IMPROVING PROFITABILITY OF THE MARYBOROUGH SUGAR INDUSTRY BY ASSESSING THE OPTIONS FOR CANE SUPPLY AND SEASON LENGTH

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SUGAR RESEARCH AND DEVELOPMENT CORPORATION

FINAL REPORT
PROJECT Nº MSF001

NOVEMBER 2002

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AND DEVELOPMENT CORPORATION

FINAL REPORT

Project Reference N$^{o.}$ MSF001

Project Title: Improving profitability of the Maryborough sugar industry by assessing the options for cane supply and season length

SRDC Program: 8. Whole-of-Industry Competitiveness

Organisations: CRC for Sustainable Sugar Production (CRC-Sugar) and CSIRO Sustainable Ecosystems

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Commencement Date: 1 July 1999 **Completion Date:** 30 June 2002

ABSTRACT

Increasing cost/price pressure has forced the Australian sugar industry to seek innovative avenues for increasing profitability. To address this, the industry saw opportunities for increasing productivity and hence profitability through optimising the harvest date of sugarcane to account for geographical and crop differences in cane yield and the sugar content of cane. Whole-of-system research within CRC-Sugar produced the statistical and optimisation models needed to conduct options analysis for these alternative cane supply arrangements using case studies in Mackay and Mossman. The tools developed in CRC-Sugar were used to develop alternative cane supply options in partnership with the Maryborough sugar region. Through exploiting the geographical differences in CCS and cane yield at harvest date, average gains in profitability were $77/ha (sugar price $350/t) versus current equity arrangements. Farms that were found to be significantly early or late maturing, had higher potential gains. Pilot implementation of alternative cane supplies took place during the 2001 harvest season and involved the Maryborough Sugar Factory, where a significant gain in CCS was achieved. Seven other farms benefited from the optimisation work. The Maryborough region will continue to adopt alternative cane supplies in 2002 with a likely increased uptake of the optimisation strategy.

SUMMARY

The harvest date of sugarcane is a key determinant of sugar yield and hence net revenue. Opportunities exist for increasing industry profitability through alternative cane supply schedules. These schedules exploit differences in CCS and cane yield at harvest date, across farms and across individual paddocks on a farm. Developing the capability to capture this opportunity required groundbreaking research combining four key components: operations research and statistical modelling to integrate across the industry value chain; novel implementation pathways; industry cooperation; and grass roots participation. This project essentially looked at the involvement of grass roots participation.

The research to construct the combined statistical and optimisation model used for the cane supply options analysis, was carried out within CRC-Sugar Subprogram 3.2 and through participatory research with the growing and milling sectors in Mackay and Mossman. The model accounted for CCS and cane yield differences of farm, variety, crop class and harvest date. Costs and capacities of growing, harvesting, transporting and milling were also incorporated into the optimisation model. These constraints were modelled using the expertise from the milling and growing sectors across the mill regions. This component of the work provided the capability to assess options that exploit geographical and crop differences that occur in cane yield and CCS across harvest dates.

Through a broad-based industry workshop (March 1999, Townsville), with 145 representatives from across the Australian sugar industry, there was a general agreement that the gains in profitability were significant, other regions were keen to explore options as well, and implementation should commence soon. Increasing the capacity to deliver cane supply options to new mill regions (other than Mackay and Mossman) was initially achieved through developing software tools and processes in SRDC CTA044. Shortly after the broad-based industry workshop, a partnership was established with the Maryborough region to explore alternative cane supply options. The time between when the partnership was established and when advanced cane supply options were delivered to Maryborough was less than one year. This was because of application of the experience gained from the Mackay and Mossman case studies as well as the efficiencies gained from the tools developed in CTA044.

The project exceeded its original milestones through the decision to proceed towards pilot implementation, which was made in March 2001. Mr Frank Sestak (Cane Protection and Productivity Board (CPPB)) championed the on-ground recruiting of growers to participate. The computer software “HarvSched”, developed in CTA044, was installed on Frank’s laptop to develop harvest schedules with the grower participants. A workshop was held with interested growers on 13 June 2001 to provide them with draft schedules and information on the pilot scheme. A total of 16 farms were involved in the scheme in 2001 and a post-harvest evaluation was conducted in March 2002.

Maryborough Sugar Factory was very successful, and through their own analysis, estimated a $34,000 gain from increased CCS. Most growers who participated during 2001 found the alternative cane supply schedules to be valuable, and will continue to participate in 2002. Further growers have shown interest to trial alternative cane supplies during 2002.

BACKGROUND

Moving into the 21st century, increasing cost/price pressure has forced the Australian sugar industry to seek innovative avenues for increasing profitability. In response, the milling and growing sectors have sought ways to make more profitable use of their capital, infrastructure, and land resources. Past advances have come from improvements in technical efficiency and cost efficiency of different industry sectors, but the challenge is to achieve quantum gains in competitiveness by exploiting interdependencies across the value chain. This involves identifying and modelling the key drivers and constraints across the value chain from cane growing on-farm, to harvesting and transport systems to milling cane to produce raw sugar. New technology was required to address the complexity of value chain optimisation, or pathways for implementation that accounted for the differences in the growing, harvesting and transport, and milling sectors. Whole-of-industry research offers scope for the delivery of even greater benefits but progress has been minimal.

One aspect of the whole-of-industry approach is concerned with cane supply management - an aspect that has implications for all three industry sectors: production, milling, and marketing. Deeply entrenched practices such as operational cultures, use of capital and infrastructure, and equity arrangements for all cane growers may have to be questioned if greater industry profitability in a mill region can be demonstrated. Research in this area required new tools and new skills for integration and analysis of information in order to evaluate alternative cane supply practices. However, it also drew heavily on the knowledge and understanding built up over the years for the individual components of the production chain through the activities of researchers in CRC-Sugar, other CRC Programs and other organisations.

Assessing opportunities for alternative cane supply arrangements for enhancing profitability was achieved through optimising the harvest date of sugar cane, accounting for geographical and crop differences in cane yield and CCS throughout the harvesting season. In terms of complexity, a mill region contains up to 10,000 paddocks on over 450 farms and harvested by up to 100 harvesting groups according to a fixed rotation, so all farms are harvested proportionally over time. Harvest schedules using a fixed rotation do not allow the exploitation of geographical variation in CCS and cane yield at harvest date, meaning that productivity and revenue are sacrificed. Optimisation modelling has shown that by not using a fixed rotation and by exploiting geographical differences in productivity, significant gains in profitability are possible.

Participatory action research has been a key component to realise the benefits of identified and agreed cane supply options for enhanced profitability. Realising the profitability gains in the Australian sugar industry is a difficult challenge since:

- Individual farms are privately owned and farmers have for a long time been governed by regulated equity to ensure each farmer and harvester cuts a constant amount of cane throughout the harvest season. Socio-economic barriers for change from this system are strong in the Australian sugar industry, and acceptance of change varies significantly across farmers and harvesting groups.
- Implementation of alternative cane supply options is not plug-and-play. In the past growers and harvesters have primarily adopted new technologies that involve a physical change (*e.g.* new harvesting equipment, new varieties, new pest control chemicals). Harvest schedules produced by the optimisation model are complex and require a change in behaviour through harvest practices, they need to be in a form that is easily interpreted by growers and harvester contractors.
- The concept of optimising more than one decision simultaneously is difficult to understand at first, even for scientists of non operations research disciplines, and optimising a harvest schedule at a farm or mill level is based on these principles. Poor communication of this concept would lead to growers, harvesters and millers being sceptical about the value of optimal cane supplies.
- Since the optimisation model uses statistical models to predict CCS and TCH response to harvest date, the optimal schedules produced by the model are not proof-of-concept themselves. Large-scale pilot implementation of the harvest schedules, produced by the optimisation model, is required to prove success.

