risk is problematic because a range of parameters must be estimated in order to carry out the analysis. To this effect, the results from this analysis should be seen as giving readers an understanding of the changes to profitability that might occur given the parameters used for the analysis. Cotton and Maize are not commonly grown in the Burdekin and market information for these crops is uncertain.

Tables 7, 8 and 9 show the parameters that were used to analyse risk around crop prices, yields and whole crop losses due to rain at harvest time. The mean and standard deviation of each crop price was calculated from 5 years of monthly pricing data, while mean crop yields were obtained from technical specialists and farmers working in the Burdekin region. The standard deviation of crop yield was assumed to be 15% of mean yield for each crop. As Mungbeans and Soybeans grown in summer are particularly vulnerable to damage from rain around the time of harvest, the risk of severe crop loss is greater than for other crops. For example, Burdekin farmers generally have around six months to harvest sugarcane and any blocks not harvested can potentially be stood over for harvest in the following year.

Table 7: Crop prices

Crops	Mean	Standard deviation (SD)	68% probability range	
			-1 SD	*+1SD*
Sugar, $/t	$424	$ 72.23	$352	$496
Mungbean, $/t	$1,000	$ 179.74	$820	$1,180
Soybean, $/t	$500	$ 52.57	$447	$553
Cotton, $/bale	$507	$ 157.64	$350	$665
Maize, $/t	$280	$ 38.18	$242	$318

Table 8: Crop yields

Crops	Mean	Standard deviation (SD)	68% probability range	
			-1 SD	*+1SD*
Sugar, t/ha	Derived from trial results	15% of mean yield	Mean -15%	Mean +15%
Mungbean, t/ha	1.8	0.3	1.5	2.1
Soybean, t/ha	4.0	0.6	3.4	4.6
Cotton, bales/ha	8.3	1.2	7.1	9.5
Maize, t/ha	9.5	1.4	8.1	10.9

Table 9: Risk of losing whole crop to rain

Crops	Percentage
Sugarcane	0%
Mungbean	25%
Soybean	15%
Cotton	5%
Maize	5%

3.6.2 Method and results

For each treatment, 10,000 risk simulations were undertaken using PiRisk[9]. The NORMINV formula in Excel® was used to develop the price and yield distributions, which were determined by the parameters shown earlier. The simulated gross margin results for each treatment were then sorted from lowest to highest to develop a cumulative distribution function (CDF) for each treatment.

Figure 7 compares the CDFs, while Table 10 shows the descriptive statistics from the risk analysis. Each treatment's CDF is colour coded to enable comparison. A CDF indicates the cumulative probability of any given gross margin value or less occurring. Essentially, the CDF that sits furthest to the right indicates an array comprised of relatively higher gross margin values. Another option is to compare the mean result for each treatment. Given the parameters inputted for the analysis, the results show that the 'soy-maize-mung' treatment (red CDF) achieves relatively higher gross margins, followed by the 'soy' (green) and the 'cotton-maize-mung' (blue) treatments.

Figure 7: Cumulative distribution functions (including fallow crops).

