FINAL REPORT

PROJECT NSC006

ACHIEVING WORLD'S BEST PRACTICE HARVESTING AND TRANSPORT COSTS FOR THE NSW SUGAR INDUSTRY

Sunshine Sugar

CSIRO

HARVESTING SOLUTIONS

AGTRIX Harvest Recording Systems

Australian Government

Sugar Research and Development Corporation

FINAL REPORT

Project Title:	Achieving world's best practice harvesting and transport costs for the NSW sugar industry
SRDC project number:	NSC 006
Research organisations:	NSW Sugar Milling Co-operative Ltd (NSWSMC) Agtrix P/L CSIRO Harvesting Solutions

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Executive Summary

This project set out to develop innovative techniques for cane supply management within the NSW Sugar Milling Co-operative Ltd (NSWSMC), assess and promote harvester group optimisation within the NSW industry and to aim for world's best practice harvest costs.
In his independent assessment of the sugar industry Hildebrand (2002) reported that forecast prices in 2004 - 2006 would create an urgent need for productivity and cost improvements for the industry to remain internationally competitive. Hildebrand also recommended worldwide benchmarking of activities against the strongest competitors followed by implementation of cost effective options.

This project concentrated on the largest cost item for cane production; harvesting, to develop innovative techniques for efficiency and cost improvement with the aim of achieving worlds' best practice harvesting costs of $4 per tonne of cane. Additionally harvest and cane supply management are significant milling costs and with the need to reduce unit costs it was essential to find ways to automate harvest management and reduce the workload for NSWSMC Cane Supply Managers at each mill. The NSW sugar industry currently has one of the most efficient co-operative harvesting arrangements and is well positioned to make additional steps to capture additional cost savings across the NSW sugar industry value chain. These economies are essential with the co-generation plans for the NSW industry. Additional costs of whole cane harvesting can be partly offset by the efficiency gains in all mill areas.

The project aimed to investigate and implement whole-of-system solutions for reduced costs in the harvesting and transport sectors of the NSW Sugar industry. At the start of the project we were interested in examining scenarios involving changes to harvesting and transport, which include reduced harvesting groups, harvest best practice, optimised/rationalised loading pad locations and automated harvest management. Such changes required a different approach and this project saw excellent collaboration between organisations and agencies involved in sugar industry research and development. Initial stages of the project involved the NSWSMC and Agtrix working together for the implementation of the harvest management system, now called CHOMP. Agtrix and the NSWSMC pioneered the development of this program that is now used widely in the Australian sugar industry. Work with CSIRO and Harvesting Solutions centred on utilising modelling tools developed through other SRDC funded projects like CSE005 to optimise locations of cane loading pads in NSW and to examine efficiencies associated with harvest group amalgamations.

The NSWSMC now has a fully operational automated harvest management system that is used to receive and interpret data from harvesters on daily operations and process this information to maintain harvest records on how much cane is cut and to develop harvester performance reports. Implementation of this automated system has reduced the cost of cane supply operations at the NSWSMC by 32%.

Harvest group optimisation studies have provided the industry with some excellent data on potential cost savings from forming one or two large harvesting groups to harvest the entire crop from a mill area. Getting this from a concept to reality has been a problem. Harvesting Co-operatives at this point in time have not been able to agree to amalgamate despite clear financial and operational benefits. Despite this much has been achieved in terms of understanding and learning of individual group issues and how they can be resolved via the formation of a one river co-operative.

Work on pad optimisation using a modified cane rail siding optimisation model developed by CSIRO has identified the location of new cane loading pads to reduce the one-way haul distance to 600 metres. Cost benefit analyses using the Harvest Haul model enabled the identification of cane pads to be constructed where the benefits to the harvesting group exceeded the pad cost over a five-year time frame. A successful project funded by the Commonwealth Government under

the Regional and Community Projects section of the Sugar Industry Reform Program is underway. This project will expand existing cane pads and construct new pads to reduce haul distance for harvesting groups, which is essential with the additional bulk of cane material from whole of crop harvesting. The pad optimisation work of CSIRO provided the economic justification in this successful submission.

This project has resulted in significant economic benefits for the NSW Sugar Industry in the areas of cane supply management and transport. The project has enhanced the capacity of staff and Co-operative members to assess changes and benefits that will flow from different business structures of harvesting arrangements.

Background

Productivity and cost improvements are key factors in a competitive sugar industry. The NSW Sugar Milling Co-operative Ltd saw a need to develop new and innovative techniques for harvest and cane supply management and had identified a need to reduce operating expenditure to remain competitive. Cane Supply staff rated the following areas as critical for efficiency and cost savings.

- · Electronic transfer of harvest data
- · Integrating harvest and transport
- · Automatic collection of harvest data, blocks cut and yield.

At the time the project commenced the NSWSMC had conducted initial development work with Agtrix P/L on a spatial harvest management system. There was an urgent need to develop an innovative harvest and cane supply management system due to cost constraints and reductions in staffing in cane supply departments. Concurrent with this, harvesting co-operative management identified a significant benefit from amalgamating existing harvesting groups and forming a single harvest group that would cover the whole mill area.

The concept for this project was developed from the need to fully test and implement an automated harvest management system and examine more efficient harvest arrangements. It was recognised that we could not do this in isolation and therefore approached project partners Robert Crossley from Agtrix P/L, Di Prestwidge and Andrew Higgins from CSIRO and Gary Sandell from Harvesting Solutions. A collaborative approach was the way forward to develop better methods of harvest management and this worked well through the life of the project.

Objectives

Objective 1: Build a least cost NSW sugar industry spatial harvest management system to automate harvest progress recording, provide an improved basis for harvesting charges, develop key performance indicators for harvest management and high quality farm productivity data

Achievement

An automated system called CHOMP (Centralised Harvest Operations Management Program) operates fully in all mill areas of NSW to maintain harvest progress

Objective 2:Provide a basis for harvesting group optimisation and the formation of one harvesting co operative per mill area utilising existing tools developed from project CSE005

Achievement

Scenarios for amalgamation of harvest groups have been examined and costed. There are savings of between $0.50 to $1.00 per tonne to be gained by the local industry if amalgamation of harvesting groups either as a one single group or two-group scenario occurred.

Objective 3:Demonstration of the benefits to industry competitiveness by the adoption of optimised harvesting and transport arrangements

Achievement

Work on cane pad locations has demonstrated significant benefits in hauling costs to harvesting groups and reduced transport costs to the NSWSMC. Construction of new cane pads on locations determined by CSIRO modelling is underway and has confirmed the benefits from this initiative.

Objective 4:Provision of the basis for industry implementation of the optimised harvest arrangements to achieve worlds' best practice harvesting costs of $4 per tonne of cane

Achievement

Major opportunities for savings in harvest cost have been identified. Harvest cost in NSW is the lowest in Australia due to the crop size and reduced haul distance. $4 per tonne of cane was probably an over ambitious target but savings of up to $1 per tonne is possible through amalgamations.

Methodology

1. Harvest Management System Development

Harvest management units that comprise sensors logging harvesting parameters of engine, basecutter, choppers and elevator coupled to a GPS logger and CDMA communication unit have been installed on all NSW harvesters (Table 1) to facilitate the use of the Agtrix software in managing harvest operations across the three NSW mills.

Table 1: Installed GPS harvest management units

Mill Area	Number of installed GPS harvest management units
Condong	8
Broadwater	10
Harwood	8
TOTAL	**36**

Software to interpret raw data from the harvesters was developed and has run for 2 seasons (2005 and 2006), with continuous improvements in performance and functionality. Tasks performed by this software were

1. Receive and interpret the track and "state" of the harvester (what it was doing) raw data from harvesters and collate it into a single database, and
2. Receive the interpreted data at the mill and process it to maintain harvest records (how much of each paddock was cut) and productivity data.
3. Develop harvester performance reports from the data produced and distribute these back to the harvester operators.

The tasks performed by this software are:

1. Harvesters were fitted with data loggers that recorded the location and state of 4 sensors on the harvester every 30 seconds whenever one of the sensors changed. This data was stored on the harvester for the day and uploaded to a server at Broadwater Mill each night from about 9 PM.

2. This data was then uploaded from the server at Broadwater Mill to another server at Agtrix.com for further processing later that night. At Agtrix.com, the point data was

interpreted to generate GIS data representing the tracks of each harvester using a program named FRANK (named after a cane officer at Mulgrave Mill). Each segment of these tracks was interpreted for what the harvester was doing at the time from the state of the sensors, as well as speed that the harvester was travelling, the paddock it was working in and whether it was cutting or not (Figure 1).

3. Track segments that were deemed to be cutting were then used to interpret the cut areas for each harvester each day. The program to do this used some fuzziness in its logic to try to overcome inherent inaccuracies in the uncorrected GPS data. The locations recorded by the GPS was only accurate to about 5m, and the program was designed to clean up the calculated cut areas to account for small parts of the paddocks that were considered to have been missed, and visa versa. The result was fairly regular representations of the areas cut, although there was an issue with the program including small areas that were not harvested as they had been previously used for plant cane. (Figure 2)

4. GIS data showing the harvester tracks and areas cut were stored in spatial database and new data was forwarded to field officers each day. They then used a customised GIS software application called CHOMP (supplied by Agtrix) to interpret the areas cut and maintain the paddock harvest status from a map interface (Figure 3). CHOMP stands for **C**entralised **H**arvest **O**perations **M**anagement **P**rogram. A number of tools were provided in CHOMP to help field officers identify consignment errors. Examples included comparisons of actual yield with estimated yield (Figure 4), areas that were cut but had no cane consigned, and areas that had consigned cane, but were not cut. Tools were also provided for the field officers to edit the cut areas and consignments from a map interface, mark off plant or plough-out cane, generate maps of productivity or harvest status that can be used by the cane officers to check progress or provide growers example of consignment accuracy.

5. Reports on harvester performance and maps of harvester tracks have been supplied to individual harvester operators that are capable of using an Access database for the last year. Recently, a more user friendly report has been developed that can give each harvester operator a summary of harvester performance as an html document that can be viewed in a web browser. These can be emailed to each harvester operator on a daily basis (Figure 5). A whole of season report, which provides harvester efficiency data has also been produced and has been distributed to harvesting groups (Figure 6).

The CHOMP and FRANK programs have evolved and have been adopted in other regions over the last year as well. Significant milestones include:

1. The CHOMP system has been extended to operate in other regions beyond NSW, namely Mulgrave, Mackay, Plane Creek and trialled in the Burdekin. Isis will use it for the 2008 season.

2. The CHOMP application and harvester tracking application (FRANK) have been adapted to work with a corporate centralised database (SQL Server), delivering a much more secure product and integrate the system with existing mill databases. SQL Server versions of CHOMP have been operational in Mackay, CSR and Mulgrave for the past season. FRANK has been based on SQL Server for the 2006 season.

