

CRC Sugar

A new approach to research and development for an industry in transition

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The sugar industry has experienced more change in the past decade than in the previous two, and will see more in the next decade than in the previous three.

In a rapidly changing world, an increasingly innovative approach to industry research and development is needed to underpin the technical and operational innovation necessary to sustain the industry's international competitiveness and improve its environmental management.

The combined effects of the recent slump in world raw sugar prices and episodic disruptions of weather and crop disease threaten the industry's emergent research and development base at a time of heightened need.

An industry in transition

Notwithstanding its image of durability, even permanence, the Australian sugar industry has experienced more change in the past decade than in the previous two, and will see more change in the next decade than in the previous three. It is instructive to review these changes briefly because they variously influence opportunities for tech-

nical and operational innovation, as well as the environment within which the research and development that underpins innovation is conducted.

During the period 1975-99, there was an 86 per cent increase in raw sugar production, stemming largely from a 70 per cent expansion in the area of cane harvested. More than half the sugar industry expansion occurred in the past decade. The expansion has been greatest in the Herbert and Burdekin regions, immediately north and south of Townsville. Scope for further horizontal growth is limited in New South Wales, southern Queensland and the wet tropics.

The expansion brought in about 1500 new growers and two new small mills on the Ord River and the Atherton Tableland. At aggregate industry level, the expansion was driven by long term cost—that is, price pressures. It provided opportunities for a greater economy of scale for individual farming, harvest/transport and mill enterprises, partly offsetting the long term downward trend in real raw sugar values and terms of trade.

At the same time, the expansion increased the industry's overall exposure to global competitive pressures, with a relatively smaller proportion of the total crop now sold into the domestic and more favourable international markets.

These pressures are most evident at regional level. In some 'land locked' areas, where lack of suitable land and/or alternative land uses constrained expansion, economies of scale have been harder to achieve and production is becoming more marginal. Further structural adjustment at mill and farm level in Queensland is inevitable over time.

Over much of the period 1975–99, mean sugar yields per hectare were stable, rising in the mid 1990s, but dropping again in the past three years due to unfavorable weather and disease. While fluctuating seasonally, sugar levels in cane have been relatively stable or even trended downward, as in the wet tropics, where long term productivity improvements in terms of sugar yields per hectare have been slowest.

The difficulty in achieving sustainable improvements in crop productivity on farm has intensified the need for efficiency gains elsewhere in the sugar production system to sustain the industry's long term international competitiveness in what few could call a level playing field (for example, see Sheales et al. 1999).

Changes to regulatory and industry arrangements

The industry expansion was facilitated by, and in turn contributed to, changes such as the progressive relaxation of the cane assignment system (which governs land where cane can be grown) and the introduction of operational practices (for example, continuous crushing, night harvest, and an extended crushing season) aimed at improving the efficiency of industry capital and infrastructure.

Further impetus for regulatory change came from the 1996 sugar industry review process (SIRWP 1996) undertaken in the context of national competition policy. Key recommendations included the removal of remnant tariff support (since implemented), the retention of the single desk selling arrangement in Queensland, and further deregulation and/or devolution to the local level of various industry arrangements (for example, the assignment of land for cane production and cane supply agreements).

The *Queensland Sugar Industry Act 1999* led to the implementation of a number of review recommendations, plus other changes viewed by government as being consistent with national competition policy objectives. The main grower representative body, Canegrowers, changed from being a statutory organisation supported by a compulsory levy to being a company supported by a voluntary membership levy. Other privatisation changes saw Queens-

land Sugar Corporation transform from being a statutory marketing organisation to being the commercial marketing company Queensland Sugar Limited, while the industry's bulk sugar terminal assets were transferred from government to industry ownership under the auspices of Bulk Terminals Limited.

While raising their own specific challenges, the moves to generally more flexible regulatory and institutional arrangements also throw up opportunities for operational efficiency gains, as illustrated below in CRC Sugar's work to optimise cane supply arrangements in two mill regions.