Addressing these issues requires a three-fold approach (strategic research, case studies and wider industry involvement), with the ultimate aim of implementing cane supply options, leading to increased profitability across mill regions within the Australian sugar industry.

1. <u>Strategic Research</u>

- Develop cane supply optimisation model (Higgins, 1999; Higgins and Haynes, 2001) under CRC-Sugar Program 3, that captures the key inputs of CCS and TCH responses to harvest date and constraints associated with harvesting, transport and milling capacity.
- Develop strategies to overcome implementation barriers (Muchow *et al.*, 2000), pilot study schemes, software tools to assist implementation, and a process for monitoring and evaluation of pilot studies.

2. <u>Case Studies</u>

- Provide partnerships with the local industries in Mackay and Mossman to ensure the strategic research is carried out with continuous input from these local industries. Through options analysis groups in Mackay and Mossman - involving growing, harvesting and mill representatives - necessary data collated and models ground-truthed and refined.
- Deliver options analysis that is relevant to the needs of the local industry with the ultimate aim of implementation.
- Provide proof-of-concept using pilot studies within the case study regions, which may lead to other mill regions within the Australian sugar industry adopting alternative cane supplies.

3. Wider Industry Delivery and Involvement

- Assist other Australian mill regions (with the Maryborough project being a core part of this) in evaluating different cane supply and harvest scheduling options and implementation of these, given the outputs from strategic research and case studies.
- Develop the capacity for the widespread delivery of options for alternative cane supplies and the implementation of these.

OBJECTIVES

The primary aim of the project was to maximise the profitability of the Maryborough sugar industry. This was to be achieved by improving utilisation of capital from both the factory and field by a combined Maryborough sugar industry approach in evaluating options with regard to cane supply to the factory.

The objective was achieved through the delivery of alternative cane supply options that maximised industry profitability through exploiting the geographical and crop differences that occur in CCS and TCH across harvest dates. A subset of these options was piloted by the Maryborough sugar industry during the 2001 harvest season to provide proof–of-concept. The Maryborough Sugar Factory was the largest participant in 2001 and estimated significant gains in CCS as a result of implementing the alternative cane supplies.

RESEARCH METHODOLOGY

Participatory research with the Maryborough Cane Supply Options Analysis Group (MCSOAG) has underpinned the project over the past three years. Action learning cycles were embedded in the participatory research to ensure that the project evolved towards beneficial change with full support by the industry (Figure 1). This approach was needed because: alternative cane supply options are new to the industry; optimisation is a difficult and sometimes a black-box concept; adoption requires the industry to change; and there are many potential barriers to implementation and difficulties with the use of software tools which could not be overcome without participatory research. Using participatory research, this project (MSF001) linked the existing CRC-Sugar Sub-program 3.2 and SRDC CTA044, which are respectively, strategic research and building capacity for wider industry delivery.

The focus at the start of the project was to obtain the necessary model data and produce preliminary options analysis within the first year. Through the delivery of preliminary options analysis, the MCSOAG would gain confidence in the potential implementation of the options and would be part of ground-truthing the preliminary results. Within the second year of the project, more advanced options analysis were delivered in light of the ground-truthing as well as the need to address local issues. After the delivery of advanced options analysis, the MCSOAG faced a stop-go decision for implementation, since implementation was the next logical step, and there was no point continuing without implementation. The decision was made to go forward. Through the experience of pilot implementations in Mossman and Mackay during 2000, the approach for Maryborough was to pilot the cane supply options on a small scale in 2001, with a proof-of-concept leading to an increase uptake in subsequent years.

DETAILED RESULTS AND DISCUSSION

Using the cane supply optimisation model input data manual (developed for SRDC CTA044), the block productivity data and its necessary data fields were obtained for 1991 to 1999, from the Maryborough Sugar Factory. These data were validated and are stored in a database to allow easy generation of cane supply model input data. A preliminary data analysis, pulling out significant key findings that would impact future cane supply options, was presented at the general MCSOAG meeting on 14 October 1999. A technical workshop was held at Maryborough Sugar Factory on 25 August 1999 to specify and set actions to collate the necessary input data (other than block productivity) for the construction of model constraints (step 2 of Figure 1). These key model constraints included milling, transport, farm and harvesting equity, and mill stoppages. The preliminary model constraints were validated and assessed at the MCSOAG meeting on 23 February 2000.

1. **Develop Shared Goals and Commitment**
   - Likely options to be evaluated
   - Partnership between growers, millers and researchers
   - Commitment by industry to resource District specific work.
2. **Technical Work**
   - Data inputs: on-farm productivity and off-farm constraints
   - Development of cane supply optimisation model
   - Model specification, runs and testing.
3. **Evaluation of Options in Partnership with Industry**
   - Ground-truthing model output and further model evaluation
   - Further model development for additional constraints.
4. **Agreement on Options for Implementation**
5. **Pathway to Implementation**
   - Identify likely barriers and strategies for overcoming/accommodating these barriers
   - Develop change management plan
   - Incremental implementation.

Figure 1. Cane Supply and Harvest Scheduling, Process Towards Implementation for Maryborough.

The cane supply optimisation model was constructed for Maryborough. Key options analysis, specified by the MCSOAG, was conducted for the Maryborough region. The potential gains in profitability for the options are contained in Table 1, which shows the average gains in profitability versus the existing system of grower and harvester equity under a sugar price of $250/t (see Higgins and Muchow, 2002). The current harvesting group arrangements limits the gains for option 2 (see Table 1 footer for explanation of options). Harvesting groups with a good spread of early maturing, average maturing and late maturing farms will have potential gains similar to that of option 1. Further gains are possible by best scheduling of farm paddocks at farm level (option 3), though an estimate of these gains is not known with reliable accuracy using modelling techniques.

Table 1. Gain in profitability for different cane supply options in Maryborough.

Option	Industry profitability gains ($/ha)	Grower profitability gains ($/ha)	Sugar yield gain (t/ha)
1	43	32	0.25
1a	41	30	0.25
2	16	14	0.10

(1) Harvesting across groups within a mill;
(1a) Same as 1 except all farms equal with the mill at 85% of total crush;
(2) Harvesting across farms within a group.

The results of these cane supply options were ground-truthed at a cane supply options meeting on 5 December 2000. As a result of the meeting and learnings from the 2000 Mackay piloting process, the model and outputs were at a stage where they could be implemented.

An action for the Maryborough local industry from the meeting on 5 December 2000 was to make a decision on moving forward to pilot implementation in harvest 2001. A positive decision was made for piloting option 2 (Table 1) as well as option 3 (*i.e.* optimal scheduling of farm paddocks on a farm). The Maryborough local industry agreed that it was not logistically possible to set up the entitlement exchange scheme required to implement option 1 for the 2001 harvest season.

