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Sugar farming systems development and demonstration on the wet tropical coast

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SUGAR FARMING SYSTEMS DEVELOPMENT AND DEMONSTRATION ON THE WET TROPICAL COAST

PROJECT No.: DPI014

DEPARTMENT OF PRIMARY INDUSTRIES

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Abbreviations

SRDC	Sugar Research and Development Corporation
SYDJV	Sugar Yield Decline Joint Venture
QDPI	Queensland Department of Primary Industry
CPPB	Cane Pest and Productivity Board
BSES	Bureau of Sugar Experimental Stations

1. EXECUTIVE SUMMARY

The QDPI Sugar Solutions Project was an extension project focussing on group activities and on-farm demonstrations. Objectives of the project included the development and testing of alternative farming practices to improve the viability of cane production on the Wet Tropical coast from Ingham to Mossman. The alternative farming practices included the use of legume fallows and minimum tillage.

Extension of these practices was done through a participatory, grower-led action learning approach. Ten grower groups were established throughout the region and a variety of legumes were established on group member farms. Soybean was the main legume promoted for summer fallows as a green manure crop. There was an excellent adoption by farmers from 7 growers, at the start of the project, to over 80 growers and 800 ha by the conclusion of the project.

A number of other legumes including; peanuts, navy beans, mungbeans and chickpeas were trialed during the winter months. These legumes, which can be grown as cash crops in a short period of time, require greater inputs than soybeans and were not always successful. Growers who did grow winter crops often followed these crops with soybeans in the summer, increasing the fallow period.

Growing fallows using minimum or zero tillage was carried out by a number of growers. A few growers also went on to plant cane following the fallows using minimum tillage methods. Adoption of the minimum or zero till concept by growers was not high with only 13% of growers planting fallows using these methods but is regarded as being on the increase.

An economic evaluation (spreadsheet), comparing fallow plant with plough-out replant, facilitated change by showing that a well-grown legume fallow and minimum tillage led to a more productive and economic cane cycle.

Publications during the life of the project included; newsletters, crop guides with gross margins and a brochure called "Best Practice for Alternative Cane Farming Systems". These publications as well as numerous media articles aided in the extension process of these alternative practices.

The increased adoption of the new technologies is leading to a more sustainable farming system with more effective fertiliser and chemical usage as well as a reduction in sediment loss.

2. BACKGROUND

The sugar industry in the Wet Tropics is suffering from reduced profitability. This is related to declining CCS levels and yield combined with low world sugar prices.

Results from the Sugar Yield Decline Joint Venture Project have indicated that changes in management practices can improve productivity and profitability. These changes include the use of complementary crops such as soybeans and other legumes that, through the addition of nitrogen and improvement in soil health, increase productivity. Other related practices that integrate into the farming system include minimum tillage and controlled traffic. While the promotion of legumes in effect reinforces that the old practice of a legume rotation was the right thing to do, the use of minimum tillage and controlled traffic is a much more innovative practice requiring greater demonstration of the benefits.

The project was seen as a component of Phase 2 of the Sugar Yield Decline Joint Venture Project (SYDJVP) and worked closely with that project particularly, Dr A Garside, in the development of operational plans and reporting of outcomes. It was essentially an extension arm of the SYDJVP. Prior to the initiation of this project the spread of information to farmers had been limited by the restricted amount of resources that could be devoted to it. This project focussed mainly on group activities and on-farm demonstrations.

This SRDC funded project was part of a larger QDPI project known as Sugar Solutions. The Sugar Solutions project was aimed at enhancing the outcomes of the on-farm demonstrations by improving the business planning skills of the farmer groups, conducting economic analyses of the various farming options, and studying broader structural issues within the sugar industry.

3. OBJECTIVES

The objective of the project was to develop and test farming practices that improved the viability of cane farming systems on the wet tropical coast using a participatory action learning approach and all the other appropriate extension methods. The project aimed at supporting sugar cane groups between Mossman and Ingham to address farm viability issues on the wet tropical coast.

Specific objectives and levels of achievement were:

- *On farm evaluation of different farming systems and complementary crops to enhance sugar cane production.*

  A wide variety of legume crops were established on farms throughout the far north as either summer or winter crops to assess their suitability for inclusion in the cane farming system. Soybeans were the preferred option although a few farmers have persevered with navybeans and peanuts. The level of adoption so far is covered in the results section.