Environmental pressures

The past decade has seen a sharp and often critical focus on the sugar industry's environmental impact and its record in natural resource management. The key driver for this is the industry's mainly coastal location, sandwiched between sensitive environmental areas like the World Heritage wet tropics, the Great Barrier Reef Marine Park and the more recently designated Dugong Protection Areas, and interspersed with remnant wetlands and riparian and natural vegetation areas with biodiversity and habitat values. (Concurrently, there have been: changes in community attitudes, with a heightened awareness of environmental issues; industry expansions into sensitive remnant habitat, combined with urban encroachment into farmland; a rapid growth in tourism; and the emergent interests of 'downstream' industries such as commercial and recreational fishing.

Key issues relate to industry effects on downstream water quality and the consequences (for example, the movement, fate and impact of sediments, nutrients and agricultural chemicals, and the management of acid sulfate soils and the consequences of acid drainage into coastal streams and the marine environment) and the retention and sustainable management of natural vegetation areas, especially riparian and wetland habitats. Cane firing before harvest is an issue near those regional urban areas where green cane trash blanketing is unable to be practised.

Historically, sugar industry research and development was strongly production

focused, and the industry was unprepared and ill equipped in terms of the scientific understanding needed to underpin better environmental practices. This need was a key rationale for the establishment of CRC Sugar.

Cyclical episodic disruptions

There have been disruptive events that sometimes obscure the underlying trends and intensify the short term pressure on industry profitability and sustainability. The most significant was the Brazilian decision to divert a substantial proportion of its sugarcane crop from fuel alcohol to raw sugar production, which had a significant impact on world sugar prices between mid 1998 and mid 2000. The average world price for raw sugar in 1999 was less than half that five years earlier.

Meanwhile, the northern regions endured an extraordinarily wet second half to the harvest season of 1998 — an event repeated in the south in the next year, when one mill finished harvest around Australia Day. These events, in tandem with wet season cyclones and the consequent flooding and water logging, contributed to the fall in crop productivity noted earlier.

In the most recent (2000) crushing season, onfarm crop productivity was further dramatically reduced when the premier variety in several key regions (Central, Burdekin, Herbert) unexpectedly succumbed to a previously obscure leaf rust disease.

The combined impact of these events on industry profitability has been massive. The gross value of payments to sugar producers declined from \$1.81 billion in 1997 to \$0.96 billion in 2000 (ASMC 2001).

Changing research and development environment

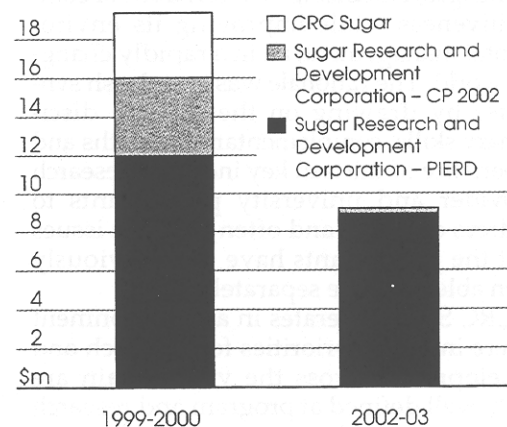
The sugar industry has a long tradition of industry funded research. The Bureau of Sugar Experiment Stations, which is focused on mostly cane breeding, production and harvest, last year celebrated 100 years of operation. The Sugar Research Institute, which is focused on mostly cane transport and sugar manufacturing technology, has operated since 1949. Smaller research and development efforts have been maintained on a local scale by milling companies and

the regional Cane Protection and Productivity Boards.

The past decade has seen a major re-shaping of the industry's research and development sector. The establishment of the Sugar Research Council in 1987 and later the Sugar Research and Development Corporation under the Primary Industries and Energy Research and Development Act in 1990 saw the introduction of contestable funding for what is now about one quarter of the industry's research and development funds. Additional expenditure was leveraged into sugar industry research and development from new provider organisations, notably the Commonwealth Scientific and Industrial Research Organisation (CSIRO), state departments, universities and agribusiness. Analysis indicates aggregate sugar industry expenditure on research and development exceeds 2 per cent of industry gross value of production, with 58 per cent sourced from the industry, 10 per cent from state governments and 32 per cent from the Commonwealth government (Wallis 2000).