The intention of the piloting process was to provide proof-of-concept in the Maryborough region that would lead to a larger uptake in 2002. A cane supply options meeting was held at Maryborough Canegrowers (10 May 2001) to plan the process for pilot implementation. Prepared information showed which growers and harvesting groups were suitable for option 2 (see Table 1 and Appendix A). About 14 harvesting groups and growers were selected for invitation to pilot the optimisation model.

Figure 2 shows the CCS trends of two Maryborough farms, the first being a high-late farm and the second a high-early farm. This was calculated using 1992-1999 block productivity data and each dot in the figure represents a paddock that was harvested in one of those years. A linear trend was fitted to each case showing the CCS trend versus the mill throughout the harvest season. If the farm is in the late category, then there are CCS gains for the farm by cutting more of that farm in the second half of the season and vice versa.

Suitable harvesting groups and growers were identified using the CCS groups (Appendix A) and the likelihood of them co-operating. These groups and growers were contacted and invited to a workshop on 13 June 2001. The purpose of the workshop was to deliver draft harvest schedules for options 2 and 3, fine tune these to make them workable on-farm, and to provide the necessary information so as to ensure motivation and commitment throughout the harvest season. Twelve growers attended the grower workshop held on 13 June 2001. The MCSOAG agreed the workshop was a success and several growers were contacted to fine-tune their harvest schedules in light of on-farm practicalities. As a result of the pilot recruitment scheme, two harvesting groups were committed for option 2, including the Maryborough Sugar Factory harvesters, and two other growers were committed to option 3. This represents about 15% of all assigned cane land in Maryborough.

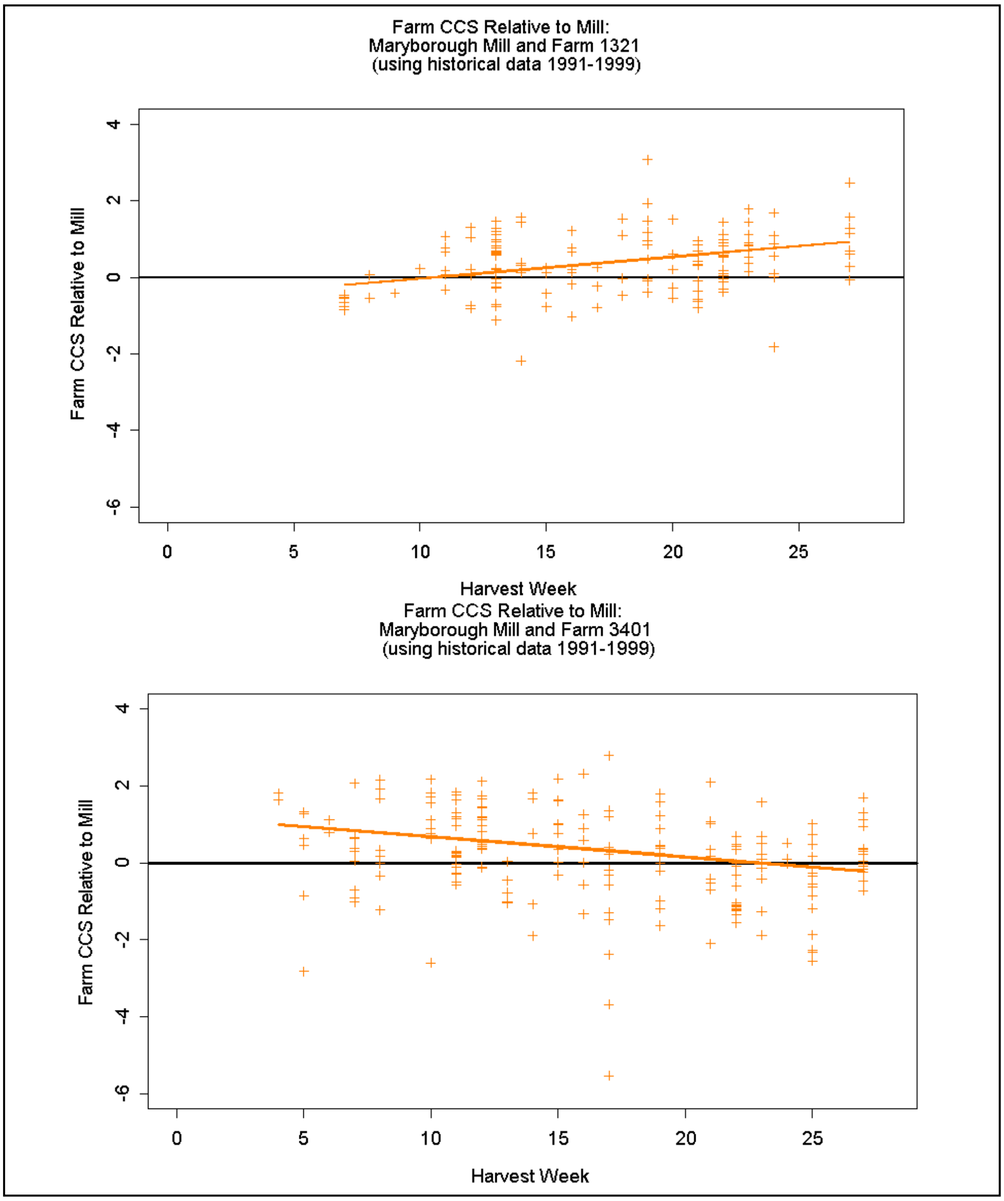

Figure 2(a) & (b). CCS effects of two contrasting farms with the first being a high late and the second a high early.

After the 2001 harvest season, it was concluded that 12 farms (including the Maryborough Sugar Factory (MSF)) were involved in option 2 and four in on-farm optimisation. In February 2002, the 2001 block productivity data was ready and used to conduct an evaluation of the pilots of the 2001 harvest season. For each of these farms, the increase in CCS (relative to the mill average) from 2000 to 2001 is illustrated in Figure 3 for option 2 and Figure 4 for option 3. The results were compared to the mill average since: 1) it accounts for year to year variability; and 2) it is a method of comparing farms that take part in the scheme versus those that do not take part. For example if a farm has an increase in CCS relative to the mill from 2000 to 2001, its position relative to the other farms has increased. If a large enough proportion of farms in the pilot scheme achieve an increase, this is evidence that the alternative cane supply options achieved positive results.

In Figure 3, the MSF farms are 1641 to 1649, while the other farms belonged to the J Schmidt harvesting group. Farms 1641 and 1642 have CCS trends that increase relative to the mill from the start of the season through to the end of the season (Figure 5), thus it was better to cut more of these farms in the second half of the season. While only farm 1641 was cut primarily in the second half of the season, a study of the CCS effects (relative to the district) for both of these farms using 2001 data, showed that there are increases in CCS with harvest date (data not shown). For these two farms, the model prediction was correct in indicating that the farms should be cut in the second half of the season. The J Schmidt harvesting group (1381, 1441, 1631 – Figure 3) was involved in an option 2, other factors outside the schedule influenced these gains. These farms were also in the CCS neutral category (Appendix A).

