The weather plays an important role in determining sugarcane yield and production, but a research project currently underway is helping provide the industry with valuable information to improve productivity and profitability in all different seasonal situations.

This project, led by Dr Joanne Stringer, is using productivity data that is collected by milling companies to assist the industry to improve production, especially by developing innovative tools and methods of summarising the data.

We know there are productivity differences across most mill areas. Although some of this regional variation is explained by extreme weather events or disease incursions, this work has looked at the key drivers of productivity in different regions and is working to broaden the adoption of improved farm practices by working with local industry.

For example, the research project has looked at factors such as clean seed uptake, variety selection, ratooning length, Pachymetra sampling and levels of infection, and numerous others, while comparing these to yield and size of production.

It follows an earlier demonstration of the project in the Herbert region. The project is now moving to other regions of the Australian sugarcane industry, including most recently at regions such as the Burdekin and Tully.

A key finding was that tonnes of cane per hectare is not related to the size of the farm, or the sub-district where the farm is located.

Jo said that the research is working closely with productivity services groups in these regions to identify the best strategies for improving production, and to ensure extension strategies were targeted effectively.

“The findings have been different in different regions,” she said. “One of the big factors in the Herbert was that we identified the need to increase the uptake of clean seed.

“Through the work of Lawrence Di Bella and Herbert Cane Productivity Services Ltd (HCPSL), clean seed use went from about 800 tonne (per year) to about 2000 tonnes. HCPSL have recently bought another farm and harvester to continue to increase clean seed use.

“We also were able to talk to growers about losses from Pachymetra, with data showing a 15 percent decrease in cane yield when they used a susceptible variety in consecutive crop cycles.”

She said in the Burdekin her work with Burdekin Productivity Services identified the value of current research and extension activity into improving soil health. It also provided the local industry with valuable information about productivity losses associated with back-to-back planting of varieties.

For example, the research found that Q183\(^{36}\) followed by Q183\(^{37}\) in the Burdekin maintained yield, while planting KQ228\(^{38}\) after KQ228\(^{39}\) or planting Q208\(^{40}\) after Q208\(^{41}\) was associated with lower yields.

At Tully, Jo is working with Tully Cane Productivity Services Ltd Manager, Peter Sutherland, Tully Sugar Cane Productivity and Development Manager, Greg Shannon, and Tully CANEGROWERS Manager, Peter Lucy.

The project has worked with Tully industry to develop a tool to automate farm productivity reports that will provide valuable information to growers and also help inform extension strategies.

Greg said that it was another tool in the toolbox to ensure the region was delivering effective extension programs and that extension officers were providing the right advice.
NEW OPPORTUNITIES OPENING UP FOR NIR

Ross Threlfall, Steve Staunton and Michelle Larsen in front of the Micro NIR instruments attached to the number five mill at Tully. Data on display as captured by the Micro NIR, measuring moisture, pol and fibre every seven seconds.
Recent advances in near infra-red (NIR) instruments and technology are creating new opportunities for Australian sugar mills. One of these next generation NIR instruments – called a Micro NIR – fits into the palm of your hand and costs about one third of the price of its predecessor instruments.

This advance in instrumentation has prompted the Australian industry to investigate the possibilities for NIR analysis in new areas of sugar mills beyond the established applications such as cane payment.

The use of on-line NIR systems, including with support from SRA to analyse and interpret the data, is well-established in a number of Australian mills, with the technology demonstrating value by providing reliable data in real time. It also allows industry to collect data in situations where traditional methods are difficult or hazardous.

In a step forward, smaller instruments have the potential to fit into new areas of the mill, and their lower capital cost puts the technology within a more realistic cost bracket for other applications.

It is something that Tully Sugar Limited (TSL) have been keen to further understand. With the help of SRA, they have been testing two Micro NIR instruments attached to the Tully mill in recent seasons.

One of these instruments has a strong research focus and is being used to provide real-time feedback on mill-mud, via an SRA-funded research project.

The other instrument is attached to Tully’s number five mill and provides real-time and online feedback of bagasse, building on previous research where SRA worked with much-larger instruments to assess bagasse at the Mulgrave Mill.

“The real advance now is the instrumentation,” SRA’s Steve Staunton said. “With the Micro NIR being so compact, it opens up new opportunities. The older systems were also difficult to install and there were challenges around sample presentation and validation.

