SRDC Grower Group Innovation Project
Final Report

SRDC project number:	028
Project title:	Facilitating enhanced peanut / sugarcane rotations by assessing and managing the issues related to growing peanuts in uncultivated cane trash blanket fallow.
Group name:	Sustainable Sugar and Peanut agriculture P/L (Spag P/L)
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Australian Government
Sugar Research and Development Corporation

Body of Report

Executive Summary:

Rotation cropping has been identified by the Sugar Yield decline Joint Venture (SYDJV) as a critical tool in addressing decline in the Australian sugar industry. Previous research demonstrates that when break crops are combined with correct row spacing, GPS guidance and minimal cultivation they can be powerful tools in addressing yield decline. Producers on sandy soil have found that the nematode controlling effects of growing peanuts as a break crop is more beneficial than other legumes. The industry standard for peanut production in cane based farming systems involves a number of cultivations. There is ample evidence demonstrating that cultivation is detrimental to soil biology and structure. This body of evidence was at the heart of the members of SSPag when they decided they wanted to try to grow peanuts in an uncultivated cane trash blanket. That was our aim. In order to achieve our goal we sought and received support from SRDC to conduct the trial work necessary. The trial included a Factorial Randomized Area as part of a 3.3ha site. The randomised area was comprised of three tillage regimes (conventional, reduced and zero) by two fertiliser treatments (nil and 100kgN/ha supplied as urea) with four replicates. Each experimental unit consisted of three 1.83m beds by 20m row length. The trial was implemented in a third ratoon paddock of Cv. Q188 that had been grown on 1.83m beds with a dual row configuration under green cane trash blanket. The whole area was treated with Lime @ 3t/ha and Dolomite @ 1t/ha applied to the trash surface. The main trial area was fertilised as dictated by soil testing but the nitrogen component was modified in the randomised trial area. A literature search made us believe that we needed to rip under the peanut row to alleviate the compaction caused by the cane harvesting equipment. This was done using a coulter and Yeoman ripper in all areas except the zero till plots. The conventionally cultivated plots were cultivated by rotary hoe in addition to the ripping. The soil was quite moist for the ripping process and not all the ripper tracks closed in even after the application of a waisted roller. The peanuts were planted using an inclined plate seed meter and “Day Break” single disc opener. The seeds were dusted with inoculant before being loaded into the planter.. The strike was slow and uneven because of a number of issues. The most critical was the failure of the disc to cut the trash cleanly resulting in the seeds being enveloped by trash causing poor soil to seed contact and therefore poor and slow germination and failure of the inoculant due to drying out Another issue was the open ripper marks saw some seeds going deep into the soil and only emerging some weeks later. The results at harvest were best in the conventional system with the zero till being the worst. Only the conventional system produced a viable result. The addition of the nitrogen had a positive effect in all cultivation regimes. The cane crop following the peanuts saw a not statistically significant effect, that the conventionally cultivated plots were most productive and the zero till the least productive. It should be noted here that no fertiliser at all was added to grow the cane crop in the rep area because we thought this would even out the resulting cane crop. This was probably true as the plots that had the N added to the peanut crop outperformed the plots that had no N added to the peanut crop. In some areas of the bulk area of the trial we fertilised the crop as is the normal practice and did not fertilise in other areas. At harvest it was determined that the unfertilised sections were less productive but more profitable when taking into account the cost of the applied fertiliser. Overall the project alerted us to the need for a purpose built planter that would be able to successfully plant peanuts through the trash blanket. We applied to SRDC for support for this and were successful in gaining funding and building the planter. The results of this project GGP040 is available through SRDC.

Background:

The farmer members of SSPag have soil organic carbon levels of between .6 and 1.2% so we are always looking for ways to increase this number and reducing cultivation has been highlighted as one way of achieving this. We already practice trash blanket retention, controlled traffic and legume rotation but saw a need to go further if we were to improve our soil health to an acceptable level. While it is an easier option to use minimum tillage with Soy Bean as our break crop the members saw peanuts as a better option in regard to Nematode suppression and profitability.