The four farms of Figure 4 are for Steven (4021) and Frederiksen (4691, 4701 and 4711). Figure 4 may indicate that option 3 had a negative effect on the farms. However, compliance to the schedule was not high enough to properly assess if the option 3 schedules were beneficial or not.

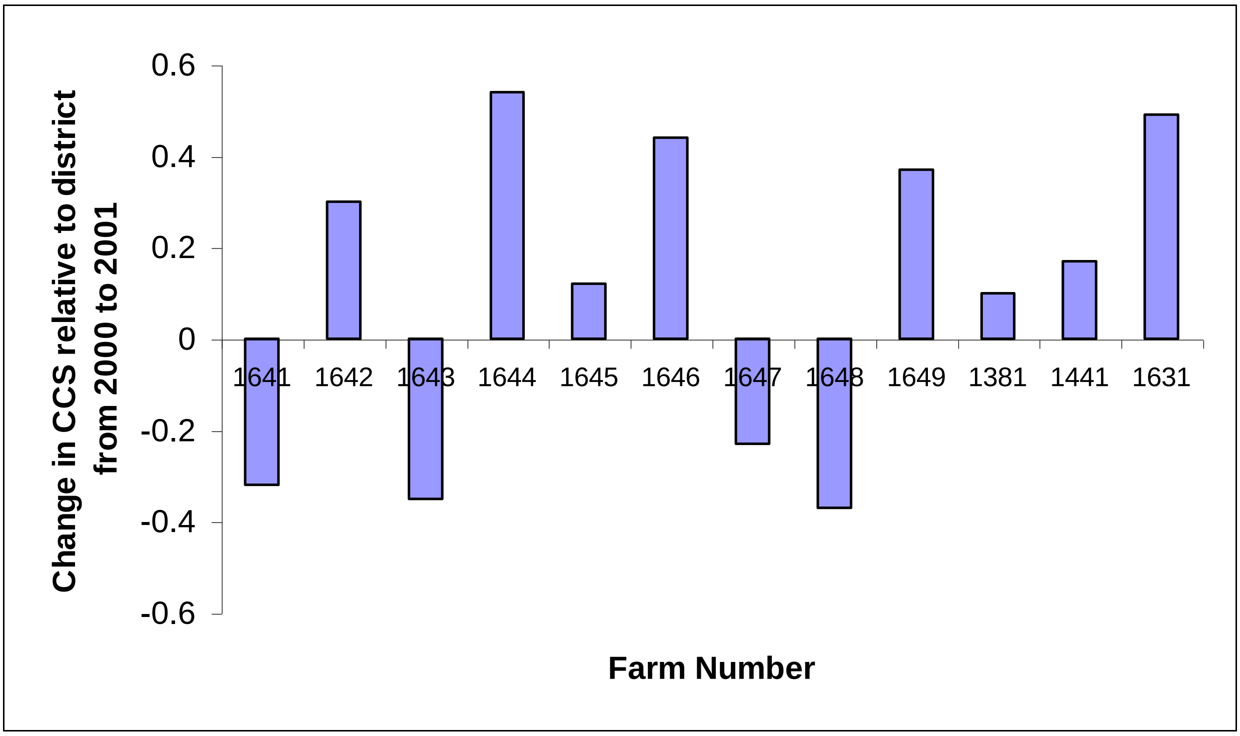

Figure 3. Increase in CCS relative to district for farms involved in option 2.

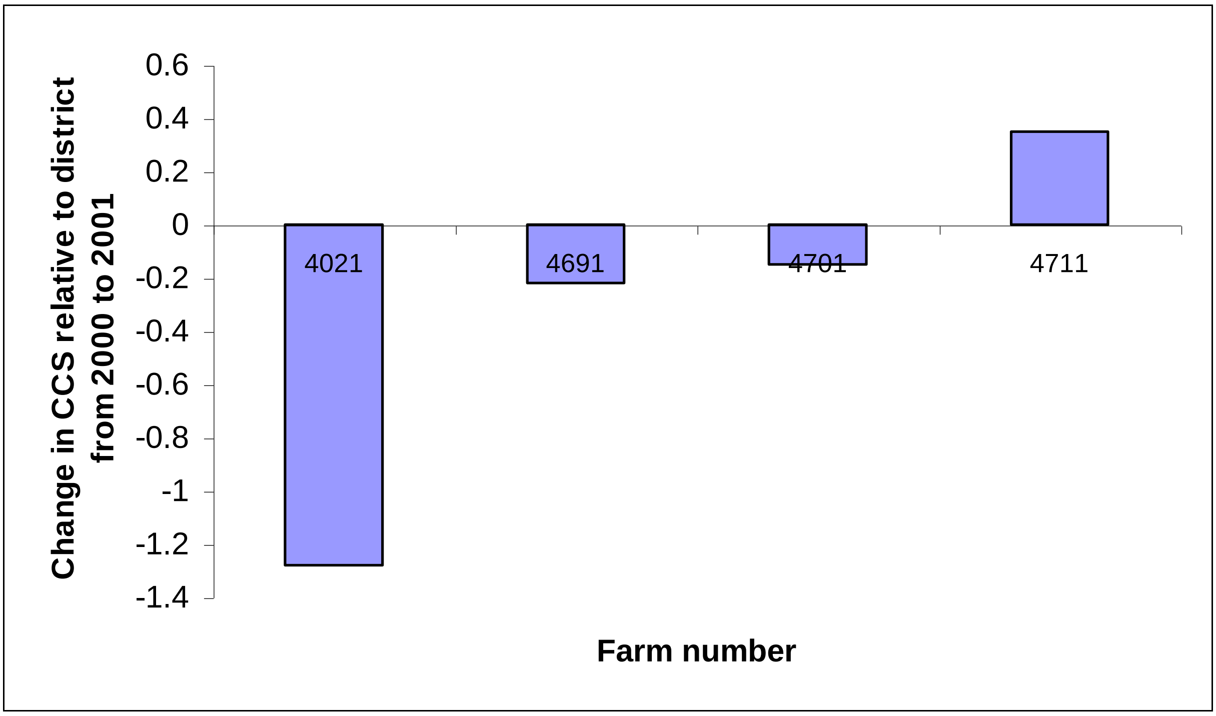

Figure 4. Increase in CCS relative to district for farms involved in option 3.

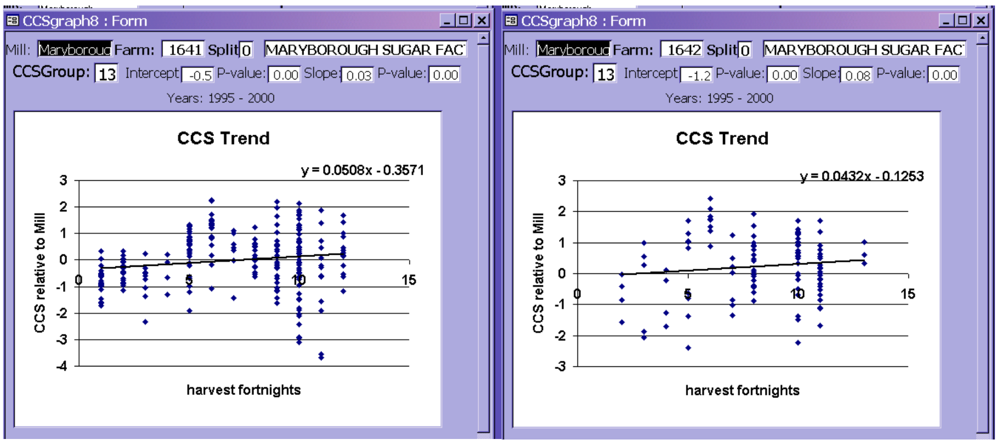

Figure 5. CCS effects of the two late maturing Maryborough Sugar Factory farms using 1992 to 1999 block productivity data.

