

SRA RECOMMENDED SUGAR MILLING RESEARCH PROGRAM

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1. Project Overview

Findings from this project will assist Sugar Research Australia (SRA) design a strategic milling research program for Key Focus Area 5 (KFA 5) under the SRA Strategic Plan 2017-2022. The project findings guide the short (2 years), medium (5 years) and long-term (10 years) investment priorities for RD&A and for development of both industry and research capability.

The overall scope of the project covered the supply chain from cane delivery/siding through to the final product at the mill. Inclusion for transport to port, and for refining operations was allowed for, however, these were not raised as matters during this project by industry participants.

2. Methodology

This project used a multi-phase approach, including, in order:

- Project scope and direction provided by Project Steering Committee comprising of Gary Longden (Chair, SRA Research Funding Panel), David Green (GM, SRI), Jay Venning (GM, Production & Technology, Wilmar Sugar) and Dr Harjeet Khanna (GM, SRA-Research Funding Unit).
- Project contracted to Lazuli consulting (Eris O'Brien and Paul Benecke); SRA-Research Funding Unit engaged in the stakeholder consultations and workshops through Program Manager Stephen Mudge.
- Consultation with the leadership of milling organisations to develop the basic themes for focus or research, as well as to understand the inclusions and exclusions of scope.
- A full day workshop with researchers from multiple institutions to document their views on the future of sugar milling and research.
- Five full day technical workshops with industry representatives, held in Cairns, Townsville, Mackay, Condong and Bundaberg. Participants were asked their views on potential research projects, how research has worked well, what the future of milling is, and industry constraints. Participants were also introduced to the outcomes of the researcher workshop to add good projects to the list and then vote on the whole list.
- Top industry priority projects were identified through the analysis of the 273 recommended projects with prioritisation based on votes from industry participants, normalised for the number of participants at each workshop and the percentage of cane crushed by each organisation.
- The draft list of top industry priority projects was taken back to the mill leadership for a commercial overview. Based on this, the final industry priority list was presented to the project Steering Committee for commentary and input.
- Program logic developed by Colere Consulting (Paul Meibusch and Lyndal Hasselman).
- The recommended milling research program and priority projects were then finalised as a report and presented to SRA Board.
- A summarised version of the report was developed for public release.

3. Recommended Milling Research Program

The following are the six recommended programs for KFA 5, Milling efficiency and technology

