SRA Grower Group Innovation Project
Final Report

Sugar Research Australia

Research Funding Unit

SRA project number:	GGP045
SRA project title:	Developing Extended Fallow Options for the Plane Creek District
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Executive Summary:

At the time of initiation of this project, sugarcane lands were being lost to cattle grazing, tree production and hobby farms due to the low returns being experienced for sugarcane. The low sugarcane returns were a product of both poor productivity and low sugar prices. This loss of land was affecting the viability of the local sugar mill on which all other local sugar growers relied for processing their crop.

This project aimed to evaluate the role of an extended fallow for improving sugarcane productivity and improving farm viability by introducing cash crops in the extended fallow period.

An evaluation, including data gathering from experienced grain industry agronomists, seed supplier companies and grain purchasers was undertaken to evaluate a broad suite of crops as potential crop candidates. Evaluation included likely suitability for the regions' climate, potential gross margins, key agronomic traits, pest and disease limitations and proximity to markets. The project established a series of field trials aimed at evaluating the most promising crop options from the desktop study. Crop options evaluated in the field included grain sorghum, maize, sweet sorghum, mungbean, linseed, sugarbeet, soybean, chickpea, forage sorghum and lab lab. Seasonal conditions prevented most crops from producing a harvestable yield during the two years of this project, but sugarbeet, chickpea, linseed and forage sorghum hay was produced from different sites.
Following crop option evaluation, the most promising crops (chickpea, soybean, mungbean, sugarbeet, linseed) were planted into commercial scale evaluation strips and compared to a standard short fallow practice.

A range of service providers participated in the project at different stages – including CSR Plane Creek mill provided ccs determination, local Landmark staff provided crop protection products and linkages to seed suppliers and expertise, Syngenta seeds provided two tropical sugarbeet varieties for evaluation, QDAFF staff provided economic evaluation and Lindeman and Associates provided assistance with crop sequence planning.

Plant cane yields improved by 18 to 38% from an extended fallow break at the W1 trial site, when compared to a standard short fallow. However, this improvement in cane yield did not persist into first ratoon for most treatments. With poor seasonal conditions preventing a harvestable yield from most crops, gross margins from the extended breaks were poorer than for the standard short fallow. Further work is recommended to improve reliability of alternative crops in this region.

Background:

This project aimed to explore the opportunities for producing a range of crops in rotation with sugarcane to improve productivity through improved soil health and to diversify income sources. The Sugar Yield Decline Joint Venture demonstrated improvements in sugarcane productivity when a substantial break was introduced into the sugar cane rotation, such as that provided by a pasture phase. Our group did not believe such a long break would be viable for their businesses, but wished to evaluate the productivity, economics and sustainability of skipping planting cane for a season and introduce an extended fallow – of approximately 18 to 20 months. During that extended fallow, a range of "cash" crops were to be grown and evaluated for their benefits in the sugarcane cropping system.
At the time of this project, demand for fuel ethanol had rapidly multiplied and a Biodiesel plant was slated for construction in Mackay. This was to provide a local outlet for grain and ethanol feedstocks that could be potentially grown in an extended fallow.

Most of the crops evaluated during the project had little or no production history within this district. This project fostered substantial gains in producer capacity in terms of evaluation of crop options, practical skill development in crop agronomy, herbicides and insecticides, managing rotations ethanol production and grain production and marketing.

Objectives:

- Trial & develop a range of fallow crop options suitable for an extended fallow program in Plane Creek District
- Address loss of land to cattle/trees/hobby farms by providing options for growers in Plane Creek to diversify without leaving the sugar industry
- Partner with industry organisations to maintain production of sugar by CSR mill, increase production of Ethanol by CSR distillery, and increase viability of growers
- By partnering with commercial organisations including Pioneer Seeds, Lindeman & Associates, Syngenta and Landmark Mackay, our group members will develop more rigorous & diverse agronomic skills, marketing and business case analysis skills than we have ever been exposed to in the sugar industry.
- Increase cane production per hectare, resulting in the same total cane production for the farm at reduced costs. Increase total sugar mill/distillery income from additional throughput of sweet sorghum, beet, grain for ethanol.

The project was able to successfully meet several objectives of the project. A number of fallow crop options were identified and evaluated in field trials. Plant cane harvest results showed increase in productivity from an extended break, although this yield increase was inconsistent in the first ratoon crop.
Significant learning's were gained by group members in other crop agronomy, pest and disease management and produce marketing. Interaction with skilled staff from numerous support organisations was very beneficial to grower capacity building.

Unfortunately, and largely driven by adverse seasonal conditions during the period of the field trials, the project was unable to successfully meet its core objective of increasing returns from crops grown – all crops gave negative gross margins. This has limited the interest in adoption of extended fallow practices in this and other regions.

Methodology:

The project commenced with a data gathering phase including data gathering from experienced grain industry agronomists, seed supplier companies and grain purchasers was undertaken to evaluate a broad suite of crops as potential crop candidates. Evaluation included likely suitability for the regions' climate, potential gross margins, key agronomic traits, seed availability, pest and disease limitations and proximity to markets. Potential crops considered included tropical sugar beet, grain sorghum, maize, chickpea, sunflower, safflower, canola, linseed, soybean, mungbean, wheat, cotton, peanuts, sweet sorghum and rice.

A matrix was developed to compare crop options. Figure 1 shows a summary example matrix developed to compare suitability of crop options.