3. FRANK was used to interpret data from about 130 harvesters each night, with approximately 16 million data records processed. FRANK was also installed into the Mackay Sugar network so that tracking data and production data existed in one location, enabling more detailed reports to be generated on harvester performance. This model is expected to be rolled out to the CSR mills for the 2007 season.

4. CHOMP was modified so that it can be used to determine average row length and number of rows for paddocks. This function is now part of the standard mapping functions and will be available to all mills that run Agtrix's mapping product FarmMap. This data were later used by the Harvest Haul Model to verify model inputs and has also been used by one harvesting manager to study the influence of row length on harvester performance.

Figure 1: GPS Harvester Tracks in a harvested field, coloured by speed.

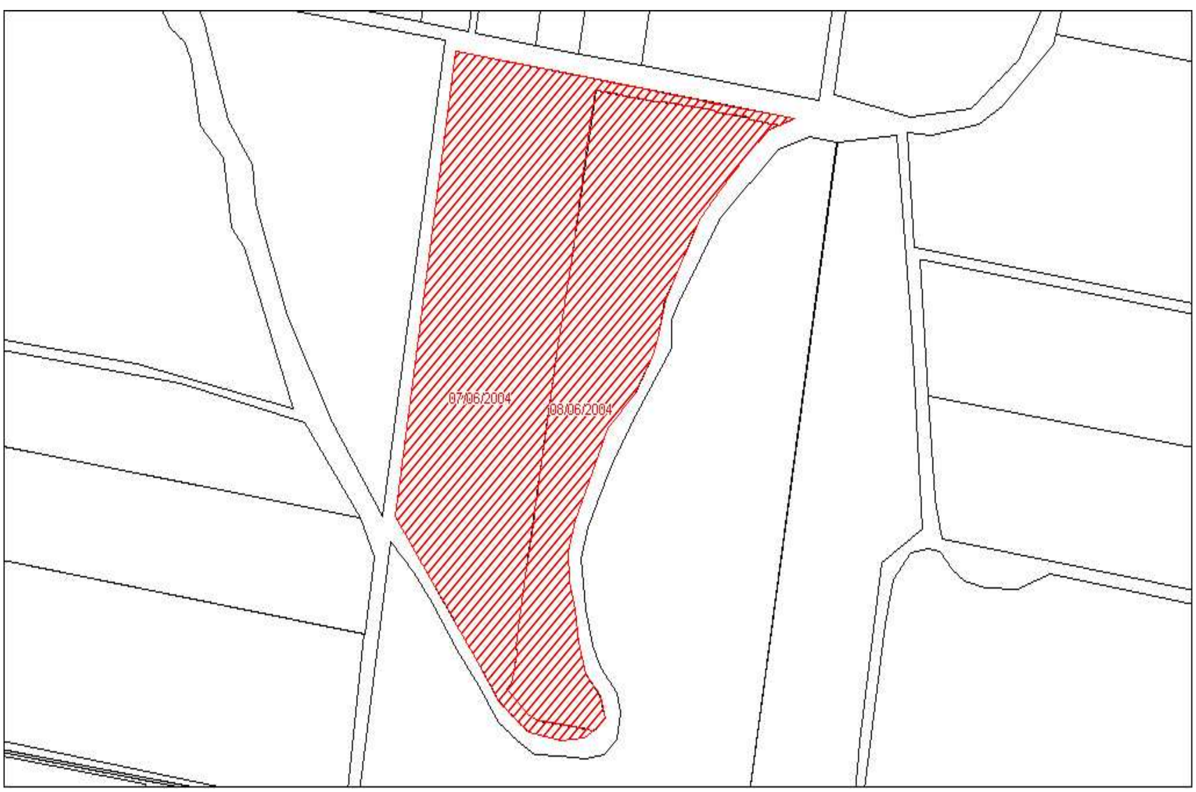


Figure 2: Map showing cut areas and date harvested

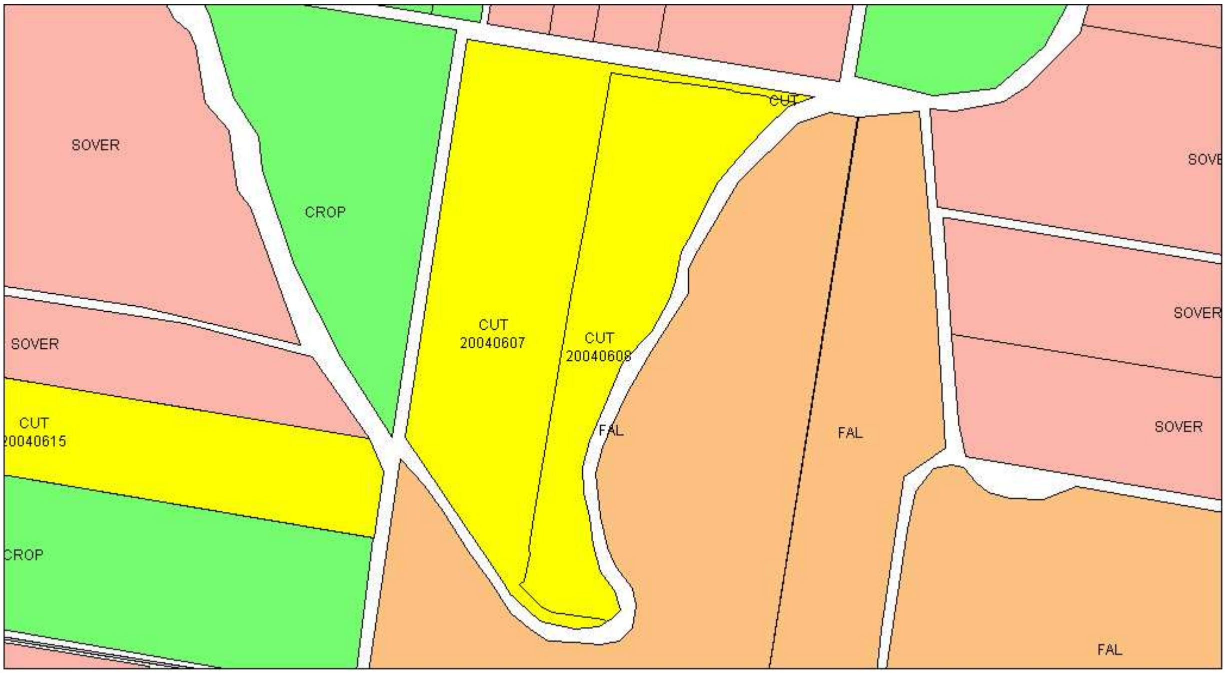
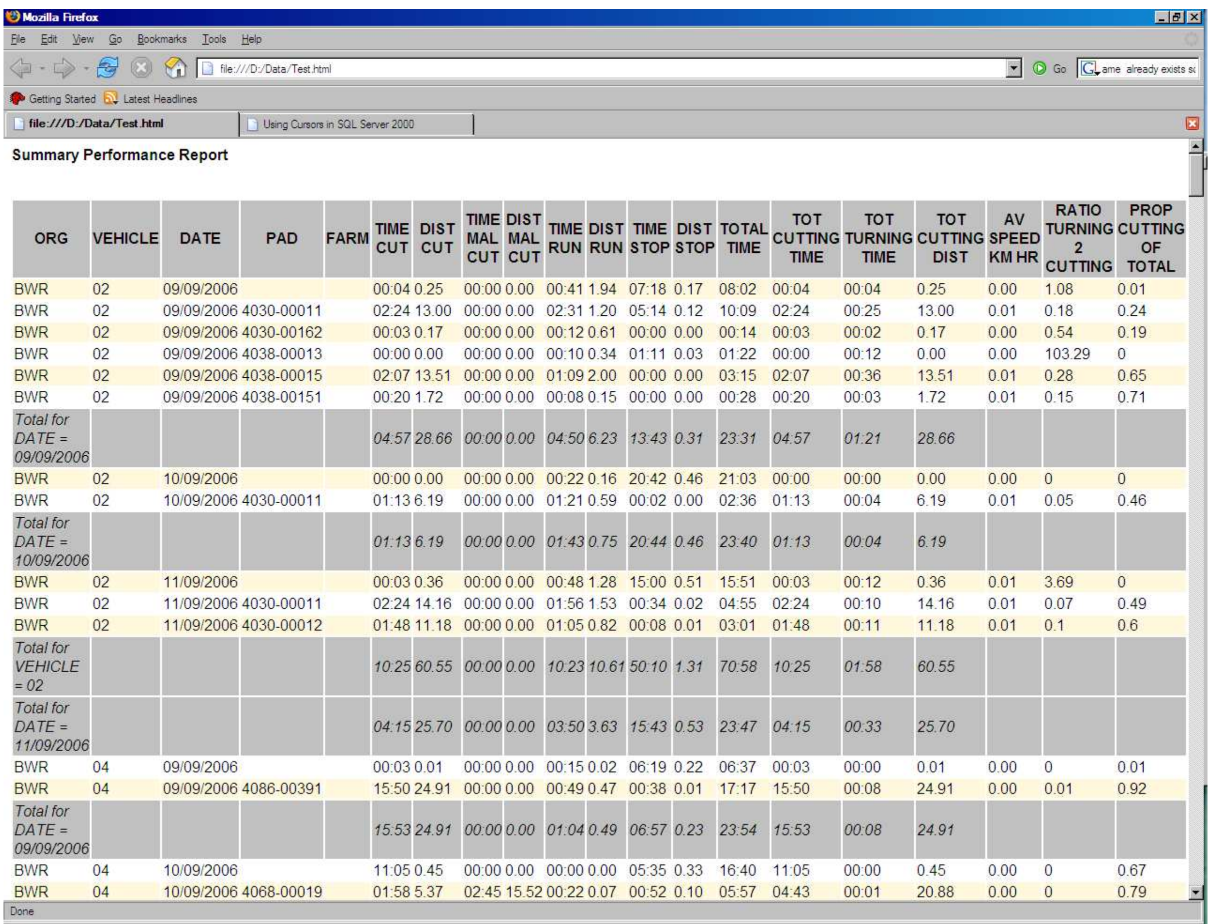


Figure 3: Maps showing paddocks harvested, paddocks remaining to be harvested and areas for standover as interpreted by CHOMP