On 4 April 2002, an evaluation workshop was held with all growers who participated during the 2001 harvest season. The main findings from the evaluation workshop were as follows:

- The harvesting across farms within the Maryborough Sugar Factory land to exploit geographical differences in CCS and TCH across harvest dates, led to an estimated gain in profitability of about $34,000 from gains in CCS.
- The "harvesting across paddocks within a farm" pilots were mixed with all growers having some difficulty complying with the schedule during the harvest season.
- Despite the mixed results, and the schedules not being followed for the whole season, most of the growers claimed the schedules were useful and were keen to continue in 2002.

- The "winner" in Maryborough was option 2 ("harvesting across farms to exploit geographical differences in CCS and TCH across harvest dates"). In light of this, the MCSOAG agreed to try to recruit more harvesting groups and growers with multiple farms for 2002. Data showing the farms with better CCS relative to the mill earlier in the harvest season and those with better CCS later in the season, will be used by Frank Sestak and the options analysis group to approach potential growers and harvesting groups for recruitment to the 2002 harvest season.

Compliance to the model schedules was a major issue for the entire cane supply options project, not just MSF001. The reasons for low compliance are complex and something the project team is learning more about all the time, for example, the optimisation options chosen can influence compliance because they do not match farm management practice. While results are not available to back up the claim, compliance is a much bigger issue with option 3, rather than options 1 and 2. Option 3 is a long list of "order of farm paddocks" requiring little change from a grower, rather than just following the order. Options 1 and 2 are a schedule simply stating how much cane should be cut from each farm throughout the harvest season, but requiring a change to equity to achieve it (no small task), unless the grower or harvester contractor owns all the land involved. Once there was a commitment to option 2, the schedule was straightforward to implement. With option 3, there are many events that can cause the grower to divert from the schedule, including: inaccuracy of consignment of block data, wet paddocks, new varieties and ploughout. Growers at the evaluation workshop raised these problems.

A potentially underlying reason why option 3 schedules were not followed closely in all case study regions (including Maryborough) is with the use of block productivity data to optimise the sequence of farm paddocks. This is a more recent learning and only applies with option 3. The statistical modelling applied to the block productivity data is used to capture the CCS trends for farms but also for variety by crop class (Higgins and Haynes, 2001). The effects for a farm are calculated using the data for that farm only, thus the estimated statistical model for the farm is reliable. This means there are no problems with schedules produced for options 1 and 2. Option 3 required that the CCS effects, by harvest date, be estimated for individual paddocks. Since there is not enough historical data to estimate these effects for each paddock, we had to estimate the variety by crop class and by harvester date effects using all paddocks within the mill region. This means that if paddock X is Q136, 1st Ratoon to be harvested in week 8, the estimate of CCS is captured using historical productivity data for all paddocks of Q136, 1st ratoon at week 8. Unfortunately variety, crop class and harvest date only explain about 50% of the CCS variation across farm paddocks. When optimising the harvest date of farm paddocks within a farm, the optimal sequence of farm paddocks is unlikely to be accurate because of this low explanation of CCS variation. Farms with paddocks that average in terms of CCS effects from variety and crop class, option 3 schedules are much more likely to be accurate. This appeared to be the case for the growers who had good compliance and achieved gains.

Prior to the 2001 harvest season in all case study regions, a large number of option 3 schedules were produced for growers and handed out to them (over 100 across the three case study regions). At the end of the season less than 10% of the farms had an 80% compliance. The main reason for growers not using the option 3 schedules at all or withdrawing early in the season, is the schedule being very different to the grower perception of the farm, thus those who do follow the schedule are the ones which the optimal schedule is accurate for their farm. Despite the shortcomings of the option 3 schedules, most growers agree they are a useful guide. Instead of producing optimal paddock sequences in the future, it would be more robust and useful to generate guides of when to harvest different variety by crop class combinations. This is an aim for the 2003 harvest season.

This SRDC project officially terminates on 30 June 2002. However, there is significant interest in Maryborough to continue using alternative cane supply arrangements, with an increasing uptake of option 2. There are also more growers interested in trialing the alternative cane supply arrangements. To increase the efficiency of generating and delivering harvest schedules to growers/harvesters using the computer tools, $5,250 of the project funds was used to invest in a more powerful laptop computer and printer for the Maryborough CPPB. This ensures that the group has sufficient computing capability for delivery of alternative cane supply arrangements.

ANALYSIS OF OUTPUTS AND OUTCOMES COMPARED TO OBJECTIVES

Project Objectives

This section lists project objectives, along with key outputs and outcomes associated with each.

Objective 1. Developing partnerships between growers, millers and researchers with a commitment to resource District specific work.

Output

The Maryborough Cane Supply Options Analysis Group was formed at the start of the project and it continued throughout the life of the project. It contained representatives from the milling, harvesting and growing sectors as well as researchers from CSIRO and BSES. This group contributed expertise, knowledge and advice to the research group and strengthened the model design and outcomes.

Objective 2**.** Development of a cane supply optimisation model with on-farm productivity and off-farm constraints data inputs.

Output

The cane supply optimisation model developed within the CRC-Sugar Subprogram 3.2 was adapted to the Maryborough region. All of the necessary input data and model constraints were collated and developed in partnership with the Maryborough Sugar Factory.

Outcome

Delivery of alternative cane supply options to the Maryborough Cane Supply Options Analysis Group, showing potential gains in profitability and the corresponding harvest schedule. These alternative cane supply options were applied and successful in the case study region.

Objective 3. Ground-truth model output with provision for further development for additional constraints.

*Outpu*t

Advanced options analysis for the Maryborough region that are credible from the milling and transport perspective i.e. they take into account the practical constraints of operations.

Outcomes

The Maryborough Cane Supply Options Analysis Group was confident that the options analyses were able to be implemented and were able to deliver benefits. A subset of the options analysis was implemented during the 2001 harvest season for a limited number of growers.

Objective 4 and 5**.** Identify likely barriers and strategies for overcoming/accommodating these barriers through the use of workshops, and the development of pathways to implementation.

Output

A demonstrated implementation pathway where a sufficient number of growers were recruited. These growers were assisted and facilitated through the adoption of the harvest schedules produced by the optimisation model.

Outcome

Alternative cane supplies implemented on 16 farms within the Maryborough sugar industry, equalling about 15% of the total crop.