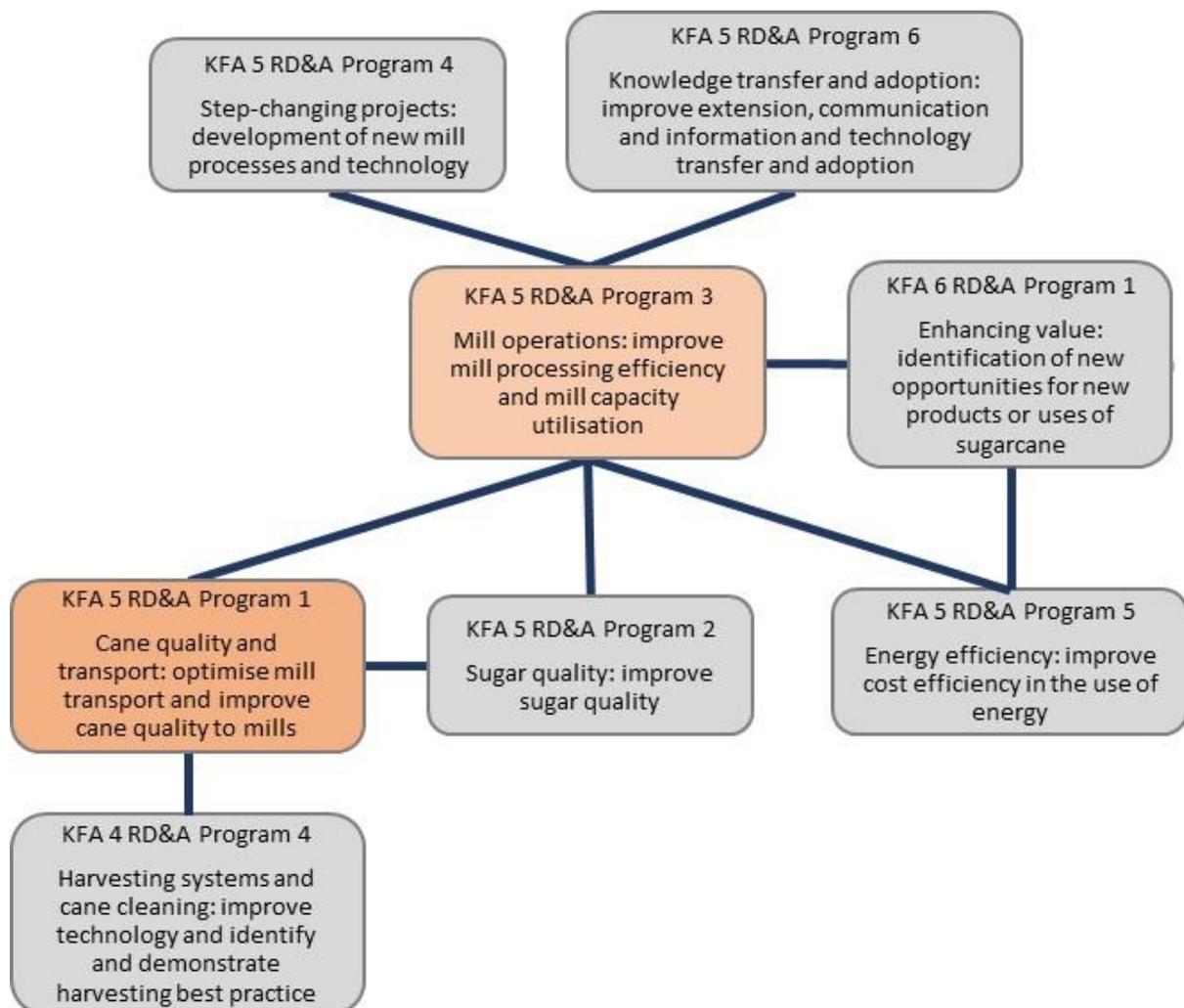
KFA 5 RD&A Program 1: Cane quality and transport	Optimise mill transport and improve cane quality to mills
KFA 5 RD&A Program 2: Sugar quality	Improve sugar quality
KFA 5 RD&A Program 3: Mill operations	Improve mill processing efficiency and mill capacity utilisation
KFA 5 RD&A Program 4: Step-changing projects	Development of new mill processes and technology
KFA 5 RD&A Program 5: Energy Efficiency	Improve cost efficiency in the use of energy
KFA 5 RD&A Program 6: Knowledge transfer and adoption	Improve extension, communication and information and technology transfer and adoption

The six programs recommended represent the key categories of research. It should be noted that the focus in any given year will depend on the priority project list plus insights on emerging issues and developing knowledge.

The current industry priority projects show the top two area of focus as improving cane transport (Program 1: Cane quality and transport), followed by longer lived materials (Program 3: Mill operations).

The following diagram also shows key linkages between the RD&A Programs in KFA 5, and with KFA 4 (harvest) and 6 (value add and diversification).

LINKAGES BETWEEN SRA'S STRATEGIC PLAN RD&A PROGRAMS RELATED TO MILLING



LOGIC OF THE MILLING RESEARCH PROGRAM

A monitoring and evaluation plan structured around a program logic has been developed for the milling program. The logic has identified the shorter-, medium-, and longer-term desired outcomes from investment in milling RD&A.