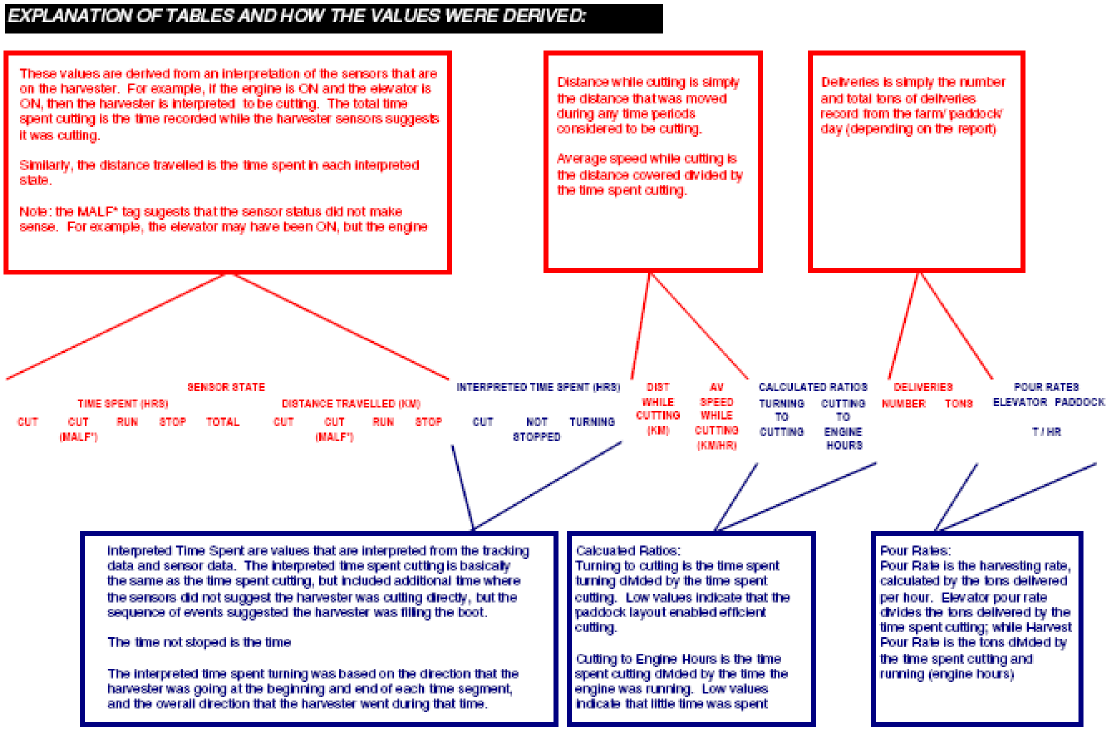
Figure 4: Map showing harvested paddocks and yields



Summary Performance Report

ORG	VEHICLE	DATE	PAD	FARM	TIME CUT	DIST CUT	TIME MAL CUT	DIST MAL CUT	TIME RUN	DIST RUN	TIME STOP	DIST STOP	TOTAL TIME	TOT CUTTING TIME	TOT TURNING TIME	TOT CUTTING DIST	AV SPEED KM HR	RATIO TURNING 2 CUTTING	PROP CUTTING OF TOTAL
BWR	02	09/09/2006			00:04	0.25	00:00	0.00	00:41	1.94	07:18	0.17	08:02	00:04	00:04	0.25	0.00	1.08	0.01
BWR	02	09/09/2006	4030-00011		02:24	13.00	00:00	0.00	02:31	1.20	05:14	0.12	10:09	02:24	00:25	13.00	0.01	0.18	0.24
BWR	02	09/09/2006	4030-00162		00:03	0.17	00:00	0.00	00:12	0.61	00:00	0.00	00:14	00:03	00:02	0.17	0.00	0.54	0.19
BWR	02	09/09/2006	4038-00013		00:00	0.00	00:00	0.00	00:10	0.34	01:11	0.03	01:22	00:00	00:12	0.00	0.00	103.29	0
BWR	02	09/09/2006	4038-00015		02:07	13.51	00:00	0.00	01:09	2.00	00:00	0.00	03:15	02:07	00:36	13.51	0.01	0.28	0.65
BWR	02	09/09/2006	4038-00151		00:20	1.72	00:00	0.00	00:08	0.15	00:00	0.00	00:28	00:20	00:03	1.72	0.01	0.15	0.71
Total for DATE = 09/09/2006					*04:57*	*28.66*	*00:00*	*0.00*	*04:50*	*6.23*	*13:43*	*0.31*	*23:31*	*04:57*	*01:21*	*28.66*			
BWR	02	10/09/2006			00:00	0.00	00:00	0.00	00:22	0.16	20:42	0.46	21:03	00:00	00:00	0.00	0.00	0	0
BWR	02	10/09/2006	4030-00011		01:13	6.19	00:00	0.00	01:21	0.59	00:02	0.00	02:36	01:13	00:04	6.19	0.01	0.05	0.46
Total for DATE = 10/09/2006					*01:13*	*6.19*	*00:00*	*0.00*	*01:43*	*0.75*	*20:44*	*0.46*	*23:40*	*01:13*	*00:04*	*6.19*			
BWR	02	11/09/2006			00:03	0.36	00:00	0.00	00:48	1.28	15:00	0.51	15:51	00:03	00:12	0.36	0.01	3.69	0
BWR	02	11/09/2006	4030-00011		02:24	14.16	00:00	0.00	01:56	1.53	00:34	0.02	04:55	02:24	00:10	14.16	0.01	0.07	0.49
BWR	02	11/09/2006	4030-00012		01:48	11.18	00:00	0.00	01:05	0.82	00:08	0.01	03:01	01:48	00:11	11.18	0.01	0.1	0.6
Total for VEHICLE = 02					*10:25*	*60.55*	*00:00*	*0.00*	*10:23*	*10.61*	*50:10*	*1.31*	*70:58*	*10:25*	*01:58*	*60.55*			
Total for DATE = 11/09/2006					*04:15*	*25.70*	*00:00*	*0.00*	*03:50*	*3.63*	*15:43*	*0.53*	*23:47*	*04:15*	*00:33*	*25.70*			
BWR	04	09/09/2006			00:03	0.01	00:00	0.00	00:15	0.02	06:19	0.22	06:37	00:03	00:00	0.01	0.00	0	0.01
BWR	04	09/09/2006	4086-00391		15:50	24.91	00:00	0.00	00:49	0.47	00:38	0.01	17:17	15:50	00:08	24.91	0.00	0.01	0.92
Total for DATE = 09/09/2006					*15:53*	*24.91*	*00:00*	*0.00*	*01:04*	*0.49*	*06:57*	*0.23*	*23:54*	*15:53*	*00:08*	*24.91*			
BWR	04	10/09/2006			11:05	0.45	00:00	0.00	00:00	0.00	05:35	0.33	16:40	11:05	00:00	0.45	0.00	0	0.67
BWR	04	10/09/2006	4068-00019		01:58	5.37	02:45	15.52	00:22	0.07	00:52	0.10	05:57	04:43	00:01	20.88	0.00	0	0.79

Figure 5: Daily Harvesting Performance Report From CHOMP



Thursday, 24 May 2007

VEHICLE	bwr02	SENSOR STATE									INTERPRETED TIME SPENT (HRS)			DIST	AV	CALCULATED RATIOS		DELIVERIES		POUR RATES	
		TIME SPENT (HRS)					DISTANCE TRAVELLED (KM)							WHILE	SPEED	TURNING	PROP	NUMBER	TONS	HARVEST	CUTTING
FARM	BLOCK	CUT	CUT (MALF*)	RUN	STOP	TOTAL	CUT	CUT (MALF*)	RUN	STOP	CUT	NOT STOPPED	TURNING	CUTTING (KM)	WHILE CUTTING (KM/HR)	TO CUTTING	CUTTING OF TOTAL			T / HR	
FARM 4008																					
4008	00010	0.9	0.0	0.5	0.5	1.9	5.7	0.0	2.0	0.0	0.9		0.1	5.7	6.5	0.15	0.47	23	550.80	295	624
4008	00011	1.1	0.0	0.9	0.0	2.0	5.2	0.0	2.4	0.0	1.1		0.2	5.2	4.8	0.15	0.54	10	247.06	121	225
4008	00012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4008	00015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	7.9	0.00	1.00			0	0
4008	00018	3.0	0.0	1.9	0.4	5.3	13.6	0.0	2.8	0.0	3.0		0.4	13.6	4.5	0.12	0.56	19	428.11	80	142
4008	00020	2.3	0.0	1.0	0.2	3.5	18.9	0.0	1.7	0.0	2.3		0.3	18.9	8.2	0.14	0.66	16	365.10	104	158
4008	00021	0.2	0.0	0.1	0.3	0.6	1.3	0.0	0.3	0.0	0.2		0.1	1.3	8	0.39	0.28			0	0
4008	00023	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4008	00111	3.6	0.0	2.3	0.8	6.8	19.9	0.0	3.8	0.0	3.6		0.2	19.9	5.5	0.06	0.53	33	771.14	113	213
4008	00121	0.1	0.0	0.1	0.0	0.2	0.4	0.0	0.4	0.0	0.1		0.0	0.4	4	0.29	0.62			0	0
4008	00123	4.1	0.0	1.7	0.8	6.6	17.4	0.0	2.7	0.0	4.1		0.3	17.4	4.2	0.07	0.63	26	614.88	93	149
4008	00141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4008	00142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4008	00161	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4008	00191	8.9	0.0	5.0	2.1	16.1	46.8	0.0	4.3	0.1	8.9		0.5	46.8	5.3	0.06	0.55	63	1447.82	90	162
4008	00222	0.0	0.0	0.3	0.0	0.3	0.2	0.0	0.5	0.0	0.0		0.0	0.2	4.9	0.35	0.11			0	0
4008	00241	2.1	0.0	1.4	0.5	4.0	16.0	0.0	2.2	0.0	2.1		0.3	16.0	7.6	0.15	0.53	18	319.82	79	151
4008	00242	4.3	0.0	2.7	0.9	7.9	31.1	0.0	3.1	0.0	4.3		0.5	31.1	7.2	0.11	0.54	40	810.26	101	188
4008	00262	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
TOTALS FOR FARM		30.6	0.0	18.0	6.8	55.4	176.5	0.0	26.8	0.2	30.6		2.9	176.5	5.8	0.09	0.55	267	6011.57	108	196
FARM 4009																					
4009	00013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4009	00014	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.8	0.0	0.0		0.1	0.0	0	-1.00	0.00			0	-1
4009	00016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4009	00017	0.2	0.0	0.3	0.0	0.4	0.5	0.0	0.9	0.0	0.2		0.1	0.5	3.3	0.38	0.36	1	11.30	25	70
4009	00101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4009	00111	2.0	0.0	0.8	0.2	3.0	9.1	0.0	1.6	0.0	2.0		0.3	9.1	4.5	0.14	0.67	8	186.12	62	92
4009	00112	2.6	0.0	0.7	0.6	3.8	14.7	0.0	1.4	0.0	2.6		0.3	14.7	5.7	0.12	0.68	25	539.75	141	208
4009	00121	0.2	0.0	0.2	0.0	0.5	1.6	0.0	0.2	0.0	0.2		0.0	1.6	6.9	0.09	0.51	21	492.95	1085	2107
TOTALS FOR FARM		5.0	0.0	2.2	0.7	7.9	25.9	0.0	5.2	0.0	5.0		0.8	25.9	5.2	0.15	0.63	55	1230.12	154	246
FARM 4013																					
4013	00012	2.8	0.0	2.1	0.2	5.1	22.3	0.0	3.9	0.0	2.8		1.1	22.3	7.9	0.40	0.55	24	525.37	102	187
4013	00015	7.7	0.0	5.0	1.0	13.8	50.6	0.0	9.3	0.0	7.7		1.7	50.6	6.6	0.21	0.56	33	746.18	54	96
4013	00017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4013	00019	1.4	0.0	0.7	0.0	2.1	8.5	0.0	0.9	0.0	1.4		0.2	8.5	6.2	0.16	0.67	10	228.18	111	165
4013	00020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0		0.0	0.0	0	-1.00	0.00			0	-1
4013	00161	1.0	0.0	0.5	0.0	1.5	7.3	0.0	1.1	0.0	1.0		0.2	7.3	7.3	0.20	0.69	4	79.17	54	79
4013	00162	0.9	0.0	0.7	0.2	1.8	6.1	0.0	1.3	0.0	0.9		0.1	6.1	6.7	0.08	0.50	6	141.00	77	153
4013	00163	1.2	0.0	0.6	0.0	1.8	9.0	0.0	1.6	0.0	1.2		0.3	9.0	7.5	0.22	0.68	6	130.50	74	109
4013	00191	0.5	0.0	0.7	0.0	1.2	3.4	0.0	1.2	0.0	0.5		0.3	3.4	7.4	0.77	0.38	3	53.04	44	116
TOTALS FOR FARM		15.5	0.0	10.3	1.4	27.2	107.2	0.0	19.8	0.0	15.5		3.9	107.2	6.9	0.25	0.57	86	1903.44	69	123