- *On farm implementation and evaluation of the outcomes of the Sugar Yield Decline Joint Venture Project specifically targeting low CCS and low profitability.*

  Over 800 hectares of soybean were grown in the 2001/2002 wet season, indicating a high level of adoption of soybean as an effective part of a cane farming system. The on farm increase in cane yield after soybeans in most cases was similar to that achieved under experimental conditions, indicating the benefits of a break crop. An economic assessment carried out using farmer-sourced yield increases, demonstrated real increases in profitability as a result of adoption of a different farming system. No changes in CCS were either demonstrated or expected.

- *Monitoring of alternative systems to provide learning about farming options.*

  Weekly monitoring of summer and winter legume crops throughout the region was implemented to collect data on growing these new crops in this environment. This information was collated and formed the basis of the content of many of the newsletters published and the crop guidelines produced.

- *A participatory, grower-led, action research approach to addressing farm viability and low ccs on the wet tropical coast.*

  Ten grower groups were established throughout the region and there was significant involvement with other grower groups facilitated by BSES and the mills. Farm walks and similar exercises ensured considerable grower participation.

- *Extension of improved sugar cane farming systems to enhance industry viability and profitability.*

  A brochure "Best Practice for Alternative Cane Farming Systems" was produced as part of the longer-term extension of information with the intention of consolidating progress in extension made through the action learning participatory farmer groups.

4. METHODOLOGY

1. New groups of farmers were established at ten locations throughout the wet tropics from Ingham north to Mossman, excluding the Atherton Tablelands. In addition, any other existing grower group already established and facilitated by the Mills, BSES and Productivity Boards were involved to some extent in the participatory learning approach. Farmers in each group were encouraged to plant a wide range of legume crops to assess their suitability as complementary crops to cane and to assess their suitability as cash crops. Two out of the ten groups were encouraged to concentrate on minimum tillage as a key part of any future cane farming system

2. Information was collected from the experiences gained by farmers with each crop and used to develop guidelines for all farmers who were interested in growing the crop.
3. An economic analysis was carried out on all proposed crops and their impact on the viability of the whole cane farming system assessed.
4. A newsletter was used to reach a wide range of people (Circulation 300) not reached by the action learning groups.

The methodology used was largely set out in the original project proposal to the SRDC and signed off by both parties. The action learning groups are well recognised as a method through which change actually occurs.

Reporting against the aims of the original project proposal inevitably means that a degree of repetition occurs.

5. RESULTS

5.1 Introduction of legumes into the farming system.

5.1.1 Seed Supply

The area of legume crops grown is one measure of the results of the project. The supply of seed was a limiting factor in the introduction of soybeans into the farming system. Twelve tonnes of seed were available in the first year and 30 tonnes in the second year for the whole cane area north of Mackay. Seed supplies in the third year were more difficult to determine with multiple sources being developed as a result of demand. Some small supplies were available from growers who grew a winter crop of soybeans, generally only one to two hectares. Ironically in the 2001/02 season it has been soybeans that are readily available and the others in short supply an indicator of changing attitudes.

5.1.2 Soybeans planted in fallow

The following table shows the change in the area grown over time. These results were from data collected. However, anecdotal evidence suggests that actual areas planted were well in excess of those recorded, particularly in 2001/2002.

Table 1 Changes in the area of soybean grown over the life of the project

Year	**1999/2000**		**2000/2001**		**2001/2002**	
Region	**No. of growers**	**Area planted (ha)**	**No. of growers**	**Area planted (ha)**	**No. of growers**	**Area planted (ha)**
Mossman			4	52.5	9	103.5
Cairns			2	30	2	15
Gordonvale	2	11	9	45	17	111
Babinda					6	22
Innisfail	2	8	5	16	16	64
Tully	2	50	5	47	16	293
Ingham	1	6	3	11	16	230
Total	**7**	**75**	**28**	**201.5**	**82**	**838.5**

The SYDJVP concentrated on legumes as the summer break crop, usually soybeans. Pastures were also assessed but no attempt was made to incorporate these into the farming system as they were seen as taking the land out of cane for too long and as a result unlikely to be profitable. However, with current sugar prices the grazing of cattle on pasture breaks in a cane system may well need re-assessing.

