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Sugar Research and Development Corporation

THE VALUE CHAIN OF THE AUSTRALIAN SUGAR INDUSTRY

DEVELOPMENTS IN THE PERIOD 1970–2005 AND FUTURE OPPORTUNITIES

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This document draws heavily on the 2005 review by Higgins *et al* entitled *Value Chain Research in Sugar: A Review of Successes and Learnings* (see Further Reading), and on the discussions at the SRDC Forum on the Sugar Industry Value Chain held in Townsville in October 2005.
It is also informed by value chain papers published in the Proceedings of the Australian Society of Sugar Cane Technologists over the last 35 years and discussions with a wide variety of industry participants.

FOREWORD

Sugarcane when harvested is a perishable product, and unlike many agricultural commodities (e.g. grains) has no value at the farm gate. Value is added through cane transport to the mill and its subsequent processing into raw sugar and other products, and through storage, marketing and shipping to the customer. The sugar industry thus operates as a value chain where value is added along the chain.

The Australian sugar industry is structured with predominately family owned farms, and a range of ownership structures for harvesting. Cooperative or company owned mills are responsible for cane transport, the manufacture of sugar and other products, and now, with a deregulated environment, for contracting storage, marketing and shipping. This means that there are many profit centres with each centre and sector seeking to maximise its income and minimise its costs. Individual sector goals, however, may impose costs across the entire value chain such that whole-of-system profitability is not maximised. Opportunities exist, therefore, for more integrated management of the value chain to enhance revenue and cost efficiency for the benefit of all industry participants.

The Sugar Research and Development Corporation (SRDC) committed increased funding to value chain Research and Development (R&D) in its R&D Plan 2003–2008. SRDC recognised that there was a need to invest not only in novel multi-disciplinary tools and technologies to analyse the benefits and costs of changes to value chain operations, but also to invest in human capacity and facilitation processes to implement change across the system as a whole. SRDC further recognised that solutions need to be tailored for individual mill areas or regions to achieve value chain improvement.

It is valuable to do a stocktake of what has been achieved through investment in value chain R&D and to assess where future R&D can underpin further opportunities for value chain improvement. This report seeks to achieve these two goals. However, SRDC also sees this publication as an important resource for industry participants at mill area and regional level to increase awareness of potential opportunities for enhanced revenue and cost efficiency, and to stimulate thinking and action towards better operation of their particular value chain.

To develop this report, SRDC funded two key activities. Firstly, SRDC funded Dr Andrew Higgins and his colleagues at CSIRO Sustainable Ecosystems to synthesise the successes and learnings from investments in value chain R&D over the last decade. SRDC then hosted a Value Chain Forum attended by more than 80 representatives from all sectors and regions of the Australian sugar industry. This Forum sought not only to improve awareness of the scope and benefits of value chain R&D, but also to identify arenas for further co-investment in value chain improvement.
I thank Mr Ian O'Hara (Australian Sugar Milling Council), Mr Bernard Milford (CANEGROWERS) and Mr Warren Males (Queensland Sugar Limited), members of the Advisory Committee, for the successful Forum.

SRDC then engaged Dr Roger Jones to write this report based on outputs from the above two key activities. Dr Jones also consulted extensively with SRDC, and the report is very much consistent with SRDC's current investment philosophy on value chain R&D.

People are the key to the successful implementation of changes in the operation of the value chain. There is no simple solution to the complex issue of better value chain management, nor does one solution fit all situations. I encourage industry participants in different mill areas and regions to use this report to stimulate debate and to partner with researchers to further develop whole-of-system solutions that enhance revenue and cost efficiency across the value chain.

RC Muchow
Executive Director, Sugar Research and Development Corporation

14 February 2006

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SUMMARY

This report by the Sugar Research and Development Corporation (SRDC) provides an overview of the "state-of-the-art" of value chain improvement in the Australian sugar industry. It seeks to firstly, improve the level of awareness of the scope and potential benefits of value chain Research and Development (R&D) by regional participants in the sugar industry. Secondly, it seeks to stimulate thinking and interest in conducting further value chain R&D to underpin a vibrant industry.

SRDC, as part of its R&D investment philosophy, believes that adoption of whole-of-system solutions based on integrated management of the value chain, particularly at mill area and regional levels, offers the opportunity to enhance revenue and cost efficiency to the benefit of all industry participants.

The report draws on the following sources:

- a review of value chain R&D conducted during the last decade by Higgins *et al* (2005);
- presentations and discussions at the Value Chain Forum hosted by SRDC in Townsville in October 2005;
- publications on value chains, particularly those concerning the Australian sugar industry; and
- extensive discussions with representatives of the various sectors and regions of the Australian sugar industry, and with researchers.

The report begins with a bold vision of what the sugar industry *could* look like in five or ten years. Achieving this vision, however, will require far-reaching changes to the existing value chain. The report then provides an explanation of value chains, and of the key factors that underpin their successful operation. It emphasises the central role of trust and commitment to the philosophy of "cooperating to compete" in improving the operation of value chains. Trust creates the environment within which investments in developing relationships (people, time, capital, processes and systems, transparency) and in re-negotiating reward systems, can flourish.

The report then provides a very encouraging snapshot of value chain developments that have occurred and/or are in progress in three regions — Maryborough, Mackay, and the Herbert. It demonstrates that the pace of value chain improvement has accelerated greatly in the last five years and that benefits are being realised. Clearly, many interesting and far-reaching developments are underway and will in time enhance the operation of the value chain across the entire industry.

The report goes on to provide an overview of past R&D on value chains conducted in the early years (1970–1997) and more recently (1997–2005). For this latter period, the main observations and conclusions of Higgins *et al* (2005) that are of particular relevance to the R&D sector have been crystallised in the form of the following recommendations.

Recommendation 1. The types of issues addressed and the number of sectors encompassed should be broadened in future value chain R&D.

Recommendation 2. Diversifying the investment in value chain improvement specifically aimed at improving the relationship between sectors and between their respective organisations should be given high priority.

Recommendation 3. The tangible and intangible benefits of past investments in value chain improvement should be widely promoted throughout the industry.

Recommendation 4. Considerable flexibility should be built into the design, operation, and management of value chain R&D projects to enable them to cope with, and adapt to, unforeseen events.

The final section of the report summarises the many ideas, actions, and strategies that have been suggested as being necessary in moving towards the vision of improved operation of the sugar industry value chain. The future focus should be on six action areas:

- improving the overall structure and functioning of the industry;
- taking account of the social and human aspects of the value chain;
- improving farming systems to enhance economic and environmental performance in the farming sector and match requirements for efficient value chain operations;
- optimising harvesting and transport;
- diversifying the range of products from cane lands; and
- improving the utility of value chain models and tools.

1. A VISION OF THE AUSTRALIAN SUGAR INDUSTRY IN 2010 OR 2015

The question … "what *could* the Australian sugar industry look like in 5 or 10 years time?" seems an appropriate point to commence this report.

Eighty representatives from all sectors and regions of the Australian sugar industry addressed this question at the Value Chain Forum hosted by SRDC in Townsville in October 2005. Everyone recognised that the future of the industry was heavily dependent on future sugar prices. However, assuming that prices were reasonable (indeed movements between October 2005 and February 2006 have exceeded expectations) and that the industry remained viable, participants saw a number of trends that were common across most sugar growing regions. These trends have been synthesised into the following picture of the industry in the years 2010 or 2015. Importantly, however, it is recognised that the way in which these trends are addressed may vary between regions and mill areas, depending on circumstances.

Across the ***entire value chain***, improvements to the chain will be developed and implemented on a mill area or regional basis rather than an industry-wide basis, in response to market signals. Sector participants will be more committed to working together to increase total revenue from the mill area or region. Personal and institutional relationships between millers and other participants in the farming, harvesting and transport sectors will be more harmonious. There will be increased adoption of the best practice philosophy in all sectors.

In the ***farming sector***, the farms or production units will be larger (through aggregation, farming cooperatives, or share farming). A range of technologies will be combined into location-specific farming systems that benefit both the farming sector and the value chain as a whole. Sugar yields per hectare and per mill area will be higher. There will be more efficient use of water and other inputs, leading to enhanced economic and environmental performance. Improved cane varieties (perhaps including GM varieties) will be released faster. Growers will have better advisory systems to assist them in selecting varieties for particular blocks, soil types, and environments. Sugarcane will increasingly be rotated with other agricultural, horticultural or industrial crops. Contracting will be used for all aspects of cane production. Every grower will have a cane supply contract with the mill that is specifically tailored, by negotiation, to the needs of each party. Harvesting of the entire above-ground crop will be more common. Most growers will participate in skill development and action learning programs and have access to a more diverse range of advisory services than in the past.

In the ***harvesting and transport sectors***, harvesting and transport operations will be better integrated and capital will be used more efficiently. Cane will be better presented to the harvester. There will be fewer harvesting groups handling much larger tonnages, fewer harvesting rounds, longer harvesting hours per day, and longer seasons. Geographical harvesting will be more widely used to capture the early sugar market. The number of sidings and loading pads and their locations will be rationalised; in general they will be fewer in number, larger, and better designed. Rail transport systems will be more efficient. Road transport will be more widely used. Communication of cane yield and cane quality information to growers and harvesters will be timelier and allow real-time modifications to operations. New payment systems and contracts between miller, grower, and harvester will provide appropriate incentives to all parties to improve performance.

Finally, in the ***milling and marketing sectors***, there will be fewer mills handling larger tonnages of cane and making better use of capital. Mills will employ fewer people but they will be more highly trained and better paid. There will be a greater diversity of products derived from sugarcane and cane lands. Production of electricity, ethanol, and animal feeds will be higher. Milling by-products will be utilised more efficiently. Some completely new products such as bio-plastics and bio-pharmaceuticals will be in early trials. The industry will be fully deregulated and this will lead to closer and more direct business relationships between millers, their suppliers and their various customers.