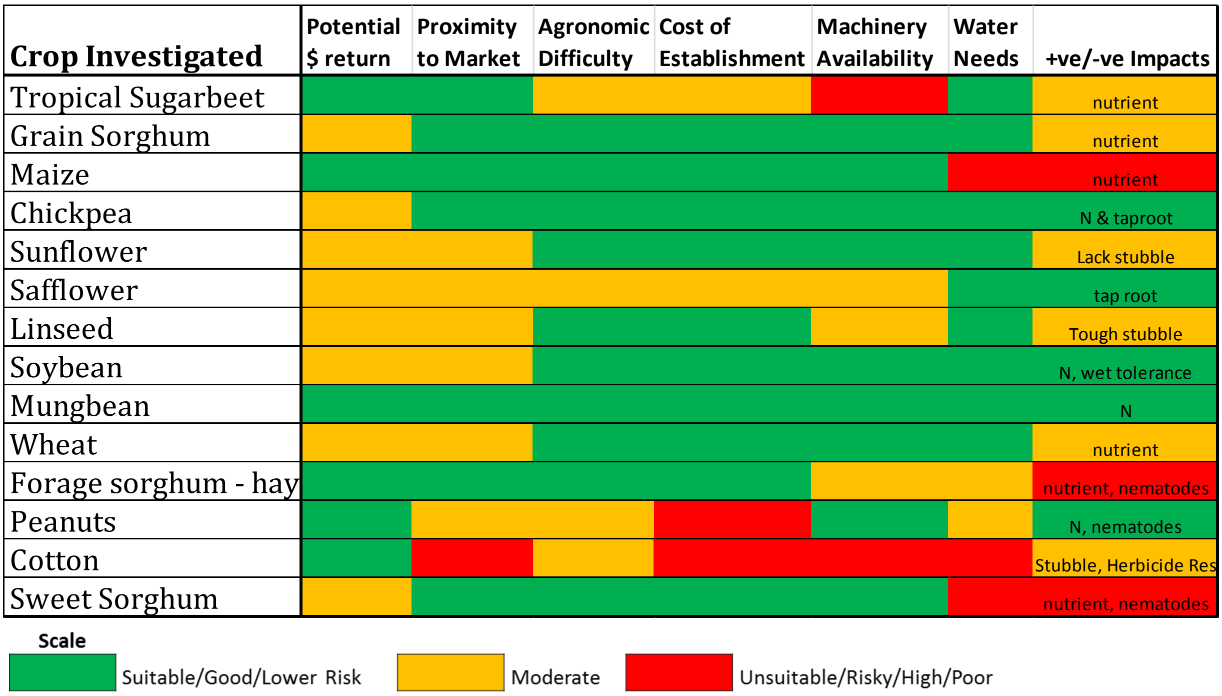

Figure 1: Crop Option Comparison Matrix

The project established a series of field trials in commercial scale evaluation strips aimed at evaluating the most promising crop options from the crop evaluation study compared to a standard short fallow practice. Crop options evaluated in the field included grain sorghum, maize, sweet sorghum, mungbean, linseed, tropical sugar beet, soybean, chickpea, forage sorghum and lab lab. Adverse seasonal conditions prevented most crops from producing a harvestable yield during the two years of this project, but sugar beet, chickpea, linseed and forage sorghum hay was produced from different sites.

Site	2008 Dec, 2009 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov		2010 Dec Jan Feb Mar Apr May Jun Jul Aug	
C1	Summer Crops	Winter Crops	Summer Crops	Sugarcane Plant
H1	Bare Fallow	Winter Crops	Summer Crops	Sugarcane Plant
B1	Bare Fallow	Winter Crops	Bare Fallow	Winter Crops
M1	Summer Crops	Winter Crops	Summer Crops	Sugarcane Plant
W1	Bare Fallow	Winter Crops	Summer Crops	Sugarcane Plant
A1	Sugarcane		Soybean green manure	Winter Crops