POTENTIAL BENEFITS AND LIKELY IMPACT TO THE AUSTRALIAN SUGAR INDUSTRY

The potential gains in profitability have been assessed for Mackay, Mossman, Maryborough and the Burdekin (Higgins and Muchow, 2002). Considering option 1 only, the average potential gains in profitability per year for Mackay, Mossman, Maryborough and the Burdekin are $119/ha (81,000 ha of harvested cane), $79/ha (13,000 ha), $77/ha (11,000 ha) and $235/ha (67,000 ha) respectively. This gives a total of $27M for these mills, over a total harvested land of 172,000 hectares. Given the Australian sugar industry has 400,000 hectares, the potential from option 1 could be approximated as $27M*400,000/172,000 = $63M per year. Further gains are possible from optimising the harvest date of farm paddocks at farm level, exploiting the differences in varieties and crop classes at harvest date.

In the 2001 harvest season, pilot implementation of alternative cane supplies took place in Mackay, Mossman and Maryborough with the Burdekin commencing in 2002. In Mossman and Maryborough, the uptake was about 5% and 15% respectively and all mills will continue in 2002. The uptake by Maryborough and Mossman is likely to increase in 2002 compared to 2001. Interest has also been shown by the Tableland, Mulgrave, Tully and the Herbert to explore options for alternative cane supplies. This further interest was partially a result of this project, since the capacity has been increased to deliver to other mill regions.

The overall likely impact on the Australian sugar industry depends on the level of uptake in each mill region and the time it will take to achieve maximum uptake. A new SRDC project CSE003 aims to develop the capacity to maximise long-term uptake.

PROJECT TECHNOLOGY

The following end-user software was produced within this project:

1 “HarvSched”

2 Cane Supply Options system (which includes HarvSched, though it can be used in isolation)

The software does use commercially sensitive block productivity data, which cannot be made available to those who do not have authorised access to the data.

RECOMMENDATIONS

In light of the learnings from the Detailed Results and Discussion section, the following recommendations are made:

- Within Maryborough, no longer use option 3 schedules that show the harvest date (produced by the model) for every farm paddock. Instead, produce simple/generic guidelines that show the preference order of variety by crop class across harvest dates. This will be addressed as part of CSE003.
- Do not consider option 3 in new mill regions (*e.g.* Plane Creek, Tableland).

ACKNOWLEDGEMENTS

A large number of people participated in this project from the Maryborough region. We firstly would like to acknowledge members of the Maryborough Cane Supply Options Analysis group for driving the projects at the local level throughout the life of the project: JC Schmidt, AM Otto, LW Petersen, JP Frederiksen, AK Birt, TH Turner, R Kelly, DG Cronau, and DM Braddock. The staff from the Coastal Cropping Systems group within CSIRO Sustainable Ecosystems who contributed to the success of the project: Dr Anna Williamson and Ms Clare Gambley for communication activities (magazine articles, fact sheets, posters etc.) and Ms Barbara Philp for managing communication with industry collaborators and planning for meetings/workshops.

PUBLICATIONS RESULTING FROM THE PROJECT

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2. HIGGINS, A.J. and HAYNES, M.A. (2001). An integrated modeling approach to enhancing sugarcane profitability. *Proceedings 2001 International Congress on Modelling and Simulation* pp.1787-1792.
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4. MUCHOW, R.C., HIGGINS, A.J., ANDREW, W.J. and HAYNES, M.A. (2000). Towards improved harvest management using a whole industry systems approach. *Proceedings Australian Society of Sugar Cane Technologists* **22**: 30-37.

APPENDIX A.

CCS groups for each farm in Maryborough

Statistical models were fitted to the "farm CCS relative to the mill" for every farm in Maryborough. In the table below, the CCS gradient is the change in CCS versus the mill per week of crush. The significance level column states the significance level of this gradient. If the significance level is <0.10 (i.e. 10% level of significance) then the farm is allocated to a "early" category if CCS gradient is negative and "late" if the gradient is positive. Other farms are put in a "neutral" category unless there was not enough data for the analysis for which case it is "insuffic".

Farm	CCS gradient	Significance level	CCS group	Tonnes in 1999	Harvesting group
1641	0.03	0.00	Late	7838.70	1
1642	0.08	0.00	Late	6361.64	1
1643	-0.02	0.85	Neutral	14783.86	1
1644	-0.02	0.52	Neutral	5003.93	1
1645	0.02	0.85	Neutral	11325.78	1
1646	0.02	0.96	Neutral	4402.58	1
1647	0.00	0.76	Neutral	7932.65	1
1648	-0.05	0.13	Neutral	9538.81	1
1649	0.01	0.65	Neutral	10677.17	1
1081	0.02	0.34	Neutral	3206.81	2
1101	0.00	0.98	Neutral	1031.66	2
1121	-0.01	0.18	Neutral	3803.64	2
1141	0.03	0.74	insuff	216.80	2
4142	-0.03	0.55	insuff	476.26	2
1111	-0.01	0.17	Neutral	3443.41	3
1112	-0.08	0.25	insuff	329.07	3
1271	-0.05	0.12	Neutral	1602.26	3
1272	0.08	0.30	insuff	2022.42	3
1273	0.01	0.56	Neutral	5602.00	3
1281	0.01	0.19	Neutral	7466.83	3
1282	-0.01	0.42	Neutral	3631.15	3
1283	-0.01	0.98	Neutral	4852.64	3
1284	0.02	0.94	Neutral	4489.38	3
1291	0.05	0.18	insuff		3
1581	-0.01	0.74	Neutral	6344.91	3
1582	0.00	0.08	Neutral	6421.62	3
1583	-0.03	0.02	Early	8791.01	3
1411	0.02	0.00	Neutral	3236.37	4
1421	0.00	0.78	Neutral	4176.72	4
1511	0.03	0.01	Late	4537.34	4
1531	-0.07	0.67	insuff	3208.44	4
1541	0.04	0.00	Late	1730.65	4
1542	0.05	0.02	Late	1219.10	4
1551	0.01	0.81	Neutral	5495.59	4
1561	0.02	0.10	Neutral	8044.72	4
1571	0.00	0.50	Neutral	2107.78	4
1131	0.01	0.08	Neutral	3175.65	5
1251	0.02	0.01	Neutral	3521.28	5
1261	0.01	0.70	Neutral	673.49	5
1341	0.03	0.34	Neutral	1133.26	5
1342	0.06	0.02	Late	1448.66	5