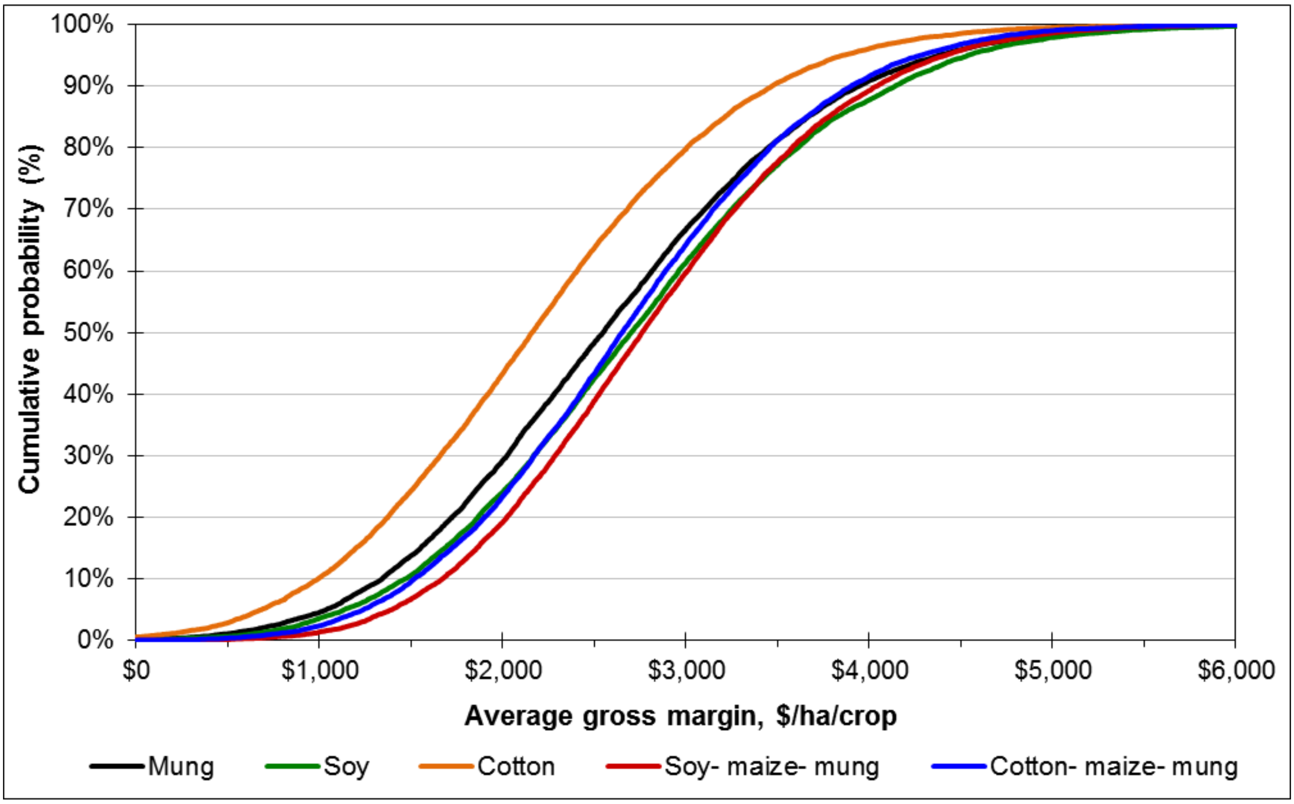


Table 10: Descriptive statistics, $/ha.

Fallow crops	Mung	Soy	Cotton	Soy- maize- mung	Cotton- maize- mung
Mean	$2,600	$2,752	$2,202	$2,813	$2,692
Minimum	-$982	-$361	-$863	-$41	-$345
Maximum	$8,545	$7,304	$6,548	$6,716	$6,707
Standard deviation	$1,025	$1,038	$972	$921	$927

[9] PiRisk was developed by the Queensland Department of Agriculture and Fisheries to undertake risk analysis.