Figure 2: Planned cropping sequences for field trial sites

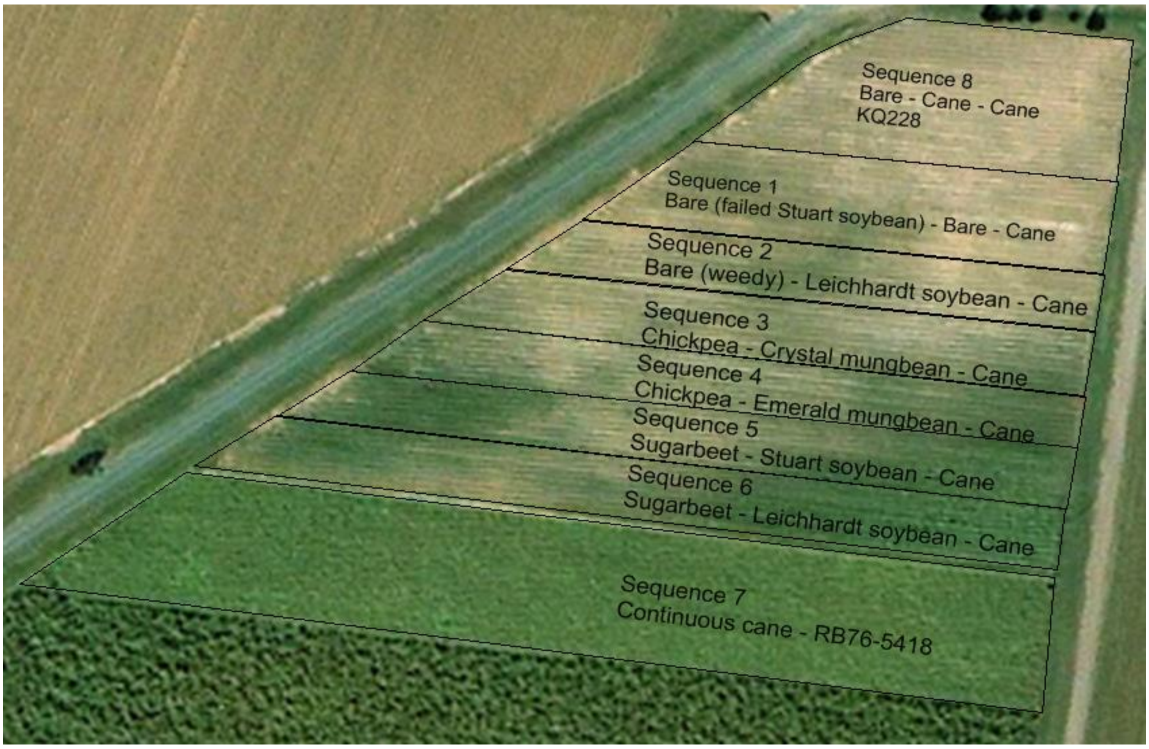

Figure 3: An example trial layout – W1 site

Fallow crops were evaluated for performance as appropriate. For example, hay crops were baled and evaluated, green manure crops had biomass assessments and nitrogen contents assessed, sugar beet, chickpea and linseed had small scale hand harvests conducted.


Figure 4: This crop of linseed is believed to be the first ever grown in coastal central Queensland.

Results and Outputs:

Weather Impact on Field Trials

Difficult weather conditions impacted on the performance of the break crops in the field trials. Figure 5 below, shows the rainfall figures measured for Koumala, compared to the long term mean. The first summer crop period (2008/09) was characterised by a persistent and excessively wet period. This caused germination failures for some crops (maize, sweet sorghum, grain sorghum), while those crops that were able to establish well in these conditions were unable to have planted agronomy inputs applied (mungbean, soybean).

The winter crop program was able to be established into moisture, however virtually no rain fell in the 6 months from May 2009, limiting the yield performance of the crops (sugar beet, linseed, chickpea).
The final summer crop planting was able to be completed, despite wet weather, however the wet prevented insecticide applications from being applied as required in mungbean and soybean. Insect pressure (*Helicoverpa sp*. and Green Vege bug) caused severe crop damage during the pod fill.

The plant cane following the extended break periods were established successfully despite some winter rain.

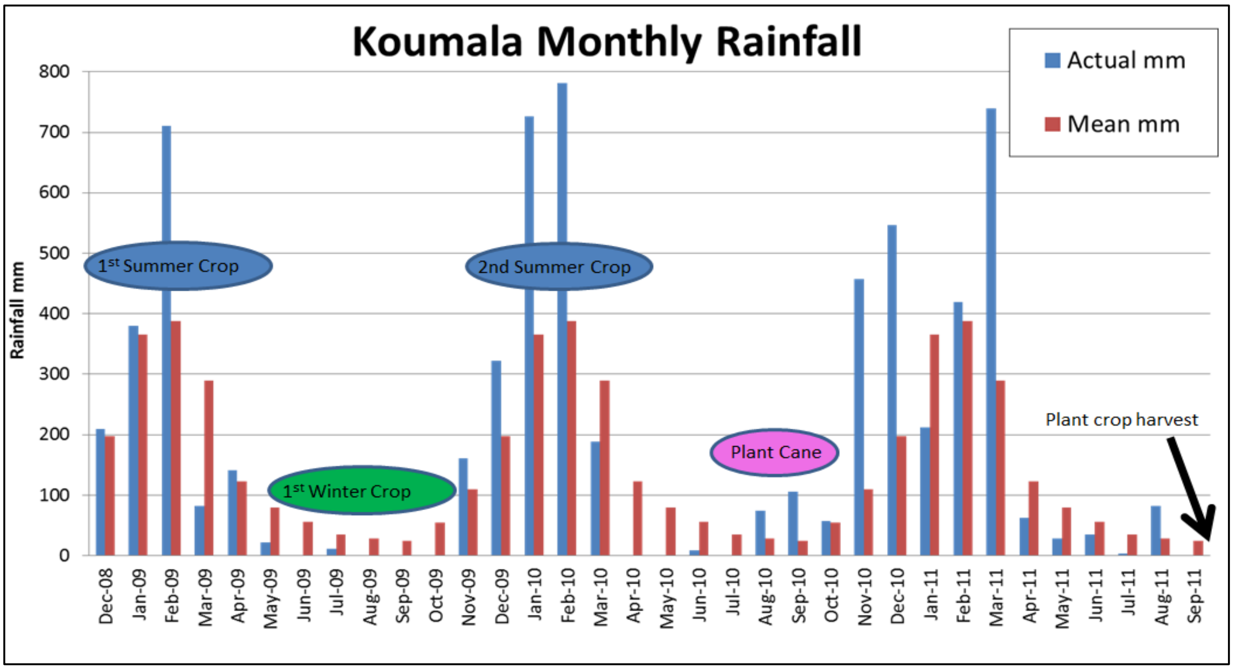

Figure 5: Koumala monthly rainfall with timing of trial activities

Figure 6: Exceptionally dry conditions impacted winter crop performance.

Soil Health

Measurements of two important sugarcane soil health parameters were made – *Pachymetra chaunorhiza* spore counts and parasitic and beneficial nematode levels. All soil health measurements were undertaken courtesy of the BSES/SRA laboratory at Tully.