Farm	CCS gradient	Significance level	CCS group	Tonnes in 1999	Harvesting group
1361	0.03	0.19	Neutral	1591.96	5
4651	0.07	0.00	Late	980.25	5
4681	0.04	0.00	Late	9266.19	5
4921	0.03	0.03	Late	3415.05	5
4922	0.02	0.79	Neutral	869.19	5
4931	0.03	0.04	Late	2818.71	5
4941	0.01	0.00	Neutral	2954.49	5
4951	0.03	0.07	Late	2850.05	5
4981	0.11	0.00	Late	3406.75	5
1071	-0.03	0.21	Neutral	676.60	6
1091	0.03	0.26	Neutral	2254.86	6
1211	0.00	0.60	Neutral	1429.63	6
1301	-0.03	0.22	Neutral	1905.63	6
1351	0.03	0.29	Neutral	786.99	6
1391	0.05	0.02	Late	2256.86	6
1392	0.01	0.25	Neutral	2593.04	6
1451	0.06	0.00	Late	3582.59	6
1461	0.06	0.03	Late	1807.11	6
1471	0.05	0.03	Late	934.15	6
1501	0.09	0.06	insuff	2993.10	6
3211	-0.04	0.00	Early	6809.15	6
4031	-0.04	0.01	Early	2553.69	6
4111	-0.05	0.00	Early	1572.86	6
4201	0.79		insuff	397.93	6
4611	0.04	0.84	insuff	707.42	6
4621	-0.04	0.18	Neutral	1794.28	6
4622	-0.04	0.04	Early	964.74	6
4631	0.02	0.79	Neutral	1456.30	6
4641	0.02	0.75	Neutral	1278.80	6
4961	-0.35	0.00	insuff	499.52	6
1601	0.01	0.60	Neutral	6819.41	7
1602	0.02	0.41	Neutral	1598.23	7
1611	0.01	0.77	Neutral	3151.40	7
1612	-0.03	0.06	Early	1549.46	7
1613	0.02	0.83	Neutral	4183.82	7
1381	0.01	0.91	Neutral	3834.12	8
1382	0.04	0.00	Late	5420.69	8
1383	-0.06	0.00	Early	3297.18	8
1431	0.03	0.16	Neutral	0.00	8
1441	0.02	0.20	Neutral	9425.67	8
1631	0.02	0.01	Neutral	3533.63	8
4481	-0.06	0.02	Early	1191.14	8
1011	0.02	0.56	Neutral	1644.92	9
1021	0.04	0.00	Late	6916.68	9
1031	-0.05	0.23	Neutral	938.60	9
1321	0.06	0.00	Late	1907.63	10
1331	0.03	0.11	Neutral	1242.89	10
1401	0.10	0.03	Late	1257.99	10
1041	0.02	0.02	Neutral	6965.51	11
2221	0.08	0.00	Late	2734.23	11
2271	0.00	0.04	Neutral	10853.09	11
2272	-0.08	0.54	Neutral	1506.70	11
2273	-0.11	0.00	Early	1911.74	11
2341	0.00	0.75	Neutral	2281.94	11
2481	0.09	0.03	insuff	1528.44	11

Farm	CCS gradient	Significance level	CCS group	Tonnes in 1999	Harvesting group
2491	0.05	0.07	Late	2403.15	11
2511	-0.01	0.99	Neutral	0.00	11
2531	0.05	0.01	Late	2126.54	11
2532	0.06	0.00	Late	1832.81	11
2533	0.10	0.23	insuff	807.55	11
2561	0.04	0.01	Late	3596.96	11
2562	0.03	0.23	Neutral	3948.96	11
2563	0.18		insuff	0.00	11
2571	0.08	0.00	Late	1906.68	11
2572	0.08	0.00	Late	882.09	11
2573	-0.03	0.86	Neutral	630.09	11
2574	-0.01	0.74	Neutral	1773.35	11
2631	-0.04	0.35	Neutral	1910.02	11
2661	0.04	0.07	Late	3157.51	11
4391	0.01	0.55	Neutral	5958.61	11
4461	-0.19	0.04	Early	4648.89	11
4491	0.08		insuff	1827.77	11
4501	0.08		insuff	257.80	11
2011	0.00	0.73	Neutral	0.00	12
2051	-0.15	0.00	Early	2009.98	12
2071	-0.31	0.03	insuff	820.62	12
2081	0.02	0.99	Neutral	1471.03	12
2211	0.15	0.01	Late	0.00	12
2231	-0.01	0.55	Neutral	0.00	12
2241	0.04	0.05	Late	1162.58	12
2251	-0.01	0.89	Neutral	930.44	12
2252	0.00	0.97	Neutral	796.11	12
2261	-0.01	0.97	Neutral	288.05	12
2281	0.05	0.01	Late	0.00	12
2291	-0.01	0.98	Neutral	3392.27	12
2301	-0.08	0.01	Early	2366.16	12
2302	-1.72	0.16	insuff	0.00	12
2311	-0.11	0.06	Early	533.14	12
2321	-0.05	0.00	Early	2496.06	12
2521	-0.06	0.18	Neutral	0.00	12
2541	-0.03	0.02	Early	4294.86	12
2551	-0.02	0.98	Neutral	1773.49	12
2591	0.04	0.47	Neutral	1214.94	12
2592	-0.15	0.01	Early	2810.18	12
2601	0.00	0.40	Neutral	1109.79	12
2602	-0.02	0.76	Neutral	1024.22	12
2641	0.02	0.39	Neutral	1498.16	12
2642	-0.01	0.96	Neutral	1913.81	12
2651	0.04	0.00	Late	2817.91	12
2652	0.09	0.00	Late	817.16	12
2671	0.03	0.60	Neutral	2496.37	12
2691	-0.09	0.00	Early	5631.98	12
2701	-0.03	0.09	insuff	344.01	12
2731	-0.03	0.50	Neutral	1946.09	12
2741	0.10	0.29	insuff		12
2751	-0.09	0.17	insuff	74.56	12
2761	0.06	0.58	insuff	49.15	12
2781	0.00	0.31	Neutral	0.00	12
2791	-0.09	0.00	Early	1036.74	12
2801	0.03	0.08	Late	1642.74	12

Farm	CCS gradient	Significance level	CCS group	Tonnes in 1999	Harvesting group
2811	-0.01	0.91	insuff	195.10	12
2821	-0.04	0.36	Neutral	4285.74	12
2831	-0.12	0.33	insuff	1168.12	12
2041	0.02	0.32	Neutral	2236.52	13
2501	0.04	0.40	insuff	371.86	14
2581	-0.05	0.38	insuff	1395.16	14
2582	-0.02	0.47	Neutral	5731.08	14
2611	-0.03	0.72	Neutral	1263.63	14
2612	-0.03	0.81	Neutral	3233.30	14
2613	0.02	0.84	Neutral	3474.25	14
2614	-0.01	0.72	Neutral	1656.94	14
2615	0.01	0.14	Neutral	2689.72	14
2616	0.02	0.75	Neutral	227.89	14
2621	0.02	0.28	Neutral	5038.01	14
4011	0.00	0.90	Neutral	2172.31	14
4012	0.01	0.85	Neutral	1646.58	14
4061	0.12	0.09	Late	907.60	14
4091	0.03	0.02	Late	2254.69	14
4092	0.09		insuff	726.48	14
4151	0.02	0.36	Neutral	1499.54	14
4161	0.15	0.00	insuff	311.83	14
4171	0.02	0.53	insuff	381.11	14
4911	-0.07	0.02	Early	1550.43	14
1051	-0.01	0.73	Neutral	2983.20	15
1061	0.02	0.19	Neutral	2060.70	15
1221	0.02	0.06	Neutral	6033.30	15
1222	-0.09	0.34	Neutral	2054.21	15
1311	0.01	0.17	Neutral	1713.61	15
3221	0.04	0.89	insuff	2133.56	15
3401	-0.05	0.00	Early	3395.85	15
3411	-0.01	0.20	Neutral	1040.54	15
3412	0.00	0.50	Neutral	759.26	15
3421	0.05	0.03	Late	2635.06	15
3431	0.04	0.08	insuff	1034.73	15
3631	-0.01	0.36	Neutral	2064.37	15
3632	0.03	0.03	Late	1643.30	15
3633	-0.01	0.14	Neutral	3024.00	15
3634	-0.03	0.33	Neutral	546.50	15
3641	0.00	0.97	Neutral	3968.95	15
3661	-0.01	0.78	Neutral	7274.33	15
3711	-0.04	0.00	Early	4859.77	15
3721	0.01	0.57	Neutral	7339.86	15
3761	0.00	0.59	Neutral	1157.29	15
3771	0.03	0.64	Neutral	1522.31	15
3781	0.06	0.77	insuff	3030.80	15
3791	0.10		insuff	269.69	15
4311	-0.01	0.94	Neutral	2486.18	15
4471	-0.01	0.47	Neutral	5248.71	15
4472	-0.09	0.11	insuff	0.00	15
3621	-0.10	0.00	insuff	659.45	16
3651	0.03	0.28	Neutral	3693.76	16
3701	0.00	0.11	Neutral	1390.60	16
3702	0.02	0.02	Neutral	3729.35	16
5011	-0.02	0.01	Neutral	10549.65	16
5021	0.02	0.56	Neutral	7380.69	16