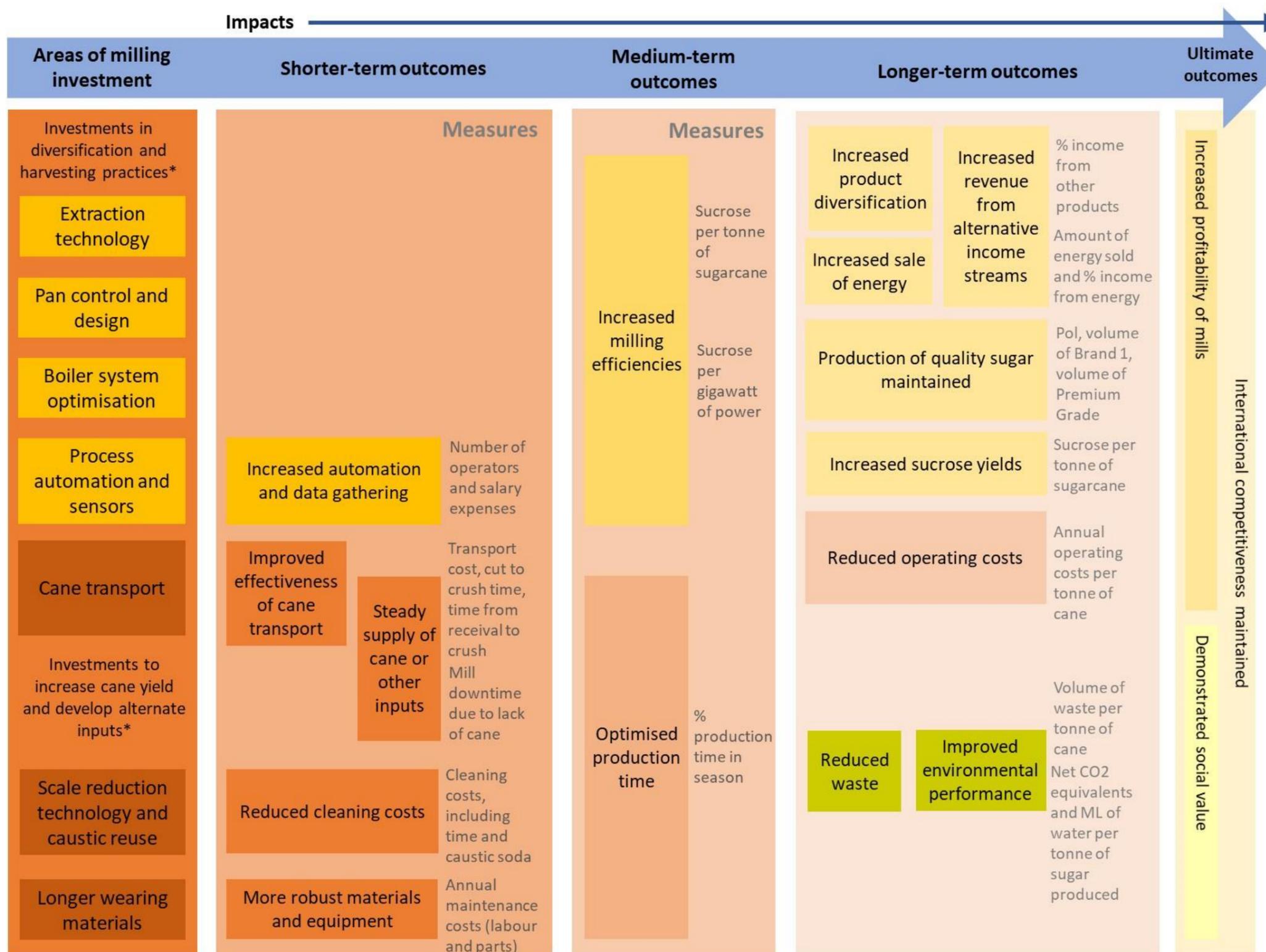
There are relationships and important detailed attributes of each of these outcomes that are not possible to show in this summarized stylized diagram. For example, it is expected that increasing milling efficiencies will also lead to an improvement in environmental performance. For milling efficiencies to be considered successful, other attributes such as this will also need to be met. These details are included as success attributes in the supporting program logic table provided in the monitoring and evaluation plan for the milling program.

Overall, the logic has a strong focus on increased milling efficiencies, as reflective of industry consultation. The dominance of this outcome in the logic may prove problematic in the future. There is high risk associated with such dominance. If efficiency gains are not possible, or only manageable in incremental levels, according to this logic there are few alternative pathways to increasing profitability. SRA will provide leadership to encourage development of an innovation culture in milling sector. SRA's milling program strategy will also encourage transformational research projects.

According to the logic, the ultimate outcome is to maintain international competitiveness, and this is expected to occur primarily through profitability.

Social value and environmental performance are expected to have lesser impact, with the pathway to these outcomes based on reducing waste.

Energy use has not been identified as having a major relationship to environmental performance. The main driver for any change to energy use is revenue and profit, as opposed to market access.



* Investments outside of milling that contribute to desired milling outcomes

4. Priority Projects

4.1 Enabling Matters

Discussions with industry participants and others highlighted the need for the following activities to guide and assist the milling companies for the delivery of KFA5.

1. Summary of prior work
2. Technology watch
3. Economic analysis

The first two activities are designed to address the industry challenges and constraints around the shrinking workforce and loss of knowledge as technical experts retire. The economic analysis is to guide the assessment of potential research investment concepts to promote economic return on investment.

4.2 Top 15 Priority Project Categories

The following top 15 project categories are listed in order of industry priority, determined through the workshops.

Cane transport was the highest priority by a large margin, followed by longer wearing material, which was also a large margin ahead of the remainder. Process automation (no. 3) through to standardisation (no. 10) were in a similar band of vote values, and the lowest five were also in a similar but lower band of voting values.