Thursday, 24 May 2007

Figure 6: Example of 2006 Harvesting Performance Report

__2. Harvest and Transport Improvements__

Modelling was concentrated on Harvesting Group Amalgamation Scenarios for the Broadwater region, as the Condong and Harwood region had already formed amalgamated groups. A workshop was held in conjunction with the SRDC Harvesting Group Project – HGP001 – "Establishing a million tonne harvesting co-operative" to develop a plan to progress Group amalgamations.

CSIRO presented the details and results of the following group amalgamations modelling scenarios for the Broadwater Region:-

- ***Scenario 1 – Total 10 harvesters***
    - All groups on the river except groups 17 cutting average of 115K tonnes (9 harvesters).
    - 1 Separate group (1 harvester)

- ***Scenario 2 – Total 11 harvesters***
    - All Up-river groups except group 17 (5 harvesters)
    - All in Down-river groups (5 harvesters)
    - 1 Separate group (1 harvester)

- ***Scenario 3 – Total 11 harvesters***
    - All Up-river groups except groups 8 and 17 (4 harvesters)
    - Down-river groups 12, 13, 6, and 4 amalgamated only (2 harvesters)
    - 5 Separate groups (5 harvesters)

The following is an explanation of how the Harvest Haul Model was further adapted to reflect the NSW conditions. Capital Value Schedules were used for each piece of equipment to obtain the Capital value at current engine hours and the Salvage value at 10,000 engine hours. Depreciation ($/hr) of capital equipment (an hourly depreciation cost) was calculated as:-

(Capital value - Salvage value) / (10000 – current engine hours)

Intangible savings from the group amalgamation scenarios were not modelled as a dollar value was unable to be put on savings. A lot of work has been done on this locally. These intangible savings could be:-

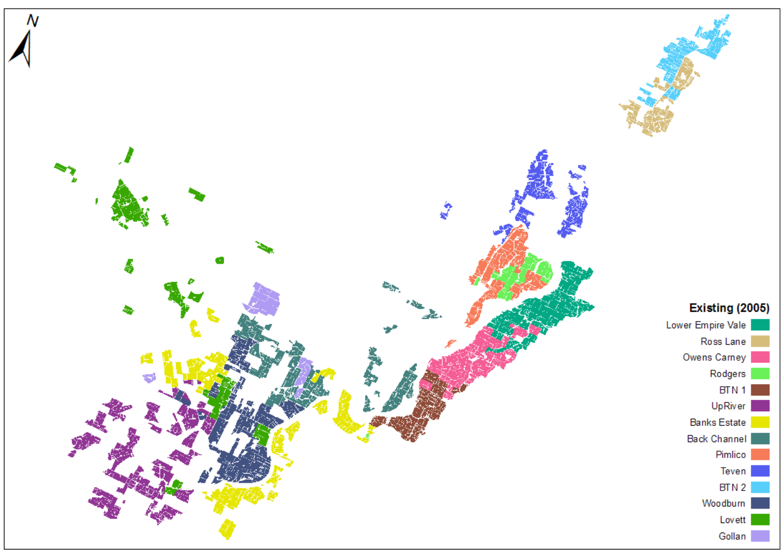
- Labour savings – ability to share labour across crews
- Off-season labour requirement reduction
- Savings from managing inefficiencies
- Repairs and maintenance savings – reduced requirement for stock ie. machine tracks
- Bulk buying opportunities
- Risk – greater ability to accommodate wet weather risks

Base case scenarios for the 2005 season were modelled using the 2005 tonnes as well as the whole of crop estimated tonnes. The whole of crop tonnes was estimated to be 20 % more than the 2005 tonnes. Each group amalgamation scenario was also modelled using the 2005 tonnes and the whole of crop estimated tonnes. The 2005 season tonnes modelled for each group in the scenarios are shown in Table 2. Figure 7 contains maps showing the geographic distribution of the group amalgamation scenarios. The result of the Base Case 2005 tonne scenarios in Table 3 show that the greatest gain from group amalgamations in the region will be from Scenario 2.

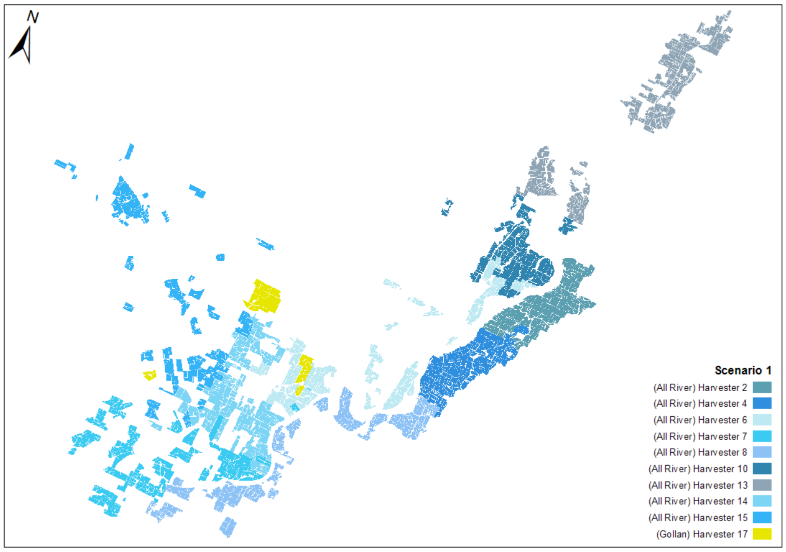
Table 2:Group Amalgamation Scenarios – Tonnes per Group

Name	Group	2005 Tonnes	Scenario 1	Scenario 2	Scenario 3	
Lower Empire	2	113,458	113,073	99,888	145,811	All River
Ross Lane	3	32,353	0	0	0	Separate
Owens Carney	4	87,692	112,867	98,068	128,245	Down River
Rodgers	5	41,281	0	0	41,281	Upriver
BTN 1	6	60,799	115,141	100,703	0	
UpRiver	7	114,302	116,745	100,327	102,189	
Bank Estate	8	99,024	114,046	100,710	99,024	
Back Channel	9	94,187	0	100,950	100,336	
Pimlico	10	87,952	116,227	106,644	87,952	
Teven	12	68,747	0	0	0	
BTN 2	13	38,447	121,299	124,861	127,439	
Woodburn	14	117,384	116,046	98,618	106,105	
Lovett	15	78,111	108,293	102,970	95,355	
Gollan	17	22,649	22,649	22,649	22,649	
		1,056,387	1,056,387	1,056,387	1,056,387	
No. of Harvesters		(14)	(10)	(11)	(11)	

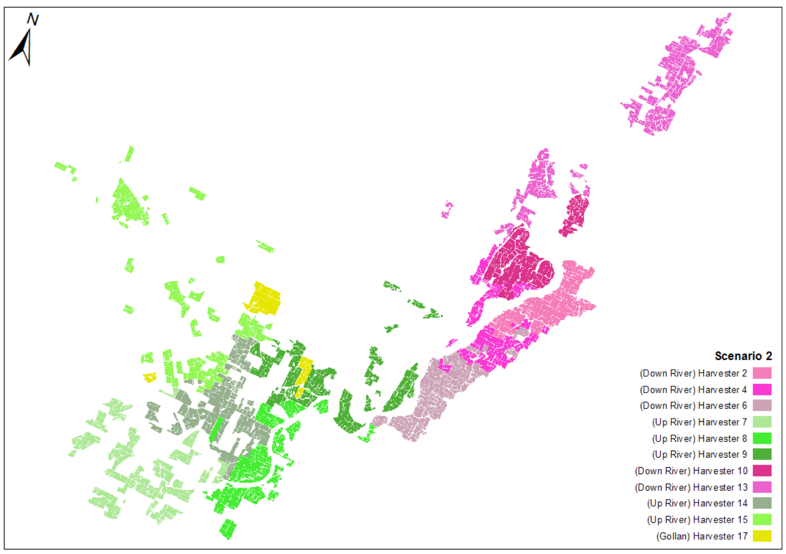
Figure 7: Maps of the distribution of Group Amalgamation Scenarios
1 – Existing 2005 Groups



2 – Group Amalgamation Scenario 1



3 – Group Amalgamation Scenario 2



4 – Group Amalgamation Scenario 3

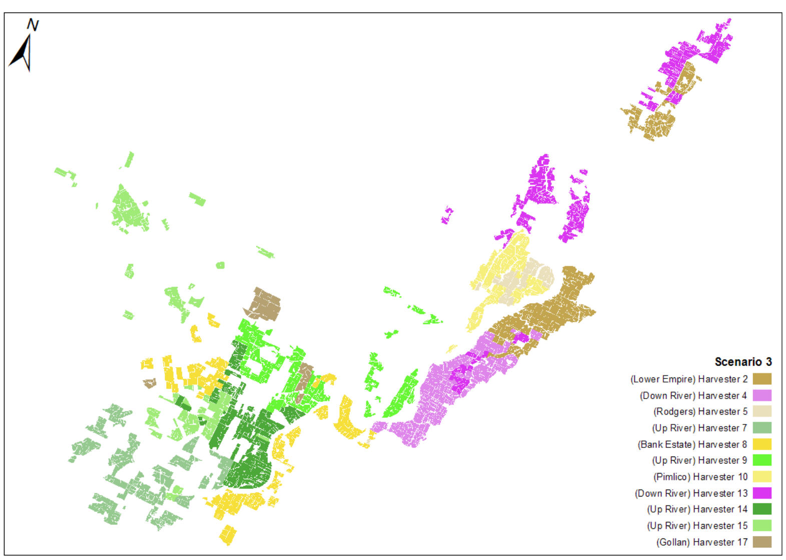


Table 3: Harvest Haul Model Scenario Results – based on Base Case 2005 Tonnes

Scenario	Cost	$ / Tonne
Base Case 2005	$5,458,305	$5.19
Scenario 1 - All River (9 harv) + 1 Separate	$5,303,779	$5.04
Scenario 2 - Up River (5 harv) + Down River (5 harv) + 1 Separate	$5,073,698	$4.82
Scenario 3 - Up River (4 harv) + Down River (2 harv) + 5 Separate	$5,385,698	$5.12

The changes from the Base Case scenario to model the Whole of Crop scenarios were to increase tonnes by 20%. Harvester modifications were costed at $75,000 each and Haul-out modifications at $25,000 each. All capital upgrades depreciated to zero over 10,000 hours of use. The cost of financing capital upgrades was incorporated as an overhead cost It was calculated with an interest rate of 8% with 4 payment periods per year and paying off at 10,000 hours. Powerhauls volume was increased to 36 m3 (8.57 tonnes). Trailer bins were increased to 45 m3 (10.71 tonnes). Cane density was decreased from 380 kg/m3 to 238 kg/m3 and Fan Speed was set to 0 rpm.