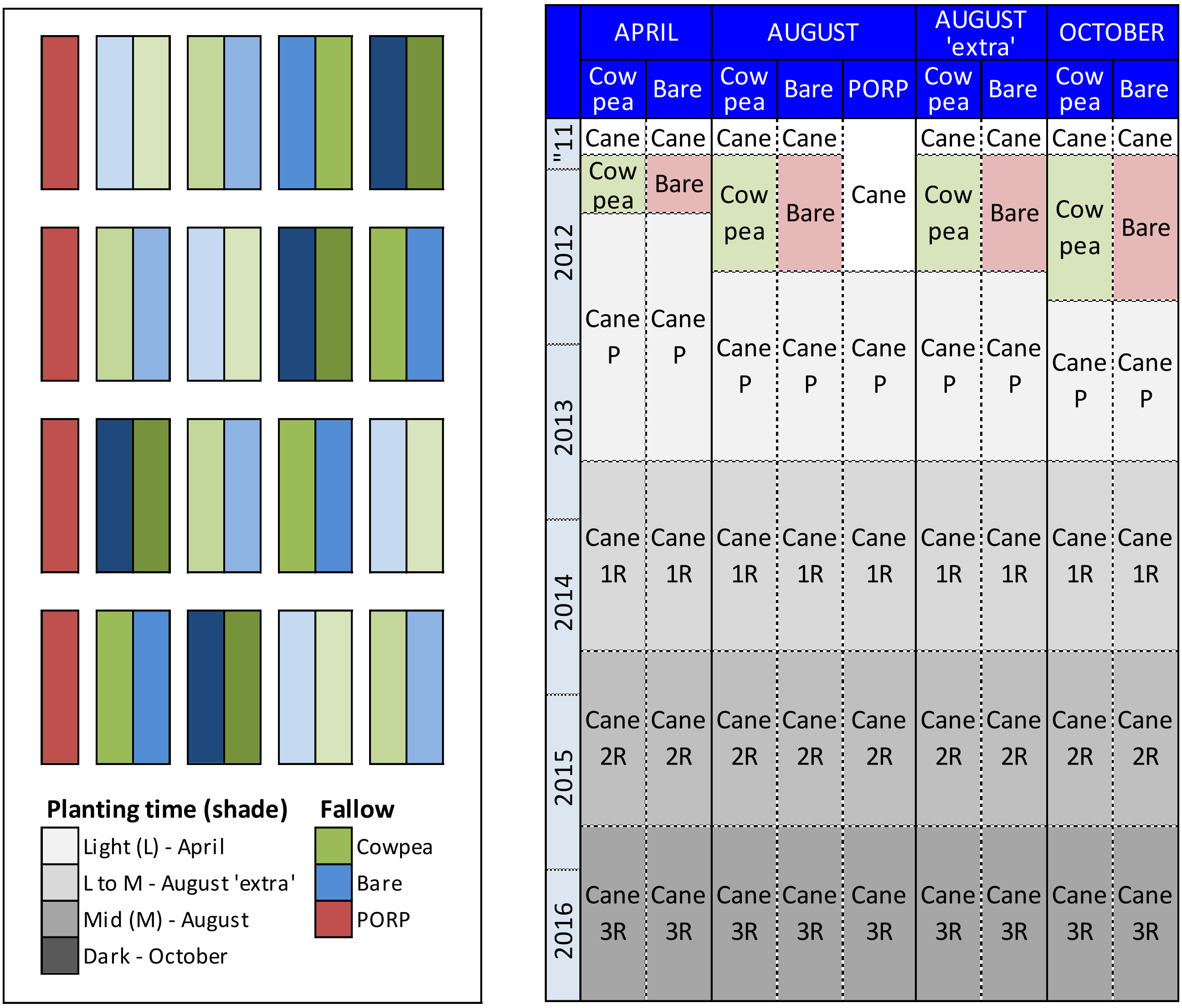
4 Experiment B – a comparison of bare and cowpea fallows at various sugarcane planting times

This experiment examines both bare and cowpea fallows at several cane planting times; April, August (as well as an August ‘extra’ treatment) and October. The trial design enables the effect of planting time on profitability to be determined as well as the influence of a fallow crop (cowpeas were used as a substitute legume crop). One of the August planting dates (August ‘extra’) was initially planned for May but was setback due to unseasonal rainfall that pushed back the planting date. An important difference between the two August planted treatments is the incorporation date of the cowpea residue. For the August ‘extra’ treatment, the residue was incorporated two months before the following cane crop was planted, while the residue for the August treatment was incorporated just one-week prior to planting. For the April and October cowpea treatments, the residues were also incorporated one-week prior to planting sugarcane.