As well as raising the overall investment in sugar industry research and development, the diversification is both broadening and strengthening the research and development sector. In particular, the industry's strategic research and development capacity has been enhanced, and the Sugar Research and Development Corporation established a coherent program to support, for the first time, postgraduate training in the universi-

Figure 1: Projected decline in contestable funding



ties. The scope of industry research and development has also widened to include a focus on natural resource management as well as production issues.

An unintended consequence of the diversification of the industry's research and development sector was the tendency for 'compartmentalisation' of disciplinary skills and capacity in the different research and development provider organisations. This situation was, if anything, reinforced by the competition for contestable research and development funds, at least in the short term.

Regulatory changes in the research and development sector paralleling those in the industry last year, saw the introduction of voluntary levies to replace the system of compulsory production based levies on millers and growers that previously supported both the Bureau of Sugar Experiment Stations and the Cane Protection and Productivity Boards. A foreshadowed review may well see the Bureau of Sugar Experiment Stations move from being a state statutory authority to an industry controlled and operated contract research provider, more akin to the model of the Sugar Research Institute.

Cooperative Research Centre for Sustainable Sugar Production (CRC Sugar)

One of the more significant changes in sugar industry research and development was the establishment of CRC Sugar in mid 1995 to address the competing sugar industry's challenges, enhancing its international competitiveness while improving its environmental management, all in a rapidly changing world. The rationale was to unleash synergies by drawing on the diverse disciplinary skills, complementary strengths and experience of thirteen key industry, research provider and university participants to address complex and often difficult issues that the participants have not previously been able to tackle separately.

CRC Sugar operates in an environment where industry priorities for research and development across the value chain are fairly well defined at program and research strategy levels through a comprehensive

Figure 2: Operational strategies of CRC Sugar to add value to sugar industry research and development ^a

- Cooperative multiparty research and postgraduate training
- Multidisciplinary teams building on complementary capabilities and experience of industry, university and research and development organisations
- Taking complex and/or sensitive research and development issues that individual organisations cannot, and being an 'honest broker' of information
- Participative research and development with industry and community end users
- A 'whole-of-system' view integrating socio-economic analysis with a biophysical understanding into frameworks useful for end users
- Generating synergies, not 'more of the same'

^a CRC Sugar's budget represents around 15 per cent of the total industry research and development budget.

process led by the Sugar Research and Development Corporation and involving all industry regions and sectors, the research and development providers and government (SRDC 1999).

CRC Sugar's strategic objectives and role are formulated jointly with industry and community stakeholders in the context that its cash and in-kind budget represents 15 per cent of the total research and development resources of the sugar industry. The aim is to ensure that CRC Sugar's program is focused on areas of comparative advantage where it can add value to the other 85 per cent of sugar industry research and development. To that end, a set of operational strategies has been developed (figure 1) against which research and development proposals are broadly benchmarked.

Research and development program

CRC Sugar has six key result areas against which performance is benchmarked. The first three of these address the principal elements of sustainable agriculture:

- protecting the environment;
- sustaining soil and water resources; and
- enhancing productivity.

Together, they comprise the core focus of CRC Sugar's research. The fourth key result area — education and training — is of some relevance given the historical lack of strong

Table 1: CRC Sugar's 'top ten' research and development outputs for the first five years a

1. Whole-of-industry productivity

Capability developed to optimise cane harvest and supply scheduling with aggregate efficiency gains of 7–11 per cent (\$13 million a year in the Mackay region alone). Gains translate to \$115–165 a hectare depending on the sugar price. Commercial evaluation is underway in a pilot study in the Mackay Sugar mills.

2. Acid sulfate soils

Acid sulfate soils project with New South Wales Sugar Milling that developed industry analytical capacity, identified areas of potential acid hazard and enabled management plans to be put in place, resulting in industry being granted self regulation of the management of acid sulfate soil. CRC Sugar models in use inside and outside sugar industry.

3. More dollars from limited water

Decision support models developed to evaluate economic feasibility and to optimise design criteria for onfarm water storage (DamEa\$y) and for use of municipal effluent to irrigate cane lands (SUGARCO\$T) in use by farmers and local councils.