“With this instrument we are getting information of a similar quality, and it can be done for an investment in the machine of about $30,000.”

SRA provides expertise and support to ensure efficient use of the Micro NIR, and also ensures the data generated by the instrument is accurate and understandable.

TSL Operations Engineer, Ross Threlfall, said TSL was interested in the Micro NIR to see where it could enhance milling efficiency and consistency.

With the bagasse, for example, they were previously only measuring moisture content via moisture meter, whereas now the Micro NIR is providing moisture, pol and fibre every seven seconds.

“Currently bagasse quality analysis is performed by the laboratory, from samples taken over an eight hour shift. These results are only available on a daily basis,” Mr Threlfall said. “With online monitoring, control or mill adjustments can be made sooner rather than later to optimise milling extraction.

“Our boiler operators are able to confirm and potentially take action earlier, in response to high moisture bagasse being received at boilers.

“It also gives us the ability to take action such as adjusting the maceration settings, or trying things like cool maceration. We have trialled different maceration settings this year, and we are still learning what we can do with the instrument.”

The instrument has been attached directly to the exit chute of the mill and requires cooling due to the temperature of the bagasse (about 85 degrees Celsius or more). This is one of many issues that SRA has worked with TSL on during this season, to better understand how to best use the instrument in the tough environment of a sugar mill. There has also been a huge effort and collaboration with the TSL information technology team and engineering team.

In the future, the Micro NIR and supporting programming may also be able to gather valuable data on the full milling train to help minimise sugar loss through the mill, especially when used in conjunction with their existing NIR instrument looking at cane at the number one mill.

As they continue to look for new ways to use the data, Mr Threlfall said the Micro NIR would also allow TSL to calculate the calorific value of bagasse, which could then be correlated back to cane variety information. This could be useful for cogeneration by targeting particular bagasse for storage for use in the off-season.

SRA Key Focus Area Leader for Milling Efficiency and Technology, Mr Steve Staunton, said the instrument could capture a wealth of information, but the key was using this data in a way to create a benefit.

“A good approach is to go for the low hanging fruit,” he said. “With the bagasse, TSL are using it to help ensure consistency for the boilers, as we know that consistency is really important for mill performance.

“Optimising rather than maximising maceration would deliver advantages.”

However, there are other opportunities that are also being considered. One of the “fruits” higher up the tree has seen SRA work with TSL engineers and boilermakers to attach a Micro NIR to the mud hopper to determine the nutrient content of the mud.

(Continued over page)
Mr Staunton said they had worked across the 2019 season to reach a point where they could gather 12-13,000 scans per day of mud moving through the hopper and then analyse these scans to understand the mud’s nutrient content.

“We are aiming for a point where we can relate those scans to individual trucks that are leaving the mill,” Mr Staunton said.

“Mud is a valuable nutrient source for the industry and this research project recognises that quantifying the nutrients in mud may be a key factor in maintaining its availability in the future.”

Mr Staunton said the project was also doing laboratory work to determine the total extractable N in the mud, which will be valuable for growers to ensure they were following the SIX EASY STEPS nutrient management guidelines, and neither under-fertilising nor over-fertilising.

This data offers advantages to both growers and millers, and may be useful for the industry to continue to demonstrate its strong adherence to best management practices.

The research has also discovered that it could be possible to understand sucrose losses leaving the mill via the mud.

“If we can provide this information in real time, we can then look at better controlling the conditions that contribute to sucrose loss,” Mr Staunton said.

Michelle Larsen with TSL said that the Micro NIR was creating new fields of research and allowing the mill to capture and use more data.

“The instrument has attracted a lot of interest within departments here at Tully Sugar and we think it is going to be very beneficial. It is exciting where it could go,” she said.

Contact Steve Staunton on sstaunton@sugarresearch.com.au or 07 4056 4502.
The SRA Milling Webinars series provides milling staff and other industry stakeholders with the opportunity to learn more about milling research topics and projects, discuss the information being presented and provide input and feedback. The series allows attendees from any cane growing region to participate without the need to travel – right from the desk in your office.

Every webinar is recorded and hosted on the SRA website to allow those who couldn’t participate on the day to watch it later or, for those who did participate, to view it again.