This is a challenging vision for a relatively conservative industry. In this report, however, it is argued that the vision can and will be achieved. SRDC believes that a value chain approach and carefully-targeted value chain R&D will play a major part in helping different mill areas and regions achieve this vision.

2. UNDERSTANDING VALUE CHAINS

The vision of the industry painted in the previous section relies heavily on improvements to the industry value chain, but what exactly is a value chain?

Some definitions

Since the terms "value chain" and "supply chain" tend to be used interchangeably, the following definitions will be used in this report.

The *supply chain* of the sugar industry refers to the physical flow of materials between the various sectors of the industry — growing, harvesting, cane transport, milling, sugar transport & storage, marketing, shipping, and refining. In a supply chain, the output from each sector becomes an input for the next sector in the chain.

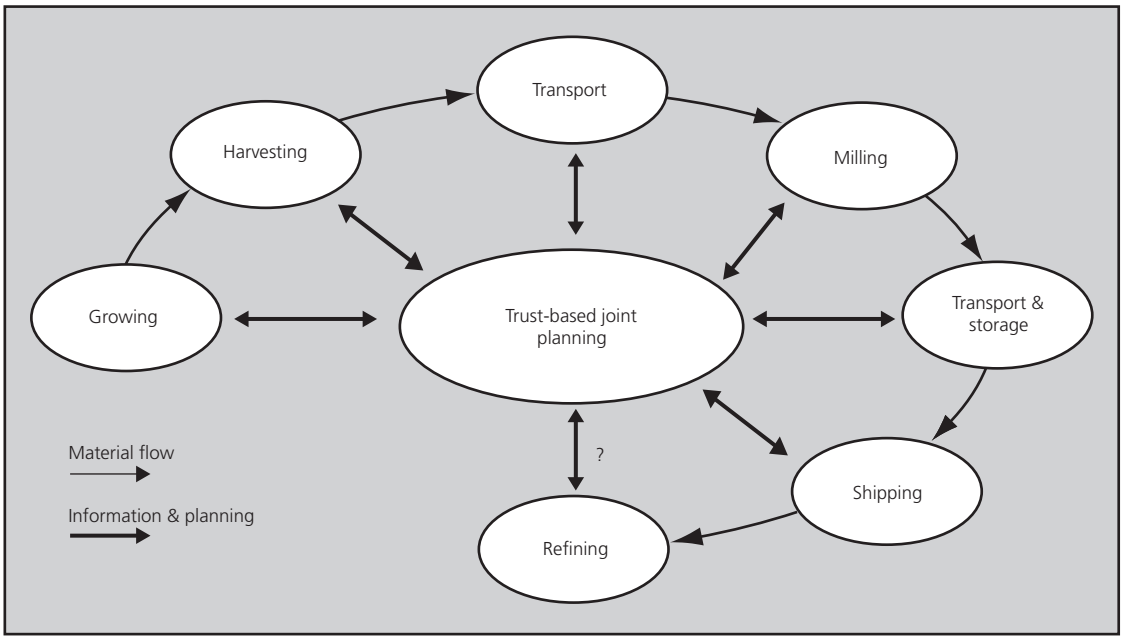
The *value chain*, on the other hand, concentrates on the flow of revenue and the amount of value added at each step along that chain. Thus, value chain management seeks to use planning and cooperation to maximise the total revenue (and customer satisfaction) produced at the end of the chain, and to distribute that revenue fairly between those who have contributed to its generation (see Figure 1).

O'Keefe (1997) discusses value chains in Australian agribusiness, and points out that one can consider value chain relationships in terms of …

" … two games being played simultaneously. The first is a win–lose game whereby the pie is divided between the … participants. This is essentially an adversarial game. The second is a win–win game in which the participants work together in order to reduce costs or to create more customer value. Thus, closer value chain relationships are not just cosy or collusive arrangements: there is still an adversarial or win–lose element in the relationship. In successful value chains, these two dimensions are both managed by appropriate management systems and structures."

Throughout the history of the Australian sugar industry, the win–lose game has been dominant. Adversarial relationships, moderated to some extent by legislation, have been the norm, although they have varied in extent between regions. One of the objectives of this report, therefore, is to accelerate the process of bringing these games into balance.

FIGURE 1. VALUE CHAIN LINKAGES IN THE SUGAR INDUSTRY. ADAPTED FROM MILFORD (2002).



Improving value chains

Successful value chains have the processes and features shown in Figure 2.

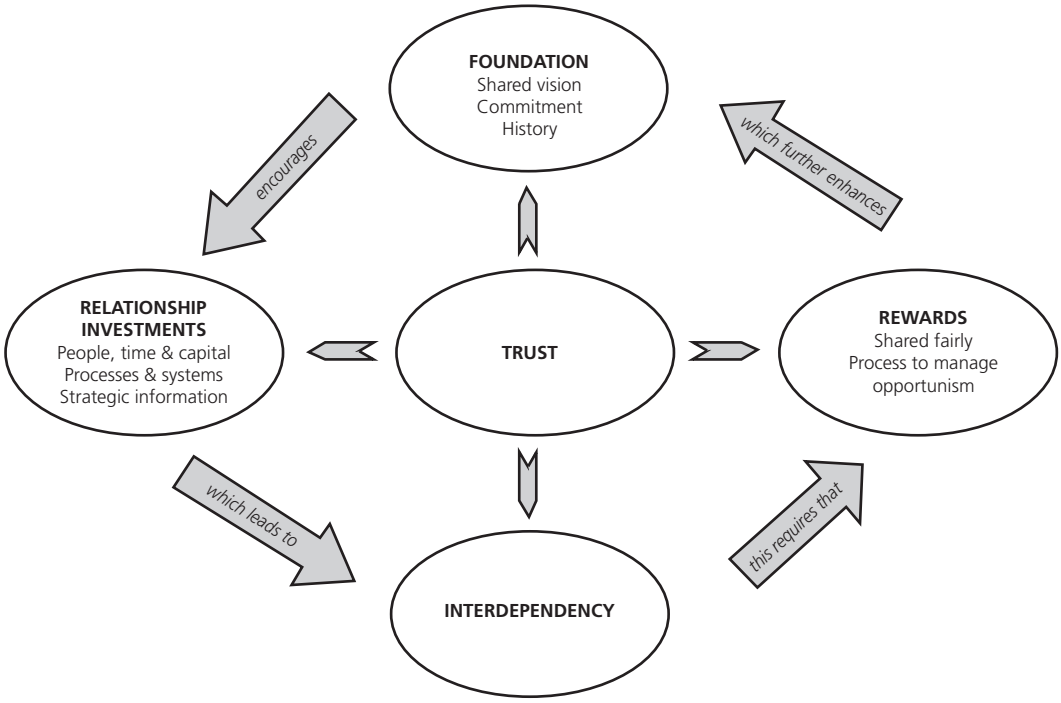
Trust occupies the pivotal central position. Trust creates the favourable environment for progress in all other areas. The first of these is the *Foundation* on which successful value chains are built. This includes a shared vision (e.g. all parties prospering by "increasing the size of the cake or pie"), a commitment to cooperating in joint planning, and a shared history.

The real work of improving the functioning of value chains, however, is planned and implemented through the *Relationship Investments* area. This is where:

- cooperative personal and institutional relationships are built;
- leadership is fostered and action learning[1] takes place;
- processes and systems are developed, e.g. strategies for dealing with unsatisfactory performance by individual sectors, price volatility, and opportunistic behaviour;
- transparency is fostered by sharing data on intermediate and final product quality, on costings, and on other relevant information for subsequent decisions in the Rewards area;
- understanding of each other's business and rationale for actions is developed;
- the capital that each sector brings to the relationship is acknowledged;
- responses to unforeseen events are planned and negotiated; and
- the competitive advantage of the mill area or region is built.

These investments in relationships build *Interdependency*. Although there is already a high degree of interdependency in the sugar

FIGURE 2. THE INVESTMENT TRUST CYCLE (ADAPTED FOR THE AUSTRALIAN SUGAR INDUSTRY FROM FIGURE 1 OF O'KEEFE, 1997)



[1] Action learning is a continuous process in which people with different interests and responsibilities come together to work towards solving a real problem, jointly reflecting on, and learning from, their experiences at each step of the way.

industry because of its structure (multiple cane suppliers clustered around a single mill with each dependent on the other), the quest to improve the operation of the value chain through relationship investment leads to even greater interdependency.

Finally, the Investment–Trust cycle is completed if the *Rewards* are seen by all sectors to be distributed fairly. The distribution must be aligned with the magnitude of the capital and other investments required as well as with the risks borne. Successful completion of the cycle further reinforces the *Foundation* and builds confidence that bolder changes can be undertaken in future cycles. This applies even in the tentative early stages of value chain improvement when only small increases in trust and small improvements in value chain performance are achievable.

Successful value chains generally deliver numerous external benefits (such as increased total revenue from a mill area or region and increased customer satisfaction). However, they can also provide various internal benefits such as reduced transaction costs. The historical adversarial approach in the industry had particularly high transaction costs and much effort was expended in promoting or defending the interests of a particular sector of the industry, often at the expense of the interests of the industry as a whole. Milford (2002) drew attention to this issue. He listed the following:

- *the cost of miller-grower negotiations (preparation, meetings, grower feedback meetings, expert assistance, mediation and arbitration, technical and negotiation support);*
- *the cost of compliance with industry regulations (e.g. applying for cane production area);*
- *the costs that arise because of asymmetry of information (seeking information that that is known to another side, mistakes due to lack of knowledge); and*
- *the cost of entering into a harvesting arrangement and the uncertainty that arises if arrangements are changed.*

He went on to say … *Transaction costs are reduced in an integrated value chain because trust and strategic alignment replace contracts and negotiating tactics; time spent negotiating is replaced with time spent developing joint strategies to create more income or reduce costs.*

The task of improving the value chain of the Australian sugar industry will require a greatly increased focus on all the components of the above Investment–Trust Cycle.