4. Natural resource management planning

Website based decision support for natural resource management planning (*NRM Tools*) and economic modeling (CLAM) developed and applied with industry, government and community stakeholders to assess economic, social and environmental implications in two major catchments.

5. Better fertiliser management

A new paradigm promoted for tailoring fertiliser use to crop needs, taking account of soil type, weather and nutrient recycling to reduce nutrient losses to environment. A website repository of soils data (*Soils of the Sugarlands*) to facilitate use of soil resource data.

6. Making better use of recycled nutrients

The dynamics of nutrient recycling via green cane trash blanketing, the use of mill muds and effluent recycling modeled, enabling these nutrient sources to be factored into fertiliser management plans.

7. Making difficult soils more productive

A *Sodic Soils Toolkit* developed to estimate how much amendment to apply to overcome sodicity problems in diverse soils. Liming strategies developed for overcoming acidity in a lower soil profile and the economic value of long term liming demonstrated.

8. Toward better environmental management

Studies on industry aggregate fertiliser and pesticide use, nutrient and sediment losses, nutrient leaching, pesticide mobility and environmental fate which enable sugar industry impacts on water quality relative to the impacts of other land uses to be assessed for first time.

9. Toward better productivity in the wet tropics

Novel analysis of productivity data which clarified the basis of the low CCS (commercial cane sugar) problem in wet tropics, and highlighted the roles of crop lodging, suckering and weather prior to harvest.

10. Investing in people

Thirty-three postgraduate students either trained or in training in the sugar industry. More than 400 technical and advisory staff undertaking continuing education through a 'train the trainer' program.

a See www.sugar.jcu.edu.au for further detail.

direct links between the sugar industry and the education sector.

The other two key result areas address less tangible but important challenges: to influence *attitudes and perceptions* by fostering (as an 'honest broker') informed debate on sustainability issues, and to deliver *synergy from collaboration* through a focus on 'value adding' strategies. Key research and development from CRC

Sugar's first five years of operation, reflecting public good as well as direct industry benefit elements, are listed in table 1.

The opportunities for gains from innovation are large in a high gross value of production industry such as sugar. CRC Sugar's whole-of-industry research with the Mackay and Mossman industries, for example, indicates opportunities for 7–11 per cent efficiency gains in cane supply to mills within

existing harvesting, transport and milling constraints. Translated across applicable regions, productivity gains of this magnitude could translate to \$100–140 million revenue annually, even at depressed sugar prices.

An external cost–benefit analysis of eight CRC Sugar activities (Agtrans Research and eSYS Development 2000), based on conservative assumptions of sugar prices, adoption rates and estimates of benefits, indicated cost–benefit ratios ranging from 2:1 to 53:1 at a 5 per cent discount rate, and internal rates of return of 12–84 per cent. The net present value of the cane supply options work alone exceeded the aggregate (7 year) value of CRC Sugar's total research and development investment.

Similarly, positive outcomes were apparent from internal benefit–cost analysis of CRC Sugar's research and development on supplemental irrigation, where sensitivity analyses showed the investment criteria remained positive across a wide range of plausible scenarios (Wegener et al. 2000).

The external benefit–cost analysis indicated that the return on investment was lower for environmental than production related projects. However, this outcome owes much to the difficulties of placing 'market value' on environmental outcomes — an area in which CRC Sugar has made its own research progress (for example, see Mallawaarachchi et al. 2001).

Application of research and development outputs

CRC Sugar's main role is an 'information broker', providing end users with science based information and assisting in its application to improve industry environmental, resource management and production practices. CRC Sugar's technology transfer strategy takes into account that (i) the CRC has a diversity of stakeholders from the industry and the community, (ii) many of the issues addressed by CRC Sugar's research are difficult and/or complex and require cultural change to facilitate implementation, and (iii) the industry has in place extension networks where CRC Sugar can add value rather than duplicate efforts. The strategy comprises several methods that are complementary to technology transfer, each

reflecting the nature of the technological innovation involved and tailored to the needs of the end users.