TOP 15 PRIORITY PROJECTS

	Project Category	Research	Development	Years	Annual Benefit Estimate	SRA Program Linkage
1	Cane transport – efficiency – locomotives	✓	✓	2-5 5-10	\$31 m	1. Cane Quality & Transport
2	Longer wearing material	✓		2-5	\$4 - 20 m	3. Mill Operations
3	Process automation		✓	5-10	\$1 - 15 m	3. Mill Operations
4	Process troubleshooting		✓	2-5	\$1 - 7 m	6. Knowledge Transfer & Adoption
5	Improved online sensors		✓	2-5	\$1 – 15 m	3. Mill Operations
6	Milling/extraction technology	✓		5-10	\$22 m	4. Step Changing Projects 3. Mill Operations
7	Pan control & design	✓		2-5	\$1 – 7 m	3. Mill Operations
8	Knowledge retention		✓	2-5		6. Knowledge Transfer & Adoption
9	Caustic reuse	✓		2	\$0.1 – 1 m	3. Mill Operations
10	Standardisation		✓	2		6. Knowledge Transfer & Adoption
11	Live process model	✓		5-10	\$1 – 7 m	3. Mill Operations
12	Boiler system optimisation	✓		2-5	\$1 – 6 m	5. Energy Efficiency 3. Mill Operations
13	Cane quality – cane cleaning – extraneous matter	✓	✓	5-10 2-5	\$2 - 22 m	1. Cane Quality & Transport 3. Mill Operations 4. Step Changing Projects
14	Training		✓	2		6. Knowledge Transfer & Adoption
15	Adoption			2		6. Knowledge Transfer & Adoption Out of scope

Note: The Annual Benefit Estimate is indicative only and has been developed by experienced professionals familiar with sugar milling costs as guidance to the potential benefits. When specific projects are submitted for funding, it is expected that they would be subjected to a more rigorous economic analysis.

4.3 Proposed milling research Investment Areas

These top project categories were then given a commercial overlay by the millers, with additional commentary from the Research Funding Panel and the project Steering Committee.

The top 15 industry priority projects were subject to detailed analysis. The actual issues to be solved and the potential research questions were identified.

From this list of 15 projects categories, four main themes emerged, under which most of the top 15 projects could be organised.

A summary of the root issues and research questions is shown in the following table.

THE FOUR MAIN THEMES FOR RESEARCH

Theme	Root issues	Solutions
Rail transport	<ul style="list-style-type: none"> Imprecise prioritisation of line, bridge and culvert maintenance. High fuel and labour costs for locomotive operations. Best utilisation of assets through scheduling – better information required on bin utilisation. Better identification of faulty bins. Paper form based system for consignment of cane. 	<ul style="list-style-type: none"> Onboard sensors to detect track condition – linked with GPS/GIS systems for prioritization. Hybrid power trains to provide battery power for AC's and reduce engine wear and tear. Smart locos – to reduce manning costs. Remote operations of locos in shunting yards. Hot axle box detectors linked with bin RFID identification. RFID/GPS tags on bins – with readers at mill able to cope with electrical interference with antennas near tipper. Electronic consignment of cane when loading – RFID tag linkages with reliable and auditable records and a robust RFID reader. or other technologies such as character recognition.
Longer wearing materials	<ul style="list-style-type: none"> Milling train erosion Corrosion in vessels, pipes and floors. Use of different materials for vessels and pipes. 	<ul style="list-style-type: none"> Development and trials of coatings for rollers. Development and trials of different materials for roller construction. Characterisation and testing of corrosion and erosion. Use of pipe liners, coatings and additives to reduce corrosion. Use of plastic piping, including supporting structures.
Process automation	<ul style="list-style-type: none"> High labour costs Variable performance Training shortfalls 	<ul style="list-style-type: none"> Improved online sensors Live process models to help maintain optimum yields. Continuous pan control, batch pan control and overall station control (batch pan sequencing, etc.) Other industry 4.0
Loss of knowledge	<ul style="list-style-type: none"> Loss of experienced people High turnover Loss of training Difficulty in attracting young people to the sugar industry Low staffing levels 	<ul style="list-style-type: none"> Capture knowledge in engineering/operations manual (reference) Produce training material – multi-format – for operators, supervisors and engineers. Entrain knowledge in equipment automation – capture the algorithms (Industry wide knowledge). Documenting prior research and identifying gaps.