5.1.3 Winter legumes

Some farmers realised that a winter as well as a summer break crop could be part of their farming system, with a longer than six-month fallow. These farmers planted legumes on land that might have otherwise been used for a plough-out replant cane system.

Winter crops were often followed by a summer soybean planting prior to returning to sugarcane. Table 2 contains some statistics on the areas used in this way. Soybeans, chickpeas, mung beans, navy beans and peanuts were all tried. Chickpeas had not been used in SYDJVP work before so this was new work.

Winter legumes are attractive because of their short duration compared to other legume crops and could potentially fit into the short period between harvesting the last ratoon and the planting of a summer legume fallow.

Table 2 Area under winter grown legume crops

Type of crop	Winter 2000 (ha)	Winter 2001 (ha)	Winter 2002 (ha)
Soybeans	1	37	
Mungbeans	60	13	4
Chickpeas	0.25	1.5	
Navy beans	8	4	8
Peanuts	4	8	

Not all the winter-grown crops performed well and this was in part due to seasonal conditions such as dry weather. Most cane farmers in the wet tropics do not have irrigation and growing winter crops without irrigation constitutes a risk.

Two growers have persisted with navy beans and peanuts as winter crops and have purchased a header to harvest grain. Winter-grown soybean crops did grow better than expected and the growing of small areas as a seed source for the following summer fallow can be expected to continue.

Another problem encountered with growing winter crops is the nutritional status of the soil after cane. Where crop performance was poor, soil tests indicated that these paddocks generally had a low soil pH and were low in potassium, calcium and magnesium. Where soil nutrition was addressed, crop establishment and subsequent yields were good.

One of the tasks set out in the original proposal was to collect agronomic data for the crops. Hence, herbicide demonstrations were established at ten sites throughout the

north. These sites allowed observations on the efficacy of the herbicides used and assisted with recommendations for various legume crops. It was also a very useful exercise for preparing crop guidelines. More detailed herbicide trials will be carried out in future to quantify the benefits of using effective weed control in legumes.

5.2 Minimum Tillage

5.2.1 Minimum tillage of soybeans

The title of "minimum tillage" is used, as it was the one used initially in the project proposal. However, the name is confusing in that different people interpret it differently. For example, many cane growers claim that they are using minimum tillage already by cultivating 4-5 times compared to 12- 15 times in the past. Others see no cultivation in the ratoon crops as practising "minimum tillage" but still use substantial soil disturbance or conventional tillage for plant/replant crops.

Unfortunately these misconceptions lead to the conclusion - "we are doing these things already" - with the implication that they do not have a problem and there is no need to change.

The following are the definitions used for the purposes of legume planting in this report:

Conventional Tillage involves ground preparation and cultivation of soil until a fine tilth is achieved for planting. Cultivation is carried out over the entire paddock and is usually achieved with equipment such as rippers, discs and rotary hoes.

Minimum tillage is the term used throughout this document and implies a number of tillage practices. These include strategic tillage (and controlled traffic) and reduced tillage.

Strategic tillage and controlled traffic means that there is only soil disturbance to the crop growth zone to provide a prepared area for planting while the inter-row area is not cultivated. Most success is achieved when row spacing matches machinery width but it can be done on the narrower 1.5 metre row widths. The term strategic tillage may create confusion and **zonal tillage**, which refers to growing crops in a cultivated zone, is a better term to use but has not been used widely to date.

Minimum tillage has also been called *reduced tillage*. This basically means a reduction in the number of tillage operations and not necessarily the separation of crop and traffic zones.

Zero tillage means what the name implies, there is no cultivation and planting occurs directly into soil/trash. Zero-tilled soybeans are planted close to the old cane stool where minimal soil compaction has occurred.

Broadcasting of soybeans refers to seed being spread onto the soil surface and then incorporated with harrows or discs. The disadvantages of this system are; planting depth is difficult to regulate resulting in patchy stands, weed control is often poor, and

higher seed rates are required. In addition broadcasted fallows require conventional tillage.

Table 3 Soybean areas planted using varying methods of establishment 2001/2002

Planting method	Total area planted (ha)	Conventional tillage (ha)	Strategic tillage (ha)	Zero tillage (ha)	Broadcast (ha)
Area	838.5	620	56	51	105
Percentage	100%	74%	7%	6%	13%

The adoption of zero or minimum tillage in soybeans was the area where least progress was made in this project. While there is little doubt that "minimum or zero tillage" are preferred options, growers have expressed concerns about actual results. Perceived lack of suitable zero till machinery may have slowed adoption of this practice.