Links to end users

CRC Sugar's industry stakeholders span the value chain, but the primary emphasis is on growers, millers and, to a lesser extent, agribusiness. All can be considered to be small or medium sized enterprises. Community based stakeholders include environmental managers (for example, the Environmental Protection Authority, the Great Barrier Reef Marine Park Authority and the Queensland Department of Primary Industries, Fisheries), environmental interest groups (for example, Landcare and environmentalists), downstream industries (for example, fishing and tourism) and policy makers in industry, financial services, and local and state government.

Because end user objectives, expectations and perceptions often differ, some emphasis is placed on CRC Sugar's role as an honest broker, providing objective scientific information to all end users. The need for such an approach is particularly evident with issues such as cane supply scheduling/season length, the management of acid sulfate soils, and natural resource management planning.

Participative research with end users

CRC Sugar has emphasised participative research and development and learning projects that actively engage end users at all levels of operation and in all phases from initial planning to evaluation and the implementation of options in pilot studies. The experience has been that participative approaches are more effective than traditional extension when dealing with complex issues, where different stakeholders may have different and even competing goals and expectations.

Examples where the participative approach has proved valuable include alternative cane supply options analysis (millers, growers and marketers), yield forecasting (cane inspectors, mill management), the onfarm management of acid sulfate soils (millers and growers, community and fishing interests), natural resource management decision making (growers, millers,

councils, community, environmental interests), the re-use of effluents (growers, councils), and the limited use of supplemental irrigation (growers).

Economic analysis and decision support tools and approaches

An integral part of CRC Sugar's strategy for applying information and facilitating beneficial change has been to integrate biophysical and economic information into frameworks useful to end users. Biophysical models and other frameworks developed by CRC Sugar enable the extrapolation of experience (for example, across regions and years) and allow complex interactions among factors (for example, among crop, soil and climate) to be understood and manipulated. Coupled with economic analyses and evaluation, the models enable scenarios to be examined and options to be evaluated in terms of economic costs, benefits, tradeoffs and risks.

A range of modeling and other integrative tools (such as cane supply options analyses NRM Tools, CLAM, DamEa\$, SUGARCOST, the APSIM Sugarcane model and the LUCID framework for nutritional information) has been developed. Economic analyses and research have focused on the benefits of specific practices and options, regional resource use, whole-of-industry management issues, and the value of research outputs (CRC Sugar 2000).

Links with the extension staff network

The sugar industry has an established network of regionally located extension staff employed by the Bureau of Sugar Experiment Stations and the Cane Protection and Productivity Boards. The extension officers are each responsible for providing advice to individual growers and millers in their area. The extension network is particularly well suited to the diffusion of technology and knowledge on better crop, soil and water management practices to the wider grower and miller community. Information is made available to end users at regional field days and shed meetings, through various extension resource materials and in response to direct requests. The range of extension materials developed by CRC Sugar spans the range of traditional materials (the occasional

publication series, posters, information sheets, extension kits and videos) to web based information packages in downloadable PDF format.

Education and training

Specific education goals are to enhance the industry's scientific capacity in sustainability of production, and to improve industry practice by promoting awareness of and fostering the use of scientific information on sustainability issues. The two main strategies to achieve these goals are postgraduate training and continuing education on key sustainability issues targeted at the industry extension and advisory personnel. Opportunities are also provided for generic skills enhancement for researchers and students. CRC Sugar has built on the Sugar Research and Development Corporation postgraduate training program to become the major higher level education provider in the sugar industry, with 36 postgraduate students receiving training support over the past five years.

The main aim of the education program is to create a pool of competent researchers with the skills and industry experience needed to sustain the flow of new ideas and promote industry innovation. The program is attracting capable trainee scientists into the sugar industry, and providing continuing education for people already in the workforce.

Postgraduate training focuses on topics of priority industry need, and student projects are integrated into research activities that provide 'real world' experience for the students. Particular emphasis has been placed on training to meet emerging industry needs in the social sciences (rural sociology, technology transfer, human geography) and economics (twelve students).

'Train the trainer' short courses on 'Sustainable nutrient management in sugar production' and 'Environmental management for sustainable sugar production' provide up-to-date scientific information, including outputs from CRC Sugar's research activities. Target participants are the extension and technical advisory personnel responsible for advising the sugar industry and community agencies on sustainability issues, including the Bureau of

Sugar Experiment Stations Extension Service, the Cane Protection and Productivity Boards, milling companies, agribusiness, Integrated Catchment Management, Landcare, local and state government agencies, environmental groups and environmental management agencies. Courses are intensive, with the individual components prepared and presented by specialists.