Aims:

- To determine whether or not a commercial crop of peanuts can be grown in an uncultivated trash blanket.
- If a crop can be grown can it then be harvested successfully using conventional equipment with minor modifications.
- If it can’t be harvested what issues need to be overcome to make harvest possible.
- What is the water requirement compared to conventional kg per kg peanut production.
- Does non incorporation of soil ameliorants affect cadmium uptake.
- What is the impact of this system on applied Nitrogen?
- What spray out regime is most effective for control of cane regrowth.
- Plant a crop of cane following the peanut harvest and monitor and assess it through to first harvest including randomised trial plot.

Methodology:

The trial design was a Factorial Randomized Complete Block Design comprising three tillage regimes (conventional, reduced and zero) by two pre-plant nitrogen applications (Nil and 100kgN/ha supplied as urea) with 4 replicates. Each experimental unit consisted of three 1.83m beds by 20m row length on a yellow dermosol (Donnollan *et al*.). The trial was implemented in a third ratoon paddock (GPS Co-ordinates 24^o. 58'08" S, 152^o.21' 51"E) of Cv. Q188[A] that had been grown on 1.83m beds with a dual row configuration with 500mm between the duals under a GCTB culture. The cane was harvested on 5th August 2006.

Tillage in the conventional tilled plots consisted of coulter / rip followed by 2 rotary hoe operations and bed former on 30.09.06. The only tillage in the reduced till plots was a coulter / ripper on the peanut plant line, approx 37cm either side of the cane bed and cane re-growth was controlled via Glyphosate (450g/L) application of 4.8 litres/ha post cane harvest pre peanut plant and via Verdict® in crop. The zero tillage plots had no mechanical cultivation and cane re-growth was controlled only by the herbicides as mentioned for the reduced tillage plots.

Soil pH was ameliorated by the application of 3t/ha of lime and 1t/ha of dolomite post cane harvest. Fertiliser for the peanut crop, Potassium as Sulphate of Potash @ 120 units of K /ha was drilled via a "Barton" single disc opener in bands 5cm beside and 5cm below the peanut plant line ten days pre-plant. The pre-plant N was applied before tillage operations. An inclined plate seed meter and "Day Break" single disc opener were used to sow the peanut crop Cv. Holt[A] at a seeding rate of 133000 seeds/ha on 17.10.2006. Traditional high input culture was used to grow the peanut crop which typically involves six and four fungicide applications of Bravo® and Alto® respectively. Irrigation of approx 3ML/ha was applied via travelling irrigator to ensure plants were not water stressed. This was a compromise between the trash section that needed less and the conventional section that could have used more.

Early season and pre-harvest peanut biomass was determined via a 0.9m^2 destructive sample in each plot the number of plants were recorded in the sample area to determine plant populations. Biomass was placed in dehydrator at 60^o C until constant dry weight was achieved.

Peanut yield was determined via threshing 10m of the centre row of each plot using a KEW small plot harvester. The samples were dried, weighed and graded using commercial practice and was performed by the Peanut Company of Australia (PCA).

Cane was Cv. Q151 was planted (20/09.07) using a conventional billet planter without the addition of any fertilizer. The conventional tilled plots were tilled pre cane plant via a rotary hoe whereas the reduced and zero tillage plots were centre ripped only to alleviate the compaction caused by the peanut harvester. Post cane planting, conventional hilling-up and cane culture were implemented. Cane yield and CCS were determined via hand harvesting 10m of the centre row of each plot as described by Liu & Kingston (1993), Muchow *et al.* (1993) and Thomas *et al*. (1993). Briefly this involved weighing total biomass from the 18.3m^2 area, partitioning a sub-sample into millable stalk (determined as the nodes below the node bearing the 5th dewlap) and trash. A record was kept of total number of stalks, total biomass, sub-sample total weight, weight of millable stalk in sub-sample and a six stalk sub-sample was sent to BSES to determine CCS content via small mill.