Pachymetra

Pachymetra spore counts were low at each trial site measured and were not influenced by fallow cropping sequence.

Block No	Variety	Crop	Spores Per/Kg	Result
6-1	KQ228	Plant	8591	Low
6-1		Bare	10181	Low
6-1		chickpea	8215	Low
6-1		linseed	1637	Low
6-1		sugarbeet	8333	Low
6-1	RB76-5418	4R	10273	Low

Table 1: Pachymetra spore counts for Site W1, pre-plant sugarcane

Nematodes

Parasitic nematode levels were low at each site and were not influenced by cropping sequence.

Variety	Crop	*Pratylenchus*	*Helicotylenchus*	*Tylenchorhynchus*	*Paratrichodorus*	*Meloidogyne*
KQ228	Plant	0	0	0	0	0
	Bare	46	0	23	0	0
	Chickpea	22	43	0	22	0
	Linseed	0	0	0	0	0
	Sugarbeet	0	22	0	0	0
RB76-5418	4R	68	114	46	0	0

Table 2: Plant parasitic nematode counts for Site W1, pre-plant sugarcane

Free living nematode populations were not largely different between cropping sequence.

Variety	Crop	*Bacterivore*	*Aphelenchida*	*Tylenchida*	*Fungivore*	*Dorylamids*	*Mononchids*
KQ228	Plant	1670	778	252	1029	114	0
	Bare	688	275	779	1054	23	0
	Chickpea	282	261	108	369	65	0
	Linseed	173	714	22	735	0	0
	Sugarbeet	155	155	221	376	0	0
RB76-5418	4R	137	46	251	297	68	0

Table 3: Free living nematode counts for Site W1, pre-plant sugarcane

Further investigation into soil health matters as a result of this project has highlighted the diverse range of technologies being developed to better monitor soil microorganisms as a benchmark of soil health. These newer methods are much more sophisticated than just undertaking counts of particular microbiological species. Group members are now having field soils tested for microbiological activity at the Australian microbiological laboratories in Adelaide.

Break Crop Performance

As detailed earlier, break crop performance was greatly influenced by weather conditions. Yields of some selected break crop trials are presented below.

Site C1 1st Summer Crop Dec 08 to May 09

Crop	Establishment	Harvest	DM t/ha	kg N/ha	GM $/ha
Leichhardt soybean	OK	Biomass	6.7	200	-$232
Emerald Mungbean	OK	Biomass	5.2	110	-$324
Sugargraze Sweet Sorghum	Failed x 2				
Pioneer 31H50 Corn	Failed x 2				

The legume crops at the C1 site were insect damaged and only suitable for green manuring. Although the legumes contributed nitrogen worth $80 to $140/ha, there was a negative gross margin of $-232 to $-324/ha for soybean and mungbean respectively.

Site M1 Summer Crop December 2009 - May 2010

Crop	Establishment	Harvest	DM t/ha	kg N/ha	Round bales per ha	GM $/ha
Leichhardt soybean	Good	Biomass	7.9	238	35	$1,352
Sugargraze Sweet Sorghum	Good	Biomass	27.1		120	$2,178
Ebony Cowpea	Good	Biomass	6.4	144	29	$1,095
Sugargraze & Ebony	Good	Biomass	26.2		116	$2,018

Summer crops cut for hay at the M1 site found a ready market and provided the highest gross margins of any break crops included in the project. Returns were directed linked to biomass yield. The hay market is very seasonal in Central Queensland and is considered a niche market that is unable to absorb large quantities of hay.

Sugarbeet

Strong interest existed in the sugar beet trial treatments. The crops established strongly on the stored moisture at the trial sites. However, the exceptional dry winter limited final yields recorded.

Figure 7: Early establishment of tropical sugar beet.

Sample Site	CCS	Yield t/ha	t sugar/ha
1a	11.9	20.3	2.4
2a	13.9	28.8	4.0
3a	13.1	34.0	4.5
4a	16.2	44.6	7.2
5a	16.8	42.3	7.1
6a	16.9	38.7	6.5
Mean	**14.8**	**34.8**	**5.3**

Table 6: Sugar beet sub-sample yields and sugar content

Sugar beet yields varied from 20.3 t/ha to 44.6 t/ha. Sugar content was low in the lower yielding, severely drought stressed parts of the field where the crop was unable to mature.

Assessment of the potential of sugar beet produced from these trials for ethanol production was unable to be completed due to CSR staff changes.

Sugarcane Productivity Following Extended Fallow Treatments

Following the extended fallow breaks, plant cane establishment, crop yield and sugar content were collected as well as first ratoon cane productivity data.