In effect, the guiding philosophy of value chain improvement must be "cooperating to compete".

Group in the Herbert considering train siding options.

3. VALUE CHAIN DEVELOPMENTS IN THREE DIVERSE MILL REGIONS

Before reviewing the history of R&D for value chain improvement in the Australian sugar industry in detail, it is instructive to examine the benefits from this R&D that are already flowing or in prospect in several regions. In this section, therefore, the contribution of R&D to the improved operation of the value chain is summarised for three regions (Maryborough, Mackay, and Herbert) that are at different stages of value chain development. Information has been drawn from the detailed project evaluations of Higgins *et al* (2005) (see Section 7 — Further Reading), from project and other documentation, and from discussions with a broad range of people in each region.

Maryborough

Background

Maryborough Sugar Factory Ltd is a publicly listed company that can trace its origins back about 120 years. The Maryborough region undertook a strategic planning exercise in 1993–94 which led to a steady expansion of the area harvested and the tonnes of cane crushed. By 1999, the 10,746 ha harvested produced over 0.96 Mt of cane. Since then, disease, droughts, and low sugar price have combined to take their toll, and production has varied between 0.68 and 0.88 Mt. The company itself produces about 25% of the cane supply — 11% from its own plantation and the balance from land it leases to growers. Historically, the relationship between the milling sector and the growing, harvesting, and transport sectors has been positive and a spirit of cooperation prevails.

Value Chain R&D since 2000

The region has initiated or taken part in numerous activities in the last five years that were aimed at improving the functioning of the value chain. Several projects examined the **optimisation of harvest and transport scheduling**. The most recent by Higgins and Downs (2005) (see Appendix 3) aimed at reducing queue time of transport vehicles at the mill, and increasing the reliability of cane supply. It resulted in an optimisation model that demonstrated the scope for significant reductions in transport costs and queue time. Unfortunately, unplanned events (e.g. road traffic delays, harvester delays, wet weather interruptions to harvesting) currently make model-based schedules for daylight operations difficult to implement. However, it is planned to use model-based schedules in 2006 for night-time operations when such disruptions are less frequent.

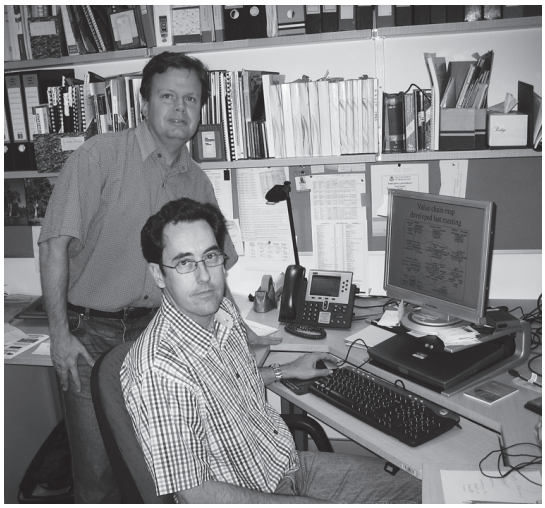
Substantial work has also been done at Maryborough on **harvest scheduling** to capitalise on differences in cane yield and CCS across the mill region. This approach seeks to harvest relatively early-maturing blocks, varieties, or sub-regions earlier than in the traditional system. (Where sub-regions are involved this is referred to as "geographical harvesting".) The approach would allow remaining areas to be harvested closer to their optimum time, thereby increasing per tonne returns as well as total returns from sugar production for the entire mill area.

According to Higgins *et al* … *on a region wide level, adoption of these harvest schedules requires growers to change the order of harvest of their farm paddocks, along with the percentage of cane cut in each harvest visit. The harvester needs to change the amount of time spent on a farm, the rotation order across farms and, for regional optimisation, the harvester may need to have varying bin quotas across the season. For regional optimisation, the mill needs to modify transport schedules to accommodate changes in harvester logistics*.

While some of the suggested changes were adopted, region-wide adoption did not occur. The disruption was seen to be too dramatic, and the task of gaining sufficient agreement from participants was considered to be too daunting to proceed. However, some growers with more than one farm and the Maryborough Sugar

Factory on its 1,400 ha plantation have adopted the basic principles, and are reaping the benefits. In the latter case, these were estimated to be of the order of $100 per hectare (or $1.00 per tonne of cane).

The third major value chain R&D activity undertaken in the Maryborough region concerned the **potential for co-generation**. This required the development of the first model of the sugar industry that captured the interactions of five separate sectors — farming, harvesting, transport, milling, and marketing. In contrast with the two activities above, its thrust was to increase mill area revenue by diversifying the product range, rather than increasing production or cutting costs. The model highlighted, in quite a dramatic way, the negative aspects of a) trash removal on the farming sector (via increased evaporation and increased costs of weed control), and b) storage of bagasse for use in the off-season (eg space, storage costs, and risks). When coupled with the high capital cost (e.g. for a trash separation unit, the electricity generation facility, new boilers, and other mill upgrades), it became clear that co-generation based on whole crop harvesting was not an attractive option for this region. Thus, one of the positive benefits of the project was the decision not to proceed with a major co-generation project, thereby avoiding considerable future losses.



Drs Andrew Higgins and Peter Thorburn work on the model of the sugar industry in the Maryborough region.

Each of these three projects made extensive use of the action learning or **participative research approach**, using the services of an experienced facilitator with a good understanding of the industry, social interaction, and human behaviour. The approach involved forming a local Reference Group consisting of grower, harvester, and miller representatives to oversee the detailed technical work. The group developed the optimisation or value chain models, formulated scenarios, modelled results and impacts, and learned from successive iterations of the process. The approach, when used in the Maryborough region — where cooperative rather than adversarial behaviour is the norm — proved to be extremely successful. This is demonstrated in part by the many positive comments made in the focus groups and interviews recorded in the review of Higgins *et al*. A selection of these comments is reproduced below.

- *The project pulled together people with a range of important expertise; it was good to have everyone involved who knew a fair bit about each sector.*
- *Specialists from different areas were involved and lots of things were discussed and probably quite a few people changed their position on things because of that.*
- *Value chain research has provided the region with a framework, which allows the industry to identify key issues and test the effects of changes through models.*
- *Harvest and transport scheduling work has had the biggest advantages; it has highlighted the need to be flexible about how to organise harvesting in the region and has provided figures to work out how to organise the harvesting system more efficiently.*
- *We have adopted some of the recommendations of the harvest and transport scheduling project.*
- *Research into geographical harvesting also highlighted the advantages and disadvantages of changing the harvesting schedule; it highlighted particular challenges associated*

with harvesting in the Maryborough region, e.g. areas very spread out.

- *Harvest group amalgamations have shown that larger groups are more economically viable.*
- *The co-generation project gave the industry a better understanding of what resources were in the field, e.g. tops and trash. A lot of that information was quite useful for us in other things we've been doing. I think that, besides the fact that it stopped us making a poor decision on co-generation, it also gave us a lot of other information that we didn't have.*
- *Identified that if they had gone ahead with co-generation, the growers and the harvesters and haul out sectors would have lost money: "that could have been disastrous" (Mill).*

During the last five years, the region has also made numerous changes that have the potential to further improve the functioning of the value chain. For example, on-line NIR has been installed in the mill for determining CCS and fibre, and potentially other characteristics of cane quality. This sets the scene for real-time feedback to harvesters and growers, and possibly the development of new payment systems. More generally, the emphasis by both the mill and the region over many years on increasing the total area of cane, as well as cane yields (by expanding irrigation and promoting good agronomy) and product range, has supported the value chain and the viability of the industry in the region.

In summary, the extensive value chain R&D conducted in these and other projects over the last five years, and the associated investments made, is in aggregate already having a significant positive impact on the region's revenue streams. The work has provided the Maryborough region with a much better understanding of the operation of its value chain and of the prospects for further developments of the chain. This has led to greater openness to new ideas and a new spirit of cooperation that provides the platform for more major changes to the value chain in the future.

Mackay

Background

The Mackay district is served by two milling groups, Mackay Sugar (operating four mills) and CSR (Plane Creek mill). Mackay Sugar expanded production considerably during the 1990s, and by the 1999 harvest, 81,700 ha were harvested to produce 6.6 Mt of cane. Comparable figures for the CSR mill were 19,870 ha and 1.77 Mt. However, production from Mackay Sugar's region slumped to 4.67 Mt in 2000 as a result of a severe outbreak of orange rust on a susceptible variety that was dominant at the time. Since then, drought conditions and low sugar prices have slowed the industry's recovery to the prosperity experienced in the late 1990s.