4.1 Trial design and timeline

Figure 8(a) shows the farm layout of the trial, while Figure 8(b) specifies the timelines for each treatment.

Figure 8: Trial layout (a) and timeline (b).



As noted in the timeline, sugarcane production data has so far been collected up to, and including, the third ratoon. Every treatment was replicated (4 replicates) and randomised except for the plough-out replant treatment. This treatment was replicated but not randomised. Consequently, the results for the plough-out replant scenario cannot be effectively compared with results from the other treatments.

One key learning from the trial was the effect of incorporating legume residues before planting. It was identified that incorporating residues just prior to planting cane had a negative effect on cane yield. This is possibly due to allelopathic effects of decomposing green residues on sugarcane bud development and early growth and the organic matter from the residue possibly reducing soil-to-sett contact. Consequently, the plant cane yields of all the legume treatments were negatively affected by this problem, except for the August 'extra' treatment.

In the next few subsections, the gross margins produced by each treatment during each sugarcane crop are compared followed by their relative performance over the full crop cycle (including the cowpea crop). Afterwards, the analysis investigates how the treatments might compare if the cowpea crop was substituted with crops that Burdekin farmers are more likely to grow as an income source and that are potentially suitable for the respective planting times. Finally, the results from a risk analysis are presented.

4.2 Sugarcane crop results

A statistical analysis of the economic data[10] was undertaken and the results are presented in Tables 11, 12 and 13. The analysis identified a significant difference between cane planting times in the plant crop, while no significant difference was identified in the following ratoon crops. As illustrated in Figure 9, sugarcane planting time had a strong influence over the gross margin produced by each treatment in the plant cane crop, with earlier planting times delivering significantly higher gross margins than later planting times.

Table 11: Type of fallow - mean gross margin, $/ha.

Crop	Bare (mean)	Cowpea (mean)	*p-value*	*95% LSD*
Plant crop	$2,087	$1,849	*0.149*	*$330*
1st ratoon	$3,735	$3,839	*0.582*	*$386*
2nd ratoon	$4,402	$4,326	*0.744*	*$483*
3rd ratoon	$3,197	$3,481	*0.120*	*$363*

Table 12: Planting time - mean gross margin, $/ha.

Crop	April	August	August EXTRA	October	*p-value*	*95% LSD*
Plant crop	$2,819 a	$1,893 b	$1,881 b	$1,277 c	***<0.001***	*$467*
1st ratoon	$3,757	$3,782	$3,672	$3,936	*0.789*	*$546*
2nd ratoon	$4,106	$4,542	$4,345	$4,463	*0.581*	*$683*
3rd ratoon	$3,026	$3,418	$3,580	$3,333	*0.183*	*$513*

While a plough-out replant (PORP) treatment was included in the trial it was not randomised. Nevertheless, its mean results have been added to Table 13 to provide an indication of relative

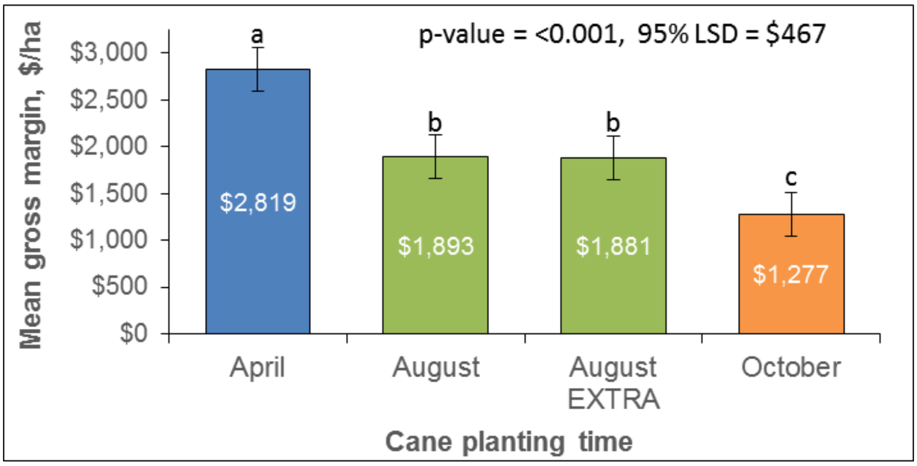
[10] An important factor to consider when interpreting the plant crop results is the impact from very wet weather conditions that occurred during the year that the sugarcane was planted (2012). Importantly, these plant cane yields are not indicative of yields produced during typical climatic conditions.