Despite this, some growers recognised the potential cost savings in legume establishment, better timeliness of operations and the potential for reduced erosion during the wet season when land is not cultivated.

Figures in Table 3 refer to the method of establishment of the legume crop. Zero till can also be used for plant cane but there is practically no adoption of this even though it is likely to have large economic impacts through cost reductions and management advantages.

5.2.2 Minimum tillage of cane

One grower group in Innisfail did make some progress with minimum tillage. The group, which has been in existence for 5 years, obtained funding through the local Landcare association to purchase equipment to enable them to plant (and harvest) cane with minimal soil disturbance. The group built a zero till cane planter and bought a bed former and elevator extension for the harvester. The first minimum tillage (zonal tillage) trials commenced in 2002.

Growers see good establishment as a key ingredient to the productivity of a crop over the following crop cycle. If extra cultivations reduce the risk of crop establishment failure then it is worthwhile. The downsides risks of one too many cultivations are seen as low compared to the downside risk of crop establishment failure. This is an area where on farm demonstrations are likely to have a big impact in building up confidence that "minimum tillage" is not a risk.

A number of growers have used minimum and zero tillage methods to plant cane after a soybean fallow. Most growers have indicated that soil after soybean fallows seems very friable and only requires one or two cultivations before planting cane. Others have planted directly into soybean fallows without any prior cultivation.

6. OUTPUTS

The outputs sought under the original project proposal were:

- Economic evaluation of crop rotation and management practice options
- Increased extension of cane production options
- Publication of cane production options, grower case studies, and economic evaluations
- Improved knowledge of the feasibility of rotation crops and other management options
- Improved farmers' confidence in new practices
- Increased adoption of practices shown to be beneficial to farm viability
- Grower input into viability options.
- Industry partnership.

6.1 Economic evaluation of crop rotation and management practice options

Although a number of growers were prepared to implement fallows based on research findings, many were reluctant due to the loss of one cane crop. To facilitate the change a spreadsheet was developed that showed an economic comparison of a fallow plant with a plough-out replant. The spreadsheet enables growers to use their own production figures in the spreadsheet to see how these two systems compared.

The spreadsheet is based on research results from the SYDJVP and includes; a yield increase of 15-20% after soybean fallows and a reduction in the cost of tillage and nitrogen fertilisers. In most cases the spreadsheet indicates that growers will be better off over a period of 3-4 years if they implement good soybean fallows.

In the process of determining the profitability of a fallow crop the optimum crop cycle length comes to light. Both these aspects have attracted considerable attention and are promoting the assessment of alternative management practices using profitability as a criteria rather than the production of sugar or sugar cane.

6.2 Increased extension of cane production options

Initial extension focussed on the implementation of soybean fallows. Meetings were held with all the 10 grower groups to extend research finding of the SYDJVP and help these growers with the establishment of soybean fallows. Further extension of the options were discussed at BSES field days and breakfast meetings, Agribusiness seminars and rural women's groups.

Initial hurdles in establishment of fallows included seed supply and planting equipment. The Sugar Solutions project obtained a Covington row crop planter that was hired out to growers for a minimal fee to ensure good crop establishment. Some growers have now built or purchased their own planters but there is still a need for planters as 25% of the 2001/2002-soybean crop was planted with the DPI machine.

Extension of legumes that could be grown for grain commenced early in 2000. A number of growers were interested in growing crops for a return before re-planting cane or as a means of having a longer fallow (1 year). Crops such as navy beans, mungbeans, chickpeas and peanuts were all planted during the winter months. These crops were monitored on a weekly basis and other farmers were made aware of these crops through field walks, farm days and newsletter articles.

6.3 Publication of cane production options, grower case studies, and economic evaluations

A number of publications were released during the time of the project and are summarised below:

- Two page crop guides for peanuts, navy beans, mungbeans, chickpeas and soybeans as a winter crop. Crop guides also included a gross margin.
- A guide to 'Growing Soybeans for Green Manure in the Wet Tropics'.
- "Best Practice for Alternative Cane Farming Systems" brochure. (This was distributed to all growers from Ingham to Mossman).
- Seven (10 page) newsletters that dealt with all aspects of legume production, equipment, tillage and relevant issues to the project. (circulation 300)

A number of other occasional one page articles on specific crops, inoculation and/or tillage were also written and handed out to growers at various meetings.