To join our webinars, you will need stable internet connection, headphones or speakers if you want to listen over the internet, or a telephone (if you plan to listen via teleconference).

The program for 2020 is being finalised. If you would like to receive email invitations for our webinar series, simply click ‘Subscribe to Updates’ on the home page of our website sugarresearch.com.au and select the Milling Webinars option.

2019 WEBINARS
(RECORDED AND AVAILABLE TO VIEW ONLINE)

WEBINAR ONE - Increasing capacity to undertake cane preparation research through modelling and experimentation, presented by Dr Anthony Mann from Queensland University of Technology.

WEBINAR TWO - Australian Research Council project with Wilmar on the subject of Asset Management, presented by Dr Michael Cholette, Queensland University of Technology.

WEBINAR THREE - Integrated standardised competency based training for Sugar Milling operations, presented by David Moller, Queensland University of Technology and Bruce King, Sugar Research Institute.

WEBINAR FOUR - Online analysis systems to measure the available nutrients in mill mud, presented by Heidi du Clou, Sugar Research Australia.
SRA has recently partnered with millers and research providers to deliver the Small Milling Research Project (SMRP) investment scheme. The scheme is an opportunity to invest in lower-cost, short-term, industry-identified and preferably industry-led research.

The investment is included in SRA’s current total investment in SRA’s Key Focus Area (KFA) of Milling Efficiency and Technology.

The following is a summary of the first round of projects that have been completed through the scheme.

**PROJECT NAME:** ACTIVATED SLUDGE PLANTS – OPTIMISING OPERATIONS AND TECHNOLOGY

**RESEARCH PROVIDERS:** WILMAR SUGAR AUSTRALIA AND HUNTER H2O

Treating and managing wastewater is a critical issue for the milling sector of the Australian sugarcane industry. Mills operate under strict requirements for discharging water, and there is a range of processes and technology deployed across the industry to ensure sugar mills meet their requirements.

At four Australian sugar mills, Activated Sludge Plants (ASPs) are used as part of the process of managing wastewater, although many other mills use systems that store effluent in ponds for passive treatment.

Through this project, Wilmar Sugar Australia worked with Hunter H2O to analyse ASP loading from the Macknade Mill and the quality of water within the plant, along with final effluent quality as it was being discharged.

A series of tests was performed to identify a suitable flocculant (and coagulant) for treating mill wastewater. Flocculant dosing over short periods (several hours) was implemented to determine the effect on final effluent quality.

Their focus was mainly on turbidity as a primary indicator which could be monitored online and verified by external laboratory analysis of suspended solids and biochemical oxygen demand. The study showed that significant improvements in final effluent quality could still be achieved when the activated sludge plant was running without effective primary anaerobic treatment and relying almost solely on mechanical aeration.

Hunter H2O identified that there is the potential for improved treatment performance through better control of dissolved oxygen, pH, nutrient application rates and sludge age. It was also identified that a number of trace elements may enhance the operation of activated sludge plants, and could be explored in future research.

The research team identified that flocculant and coagulant dosing systems provide potential enhancement to ASP operations.

Although relatively few sites operate activated sludge plants, there are still many plants with alternate effluent treatment systems in operation or sites that simply generate and store effluent in...
The research found that sugar mills efficiency with Robert type evaporators evaporator condenser. This study also investigated the feeding of small quantities of caustic soda into the calandria to next effect calandria and steam efficient factories leading to increased corrosion and poor performance of evaporator stations. Several steam efficient Australian factories experience significant problems with corrosion at the evaporator station. Part of the problem is due to management of incondensible gases and acidic condensates which results in the severe corrosion of pipes, valves and tubes. There can also be poor heat transfer at the evaporators. If not controlled, overall factory performance decreases. Leaking pipes also pose significant burn hazards to factory personnel. The main operational issue is the premature failure of these major items of plant.

Having experienced this problem at Racecourse Mill, Mackay Sugar and the research team investigated, at full scale, the influence on condensate pH from passing incondensible (NOX) gases through two pathways in an evaporator set comprising Robert type evaporator vessels. These were, namely, from calandria to next effect calandria and the path from each calandria to the evaporator condenser. This study also investigated, at full scale, the feeding of small quantities of caustic soda into primary juice to mitigate pH changes of both condensate and juice in the evaporators.