The comparison of the Whole of Crop modelled results compared to the Base Case results are shown in Table 4. This also shows the extra cost of harvesting the same amount of cane in the Base Case scenario along with the extra cane tops in the Whole Crop scenario is $1.11 per tonne.

Table 4:Harvest Haul Model Results – Comparison of Base Case to Whole of Crop

Scenario	Tonnes	Cost	$ / Tonne
Base Case 2005	1,052,552	$5,458,305	$5.19
Whole of Crop 2005	1,263,063	$6,633,752	$5.25
(÷ Base Case Tonnes)	1,052,552	$6,633,752	$6.30
Difference	210,511	$1,175,447	$0.06
(÷ Base Case Tonnes)	0	$1,175,447	$1.11

Table 5 shows the results of the Group Amalgamation Scenarios modelled using the Whole of Crop tonnes. This also shows the extra cost of harvesting the whole of the crop to produce the same Base Case tonnes.

Table 5:Harvest Haul Model Results – Whole of Crop Scenarios

Scenario	***Cost***	***$ / Whole Crop Tonnes***	***$ / Base Case Tonnes***
Whole of Crop 2005	$6,633,752	$5.25	$6.30
Scenario 1 - All River (9 harv) + 1 Separate	$6,281,359	$4.97	$5.97
Scenario 2 - Up River (5 harv) + Down River (5 harv)+ 1 Separate	$6,388,935	$5.06	$6.07
Scenario 3 - Up River (4 harv) + Down River (2 harv) + 5 Separate	$6,612,809	$5.24	$6.28

3. Cane Loading Pad Optimisation

Harvesting and transport have been recognised as the least integrated sectors of the sugar supply chain, with past analysis highlighting potential reductions in costs of up to $4.00/tonne of cane. In the NSW sugar industry there are several initiatives to improving efficiencies in harvesting and transport, with this project focusing on adding additional vehicle loading pads to improve harvesting efficiencies.

This project was industry led and involved a working group of miller, harvester and grower representatives, who met regularly with the research team to progress analysis. The working group focused on adding loading pads in the Broadwater, Condong and Harwood regions at the optimal locations, with the goal of significantly reducing the costs of harvesting. The working group agreed that loading pads would be added if the reduction in harvesting costs over 5 years would be greater than the cost of installing the pad. The purpose of the modelling work was to identify locations where loading pads could be added to achieve the desired benefits to the industry over 5 years.

Two existing modelling tools were adapted to the NSW sugar region, namely the Siding Optimisation Model and Harvest Haul Model. The Siding Optimisation Model, originally used for locating sidings on a cane railway system, was adapted for the road transport system in NSW and was named the Pad Optimisation Model. It optimally positioned the minimal number of new loading pads on the sugarcane landscape so as to achieve the desired average haul-out distance. The Harvest Haul model measures the costs and efficiencies of all of the harvesting groups within a mill region, and for this project, estimated the cost savings to harvesters from having the additional loading pads.

Through application of the modelling tools, two main scenarios were considered: 1) existing burnt cane base case, and 2) whole-crop harvesting. The benefits of adding new loading pads to each region varied significantly between these scenarios, with the benefits being largest for the second scenario, whole crop harvesting. Under this scenario, which is the plan for the NSW sugar industry, the optimal number of new loading pads to be located at Broadwater, Condong and Harwood is 21, 12 and 1 respectively. The benefit to the industry over the next 5 years is $1,476,439, with the estimated costs of adding the pads being $690,000. Actual locations of each of these new pads along with savings in harvesting costs are contained in the body of this report.

This project has achieved its objectives and has given the industry working group a detailed understanding of how many new pads to add to each region and the impacts of adding each of the new loading pads at the optimal locations.

Applying mathematical modelling in conjunction with GIS spatial analysis techniques to optimise the location of new loading pads across the three mill regions, Broadwater, Condong and Harwood.

The objective of the mathematical modelling was to add new pads at the optimal locations to reduce the average haul-out distance across the harvesting regions and ultimately the cost of harvesting. The modelling work and follow-up analysis by the local industry would ensure the location of new pads account for trafficability from the farm paddocks to the loading pads, accounting for obstacles such as creeks and suitable road, and also take into consideration proximity to residences.

Through the Sugar Research and Development Corporation (SRDC) project CSE005 a model was developed to optimise the location of sidings on a sugar rail transport network. The model was subsequently used to select desirable and redundant sidings for siding rationalisation initiatives in the Herbert and Mourilyan regions. The model would select the sidings to be removed from the network, which would have minimal negative impact on the harvesters. In selecting the new sidings or sidings to be upgraded, the model aims to maximise economic return to both the milling and harvesting sectors.

For this project with the NSW sugar industry, the siding location model was adapted to handle a road transport system. The main aim was to provide additional loading pads which will lead to a reduced distance of haul between the harvester and nearest loading pad, which in turn reduces harvesting costs. Through using the mathematical optimisation model a minimal number of new pads can be added to achieve the greatest reduction in harvesting costs.

Data of various formats (e.g. GIS, Excel) were collected on existing loading pads, farm paddock positions, loading pad capacities, and barriers such as creeks and highways. Through using these data, the optimisation model was adapted to all three mills in the NSW sugar region. Existing pad locations and paddocks allocated to these were considered in the analysis to benchmark the reduction in haul-out distance, which can then be costed using the Harvest Haul Model. Data on existing pad locations and the allocation of blocks to the pads were validated using GIS methods and validated with several representatives from the NSW sugar region, to ensure that any new solutions produced from the Pad Optimisation Model would be accurate. The biggest issue in adding additional pads was to ensure that the new pads were in sensible locations and proximity to the paddocks allocated to them. Representatives from NSW Sugar highlighted barriers on the GIS maps as a means for helping select suitable locations for additional pads. An example of the location of these barriers is contained in Figure 8 for Broadwater mill.

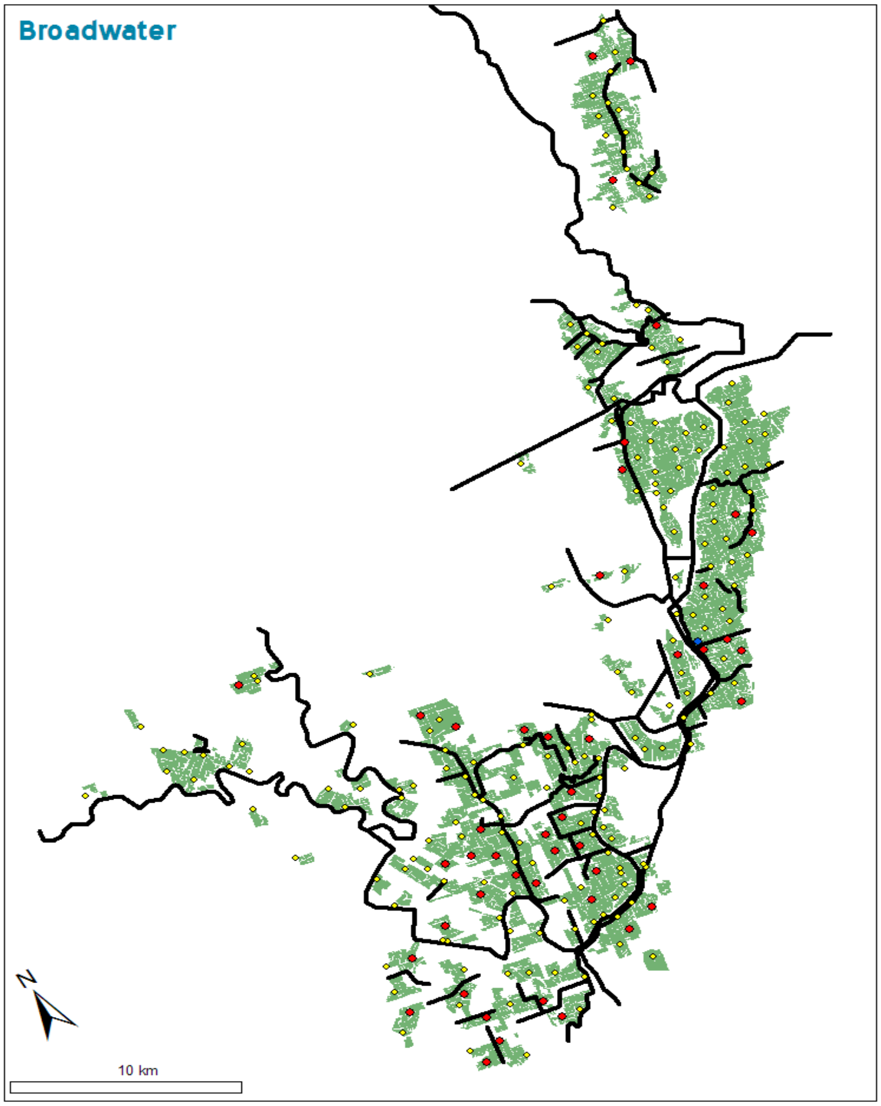


Figure 8.   Location of barriers (black lines) for the Broadwater mill region

However, barriers alone were not enough to provide sensible locations for new pads. To ensure optimal solutions for new pads locations were realistic, the analysis was done in two steps. Firstly, an optimal solution was produced ignoring barriers such as creeks, rivers, and railway lines. Then using the barriers highlighted in the GIS by NSW Sugar Cane Supply Staff, the optimal solution was revised so that no paddock is hauled across the barrier to reach the pad.