performance. However, it could not be included in the statistical analysis and readers cannot make valid comparisons between the plough-out replant treatment and other treatments.

Table 13: Fallow x planting time (interaction) - mean gross margin, $/ha.

Crop	Fallow	April	August	August EXTRA	October	p-value	95% LSD	PORP (August)
Plant crop	Bare	$3,017	$2,164	$1,768	$1,397	0.374	$661	$1,311
	Cowpea	$2,621	$1,613	$1,993	$1,157			
1st ratoon	Bare	$4,053	$3,733	$3,594	$3,558	0.118	$773	$3,082
	Cowpea	$3,461	$3,830	$3,750	$4,313			
2nd ratoon	Bare	$4,019	$4,486	$4,309	$4,796	0.552	$967	$4250
	Cowpea	$4,193	$4,597	$4,381	$4,131			
3rd ratoon	Bare	$2,876	$3,375	$3,067	$3,471	0.835	$726	$3,917
	Cowpea	$3,176	$3,461	$3,598	$3,688			

Figure 9: Planting time - plant crop gross margins. Error bars represent the 95% LSD.



As mentioned previously (page 11), the early incorporation of legume residue[11] improves yield outcomes in the following sugarcane crop. Regrettably, the plant cane yields of all the legume treatments were negatively affected by the acknowledged legume incorporation problem, except for the August 'extra' treatment. This is highlighted in the economic results with the August 'extra' cowpea treatment being the only cowpea treatment that outperformed the corresponding bare fallow treatment, which is more consistent with results from other experiments that have examined the influence of legume fallow crops on sugarcane production/soil health (e.g. cane yield decline joint venture). Also notable was the relative profitability of the August and August 'extra' cowpea treatments, with the August 'extra' cowpea treatment delivering a gross margin noticeably higher than the August cowpea treatment.

A key factor known to influence the performance of using a plough-out replant strategy or a bare fallow is the cumulative effect of a continued monoculture over time. It must be noted that the block used for the trial has not been able to capture this effect as it has not had a continual monoculture. Consequently, it may be reasonable to consider that the plough-out replant results and the bare fallow results are at the high end of the distribution. The farm has also had controlled traffic for the past twelve years and as such has had less compaction, which is a contributing factor to soil health.

[11] Or possibly alternative methods such as leaving crop residues on the top (not incorporating).

4.3 Performance over the sugarcane crop cycle (all harvests)

A repeated measures ANOVA was undertaken to statistically analyse the economic data over the sugarcane crop cycle (all sugarcane crop harvests). Table 14 outlines the statistical significance of all the parameters fitted to the statistical model, while Tables 15, 16 and 17 summarise findings from the key parameters. While the model parameter 'crop class' was statistically significant, making inferences based on this parameter has little practical benefit as the differences are generally commonplace and expected. The statistical significance of 'planting time x crop class' was already identified in Table 12, where the differences between crops was observed in detail.

Table 14: Model parameters and summary of results

Model parameter	*p-value*	*95% LSD*
Type of fallow (see Table 15)	*0.856*	*$204*
Planting time (see Table 16)	*0.753*	*$289*
Crop class (harvest)	***<0.001***	*$277*
Fallow x planting time (see Table 17)	*0.569*	*$409*
Fallow x crop class (results match Table 11)	*0.253*	*$394*
Planting time x crop class	***<0.001***	*$557*
Fallow x planting time x crop class	*0.347*	*$787*

Table 15: Type of fallow - mean gross margin, $/ha.