Value Chain R&D since 2000

There has probably been more value chain R&D conducted in the Central Queensland region, and particularly in the region served by the Mackay Sugar, than in any part of the Australian industry (see papers listed in Appendix 3 for reports on some of these). The centrepiece is the impressive **Cooperative Systems** work undertaken by Mackay Sugar, and supported in part by the SRDC-funded project entitled *A Cooperative Systems Model for the Mackay Regional Sugar Industry* (see Appendix 1). It commenced in an environment where major cost-cutting by the mill, outsourcing of services, and the termination of the cane inspector service had brought miller-grower relations to a low ebb. The mill made the decision to invest heavily in information technologies to collect, store, and communicate information electronically to growers, and involve all sectors in the decision-making process using a participative approach. The team saw information as the key initial ingredient for improving the performance of the value chain, presumably subscribing to the philosophy that *"You can't manage what you can't measure"*. Timely and relevant information about all sectors is required by participants in each sector to make decisions that support an integrated value chain. Extensive R&D was therefore conducted and systems developed to:

- record yields, paddock inputs, and pest and disease management actions;
- select varieties for use in particular blocks based on past performance on, for example, the farm, soil type, or sub-region;
- display mapping information (e.g. farm and soil maps, aerial photographs, satellite imagery, paddocks harvested, etc);
- analyse cane quality for pol, brix, fibre and ash (from which to calculate sucrose, impurities, clean fibre, dirt, and extraneous matter) by on-line NIR and provide rapid access to it (at an appropriate level of aggregation) for participants in all sectors;
- monitor harvester performance (engine on/off, elevator on/off, fan speed, and chopper pressure), track their movements by GPS, and monitor and benchmark harvesting costs using the Harvest-Haul model;
- consign cane electronically from the farm to the mill;
- benchmark all measures of performance against that of other members of the value chain; and
- store information centrally in a secure environment and provide appropriate access and application tools to all parties via a Web portal.

After four years of significant investment and an intensive effort by numerous parties, many of these systems are now fully operational or are undergoing advanced testing.

Without doubt, the most significant outcome has been the development of a ground-breaking new payment system which came fully operational in 2005. It brings the interests of the grower and the miller into close alignment and pools all revenue from sugar (including sugar quality payments), electricity, molasses, and any future products before dividing it (by negotiated agreement) between miller and grower. According to Fleming *et al* (2005), the new system overcomes the disadvantages of the traditional cane price formula which:

- *Divides millers and growers. Growers receive all the benefits of increased CCS and millers received all the benefit of improved sugar recovery. This has been the root of traditionally adversarial negotiations over issues such as season length: why should the mill invest capital to shorten the season for a higher CCS?*
- *Does not adequately reward individual performance. Growers are not sufficiently rewarded or penalised for cane quality, especially when class fibres are used to determine CCS.*
- *Does not allow growers to share in the revenue from products other than sugar. Mills received all the income from molasses, co-generation, ethanol, and so on. Why should growers change any practices to assist diversification?*

The change to a new payment system is already having an impact on the behaviour of growers, harvesters and millers because it has the incentives for all parties aligned with the regional objective of "growing the size of the cake" and distributing the revenue equitably.

The new system is probably one of the most important and far-reaching developments in the Australian sugar industry in the last decade.

"Our new payment system is making a big difference. It has brought a lot more clarity to the system, particularly with information on individual fibres, and separate payments for fibre and molasses. It also enables us to share in future income streams from our product. I think we have made more money as a result!"
Steve Young (grower and harvesting contractor, Mackay)

The Mackay Sugar region was also a major location for the early work on **Cane Supply Scheduling** (or geographical harvesting). This is explained in greater detail in the Maryborough section above. A huge amount of participative R&D effort went into this activity in the period 1997–2003 (see Project 2 in Higgins *et al*, 2005). To date it has been adopted mainly at the block or farm level so impact has been limited. However, knowledgeable industry leaders believe that the time will come when the industry will adopt it at the regional level and reap substantial benefits.

Attending to the social component of change management was fundamental to the success of all the above work. The **participative research approach**, as described in the Maryborough section, was used throughout. In the Cooperative Systems work, for example, stakeholders from across the value chain were involved from the outset at a number of levels. An Advisory Committee (the Cane Supply Consultative Group) worked with project researchers coordinating, reviewing, and evaluating the overall project. Reference groups of growers, harvesters, and millers worked with the individual project teams as they developed and tested their respective systems. This participative research approach was highly successful in overcoming many of the barriers to change and in building the capacity of the participants for leading ongoing change directed at improving the functioning of the value chain.

In addition to the above, much excellent R&D has been done in the last decade on the economics and logistics of harvesting (harvest best practice, harvesting efficiency, crop size, field layout, haulage distance, group size, hours of harvesting, etc) and transport (siding rostering, siding design, transport infrastructure, maintenance and management, etc). However, space limitations prevent the inclusion of a detailed summary of this work here.

In summary, the Mackay Sugar region seems poised to capitalise on the investment in physical infrastructure, technical systems, and intellectual inputs that have been directed at improving the functioning of the value chain during the last 5–10 years. The stage is now set for a much closer linkage between the technical aspects of cane production and the financial management and decision making processes of each farming business. Further opportunities and challenges across this value chain are certain to arise as a result of the continuing deregulation of the industry. Mackay Sugar is particularly well positioned to seize opportunities because of the alignment of grower and miller interests established through the new cane payment formula.

Herbert

Background

CSR Ltd owns two major mills in the Herbert region. During the 1990s, the area of cane harvested increased by about 30%, and by 1999, 59,950 ha were harvested to give 4.15 Mt of cane. Production since then has fluctuated widely between 2.8 and 5.6 Mt of cane, with the lower production years resulting from a combination of orange rust, wet finishes to seasons, and low sugar price.

Value Chain R&D since 2000

R&D on the value chain was surprisingly slow to start in the Herbert region, given its size and importance. Thus, only two of the eleven Australian projects reviewed by Higgins *et al* (2005) — Projects 5 and 11 — had work in the Herbert and these did not commence operations until 2004. Moreover, relatively few of the ASSCT publications listed in Appendix 3 are from work done in the Herbert. A history of adversarial relationships between the miller and the farming and harvesting communities may have acted as a deterrent to collaborative R&D. However, in recent years, the Herbert region, along with other regions, has developed better relationships across the sectors and taken on a number of multi-sector activities. One such initiative, addressing productivity issues, has been the McKinseys-inspired Cane Productivity Initiative, sponsored by CSR. Even more recently, SRDC has funded a new style of project under its Industry Capacity Program, entitled *Herbert cultural imprint analysis — a pathway*

to greater understanding and cooperation in decision-making. Although not formally a value chain project, its overall objective is to improve trust between sectors and thereby provide a favourable environment for value chain improvements.

A snapshot of the Herbert sugar industry in 2005, provides quite an optimistic picture. Although problems with milling and transport infrastructure are a continuing irritant to relations between miller and growers and harvesters, a number of excellent initiatives based on value chain R&D are showing great promise and are receiving strong support from all sectors. The region's application for funding from the Commonwealth Government Sugar Industry Restructure Package to rationalise the harvesting and transport sector was successful. This will result in the injection of $7.2 million (50% CSR, 50% Commonwealth) into this aspect. This rationalisation is being underpinned by value chain R&D that seeks to optimise the economics and operations at the harvest/transport interface by:

- reducing the total number of sidings and building new, larger ones in locations agreed with growers and harvesters;
- utilising the 4 a.m. to 6 p.m. time window of harvesting more productively, paving the way for a staged reduction in the number of harvesting groups; and developing new harvest schedules;
- optimising the scheduling of transport of cane from farm to mill.

The first phase of the **Cultural Imprint project** showed participants in the industry what was seen as an accurate view of "how we do business in the region". It conveyed the perceptions of a broad cross-section of the industry and community, revealing how distrust had resulted from prior history. However, the fact that the project was jointly proposed and supported by all industry sectors is indicative of recognition of the need to get beyond history and to work cooperatively together.

"I've just been to Meeting No 45 with growers and harvesters about siding closures and relocations in one area. It went pretty well. We put our suggestions on the table and they have gone away to think it over and get back to us with their reactions and perhaps an alternative way of solving the problem."
Paul Giordani (CSR, Herbert)

The region is also actively working to make **geographical harvesting** a reality, using a partnership approach. The region has the potential to use geographical harvesting on a much larger scale than anywhere else in Australia since it is uniquely suited to the approach. It has a sub-region in the Ingham line/Stone River area which has relatively high CCS early in the season and problems with wet weather at the end, where an earlier start to harvesting would be advantageous. There is scope to link this with other sub-regions where early CCS levels are relatively low, but the season ends later. Provided suitable arrangements can be made to preserve equity between growers, and provided changes can be made to allow transport infrastructure to cope, geographical harvesting has much to offer. Benefits could flow to the region (earlier sugar production for premium markets, higher seasonal CCS), to the miller (reduced milling and transport costs), to the harvester (reduced harvesting costs with harvesting done in the one sub-region and even "on a front"), and to the grower (reduced wet finish risks in susceptible sub-regions and better ratoons).

Harvesting costs are also receiving considerable attention in the Herbert. One grower/harvester is pioneering the development of new payment systems, based on improved instrumentation of harvesters, which provide appropriate incentives

to growers to improve aspects of their farming systems, such as farm layout. There is also considerable interest in investigating options for GPS tracking of harvesters to assist with harvester equity and provide valuable data on the true costs of harvesting different blocks. Models of the harvest/haul-out operation are also being refined to allow a variety of costing and pricing scenarios to be examined in detail.

In summary, the Herbert region seems poised to make rapid and substantial progress in improving its value chain to realise substantial benefits. Despite its late start and the earlier low trust environment, there is a growing realisation by participants in all sectors that the future of the industry in the region is dependent on innovative thinking, increased communication, and greater cooperation between sectors.

4. HISTORY OF AUSTRALIAN R&D ON THE SUGAR INDUSTRY VALUE CHAIN

This section looks firstly at SRDC's definition of a value chain R&D project. Using this definition, it then reviews the value chain R&D that has been conducted for the Australian sugar industry over the last 35 years, in two major phases, 1970–1997 and 1997–2005. As a result of this review, particularly of the R&D done in the 1997–2005 period, a number of recommendations are made to guide future investment in R&D.

What is a value chain R&D project?