The impact of adding new loading pads at optimal locations on the average haulout distance is contained in Figure 9 for each of the three mills. Whilst adding 10, 20 or 30 pads has a significant reduction in average haulout distance, the marginal benefits of adding additional pads decreases with increased number of new loading pads. This is reflected in Figure 9 with a fitted quadratic curve to the bars. If the costs of adding new loading pads is linear with respect to the number of pads added, there will be a threshold of an optimal number of pads to be added to each region.

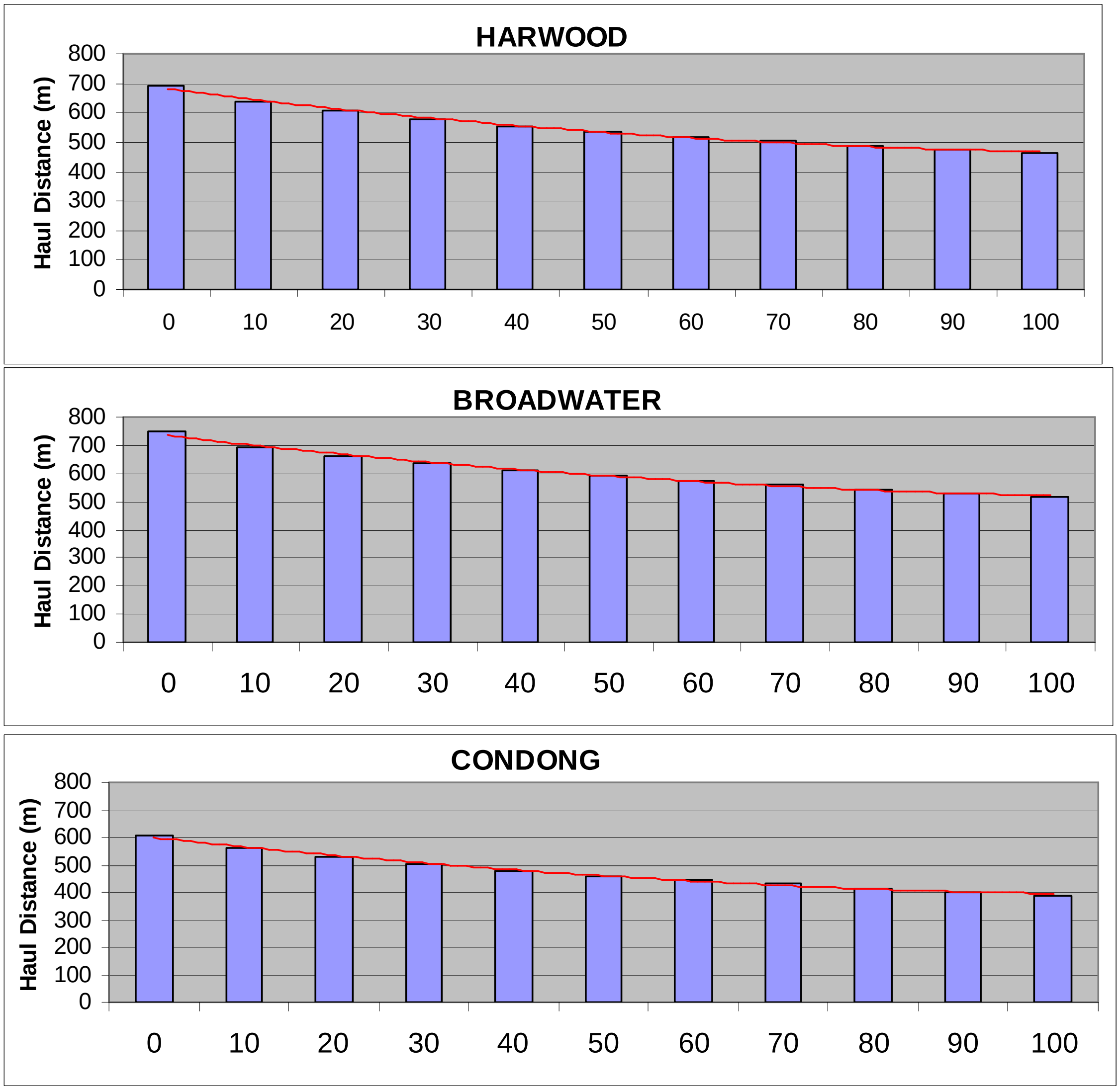


Figure 9. Impact of additional loading pads on average haulout distance, along with a fitted quadratic curve.

The next section details the application of the Harvest Haul Model to calculate the savings in harvesting costs, but also to calculate the benefits of each new pad optimally located using the Pad Optimisation Model

Applying the Harvest Haul model to measure the cost savings to each harvester, as a result of the additional loading pads

Through an SRDC project, a Harvest Haul Model was developed to measure the efficiency and costs of harvesting for each harvesting group within a mill region. It has numerous applications, including measuring the benefits of harvesting group amalgamations, costing out harvest best practice, optimising the number of haul-out units, and measuring the impacts of upgrades in the transport system or whole crop harvesting. It has been applied extensively in other regions such as Mourilyan, Herbert, Maryborough, Invicta and Pioneer.

The Harvest Haul Model is very data intensive. At a group level, it requires information on the harvester and haul-out equipment, salaries, depreciation, debts, capacities, turning times, etc. At a paddock level, it requires accurate information on paddock row length, ground speeds, haul-out distance, crop yield, and level of trash. The difficulty at paddock level is there are over 15000 paddocks in the NSW region, which makes it difficult to manually provide accurate measurements. Automated methods in GIS linked with harvester tracking equipment need to be used.

A new GIS analysis technique has been developed by Robert Crossley (Agtrix P/L) with CSIRO to more accurately estimate row-lengths for all blocks in each region. This technique will enhance the effectiveness of the Harvest Haul Model. Block productivity data has been incorporated with linkages to harvesting groups. GIS analysis using block to pad allocations has been run to estimate haul-out distances. Significant work has gone into interpreting harvesting parameters such as ground speeds and elevator pour rates from the GPS harvester tracking data (CHOMP – Agtrix Pty. Ltd.) from the 2004 season. This process is a new technique that has further enhanced the accuracy of the Harvest Haul Model.

A schedule has been developed with capital and salvage values for harvesting equipment in the regions for inclusion into the model. However, in these analyses book values were used for machinery capital value. This is an overestimate of the cash cost of harvest however it has the advantages of ease of data collection (compared to an individual market valuations of all machinery) while still maintaining the correct relativities between groups and changes between scenarios.

Capital costs of harvesting are split between finance cost and depreciation cost. Capital finance cost was assumed to be 8% of the book value. Capital depreciation cost (loss in market value of equipment) was assumed to be the 27.5% book write-off.

The modelling process uses a process called ‘cheapest haul’. This process determines, for every block of cane, if it cheaper to use two haul-outs or to use three haul-outs. The cheaper of these two options is used in the final analysis.

As a result of these methods (and others) for obtaining the data, the Harvest Haul Model input databases for each mill region were populated. Harvest Haul Model analyses were run for each mill region using blocks from the 2004 season. Upon agreement that the outputs from the Harvest Haul Model closely resembled the costs experienced in practice (or at least the relative differences between the harvesting groups), the Harvest Haul Model was then applied to measure the harvesting costs/efficiency of the loading pad scenarios.

To accurately cost savings from pad optimisation it was important that the modelling consider all blocks, not just those harvested in the 2004 season and the Harvest Haul Model was adjusted to nominally harvest all blocks in the region. To remove the seasonal bias, yield for each block was scaled to five-year farm average yield.

The Harvest Haul Model accounted for ‘overflow cane’ cane (that is delivered to the next nearest siding because the closest siding is currently full) by weighting haul distance for each block by five-year average tonnes and accounting for:-

- Group Haul-out capacity (Tonnes per Bin)
- Tonnes delivered to Home and Overflow Pads
- Number of trips per Pad calculated (Tonnes per Pad / Tonnes per Bin)
- Total haul distance travelled calculated

Figure 10 shows the optimal pads locations for the first 30 pads (from the Pad Optimisation Model), along with the savings in harvesting costs over 5 years for Broadwater mill. The larger the dot, the larger the savings, with the green dots representing pads where the benefits exceed costs over the 5 year time frame. Figures 11 and 12 show the results for Condong and Harwood respectively, with only the first 10 pads needing to be shown for Harwood due to the smaller benefits. The costs per new pad for Broadwater, Condong and Harwood were assessed as $20,000, $20,000 and $30,000 respectively. The benefits for Harwood were smaller compared to the other regions partly due to the cost of pads being more expensive than the other two mills. Other reasons include the Harwood region being newer than Condong and Broadwater, with the loading pads already being in suitable locations.

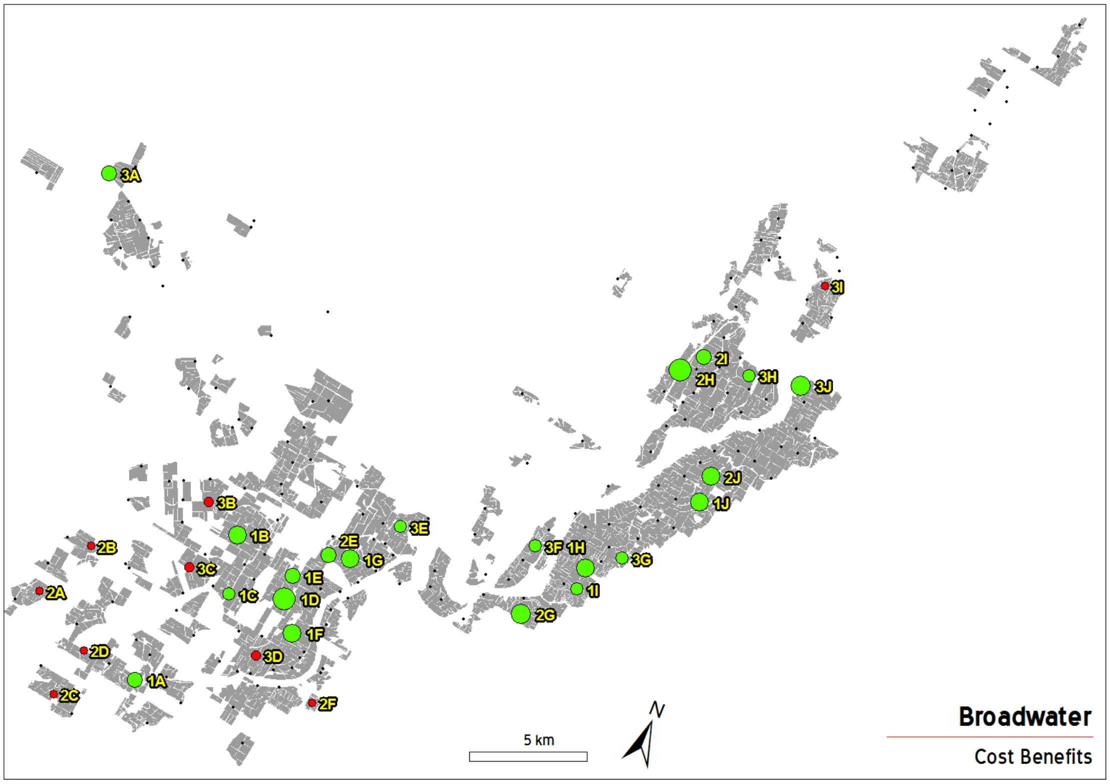


Figure 10. Savings in harvesting costs over 5 years for each of the new pad at optimal locations in Broadwater mill