Crop	Bare (mean)	Cowpea (mean)	*p-value*	*95% LSD*
All harvests	$3,355	$3,373	*0.856*	*$204*

While planting time was statistically significant in the plant cane, Table 11 shows that planting time was not significant when analysed over the crop cycle. This is somewhat explained by the results in Table 12, where it shows that the April planting time performed well in the plant crop but relatively poor in the following ratoons. However, there still seems to be a slight downward trend in profitability the later the bare fallow treatments were planted but this difference is not significant.

Table 16: Planting time - mean gross margin, $/ha.

Crop	April	August	August EXTRA	October	*p-value*	*95% LSD*
All harvests	$3,427	$3,409	$3,308	$3,314	*0.753*	*$289*

The legume incorporation problem is also evident in the crop cycle results with the August 'extra' cowpea treatment being the only cowpea treatment that convincingly outperformed the corresponding bare fallow treatment on average (little difference between the October treatments). Had the legume residues been incorporated when ideal, the profitability of the cowpea treatments could potentially have been greater than the corresponding (by planting time) bare fallow treatments.

Table 17: Fallow x planting time - mean gross margin, $/ha.

Crop	Fallow	April	August	August EXTRA	October	*p-value*	*95% LSD*
All harvests	Bare	$3,491	$3,439	$3,185	$3,306	*0.569*	*$409*
	Cowpea	$3,363	$3,378	$3,431	$3,322		

4.4 Surrogate fallow crop analysis

Because of the availability of irrigation water, productive soils and suitable climatic conditions, Burdekin growers have a broad range of fallow crop options available that they can harvest for income. Using the results from each cane planting time, it is informative to substitute cowpeas with the potential returns (using the gross margins in Table 3) from a variety of other crops. Importantly, this analysis assumes that the production results for the alternative crops are exactly the same as what was produced in the trial by the surrogate cowpea crop scenarios.

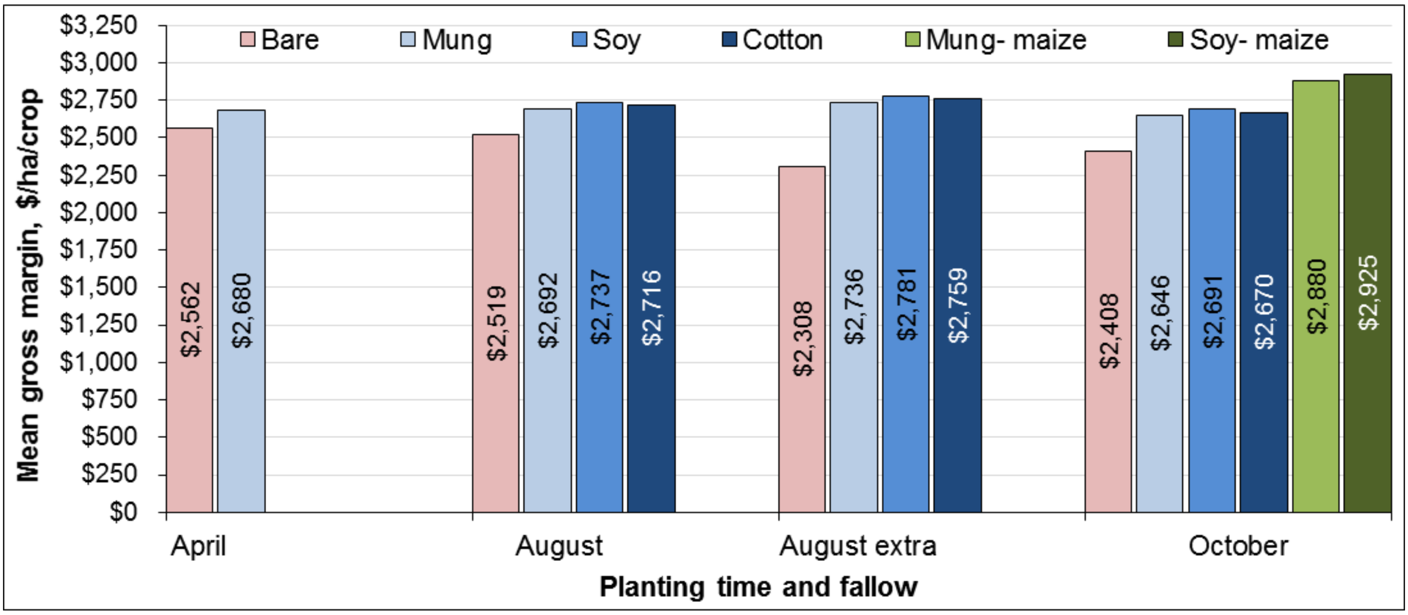
Readers must be cautious about the problems faced by the April, August and October cowpea treatments. As mentioned on page 11, the cane yields of these treatments were negatively affected by the incorporation of cowpea residues just prior to planting cane.