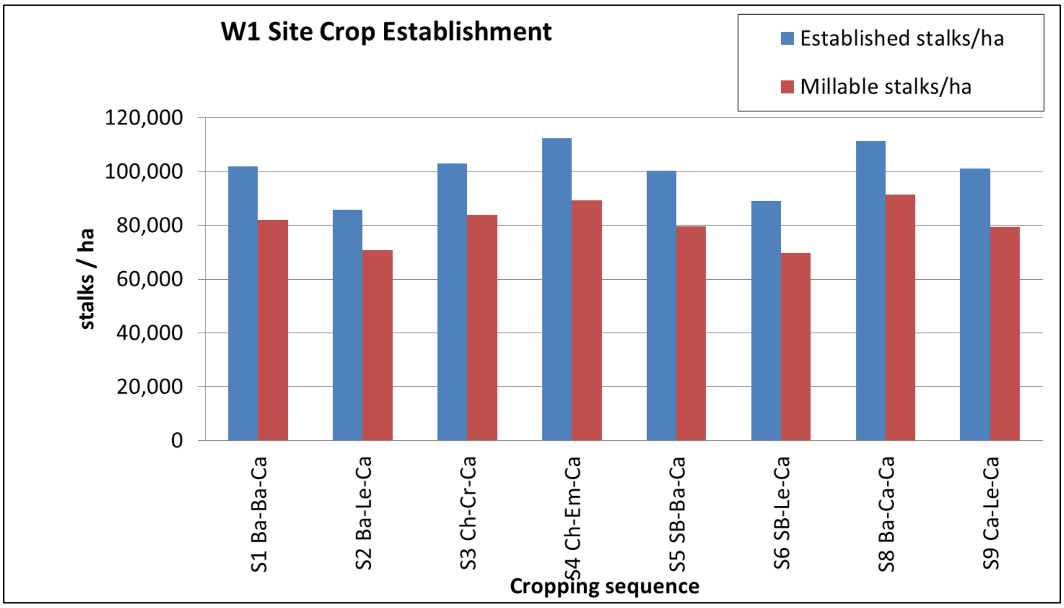

Figure 8: Plant cane establishment and mature stalk count comparisons

There were small differences between treatments in plant crop establishment and millable stalk counts. However, these differences were not consistent with plant cane yield (Figure 9).

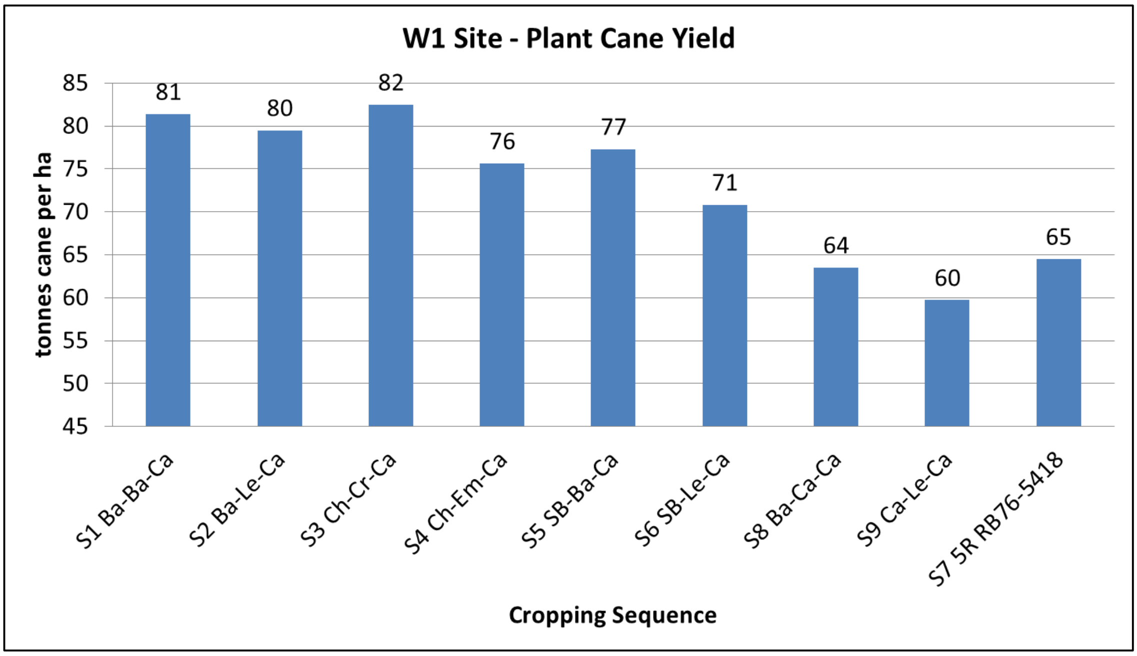

Figure 9: Plant cane yield for each cropping sequence.

All of the extended fallow treatments gave a higher plant cane yield than Sequence 9, standard short fallow treatment. Cane yield increases varied from 19% to 38% higher in the plant cane crop and all sugar yields were also higher (Figures 10 and 11).