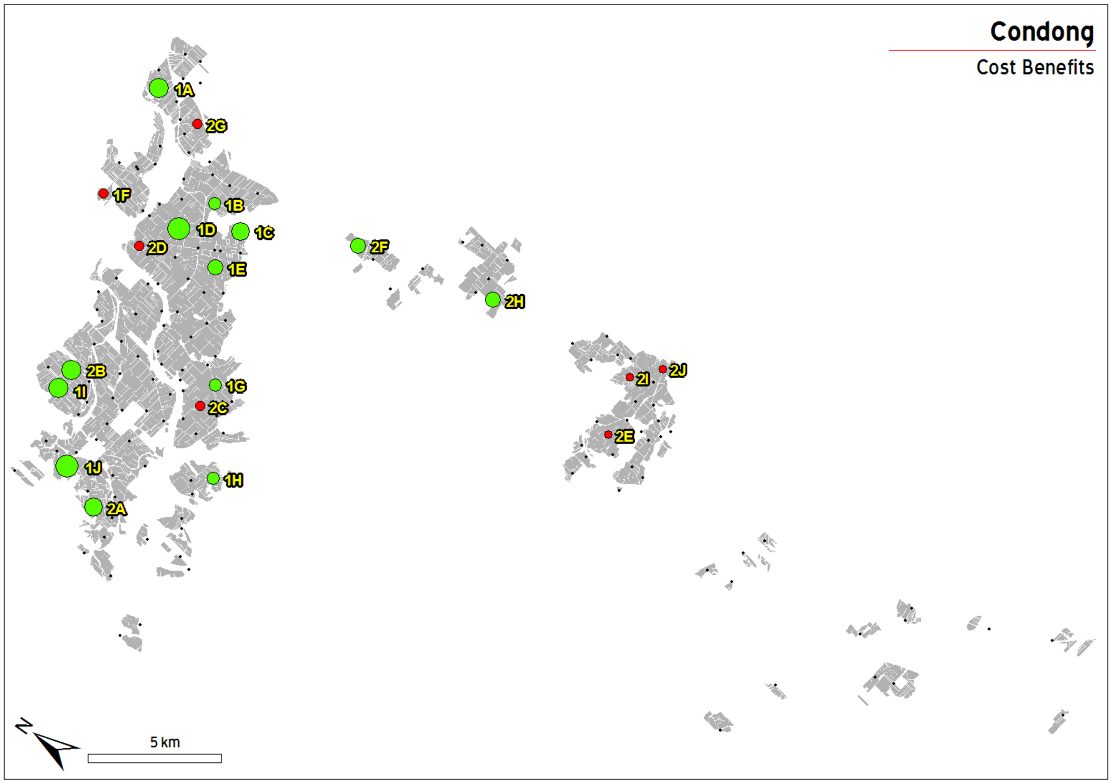


Figure 11. Savings in harvesting costs over 5 years for each of the new pad at optimal locations in Condong mill

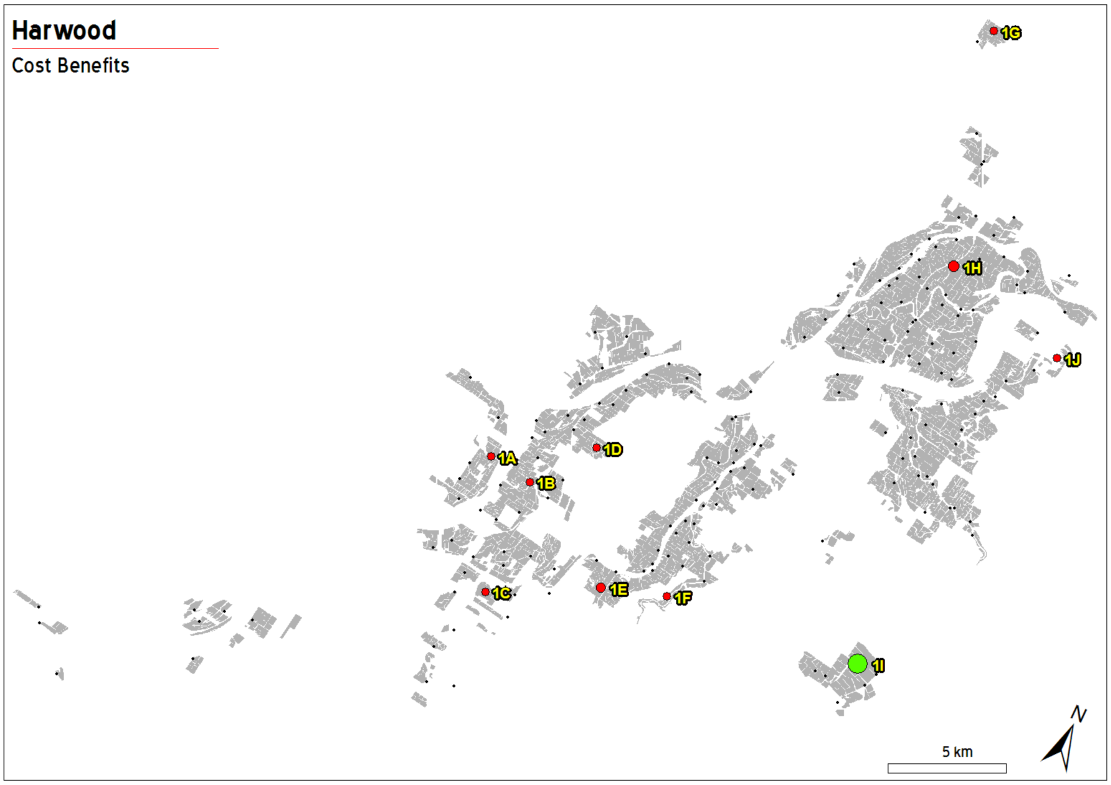


Figure 12. Savings in harvesting costs over 5 years for each of the new pad at optimal locations in Harwood mill

Figure 13 shows a close-up of location of two of the new pads for Broadwater, using an aerial photograph. This level of detail has been provided for each new pad recommendation in Figures 10 to 12.

Figure 13. Close-up of the new pads, 1D and 1E from Figure 10, highlighting the exact location of the new pads

The dollar benefits for each of the pads listed in Figures 10 to 12 are contained in Figures 14 to 16 respectively. These figures show for each new pad the savings over 5 years from harvesting the whole of crop for cogeneration (Full Trash) and the burnt crop (Base Case). Figures 14 to 16 show that the benefits outweigh the costs of new pads (i.e. orange bars higher than cost of pads line) for adding 21, 12 and 1 new pads to Broadwater, Condong and Harwood mills respectively. The number of new pads required is greater for the full trash case and is worth a short discussion as to why this occurs.

There are two key variables:

A. The time taken to fill a haulout.
B. The time required for a haul-out to travel to the pad, unload and return.

If the haulout can get back to the harvester before the other haulout(s) are filled (A>B) then the harvester can cut continuously. However if the haulout cannot get back before the remaining haulout(s) are full (A < B) the harvester must wait. This is expensive because it extends shift length and increases harvester fuel.

These scenarios adjust what happens to A and B and the relative difference between then:

- Decreasing haul distance reduces haulout travel, unload and return time (B).
- Whole-of-crop harvesting (full trash), with 20% more material, decreases haulout fill time.
- Whole-of-crop harvesting, with a low bulk density, decreases time taken to fill a haulout. However this is offset by an increase in bin volume. For Broadwater, Full trash haul capacity is 89.4% of base case.

New pad benefits identified in Figures 14 to 16 are calculated as the difference between with and without the new pad.

For full trash, haulouts are filled in much less time. For Broadwater, haul-outs for full trash are filled in 74.5% of the time taken in base case. This makes it more likely (compared to bas case) that a haulout will not return before remaining haul capacity is filled. Harvester waiting time, and therefore cost, will increase. Adding a new pad (viz. reduced haul distance) will now allow haulouts to return to the harvester in less time and will have a bigger reduction compared to that of the base case. Therefore the benefits identified in Figures 14 to 16 (calculated as the difference between full trash harvest with and without the new pad) are larger for full trash compared to base case.

Further analysis has shown that the results in Figures 14 to 16 to be sensitive to ground speed of the harvester. The benefits of adding new loading pads decrease with reduced harvester grounds speeds. Harvesting contractors and industry personnel present at the 29th September and the 13th October meetings held a view that, while there may be some reductions in harvester ground speed initially, harvester ground speed would be progress back to the current ground speed well within the five year time period of the pad analyses. This would occur through improvements in machine design (such as we are seeing in latest model machines) and through grower innovation.

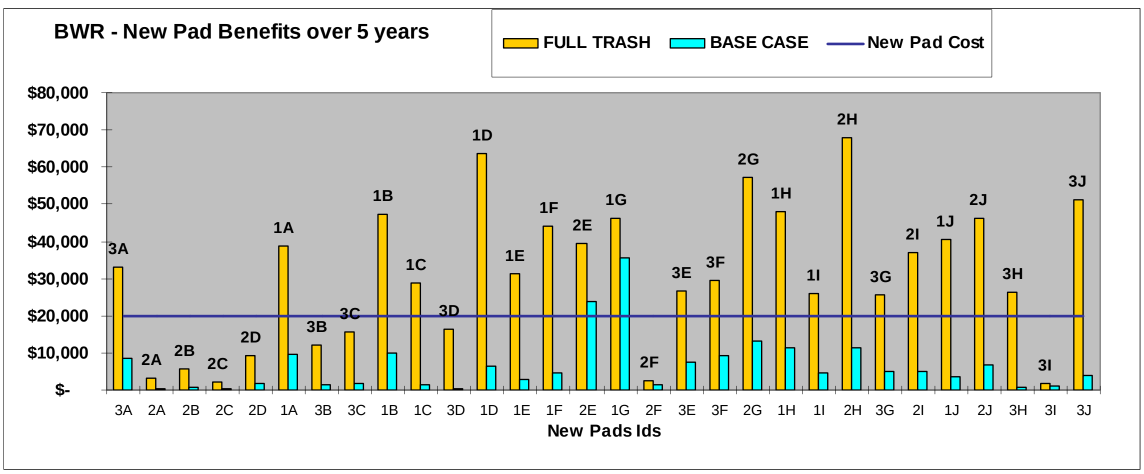


Figure 14. Costs saving for each of the pads listed in Figure 10 for the co-generation scenario - Broadwater