All data was analysed with GenStat® package release 9.2. Analysis of variance (ANOVA) was used on all data with the model Tillage * Nitrogen and replicates as block in general analysis of variance. Significant difference determined via pairwise test between means using the LSD procedure to rank means.

Results and Outputs:

When attempting to evaluate complex farming systems, access to machinery capable of establishing a crop in the heavy trash layer left by sugarcane grown under GCTB culture is essential. Peanut productivity, rhyzobium survival and subsequent sugarcane productivity were affected by the inability of the single disc opener planter to establish the peanut test crop. This led to the development of a prototype planter for the second experiment in the following season.

Early Peanut Growth

Peanut biomass in the conventional tillage treatment was 83.6% and 95.2% greater than the reduced and zero tillage treatments respectively approx 60 days after sowing, Figure 1. Crop establishment was significantly effected by reduction in tillage (Table 1) due to the single coulter inability to cut cleanly through the trash resulting in the seed enveloped by trash in the soil.

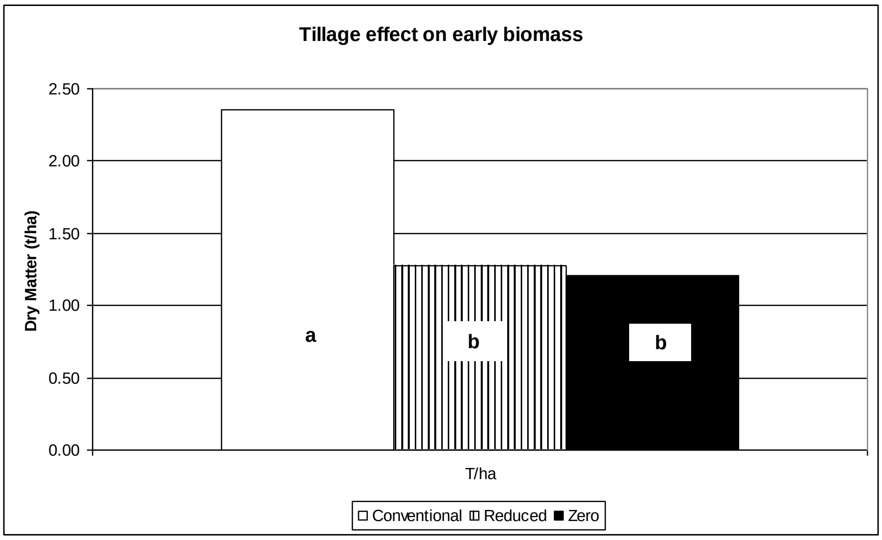

Figure 1: Tillage effect on peanut biomass 60 days after sowing. (Values with the same letters are not significantly different p = 0.05)

Treatment	Plant Population (plants/ha)
Conventional	131 943
Reduced	99 999
Zero	106 943
lsd (5%)	**14 689**

Table 1: The effect of tillage on peanut establishment

There was a 130% improvement in early peanut biomass production from the pre-plant application of 100 kgN/ha, Figure 2.