Figure 10 investigates the prospective gross margin from planting in:

- April – after a mungbean crop
- August – after either a mungbean, soy or cotton crop (for both the August and August 'extra' scenarios)
- October – after three single crop scenarios (mungbean, soy or cotton) and two double crop scenarios (mung-maize or soy-maize)

The results show that when the alternative crops are substituted for cowpeas, the profitability of the single crop scenarios is enhanced. Under the given assumptions, each of the single crop scenarios regardless of planting time produced a higher gross margin over the crop cycle than the best performing bare fallow treatment (planted in April), while the double fallow crop scenarios produced even higher gross margins. However, this analysis does not take into account yield and price risk, which is examined in the following section.

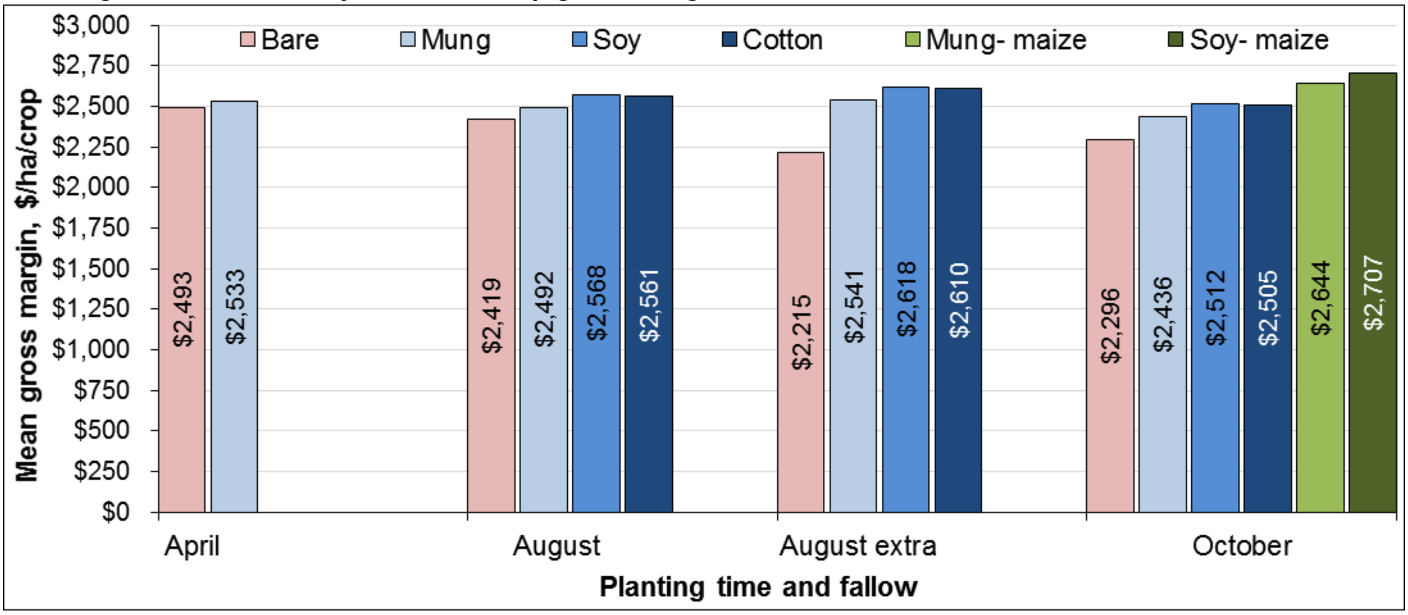
Figure 10: Cash crop gross margins.