The project has received extensive media coverage with articles and photographs published in the Innisfail Advocate, Tully Times, Mossman Gazette, Cairns Post, Rural post, “Canegrowers”, Queensland Country Life, QDPI Farming Systems Newsletter and the Commonwealth publication "Rural Vision".

Other publicity and exposure of the project has been in the form of numerous radio interviews and a number of television appearances by the two extension officers assigned to the project.

6.4 Improved knowledge of the feasibility of rotation crops and other management options

The economic comparison of fallow plant compared to plough-out replant clearly shows a greater profitability after soybean fallows. The benefits of soybean fallows were also measured on-farm in terms of nitrogen benefits and through the reduction of cane parasitic nematodes.

Economic information has been provided to all growers on each of the potential complementary crops.

6.5 Improved farmers confidence in new practices

Many growers now accept that there is a need for change in their present farming system. The fact that the number of growers using soybeans in fallows has increased

dramatically (Table 1) indicates a growing confidence in this crop as a suitable fallow crop. Growers are also continuing with this practice, with the same growers in 2000 again planting soybeans in 2001.

Many growers have now either converted old equipment or bought planters to enable row planting of soybeans. This indicates they will continue the practice of fallowing. Seed suppliers have also invested in the increased production of Leichhardt soybean seed showing their confidence in the crop and in its future.

6.6 Increased adoption of practices shown to be beneficial to farm viability

While the relative short duration of the project prohibits the accumulation of data showing increased farm viability, the increasing participation by growers indicates that they feel the growing of a legume fallow will be of benefit to the farm business. The potential of income-generating fallows has been recognised and pursued by a number of growers as increased income will directly impact on viability. To date, fallow crops have provided little, if any, income but growers are persisting, recognising some cash income potential and clear benefits in the subsequent cane crops. The increased interest in fibre crops such as kenaf may add to the fallow crop alternatives, breaking the cane monoculture and providing cash injection to the business.

The possibility for big savings in tillage after a fallow has been capitalised on by some growers. Many have been surprised by the ease of preparing land and the substantial savings in fuel costs and time. They recognise how this can impact favourably on farm viability. With suitable land preparation prior to the fallow it has been shown that a cane crop can be established with no tillage whatsoever but as mentioned earlier there is still some lack of confidence in this approach.

6.7 Grower input into viability options

Many growers have devoted their land and time to growing complementary crops. There is an element of risk and loss of credibility with peers in experimenting with new farming systems and some growers have made large contributions. An example is one grower who has planted soybeans, navy beans, peanuts, chickpeas and kenaf and has purchased a small second-hand header to harvest the grain crops. Despite variable success with the break crops he has continued with this practice and grown excellent cane crops in subsequent years.

6.8 Industry partnership

The implementation of this project could not have been achieved without the cooperation of BSES staff, Cane Officers in the various mills, Cane Pest and Productivity Officers and the SRDC.

Cooperation with the above organisations was in the form of Sugar Solutions staff speaking at grower meetings, field days and group functions. We have similarly taken advantage of the skills in their organisations to involve them in our functions.

The success of this collaborative approach is seen in the reports we are getting from other organisations now actively promoting the use of break crops.

The project has also been involved in the training of agribusiness to enable them to answer grower questions related to the growing of legumes.

7. EXPECTED OUTCOMES

The expected outcomes sought under the original project proposal were:

- Development of farming systems and technologies for improved ccs and farm viability.
- Development of viable cane systems that maintain cane production
- Increased adoption of improved technologies developed in the yield Decline Joint Venture.
- Sustainable production systems, resulting from the adoption of improved practices, resulting in optimised fertiliser and chemical usage.
- Community benefits flowing from improved farm and mill viability and agricultural diversification.

7.1 Development of farming systems and technologies for improved ccs and farm viability.

Farming systems that use the practice of fallow cropping and a reduction in the number of cultivations are likely to be more financially viable in the long term. This is shown in the economic analysis comparing fallow plant with plough-out replant. However due to the short time frame of this project we have not been able to ascertain the actual viability of a farm due to changed farming systems.