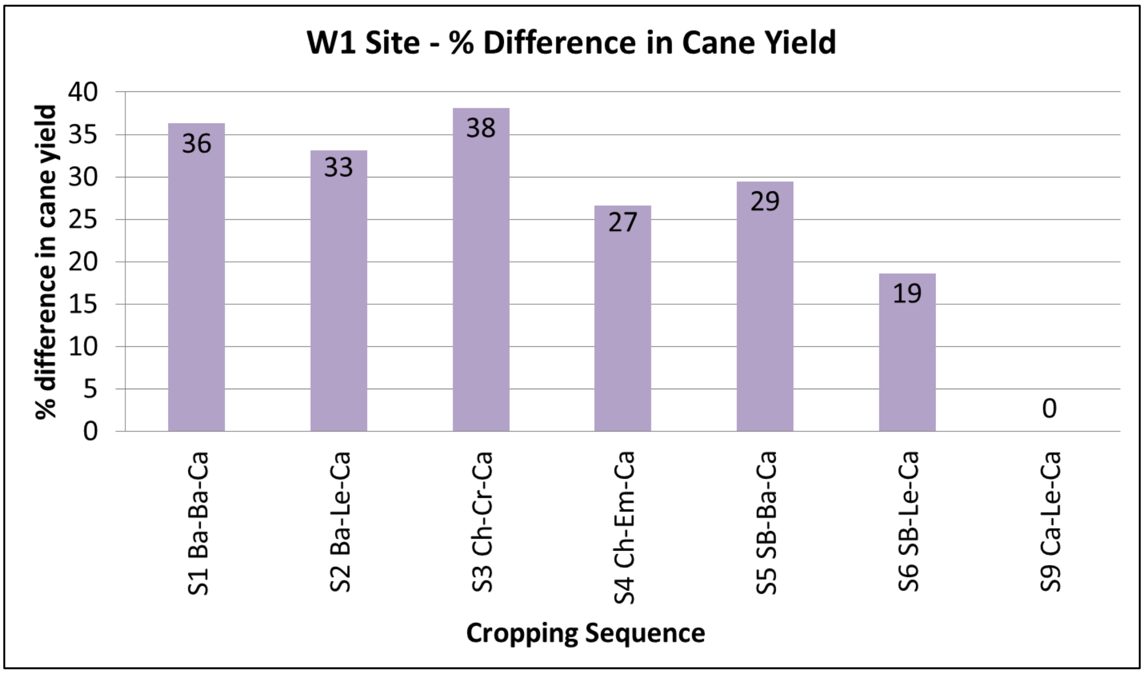

Figure 10: Percentage difference between treatments – Plant Cane Yield

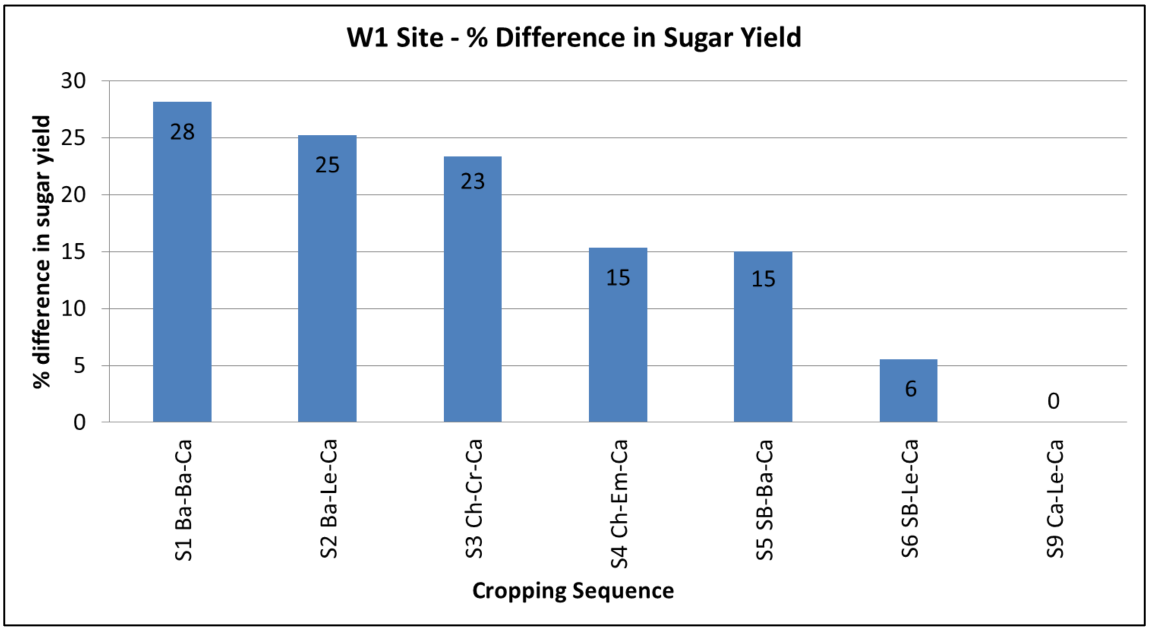

Figure 11: Percentage difference between treatments – Plant Cane Sugar Yield

1st Ratoon Cane Productivity

First ratoon treatment cane yields were not consistently better than the standard treatment. This was a disappointing result (See Figures 12 & 13).