SRDC considers a value chain R&D project or activity to be one that has active concurrent engagement with more than one sector of the value chain and that requires concurrent changed practices in more than one sector for success.

For example, *SRDC considers* R&D to optimise the interface between harvesting and transport that also looks at the impact of these changes on cane quality at the mill, to be value chain R&D.

However, *SRDC does not consider* R&D aimed at increasing cane yields or cane quality (by variety improvement, pest management, fertilisers, etc) that does not also study in detail the impact of those increased yields on processes and decision-making in another sector or sectors, to be value chain R&D.

The early years (1970–1997)

Some of the earliest thinking about improving the functioning of the sugar industry value chain, particularly the interface between the harvesting and transport sectors, was probably done by Scott Grimley at the Mossman mill in the late 1970s and early 80s. Much of this thinking is embedded in the 2001 Report of the Far North Queensland Sugar Industry Task Force (see Further Reading). However, perusal of the Proceedings of the Queensland and Australian Societies of Sugar Cane Technologists (QSSCT/ASSCT) back as far as 1970 shows that the earliest published paper is probably that of John Reghenzani in 1977 (see Appendix 3). He developed a simple model to optimise the interaction between harvesting and the first stage of the transport sector, the haul-out to the tramline.

Reghenzani's paper was followed by a groundbreaking paper by Page, Couchman, and Bathgate (1985) from research undertaken in both the Herbert and Burdekin mill regions. They examined harvest group costs and sizes as well as their impact on the transport and milling sectors. Unfortunately, the structure of the industry and the adversarial relationships between sectors at that time prevented the implementation of their findings. Only now, 20 years later, are many mill areas and regions seriously attending to the substance of their recommendations about harvesting group sizes, the number of shifts, and transport requirements.

"In the mid 1980s whilst working at the Herbert River mills, Allan Page, Ron Bathgate and I presented a paper on economies of scale in harvesting and transport and their effect on cane and sugar quality. We didn't fully realize at the time that what were doing was some of the earliest work on the sugar value chain! Increasing harvester group size, extending harvesting hours, and improved transport scheduling made a lot of sense to us, but our ideas weren't initially adopted. In retrospect, it was all "mill push"; there was only minimal involvement of the growers or harvesters. If we had known just how important these relationship issues were, we might have had more success."
John Couchman (retired CSR Mill Manager)

This pioneering work was followed by four papers from the Mackay region published between 1988 and 1997, with authorship by various combinations of the following people — Absolon, Brennan, Cameron, Crawford, McWhinney, Powell, and Ridge (see Appendix 3). All four papers addressed aspects of the interface between farming, harvesting and transport to the mill. Collectively, the work resulted in a much improved understanding of the interactions between these sectors. It also produced relationships and models to describe these interactions and made recommendations on ways of improving the performance of these sections of the value chain.

The number of value chain papers published in the QSSCT/ASSCT Proceedings increased dramatically between 1971 and 2005 (Figure 3). This reflects the growing awareness — both by the industry and the R&D community — of the importance of the value chain as a research topic in its own right. It is worth noting, however, that the peak of 17 value chain papers published in the 2001–05 period represents only 5% of the total number of papers published in these Proceedings in that period.

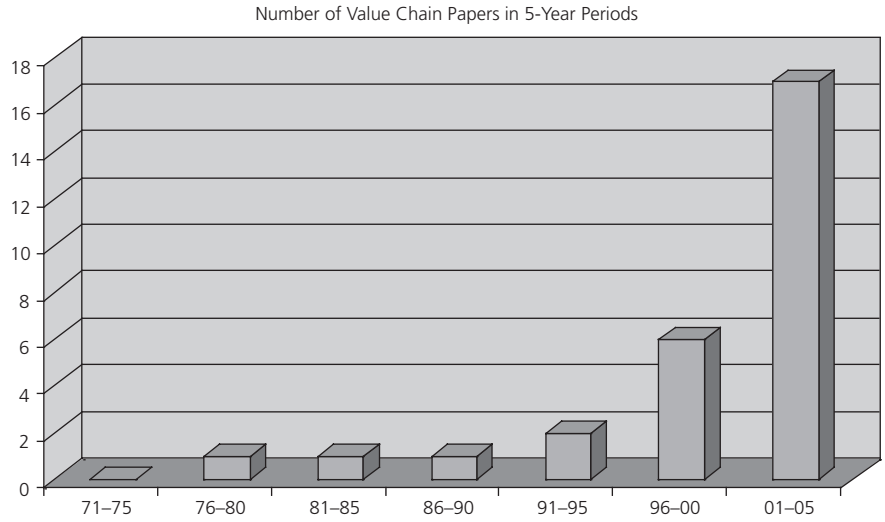
The year 1997 represents something of a turning point in R&D on the sugar industry value chain. New value chain R&D commenced within the CRC for Sustainable Sugar Production and additional funding became available from SRDC. The work from 1997 onwards has been thoroughly reviewed by Higgins *et al* (2005) and an overview of their main findings is presented in the next section.

Value Chain R&D comes of age (1997–2005)

In 2005, SRDC commissioned Dr Andrew Higgins and colleagues in CSIRO Sustainable Ecosystems to review R&D projects that had been conducted since 1997. This section draws on their observations and conclusions for a group of eleven Australian projects that they reviewed — nine of which had been completed or had made substantial progress by that time.[2]

In summarising these observations and conclusions, we have chosen to put them in the form of recommendations for future value chain improvements.

FIGURE 3. TOTAL NUMBER OF VALUE CHAIN PAPERS PUBLISHED IN ASSCT PROCEEDINGS SINCE 1971 (IN PERIODS OF 5 YEARS).



[2] Appendix 1 includes copies of their detailed documentation for three projects conducted in the Mackay, Maryborough/Burdekin, and Herbert/Mossman/Mourilyan mill areas to give the interested reader a better appreciation of the evaluation approach they took in reviewing projects. The full review by Higgins *et al* (2005) is available at www.srdc.gov.au/ProjectReports/CSE013.htm and in the CDROM contained in the SRDC Annual Report 2004–2005 as CSE013

Recommendation 1.
The types of issues addressed and the number of sectors encompassed should be broadened in future value chain R&D.

Higgins *et al* observed that many of the past value chain projects were concerned with logistical and operational issues such as scheduling, particularly at the interface of the harvest and transport sectors (see Table 1).

This led them to draw particular attention to the fact that issues from which other agricultural and food industries had received their greatest benefits from value chain improvements had received little attention to date in the sugar industry. These issues include the following.

- *Improving the transparency of information* both within and between sectors. Increased sharing of information would enable overall improvements to the value chain to be developed, tested and implemented.
- *Improving the responsiveness of the value chain* (e.g. the ability to react quickly and imaginatively to short-term situations such as wet weather delays, as well as the ability to respond rapidly to medium-term situations such as the emergence of new markets).

Table 1. Value Chain issues addressed in R&D for the Australian Sugar Industry: 1997 to 2005
(Projects listed in chronological order. Table adapted from Higgins *et al*, 2005)

No.	Main Issue Addressed/(Mill Regions)	Farm	Harv.	Transp.	Mill	Market	Ship
1	Harvest and transport logistics (Mossman, Mulgrave, Tully, South Johnstone)		✓	✓			
2	Logistics to exploit yield variability (Mackay, Maryborough, Mossman)	✓	✓				
3	Regional expansion (Rocky Point)		✓	✓			
4	Business integration and transparency (Three unnamed milling regions)	✓	✓		✓		
5	Harvest and transport logistics and rationalisation (Herbert, Mossman, Mourilyan)		✓	✓			
6	Logistics, rationalisation and diversification (Mossman)		✓	✓	✓		
7	New markets through co-generation (Maryborough, Burdekin)	✓	✓	✓	✓		
8	Information transparency, new payment formulas (Mackay)	✓	✓	✓	✓		
9	Logistics (Cairns, Mourilyan, Lucinda, Townsville, Mackay, Bundaberg, Brisbane)				✓	✓	✓
10	Logistics and expansion (New South Wales mills)		✓	✓			
11	Logistics and rationalisation (Herbert)	✓	✓	✓	✓		

- *Improving the integration of the operation of businesses within sectors* by the development of new partnering arrangements (e.g. the virtual "100,000 tonne farm", partnering of harvester groups).
- *Improving the awareness of new market opportunities* (e.g. via detailed market research and evaluation of the costs, benefits, and impacts of changes at a mill area or regional level).

It is interesting to note that most of these issues are covered in the list under *Relationship Investments* in Figure 2. Clearly, they need greater attention by the sugar industry.

In relation to the number of sectors involved in value chain R&D projects, examination of Table 1 shows that the number has been increasing over the years. It is now common for projects to span three or four sectors. SRDC believes that it is highly desirable that this trend continues and that, in future, most projects encompass the entire value chain and be supported by appropriate system-wide tools such as models.

> Recommendation 2.
> Diversifying the investment in value chain improvement specifically aimed at improving the relationship between sectors and between their respective organisations should be given high priority.

Higgins *et al* noted that mill regions that have a tradition of cooperative relationships between miller, grower and harvester, or that put a major effort into developing and nurturing these relationships, tended to make more progress in improving their value chain than others where the relationship was more adversarial. This observation simply reinforces the points made earlier in this report about the central role of *Trust* in the development of efficient and effective value chains.

The value chain work in the Mackay region for example (see also Section 3 and Project 8 in Appendix 1) put consultation and relationship building at the forefront. The project had a high-level advisory committee (the Cane Supply Consultative Group) that interacted with the project's technical participants. This was supplemented by reference groups for the growing, harvesting, and milling sectors that interacted with the relevant technical teams. This *participatory or action learning approach* contributed substantially to the many achievements of this work, including:

- the design and acceptance of a new cane payment system based on on-line NIR analyses;
- the development of a harvester monitoring and tracking system; and
- the development and implementation of a Web portal and associated central database.