Farm	CCS gradient	Significance level	CCS group	Tonnes in 1999	Harvesting group
5031	0.03	0.02	Late	5406.61	16
5041	-0.01	0.39	Neutral	1845.85	16
5051	0.07	0.06	Late	1209.69	16
5061	0.04	0.18	Neutral	4288.89	16
5071	0.20	0.04	insuff	406.77	16
5081	0.06	0.03	Late	1938.16	16
3611	0.00	0.72	Neutral	2570.33	17
3671	0.00	0.31	Neutral	3079.50	17
3681	0.02	0.14	Neutral	2397.45	17
3691	-0.03	0.07	Early	3789.95	17
3692	-0.01	0.60	Neutral	2567.61	17
3011	-0.04	0.08	Early	4032.83	18
3021	0.01	0.83	Neutral	686.05	18
3061	0.03	0.06	Late	3623.70	18
3062	0.05	0.16	Neutral	4780.76	18
3063	-0.02	0.90	Neutral	2243.00	18
3064	0.02	0.39	Neutral		18
3065	0.01	0.34	Neutral		18
3091	0.12		insuff	1937.55	18
3331	-0.03	0.01	Early	7327.17	18
3051	-0.01	0.06	Neutral	2131.00	19
3081	0.00	0.22	Neutral	13939.56	19
5531	0.08	0.00	Late	7957.57	19
5561	0.12	0.00	Late	6765.04	19
3311	0.00	0.49	Neutral	79.30	20
3321	-0.09	0.01	Early	410.14	20
3371	0.01	0.57	Neutral	2036.56	20
3441	-0.04	0.02	Early	1364.54	20
3731	0.02	0.10	Neutral	5526.09	20
3741	-0.08	0.10	Early	277.24	20
3742	0.01	0.93	Neutral	1116.55	20
3751	-0.01	0.99	Neutral		20
3111	0.01	0.48	Neutral	2634.70	21
3141	-0.03	0.00	Early	2979.85	21
3151	0.03	0.23	Neutral	6544.97	21
3152	0.03	0.62	Neutral	3719.56	21
3171	0.04	0.00	Late	5202.23	21
3181	-0.01	0.89	Neutral	4859.89	21
3191	0.05	0.35	Neutral	833.98	21
3201	-0.15	0.02	Early	1118.45	21
4771	0.07	0.00	Late	3610.72	21
4841	0.00	0.41	Neutral	9588.01	21
4851	0.02	0.20	Neutral	2015.19	21
5511	-0.01	0.42	Neutral	6480.90	21
5521	0.01	0.31	Neutral	10115.80	21
5541	-0.06	0.00	Early	3750.32	21
5551	0.06	0.00	Late	6225.17	21
5571	0.26	0.00	insuff	2066.24	21
5581	-0.02	0.71	Neutral	1679.86	21
5591	0.00	0.34	insuff	1658.66	21
5601	0.02	0.81	insuff	1408.11	21
5611	0.00	0.99	insuff	1101.36	21
5631		0.65	insuff	4928.22	21
3031	-0.04	0.07	Early	2746.19	22
3041	-0.01	0.41	Neutral	4229.41	22

Farm	CCS gradient	Significance level	CCS group	Tonnes in 1999	Harvesting group
3071	0.06	0.00	Late	3926.05	22
3341	-0.04	0.01	Early	845.11	23
4691	-0.02	0.00	Neutral	17398.74	24
4701	0.00	0.88	Neutral	18471.84	24
4711	-0.01	0.81	Neutral	2993.90	24
4741	-0.06	0.37	Neutral	2389.76	25
4742	-0.05	0.12	Neutral	895.36	25
4751	-0.01	0.27	Neutral	4320.48	25
4781	0.04	0.00	Late	5734.73	25
4791	0.03	0.00	Late	6160.04	25
4801	-0.02	0.51	Neutral	4155.55	25
4802	-0.04	0.38	Neutral	863.07	25
4811	0.05	0.00	Late	19900.43	25
4831	0.01	0.60	Neutral	5608.92	25
1371	0.07	0.03	Late	3862.75	26
3451	0.01	0.20	Neutral	5280.15	26
3461	0.74		insuff	406.46	26
3561	0.11		insuff	322.00	26
3571	0.01	0.06	Neutral	3858.90	26
3591	0.04	0.40	Neutral	1612.24	26
4131	0.02	0.13	Neutral	4490.33	26
4141	0.02	0.06	Neutral	1542.60	26
4321	0.03	0.01	Late	1341.29	26
4322	0.04	0.28	Neutral	264.65	26
4351	-0.09	0.01	Early	1842.79	26
4371	0.01	0.76	Neutral	1469.06	26
4441	-0.22	0.29	insuff	0.00	26
4671	0.01	0.87	Neutral	2380.17	26
4721	0.10	0.20	insuff	676.16	26
4761	0.03	0.00	Late	7617.02	26
4762	0.00	0.35	Neutral	4955.68	26
4821	0.01	0.39	Neutral	647.99	26
4861	0.03	0.08	Late	2546.86	26
4862	0.03	0.42	Neutral	1748.59	26
3601	0.00	0.03	Neutral	1889.48	27
4041	0.01	0.66	Neutral	3441.97	27
4051	0.02	0.32	Neutral	2640.59	27
4071	0.05	0.05	Late	1129.42	27
4081	-0.05	0.00	Early	9124.91	27
4101	0.02	0.94	Neutral	4132.81	27
4121	0.00	0.89	Neutral	4941.61	27
4211	0.09		insuff	380.00	27
4221	-0.71	0.62	insuff	246.78	27
4021	-0.01	0.01	Neutral	2829.31	28
4022	0.00	0.25	Neutral	825.70	28
4361	0.02	0.11	Neutral	7292.31	29
4181	0.09	0.61	insuff	492.69	30
4331	-0.05	0.06	Early	605.83	30
4332	-0.15	0.00	insuff	304.78	30
4341	0.02	1.00	insuff	118.75	30
4451	0.16	0.27	insuff	931.17	30