5. Views of the leadership at milling organisations

Mill Leadership Priorities				
Industry Priority	Key Outcomes	Short-term QUICK PAYBACK LOW INVESTMENT COST BUILD ON EXISTING KNOWLEDGE RECORD EXISTING KNOWLEDGE SPREAD EXISTING KNOWLEDGE	Medium-term NOVEL TECHNOLOGIES ALTERNATIVE APPROACHES	Impact
PROCESS EFFICIENCY IMPROVEMENT	Incremental improvement to existing processes. Lower energy use. Improved environmental performance.	Incremental improvement to existing processes. Lower energy use. Improved environmental performance.	Live process models feeding back to decision-making. Optimised batch and continuous pan control incl. overall station control.	Improved yields at lower cost.
CANE & SUGAR LOGISTICS IMPROVEMENT	Optimize cane transport. Smart locomotives. Improved bin/truck handling systems.	Improved sensors to monitor rolling stock and track condition leading to improved performance. Remote operations for loco shunting. Electronic consignment of cane.	Hybrid power systems for locos. "Smart" locos.	Lower cost per tonne to transport cane and sugar
ENGINEERING IMPROVEMENTS	Better materials to reduce maintenance & future Capex. Longer-lived material. Strategies to reduce factory downtime.	Erosion/corrosion resistant rollers. Erosion/corrosion resistant vessels using coatings.	Alternative materials of construction of vessels, pipework, etc.	Lower OPEX per tonnes and Capex per tonne
TRAINING AND RETENTION	At operator level. At technologist level. At engineering level.	Library of current knowledge available to all. System to maintain the library.	Online training courses for operators, technologists and engineers. System to maintain currency of the training database.	Improved control over the process and lower fault recovery times. Competent personnel at all levels.
OTHER	Diversification & value-add	Out of Scope (part of KFA 6)	Out of Scope (part of KFA 6)	Increased revenues, alternate revenue streams, increased profits.

6. The mill of the future

Industry participants and researchers were asked to formulate what a brand new mill to be built in 2030 would be like. The concept was to obtain a view on what mills should be in order to help map a pathway for achieving that given the current state of sugar mills in Australia.

The following is a summary of the key aspects of the mill of the future, as defined by workshop participants.

VIEWS ON THE MILL OF THE FUTURE

OVERARCHING / ASSET MANAGEMENT	PROCESS EFFICIENCY
<ul style="list-style-type: none"> • Longer asset utilization (11 months) • Longer lived assets • Increased reliability • Built in redundancy • Reduced deterioration of factory plant and machinery • Better relationships between growers, harvesters and millers 	<ul style="list-style-type: none"> • High efficiency • Fully electrified • Air cooled crystallisers • Membrane technology • Online analytics • Continuous pan stage • Electric/hybrid trains • Lower energy consumption
AUTOMATION & OPTIMISATION	DIVERSIFICATION
<ul style="list-style-type: none"> • Real time scheduling • Predictive cane analysis & responsive factory • Single control room • Driverless locomotives • Automatic cane receipt & consignment • Simple design • Predictive maintenance 	<ul style="list-style-type: none"> • Multi-feedstock • Diversified products & revenues • Market responsive • Co-located/integrated with other industries to reduce electricity costs
ENVIRONMENT	OTHER
<ul style="list-style-type: none"> • Proximity to the Great Barrier Reef • Zero discharge – all waste returned to the field • Uses safe, environmentally friendly, robust & effective technology & knowledge 	<ul style="list-style-type: none"> • Cane cleaning (in-field or at mill) • 24 hour harvesting • Simulators for next generation driver training • New cane payment system • Training for all levels at the mill

7. Constraints/commercial issues facing the mills

The constraints facing industry are considerable, and the following summary are comments from across all groups highlighting the issues that are taken into account during decision making by sugar millers.