4.5 Risk analysis

The risk analysis in this section was carried out using the same parameters and method used for the preceding risk analysis in section 3.6. While the results from the earlier analysis are presented in the form of CDFs, this technique does not enable a clear presentation of the results here as there are more than three times as many scenarios. Instead, Figure 11 compares the mean gross margin from the description statistics to make comparisons. The results are similar to those presented in Figure 10, except the difference between the bare fallow and fallow crop scenarios has decreased. Nevertheless, the majority of the fallow crop scenarios deliver comparable, or higher, mean gross margins to the best performing bare fallow scenario (April planted). Importantly, the results from the risk analysis are dependent on the parameters entered into the model (see sections 3.6.1 and 3.6.2 for an outline of the parameters and method used for the risk analysis).

Figure 11: Risk analysis – cash crop gross margins.



5 Conclusion

Past research has found that breaking the sugarcane monoculture with the inclusion of fallow crops in a sugarcane rotation supports soil health and offsets yield decline. Because of good soils and the availability of irrigation water, Burdekin growers have a broad range of fallow crop options available to them. Nevertheless, growers may be reluctant to include other crops into their rotations without an understanding of the likely production and economic impacts on their farming businesses. Consequently, two different experiments were established in the Burdekin during late 2011 that investigated different planting times and fallow crop sequences. This report complements the production results from these trials by examining the relative profitability of the different treatments.

Experiment A compared the profitability of three short fallow crop scenarios and two extended fallow crop scenarios over one full crop cycle. A factorial analysis suggests that the extended fallow treatments delivered significantly higher mean gross margins in the plant crop, while no statistically significant differences were identified in the first and second ratoons.

Experiment B compared the profitability of bare and cowpea fallows with different sugarcane planting dates. Unfortunately, in several of the cowpea treatments the crop residues were incorporated just prior to planting, which had a negative effect on yield in the following sugarcane crop. Nevertheless, the results identified that treatments with earlier sugarcane planting times delivered significantly higher plant crop gross margins than later planting times, while no significant differences were observed during the following ratoon crops. While planting time was statistically significant in the plant cane, planting time was not significant when analysed over the whole sugarcane crop cycle. In addition, little difference was found between the bare fallow and cowpea fallow treatments.

As the cowpea crop was grown as a surrogate for other fallow crops, the results for the cowpea crop were substituted with a number of crop options available to Burdekin sugarcane growers to examine their attractiveness. This analysis identified that growing one or two fallow crops at the trial site could potentially improve profitability relative to maintaining a bare fallow, regardless of planting time. However, the risk of crop losses due to rain at harvest highlights an important factor that needs to be taken into account. A risk analysis showed that the higher profitability of the cropped fallow scenarios decreased relative to the bare fallow scenarios when taking into account risk, but this result is heavily dependent on the estimated likelihood of crop losses (important given that this parameter needs to be entered into the risk model).

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