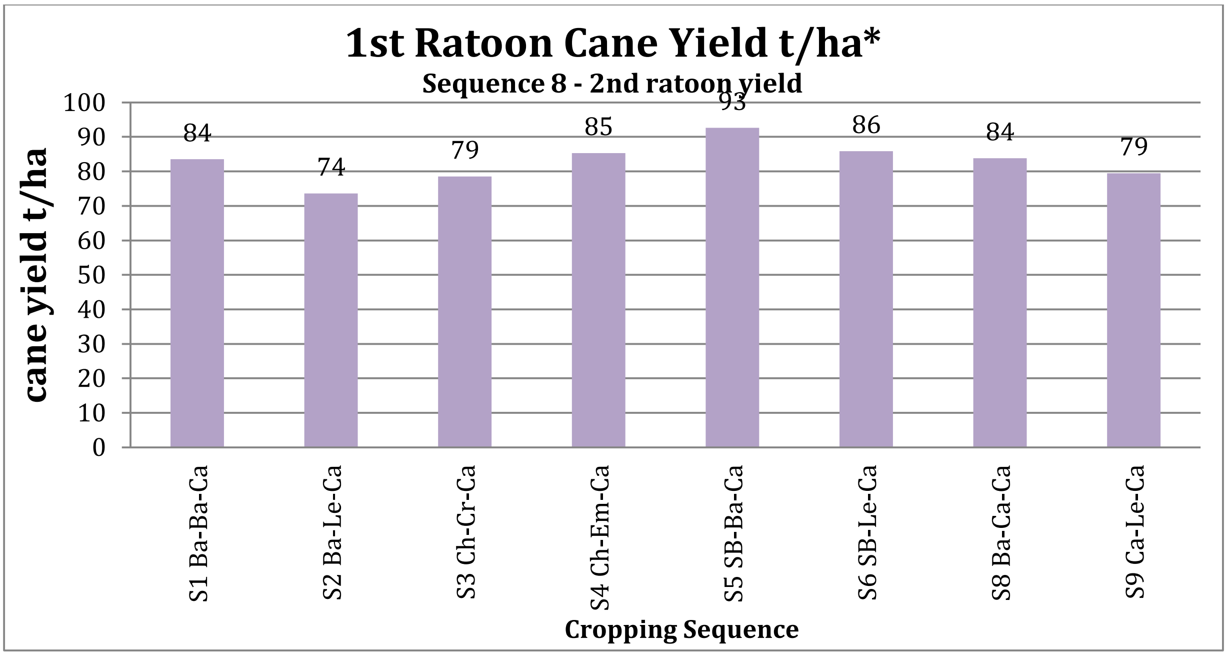

Figure 12: 1st Ratoon Cane Yield

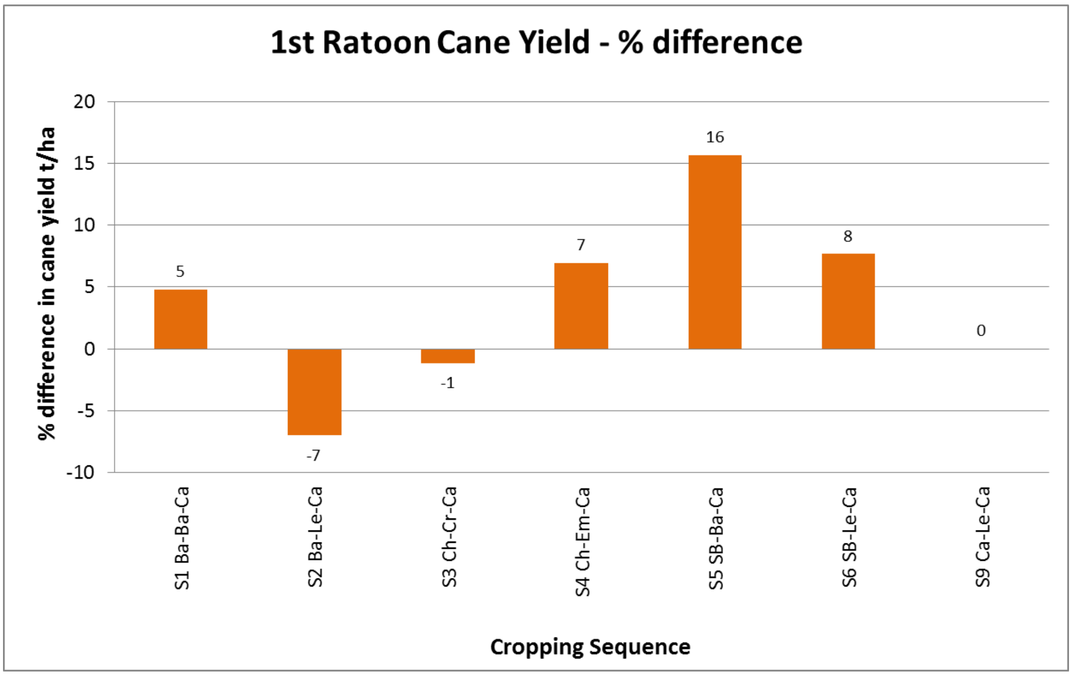

Figure 13: 1st Ratoon Cane Yield - % difference

Economic Evaluation of Extended Fallow Options

Grower economic returns are presented for each of the treatments in the W1 trial (Table XX). Each of the fallow options (including standard short, Sequence 9) gave a negative gross margin for the fallow period due to no viable harvest being undertaken. When the cane crop gross margins are included for each of the cropping sequences evaluated, Sequence 8 gave the highest return at $4604/ha. The highest return extended fallow treatment was two bare fallows in succession (Sequence 1) at $3876/ha.

	Cropping Sequence and Gross Margin Achieved $/ha							
Crop Option	S1 Ba-Ba-Ca	S2 Ba-Le-Ca	S3 Ch-Cr-Ca	S4 Ch-Em-Ca	S5 SB-Ba-Ca	S6 SB-Le-Ca	S8 Ba-Ca-Ca	S9 Ca-Le-Ca
1st Bare Fallow	-193	-193					-193	
2nd Bare Fallow	-138				-138			
Leichhardt soybean		-373				-373		-373
Jimbour chickpea			-330	-330				
Sugarbeet					-199	-199		
Emerald mungbean				-416				
Crystal mungbean			-416					
Continous RB76-5418								
4R Q209								1141
Plant KQ 228	1094	1341	1210	1088	734	864	1037	462
1R KQ 228	3113	2649	2879	3124	3430	3022	832	2830
2R KQ 228							2928	
Cumulative Gross Margi	**3876**	**3424**	**3343**	**3466**	**3827**	**3314**	**4604**	**4060**

Table 7: Gross Margin Comparison of treatments

QDAFF staff also undertook an economic assessment of the adoption of an extended fallow program on a commercial scale farm (Appendix 1). Their analysis concluded that extended fallows have the potential to improve overall property gross margin and diversify income risk. However, for extended fallows to be viable, suitable fallow crops with positive gross margins need to be identified and the opportunity to diversify income must be balanced with the increased risk of negative returns, as experienced in these trials.