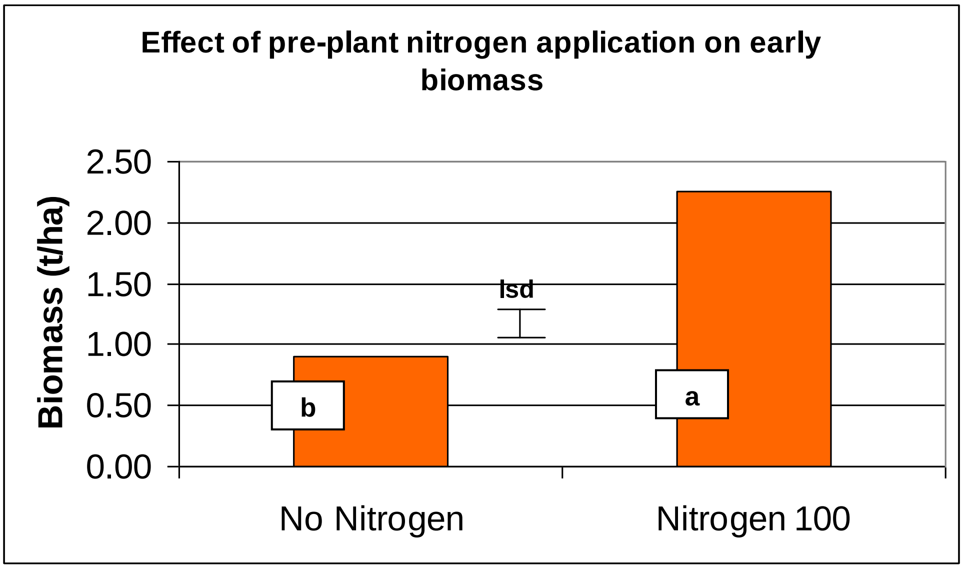

Figure 2: Effect of pre-plant nitrogen application on early crop production. **(Values with the same letters are not significantly different p = 0.05)**

Peanut Yield

Tillage had a significant effect on peanut yield (t/ha), crop value ($/t), gross crop value ($/ha) and grades (%Jumbo's, %1's, %2's and %Oil), Table 2.

P-Value							
	t/ha	$/t	$/ha	%Jumbo	%1's	%2's	% Oil
Tillage	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Nitrogen	0.111	0.002	0.083	0.002	0.075	<0.001	<0.001
Till * N	0.881	0.248	0.912	0.393	0.725	0.289	0.196
Tillage	t/ha	$/t	$/ha	%Jumbo	%1's	%2's	% Oil
Conventional	5.45[a]	812[a]	4 443[a]	51.25[a]	9.26[b]	5.51[b]	5.41[b]
Reduced	3.07[b]	762[b]	2 356[b]	43.14[b]	13.3[a]	8.08[a]	7.41[a]
Zero	2.39[b]	747[b]	1 801[b]	39.05[b]	15.19[a]	9.62[a]	7.59[a]
LSD (5%)	**1.026**	**25.66**	**873.3**	**4.792**	**2.204**	**1.603**	**1.167**
Nitrogen	t/ha	$/t	$/ha	%Jumbo	%1's	%2's	% Oil
0N	3.31	754.8[b]	2 556	41.14[b]	13.39	9.12[a]	7.84[a]
100N	3.97	792.8[a]	3 177	47.82[a]	11.77	6.35[b]	5.77[b]
LSD (5%)	**N/A**	**20.95**	**N/A**	**3.913**	**N/A**	**1.309**	**0.953**

Table 2: Statistical summary of peanut yields. **(Values with the same letters are not significantly different p = 0.05**

Pre-plant application of 100kgN/ha significantly affected peanut grades which in-turn impacted on crop values ($/t). Whilst there wasn't a significant interaction between tillage and nitrogen, there was a trend for the pre-plant nitrogen application to have a greater effect in the reduced and zero tillage treatments. Peanuts are an indeterminate crop and crop value ($/t) is determined via grades with "Jumbo's" being the highest value and "Oil's" the lowest. Pre-plant nitrogen application improved the % Jumbo’s by 6.3%, 19.2% and 27% for the conventional, reduced and zero tillage treatments respectively Figure 3.