The main tool currently available for those seeking to improve relationships between sectors is the *participative or action learning approach*. In it, representatives from each sector are involved from the outset, as in Mackay, in the planning and design, testing, and implementation of changes to the value chain. While the approach *can* encompass processes such as conflict resolution, social learning, and negotiation, these social interaction aspects need to be targeted more deliberately.

SRDC believes that the state of "health" of inter-sectoral relationships is so crucial to the objective of improving the performance of the sugar industry value chain, that increased investment, new skills, and substantially more imagination and innovation are required in this area.

> Recommendation 3.
> The tangible and intangible benefits of past investments in value chain improvement should be widely promoted throughout the industry.

Tangible benefits. Higgins *et al* found that the potential benefits from full adoption of the research results from a number of projects normally fell in the range of $1.00–$2.50 per tonne of cane. However, they had difficulty in determining the extent to which these potential benefits were converted into actual benefits. Realisation of potential benefits clearly depends

on the extent of adoption of the R&D results. This in turn, depends on the degree of change that participants were prepared to contemplate.

The extensive work on "geographical harvesting" provides a good example (see Project 2, Higgins *et al*, 2005). (Geographical harvesting refers to the harvesting of varieties, blocks, and regions with higher early CCS before they would otherwise have been harvested in the traditional system.) Potential gains from full adoption of geographical harvesting in the Mackay, Maryborough and Mossman regions were of the order of $1.00 per tonne, but achieving this involved undertaking significant changes to the harvesting, transport and milling sectors. In an environment where trust is low or uncertain and the changes are socially disruptive, reluctance to make such major changes is a natural human reaction. However, this reluctance has meant that the direct impact of the work has been relatively small to date. Adoption has been mainly by growers with a number of widely scattered farms. Nevertheless the idea behind geographical harvesting still has great merit and Project 11 in Higgins *et al* (2005) and other projects in the Herbert region are investigating its potential in greater depth.

Intangible benefits. In a number of cases, Higgins *et al* found that projects had other less-direct or intangible benefits. Such benefits include:

- identification of potential opportunities for Commonwealth Sugar Industry Restructure funding;
- an increased spirit of co-operation between millers and grower/harvesters;
- the development of modelling and optimising tools and approaches that have application in other projects and regions; and
- "learnings" about project design and implementation that have shaped subsequent R&D.

In order to better describe the benefits, particularly the intangible benefits, Higgins *et al* interviewed a total of 16 people from across the farming, harvesting, transport, and milling sectors in two contrasting regions — Maryborough and Herbert. They used a combination of small focus groups and one-on-one interviews involving people who had been involved in some way or other in value chain improvement. These groups were posed a number of key questions about the strengths and weaknesses of the approach, its achievements and limitations, areas for improvement, and future opportunities for value chain research. The main positive aspects of participating in value chain R&D projects that these people saw were that it:

- brought together, in the one place and on a regular basis, a very diverse group of people with different skills, backgrounds, experience, and expert knowledge of at least one of the industry sectors;
- improved participants' understanding of the operation and interactions of the current system and helped in the identification of weak links and blockages in the system;
- challenged participants to increase their understanding, and to be more understanding, of the motivations and drivers in sectors other than their own;

"After I got myself onto the Transport sub-Group for bin deliveries in the Herbert, I realised that I didn't know how the daily allocation of bins to each harvesting group was made, or which sidings the bins were to be delivered to, especially when things changed. I needed to have a better understanding of what happened here, so I arranged with the mill to do a 12-hour shift in the Operations Centre and spent from 4 a.m. to 4 p.m. just watching and learning. I now have more insight into the problems they are wrestling with and feel that I'm better equipped to make a contribution to the Transport sub-Group."
Liz Bosworth (Canegrower, Herbert)

- improved trust, communication, and cooperation between sectors and increased the willingness of participants to work together to solve problems with the operation of the value chain;
- provided opportunities for the development of friendships and improved personal relationships between participants; and
- increased participants' understanding of the importance of social factors and historical relations between sectors in impeding progress on value chain improvement.

Participants from these regions also identified a number of limitations of the value chain improvement work that they had been involved in. They centred around four main points: (a) whether all the right people were involved in the process; (b) whether the researchers were having too much influence on project priorities; (c) whether some of the assumptions behind the models were appropriate in all circumstances: and d) whether the modelling outputs could be made more compatible with financial systems and software in use in the various sectors. These issues have been developed further as a series of questions for those involved in the R&D system when designing and/or evaluating value chain research projects (see Appendix 2).

Recommendation 3 is made in the light of the fact that describing and quantifying costs, benefits, and impacts of the many types of changes that can result from improvements to value chains is a complex task and requires specialised input from professionals from a number of disciplines. Documentation from such studies would be invaluable in further raising the awareness of the industry to the potential of value chain improvements in the Australian sugar industry.

Recommendation 4.
Considerable flexibility should be built into the design, operation, and management of value chain R&D projects to enable them to cope with, and adapt to, unforeseen events.

Higgins *et al* found that all projects they reviewed had been affected by external events that were beyond the control of the R&D participants. These included changing regional priorities, major disease outbreaks, transfer of key industry participants, change in cross-sectoral relationships, change in the costs of implementing solutions, and the emergence of new implementation barriers. They noted that the multi-sectoral nature of most projects meant that they were much more vulnerable to unforeseen external events than single component, single sector projects. Adaptability on the part of the research team and flexibility in project management are clearly required.

5. OPPORTUNITIES FOR FURTHER DEVELOPMENT OF THE SUGAR INDUSTRY VALUE CHAIN

While a great deal has been achieved, particularly in the last five years, from the value chain R&D that has been conducted, there is still a very long way to go. The following ideas and suggestions about future opportunities for value chain R&D are based on inputs from focus groups and interviews conducted by Higgins *et al* (2005), and from the 80 representatives from all sectors and regions of the Australian sugar industry who participated in the Value Chain Forum in Townsville in October 2005.

The ideas on opportunities have been grouped under six headings.

- Improving the overall structure and functioning of the industry
- Taking account of the social and human aspects of the value chain
- Improving farming systems
- Optimising harvesting and transport
- Diversifying the range of products from cane lands
- Improving the capability of value chain models and tools

Improving the overall structure and functioning of the industry

Deregulation of the industry in 2006 and a stronger focus on the mill area or region as the key industry unit is leading to consideration of a much wider range of options than in the past. "Big Picture" suggestions from participants for detailed consideration included:

- further integration of the industry, e.g. through mergers, aggregation of farms and possibly mills within a region;
- improved alignment of the activities of the numerous R&D, regulatory, and extension resources in a region with the regional focus;
- development of various "model" contracts and protocols for services to encourage greater use of cooperatives and share farming;
- development of a variety of contracts between miller and grower for the supply of cane ex farm, and a range of pricing options including the use of futures;
- adoption of a best management practice philosophy across all sectors of the industry, not just in particular sectors or aspects such as harvesting and environmental management;
- increased value-adding through diversification of the range of industry products beyond raw sugar, electricity and ethanol — possibly using a joint-venture approach;
- a renewed search for improved milling technology that will give a step change in cost efficiency.

Participants recognised, however, that all these possible developments require the capacity to predict or model the full suite of implications (financial, productivity, environmental, social, equity, etc) of a variety of potential scenarios before undertaking any changes. While substantial progress has been made in the last five years in developing such capacity for particular parts of the value chain, few mill areas or regions currently have appropriate models and tools for their entire value chain — from planting the cane to delivering the final product to the customer.

Taking account of the social and human aspects of the value chain

As noted earlier (Figure 2), trust is the key ingredient for improved functioning of the entire value chain. Trust is slow to build and easy to destroy. Participants recognised that great care was required in nurturing and building trust through activities such as:

- working in close collaboration on cross-sector projects;
- developing real friendships between key players;

- fostering openness with respect to the motives and actions;
- sharing information willingly;
- improving the understanding by all participants of the drivers and operations of all sectors;
- developing a commitment to "increasing the size of cake" first, followed then by attention to the fair sharing of the risks and rewards of changes to value chain.

Participants recognised that the industry was coming from a relatively low base in respect of trust between sectors, and that a major effort would be required to rectify the situation. The task would require continuing support for activities such as:

- understanding the current social patterns of interaction between sector participants within a mill region;
- developing the human capacity for more effective participation in value chain improvement, (e.g. in managing conflict) and fostering the emergence of sector and industry leaders and "product champions", particularly from amongst younger participants;
- developing new forms of coordinated action, cooperation, and organisation among diverse industry stakeholders;
- addressing the social aspects of the trend towards 24-hour operations in the harvesting, transport, and milling sectors;
- developing novel incentives to accelerate improvement to the value chain;
- understanding the motivations of sub-economic producers and "slow or non-adopters" and tailoring systems to their needs (e.g. through the provision of assistance with restructure or exit options, succession planning, financial analysis, development of modified supply contracts, provision of management services for such growers, etc).

Improving farming systems

Many improvements to the productivity and profitability of the farming systems are either currently available or are undergoing intensive R&D. A small sample of these is listed below:

- the use of precision farming approaches;
- the development of new cane varieties including GM cane varieties;
- the use of crop ripeners to enable earlier harvesting at acceptable CCS levels;
- the use of climate prediction;
- the incorporation of break crops in the farming system;
- the improvement of crop presentation e.g. via controlled traffic systems, row profiling, and variety selection;
- the tailoring of fertiliser applications to specific soils and cropping systems.