The research found that sugar mills configured for cogeneration and steam efficiency with Robert type evaporators have increased residence times of juice at higher temperatures than factories that are steam inefficient. Increased sugar degradation occurs in these steam efficient factories leading to the formation of increased levels of acidic compounds in the juice and in the vapour. The study has highlighted the problem of increased sugar losses leading to increased corrosion and poor performance of evaporator stations.

**PROJECT NAME:** UNDERSTANDING THE CAUSES OF HIGH COLOUR SUGAR

**RESEARCH PROVIDERS:** WILMAR SUGAR AUSTRALIA AND QUEENSLAND UNIVERSITY OF TECHNOLOGY

This project sought to better understand the relationship between cane quality and sugar colour, particularly in relation to extraneous matter. The project was a collaboration between Wilmar Sugar and the Queensland University of Technology, with investigations occurring at three mills during the 2018 season.

The key message from this project is that the colour of refined sugar can vary substantially during the season and increase to levels that are problematic for refiners. It is likely that mills are unaware that this may be occurring from time to time.

As boiling practices are basically consistent through the season for each mill, the change in the partitioning of the impurities is attributed to changes in specific (unknown) impurities in the cane supply. It is not known whether these changes are in the composition or concentration of the impurities but most likely the changes are associated with the extraneous matter in the cane supply.

It was also shown that variations in boiling practices can also contribute to the higher partitioning of colour into the crystals and affect the ease of removal of colour from raw sugar during washing of shipment sugar in the batch fuggals. The final report from this project is confidential to the Australian sugarcane industry. To discuss the final report, please contact the SRA Research Funding Unit on fundingunit@sugarresearch.com.au or 07 3331 3333.

The main determination from the project is that the colour transducer can be used successfully to automatically control the purity of the C sugar produced by individual massecuite fuggals. In undertaking this control the magnitude of the sucrose loss to final molasses is also controlled indirectly. Thus, by use of the colour transducer for automatic control of the process variables (e.g., water addition rate, motor load) to maintain a consistent output of C sugar at the target purity, tighter control of impurities recycled to the pan stage and sucrose losses in final molasses can be achieved.

**PROJECT NAME:** EVALUATION OF THE NELTEC COLOUR Q FOR MEASURING THE PURITY OF MAGMA FROM C CENTRIFUGALS

**RESEARCH PROVIDERS:** ISIS CENTRAL SUGAR MILL, QUT, AND NELTEC

In Australian sugar mills, one person typically manages the high grade fuggaling, sugar drying and low grade (C) fuggaling stations. The C fuggals are managed least effectively as there is no process instrumentation to monitor on-line C sugar purity or final molasses purity. Conditions can change rapidly in the C fuggals without the operator being aware and poor performance can persist for several hours. Tight control of the C sugar purity is important to avoid high sucrose losses to final molasses or an excessive recycle of impurities in the C sugar to the pan stage.

For the 2017 season Isis Mill purchased a Neltec ColourQ 1700CC transducer, which had been recently released on the market to measure the colour, for measurement of the total C sugar magma production of the station. The transducer proved effective for the operators to pragmatically achieve tighter control of the purity of the C sugar magma.

For the 2018 season Isis Mill purchased a ColourQ 1700CC transducer to monitor the colour of the C sugar on the screen within their large capacity fugal.

Through this project, the research team conducted extensive testing of the transducer mounted on the fugal and the use of the transducer to assist operators achieve tighter control of the magma purity was conducted. The experiences with the use of the transducer on the magma screw for monitoring the purity of the total C magma production from the station were also assessed.

The main determination from the project is that the colour transducer can be used successfully to automatically control the purity of the C sugar produced by individual massecuite fuggals. In undertaking this control the magnitude of the sucrose loss to final molasses is also controlled indirectly. Thus, by use of the colour transducer for automatic control of the process variables (e.g., water addition rate, motor load) to maintain a consistent output of C sugar at the target purity, tighter control of impurities recycled to the pan stage and sucrose losses in final molasses can be achieved.