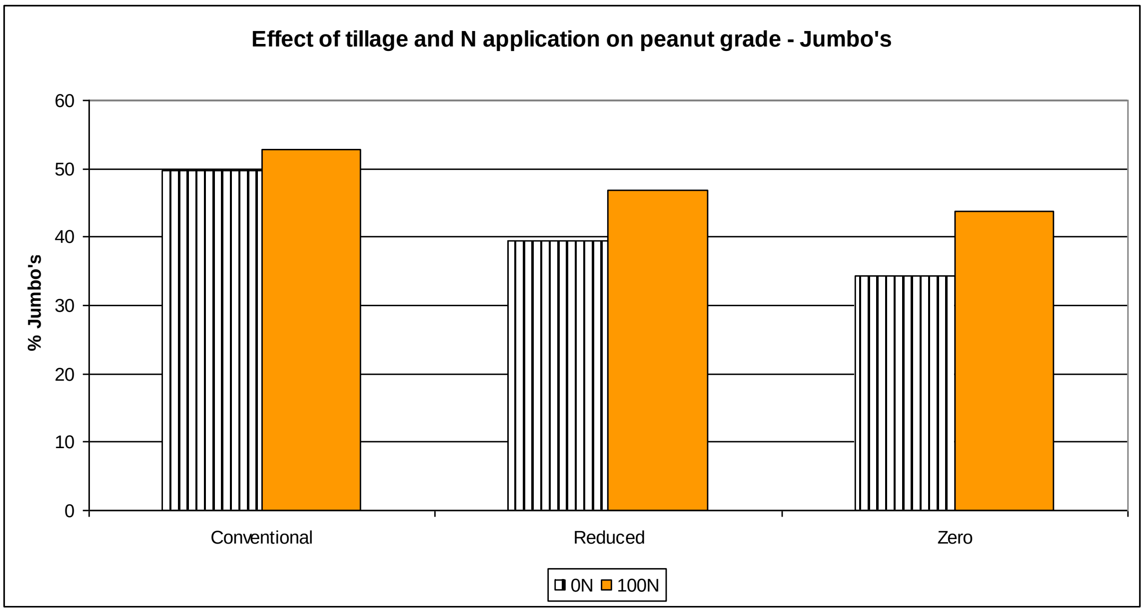

Figure 3: Effect of pre-plant nitrogen application on % “Jumbo’s” in the differing tillage treatments.

Subsequent sugarcane productivity.

Whilst tillage and pre-peanut plant nitrogen application did not have a statistically significant effect on sugarcane total biomass, millable stalk yield, number of stalks, individual stalk weight (ISW), CCS ,(Table 3), there was close to a significant effect (p=0.055) on sugar productivity, Figure 4. This was due to a trend of lower millable stalk yield and lower CCS content in the reduced/zero tillage treatments that when combined resulted in a different sugar yield.

P-Value						
	Total Biomass	Millable Stalk	Stalks	ISW	CCS	Sugar
Tillage	0.134	0.124	0.592	0.880	0.158	0.055
Nitrogen	0.411	0.335	0.256	0.525	0.541	0.448
Till * N	0.920	0.496	0.808	0.818	0.678	0.645
Tillage	(t/ha)	(t/ha)	(stalks/ha)	(kg/stalk)		(t/ha)
Conventional	149.1	114.6	96 697	1.117	15.216	17.40
Reduced	138.4	105.9	92 492	1.139	14.917	15.80
Zero	137.8	104.7	94 567	1.146	14.802	15.51
LSD (5%)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Nitrogen	(t/ha)	(t/ha)	(stalks/ha)	(kg/stalk)		(t/ha)
0N	139.7	106.1	92 656	1.150	15.031	15.99
100N	143.8	110.4	96 533	1.118	14.925	16.49
LSD (5%)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

Table 3: Statistical summary of sugarcane productivity post peanut break crop.
(Values with the same letters are not significantly different p = 0.05).