Total Cane Production – Industry Viability

Whole of industry viability is driven by throughput of cane supply. Cane yield improvements from plant and 1st ratoon following the extended fallow were insufficient to make up the supply shortfall from the traditional short fallow treatments that included an extra cane harvest in the trial period. Milling viability is likely to be reduced by any reduction in cane supply.
Extended fallows will only be viable if cane yield improvements are measured into later ratoon crops.

Treatment	2009 4th Ratoon t/ha	2010 Plant cane t/ha	2011 Plant cane t/ha	2011 1st Ratoon t/ha	2012 1st Ratoon t/ha	2012 2nd Ratoon t/ha	cumulative t cane/ha
S1 Ba-Ba-Ca			81.4		83.5		164.9
S2 Ba-Le-Ca			79.5		73.6		153.1
S3 Ch-Cr-Ca			82.5		78.5		161.0
S4 Ch-Em-Ca			75.6		85.3		160.9
S5 SB-Ba-Ca			77.3		92.6		169.9
S6 SB-Le-Ca			70.8		85.9		156.7
S8 Ba-Ca-Ca		92.0		63.5		83.8	239.3
S9 Ca-Le-Ca	73.0		59.7		79.48		212.2

Table 8: Cumulative Cane Yields from Each Treatment

Intellectual Property and Confidentiality:

There are no aspects of intellectual property protection that have arisen from the conduct of this project.

Capacity Building:

Group members have improved their understanding and skill with agronomy of a range of new crops. Agronomy skills include planting and crop establishment, crop protection with herbicides and insecticides, harvest decision making. Issues of herbicide plant back periods and harvest with holding periods and MRL's were important factors learned and considered in crop sequence planning. Skills were gained from communication with a range of outside experts and service providers, various group members visiting the Agrotrend field days at Emerald, GRDC update at Goondoowindi. Each of the field days and GRDC update allowed group members to discuss grain marketing, demand, logistics and returns.

Figure 14: Trial field walks were common during the fallow crop evaluation phase.

Environmental and Social Impacts:

There have been no adverse environmental or social impacts from any activity of the project.
Social impacts have been positive with improved knowledge and skill development among group members, enhanced interaction with other growers from other regions through communication of project results.

Outcomes:

Unfortunately, the extreme seasonal conditions experienced during the field trial phase limited the performance of the crops evaluated which resulted in negative gross margins. This limits the appeal of the extended fallow concept to many and has led to little adoption of the concept to date.
Astute growers are considering the opportunity offered by extended fallow lengths and are considering options to re-evaluate and enhance the profitability of other crops. A new extended fallow trial has been established by an interested grower at North Eton in 2013 with support from Plane Creek Sustainable Farmers members.
Several group members are now growing a legume crop in the summer post ploughout, followed by a cereal (oats) cut for hay then cane late planted. This is not skipping a cane planting season, but is an extension of the traditional fallow period. Oats provide some beneficial suppression of nematodes and take up much of the potentially excessive nitrogen supplied by large soybean crops.
Several growers throughout the industry are now evaluating the production of other crops in combination with skip row cane planting.

The economic analysis undertaken by QDAFF staff suggests sugar price will have an important bearing on the economic performance of an extended fallow regime. Lower sugar prices enhance the attractiveness of extended fallows.

The project has led to further investigations and learning about soil health by group members. This learning resulted in Plane Creek Sustainable Farmers facilitating soil health workshops in Mackay and the

Burdekin, with over 70 growers paying to attend. The workshops were conducted by Dr Ash Martin from Microbiology Laboratories Australia.

Communication and Adoption of Outputs:

Numerous field walks were conducted during the field trial phase of the project. Project activities have been written up by SRDC staff, articles in the Bush Telegraph, presentation at Project Catalyst forums and most recently a presentation at GIVE 2014. Mark Hetherington (formerly BSES), Jackie Richters (formerly PCPSL) and John Hughes (QDAFF) assisted in numerous communication activities. The financial contributions of SRDC and SRA have always been acknowledged in project communications.

Figure 15 : A key form of communication used in the project was field walks and discussions

Recommendations:

There is significant opportunity for further development of complimentary break crops to improve their viability and suitability for inclusion in the sugarcane farming system. Further work to evaluate various crops, different varieties of trialed crops, experimentation with planting dates, improved agronomics such as weed and pest control. Sugarcane yield improvements must extend into later ratoons to ensure the total cane crop produced for a mill area is not reduced.

Refinement and successful extended fallow cropping promises a more resilient sugar farming business through improved cane yields, reduced nitrogen fertiliser input costs, reduced nitrous oxide emissions, improved income in lower sugar price environments and increased and more diverse farm income streams with price cycles unrelated to the sugar price cycle.

Publications:

Edwards B, Sluggett R, Star M (2013) Informing policy design for water quality improvements in the sugar cane industries adjacent to the Great Barrier Reef: a case study approach. 57th Australian Agricultural and Resource Economics Society, Annual Conference, Sydney.

SRDC Update – October 2010. Fallow crops boosting productivity.

Acknowledgements:

(List people and organisations that assisted and/or supported you, to enable you to complete this project.)

Numerous people and organisations provided assistance to this project including, Mark Hetherington (formerly BSES), Jackie Richters (formerly PCPSL) and John Hughes (QDAFF) assisted in numerous communication activities. BSES/SRA provided ccs, nematode and Pachymetra analysis, Brooke Edwards and Megan Star of Queensland Department of Agriculture, Fisheries and Forestry for economic analysis of fallow cropping strategies. Don McNichol of Landmark for assistance with crop seeds and crop protection products. Roger Lindeman, Ag Consultant for assistance with crop rotation planning and crop options.