The reduction in tillage is providing greater farm viability due to the reduced costs of cultivation. Minimum tillage is a practice that has found a number of followers mainly due, at this stage, to the reduction in production costs. However, over time, it is expected to improve soil structure, ,soil health and improve productivity.

The SYDJVP trials showed that cane following fallows produced 15 – 20% more yield but fallows had little impact on CCS. This has been validated in grower demonstration blocks. The CCS of cane is more dependant on variety, harvest maturity, fertility and weather conditions. The practice of fallow cropping and reduced tillage may enable farmers to plant more frequently to newer, high CCS varieties at a lower cost.

7.2 Development of viable cane systems that maintain cane production

Maintenance or improvement of cane production is dependant on a number of factors such as climate, varieties and soil. The development of a viable cane system through the use of fallows and minimum tillage addresses the issue of soil health. The use of legume fallows created a greater soil biodiversity, reduced parasitic nematodes, improved the nitrogen status of the soil and improved soil structure.

The number of tillage operations can be drastically reduced following a legume fallow. The practice of minimum till also has benefits for soil health through fewer disturbances of soil micro-organisms and less compaction

7.3 Increased adoption of improved technologies developed in the Yield Decline Joint Venture.

Technologies developed through SYDJVP and extended through this project included fallow management and minimum tillage. There were limited areas of soybeans grown as a fallow legume at the commencement of the project. Common fallow legumes used instead of soybeans consisted of lablab and cowpeas that frequently died with the onset of the wet season. Farmers have now seen the tolerance of soybeans to wet conditions and many are converted vowing never to plant cowpeas again. As previously stated, the 2002 soybean area was in excess of 800 ha showing a significant increased adoption of the technology.

At the outset of the project there was little minimum tillage done and it was common to see very fine seedbeds for planting cane. There was a belief, and still is to a certain extent, that a very fine seedbed is required for good establishment. The minimum tillage work done by Dr M Braunack of the SYDJVP showed that a seedbed could be prepared at half the cost, which resulted in cane establishment that was no different to conventional methods.

The current situation is that a number of growers use minimum tillage (zonal and reduced tillage) for the planting of both fallow-plant and plough-out replant with just one pass of a rotary hoe or the Wilkinson Rotocult[1]. In a few cases cane has been planted with no tillage into pre-prepared soybean or navy bean fallows with no visible difference in establishment. It should be an aim to try and increase this practice.

7.4 Sustainable production systems, resulting from the adoption of improved practices, resulting in optimised fertiliser and chemical usage.

The implementation of well-managed soybean fallows has a number of benefits in terms of fertiliser and chemical usage in the plant cane crop. Good soybean fallows can return as much as 300 kg/ha of nitrogen back to the soil and additional nitrogen will not be required when planting a cane crop. Fallow crops that are incorporated

[1] The Wilkinson Rotocult is a recently developed piece of equipment that allows land preparation with just one pass. Mode of action in the soil is similar to a power harrow but with blades like a rotary hoe.

also provide organic matter, which in turn improves soil cation exchange capacity. This will allow more effective fertiliser applications.

The rotation of a grass crop (cane) with a broadleaf crop (legume) can have major advantages in terms of weed control. Trials with herbicides have shown that grasses are easy to control in broadleaf crops such as soybeans without damage to the crop itself. Good weed control in the fallow crop means that less herbicide will need to be used in the cane crop. The use of legume herbicides also increases the range of products and chemical groups used in cane paddocks. This will reduce the risk of resistant weeds developing which has occurred in other cropping areas.

7.5 Community benefits flowing from improved farm and mill viability and agricultural diversification.

Most of the coastal towns in Queensland depend on the sugar industry for their prosperity. With recent poor crops and low prices both farmers and the communities in which they operate have suffered major hardships. By the future adoption of well-managed fallows and reduced tillage the profitability of farms will improve, trickling on to other businesses in the community.

The development of other crops has already impacted on agribusinesses who have reacted by producing more Leichhardt soybean seed on a yearly basis along with an accompanying distribution chain.

Other community benefits from the adoption of the new technology are environmental as the fallow system can lead to reduced fertiliser and chemical use. The reduction of tillage will also reduce the movement of soil into the waterways giving benefits through reduced sediment and nutrient levels in the water.