CRC Sugar also sponsors/co-sponsors specialist workshop courses for sugar industry researchers and advisors on topics as diverse as nutrient cycling/trash management, optimising nutrient management, basics of modeling, soil characterisation, analyses of productivity data, sodic soils, economics and farm management, rural sociology and irrigation modeling and extension. To date, more than 400 participants have been trained through CRC Sugar's 'train the trainer' short courses and specialist workshops.

The future

The challenges facing the sugar industry, especially in the area of innovation, to sustain international competitiveness require the research and development sector itself to adopt innovative approaches to its operations. To a large extent, the easy gains have been made, as illustrated by the long term difficulty in raising onfarm crop productivity above now high levels. CRC Sugar's research suggests there is a need for greater focus on opportunities for improving efficiency and competitiveness from a whole-of-industry rather than sectoral perspective — a view shared by the industry in the most recent industry prioritisation for research and development (SRDC 1999). Sustained effort is also required in relation to improved natural resource management, given that emergent community pressures of the past eight to ten years can be expected to only intensify in coming years.

A key issue is the extent to which the industry can consolidate and capitalise on its newly emergent research and development sector. The short to medium term funding outlook for industry research and development is somewhat pessimistic. Contestable funding for 2002–03 is projected to fall to less than half that available in

1999–2000 (figure 1). This will result in a substantial reduction in leveraged expenditure by nonindustry specific research and development providers such as the CSIRO, the universities and some state departments.

In something of a catch-22, the bid for a cooperative research centre for the Australian sugar industry commencing mid 2002 was not supported in the latest selection round of the cooperative research centre program, partly because the ratio of proposed participant expenditure to proposed Commonwealth expenditure was substantially less than the average 3.8:1 of the nineteen successful cooperative research centres. While CRC Sugar attracted a wider range of end user participants into the new bid, commercial realities constrained the bid contributions of individual companies. Meanwhile, the projected reduction in contestable levy funds constrained the capacity of the Sugar Research and Development Corporation to raise its contribution and, no doubt, influenced the leverage that individual research and development providers were prepared to consider. Ironically, the failure of the industry to secure ongoing cooperative research centre funding exacerbates the circumstances that precluded a more competitive bid in the first place (figure 1).

Note: Since this paper was drafted, the Federal Government announced an extension of the term of CRC Sugar to 2003 to enable the sugar industry to develop a proposal to compete in the 2002 program selection round. The government's decision reflected an acknowledgement of the value of the innovative research and development approach that CRC Sugar has taken. The clear challenge for the industry and its research and development providers is to develop a competitive proposal for a replacement cooperative research centre, given the economic circumstances and the research and development funding environment projected to persist into the near future.

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Bob Lawn has been Foundation Professor of Tropical Crop Science at James Cook University since 1995, as well as chief executive officer of the CRC for Sustainable Sugar Production (CRC Sugar).

Professor Lawn's main current research interest is sustainable sugar production, improving the productivity and sustainability of tropical crops, especially sugarcane.

From 1973 to 1994 Professor Lawn worked in various research positions at the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Division of Tropical Crops and Pastures, where his main research focus was on tropical grain legume improvement. His research contributed to the establishment of soybeans and then mungbeans as commercial crops in Australia.

Professor Lawn chaired the joint working party that secured the Commonwealth CRC Program cash support of \$14.256 million, industry in-kind support of \$11.4 million, Sugar Research and Development Corporation cash and project support of \$4.2 million, and Queensland and New South Wales government cash support of \$160 000 to set up CRC Sugar.

Professor Lawn is the author/co-author of over 220 scientific papers, books and articles on various aspects of crop science, crop improvement and sustainable crop production. He was awarded the Australian Medal of Agricultural Science in 1992, and is a fellow of the Institute of Biology and the Australian Institute of Agricultural Science and Technology.

Professor Lawn has a master of agricultural science from Queensland and a PhD from Minnesota.