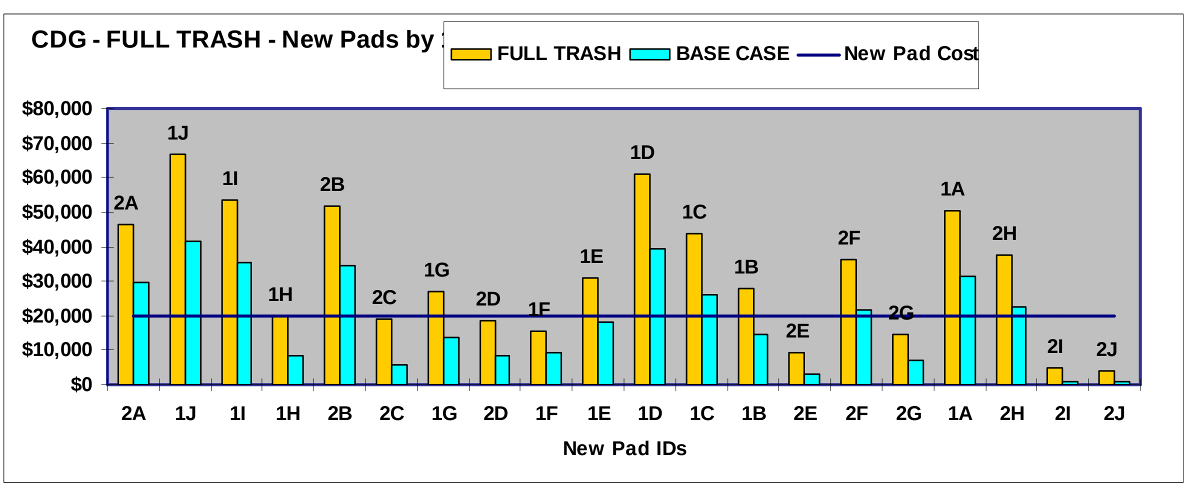


Figure 15. Costs saving for each of the pads listed in Figure 11 for the co-generation scenario - Condong

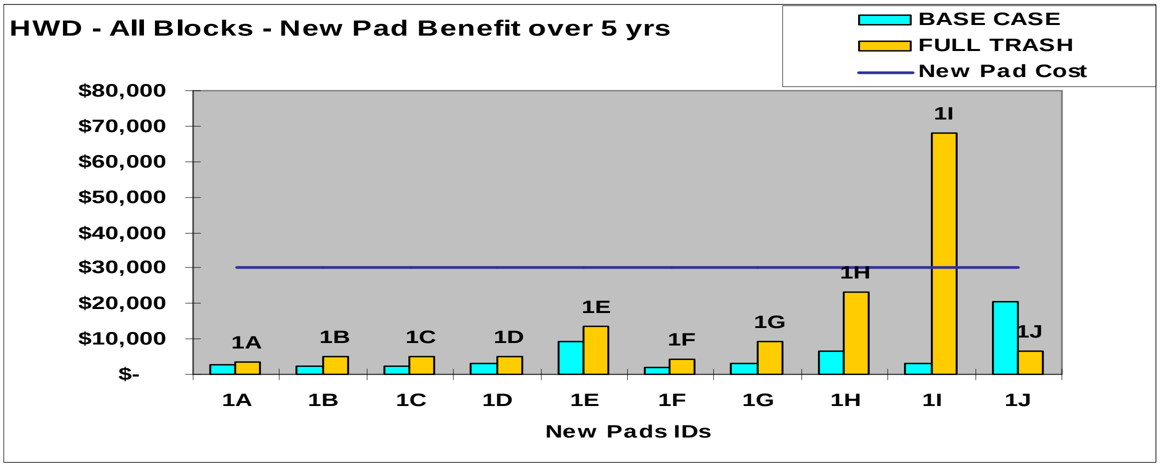


Figure 16. Costs saving for each of the pads listed in Figure 12 for the co-generation scenario - Harwood

Table 6 shows the economic benefits to the industry for the proposed number of new pads added. The two columns on the right account for the costs of building the pads.

Table 6. Summary of benefits of new loading pads

Region	No. of New Pads	Total tonnes transported to new pads	Gross savings in harvesting costs over 5 years	Gross savings as a per tonne of cane sent to the new pads	Costs of the new pads	Net savings in harvesting costs over 5 years	Net savings as a per tonne of cane sent to the new pads
BWR	21	327,423	$ 854,672	$ 2.61	$ 420,000	$ 434,672	$ 1.33
CDG	12	106,581	$ 553,863	$ 5.20	$ 240,000	$ 313,863	$ 2.94
HWD	1	15,710	$ 67,904	$ 4.32	$ 30,000	$ 37,904	$ 2.41
Total	34	449,713	$ 1,476,439	$ 3.28	$ 690,000	$ 786,439	$ 1.75

The project involved regular meetings between the research team and the local industry working group comprising of representatives from NSW Sugar Milling Co-operative and harvester operators. The meetings initially concentrated on the work in progress with the Harvest Haul Model and the Pad Optimisation Model, along with preliminary solutions for optimal locations of new pads. For the Harvest Haul Model, the regular meetings were required to fine tune the input variable data and ensure it is accurate and that the modelled costs for each harvesting co-operative is comparable to actual costs. This has been an important process and is essential to the success of this part of the project.

Specific topics covered at the meetings were:

- Outputs from Harvest Haul Model, along with an evaluation of their accuracy
- Identification of the relative impact of variables in the harvest haul model on harvest cost
- Outputs from Pad Optimisation Model
- Identification of the relative costs of harvesting as influenced by the numbers of new pads to be constructed
- Cleaning up the spatial data including the sorting out of unused pads, blocks/farms that no longer grow cane or wont in the future, New cane pads that would be required for future new cane land have not been included in the calculations.

Cane Supply Managers from the three NSW mills attended the meetings enabling local feedback on proposed rationalisation scenarios to be provided to the project researchers. Communication with stakeholders, including representatives of the NSW Canegrowers Association, was of particular importance when it came to finalising the set of parameters to an ‘existing’ scenario across the three mill regions. Unlike other sugar regions, it was important to consider the existence of 2-year crop rotations, as some productivity and transport data for a particular year would only apply to some of the blocks in the region.

Through the process of holding several meetings between the local industry and researchers from CSIRO and Harvesting Solutions, there was considerable joint learning about the harvesting and transport system in NSW. For example, the researchers gained a ground-level understanding of the complexities of the harvesting and transport system and how to accommodate it into the modelling work. The representatives from the NSW mills learned about the modelling work/analysis, and in turn gained a better understanding of their own system and potential opportunities.

The list of meeting dates between the NSW sugar industry and research team are as follows:

13th October 2005 – Video hook-up
29th September 2005 – Meeting at Broadwater Mill to discuss final results and further information required
31st August 2005 – Meeting at Condong mill to sort out data requirements for the final analysis
24th August 2005 – Meeting at Broadwater to discuss draft results and requirements for final report
20-21st June 2005 – Meetings at the NSW mills to sort out and fine tune data needs for the Harvest Haul model.

Outputs

- Automatic harvest progress recording using machine sensors, GPS and digital communication
- Automated paddocks harvested information.
- High quality harvest performance data and the ability to produce harvest activity reports
- Provision of the information for significant improvements in cost efficiencies in NSW harvesting costs through harvesting group optimisation and amalgamation
- Improved ability of people in the NSW Sugar Industry to collaborate and use modelling techniques for identification of infrastructure and cost savings for changes in harvesting structures

Intellectual Property

Agtrix P/L provides systems to interpret and report harvester data and mill based harvest recording software as commercial products. Agtrix did the development of the software outside of this project. The use of the software was provided to the project as a service. Agtrix P/L will do on-going product development and all IP on such products will remain with Agtrix P/L.

Environmental and Social Impacts

Environmental benefits will be accruing indirectly from the new cane pads from reduced energy usage for cane hauling. The activities in this project relate directly to the NSW Sugar Milling Cooperative Ltd co-generation project, which will use cane based fuels derived from cane trash and bagasse to power two 30MW generators and produce renewable electricity.
Improved harvest and transport efficiency provide direct benefits through the co-generation project to the entire NSW industry.
Improving the ability of farmers and staff members of the NSW industry to assess change has been a positive social benefit from this project.

Expected Outcomes

As a result of implementation of the cane supply management system (CHOMP) to the three NSW sugar mills the costs of operation have reduced by **32%**. In 2003 the costs of operation of the cane supply department of the NSW Sugar Milling Co-operative were assessed and documented. The same analysis was conducted in 2006 after full implementation of the automated harvest management system.
This is a significant saving to the NSW sugar industry and contributed to a key strategy of the NSWSMC to optimise efficiency at every step along the supply chain and target removal of elements of operating costs for managing cane supply and transport. Complimentary to this cost saving is the improved data captured by CHOMP for routine cane supply management operations and the other future uses for CHOMP data for identification of harvester efficiency factors.
This system is now in place in Mulgrave, Mackay, Plane Creek and Isis. The NSW Sugar Milling Cooperative Ltd and Agtrix P/L pioneered the development of this product through the support of this project and wider benefits will be seen in other areas of the Australian industry.

The target of group amalgamation and a harvest cost of $4 per tonne of cane has not been realised but this project and a companion SRDC project HGP001 “Establishing a million tonne harvesting co-operative” have developed a more co-operative approach to addressing problems in the harvesting sector. This has been evident in the way in which groups have shared information and problem solved in terms of the introduction of whole of crop harvesting this coming season.
It is believed that the information developed will enable the formation of 1 or 2 larger harvesting groups that will result in cost saving to farmers.

The benefits of adding new loading pads to each region were assessed for each mill area in NSW under the scenario of whole crop harvesting. Under this scenario, which is being introduced at the Condong and Broadwater mills in 2007 season the number of new loading pads to be located at Broadwater, Condong and Harwood was assessed. The benefit to the industry over the next 5 years is $1,476,439, with the estimated costs of adding the pads being $690,000. Actual locations of each of these new pads along with savings in harvesting costs were fully assessed. Knowledge of cost factors for harvesting has greatly improved for cane supply management staff as a result of the collaboration with project partners.

Future Research Needs

Barriers to change are always apparent and some research to determine simple ways to overcome these social issues would be an interesting opportunity.

Recommendations

This project has provided the NSW Sugar industry with an excellent harvest management system. On going development will occur with Agtrix to develop additional product features and reports.

Modelling programs developed by CSIRO and Harvesting Solutions have shown to be invaluable for assessing benefits and costs of harvest group changes and the locations of cane loading infrastructure. This expertise has wider application in the Australian industry and should be utilised.

List of Publications

Prestwidge, D., Lamb, B., Higgins, A.J., Sandell, G. and Beattie, R (2006). Optimising the number and location of new cane delivery pads in the NSW sugar region. Proc. Aust. Soc. Sugar Cane Technol., 28: 86-95