For more information on these projects, visit the SRA elibrary via sugarresearch.com.au or contact the SRA Research Funding Unit via fundingunit@sugarresearch.com.au or 07 3331 3333.
INCREASING TECHNOLOGY & INNOVATION CAPABILITY IN THE MILLING SECTOR

A CAPABILITY INVESTMENT SCHEME THAT IS A JOINT INVESTMENT BY SUGAR RESEARCH AUSTRALIA (SRA), THE SUGAR RESEARCH INSTITUTE (SRI) AND QUEENSLAND UNIVERSITY OF TECHNOLOGY (QUT) IS PROVIDING THREE RESEARCHERS AN OPPORTUNITY TO BUILD INDUSTRY MILLING RESEARCH CAPACITY BY WORKING WITHIN THE QUT CENTRE FOR TROPICAL CROPS AND BIOCOMMODITIES.
Milling Matters recently met with Dr Changrong Shi and Dr Ehsan Arzaghi who are two of the participants within the milling sector capability building initiative by SRA, SRI and QUT.

Dr Changrong Shi is a postdoctoral research fellow, investigating projects related to sugar manufacturing and she is being mentored by Professor William Doherty.

Dr Shi has a BSc Degree in Applied Chemistry from Huangshan University in Anhui, China. She then went to Guangxi University in Southwest China, which is where most of the country’s sugarcane is grown, to do a Masters of Sugar Engineering, with particular interest in the chemistry of sugar manufacture. Her PhD focused on membrane filtration of sugarcane juice with emphasis on the fouling mechanisms of the filtration process. She also examined options to find value for the retentate.

Dr Shi is currently working on two projects with Professor Doherty. The first relates to studying sugar degradation at the milling stage, and the second project is the development of calcium phosphate-based nanoparticles as a clarifying agent to significantly improve juice clarification efficiency. This will be achieved through the enhanced removal of both soluble and insoluble impurities, as the traditional clarification process is not very effective to remove these impurities.

We also met with Dr Ehsan Arzaghi who is being mentored at the Centre for Tropical Crops and Biocommodities by Dr Geoff Kent.

Dr Arzaghi has a Bachelor’s Degree of Mechanical Engineering, Masters in Fluid Mechanics and Maritime Engineering and a Graduate Certificate in Management and Logistics. Dr Arzaghi’s PhD research was on asset integrity management of large infrastructures which he completed in 2018. He then spent a year conducting postdoctoral research at Delft University of Technology in the Netherlands where he investigated methods for uncertainty reduction and decision making with regard to the operation and maintenance of offshore wind farms. Dr Arzaghi has a personal research interest in making assets utilised in different industries to operate more efficiently and safely. While he has worked at improving reliability and availability of renewable energy technologies, he is particularly interested in making the exploitation and usage of conventional resources safer, not only for humans but also for the environment.

Dr Arzaghi has spent three weeks running an experiment at the Isis Central Mill which allowed him to learn about sugarcane milling processes. He has also spent time with the mill staff with regard to the problems that relate to his own expertise including deterioration of crystallisation pans. Dr Arzaghi said he looks forward to helping the milling sector become more efficient through reducing mill downtime.

Dr Arzaghi is currently working on three projects at QUT. One of them is related to improving cane feeding at the beginning of the milling process by investigating the application of feeder rolls on shredders. He is planning to conduct some experimentation work with MSF Sugar at their Tableland Mill in 2020.

The second project follows on from SRA-funded research on achieving a better understanding of the millability of various cane varieties. This includes strategies to improve the processing of existing varieties that have posed some challenges for milling.

The third project relates to the economics of mill roll shell maintenance and is part of a larger SRA-funded project to identify ways to reduce the cost of roll shell maintenance and eliminate roll arcing.

Dr Harjeet Khanna, General Manager, Research Funding Unit, SRA, said: “The investment from SRA, SRI and QUT will span across five years. It is recognition of the importance of building and maintaining research capability for the milling sector.”

This investment scheme captures mentoring as one of the modes of transfer of discipline knowledge and intellectual capital. It gives new industry entrants the hard skills they need to succeed in their current roles and prepare them to assume more advanced responsibilities over time. It is therefore also a mechanism to ensure good succession planning where senior professional staff pass on the experience-based knowledge they have acquired over the course of their careers to the early and mid-career professionals who ultimately will take over from them.
### TOTAL RESEARCH AND DEVELOPMENT INVESTMENT

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