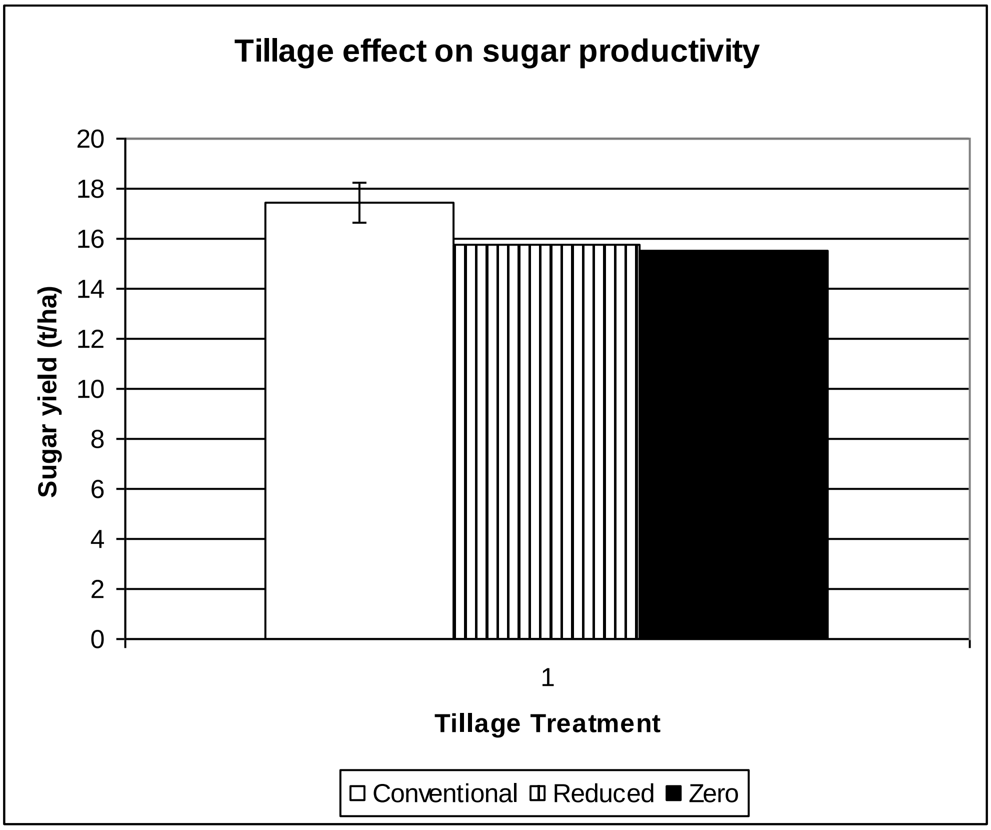

Figure 4: Tillage regime impact of sugar productivity.

Further analysis of the data demonstrated that sugar productivity was significantly correlated to the total biomass production of the previous peanut crop (p=<0.001) Figure 5.

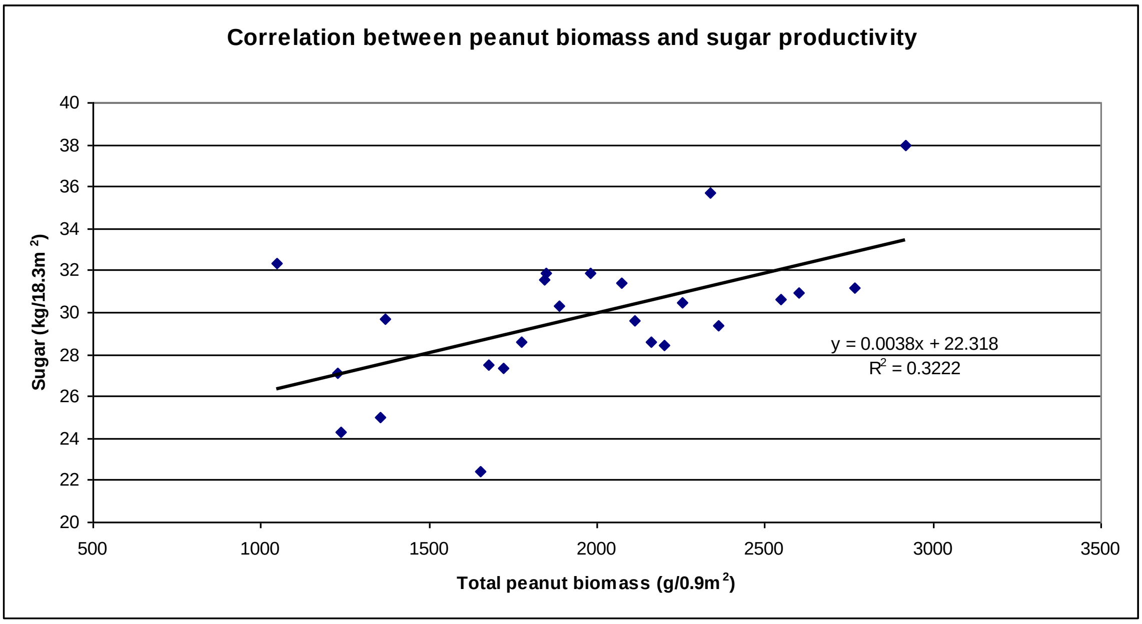

Figure 5: Correlation between previous peanut crop total biomass production and subsequent sugar yield.