While it is efficient and quite appropriate to develop and refine many of these technologies in isolation from other sectors, there comes a time when they need to be put together into farming systems packages. It is at this stage that their implications for other sectors of the value chain need careful study. This activity of integrating new or improved technologies into the value chain and assessing the implications for all other sectors was recognised as being of high priority but currently under-resourced.

Some examples of value chain questions for which there are currently few answers are listed below.

- How will the farming and harvesting sectors be impacted by the more widespread availability of online NIR measurements on cane and their incorporation into cane payment formulae?
- If GM varieties become available and require strict segregation in all sectors of the value chain, what impacts will this have on the overall value chain?
- What impacts will a change to whole crop harvesting have on the productivity, profitability, and sustainability of farming systems in the various mill areas or regions?

- What impact will product diversification have on variety selection? For example, will high fibre varieties be more desirable, if maximising co-generation is a key objective?

Increasingly robust and resilient farming systems need to be implemented that not only enhance economic and environmental performance in the farming sector, but also match value chain requirements for overall efficiency.

Optimising harvesting and transport

While this topic has received a great deal of R&D attention over the years and particularly since 2000, there are important opportunities for further improvement. Participants identified the following specific opportunities:

- investigation of the value chain implications of increased season length or sideways shifts of the traditional harvest season;
- further investigation of geographical harvesting (i.e. selecting high early-CCS localities and blocks within the mill area for preferential early harvest, thereby allowing other localities to be harvested closer to their optimum time);
- consolidation of harvesting groups to provide improved capital utilisation and more efficient harvesting operations, including extended hours of harvest;
- development of tailored contracts between cane harvesters and growers that provide the incentives to optimise cane quality and sugar yield per hectare, and share the costs, risks, and rewards equitably;
- faster communication of cane yield and quality data from the mill to the grower and harvester to enable rapid modification of the harvesting operations;
- electronic consignment of cane.

Diversifying the range of products from cane lands

The Australian industry has traditionally derived its revenue stream from the sale of raw sugar and, to some extent, molasses, electricity, and ethanol. The deteriorating international competitiveness of the industry in recent years, however, has accelerated the search for additional products with potential to add value, i.e. to supplement the revenue stream. The range of products that has been suggested and/or studied is extensive. It includes: animal feeds, specialised sugar products, starches, waxes, fibre-based products (papers, building materials), and bio-plastics and bio-pharmaceuticals from GM cane varieties. The technologies required for some of these are well known, but for others (e.g. industrial products from GM canes) they are highly speculative and production of such products is probably many years away from commercial reality. In all cases, however, participants drew attention to the need to:

- thoroughly investigate the benefits and the practicalities, capital requirements, and costs of production of each potential product;
- understand the needs of customers, the nature of the markets for each, and the sustainability of those markets over time;
- understand the implications of the addition of each product for the operations, productivity, and sustainability of all other sectors in the value chain;
- consider developing joint ventures with partners with technical or marketing experience in the particular product.

Improving the capability of value chain models and tools

Few, if any, mill areas or regions currently have adequate comprehensive models of the operation and functioning of their entire value chain. Participants considered that improvements in capability were required in many areas, including:

- integrating models with GIS of the mill area to make the information more readily usable;
- increasing the flexibility and ease of interaction with the models;

- making the costs of adoption of suggested changes more explicit for each sector affected;
- providing users with a clearer understanding of the limitations of the models and their underlying assumptions;
- increasing the capacity of the models to optimise farm layout, row spacing, etc, given information on soil type, drainage, variety, and pad location, and to understand the implications of such changes for both the farming and harvesting sectors;
- broadening the scope of the models so that they encompass the entire value chain right through to sugar quality, marketing and shipping rather than just particular sections of the chain (eg 2 or 3 adjacent sectors);
- linking the outputs of value chain modelling more closely with the financial modelling software used by growers and harvesters;
- developing models and tools to assist consideration of diversification options.

6. CONCLUSION

A key component of SRDC's R&D investment philosophy is that adoption of whole-of-system solutions, based on integrated management of the value chain particularly at mill area and regional levels, offers the opportunity to enhance revenue and cost efficiency to the benefit of all industry participants. This report has sought to support this thrust by:

- providing an overview of the "state-of-the-art" of value chain improvement in the industry and of the R&D that supports it;
- improving the level of awareness of the scope and potential benefits of value chain R&D by regional participants in the industry; and
- stimulating thinking and interest in conducting further value chain R&D to underpin a vibrant Australian sugar industry.

It is clear from the information and ideas presented, that many people throughout the industry have already given a lot of thought to ways in which the value chain could be further improved. Good ideas are in ample supply and excellent progress is being made in many regions.

Further improvements to the value chain of the Australian sugar industry will require stronger sector and industry leadership, a greater commitment to the vision outlined, increased investment, and, most importantly, industry-wide endorsement of the value chain philosophy of "cooperating to compete".

7. FURTHER READING

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3. Milford, B.J. (2002). Value chains in the Australian sugar industry: an assessment and initial study. *Proceedings of the Australian Society of Sugar Cane Technologists*, 24: 56–62.

4. O'Keefe, M. (1997). Supply Chain Management. Agricultural Science, May–June 1997: 29–32.

5. Sing, N.C. (Edt) (2001) Far North Queensland Sugar Industry Task Force, Review and Report. Far North Queensland Sugar Industry Task Force.

APPENDIX 1

Selected evaluations of value chain projects conducted in the Maryborough, Mackay, and Herbert districts

(Extracted from the SRDC-commissioned Review … *Value Chain Research in Sugar: A Review of Successes and Learnings* by Higgins et al (2005) and lightly edited and updated)

PROJECT 7. Maryborough, Burdekin

Title: **Integrated Value Chain Scenarios for Enhanced Mill Region Profitability**
Principal Investigator: PJ Thorburn *et al*
Years: 2003–2005

Reason/Objectives

This project looked beyond the harvesting and transport system and considered opportunities that required change to potentially all sectors of the chain. The two-year project commenced in 2003 and required collaboration between CSIRO, SRI and BSES to have the necessary skills and expertise to analyse whole-of-value chain scenarios. In the two case study regions, Maryborough and the Burdekin, the local reference groups agreed upon co-generation of electricity as the key scenario to be addressed. Unlike harvesting and transport integration that focuses on cost cutting to produce the same level of industry income, co-generation increases industry income through the production of other products as well as sugar.

Method and Results

The methodology has similarities to the harvesting and transport project, in that a local reference group was formed in each case study, comprising of grower, harvester and miller representatives. The project used participatory research principles in modelling the supply chain, formulating scenarios, developing results, and learning for successive iterations of the process. Prior to the start of the project, there was no value chain model available to the industry to provide a comprehensive whole-of-chain analysis for scenarios such as co-generation. Past attempts to measure the benefits of scenarios such as co-generation, were either rough "back-of-the-envelope" studies, or an application of some industry models (harvest-transport, transport scheduling, mill model) in a linear manner without capturing many of the important interactions across the chain. To capture the complex interactions across the chain whilst still being understandable by industry, a multi-agent supply chain model was developed. Instead of the industry models (APSIM, Harvest Haul, Transport scheduling, Mill Model) being directly built into the supply chain model, simplified versions of these models (e.g. diamond models or functional relationships) were developed.

Outcomes/Learning

Scenarios for co-generation of electricity were produced for the Maryborough and Burdekin regions, along with alternative scenarios that consider partial trash recovery for co-generation, and scenarios that look at ways of fine-tuning the harvesting and transport system to reduce costs. The main benefit of the project in Maryborough was that it highlighted additional costs that the Maryborough working group were unaware of (or didn't account for in their own analysis), which now made co-generation of electricity non-beneficial for the region. As a result, the outcome of the project for Maryborough was a decision not to go ahead with their original co-generation plans, and to further explore the alternative co-generation scenarios highlighted by the project. The following learnings and shortcomings resulted from the project:

- The outcomes from the project were different to those anticipated at the start of the project but the local reference group agreed they were still significant. An increased understanding of their own chain and capacity to consider a wide range of value chain scenarios were valuable outcomes for the local industry at Maryborough.

- The value chain project required a multi-organisational collaboration to achieve the necessary skills base, which requires a large amount of resources just to manage and co-ordinate. Projects of this type will have high transaction costs and will be high risk.
- The project had much less impact and influence on the Burdekin local reference group, compared to Maryborough. It may have been wise to take on a replacement case study which had much more industry pull. These types of value-chain projects need mechanisms to reduce the risks and negative impacts.
- The value chain model was produced using Excel and produced the results necessary for this project. An extension of the value chain model to address other issues may require the model to be developed differently to handle the systems complexity, whilst being robust and understandable by industry. There is a considerable amount of new science and R&D to achieve this however, so it would be difficult to fund exclusively by the Australian sugar industry.

PROJECT 8. Mackay

Title: **A Co-operative Systems Model for the Mackay Regional Sugar Industry**
Principal Investigator: GF Fleming
Years: 2003–05

Reason/Objectives

The objective of the project is to develop a whole-of-chain management strategy underpinned by technology to facilitate reduction of costs and improved profitability and sustainability for all sectors of the Mackay sugar industry. It focuses on the development of a co-operative systems model, using participatory action learning principles, that integrates the links of the value chain in order to add value to its component parts. The co-operative systems were defined as computer based systems used by individual businesses to support integrated management decision making across the chain. It is a unique value chain project in the sugar industry in that it tries to improve information transparency across the chain, to provide a basis for better decision making across sectors. The project also tries to provide a means for increased adaptability to new markets and re-structuring. The co-operative systems model involved a large range of linked models and information tools in productivity performance, farm financial performance, farm management practice, harvesting performance, transport planning and scheduling, mill process control and process efficiency/quality.