CONSTRAINTS/COMMERCIAL ISSUES

BUDGET	CANE AVAILABILITY
<ul style="list-style-type: none"> • Low sugar prices now and in future means there is a low budget for all areas of mills. • 2-3 year payback is preferred. 12 months is even better. • Need to demonstrate lower capital and operating costs over time. Replacing like with like at the mills will not change this. • High labour costs • The cane payment formula reflects mill processes from 100 years ago. 	<ul style="list-style-type: none"> • Losing land under cane to other crops and urban encroachment. The focus is now on filling the mill rather than equipment replacements or upgrades • Loss of yields as growers take second jobs. • Lack of 24 hour harvesting decreases efficiency. • Local and State government approval for b-Double trucks.
LOSS OF PEOPLE AND SKILLS	REGULATORY CHANGES
<ul style="list-style-type: none"> • Lean organisations – most companies have reduced their workforce to a core to produce sugar, outsourcing the rest. • Loss of knowledge – people are solving one problem and introducing old ones which had been forgotten. • There is no clear career path anymore. • People are working longer hours to compensate for a reduced maintenance budget. • The aging workforce affecting knowledge left in industry. • Need to attract, train and retain skilled people. This will also be true with increased automation. • Decreased number of suppliers to the industry. 	<ul style="list-style-type: none"> • Compliance with new standards costs money. • Great Barrier Reef legislation in Queensland.
ADOPTION	ELECTRICITY MARKET
<ul style="list-style-type: none"> • The industry is unlikely to be early adopters of new technologies. • Mill replacement occurs a bit at a time. • Existing mills have built themselves in and it is both hard and costly to access and replace parts. • Sugar mill processes are interdependent and should be modelled as such. • Some technologies are standard overseas but not yet adopted here. • International sugar industry advisors could provide help in Australia. E.g. the sugar beet industry has a much greater focus on reducing energy usage. 	<ul style="list-style-type: none"> • Electricity tariffs are out of touch with the market. Renewable energy has dropped daytime prices considerably. • Cogeneration requires long term contractual arrangements. • Constraints on access to the electricity grid are affecting the ability to export electricity.

8. Other Matters

8.1 Sustaining industry involvement

There was consistent agreement that the milling organisations needed to engage better with each other to assist SRA in their milling program for the future. Increasing and sustaining miller involvement seems to be a universally well regarded idea.

One of the key suggestions was for SRA to have a side session on those days that the annual SRA sponsored QUT/SRI roadshow occurred in the various regions during the non-crush season. This option was widely discussed as it is an event that key milling industry representatives already attend. This also dovetailed with the potential need for regional target setting. For example, the Maryborough and Bundaberg regions are losing land under cane and have lower rainfall compared to their counterparts in the Burdekin.

8.2 Treatment of commercially sensitive information

At a CEO level the need for SRA to be commercial in its work with milling was well recognized. Milling organisations are now accustomed to the current data licence with SRA for sharing information on productivity and varieties, and it was suggested that a simpler version of this process and licence be used.

The key issue for the organisations is that the information is not shared outside of SRA.

8.3 Syndication

Syndication was well accepted as an option, with caveats around IP, likelihood of participation given current low sugar prices, and the need for mechanisms to ensure that syndicated work won't reduce any milling expertise or work at SRA under the levy.

8.4 Documenting lessons learned

Given that most initiatives will likely be mill-led and beyond the budget limits of SRA, the possibility for SRA having some limited scope, and then also documenting the journey of implementation/adoption of initiatives was discussed with the various milling organisations and largely well accepted. Caveats were that this would work for issues that benefit the majority of industry, but not for projects that with specific competitive advantage to a mill.

The idea was overall well accepted as there are many technologies in Europe, Asia and South America that could be adopted here and SRA documenting their adoption for the benefit of the industry could be of use.

8.5 eLibrary

How the eLibrary can be brought up to date was considered important by industry participants. There was a suggestion that access to the library could be restricted by:

- Geographic regions – with Australian company representatives have full access to reports upon login. The public and foreign nationals could have access to less restricted data.
- Role – access to information could be further restricted by role within an organisation.

9. Industry Feedback

SRA sought comment and feedback from the leadership of the milling organisations on the prioritised projects and program, as presented above. The key feedback provided was:

- a) Each milling organisation has different priorities. Consequently, there was an ongoing request of SRA to allow milling organisations to allocate some of their funding to their preferences.
- b) Promotion of the expansion of the Small Milling Research Program to tackle many of the applied research topics covered in the report.
- c) Encouragement for SRA to allocate more effort into 'blue sky' research on transforming sugar mills. This comment was provided as most of the research topics prioritised by industry participants in the workshops focussed on near to mid-term issues.
- d) Support was provided for ongoing consultation and 'ownership' of the research program as well as evaluation and reporting on progress. The Australian Sugar Milling Council (ASMC) suggested the establishment of a milling sector R&D taskforce – made up of representatives of the milling companies and the ASMC – to meet annually to discuss milling sector investment priorities in advance of finalising SRA's annual investment plan. To avoid duplication this group could also provide feedback on proposed small milling projects.
- e) Support was provided for the maintenance of a research library to facilitate adoption, and to ensure research is not repeated.



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