Intellectual Property and Confidentiality:

There are no confidentiality issues in relation to this project.

Capacity Building:

During the conduct of the project it became evident that members had both strengths and weaknesses and we learned to use the strengths for the greatest benefit while still encouraging some involvement in the areas of weakness even if to highlight the contribution of each member in their strong areas to the other members. Because of this approach we believe that we have all learned to work better as part of a team and all have learnt more about conducting research..

Outcomes:

The main outcome from this project was the identification of some of the impediments to instigating a minimal till cane/peanut rotation system. Some of the things we assumed would be problematic were not eg harvesting while other things that were not expected to be an issue eg inoculation were. A key result of this project was that it spawned a second project GGP040 that led to the production of a planter capable of planting peanuts in the cane trash blanket. This one step significantly increased production from the new system but there are still impediments to the introduction of the new system that must be addressed before it can be put forward as a viable option to producers..

Environmental Impact:

There were no negative environmental outcomes from the conduct of the trials but there is an opportunity for many environmental benefits to flow from this type of system if the limiting factors can be addressed and the system is adopted. These include improvements in soil quality, less erosion, the reduction in fossil fuel use and water savings.

Communication and Adoption of Outputs:

SSPag has conducted a number of farm walks, information meetings and aligned itself with grower representative bodies in our area in order to be included in their field day activities. This either meant SSPag members presenting at associated activities or groups visiting our trial sites with us explaining the project and any relevant findings. On every occasion the support of SRDC has been highlighted and recognised. The group has delivered a number of media releases and made ourselves available for interview by local, state and national media outlets and industry publications. While the new system is not yet at a point that it is viable in comparison to conventional systems group members are changing their cane growing system from dual row to single row in anticipation of achieving better results if peanuts can be planted beside the stool instead of into the stool. Next peanut season 10/11 will see the first single row cane areas being planted to peanuts through the trash. Two group members have planted areas other than the trial sites to the new system to mixed results. One area that was prone to severe erosion exhibited no erosion under the new system but a wetter than average season saw ill effects from the moisture retaining properties of the new system thereby reducing yield. Some group members have committed to trial the system further in the hope of identifying and eliminating the issues still causing negative impacts. As part of the trial cane crops grown after the peanuts were grown without the use of any additional fertiliser and still produced crops in excess of 100t/ha. Those farmers visiting the sites and attending briefings were given this data and will hopefully consider at least reducing their fertiliser applications after peanut break crops.

Recommendations:

As a result of this project SSPag with the support of SRDC undertook another project GGP040 that involved building a prototype planter capable of planting peanuts through the sugarcane trash blanket and then growing a crop of peanuts in the trash followed by a cane crop. While the planter developed successfully planted the peanuts through the trash blanket, the resulting peanut crop although being much improved in comparison to the initial trial, was still only 76% of the production of the conventionally grown crop in the same block. The following cane crop on the minimum till area was only 93% of the cane crop following the conventionally grown peanuts. This indicates to us that there are other factors at play that if identified by further trials may be managed so that the minimum till cane/peanut rotation can become a viable proposition. We therefore recommend more research be undertaken in this field probably by Research Scientists as the protection of the reef is a high priority of both levels of government in Australia.

Publications:

The CD that accompanies this report contains a number of articles written about the project as well as relevant pictures of field days etc, our presentation to Give 08 and a paper written on the project for AASCT 2010. The pictures and Give presentation also relate to the sister project GGP040.