Method and Results

The project methodology was based on action learning and a well organised consultative group of project teams in farming, harvesting/transport, and milling. This consultative group was responsible for communication of the objectives and progress to growers through to industry leaders. There was also a project committee which also included an IT and change management teams. Across these teams, there were representatives from Mackay Sugar, Queensland Mechanical Cane Harvesters, Canegrowers, and BSES. The project has achieved a large amount of outputs to date (e.g. computer models, trials, and web based tools).

Outcomes/Learning

There are some very important achievements (outcomes) including: a new cane payment system that promotes new markets and increased quality/efficiency; electronic consignments and NIR that will achieve more accurate information and better transparency of it; and a formulation of models across the industry that can be linked with the co-operative systems for better decision making across the chain. In 2005, the new cane payment system was adopted by the entire Mackay industry, which the project leader suggests would have not happened without the participatory research principles adopted by the project teams. The project differed from the other major value chain projects undertaken in the sugar industry from a perspective that the R&D funding from SRDC covered a very small percentage of the overall resources put into the project objectives by the industry organisations. This is primarily a result of minimal involvement from R&D organisations, and should mean continued momentum after the R&D funding finishes.

PROJECT 5. Herbert, Mossman, Mourilyan

Title: **Integrating and Optimising Farm-to-Mill Decisions to Maximise Industry Profitability**
Principal Investigator: AJ Higgins *et al*
Years: 2002–2006

Reason/Objectives

The harvesting and transport sectors of the sugar industry are poorly integrated due to separate and individual ownerships, along with large systems complexity. Several independent industry reports (e.g. Hildebrand, Boston Consulting) have indicated up to $5.00/tc potential savings across these two sectors, which would be achieved through increased integration, increased efficiencies, and re-structuring. With funding from CRC Sugar and SRDC (CSE005), researchers in CSIRO and BSES are exploring opportunities for improvements in these sectors. (A related project on harvester and siding roster optimisation in Mackay commencing in 2000 and involving the same CSIRO researchers is also included here).

Method and Results

The project initially started in 2002 with case studies in Mourilyan, Mossman and Plane Creek, with the Herbert taking over as the main case study in 2004. For each of the case studies, a working group comprised of influential growers, harvesters and millers was set up to formulate a range of harvesting and transport scenarios that would be suitable to the region. The main scenarios considered were: increased time window of harvesting, increased harvesting group size, reduced number or upgrading of sidings, and optimised siding rostering. All of these scenarios require changed decision making in the growing, harvesting and transport sectors to achieve adoption.

To achieve the analysis capability, a modelling framework was developed with the Mourilyan working group which provided an understanding of the numerous drivers across the harvesting and transport system. Existing component models (Harvest Haul, siding rostering) and new models (transport capacity planning, siding location) were then integrated into the framework to provide the capability. Since the researchers conducted the modelling work in close contact with representatives of the working group, the industry developed confidence in the models. While the Mourilyan region anticipated about a $5.00/tc gain from integrating the harvesting and transport sectors, the modelling work showed potential gains ranging only to about $2.00/tc. Also, the bigger the gain in the scenarios, the larger the change required to achieve benefits, with siding and group rationalisation requiring substantial capital investment.

Outcomes/Learning

The rate of adoption has generally been slow (except for roster optimisation in Mackay), with Mourilyan and Mossman implementing an extended time window of harvest to about 17hrs in 2004. The Herbert has started to adopt optimised harvester rosters and extended time window of harvest from 2005, though benefits are unclear at this stage. The project provided several learnings as follows:

- There have been some hard-to-measure tangible benefits (e.g. delay on costly purchase of new bins, reduced labour requirements for planning (Mackay harvester and siding rosters), economic benefits of reduced delays to harvesters) as well as intangibles (e.g. improved relations and planning capability between harvesters and millers, ability to achieve substantial funding from government from industry restructure package). This has been particularly noticeable when adoption has been in place for at least 2 years (e.g. Mackay rosters, and Mourilyan).
- The research must be driven at all times by the local region. The use of external facilitators and researcher dominance has made it easy for industry representatives to become complacent. Thus, in time, the process can become researcher-driven, with a small proportion of the industry representatives doing most of the work. This was particularly the case in the Mourilyan case study which failed on the departure of the two key industry representatives.

- Adoption was slow and can be difficult for the larger benefit scenarios. Implementation of an extended time window of harvest required all (or at least most) harvesters to agree to alternative start times for the scenario to be effective. If the goal of the region is for a 20-hour time window of harvest and currently operates in daylight hours only, the first year of implementation may be a 14-hour time window (e.g. Mulgrave), with the second year extended to 16 hours. Change needed to occur in small steps, to build trust and ensure that the incremental steps were delivering benefits. While the working groups agreed that having fewer harvesters would benefit the region, this was not able to be achieved in practice in the Mourilyan case study. (However, other initiatives in Mackay and Plane Creek outside this project have achieved a reduced number of harvesting groups through co-operatives and consolidations.)
- Regions with poorer relations between the growing, harvesting and milling sectors had more potential benefits (tangible and intangible) available to them than those with good relations. Regions with good relations such as Maryborough, Isis and Mulgrave, already had more efficient transport systems and a well serviced harvesting sector, in comparison with Mourilyan and the Herbert. The latter regions required a more intensive participatory process in order to more forward.
- Insights gained from the research have left unforeseen legacies inside the case study regions and to other regions. Several regional plans submitted to the government for re-structuring funding, have been influenced by the learnings from this project. Moreover, industry representatives from regions not involved in the project are already promoting opportunities to others within their local region.

APPENDIX 2

Issues for the R&D system

Key Questions to Consider when Designing or Approving Value Chain Research Project

1. Is the proposed work aligned with the strategic plan and priorities of the mill area or region? Should a "Needs Analysis" be conducted first? Are participants (particularly the researchers) coming with their own agendas and priorities rather than working together as a team and deciding priorities jointly?
2. Has adequate attention been given to improving non-logistical issues of the value chain such as transparency, trust, business integration, development of new markets, and chain responsiveness?
3. Are adequate benchmarks available so that the project team (and others) can gauge progress at the end of the project or should they be established as part of the project activities?
4. Are the project's objectives sufficiently flexible to enable the project team to cope with the inevitable changes imposed by outside events?
5. Does the project team have enough participants to adequately cover all sectors involved in the study?
6. Does the project team have the leadership, team structure, and skills to manage and/or train such groups in tasks such as relationship building, working together in a team, building trust, resolving conflict, and negotiating?
7. Do project participants have an adequate understanding of the history of relationships between the sectors in the mill area or region to underpin and guide the work?
8. Are the "right" people involved? Is there a good understanding within the project team of the decisions that each participant is empowered to make?
9. Are the outputs of any modelling undertaken able to be directly linked with financial modelling software used by growers and harvesters and miller?

APPENDIX 3

Value Chain Papers Published in the Proceedings of the Queensland and Australian Societies of Sugar Cane Technologists since 1970

1. Reghanzani, J.R. (1977). A study of field to tramline cane transport utilising a simple model. *Proceedings of the 44th Conference of the Queensland Society of Sugar Cane Technologists*, pp 173–178.
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3. McWhinney, W., Crawford, D.M., Ridge, D.R., Cameron, J.M., and Absolon, J.E. (1988). The economics of cane from field to factory. *Proceedings of the Australian Society of Sugar Cane Technologists*, 10: 7 to 18.
4. Powell, J.G. (1992). The effect of row length, crop density and haulage distance on harvest and delivery rate in the Mackay district for 1991. *Proceedings of the Australian Society of Sugar Cane Technologists*, 14: 163–168.
5. McWhinney, W. (1995). Harvest control and cane transport — the vital link between field and factory. *Proceedings of the Australian Society of Sugar Cane Technologists*, 17: 46–54.
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13. Milford, B.J. (2002). Value chains in the Australian sugar industry: an assessment and initial study. *Proceedings of the Australian Society of Sugar Cane Technologists*, 24: 56–62.
14. Higgins, A.J. and Postma, S. (2003). Siding roster optimisation: case studies in the Mackay region. *Proceedings of the Australian Society of Sugar Cane Technologists*. (Proceedings of the 25th Annual Conference, published on CDROM.)
15. Crane, J.A. and Fleming, G.F. (2003). Improving information flows in the sugar industry supply chain: the Mackay sugar web portal. *Proceedings of the Australian Society of Sugar Cane Technologists*. (Proceedings of the 25th Annual Conference, published on CDROM.)
16. Markley, J., Raines, A., and Crossley, R. (2003). The development and integration of remote sensing, GIS and data processing tools for effective harvest management. *Proceedings of the Australian Society of Sugar Cane Technologists*. (Proceedings of the 25th Annual Conference, published on CDROM.)

17. Antony, G, Prestwidge, D, Sandell, G, and Higgins, A (2003). Scope for cost savings from harvesting rationalisation in the Australian sugar industry. *Proceedings of the Australian Society of Sugar Cane Technologists*. (Proceedings of the 25th Annual Conference, published on CDROM.)

18. Higgins, A., and Davies, I. (2004). Capacity planning in a sugarcane harvesting and transport system using simulation modelling. *Proceedings of the Australian Society of Sugar Cane Technologists*. (Proceedings of the 26th Annual Conference, published on CDROM.)

19. Sandell, G.R. and Prestwidge, D.B. (2004). Harvest haul model — the cost of harvesting paddocks of sugarcane across a sugar milling region. *Proceedings of the Australian Society of Sugar Cane Technologists*. (Proceedings of the 26th Annual Conference, published on CDROM.)

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25. Fleming, G.F. (2005). Cooperative systems: an information systems model for industry value chain management. *Proceedings of the Australian Society of Sugar Cane Technologists*, 27: 40–50

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